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**Report Number 052308-1**

# Preliminary Environmental Noise Assessment

**For**

**The Calvert Cliffs Nuclear Power Plant (CCNPP) Expansion Project**

May 2008

Prepared For:

**UniStar Nuclear Energy**
750 E. Pratt Street
Baltimore, Maryland 21202

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## 1.0_Introduction

Hessler Associates has been retained by Unistar Nuclear Energy to provide an environmental noise assessment for a planned expansion to the Calvert Cliffs Nuclear Power Plant (CCNPP) located near Lusby, Maryland in Calvert County. The company plans on adding a third reactor and associated steam turbine/generator for additional plant generating capacity.

The noise assessment consists of measuring and documenting baseline or existing conditions, predicting noise emissions from the existing and planned facilities, determining legislated noise limits and assessing any potential impact during construction and operation of the planned expansion. Seven potentially sensitive residential receptor locations have been identified that surround the expansion area and are illustrated on Figure 1.0 below:

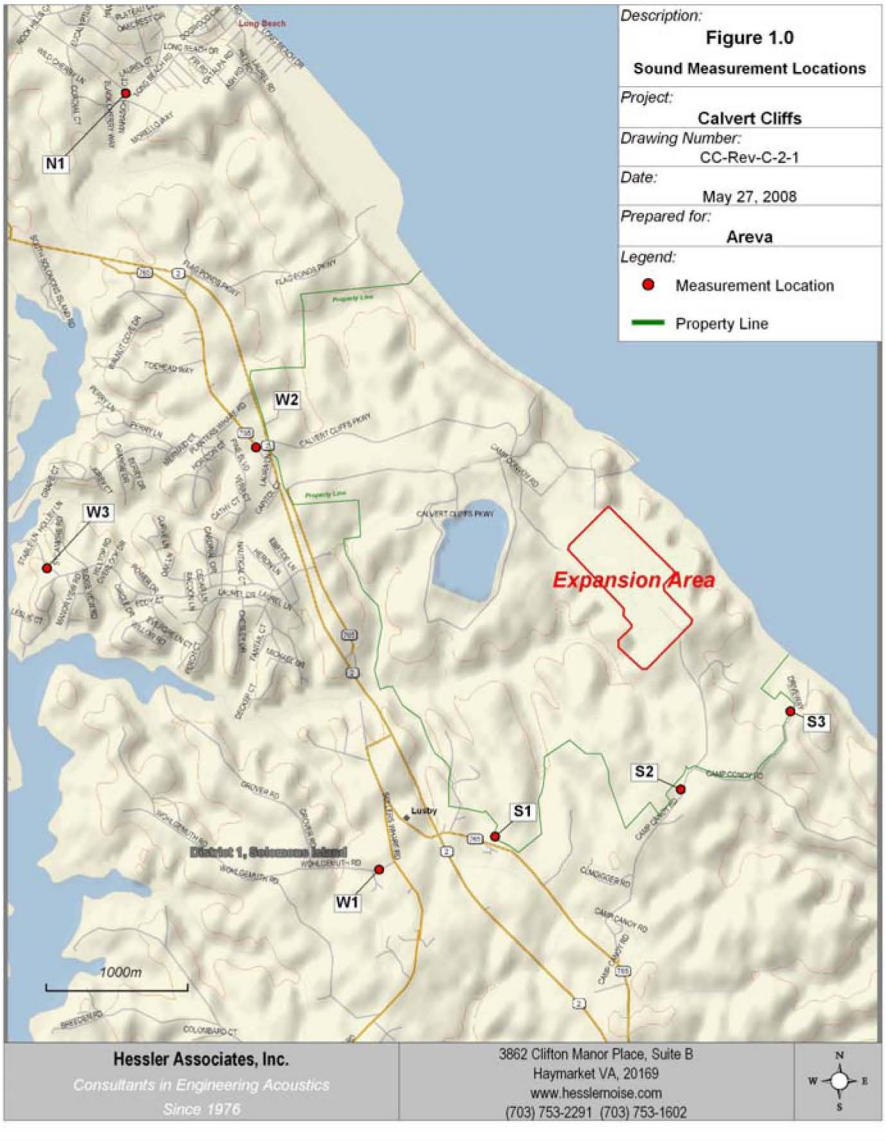



***Figure 1.0:*** *Seven Potentially Sensitive Receptor Locations at the CCNPP Expansion Area.*

Existing conditions have been measured during leaf-off and leaf-on conditions in November 06 and August 07 and are documented in Hessler Associates, Inc. reports:

Report Number 121106-1: Leaf-off Season Sound measurement Survey
Report Number 082007-1: Leaf-on Season Sound measurement Survey

The noise contribution attributable to the proposed hybrid cooling tower has been estimated in:

Report Number 051007-1: Estimated Cooling Tower Sound Emissions

Since this report was issued, the hybrid cooling tower has been changed to a plume-abated design with significantly different sound emissions.

