Hessler Associates, Inc.
Consultants in Engineering Acoustics

3862 Clifton Manor Place
Suite B
Haymarket, Virginia 20169 USA
Phone: 703-753-1602
Fax: 703-753-1522
Website: www.hesslernoise.com

Report Number 121106-1
Baseline Environmental Noise Survey
Leaf-off Season

Calvert Cliffs Nuclear Power (CCNPP) Expansion Project
December 2006

Prepared For:

AREVA NP Inc.
400 Donald Blvd.
Marlborough, MA 01752

Prepared By:
Hessler Associates, Inc.
Consultants in Engineering Acoustics

Principal Consultant:
George F. Hessler Jr., P.E., Bd. Cert. INCE

Table of Contents
Report 121106-1

List of Figures and Tables

Figures

Tables

Appendix

1.0_Introduction

Hessler Associates has been contracted by AREVA NP, Inc. to conduct a baseline environmental noise level measurement survey in the surrounding environs at the existing Calvert Cliffs Nuclear Power Plant (CCNPP) located near the town of Lusby in Calvert County, Maryland. The survey results are required environmental information for an application to expand the existing plant by adding a third generation unit.

Ambient or existing environmental community noise levels were to be measured over at least a 24 hour period during leaf-off seasonal conditions. Any noise emissions from the existing plant would be highest due to the lack of tree leaf noise reduction over the large buffer distances. Ideally, environmental levels should be measured during quiescent or calm and still weather conditions when minimum levels occur to provide the most conservative baseline[1]. Baseline residual levels measured under these conditions provide always-present masking noise for evaluation of any new predicted emissions.

Levels at the closest potentially sensitive receptors are used as existing conditions to assess any potential noise impact from the plant expansion. Typical receptors of concern are residential units, hospitals and houses of worship. In this case, bald eagle nesting sites on the plant grounds were also a consideration.

2.0_ Executive Summary and Results

Environmental sound levels were measured continuously at eight carefully chosen locations over a 45 hour period from noon on Monday, November 20th through 10 a.m. on Wednesday, November 22, 2006. Wind speeds for the first 24 hours of the survey were low but gradually increased with an approaching unpredicted wind and rain storm that caused the termination of the planned 48 hour survey at 45 hours.

LOCATION	MINIMUM L_{90} (1)	AVERAGE DAYTIME L_{90} (2)	24 HR DNL (3)	24 HR DNL (4)
P1	N/A	N/A	65	65
N1	34	44	55	56
W1	30	40	49	52
W2	37	56	65	66
W3	33	46	59	60
S1	31	43	49	51
S2	30	39	49	51
S3	33	44	53	55

Notes:
1. Minimum measured hourly L_{90} over 45 hour sampling period.
2. Arithmetic average of the measured hourly L90 for the 28 hours from 7 a.m. to 10 p.m.
3. Calculated for 24 hours from noon 11/20/06 to noon 11/21/06 with lowest wind speed, nearly calm & still.
4. Calculated for 24 hours of 11/21/06 with increasing wind speed.

Table 2.0.1: *Table of measured A-weighted sound levels in the metrics commonly used to assess noise level impact.*

Table 2.0.1 tabulates the major survey results giving a tabulation of L_{90} residual and the Day/Night average (DNL) sound levels at all locations in each of the metrics most commonly used for assessing noise impact. See Section 7.0 for a discussion of assessment metrics.

Locations P1 through S3 are illustrated on *Figure 2.0.1* that follows the text portion of this report. There are single family residences at the locations N1 through S3, which are representative of the closest potentially sensitive receptors in all directions from the plant site.

Figure 2.0.2 below plots the hourly residual sound levels at the residential locations for the survey period. Notice that levels tend to follow increasing wind speed. This is not due to any wind effects on the microphone protected by an appropriate windscreen, but simply because higher tree branch and grass movement sounds are created at all of the heavily wooded locations.

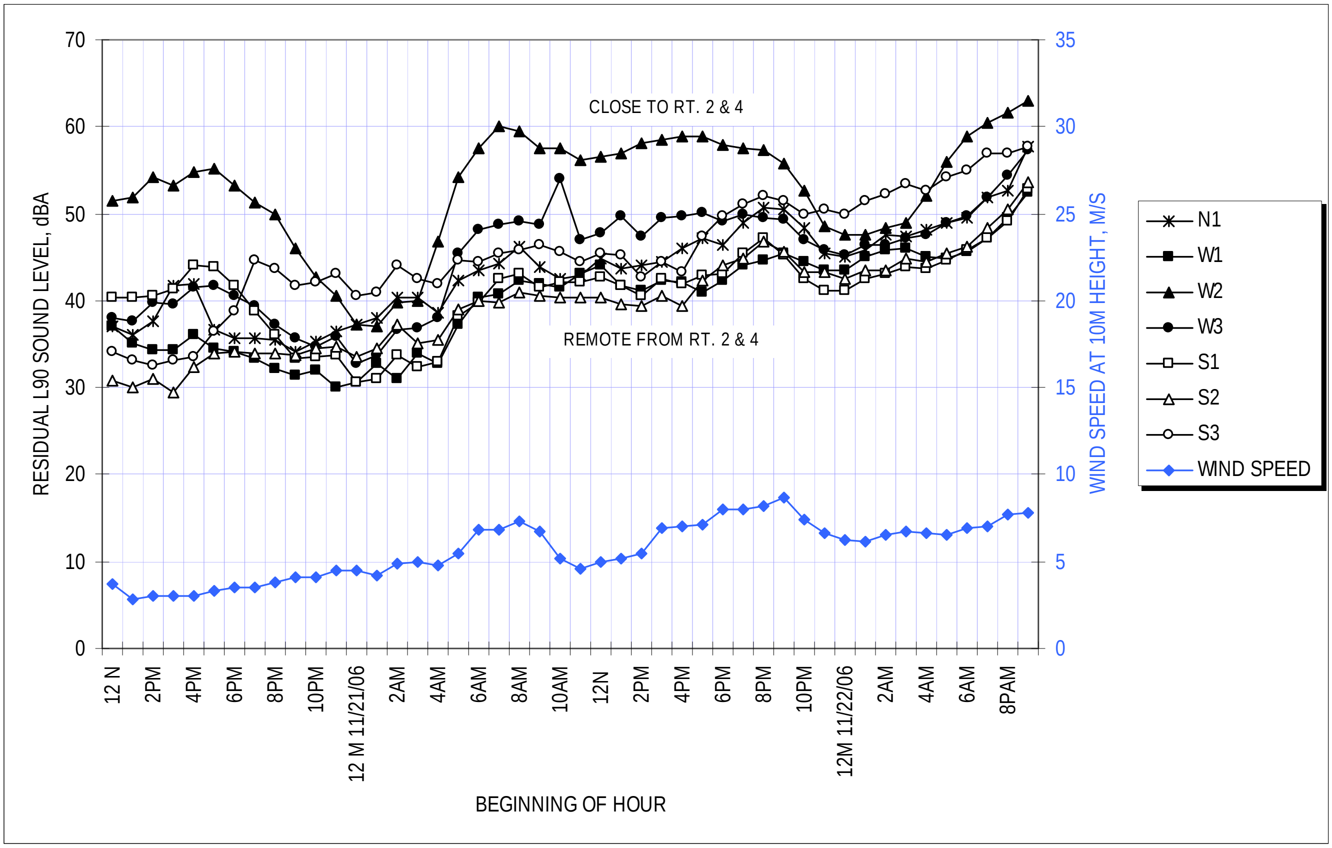


Figure 2.0.2: *Measured hourly residual level at potentially sensitive receptors surrounding the CCNP.*

The measurements and observations document the fact that the major environmental noise source in the area is the four-lane State highway 2 & 4 that can be heard and measured at all locations except for the ones most remote from the roadway.

