Appendix E:
Noise Technical Memorandum for the Deer Creek Station Project

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NOISE TECHNICAL REPORT

DEER CREEK STATION PROJECT

prepared for

Basin Electric Power Cooperative

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Project No. 51236

prepared by

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1.1 INTRODUCTION

Sound is caused by vibration of air molecules and is measured on a logarithmic scale with units of decibels (dB). Sound is composed of various frequencies. Frequency is measured in Hertz (Hz), which is the number of cycles per second. The typical human ear can hear frequencies ranging from approximately 20 Hz to 20,000 Hz. Typically, the human ear is most sensitive to sounds in the middle frequencies (1,000 to 8,000 Hz) and is less sensitive to sounds in the low and high frequencies. As such, the A-weighting scale was developed to simulate the frequency response of the human ear to sounds at typical environmental levels. The A-weighting scale emphasizes sounds in the middle frequencies and de-emphasizes sounds in the low and high frequencies. Any sound level to which the A-weighting scale has been applied is expressed in A-weighted decibels, dBA. For reference, the A-weighted sound pressure level and subjective loudness associated with some common noise sources are listed in Table 1-1.

Table 1-1: Typical Sound Pressure Levels Associated with Common Noise Sources

Sound Pressure Level (dBA)	Subjective Evaluation	Environment	
		Outdoor	Indoor
140	Deafening	Jet aircraft at 75 ft	
130	Threshold of pain	Jet aircraft during takeoff at a distance of 300 ft	
120	Threshold of feeling	Elevated train	Hard rock band
110		Jet flyover at 1000 ft	Inside propeller plane
100	Very loud	Power mower, motorcycle at 25 ft, auto horn at 10 ft, crowd noise at football game	
90		Propeller plane flyover at 1000 ft, noisy urban street	Full symphony or band, food blender, noisy factory
80	Moderately loud	Diesel truck (40 mph) at 50 ft	Inside auto at high speed, garbage disposal, dishwasher
70	Loud	B-757 cabin during flight	Close conversation, vacuum cleaner, electric typewriter
60	Moderate	Air-conditioner condenser at 15 ft, near highway traffic	General office
50	Quiet		Private office

Sound Pressure Level (dBA)	Subjective Evaluation	Environment	
		Outdoor	Indoor
40		Farm field with light breeze, birdcalls	Soft stereo music in residence
30	Very quiet	Quiet residential neighborhood	Bedroom, average residence (without TV and stereo)
20		Rustling leaves	Quiet theater, whisper
10	Just audible		Human breathing
0	Threshold of hearing		

Source: Adapted from Architectural Acoustics, M. David Egan, 1988 and Architectural Graphic Standards, Ramsey and Sleeper, 1994.

It has been found that the A-scale weighting best approximates the frequency response of the human ear. The human ear responds to noises in the audible frequencies in a similar manner in most individuals. Most humans perceive the change in a noise level as follows:

- 3 dBA – Barely perceptible change
- 6 dBA – Readily perceptible change
- 10 dBA – Doubling (or halving) of the apparent loudness

There are also objective factors to consider when determining the noise and how people may be affected by the noise. Noise in the environment is constantly fluctuating, such as when a car drives by, a dog barks, or a plane passes overhead. Therefore, noise metrics have been developed to quantify fluctuating environmental noise levels. These metrics include the exceedance sound level. The exceedance sound level, L_X, is the sound level exceeded “X” percent of the sampling period and is referred to as a statistical sound level. The most common L_X values are L_{eq}, L_{90}, L_{50}, and L_{10}. L_{eq} is the level of a constant sound over a specific time period that has the same sound energy as the actual sound over the same period. For this noise study, the most logical metric for noise measurements is L_{eq}.

1.2 STUDY PURPOSE

The purpose of this study is to collect background noise measurements and describe the existing noise environment for White Site 1 and use noise modeling techniques to determine the noise levels during the operation of the proposed 300 MW combined cycle combustion turbine.

1.3 LAND USE

The land in the vicinity of the Project is generally used for primarily agricultural purposes with scattered rural residences evident. There are minimal noise sources in the study area, with vehicular traffic and farming equipment being the primary sources of existing noise. Accordingly, the background noise levels vary by time of day.