This report provides a preliminary noise assessment for both construction and operation of the facilities.

## 2.0_ Executive Summary and Results

The most sensitive receptors are identified south of the plant at locations S2 and S3. There are less than a dozen residences at these locations and they are both the closest receptors to the plant and environmental sound levels are the quietest measured during both ambient surveys at these locations.

Construction noise was predicted and expected levels at the seven identified receptors in **Figure 1.0** are all well below that prescribed by Maryland law. Any potential annoyance due to construction noise is limited to locations S2 and S3 where construction noise levels exceed existing levels. No adverse response to construction noise is expected at all other locations due to the large wooded buffer distances between the planned expansion area and the residences.

Predicted operational noise emissions were developed by computer noise modeling for the plume-abated cooling tower that is expected to be the major acoustic source from the planned expansion. The project design is not at a late enough stage to allow noise modeling for the balance of plant equipment, but again, the cooling tower is expected to be the highest and principal source of plant noise emissions. Modeling results indicate that noise emissions from the plume-abated cooling tower will comply with the 55 dBA limit prescribed by the State of Maryland.

## 3.0_Conclusions

As shown in the report, the planned installation of new capacity at the Calvert Cliffs site can and will be acoustically designed to comply with the requirements of Maryland law regulating industrial noise emissions. It is concluded that construction and operational noise from the project meets all applicable regulations without restrictions or exceptions.

## 4.0_Recommendations

It is recommended that construction and operational noise emission modeling for the complete plant expansion is continued as more design information becomes available.

## 5.0_ Construction Noise

### 5.1_ Assessment Criteria

The site has large buffer distances between the expansion area and the closest sensitive receptors and all are wooded with soft sound absorptive ground. The State of Maryland regulations[1] limit maximum noise levels attributable to construction activities to 90 dBA at any and all sensitive receptor locations during daytime hours (7 am to 10 pm) and to 55 dBA for nighttime hours.

### 5.2_ First Order Compliance Analysis

The Table below is taken from Table B.1 of reference[2]. This reference is now 30 years old but remains the most comprehensive study of construction noise specific to power plant construction, including nuclear power plants. Over 1300 hours of measurements were collected for analysis and to develop a construction noise prediction methodology. More recent equipment noise measurement data indicates there have been noise reduction improvements made for current construction equipment and current equipment is quieter than that reflected in the referenced study. Hence the results shown below can be considered conservative.

The maximum instantaneous level for each type of common construction equipment that would propagate to off-site sensitive locations is estimated for the seven identified residential receptors. It can be deduced from this table that the State daytime limit of 90 dBA will indeed be met at all locations with a very comfortable margin of safety due mainly to the large buffer distances. Maximum levels can be expected at the closest receptors to the south at locations S2 and S3.

| Type of Equipment | Engine Rating | Range of Maximum Sound Levels | Maximum level from Any Individual Source at Location: | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | HP | at 50 feet, dBA | N1 | S1 | S2 | S3 | W1 | W2 | W3 |
| Crawler | 101-250 | 81-85 | 15 | 38 | 45 | 45 | 32 | 28 | 21 |
| Dozers | 251-700 | 85-90 | 20 | 43 | 50 | 50 | 37 | 33 | 26 |
| Front End Loaders | 300-750 | 86-90 | 20 | 43 | 50 | 50 | 37 | 33 | 26 |
| Tractor Shovels | 116-299 | 82-86 | 16 | 39 | 46 | 46 | 33 | 29 | 22 |
| Backhoe Excavators | 336-760 | 88-90 | 20 | 43 | 50 | 50 | 37 | 33 | 26 |
| Self Propelled Scrapers | 551-1000 | 88-91 | 21 | 44 | 51 | 51 | 38 | 34 | 27 |
| Graders | 351-600 | 86-89 | 19 | 42 | 49 | 49 | 36 | 32 | 25 |
| Off-Highway Haulers | 501-800 | 88-90 | 20 | 43 | 50 | 50 | 37 | 33 | 26 |
| Steel Rollers | 89-110 | 80-82 | 12 | 35 | 42 | 42 | 29 | 25 | 18 |
| Rubber Tired Rollers | 121-150 | 82-83 | 13 | 36 | 43 | 43 | 30 | 26 | 19 |
| Derrick Crane | 121-280 | 82-86 | 16 | 39 | 46 | 46 | 33 | 29 | 22 |
| Mobile Crane | 161-240 | 83-85 | 15 | 38 | 45 | 45 | 32 | 28 | 21 |
| Concrete Pumps | 51-220 | 78-84 | 14 | 37 | 44 | 44 | 31 | 27 | 20 |
| Air Compressors | 401-600 | 87-89 | 19 | 42 | 49 | 49 | 36 | 32 | 25 |
| Portable Generators | 101-400 | 81-87 | 17 | 40 | 47 | 47 | 34 | 30 | 23 |
| Trucks | 201-400 | 84-87 | 17 | 40 | 47 | 47 | 34 | 30 | 23 |
| Rock Drills | | 83-99 | 29 | 52 | 59 | 59 | 46 | 42 | 35 |
| Chain Saw | | 72-88 | 18 | 41 | 48 | 48 | 35 | 31 | 24 |
| Warning Horns | | 98-102 | 32 | 55 | 62 | 62 | 49 | 45 | 38 |

