Baseline Sound Survey Report

Horse Heaven Wind Project

Benton County, Washington

Prepared for:
Horse Heaven Wind Farm, LLC

Prepared by:

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TABLE OF CONTENTS

LIST OF TABLES

FIGURES

ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

µPa	microPascal
Applicant	Horse Heaven Wind Farm, LLC
ANSI	American National Standards Institute
dB	decibel
dBA	A-weighted decibel
dBL	linear decibel
Hz	hertz
L_{eq}	equivalent sound level
L_P	sound pressure level
L_w	sound power level
Micrositing Corridor	Wind Energy Micrositing Corridor
NSR	noise sensitive receptor
Project	Horse Heaven Wind Farm
Turbine	wind turbine generator
UTM	Universal Transverse Mercator
WAC	Washington Administrative Code

1 INTRODUCTION

Horse Heaven Wind Farm, LLC (the Applicant), a subsidiary of Scout Clean Energy, proposes to construct and operate the Horse Heaven Wind Farm (the Project), a wind and solar energy project with a nominal generating capacity of up to approximately 1,150 megawatts located in Benton County, Washington. At its closest point, the Project is located approximately 4 miles south/southwest of the city of Kennewick and the larger Tri-Cities urban area, along the Columbia River.

To provide quantitative detail required under Washington Administrative Code (WAC) 463-60-352(1)(a) to describe the background noise environment, the Applicant has collected ambient sound data to document existing conditions within the Project Lease Boundary and vicinity. The purpose of conducting a baseline sound survey is to characterize the existing land uses, sound sources, and acoustic environment within the Project Lease Boundary and vicinity across a range of wind speeds and future wind turbine generator (Turbine) operational conditions.

1.1 Project Lease Boundary and Vicinity

The Project Lease Boundary (i.e., the extent of parcels in which the Applicant has executed a lease to construct Turbines, the solar array, and associated facilities) encompasses approximately 72,428 acres. The Project's Wind Energy Micrositing Corridor (Micrositing Corridor) encompasses 11,489 acres and consists of the area in which the Turbines and supporting facilities would be sited during the final design. The Solar Siting Areas (which consist of the three areas under consideration for siting of the proposed solar arrays during the final design) encompass 10,438 acres located within the Project Lease Boundary. The Micrositing Corridor and the Solar Siting Areas are larger than the Project's final footprint to allow minor rerouting to optimize the design and to avoid resources that may be discovered during the final design and pre-construction process.

The elevation within the Project Lease Boundary ranges from 604 to 2,051 feet above mean sea level. The Project Lease Boundary is dominated by rolling hills bisected by meandering canyons, some of which constitute ephemeral or intermittent drainages. The Horse Heaven Hills ridgeline lies along the northern border of the Project, particularly in the western portion of the Project Lease Boundary; on the southern side of this ridge, the landscape transitions to relatively rolling topography with shallow, meandering canyons that drain southwest into the Columbia River. While the majority of this western portion of the Project Lease Boundary drains to the southwest into the Columbia River, a small portion of the Project along the northeastern boundary ultimately drains northwest into the Yakima River and northeast into the Columbia River. The eastern portion of the Project Lease Boundary similarly drains primarily to the south into the Columbia River with a small portion of the Project draining northeast into the Columbia River.

To document actual ambient sound levels in the Project Lease Boundary and vicinity, five noise sensitive receptors (NSRs; i.e., residences) were selected as monitoring positions for the baseline sound survey. These residences were selected because they are distributed throughout the area and would act to represent the existing acoustic environment. Figure 1-1 shows the Project Lease Boundary and vicinity and the location of the five baseline sound monitoring stations.

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Horse Heaven Wind Farm

SCOUT CLEAN ENERGY

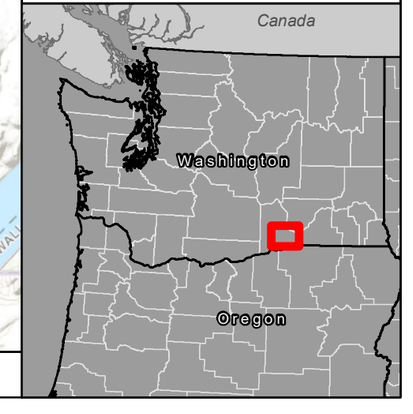
Figure 1-1
Project Lease Boundary and Vicinity

BENTON COUNTY, WA

- Noise Receptor - Participating
- Noise Receptor - Non-participating
- Option 1 Turbine Location
- Baseline Sound Monitoring Location
- Project Lease Boundary
- Proposed Project Substation
- Solar Siting Area
- Solar Array

TETRA TECH

Reference Map



ML-1
ML-2
ML-3
ML-4
ML-5

1:140,000 WGS 1984 UTM Zone 11N

0 0.5 1 2 3 4 Miles

NOT FOR CONSTRUCTION

R:\PROJECTS\HORSE_HEAVEN_6430\NOISEMAPS\NOISE_MONITORING_LOCATIONS_20210216.mxd

1.2 Acoustic Metrics and Terminology

All sounds originate with a source, whether it is a human voice, motor vehicles on a roadway, or a combustion turbine. Energy is required to produce sound and this sound energy is transmitted through the air in the form of sound waves – tiny, quick oscillations of pressure just above and just below atmospheric pressure. These oscillations, or sound pressures, impinge on the ear, creating the sound we hear. A sound source is defined by a sound power level (L_W), which is independent of any external factors. By definition, sound power is the rate at which acoustical energy is radiated outward and is expressed in units of watts.

A source sound power level cannot be measured directly. It is calculated from measurements of sound intensity or sound pressure at a given distance from the source outside the acoustic and geometric near-field. A sound pressure level (L_P) is a measure of the sound wave fluctuation at a given receiver location and can be obtained through the use of a microphone or calculated from information about the source sound power level and the surrounding environment. The sound pressure level in decibels (dB) is the logarithm of the ratio of the sound pressure of the source to the reference sound pressure of 20 microPascals (µPa), multiplied by 20.1. The range of sound pressures that can be detected by a person with normal hearing is very wide, ranging from about 20 µPa for very faint sounds at the threshold of hearing, to nearly 10 million µPa for extremely loud sounds such as a jet during take-off at a distance of 300 feet.

