AQUILA, INC.
AQUILA NETWORKS-MISSOURI (ELECTRIC)
CASE NO. EA-2006-309
STOPAQUILA.ORG
DATA REQUEST NO. SAO-0017

DATE OF REQUEST: March 24, 2006

DATE RECEIVED: March 24, 2006

DATE DUE: April 3, 2006

REQUESTOR: StopAquila.org

FILED[3]
MAY 11 2006
Missouri Public Service Commission

REQUEST:

Copies of all noise studies performed after the South Harper Plant became operational.

RESPONSE:

Please see attached.

ATTACHMENT(S):

Noise Measurement Study dated September 27, 2005
Residential Noise Assessment Study dated August 2005
Noise Compliance Test dated August 2005
Noise Compliance Test – Peculiar Substation dated August 2005

ANSWERED BY: Block Andrews

DATE ANSWERED: March 31, 2006

Exhibit No. 16
Case No(s). EA-2006-0309
Date 4-27-06 Rptr KP

Project 670800

Noise Measurement Study

South Harper Peaking Facility
Cass County, Missouri

September 27, 2005

PREPARED FOR:

Aquila Inc.

PREPARED BY:

ATCO Noise Management

EXECUTIVE SUMMARY

ATCO Noise Management (ATCO) conducted a noise measurement study from August 25th to August 28th, 2005 at the South Harper Peaking Facility of Aquila (SHPF) located in Cass County, Missouri. This report documents the long-term sound level measurements at the residential locations and the measurements of equipment noise emissions within the site.

The facility consists of three identical Siemens 501D5A simple cycle gas turbine generator packages. Each package includes: gas turbine enclosure, generator enclosure, turbine exhaust transition duct, exhaust stack, turbine inlet filter house, lube oil skid, starting motor enclosure, and step-up transformer. Various other equipment installations were also identified on the site, such as the regulation metering station.

During the site investigation, SHPF and ATCO established seven long-term sound level measurement locations at the nearby residences and within the facility property. Ambient sound levels of existing acoustic environments without the facility in operation and comprehensive sound levels at residences with the facility in operation were recorded. Measurements of equipment noise emissions were also collected at each piece of operating equipment on the site. The data was then analyzed to identify the dominant noise sources within the facility.

On August 26th and August 27th, 2005, one unit (Unit # 1) of three units of SHPF was operating.

ATCO investigated and analyzed the measurement results, the major conclusions are summarized below:

1. The existing ambient environment at the residences is a typical rural area characterized by local residential activities, traffic, and natural sound;
2. A heavy insect sound was investigated in the ambient acoustic environment, especially during the nighttime. The insect sound dominates the high frequencies around 6300 Hz and 8000 Hz;
3. Comprehensive sound level measurements with SHPF in operation confirmed the noise impact from the facility to the residences;
4. The noise impact of the facility mainly focuses on the low frequency noise below 63 Hz and high frequency noise in the range from 1000 Hz to 3150 Hz;
5. Diagnostic measurement of equipment noise emissions revealed the dominant noise sources responsible for the noise impact. Some tonal components were identified from the measurements, they are: turbine filter house at 1250 Hz; turbine inlet transition duct casing at 1250 Hz and 2500 Hz; and turbine exhaust transition duct casing at 3150 Hz.

In order to reduce the noise impact from SHPF to the nearby residences, a further detailed engineering noise control study of the facility is recommended.

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Background

Aquila Inc. retained ATCO Noise Management (ATCO) to conduct a noise measurement study during plant operations at their South Harper Peaking Facility (SHPF), located in Cass County, Missouri.

The facility consists of three identical Siemens 501D5A simple cycle gas turbine generator packages. Each package includes a gas turbine enclosure, generator enclosure, turbine exhaust transition duct, exhaust stack, turbine filter house, lube oil skid, starting motor, and step-up transformer. Various other noise sources were also identified on the site, such as the regulation metering station.

The facility has received complaints from the nearby residents regarding plant operation noise. The scope of this study required ATCO to measure sound level data at locations representative of the complainants while the facility was in operations; investigate and collect noise emission measurements for the various sources on the site; and identify the dominant noise sources.