There was no observed audible plant noise from the existing facility at any of the locations day or night although units 1 and 2 were operating continuously.

3.0_Conclusions and Recommendations

Actual daily sound levels could increase significantly over the levels reported above during less calm conditions, and possibly could decrease slightly during exceptionally "dead" calm and still conditions. The completed survey results document existing conditions for a typical and representative day during the leaf-off season.

During leaf-on season, fully leafed trees would attenuate or reduce traffic noise from route 2 & 4 and any existing plant emissions, both factors tending to decrease residual levels. Offsetting these factors, leaf-on conditions create higher natural foliage sounds, and other sound sources increase in the leaf-on season. Since receptors are outdoors more often during leaf-on seasons, we recommend an identical survey be conducted in the June to August timeframe.

4.0_ Definitions and Background Information

Units and Discussion of Sound Levels

The universal measure of noise in decibels used throughout the world is the A-weighted sound level, abbreviated dB(A) or dBA. The overall sound level is defined as the summed level in decibels over the entire *audible* frequency range (for young adults) of approximately 20 to 20,000 cycles/second (Hertz). The A-weighted sound level is a convenient single number to quantify the entire spectrum of a sound. A-weighting is an electronic filter applied to the spectrum that reshapes the spectrum to simulate human hearing response to frequency content. Lower frequency sound is subtracted by the A-weighting filter since humans perceive higher frequencies easier than lower notes. The reshaped or weighted new spectrum is summed over the same audible frequency span and is called the overall A-weighted level. Thus, the A-weighted sound level becomes an excellent single number descriptor for audible sounds.

Reference [2] is an informative and a more detailed reference source for definitions and units used in this report.

Table 4.0.1 below is a scale of common sound levels that have similar character to the sounds created by a well designed power plant and many industrial facilities. These data come from the author's files over many years. All of the sounds are broadband, meaning the spectrum is smooth without sharp peaks or tonal noise. Examples of broadband noise are slow speed airflow from HVAC ducting, rushing water, tree leaf rustling and traffic noise without truck diesel tones. More irritating non-broadband tonal noise examples are an alarm clock, siren, diesel engine or digital alert tone.

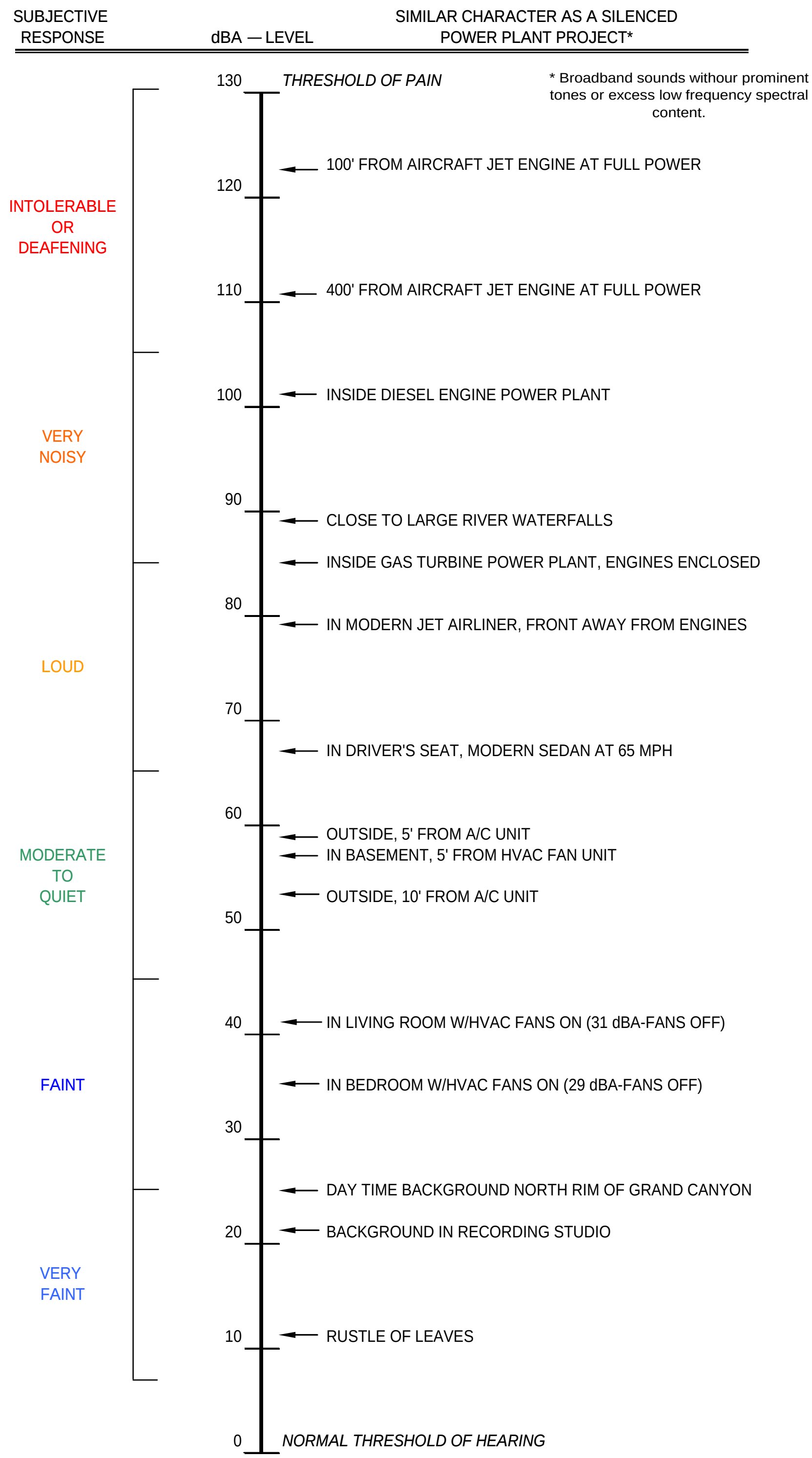


Table 4.0.1: *Table of Common Sounds in A-weighted dBA Units*

The *instantaneous* A-weighted sound level in any residential community over any sampling period varies as sporadic noise events occur. Such events may be passing vehicles, aircraft or rail events, dog barking, tree leaf rustle, song birds, etc. *Figure 4.0.1* below shows the instantaneous level for two distinctly different environments:

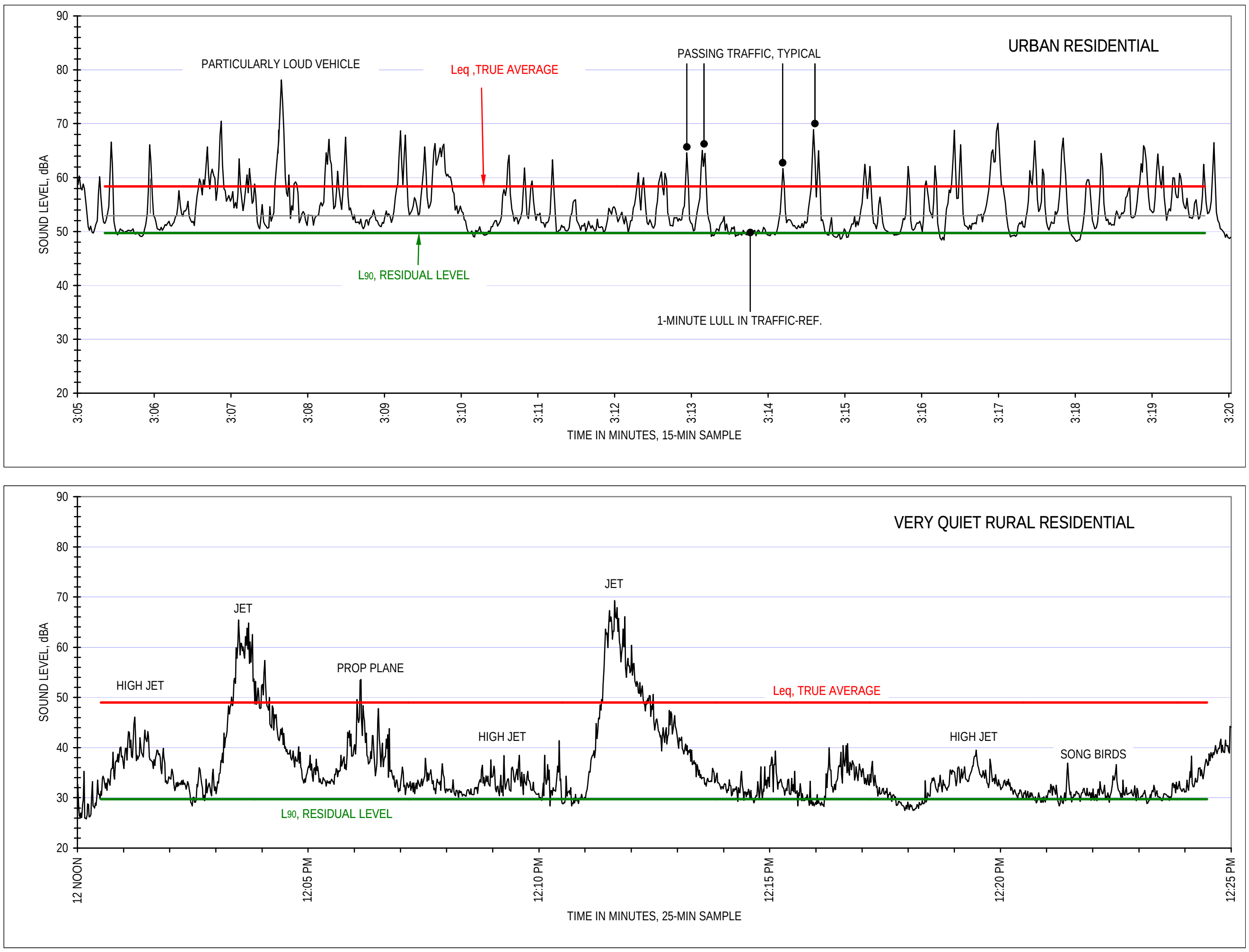


Figure 4.0.1: *Instantaneous sound level plots for a very quiet and moderately loud residential environment. Measurements from HAI files.*

To condense this widely varying data to a more usable form, standard measurement metrics are defined in reference 2. The obvious ones are the minimum, maximum and average levels that occur over the interval. The max and min are the highest and lowest measured level during the sampling period. The average, designated Leq is the *equivalent* steady sound level that has the same acoustic energy as the actual time varying signal. It can be thought of as the true energy average, and is not simply the arithmetic average over the period.

Percentile levels or exceedence levels, designated L_1, L_{10}, L_{50} and L_{90} are statistically derived units over the sampling period. They are the levels exceeded for 1, 10, 50 and 90% of the sampling time. Of all the units, Leq and L_{90} are the most useful for evaluating community noise. Of course, all of these units would be identical if the sound were perfectly steady without any variance with time, i.e., L_{min} would equal L_{max} would equal L_{eq}. etc.

The L_{90} percentile level is the most common for evaluating community noise in residential environments. L_{90} is defined in reference 5 as the "residual" sound level, which is the quasi-steady level that occurs in the absence of all identifiable sporadic sound levels occurring over the interval. The vast majority of all residual sound levels found in communities come from far-away unidentifiable steady levels from traffic and/or industrial sources.

The L_{eq} equivalent and L_{90} residual levels are shown in red and green on Figure 4.0.2 above and are computed from the actual time-varying level over the measurement interval. Observe that the residual level *excludes* the sporadic sources and is the near-minimum measurement, while L_{eq} *includes* the sound energy from the sporadic events.

Typical residual daytime levels[3 4 5] found throughout the U.S. under calm and still wind conditions are shown in *Table 4.0.2* below:

Typical Residential Area Sound Levels
Daytime Residual Level, dBA, Level Exceeded 90% of the Time, L90

Description	Typical Range	Average
Very Quiet Rural or Remote Area	26 to 30 inclusive	28 (New, HAI Study)[3]
Very Quiet Suburban or Rural Area	31 to 35 inclusive	33 (ANSI B133.8)[4]
Quiet Suburban Residential	36 to 40 inclusive	38
Normal Suburban Residential	41 to 45 inclusive	43
Urban Residential	46 to 50 inclusive	48
Noisy Urban Residential	51 to 55 inclusive	53
Very Noisy Urban Residential	56 to 60 Inclusive	58

Table 4.0.2: *Typical Residual Sound levels in Residential Communities.*

Based on the above table, we should expect to find residual daytime levels in the range from 36 to 45 dBA in the surrounding suburban residential neighborhoods at CCNPP depending on the proximity of major roads.

5.0_ Methodology

5.1_Instrumentation for Continuous and Manual Measurements

The instantaneous sound level was measured on a continuous and simultaneous basis over the 45-hour period using type 1 & 2 precision data loggers programmed to record the metrics discussed in Section 4 above. The meters report the data in hourly intervals. A typical continuous data logger is shown in *Figure 5.0.1* below:

Figure 5.1.1: *Data logger shown in weatherproof case with power supply and remote microphone.*

The specific test setup for this project is shown schematically in *Figure 5.2* below:

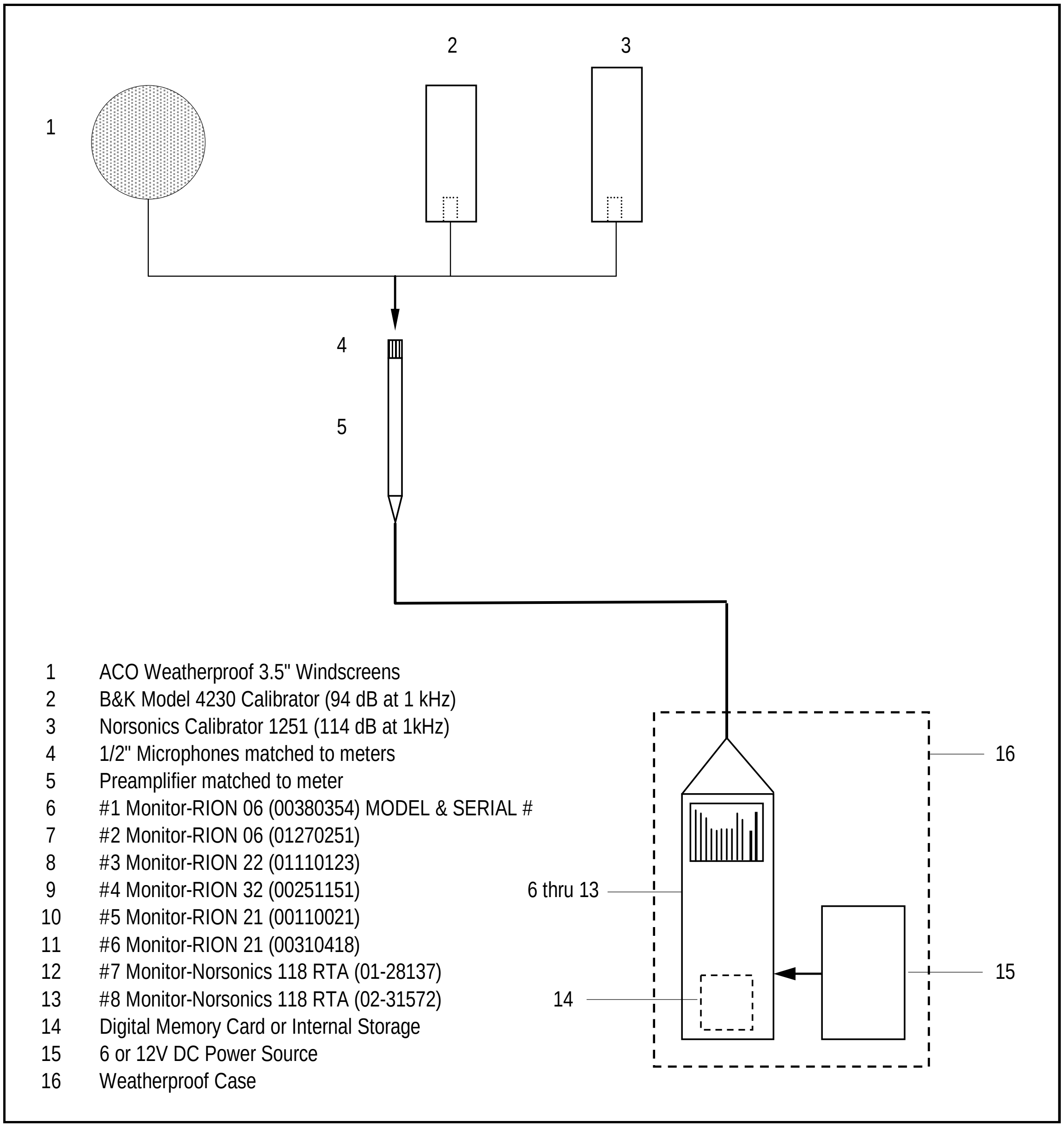


Figure 5.1.2: *Test instrumentation and calibration*

The loggers were checked for calibration by inserting two independent type 1 precision portable calibrators onto the microphone when each meter was setup and taken down. This calibrates the entire system of microphone, preamplifier and sound level meter (SLM) electronics. The reason for using separate calibrators, each with a different sensitivity (94 and 114 dB at 1000 Hz), is to insure accuracy even though each calibrator is checked for accuracy yearly at a NIST certified laboratory. The chance of one being out of calibration is low, but would show up immediately if the proper sensitivity of each did not agree.

In addition to the continuous data loggers, manual measurements were carried out at each location during day and night periods with a Rion model NA27 type 1 precision sound level meter (SLM) and 1/3 octave band frequency analyzer. The meters were programmed to run for ten-minute intervals to calculate the average and other statistical metrics described in 4 above. Attended measurements allow observations of weather effects and identification of environmental noise sources.

5.2_Test Locations

Eight locations were chosen after review of the site. Each location is shown on *Figure 2.0.1*.

One monitor (P1) was placed in the plant behind the visitor center building where the plant is quite audible and dominant to demonstrate the continuous (or not) operation of the plant.

All of the remaining monitors were located at residential locations to the north, west and south. CCNP is bounded by the Chesapeake Bay to the east. The monitors were mounted to trees or utility poles at a height of approximately 8 feet, and were placed at the setback distance from the road to house front of the nearest house.

Location N1 represents the Long Beach residential community located over 3 miles from the plant expansion site. In addition to the large buffer distance the terrain is rolling and heavily forested so one would not expect any noise issue to the north so only one monitor was employed in this direction even though residential development is dense.

There is also dense residential development to the west of the plant so three monitors were placed at varying distances from route 2 & 4, the suspected major environmental noise source. W2 is approximately 285 feet from the center of the route and represents the ambient sounds experienced by home sites very close to 2 & 4, while W3 is remote and over a mile from 2 & 4. W1 is approximately 1400 feet from the highway.

The planned expansion area is shown on *Figure 2.0.1* to the south of the plant. Three locations S1, S2 and S3 were used to characterize the ambient sounds at the closest residential units to the expansion area and at distances of 1700, 5100 and 1.6 miles from highway 2 & 4. The residential development to the south is not dense, consisting of scattered homes along route 765 and limited homes along Camp Canoy Road.

6.0_Discussion of Results

6.1_Monitor Measurement Results

Appendix A-1, A-2 and A-3 give the measured hourly data at each location in graphic format. Appendix A-1 has the GPS coordinates for each location, and the start and finish measured calibration tones and drift. All of the meters were within 1 dB over the sampling period.

The result at P1, shown on A-1, show clearly that the plant sound was steady over the entire 45-hour survey period. The statistical units are grouped in a 6 dBA range indicating very little variation with time. A-1 also plots the hourly values at N1 and the L_{eq} and L_{90} values of major interest are plotted in red.

Sheet A-2 shows the results for the three westerly locations. The plot for W2 shows the highest levels dominated by traffic flow on route 2 & 4. Minimum levels always occur during early morning hours for sites dominated by traffic flow noise. Similarly, sheet A-3 plots the results at S-1 through S-3. One could hear continuous noise from route 2 & 4 at S-1, but could not at the more remote S-2 and S-3. The only continuous sound heard at S-3 was the arriving waves from the Chesapeake Bay.

A summary plot of the measured residual hourly L_{90} levels at all locations was given in *Figure 2.0.2*. Clearly, levels are highest at locations close to route 2 & 4 and quietest at remote locations indicating the residual level in the CCNPP project area is dominated by traffic noise from route 2 & 4.

6.2_Attended Measurement Results

Appendix B-1 presents the measured 10-minute residual L_{90} one-third octave band spectra at P1, W3 and W2 for day and night visits. The one-third octave spectra at P1 show the tonal noise from the plant switchyard characterized by the peaks in the 31.5 and 125 Hz bands. The graphic to the right is a narrow band spectrum that more clearly shows the peaks at the electrical frequencies of 30, 120, 240 and 480 Hz.

At location W3, there was a distinctly heard tone or hum from the NE during the day but not at night. This was traced to a daily saw mill operation about a mile away. The narrow band spectrum shows the tone at 162 Hz and a harmonic at 324 Hz.

Finally, the plots at W2 show very broadband (atonal) sound from the highway just 285 feet away. The cover photo shows the monitor mounted to a utility pole and manual meter on a tripod at this location.

7.0_ Metrics for Noise Assessment

The measured results in Table 2.0.1 may be used to assess any new emissions from the planned expansion.

For example, the first two columns tabulate the minimum and average residual sound level, L_{90} at each location. Three states (MA, CA and NY) use the minimum L_{90} metric as a baseline to compare predicted emissions from a planned new source. Of interest is the *increase* to the baseline caused by the new source. In general, if the baseline increase is small there is insignificant impact and adverse impact if large. In a similar fashion, the average daytime residual level is used as a baseline in Appendix A of ANSI B133.8: “Gas Turbine Installation Sound Emissions”, and other standards and guidelines in use in the power industry.

The 24-hour day night sound level or DNL in columns 3 and 4 of Table 2.0.2 has become a de facto standard ever since publication in a watershed EPA *guideline* report titled “Information on Levels on Environmental Noise Requisite to Protect Health and Welfare with an Adequate Margin of Safety” in reference 2. DNL is calculated from the average hourly L_{eq} sound level over a 24 hour period except that a 10 dBA weighting factor is added to all levels from the nighttime period from 10 p.m. to 7 a.m. to account for greater sensitivity to noise at night. The World Health Organization (WHO) and World Bank use this metric.