Broadband sound includes sound energy summed across the entire audible frequency spectrum. In addition to broadband sound pressure levels, analysis of the various frequency components of the sound spectrum can be completed to determine tonal characteristics. The unit of frequency is hertz (Hz), measuring the cycles per second of the sound pressure waves. Typically, the frequency analysis examines 11 octave bands ranging from 16 Hz (low) to 16,000 Hz (high). Since the human ear does not perceive every frequency with equal loudness, spectrally-varying sounds are often adjusted with a weighting filter. The A-weighted filter is applied to compensate for the frequency response of the human auditory system and is represented in A-weighted decibel (dBA).

Sound can be measured, modeled, and presented in various formats, with the most common metric being the equivalent sound level (L_{eq}). The L_{eq} has been shown to provide both an effective and uniform method for comparing time-varying sound levels and is widely used in acoustic assessments in the State of Washington. Estimates of noise sources and outdoor acoustic environments, and the comparison of relative loudness are presented in Table 1-1. Table 1-2 presents additional reference information on terminology used in the report.

Table 1-1. Sound Pressure Levels and Relative Loudness of Typical Noise Sources and Acoustic Environments

Noise Source or Activity	Sound Level (dBA)	Subjective Impression
Vacuum cleaner (10 feet)	70	Moderate
Passenger car at 65 miles per hour (25 feet)	65	
Large store air-conditioning unit (20 feet)	60	
Light auto traffic (100 feet)	50	Quiet
Quiet rural residential area with no activity	45	
Bedroom or quiet living room; Bird calls	40	Faint
Typical wilderness area	35	
Quiet library, soft whisper (15 feet)	30	Very quiet
Wilderness with no wind or animal activity	25	Extremely quiet
High-quality recording studio	20	
Acoustic test chamber	10	Just audible
	0	Threshold of hearing

Adapted from: Kurze and Beranek (1988) and EPA (1971)

Table 1-2. Acoustic Terms and Definitions

Term	Definition
Noise	Typically defined as unwanted sound. This word adds the subjective response of humans to the physical phenomenon of sound. It is commonly used when negative effects on people are known to occur.
Sound Pressure Level (L_P)	Pressure fluctuations in a medium. Sound pressure is measured in dB referenced to 20 µPa, the approximate threshold of human perception to sound at 1,000 Hz.
Sound Power Level (L_W)	The total acoustic power of a noise source measured in dB referenced to picowatts (one trillionth of a watt). Noise specifications are provided by equipment manufacturers as sound power as it is independent of the environment in which it is located. A sound level meter does not directly measure sound power.
Equivalent Sound Level (L_{eq})	The L_{eq} is the continuous equivalent sound level, defined as the single sound pressure level that, if constant over the stated measurement period, would contain the same sound energy as the actual monitored sound that is fluctuating in level over the measurement period.
A-Weighted Decibel (dBA)	Environmental sound is typically composed of acoustic energy across all frequencies. To compensate for the auditory frequency response of the human ear, an A-weighting filter is commonly used for describing environmental sound levels. Sound levels that are A-weighted are presented as dBA in this report.
Unweighted Decibels (dBL)	Unweighted sound levels are referred to as linear. Linear decibels are used to determine a sound's tonality and to engineer solutions to reduce or control noise as techniques are different for low and high frequency noise. Sound levels that are linear are presented as dBL in this report.
Propagation and Attenuation	Propagation is the decrease in amplitude of an acoustic signal due to geometric spreading losses with increased distance from the source. Additional sound attenuation factors include air absorption, terrain effects, sound interaction with the ground, diffraction of sound around objects and topographical features, foliage, and meteorological conditions including wind velocity, temperature, humidity, and atmospheric conditions.

2 EXISTING SOUND ENVIRONMENT

With the assistance of the Applicant, landowner permissions were secured at several pre-determined baseline monitoring locations prior to the survey. The sites were then screened on the day of deployment by experienced acoustic engineers to ensure the locations were in character with the overall area. The baseline sound survey commenced on December 22, 2020 and concluded on January 19, 2021. Data were collected at each monitoring location for a period of approximately 14 days occurring within that window. A long-term baseline survey is requisite to provide a statistically relevant data set, covering the full range of wind speeds and future operational scenarios. Extensive experience on several wind energy farms sited in the United States and Canada indicates that this data set can typically be obtained over a 10-day monitoring period, weather permitting.

2.1 Instrumentation

All measurements were taken with a Larson Davis 831 real-time sound level analyzer equipped with a PCB model 377B02 1/2" precision condenser microphone. This instrument has an operating range of 5 dB to 140 dB, and an overall frequency range of 16 to 20,000 Hz and meets or exceeds all requirements set forth in the American National Standards Institute (ANSI) standards for Type 1 sound level meters for quality and accuracy (precision). All instrumentation was laboratory calibrated within the previous 12-month period with calibration documentation provided in Attachment A.

The Larson Davis 831 sound level analyzer is designed for service as a long-term environmental sound level data logger measuring the A-weighted sound level. Each sound level analyzer used was enclosed in a weatherproof case and equipped with a self-contained microphone tripod. The microphone and windscreen were tripod-mounted at an approximate height of 1.5 to 1.7 meters (4.9 to 5.6 feet) above grade away from effects of ground level rustling vegetation and fallen leaves. When sound measurements are attempted in the presence of elevated wind speeds, extraneous noise can be self-generated across the microphone. Air blowing over a microphone diaphragm creates a pressure differential and turbulence. All sound level analyzer microphones were protected from wind-induced self-noise effects by a 3.5-inch-diameter open-cell foam windscreen. By using this microphone protection, the pressure gradient and turbulence is effectively moved farther away from the microphone, minimizing self-generated wind induced noise. Table 2-1 lists the measurement equipment employed during the survey. The sound level meters were programmed to sample and store A-weighted and octave band sound level data, including L_{eq} and the percentile sound levels.