***Table 5.2.1:*** *Estimated individual construction noise sources at the seven identified residential locations surrounding the site.*

It should be noted that the above are for individual equipment sources operating at their maximum noise output.

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

[2] "Power Plant Construction Noise Guide", BBN Report 3321, Prepared for the Empire State Energy Research Corporation, NY, NY, May 1977.

### 5.3_Second Order Construction Noise Assessment

Actual construction noise contains an accumulation of many transient sources of varying noise from countless individual sources at varying degrees of usage from day to day, and is far more complex than a table of individual sources given above. There are five distinct phases common to all power plant construction projects tabulated below. For this project, these construction phases are expected to commence in 2009 and conclude in 2015.

Construction Phases:
1. Excavation
2. Concrete Pouring
3. Steel Erection
4. Mechanical Equipment
5. Commissioning and Clean-up

Reference 1 documents the long term measured sound level from 15 power plant construction projects and derives a prediction scheme from the measurements. Based on this methodology that has been simplified for purposes of this preliminary report, the following table shows the estimated long term average sound level for each construction phase at each of the seven evaluation receptors. Although these results are conservatively estimated they are considered adequate for this preliminary assessment.

| | ESTIMATED LONG TERM Leq CONSTRUCTION NOISE AT LOCATION | | | | | | |
|---|---|---|---|---|---|---|---|
| **CONSTRUCTION PHASE** | **N1** | **S1** | **S2** | **S3** | **W1** | **W2** | **W3** |
| EXCAVATION | 36 | 46 | 50 | 50 | 43 | 41 | 38 |
| CONCRETE POURING | 32 | 42 | 46 | 46 | 39 | 37 | 34 |
| STEEL ERECTION | 36 | 46 | 50 | 50 | 43 | 41 | 38 |
| MECHANICAL | 31 | 41 | 45 | 45 | 38 | 36 | 33 |
| CLEAN UP & CHECKOUT | 26 | 36 | 40 | 40 | 33 | 31 | 28 |

***Table 5.3.1:*** *Predicted Long –Term Average Construction Noise Levels at Seven Residential Receptors*

The results show again that the long term average sound levels attributable to construction noise are well below both the daytime and nighttime limits promulgated by the State of Maryland (90 and 55 dBA, respectively). To assess these results it is necessary to compare them to the existing noise environment. The change or increase to existing levels is the relevant assessment parameter. The daily hourly measured Leq for the leaf-off survey in November 06 is tabulated below in **Figure 5.3.2**. This data represents the spring, fall and winter seasons.

Leq data from the leaf-on summertime survey conducted in August 07 contains high levels of insect sound, particularly at locations S2 and S3 that is heavily wooded with natural underbrush and ground cover. Insect noise occurs at very high frequencies (2000 Hz and above for this case) and controls and dominates the measured Leq metric. The measured Leq leaf-on data is magnitudes higher than the leaf-off results due only to this single source. While a natural environmental sound, high frequency insect sound provides no masking of construction or operational noise and should not be used for comparative assessment purposes.

| MEASURED 11/21/06 | HOURLY Leq AT LOCATION | | | | | | |
|---|---|---|---|---|---|---|---|
| START OF HOUR | **N1** | **S1** | **S2** | **S3** | **W1** | **W2** | **W3** |
| 7AM | 44 | 43 | 40 | 45 | 41 | 60 | 49 |
| 8AM | 46 | 43 | 41 | 46 | 42 | 59 | 49 |
| 9AM | 44 | 42 | 41 | 46 | 42 | 58 | 49 |
| 10AM | 43 | 42 | 40 | 46 | 42 | 58 | 54 |
| 11AM | 43 | 42 | 40 | 44 | 43 | 56 | 47 |
| 12N | 45 | 43 | 40 | 45 | 44 | 57 | 48 |
| 1PM | 44 | 42 | 40 | 45 | 42 | 57 | 50 |
| 2PM | 44 | 41 | 39 | 43 | 41 | 58 | 47 |
| 3PM | 45 | 43 | 41 | 45 | 42 | 58 | 50 |
| 4PM | 46 | 42 | 39 | 43 | 42 | 59 | 50 |
| 5PM | 47 | 43 | 42 | 47 | 41 | 59 | 50 |
| 6PM | 47 | 43 | 44 | 50 | 42 | 58 | 49 |
| 7PM | 49 | 45 | 45 | 51 | 44 | 58 | 50 |
| 8PM | 51 | 47 | 47 | 52 | 45 | 57 | 50 |
| 9PM | 51 | 45 | 46 | 51 | 46 | 56 | 49 |
| **AVERAGE DAYTIME Leq** | **47** | **43** | **42** | **48** | **43** | **58** | **50** |