There are two substations located to the south of the proposed Project which will contribute to ambient noise especially to residences located close to the substations, located to the south of the Project site. Additionally, an existing wind farm is located approximately three miles east of the proposed Project site and a proposed wind farm may be constructed to the west of the proposed site in the future. Because of the distance of the wind farms to the Project site, noise associated with the wind farms is not expected to contribute to ambient noise near the proposed site.

1.4 EXISTING NOISE LEVELS

An ambient noise survey was conducted in the vicinity surrounding the Project site. Background sound level measurements were taken during several time periods on May 19, 2009 and May 20, 2009 to capture the ambient sound levels near the proposed site. Measurements were made using a Larson-Davis Model 824 sound level meter (Type I sound level meter as specified in American National Standards Institute S1.4-1984/85A). The sound level meter was calibrated before and after each set of measurements. None of the calibration level changes exceeded ± 0.3 dB. A windscreen was used at all times on the meter, and the meter was mounted on a tripod, approximately five (5) feet above ground, with the microphone directed toward the Facility.

Strong winds were present during each of the noise survey periods. High wind speeds generate higher noise levels as winds interact with vegetation and other nearby objects and therefore tend to increase ambient noise level readings over times when light wind or still conditions exist. Approximate ambient meteorological conditions during the noise survey are displayed in Table 1-2.

Table 1-2: Meteorological Conditions During Noise Measurements

Date	Time Period	Temperature (°F)	Relative Humidity (%)	Wind Direction[1]	Wind Speed (mph)	Sky Cover
May 19, 2009	6 P.M. to 7 P.M.	90 to 92	24 to 29	South-southwest	17 to 26, gusts to 32	Clear
May 19, 2009 and May 20, 2009	11 P.M. to 1 A.M.	73 to 75	39 to 43	South-southwest	6 to 18, gusts to 20	Clear
May 20, 2009	6 A.M. to 7 A.M.	65 to 66	51 to 57	South-southeast	2 to 20, gusts to 27	Partly Cloudy (Cirrostratus)
May 20, 2009	9 A.M. to 11 A.M.	72 to 75	41 to 43	South-southwest	2-8 (MP1 only); 16 to 26, gusts to 37	Partly Cloudy (Cirrus)

[1]Direction wind blew from

Sound level measurements were made at seven locations (Figure 1-1). Each measurement was 5 minutes in duration. Noise measurements were not captured at three measurement points (MP2, MP3, and MP7) during three survey periods due to very high winds that were blowing dust into the microphone and meter. American National Standards Institute (ANSI) recommends noise measurements be taken with wind speeds less than 12 miles per hour (mph). Because wind speeds were above 12 mph in many instances, when the wind was not blowing or was low, instantaneous noise levels were also recorded. Table 1-3 displays the L_{eq} noise level (which normally included high winds) and minimum noise level (during low winds) that was captured during each measurement.

Table 1-3: Background Noise Levels

Measurement Point	Time Period	Measured L_{eq} (dBA)[1]	Minimum Measured Noise Level (dBA)	Extraneous Noises
MP1	6PM to 7PM	54	44	wind rustling trees and grass, birds
MP2	6PM to 7PM	--	--	
MP3	6PM to 7PM	--	--	
MP4	6PM to 7PM	57	44	wind rustling trees and grass, birds
MP5	6PM to 7PM	66	52	wind rustling trees and grass, birds, pole hitting fence
MP6	6PM to 7PM	59	43	Paper blowing, grass rustling, gate clanging, birds
MP7	6PM to 7PM	--	--	
MP1	11PM to 1AM	51	43	Wind rustling trees and grass, creaking gate, slight insect noise
MP2	11PM to 1AM	55	48	Wind rustling trees and grass, faint substations, frogs
MP3	11PM to 1AM	64	52	Wind rustling grass
MP4	11PM to 1AM	56	42	Wind rustling grass, frogs
MP5	11PM to 1AM	61	49	wind rustling trees and grass, frogs, pipe against gate
MP6	11PM to 1AM	49	39	wind rustling trees, wind howling through power lines
MP7	11PM to 1AM	52	42	wind rustling grass
MP1	6AM to 7AM	53	44	Wind rustling trees and grass, gate clanging
MP2	6AM to 7AM	--	--	
MP3	6AM to 7AM	--	--	
MP4	6AM to 7AM	58	46	Wind rustling trees and grass, birds
MP5	6AM to 7AM	61	49	wind rustling trees and grass, birds
MP6	6AM to 7AM	54	43	Wind rustling trees and grass, birds
MP7	6AM to 7AM	--	--	
MP1	9AM to 11AM	53	47	Wind rustling trees and grass, gate clanging, faint substation, faint birds
MP2	9AM to 11AM	--	--	
MP3	9AM to 11AM	--	--	
MP4	9AM to 11AM	65	50	Wind rustling trees and grass, faint birds
MP5	9AM to 11AM	70	53	Wind rustling grass, birds
MP6	9AM to 11AM	61	45	Wind rustling trees and grass, gate clanging, faint birds
MP7	9AM to 11AM	--	--	

[1]**Some measurements were not possible due to high winds blowing dust into the microphone**.