ATCO conducted the noise measurements during the period of August 25th to 28th, 2005. This work was authorized by Aquila.

This report documents the long-term sound level measurements at the residences and the measurements of equipment noise emissions within the site. This report also contains information on noise and noise mitigation alternatives affecting the environment. Noise is described spectrally, by One-third Octave Band Frequency and Octave Band Center Frequency, in decibel levels of sound pressure as well as by percentile sound levels - L_{01}, L_{10}, L_{50}, L_{90}, and L_{99} statistical descriptors that describe and define the temporal characteristics of noise. A glossary of acoustical and sound level terminology is given in Appendix A.

1.2 Study Objectives

The key objective of this study is to establish, through methods of acoustical diagnostic measurement, the dominant noise sources impacting the residences. This process includes the following:

1. Collect long-term comprehensive sound level measurements at the identified locations while the plant is operating;
2. Measure the ambient/background sound levels at the residential locations when the plant is shut down, and determine the lowest ambient sound levels at these locations;

3. Investigate the sound propagation within the site and make observations on major noise sources;
4. Conduct equipment noise emission measurements and analyze the collected data to determine the dominant noise sources within the facility;
5. Identify and rank the major noise sources measured on the site;
6. Summarize and document the collected noise measurement data in a written report.

1.3 Site Description

SHPF is located in a rural area of agricultural, industrial, and residential land uses. The facility is surrounded by the following land features and activities:

1. To the east and northeast, by South Harper Road; some residences are located along the road;
2. To the northeast corner of the site, bounded by industrial land of Southern Star Central Gas Pipeline;
3. To the north, by East 241 Street; residences are located on the north of the street;
4. To the west, by trees with a few residences located on the other side of trees; and
5. To the south, by farms.

The aerial view of the site and the surrounding area is shown in Figure 1.1.

1.4 Plant Operations

During the noise survey, SHPF operated on August 26th, and 27th, 2005. Only Unit #1 was in operation during the measurement periods. The operation of this turbine unit is briefly described below. This data was provided to ATCO by SHPF.

1. August 26th, 2005: Unit # 1 was operating at base load from 12:26 PM to 15:55 PM; 80MW load from 15:55 PM to 16:39 PM; and base load again to 17:54 PM;
2. August 27th, 2005: Unit #1 was operating at base load from 13:39 PM to 18:20 PM.

2.0 MEASUREMENT PROCEDURES

2.1 Measurement Methodology

The following is a description of the measurement methodology that was developed by ATCO to analyze the sound levels at noise monitoring locations exterior to the site and also the equipment noise emissions within the site.

All measurements were taken with sound level meters set on both the linear and A-weighted scales. The meters were calibrated at the beginning and end of the measurement session. The microphone of each sound level meter was set at 5 ft above the ground/berm with a windscreen to reduce the effects of wind-induced noise while monitoring the long-term sound levels.

The measurements were performed in accordance with American National Standards Institute (ANSI) standard ANSI S12.9-R 1993, ANSI S12.18 – 1994, ANSI B133.8 – 1977, and other appropriate standards, such as ISO 3744:1994 and ISO 10494:1993. These standards provide basic quantities for the description of sound in community environments, general procedures for measurement of noise sources and calculation method of sound power levels.

The measured sound level data were recorded and stored in the equipment for later analysis in ATCO's office. The data were analyzed throughout the frequency spectrum, showing the distribution of sound levels versus frequency and statistical levels versus time to separate the plant source noise from extraneous environmental noise. Measurement results are shown in Appendix C and Appendix D.

2.1.1 Long-Term Sound Level Measurement

Long-term sound level measurements were conducted at seven locations, six exterior to the site and one within the SHPF property. A description of these measurement locations is given in the following sections. Details of the measured levels are provided in Appendix C.

The measurements started at about 11:00 AM August 26th and ended at about 10:00 AM August 28th, 2005. Unit #1 was in operation for 6 hours and 5 hours respectively during two days. The intervals of measurement were set from 5 minutes to 1 hour at different locations and in different measurement periods. Sound levels were recorded in terms of the equivalent sound level L_{eq}, and percentile sound levels, L_{01}, L_{10}, L_{50}, L_{90}, and L_{99}, as well as detailed sound levels in One-Third Octave Band Frequency.