Many states and local communities publish “Emission Limits” or maximum sound level limits, regardless of existing conditions. For example, the State of Maryland[6] limits maximum sound levels from industrial sources at residential receptors to 65 dBA during day and 55 dBA during night periods. The State fully acknowledges that such limits are the “upper bounds of annoyance acceptance for the majority of people” and experience since 1974 indicates that ½ of complaint investigations are found in compliance.

The Maryland statute also states that a limit of DNL = 55 dBA is the environmental "goal" of the state standards. A DNL limit of 55 dBA would require maximum day and night limits of 55 dBA and 45 dBA, 10 dBA lower than the State maximum levels to achieve this goal. Alternately, a plant could emit a maximum continuous day and night noise level of 49 dBA which would sum up to a DNL value of 55.

8.0_Eagle Nest Sites

As indicated on Figure 2.0.1, two of the eagle nest sites are located to the south in areas with low ambient sound levels, while the one to the north is near the plant.

9.0_References

[1] Hessler, G. F., "Controlling Noise Impact in the Community from Power Plant Operations – Recommendations for Ambient Noise Measurements", *Noise Control Engineering Journal*, Volume 48, Number 5, 2000 Sept-Oct

[2] "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety", US EPA Report PB-239 429, March 1974

[3] Hessler, G.F., Hessler, D.M., "Power Plant Noise Impact Policy for Quiet Ambient Environments", Prepared for Calpine Corp., Report # 1598A, November 2001.

[4] ANSI B133.8, "Gas Turbine Installation Sound Emissions", 1977, Reaffirmed 1987.

[5] "Community Noise", US EPA Report NTID300.3, Dec. 1971.

[6] Title 26, Department of the Environment, Chapter 03 Control of Noise Pollution, Environmental Noise Act of 1974

End of Text

.

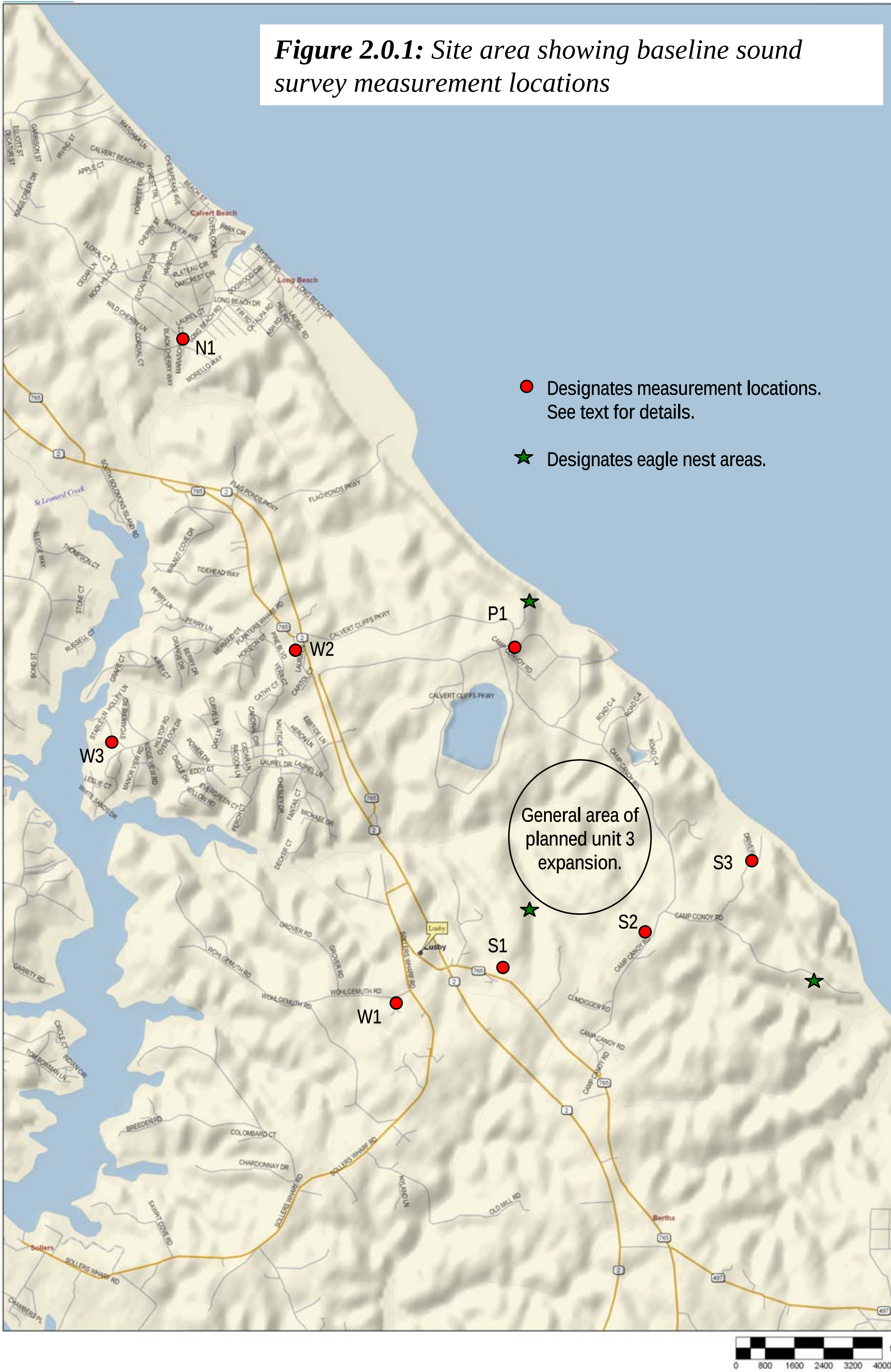
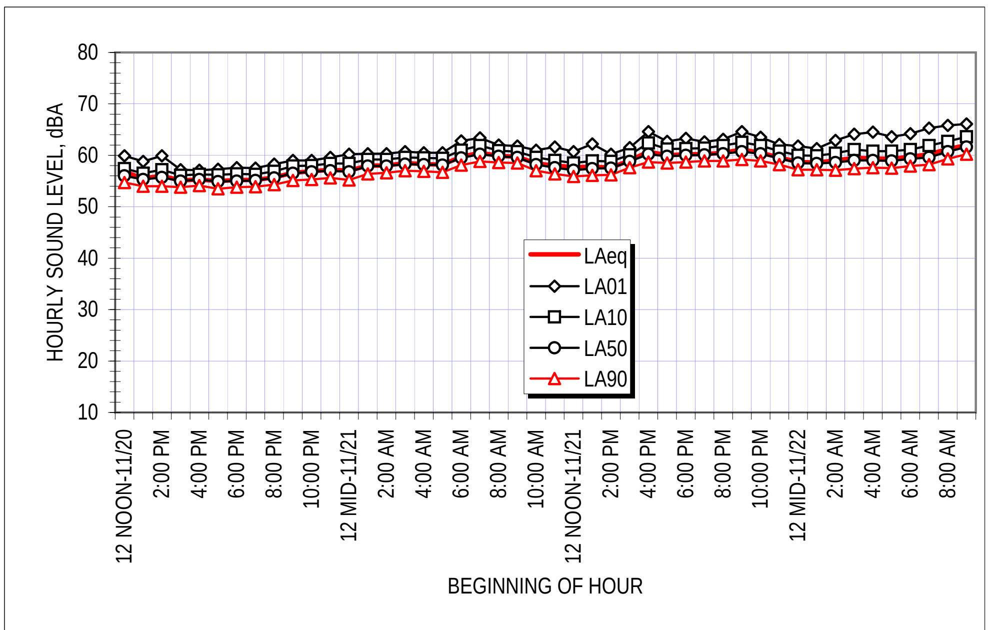
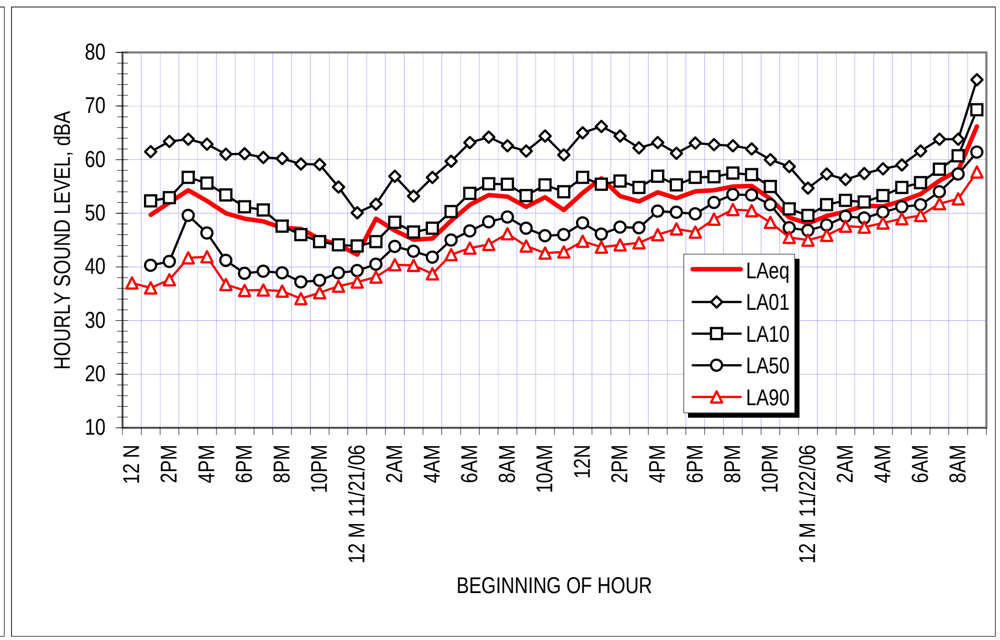