Table 2-1. Measurement Equipment

Description	Manufacturer	Type
Signal Analyzer	Larson Davis	831
Preamplifier	Larson Davis	PRM902
Microphone	PCB	377B02
Windscreen	ACO Pacific	7-inch
Calibrator	Larson Davis	CAL200

The baseline monitoring stations were deployed within 7.5 to 30 meters (25 to 98 feet) of the principal residential structure with their position secured by fastening the monitoring station to a fencepost or other

stationary object. All monitoring stations were anchored in a manner that avoided interference from any large vertical reflective surfaces.

Prior to and immediately following the measurement session, the sound analyzers were calibrated (no level adjustment was required) with two ANSI Type 1 calibrators which have an accuracy traceable to the National Institute of Standards and Technology. The maximum observed calibration drift ranged from -0.1 dB to +0.2 dB, which is well within acceptable tolerances for long term baseline sound measurements.

2.2 Monitoring Locations

Monitoring locations were selected with the assistance of the Applicant to be representative of residences that would be in proximity to Project Turbines. Measurements were continuously logged at each location and those measurements were correlated with wind speed data collected by on-site meteorological towers as shown in Figure 1-1. Using the sound level measurement and wind speed data, a regression analysis was conducted for each monitoring location and the best fit correlation coefficient using a second order polynomial equation was evaluated. The measured L_{eq} sound levels were divided into daytime (7:00 a.m. to 10:00 p.m.) and nighttime (10:00 p.m. to 7:00 a.m.) periods to show diurnal variation at a monitoring position. Additional descriptions of the monitoring locations and field observations are provided in Section 3. Time history and regression analysis plots are also given for each monitoring location. Please note that measured sound pressure level data were evaluated and filtered to eliminate precipitation events and atypical extraneous sound contributions.

3 RESULTS

3.1 Monitoring Location 1

Monitoring location 1 was situated at a residence along Henson Road in Prosser, Washington (Universal Transverse Mercator [UTM] Zone 11T: 311134E, 5117731N). Larson Davis 831, Serial No. 3386, was used to collect data at this location. Observations during deployment were that the location was relatively quiet with agricultural activities and sporadic noise from animals onsite contributing to ambient sound levels. Figure 3-1 includes a photograph of the monitoring location. Figure 3-2 provides the time history and Figure 3-3 provides the regression analyses of ambient sound levels during daytime and nighttime monitoring periods.