1.5 PROPOSED ACTION

Potential noise impacts resulting from implementation of the proposed Project include increased noise levels near sensitive noise receivers, such as residences. An analysis was completed to ensure that proposed Project is located and designed appropriately from a noise perspective and to evaluate the noise impact on the surrounding community.

The analysis focused on the nature and magnitude of the change in the noise environment associated with implementation of the proposed Project. The primary sources of noise associated with the Project would be construction activities during construction of the facility and the operation of the facility, once it has been constructed.

1.5.1 Construction Noise

The Project has the potential to cause a localized and temporary increase in ambient noise levels near roadways used for transporting equipment and materials; and around the construction of pipelines, transmission lines, and the electrical generating facility. There will also be an increase in traffic in the area during the construction of the facility, pipeline and transmission line which will also temporarily increase noise levels in the area. The actual noise levels generated by construction will vary on a daily and hourly basis, depending on the activity that is occurring, and the types and number of pieces of equipment that are operating. The U.S. EPA has compiled data regarding the noise generating characteristics of specific types of construction equipment and typical construction activities. This data is presented in Tables 1-4 and 1-5.

Table 1-4: Noise Ranges of Typical Construction Equipment

Equipment	Noise Levels (Leq, dBA) at 50 feet[1]
Back Hoe	73-95
Compressors	75-87
Concrete Mixers	75-88
Concrete Pumps	81-85
Cranes (moveable)	75-88
Cranes (derrick)	86-89
Front Loader	73-86
Generators	71-83
Jackhammers	81-98
Paver	85-88
Pile Driving (peaks)	95-107
Pneumatic Impact Equipment	83-88
Pumps	68-72
Saws	72-82
Scraper/Grader	80-93

Equipment	Noise Levels (Leq, dBA) at 50 feet[1]
Tractor	77-98
Trucks	82-95
Vibrator	68-82

[1]Machinery equipped with noise control devices or other noise-reducing design features do not generate the same level of noise emissions as shown in this table. Source: U.S. EPA, 1971

Table 1-5: Typical Outdoor Construction Noise Levels

Construction Phase	Noise Level at 50 feet (L_{eq}, dBA)	Noise Level at 50 feet with Mufflers (L_{eq}, dBA)
Ground Clearing	84	82
Excavation, Grading	89	86
Foundations	78	77
Structural	85	83
External Finishing	89	86

Source: U.S. EPA, 1971

Noise levels diminish rapidly with distance from the construction site at a rate of approximately 6 dBA per doubling of distance. For example, a noise level of 84 dBA measured at 50 feet from the noise source to the receptor would reduce to 78 dBA at 100 feet from the source to the receptor, and reduce to 72 dBA at 200 feet from the source to the receptor.

Once construction is near completion, a short-term occurrence of loud steam blows will likely impact nearby neighbors. The steam blows are necessary to remove debris in the steam turbine prior to initial startup of the units. The steam blows will occur during the daytime for approximately two to four weeks depending on the number of blows that are required to meet the cleanliness requirements of the steam turbine vendor. The typical sequence time is 5 minutes per blow and 30 - 60 minutes between blows to re-fill the drums, heat the water and re-pressurize.

The steam blows are expected to be near 115 dBA at 3-feet from the steam vents. This noise level will be approximately 55 dBA at the nearest residence when it occurs. Because this is a short-term event, this noise level will not significantly impact the nearby residences.