***Table 5.3.2:*** *Measured Existing Daytime Ambient Sound Levels at Residential Receptors*

The change or increase to existing levels attributable to construction noise is calculated and tabulated below for assessment purposes.

| | ESTIMATED INCREASE FROM CONSTRUCTION NOISE AT LOCATIONS | | | | | | |
|---|---|---|---|---|---|---|---|
| **CONSTRUCTION PHASE** | **N1** | **S1** | **S2** | **S3** | **W1** | **W2** | **W3** |
| EXCAVATION | 0 | 3 | 8 | 2 | 0 | 0 | 0 |
| CONCRETE POURING | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| STEEL ERECTION | 0 | 3 | 8 | 2 | 0 | 0 | 0 |
| MECHANICAL | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| CLEAN UP & CHECKOUT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

***Table 5.3.3:*** *Estimated Increases to Existing Daytime Ambient Sound Levels at Residential Receptors*

It can be observed that construction activities will have no effect at locations N1, W1, W2 and W3 where the change or increase to the ambient is zero for all construction phases. The maximum increase to the ambient occurs at location S2.

It is generally agreed in the scientific community that an increase of 5 to 10 dBA to the ambient is the threshold for potential adverse impact for construction noise. This leaves location S2 as the only location where adverse impact may occur based on this preliminary analysis. More accurate detailed modeling that accounts for topography shielding and quieter construction equipment may also show that actual expected construction noise levels increases are below 5 dBA at all locations.

Nevertheless, this preliminary study shows that locations to the south are the only locations that may experience adverse response from construction noise. There are less than a dozen residences along Camp Conoy road at locations S1 and S2.

### 5.4_Construction Noise Mitigation Measures

It is shown that no special mitigation measures are required to comply with the State of Maryland regulations as long as noisy construction activities are restricted to daytime hours defined as 7 a.m. to 10 p.m. by the State. Nevertheless, it is recognized that the most effective mitigation measure is to restrict noisy construction activities to normal daytime hours of 7 a.m. to 7 p.m. This scheduling effort is under consideration by the owner to the extent possible. However, there may be times when a continuous work activity (such as a large concrete pour), or scheduling constraints may necessitate some nighttime activities past 7 p.m.

## 6.0_Operational Noise Analysis

### 6.1_ Noise Requirement

About a dozen states and many local communities publish "Emission Limits" or maximum sound level limits for operational plant noise emissions, regardless of existing conditions. A search of the Calvert County web site did not turn up any noise rules. The State of Maryland limits maximum sound levels from industrial sources at residential receptors to 65 dBA and 55 dBA during day (7 am-10pm) and night periods (10 pm to 7 am), respectively.

The Maryland statute also states that a limit of DNL = 55 dBA is the environmental "goal" of the state standards. DNL is a complex metric developed by EPA that weights or penalizes levels that occur after 10 p.m. A DNL goal of 55 dBA would require maximum day and night limits of 55 dBA and 45 dBA, fully 10 dBA *lower* than the State *maximum* levels to achieve this goal.

A nuclear power plant is base load generation operating 24/7. Any nighttime noise requirement becomes the plant design requirement since noise emissions are essentially constant throughout the day and night. For purposes of this report, the project noise requirement is established at 55 dBA or less at all potentially sensitive receptors.

### 6.2_Predicted Operational Noise

Detailed operating information and vendor supplied noise source information is not yet available for a comprehensive noise model. The major sources of operational noise emissions from a nuclear power plant are tabulated below:

1. Condensate cooling tower
2. Steam turbine/generator building walls and ventilation including all air inlets and exhausts.
3. Core building walls and ventilation including all air inlets and exhausts.
4. Electrical transformers
5. Standby diesel generator set building walls and ventilation including all air inlets and exhausts.

Noise emission data is available for the cooling tower thought to be the major source of operational noise. Appendix A contains this data and an illustration of the hybrid plume-abated cooling tower. The program used for predicting cooling tower emissions is Version 3.0 of "Cadna A"; an acronym for Computer Aided Design for Noise Abatement, published by DataKustik, Ltd., Munich, Germany. All calculations are carried out in accordance with international standard ISO 9613. There is no equivalent U.S. standard for outdoor sound propagation modeling. The program calculates the sound level from the cooling tower at grid points, typically a 1 meter square pattern, covering the whole project area resulting in multi-thousands of calculations. Equal level noise contours can then be plotted over the whole project area.