The purpose of these measurements was to capture both the ambient/background sound levels and the characteristics of sound propagation to the measurement locations. The collected data was then compared with the equipment noise measurement results. The facility noise contribution to the acoustic environment can be determined from this information.

2.1.2 Equipment Noise Emissions within the Site

Sound level measurements of noise emissions were taken for the following equipment while only Unit #1 was operating: gas turbine enclosure and ventilation, turbine inlet system, generator enclosure and ventilation, turbine exhaust transition duct, exhaust stack casing and exit, turbine exhaust transition duct enclosure and ventilation, lube oil skid and cooler, rotor air cooler, starting motor, step-up transformer and the gas metering piping.

The measurements were generally conducted at a distance of approximately 3 ft from the equipment surface. The measuring interval was set from 15 to 30 seconds for each measurement. The maximum sound level L_{max} and the equivalent sound level L_{eq} were collected.

These data were collected for the purpose of determining the contribution of each piece of equipment to sound levels at the residential locations.

2.2 Instrumentation and Set Up

All sound level measurements were taken with the following sound level meters: four Larson Davis LDL 824 Sound Level Meters, one Larson Davis LDL 3000+ Dual Channel Real-time Sound Level Analyzer, one Bruel & Kjaer 2238 Sound Level Meter and one Rion NA-27 Sound Level Meter.

The precision sound level meters are Type 1 sound level meters and all meet the ANSI S1.4, Type 1 Specification. The instruments were set to measure sound pressure levels on the linear and A-weighted frequency scales. The frequency range of the LDL 824 and 3000+ instrument were set from 12.5 Hz to 20000 Hz.

For long-term measurements, the sound level meters collected the sound levels in one-third octave bands and octave band center frequencies, as well as the percentile sound levels L_{01}, L_{10}, L_{50}, L_{90}, and L_{99}.

All sound level meters were field calibrated for sound measurement, and have current laboratory certification.

2.3 Long-term Measurement Locations

Six residential locations were identified by Aquila, and one monitoring location within the facility property was selected by ATCO. The residences are located to the northeast, north, and west of SHPF. Descriptions of these noise receptors (R) are as follows:

1. **R 1** – Frank Dillon's residence, located at South Harper Road, northeast of the site. R 1 is about 1190 ft (364 m) from Stack # 1 on the site, and located at GPS coordinates N38°40'58", W 94°28'47";
2. **R 2** – Unoccupied new house, north of the site at 241st Street. R 2 is about 1957 ft (597 m) from Stack #1, and at GPS coordinates N 38°41'9", W 94°28'54";
3. **R 3** – Nancy Manning's residence, located at 241st Street, northwest of the site. R 3 is 2180 ft (666 m) from Stack # 1, GPS coordinates are N 38°41'9", W 94°29'11";
4. **R 4** – Della January's residence, 3668 ft (1119 m) northwest of the site. R 4 is at GPS coordinates N 38°41'25", W 94°29'9";
5. **R 5** – Harold Stanley's residence, located at E 240 Street, northeast of the site. R 5 is about 3695 ft (1127 m) from Stack # 1, at GPS coordinates N 38°41'10", W 94°28'19";
6. **R 6** – Mark Andrews' residence, 2193 ft (669 m) west of the site. R 6 is at GPS coordinates N 38°40'45", W 94°29'25";
7. **R 7** – within the site property, on the north berm. R 7 is about 262 ft (80 m) north of Stack # 1, at GPS coordinates N 38°40'53", W 94°28'58". This location is a reference point to calibrate the sound propagation between the actual measurements and the predicted sound levels from the acoustic modeling. The results of R 7 are not included in this report.

Locations R 1 - 6 are located in a typical rural area; the acoustic environment is characterized by noise generated from nearby road traffic; local residential activities; natural sounds such as insect sounds, rustling leaves, and barking dogs; and intruding industrial noise. These measurement locations are shown in Figure 1.1.