1.5.2 Operational Noise

In order to evaluate expected noise levels from the operation of the proposed Project, noise data for sources (such as the combustion turbines, steam turbines, cooling systems, and various other lesser sources) from the Project were modeled. The industry-accepted noise modeling software, Computer Aided Design for Noise Abatement (CadnaA), Version 3.72.127, published by DataKustik, Ltd., Munich, Germany, was used for this analysis. The CadnaA program is a scaled, three-dimensional program which takes into account each piece of noise-emitting equipment on the project site and predicts noise levels in circular contours of equal sound pressure. Appropriate sound generation was applied for all sound radiating surfaces and points. The model calculates noise propagation based on ISO 9613-2:1996, General Method of Calculation. ISO 9613 and CadnaA assess the sound levels based on the Octave Band Center Frequency range from 31.5 Hz to 8000 Hz.

The input data for each modeled source has been provided by each individual equipment supplier, matched with similar equipment in Burns & McDonnell's Noise Source Inventory, or calculated if the data was not available. Equipment sound power levels are used in the model to predict sound pressure levels at nearby locations. Even though all equipment may not be operating at the same time (i.e – some equipment may only operate during start-up) all equipment that emits sound was included in the model and assumed to operate at the same time. This provides a conservative estimate of the noise from the Project. Table 1-6 displays the noise-emitting sources that were modeled for this project and their corresponding sound power levels.

Table 1-6: Modeled Overall Sound Power Levels

Unit	Overall Sound Power Level, dBA
CT Inlet Ducting	86.5
CT Inlet Filter Face	98.7
CT Accessories	103.4
CT Inlet Plenum	102.2
CT Turbine Compartment	110.2
CT Exhaust Diffuser	110.2
CT Load Compartment	104.4
CT Generator	107
CT Compt Vent Fans	103.8
CT Exhaust Enclosure Vent Fans	102.2
CT Exhaust Expansion Joint (inside gas)	145.3
Step-Up Transformer	93.7
Auxiliary Transformer	87.5
Steam Turbine Generator	92.4
Steam Turbine	92.5
STG Building Fans	81.9
ST Generator Slip Ring House	92.5
Steam Trunk Main Start Up	103.1
Steam Trunk Duct 2a Start Up	101.1
Steam Trunk Duct 2b Start Up	100.1
Steam Trunk Duct 3 Start Up	96.2
Steam Trunk Duct 4 Start Up	93.1
H1 HRSG Inlet Duct	111.2
H2 HRSG Module 1-3	102.2
H3 HRSG Module 4-7	97.2
Stack Exit	110.0
Boiler Feedwater Pump	109.9
Air Cooled Condenser (total fan assembly)	99.8
FIN FAN Cooler	98.5

In the model, attenuation was included for sound propagation over vegetation, terrain, barriers, and shielding. The atmospheric conditions were assumed to be calm and the temperature and relative humidity were set to 50 degrees Fahrenheit and 70 percent, respectively (based on program defaults). Receptors were placed in the model at locations that correspond to the locations where ambient measurements were taken as noted in Figure 1-2.

Modeled plant operational noise levels, associated solely with the operation of the proposed Project, were logarithmically added to minimum noise levels for each measurement point. The predicted and overall operational sound levels for the modeled receptors are shown in Table 1-7. Figure 1-2 displays the sound contour levels in 5-dBA increments for the area surrounding the Project site based on the proposed Project location and layout of the facilities as noted.

Table 1-7: Estimated Operational Noise Levels

Measurement Point	Minimum Measured Noise Level (L_{eq}, dBA)	Modeled Plant Noise Level (L_{eq}, dBA)	Estimated Total Operational Noise Level (L_{eq}, dBA)
MP1*	43	45	47
MP2	48	51	53
MP3*	52	41	52
MP4*	42	43	45
MP5*	49	45	50
MP6*	39	44	45
MP7	42	54	54

*Represents sensitive noise receiver (residence).

The maximum increase in noise levels at the sensitive noise receivers is projected to increase by no more than 6 dBA over the background noise levels. This noise level is considered noticeable, but is not perceived as a doubling of the sound level at the receiver.

The Department of Housing and Urban Development (HUD) has development guideline noise levels for HUD housing. This level is 65 dBA L_{dn}, where L_{dn} is a day-night average noise level in which a 10 dB penalty is applied to the nighttime noise levels. Essentially, the nighttime noise level should be below 55 dBA and the daytime noise level should be below 65 dBA. Since the greatest contribution to noise levels in the area at any residence is modeled to be at 45 dBA, this Project will be within the HUD guideline noise levels.

A noise analysis was not conducted for the White Site 2 Alternative. However, distances between residences and the White Site 2 Alternative are closer than the White Site 1 and therefore, would likely result in higher noise impacts at sensitive receptors than at White Site 1

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