Appendix B contains Graphic A and B showing the equal noise contours from the cooling tower during Leaf-on and Leaf-off seasons, respectively. The table below summarizes the results at the seven identified receptors from Figure 1.0:

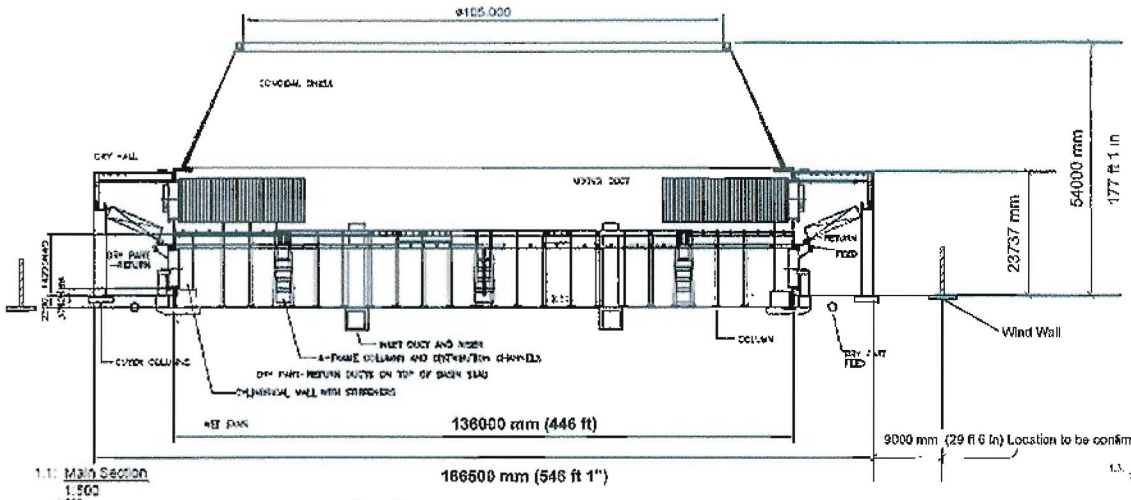
| | ESTIMATED Leq, dBA FROM COOLING TOWER AT LOCATIONS: | | | | | | |
|---|---|---|---|---|---|---|---|
| | **N1** | **S1** | **S2** | **S3** | **W1** | **W2** | **W3** |
| LEAF-ON SEASONS | <<30 | 44 | 51 | 49 | 39 | 35 | <30 |
| LEAF-OFF SEASONS | <30 | 48 | 54 | 53 | 43 | 39 | 32 |
| | | | **AMBIENT LEVEL** | | | | |
| AVERAGE DAYTIME Leq | 47 | 43 | 42 | 48 | 43 | 58 | 50 |
| | | | **INCREASE TO AMBIENT** | | | | |
| LEAF-ON SEASONS | 0 | 1 | 9 | 1 | 0 | 0 | 0 |
| LEAF-OFF SEASONS | 0 | 5 | 12 | 5 | 0 | 0 | 0 |

***Table 6.2.1:*** *Estimated Cooling Tower levels at Seven Receptors Compared to Existing levels.*

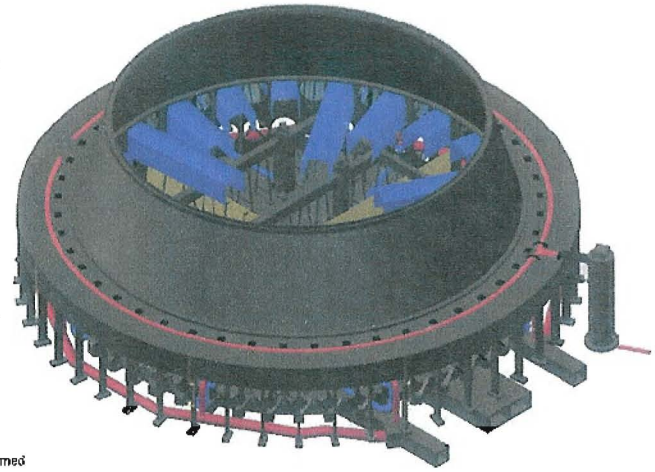
Two points can be deduced from the results table. The levels propagated to the community from the cooling tower are all in full compliance with the Maryland limit of 65 and 55 dBA during day and night hours at all locations. As for the previous construction analysis, the cooling tower noise emissions may have some effects at locations to the south, but no effects at any other location where there is no increase to the ambient.