2.4 Meteorological Conditions

Wind, temperature and relative humidity can have a large effect on the propagation and measurement of sound. When long-term sound level monitoring and equipment noise emission measurements were taken, the wind speed, temperature and relative humidity were within limits recommended for the proper operation of the instruments or ANSI standards. There was no atmospheric turbulence and inversion layers were not present. A brief description of the weather conditions is presented in Table 2.1. A detailed weather record is attached in Appendix B.

TABLE 2.1 Meteorological Conditions during Measurement Period

Measuring Period	Wind Speed Range (mph)	Temp (°F) Max/Mean/Min	Humidity Range (%)
August 26th, 2005	Calm ~ 8	84/76/69	65 ~ 84
August 27th, 2005	Calm ~ 6	87/78/69	51 ~ 97
August 28th, 2005	Calm ~ 7	87/78/66	62 ~ 93

3.0 MEASUREMENT RESULTS AND ANALYSIS

3.1 Ambient Sound Levels at Residences

The ambient or background sound level within community environments is defined as the all-encompassing noise level that seems to come from "all around", but excludes intrusive noise of short duration such as aircraft over flight.

Sound level measurements, L_{eq}, L_{01}, L_{10}, L_{50}, L_{90}, L_{99}, were collected at six residential locations, during the facility's operation and shut-down. Generally, the equivalent sound level L_{eq} is an energy-average quantity over a measurement period. The percentile sound level (L_n) describes the various characteristics of intrusive sounds in the environment. For example, L_1 represents the measured sound levels exceeded 1% of the measuring time and is usually regarded as the average maximum noise levels; L_{50} is the sound level exceeded 50% of the measurement time, and provides an indication of the median sound level; and the L_{90} is usually regarded as the residual level or the best approximate background noise level at the measurement locations.

In this report, the L_{eq} sound level is selected as the descriptor of the ambient sound level. The L_{eq} sound level is the most important measure of outdoor noise for the purpose of correlating noise and community reaction. It represents all sounds in the environments during the time period.

According to the measurement results, the ambient sound levels at the residential locations without the plant operations were selected and then the ambient sound levels during the day time (7:00 AM to 22:00 PM) and nighttime (22:00 PM to 7:00 AM) were determined at each measurement location.

The intervals or duration of measurement were set from 5 minutes to 1 hour at different locations and in different measurement periods. For example, during the day time, the measuring interval was set to 5 minutes at locations R 1, R 3, and R 5; and to 1 hour during the nighttime.

During the measurement periods, the nearby facility of Southern Star Central Gas Pipeline was not operating.

Table 3.1 summarizes the ambient sound level measurement periods at six residential locations while the plant was not operating.

Table 3.2 tabulates the low and high ambient sound levels measured during the day time and nighttime at the six locations. Extremely high levels caused by occasional activities, like lawn mowing, were excluded in this summary table. Detailed measurement results at six locations are attached in Appendix C of the report.

TABLE 3.1 Summary of Ambient Sound Level Measurement Periods

Measurement Location	Location Description	Time Period
R 1	24211 S. Harper Rd.	18:00 PM August 26 to 13:00 PM August 27
		18:30 PM August 27 to 9:30 AM August 28
R 2	New House at 241st St.	19:16 PM August 26 to 9:30 AM August 27
R 3	24021 S. Lucille Ln.	18:00 PM August 26 to 13:00 PM August 27
		18:30 PM August 27 to 9:40 AM August 28
R 4	23811 S. Lucille Ln.	18:00 PM August 26 to 13:00 PM August 27
		18:30 PM August 27 to 9:50 AM August 28
R 5	10707 E. 240th St.	18:00 PM August 26 to 13:00 PM August 27
		18:30 PM August 27 to 9:20 AM August 28
R 6	24407 S. Overfelt Rd.	19:34 PM August 27 to 9:44 AM August 28