Figure 3-1. Photograph of ML-1

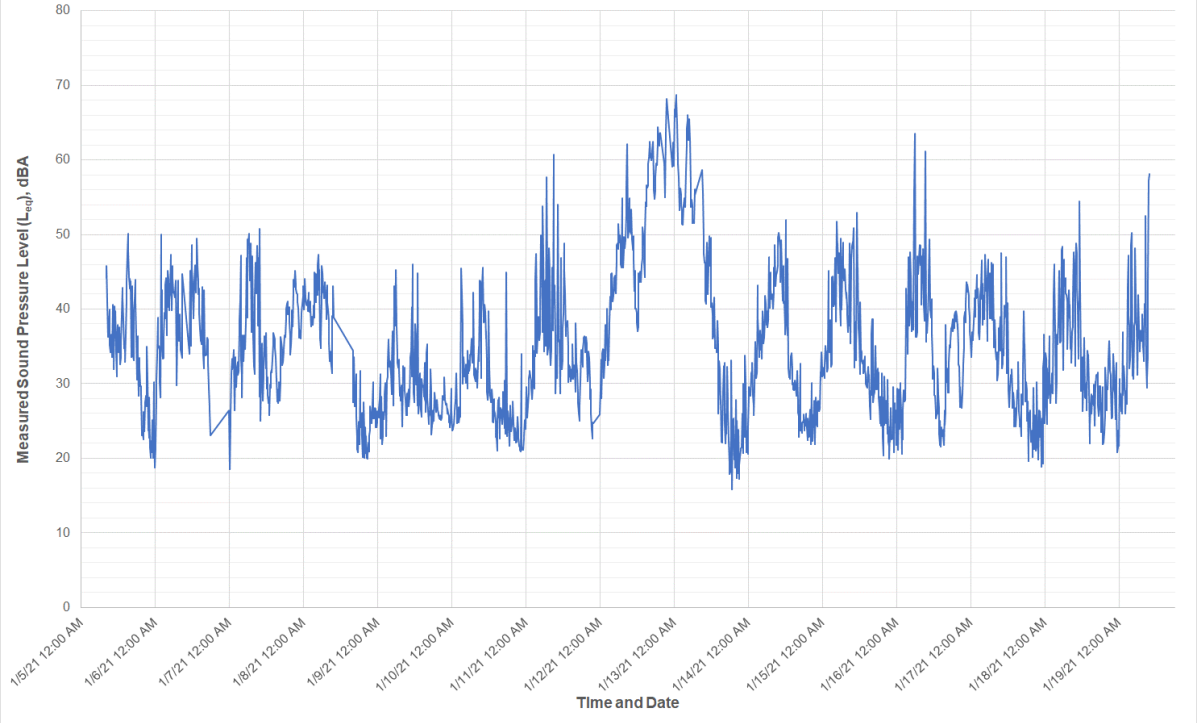


Figure 3-2. ML-1 Time History Plot

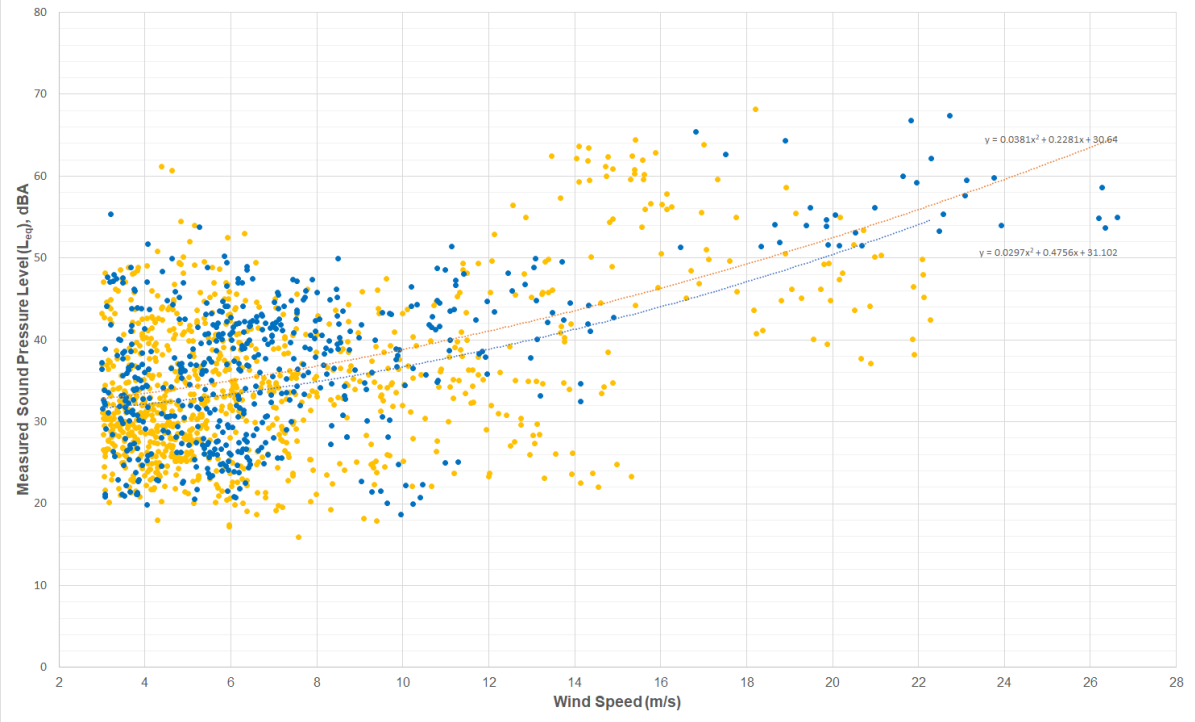


Figure 3-3. ML-1 Regression Analysis

3.2 Monitoring Location 2

Monitoring location 2 was situated at a residence along C Williams Road in Kennewick, Washington (UTM Zone 11T: 321518E, 5109850N). Larson Davis 831, Serial No. 2984, was used to collect data at this location. Observations during deployment were that the location was very quiet with no roadway noise heard during deployment and/or retrieval. Figure 3-4 includes a photograph of the monitoring location. Figure 3-5 provides the time history and Figure 3-6 provides the regression analyses of ambient sound levels during daytime and nighttime monitoring periods.