# APPENDIX A

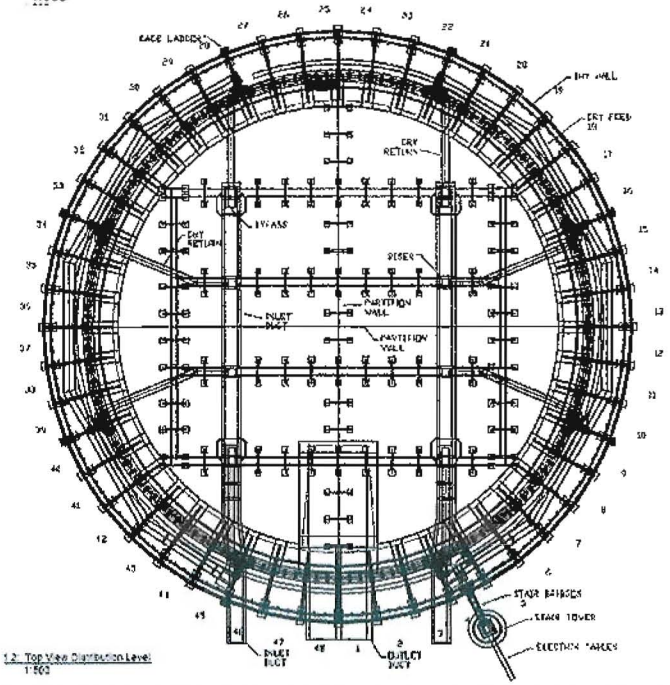
NOISE MODELS FOR EXISTING GENERATION




1.1: Main Section
1:500



1.3: Isometric View of Cooling Tower Main Structure
1:500



1.2: Top View Distribution Level
1:500


1.4: Details of Wet and Dry Fans

| Summer Design Point | |
|---|---|
| Parameter | Value |
| Flow = | 800,000 gpm |
| TW1 = | 118.0°F |
| TW2 = | 90.0°F |
| TF1 = | 80.0°F |
| TL1 = | 91.78°F |
| RH = | 60.0% |
| Pb = | 29.92 in HgA |
| Range = | 28.0°F |
| Approach = | 10.0°F |

| Plume Design Point | |
|---|---|
| Parameter | Value |
| Flow = | 800,000 gpm |
| TF1 = | 25.00°F |
| TL1 = | 23.30°F |
| RH = | 80.00% |
| Pb = | 29.92 in HgA |
| Range = | 28.0°F |

04/30/08

Bechtel US EPR PROJECTS
Constellation Calvert Cliffs
Round Hybrid Mechanical Draft Cooling Tower
Preliminary Arrangement

SPX Cooling Technologies

TYPE OF EQUIPMENT: *Forced Draft Hybrid Cooling Tower* SUPPLIER/ MANUFACTURER: *SPX Cooling Technologies* *

EQUIPMENT NO.: *Bechtel/UniStar Calvert Cliffs* MECHANICAL POWER(kW/HP): *See Appendix A Data Sheet* *

SIZE *l* x *w* x *h* (ft): *See Arrangement Drawing* *

NOISE DATA – LEVELS GUARANTEED BY SELLER NOT TO BE EXCEEDED BY EQUIPMENT

1. The noise generated by the equipment shall not exceed the noise limits of ~~*[Project derived, typically 85 dBA @ 3 feet]*~~, for any of the conditions of operation for which the equipment may normally be expected to be used
2. $L_p$ is the maximum sound pressure level, re 20μ Pascal in dB, at any location at **1 m** from the equipment surface, $L_w$ is the maximum sound power level, ref. 1 pico Watt
3. If the equipment generates noise with audible tonal or impulsive components, this shall be indicated on the following page
4. Noise level will be verified in accordance with ISO 3740 series or equipment specific noise test protocols (no test tolerances or uncertainty corrections allowed)
5. The supplier shall state which noise mitigation features were added to meet the noise requirements

| Equipment Items/Locations | | Sound Pressure/Power levels guaranteed by supplier | | | | | | | | | | Remarks (noise mitigating measures) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Un-weighted octave band levels | | | | | | | | | dBA | |
| | | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | | |
| At Dry Section Inlet | $L_p$ | | | | | | | | | | | |
| | $L_w$ | 95.8 | 102.6 | 112.8 | 116.5 | 119.2 | 120.1 | 116.8 | 116.2 | 113.4 | 125.6 | |
| At Wet Section Inlet | $L_p$ | 68.1 | 74.9 | 85.0 | 88.6 | 91.1 | 91.6 | 86.4 | 84.7 | 81.3 | 96.7 | At 1 m from fan inlet bell |
| | $L_w$ | 100.8 | 107.6 | 117.7 | 121.3 | 123.8 | 124.3 | 119.1 | 117.4 | 114.0 | 129.4 | |
| At Tower Outlet | $L_p$ | | | | | | | | | | | |
| | $L_w$ | 90.3 | 101.5 | 113.1 | 118.0 | 116.8 | 117.9 | 115.5 | 112.1 | 102.9 | 124.0 | |
| | $L_p$ | | | | | | | | | | | |
| | $L_w$ | | | | | | | | | | | |
| | $L_p$ | | | | | | | | | | | |
| | $L_w$ | | | | | | | | | | | |
| | $L_p$ | | | | | | | | | | | |
| | $L_w$ | | | | | | | | | | | |
| | $L_p$ | | | | | | | | | | | |
| | $L_w$ | | | | | | | | | | | |