TABLE 3.2 Summary of Day and Night Ambient Sound Level

Measurement Location	Daytime				Nighttime			
	Lowest Sound Level / Time		Highest Sound Level / Time		Lowest Sound Level / Time		Highest Sound Level / Time	
R 1	43 dBA	18:35 PM Aug 27	64 dBA	10:00 AM Aug 26	51 dBA	22:00 PM Aug 27	56 dBA	23:00 PM Aug 26
R 2	49 dBA	19:36 PM Aug 26	55 dBA	21:16 PM Aug 26	55 dBA	22:36 PM Aug 26	57 dBA	6:16 AM Aug 27
R 3	39 dBA	18:39 PM Aug 27	55 dBA	12:44 PM Aug 27	50 dBA	22:00 PM Aug 28	54 dBA	1:00 AM Aug 27
R 4	49 dBA	7:00 AM Aug 28	59 dBA	12:43 PM Aug 27	49 dBA	3:00 AM Aug 28	55 dBA	22:30 PM Aug 26
R 5	44 dBA	18:34 PM Aug 27	64 dBA	18:35 PM Aug 26	50 dBA	3:00 AM Aug 28	59 dBA	0:49 AM Aug 27
R 6	49 dBA	9:14 AM Aug 28	59 dBA	19:54 PM Aug 27	47 dBA	3:14 AM Aug 28	52 dBA	5:34 AM Aug 28

Figure 3.1 through Figure 3.6 graphically illustrate the measurement results over measuring times at the six locations. Detailed measurement results at six locations, including sound levels of L_{eq}, L_{01}, L_{10}, L_{50}, L_{90}, L_{99}, are attached in Appendix C of the report.

Table 3.2 shows that the lowest ambient sound levels occurred during the evening or early morning, rather than during the nighttime. This is because the heavy insect noise present dominates the nighttime acoustic environment. Based on the spectral data, insect noise typically manifests itself in the high frequency bands around 6300 Hz and 8000 Hz. This high frequency noise yields a high overall A-weighted ambient sound level during the nighttime.

Generally, without SHPF's operation, the acoustic environments at the six locations are typical rural areas, characterized by noise from nearby road traffic; local residential activities; natural sounds such as insect sounds, rustling leaves, barking dogs and other animal sounds.

3.2 Comprehensive Sound Levels at Residences

While Unit # 1 of SHPF was in operation, comprehensive sound levels including plant operational noise and background noise were recorded at six measurement locations. The intent of this section is to examine and determine the noise impact from SHPF's operation to the receptors R 1 to R 6.

The Unit # 1 turbine operated from 12:26 PM to 17:54 PM on August 26th, 2005; and from 13:39 PM to 18:20 PM on August 27th, 2005.

The measurement intervals for comprehensive measurements were set to 5 minutes or 10 minutes to capture the noise fluctuations caused by the operation at the receptors.

Figures 3.1, 3.3, 3.4, and 3.5 also show the measured sound levels over time during the facility operation. Detailed measurement results at locations R 1, R 3, R4 and R5, including sound levels of L_{eq}, L_{01}, L_{10}, L_{50}, L_{90}, L_{99}, can be found in Appendix C of the report.

The noise of the facility was generally perceptible at the measurement locations. In order to investigate and determine the noise impact from SHPF at the residences, spectral analysis was conducted. Sound levels in One-third Octave Band Frequency were compared before and after the facility's operation. An example is presented below for location R 1, which is the closest residence to the facility and would receive the most noise impact.

Figure 3.7 displays two spectral sound levels in One-third Octave Band Frequency with and without Unit # 1 in operation. Table 3.3 gives two spectra by Octave Band Center Frequency and the differences in the sound levels between the two conditions.

TABLE 3.3 Example of Change of Sound Levels at R 1

Measuring Time	Octave Band Center Frequency Hz/dB re 20 μPa									
	16	31.5	63	125	250	500	1k	2k	4k	8k
Unit # 1 operating, 14:50 PM, Aug 26	69	65	58	53	43	36	41	43	39	51
Unit #1 shut-down 18:45 PM, Aug 26	54	56	57	53	39	33	37	33	31	42
Change	+15	+9	+1	0	+4	+3	+4	+10	+8	+9

Figure 3.7 and Table 3.3 indicate that a significant increase in noise levels at R 1 when the facility was in operation, particularly in the low frequency bands below 63 Hz, and in the high frequencies between 1000 Hz and 3150 Hz. The ambient measurements confirmed that the sound around 6300 Hz and 8000 Hz is probably caused by insects. Therefore, the major noise impact by the facility at R 1 is in the low frequencies below 63 Hz and in the high frequency range from 1000 Hz to 3150 Hz.