Figure 3-4. Photograph of ML-2

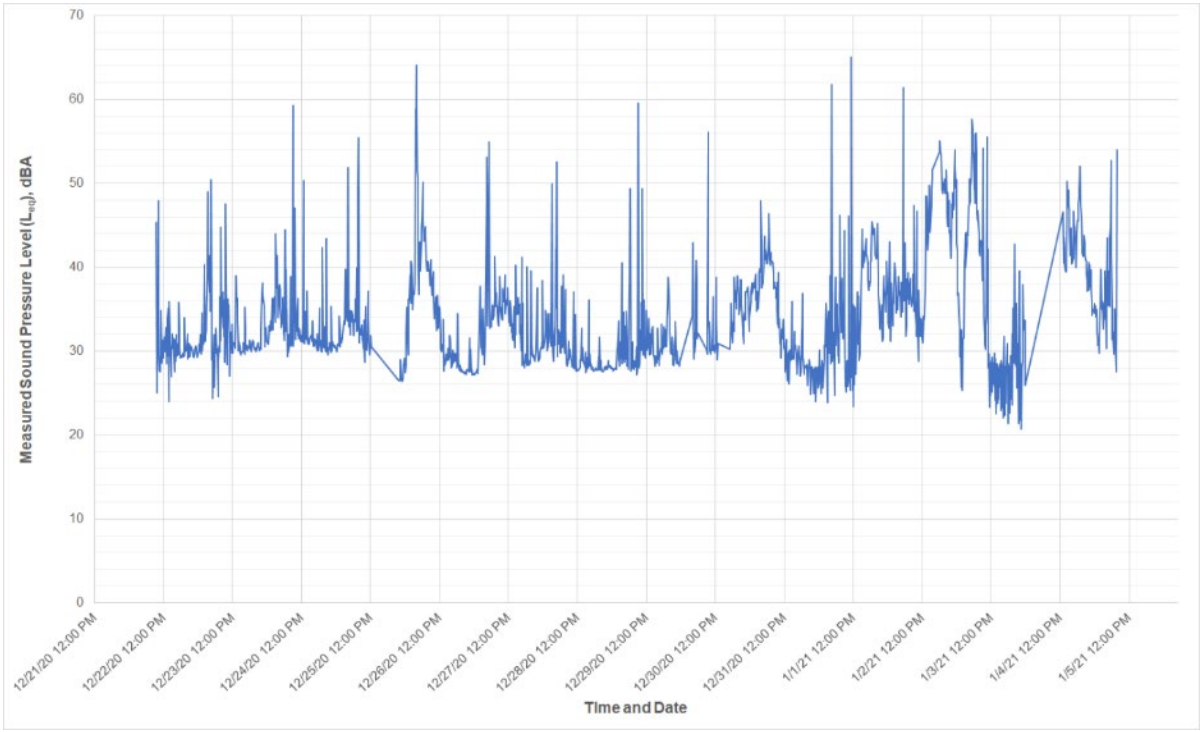


Figure 3-5. ML-2 Time History Plot

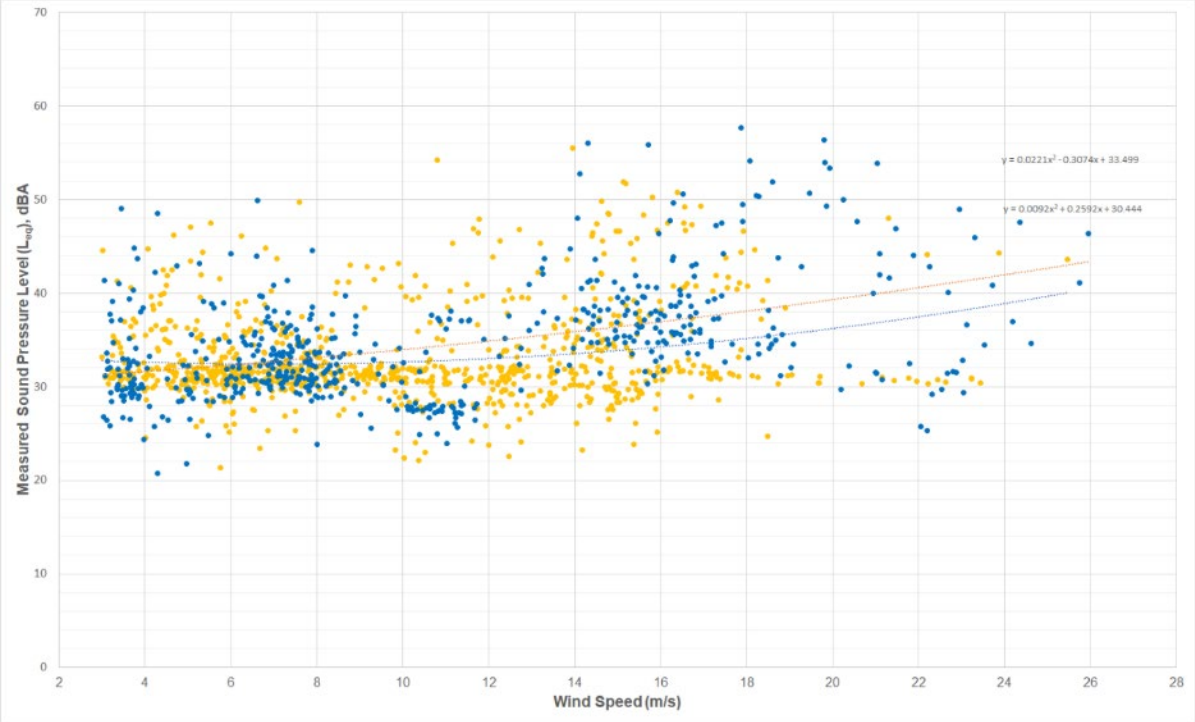


Figure 3-6. ML-2 Regression Analysis

3.3 Monitoring Location 3

Monitoring location 3 was situated at a residence along S. Bofer Canyon Road in Benton County, Washington (UTM Zone 11T: 328433E, 5104539N). Larson Davis 831, Serial No. 2985, was used to collect data at this location. Observations during deployment were that the location a low activity property. Some distance roadway noise from Interstate 82 could be heard. Figure 3-7 includes a photograph of the monitoring location. Figure 3-8 provides the time history and Figure 3-9 provides the regression analyses of ambient sound levels during daytime and nighttime monitoring periods.