SUBMITTED DATA BASED ON: *[Supplier]* *

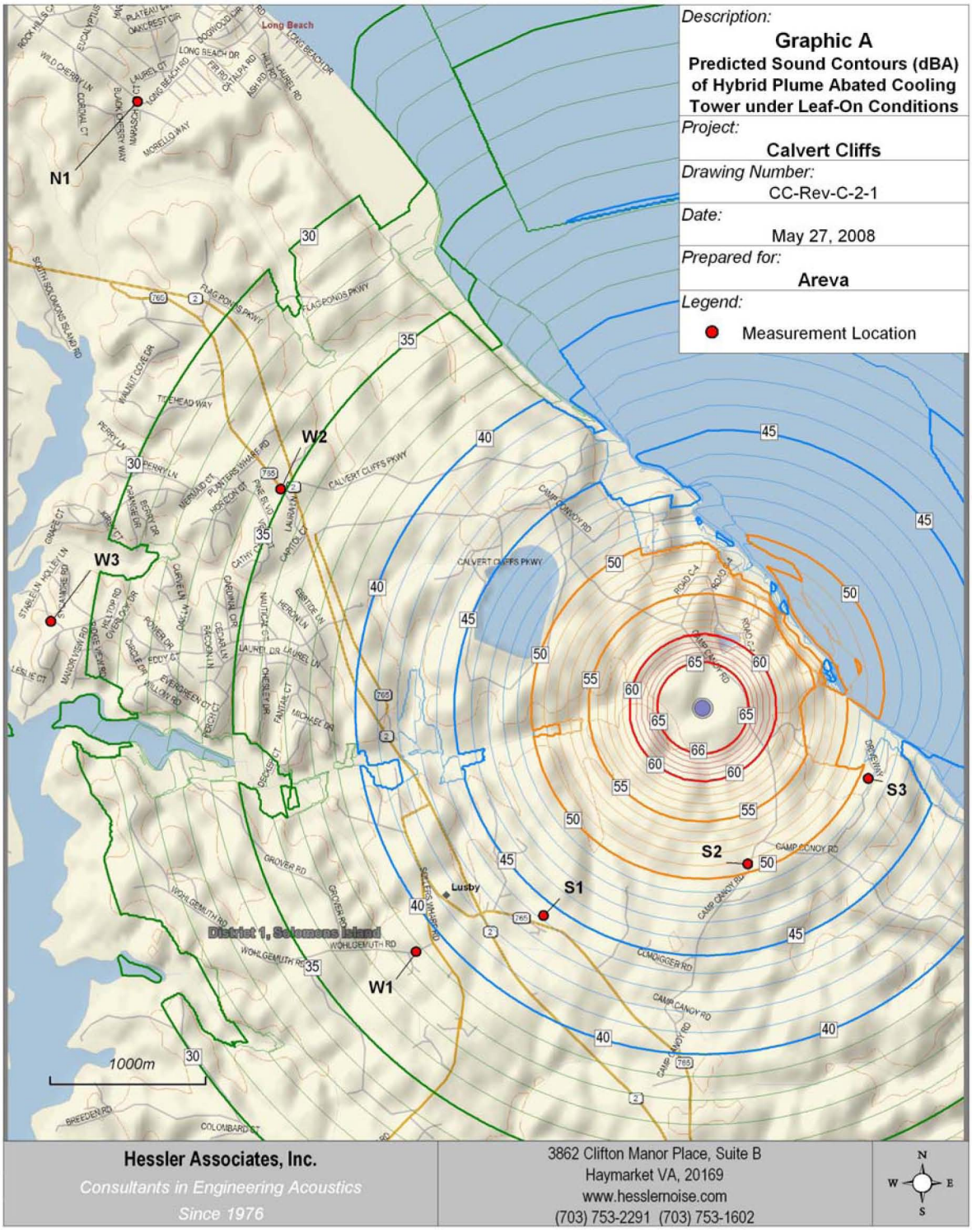
( ) TEST ON SIMILAR UNIT
( ) TEST ON ACTUAL UNIT
( ) TEST ON SCALE MODEL
( ) CALCULATION
( ) OTHER