The human ear is more sensitive to sound in the high frequency than the low frequency. The 10 dB increase of sound level in frequencies from 1000 Hz to 3150 Hz is clearly perceptible and would cause annoyance at the residence. High low-frequency noise may produce noise-induced vibrations in lightweight structures like ceilings, windows, and ductwork; and can be expected to cause rattles in these structures. Low and high frequency noise, while producing different effects, are both sources of noise complaints.

Spectral analysis was applied to other comprehensive sound level measurement results. Although the magnitude of the increase of the sound levels varied at the different locations, similar results showing impacts from low and high frequency were obtained. The dominant noise sources causing the noise impact were identified through noise diagnostic measurement at the operating equipment within the site.

It should be noted that comprehensive sound levels at residential locations were collected while only one of the three units was in operation. When all three units are operating, the comprehensive sound levels at residential locations will be a few decibels higher.

3.3 Measurement Results for Equipment Noise Emissions within the Site

Sound level measurements of the various pieces of equipment while Unit # 1 was operating were taken on the site.

The aim of these measurements was to capture the noise emitted from the operating equipment and then determine, through analysis, the dominant noise sources that influenced the sound levels at the residential locations.

The table in Appendix D gives the sound levels measured from the various pieces of equipment between 10:20 AM to 10:30 AM on August 25th; 13:00 PM to 18:30 PM on August 26th; and 14:20 PM to 18:40 PM on August 27th. The measurement point file ID, its description, measured overall A-weighted sound level and sound levels in Octave Band Center Frequency are summarized in this table. Unless otherwise indicated, the measurements were taken 3 ft from the equipment surface.

3.3.1 Ranking of Measured Sound Levels

Table 3.4 below summarizes the ranking of the highest measured sound levels in Octave Band Center Frequency for each piece of equipment while Unit # 1 was operating. This data is presented in descending order in terms of overall dB(A) sound level. For each piece of equipment, only the highest sound level is listed in the table.

Table 3.4 Ranking of Measured Source Sound Levels within Site

Rank	Measurement Location	Octave Band Center Frequency Hz/dB re 20 µPa										dBA
		16	31.5	63	125	250	500	1k	2k	4k	8k	
1	under starting motor enclosure	89	84	88	91	93	99	102	103	110	9[illegible]	112
2	turbine gas purge vent	92	88	89	88	82	88	95	99	102	10[illegible]	109
3	under starting motor enclosure, side	90	86	90	93	87	94	100	99	102	89	106
4	starting motor exhaust louver	88	88	90	93	93	92	96	102	97	85	105
5	start motor enclosure upper louver	89	83	82	83	86	89	96	93	95	88	101
6	turbine transition duct enclosure, west	100	96	98	86	100	93	91	88	81	76	97
7	starting motor casing	87	84	82	87	79	83	88	89	93	79	96
8	turbine inlet duct casing, under insulated section	102	96	91	84	80	78	94	88	79	72	96
9	turbine inlet duct casing, north side, under silencer	100	95	92	88	78	74	90	87	82	72	93
10	front of lube oil skid ventilation fan	98	95	97	94	92	87	86	84	79	73	92
11	generator enclosure casing, west side	98	94	90	93	87	79	89	83	76	68	91
12	turbine filter house west, 1' inside hood	100	98	93	85	78	72	89	81	83	78	91
13	top of lube oil cooler	110	110	105	99	92	88	82	80	78	73	91
14	under hood of turbine enclosure intake between two vents	98	91	91	99	90	85	81	81	80	78	90