Figure 2.0.1: *Site area showing baseline sound survey measurement locations*

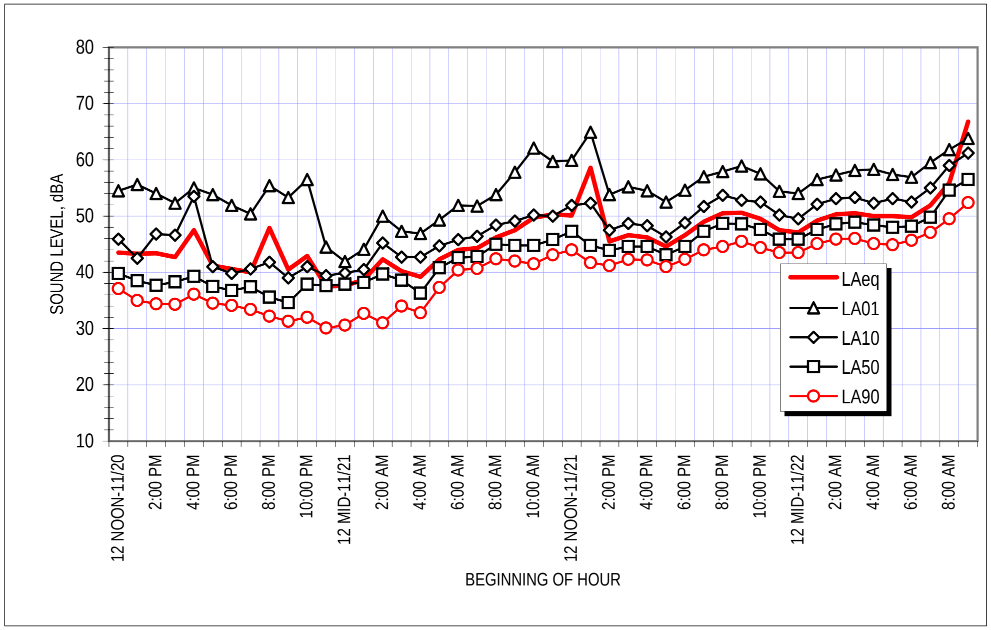
LOCATION:	LATTITUDE	LONGITUDE	DESCRIPTION	METER CALIBRATION LEVELS AT START AND END OF MONITORING PERIOD CAL 1 START	CAL 2 START	CAL 1 END	CAL 2 END	MAX DRIFT dB
P1			In plant behind Visitor's Center overlook plant	93.9	113.9	94.0	114.0	-0.1
N1	N38 DEG 27.1'	W76 DEG 28.7'	Along Long Beach Rd.75' setback	94.1	113.9	93.9	113.9	0.1
W1	N38 DEG 24.5'	W76 DEG 27.0'	Wohlgemuth Rd, 100' from Sollers Wharf Rd.	93.8	114.0	93.9	114.0	-0.1
W2	N38 DEG 26.0'	W76 DEG 28.0'	120' North to rt 765 on Laura Lane	93.7	113.6	94.2	114.3	-0.6
W3	N38 deg 25.6'	W76 deg 29.1'	Driveway on Jim's house Stable lane	94.2	113.9	93.9	113.9	0.1
S1	N38 DEG 24.6'	W76 DEG 27.0'	550' from rt 765	94.2	113.9	94.2	114.0	0.0
S2	N38 DEG 24.8'	W76 DEG 26.0'	On Camp Canoy Rd.200'SE of plant rd.	94.4	114.3	93.6	113.6	0.8
S3	N38 DEG 25.0'	W76 DEG 25.4'	On Camp Canoy Rd. driveway to Bay residence	93.9	113.7	93.8	113.8	0.0