TEST LOCATION: *[Supplier]* *

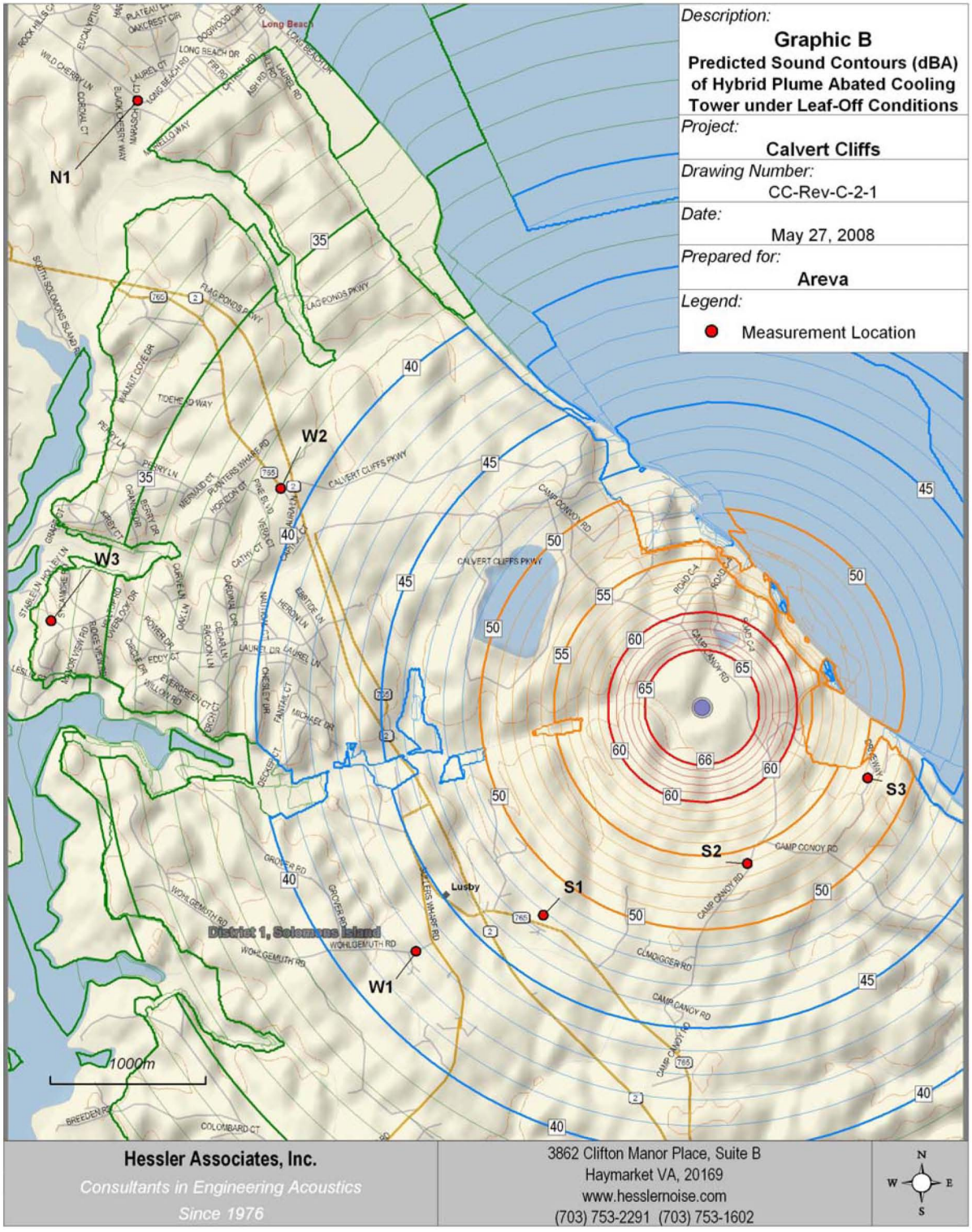
( ) SELLER'S PLANT
( ) SIMILAR PLANT
( ) REVERBERATION CHAMBER
( ) ANECHOIC CHAMBER OR OUTDOORS
( ) OTHER

| | EQUIPMENT NOISE DATA SHEET | Job No | |
|---|---|---|---|
| BECHTEL | PROJECT | MR | |
| | | Appendix | Rev. |
| | | Sheet 1 of 2 | |

# APPENDIX B
GRAPHICAL NOISE MODELS




***Graphic A:*** *Predicted Noise Contours from Hybrid Cooling Tower during Leaf-on Seasons*




***Graphic B:*** *Predicted Noise Contours from Hybrid Cooling Tower during Leaf-off Seasons*