Rank	Measurement Location	Octave Band Center Frequency Hz/dB re 20 µPa										dBA
15	generator enclosure exhaust louver	114	109	100	94	91	84	83	80	80	76	89
16	under hood of turbine enclosure intake west vent	97	90	90	98	[illegible]	84	80	81	80	78	89
17	transformer fan	73	70	78	80	84	86	85	82	74	71	89
18	generator enclosure casing, east side	94	91	96	92	92	83	82	77	74	64	88
19	turbine enclosure casing, west side	97	91	86	85	76	81	85	82	73	65	88
20	lube oil skid louver	95	94	93	88	[illegible]	84	81	81	78	73	88
21	pipe casing from turbine to cooler	95	91	89	87	83	77	81	82	76	66	87
22	rotor air cooler fan	111	96	94	91	[illegible]	85	79	77	76	67	87
23	exhaust transition duct, west side	105	103	98	95	[illegible]	81	76	76	80	62	86
24	under turbine encl. intake east vent	95	90	91	96	89	81	78	76	73	69	86
25	turbine exhaust duct enclosure casing	101	95	92	84	[illegible]	86	80	73	69	62	86
26	turbine filter house west, 3' outside hood	93	96	97	83	[illegible]	70	83	74	79	76	86
27	turbine exhaust transition duct, west side, middle level	102	101	98	93	83	81	76	75	78	60	86
28	turbine inlet silencer casing, north side	98	93	89	82	73	75	82	80	75	65	86
29	generator enclosure intake filter	88	92	93	90	[illegible]	74	81	79	75	68	85
30	stack casing, 10 ft under platform level	98	98	89	88	[illegible]	79	77	77	78	72	84
31	pipe of metering station	82	77	70	68	[illegible]	57	68	79	80	76	84
32	top of rotor air cooler	95	91	92	87	[illegible]	78	79	77	73	61	84
33	stack casing, under bottom of stack	108	103	97	97	81	75	73	69	69	55	83
34	45 degree from stack exit edge	106	100	91	88	85	80	76	73	71	64	83
35	turbine filter house casing, north side	100	92	87	79	76	73	77	75	72	65	81
36	90 degree from stack exit edge	106	100	91	86	82	78	74	71	69	61	81
37	lube oil skid casing	93	91	94	87	81	77	74	69	70	66	80
38	turbine enclosure exhaust west vent	107	101	93	90	80	74	73	70	71	63	80
39	stack casing, platform level	99	93	86	87	78	68	68	66	62	57	76
40	stack casing, 10 ft under top	100	92	84	79	72	63	61	59	53	52	69

3.3.2 Tonal Analysis

A tonal noise source is any sound that can be distinctly identified through the sensation of pitch. Tonal or discrete frequency sound is characterized by spikes of high energy at specific frequencies in an otherwise continuous noise spectrum.

In ANSI Standard 12.9 Part 3 – 1993 "Quantities and Procedures for Description and Measurement of Environmental Sound – Part 3: Short Term Measurements with an Observer Present", Appendix C, Sections C.1 and C.2 describe a method for the determination of the presence of tonality in an environment. The standard states:

For a prominent discrete tone to be identified as present, the equivalent-continuous sound pressure level in the one-third octave band of interest is required to exceed the average equivalent-continuous sound pressure level for the two adjacent one-third octave bands by some constant level differenc, K_t.

Note: This constant may vary with frequency. Possible choices for the level differences are 15 dB in low one-third octave bands (25 – 125 Hz). 8 dB in middle-frequency bands (160 – 400 Hz), and 5 dB in high-frequency bands (500-10,000 Hz).

TABLE 3.5 Prominent Discrete Tone Definitions

Frequency Range, Hz	25 Hz – 125 Hz	160 Hz – 400 Hz	500 Hz – 10 kHz
Level Difference for Two Adjacent One-third Octave Bands (dB)	15	8	5

In accordance with Table 3.5, some noise sources were identified with tonal components. These noise sources are the turbine inlet filter house, turbine inlet transition duct and turbine exhaust transition duct casing.

Figure 3.8, Figure 3.9 and Figure 3.10 illustrate the measured spectral sound levels in One-third Octave Band Frequency at 3 ft from the turbine inlet filter house, turbine inlet transition duct casing, and turbine exhaust transition duct casing, respectively.

It can be seen that the turbine inlet filter house has a tonal component at 1250 Hz; the turbine inlet transition duct casing carries tones at 1250 Hz and 2500 Hz; and the turbine exhaust transition duct casing has a tone at 3150 Hz. These high-pitched tonal components could be the dominant contributors for the noise increase in frequencies from 1000 Hz to 3150 Hz at the residential locations.