Figure 3-7. Photograph of ML-3

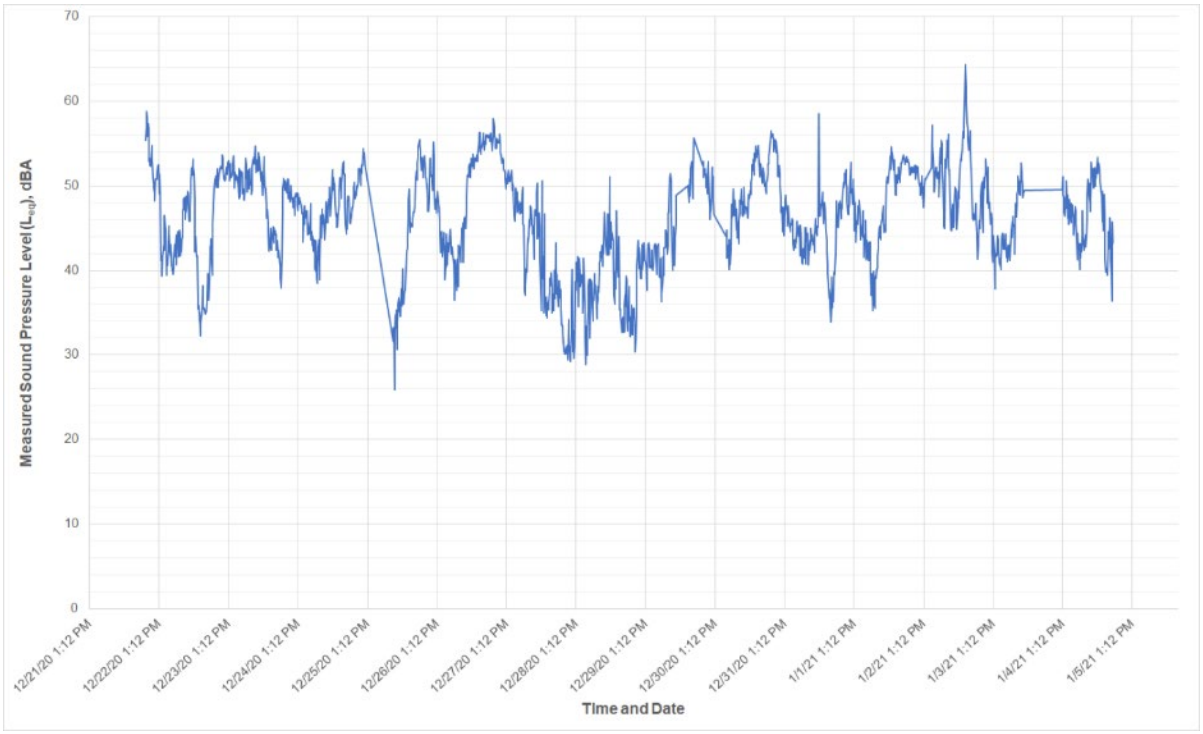


Figure 3-8. ML-3 Time History Plot

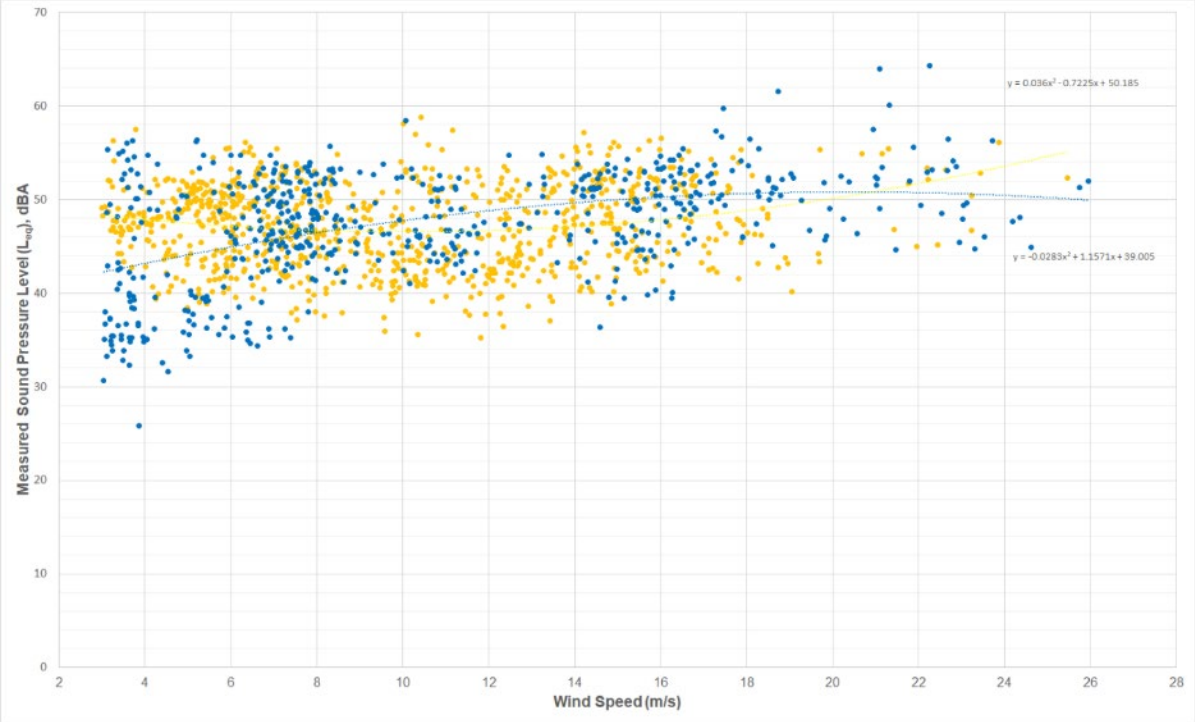


Figure 3-9. ML-2 Regression Analysis

3.4 Monitoring Location 4

Monitoring location 4 was situated at a residence along Finley Road in Kennewick, Washington (UTM Zone 11T: 343329E, 5108162N). Larson Davis 831, Serial No. 3548, was used to collect data at this location. Observations during deployment were that the location includes some farming activity; however, the monitor was located away from those activities. Noise from geese could also be heard. Figure 3-10 includes a photograph of the monitoring location. Figure 3-11 provides the time history and Figure 3-12 provides the regression analyses of ambient sound levels during daytime and nighttime monitoring periods.