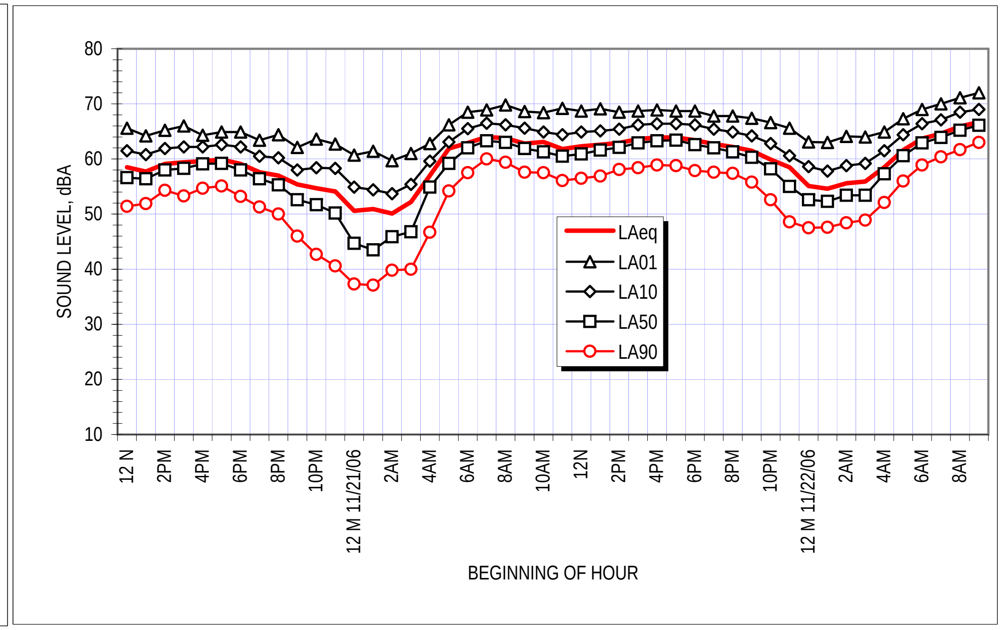
MONITOR 7 AT P1



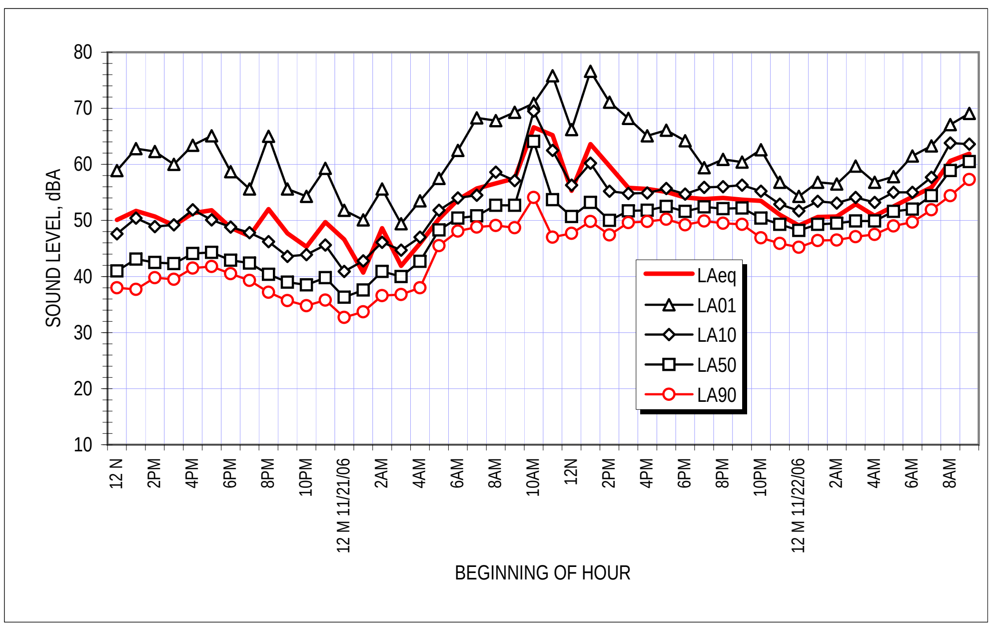
MONITOR 4 AT N1



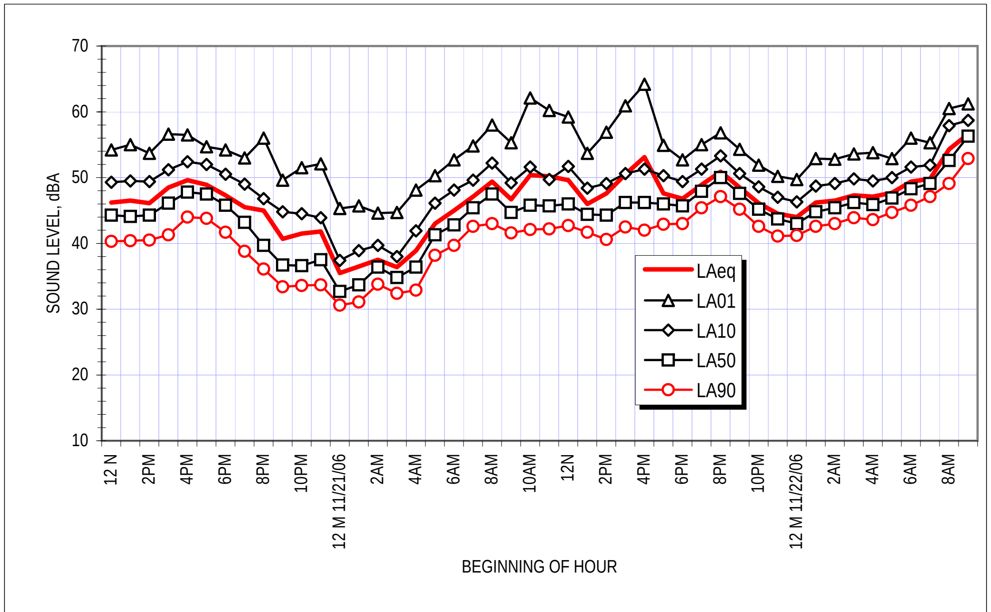
MONITOR 8 AT W1



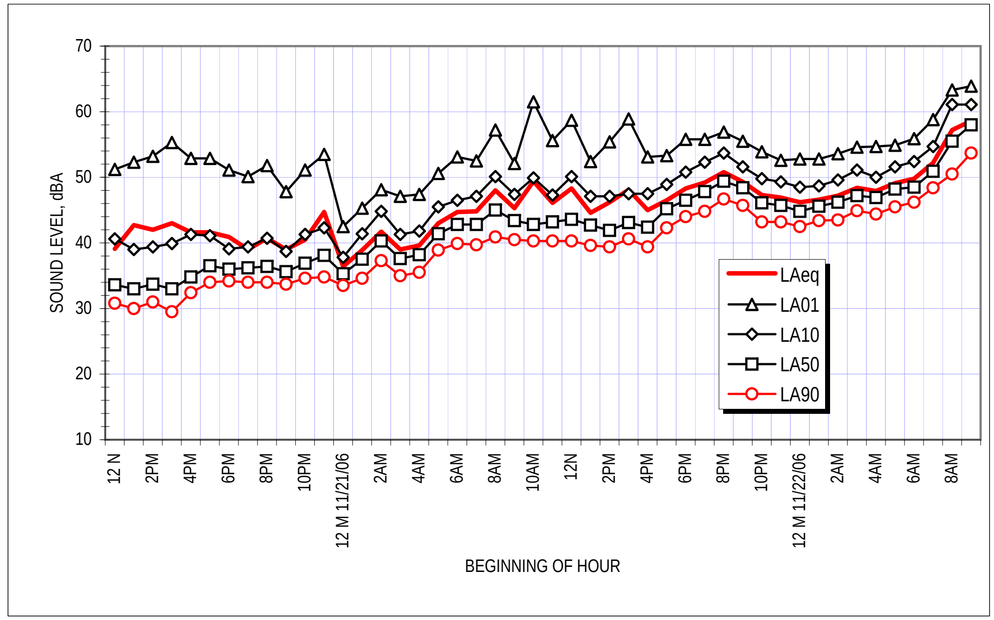
MONITOR1 AT W2



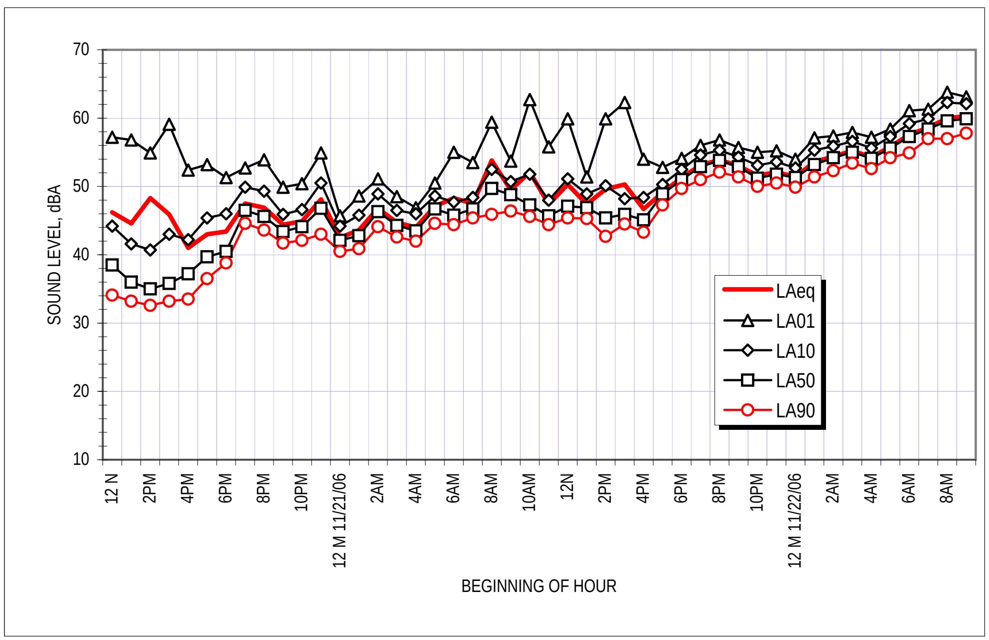
MONITOR 2 AT W3



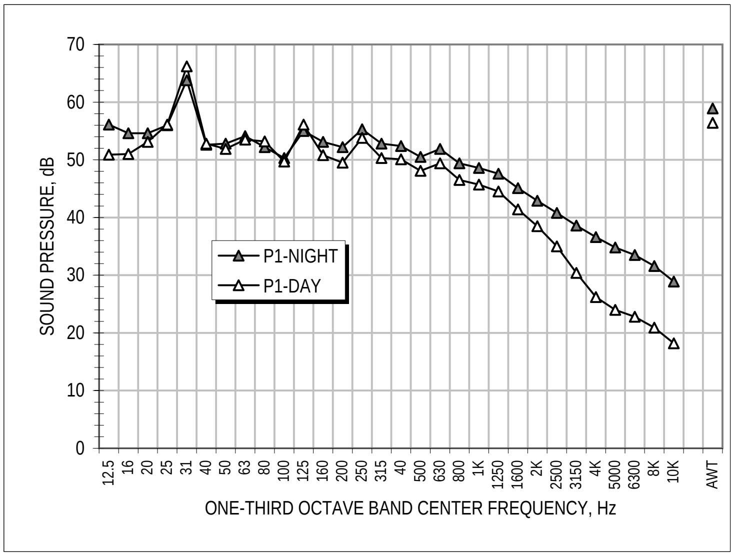