It should be noted that noise mitigation insulation is being implemented on three turbine inlet transition ducts by Aquila. The lagging system is made of mineral wool insulation, gypsum board layer and metal covering. The lagging will reduce the noise emissions and tonal components greatly from the turbine inlet transition duct.

3.3.3 Dominant Noise Sources

Based on the diagnostic measurement of equipment noise emissions, the components presented in Table 3.4 represent the dominant noise sources that contribute to the noise impact on the residential locations.

Through acoustic analysis, and considering the source geometry dimensions, the noise sources identified as major contributors of noise at the measurement locations include (but are not limited to):

1. Starting motor enclosure, including underneath openings, motor exhaust louver, and enclosure casing. These component have very high overall sound levels;
2. Exhaust stack casing, carrying significant low frequency noise;
3. Exhaust transition duct casing, having low frequency noise as well as a tonal component at 3150 Hz;
4. Turbine inlet filter house, having a tonal component at 1250 Hz;
5. Turbine inlet transition duct, with tones at 1250 Hz and 2500 Hz;
6. Turbine gas purge vent;
7. Generator enclosure exhaust;
8. Lube oil cooler fan;
9. Lube oil skid ventilation fan; and
10. Step-up transformer.

The starting motor is housed in an enclosure; however, the enclosure is open underneath from which a significant amount of noise is escaping. The starting motor operates about six minutes before the turbine begins running, and two times after turbine shutdown. The operation of the starting motor after turbine shutdown is called "spin cool". Should the spin cool occur during the nighttime, it would cause noise annoyance at the residences.

After turbine shutdown, the gas will be vented to the atmosphere through a gas purge vent. This process lasts a couple of seconds and makes a high-pitched impulsive noise.

All these noise sources contribute to the noise impact at the residences which is causing noise complaints. To reduce the noise impact from SHPF, noise mitigation measures should be applied. Further engineering noise control studies of these noise sources should be completed.

4.0 CONCLUSIONS

In this study, ATCO has presented the sound level measurements at six long-term measurement locations that are representative of the residences located near the South Harper Peaking Facility. Both ambient and comprehensive sound level measurement results were reported. Equipment noise emission measurements within the site during Unit # 1 operation have also been presented.

ATCO investigated the ambient measurement results and examined the noise impact from SHPF at the nearby residences; the major conclusions are summarized below:

1. The existing ambient environment at the residences is a typical rural area characterized by local residential activities, traffic, and natural sound;
2. A heavy insect sound was investigated in the ambient acoustic environment, especially during the nighttime. The insect sound dominates the high frequencies around 6300 Hz and 8000 Hz;
3. Comprehensive sound level measurements with SHPF's operation confirmed the noise impact from the facility to the residences;
4. The noise impact of the facility mainly focuses on the low frequency noise below 63 Hz and high frequency noise in the range from 1000 Hz to 3150 Hz;
5. Diagnostic measurement of equipment noise emissions revealed the dominant noise sources responsible for the noise impact. Some tonal components were identified from the measurements, they are: turbine filter house at 1250 Hz; turbine inlet transition duct casing at 1250 Hz and 2500 Hz; and turbine exhaust transition duct casing at 3150 Hz.

In order to reduce the noise impact from SHPF to the nearby residences, a further detailed engineering noise control study of the facility is recommended.

5.0 DISCLAIMERS

ATCO's study is based on an examination of representative portions of the background noise conditions, which occurred at the time of the survey. We cannot and do not warrant any different conditions that may exist but which were not represented at the time of the survey. It must be further acknowledged that ATCO's survey is based on the present condition only, and that we cannot predict whether or not future conditions will occur that would alter the results of this study.

Third Party:

The "study" reported in the preceding pages, has been prepared in response to a specific request for service from the Client to whom it is addressed. The information contained in this "study" is not intended for the use of, nor is it intended to be relied upon, by any person, firm, or corporation other than the Client to whom it is addressed. We deny any liability whatsoever to other parties who may obtain access to the information contained in this "study" for any damages or injury suffered by such third parties arising from the use of this "study" by them without the express prior written permission from ATCO and its Client who has commissioned this "study".

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FIGURES

Figure 1.1 Aerial View of SHPF Site and Residential Measurement Locations