Figure 3-10. Photograph of ML-4

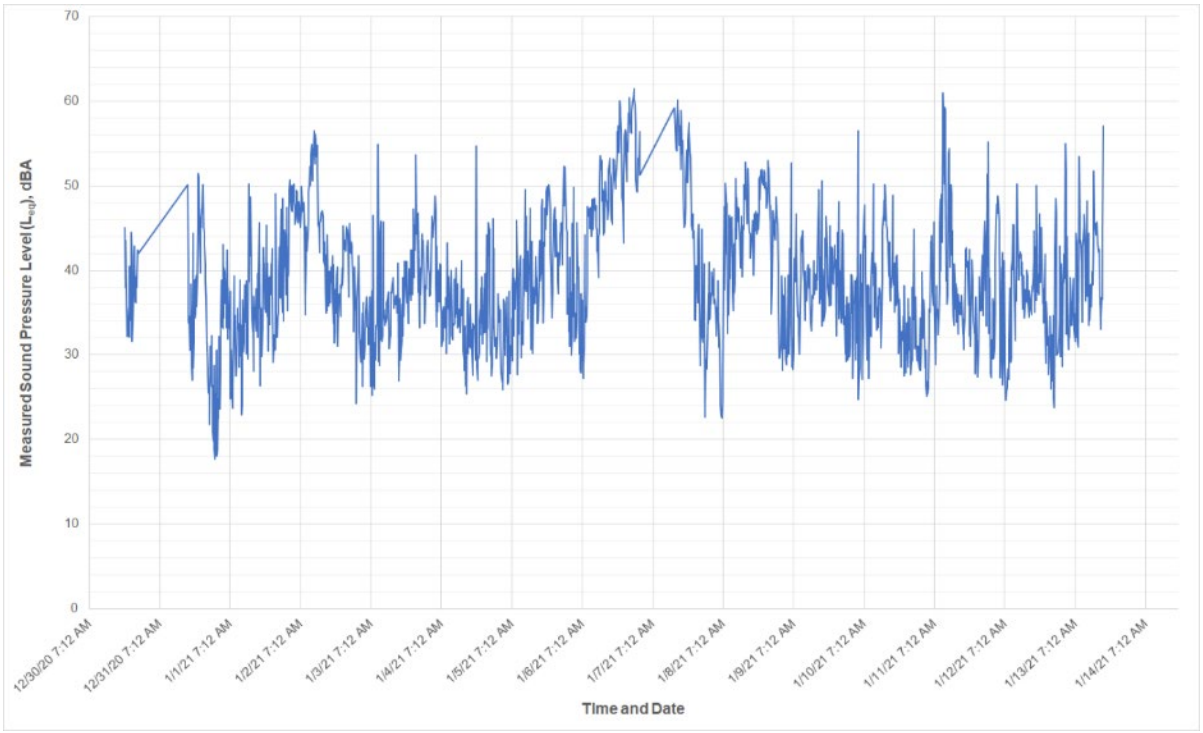


Figure 3-11. ML-4 Time History Plot

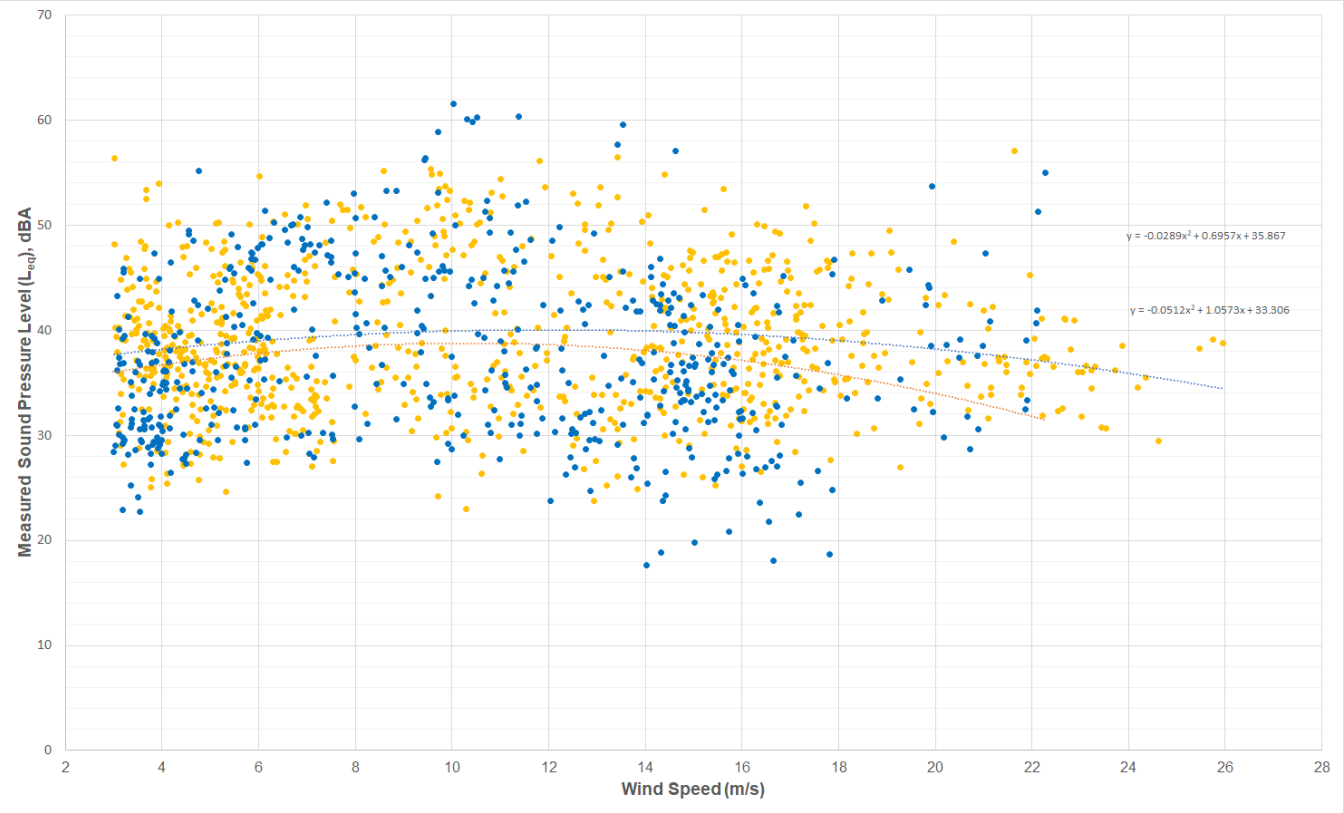


Figure 3-12. ML-4 Regression Analysis

3.5 Monitoring Location 5

Monitoring location 5 was situated at a residence along S. Travis Road in Prosser, Washington (UTM Zone 11T: 310369E, 5112039N). Larson Davis 831, Serial No. 3386, was used to collect data at this location. Observations during deployment were that the location has moderate agricultural activity. In addition, there was semi-frequent road traffic along S. Travis Road. Figure 3-13 includes a photograph of the monitoring location. Figure 3-14 provides the time history and Figure 3-15 provides the regression analyses of ambient sound levels during daytime and nighttime monitoring periods.