MONITOR 3 AT S1

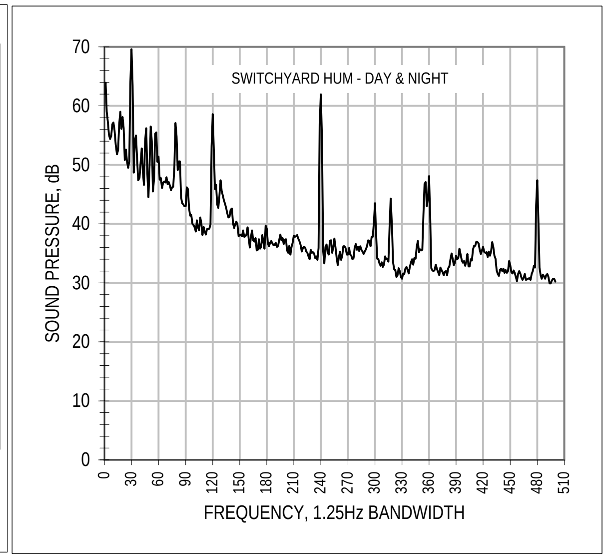


MONITOR 5 AT S2

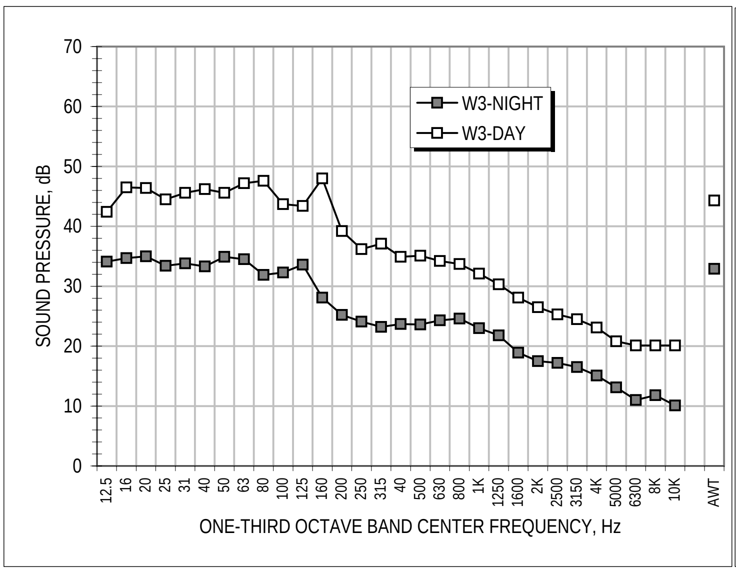


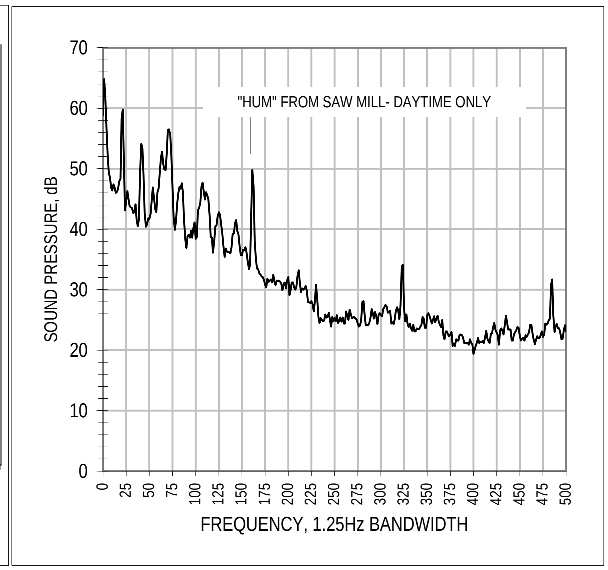
MONITOR 6 AT S3



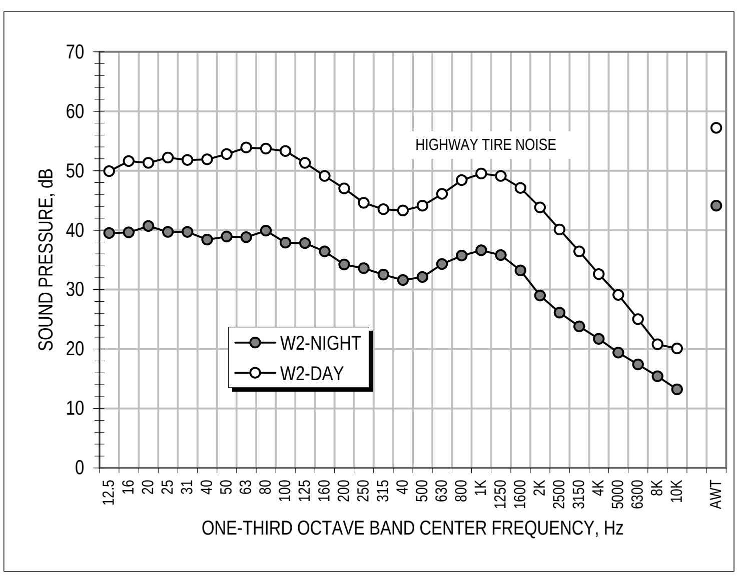


INSIDE PLANT AT P1





AT REMOTE WESTERLY RESIDENCE AT W3



NEAR ROUTES 2 & 4 AT W2