Figure 3-13. Photograph of ML-5

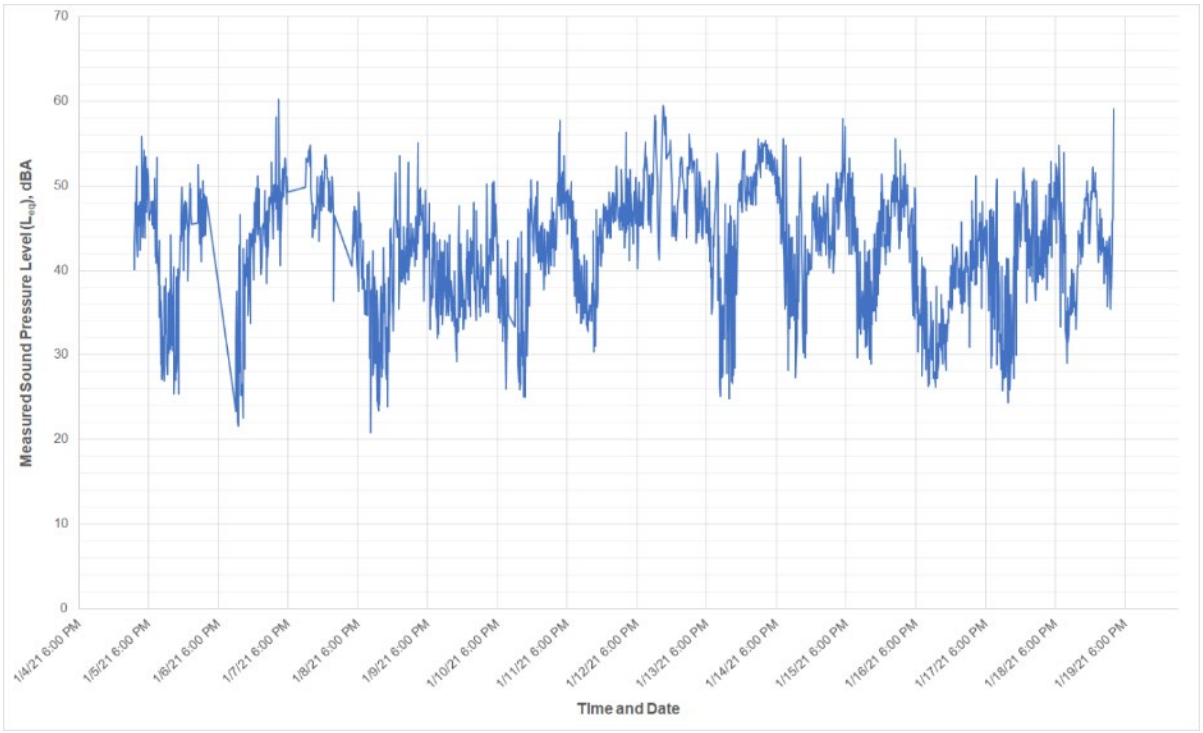


Figure 3-14. ML-5 Time History Plot

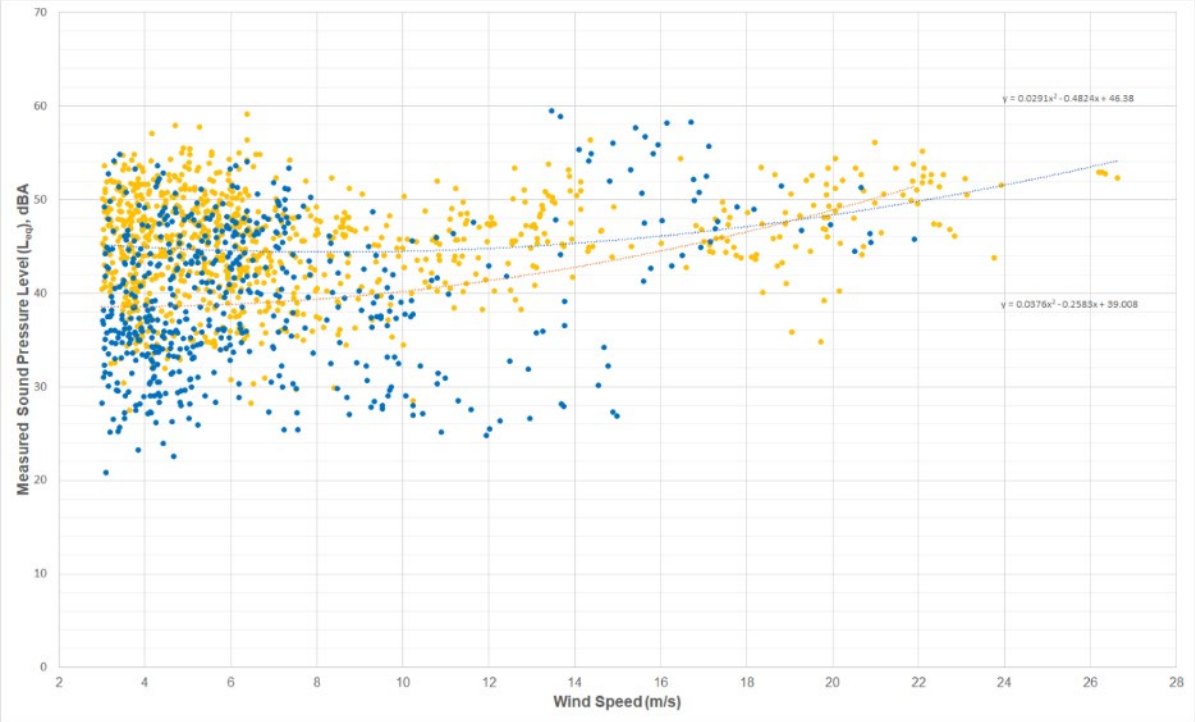


Figure 3-15. ML-5 Regression Analysis

4 CONCLUSIONS

Table 4-1 provides the results of the regression analyses for each monitoring location and cumulatively for all locations, representing the ambient sound levels across the Project Lease Boundary and vicinity. Table 4-1 displays daytime and nighttime ambient sound levels for each monitoring location and the Project Lease Boundary and vicinity for wind speed conditions ranging from calm to maximum rotational wind speed.

Table 4-1. Baseline Sound Survey Results, L_{eq} (dBA)

Monitoring Location	UTM Coordinates (UTM Zone 11T)		Time Period	Wind Speed (m/s)									
	Easting (m)	Northing (m)		3	4	5	6	7	8	9	10	11	12
ML-1	311134	5117731	Day	32	32	33	33	34	35	36	37	38	39
			Night	33	33	34	35	36	37	38	39	40	41
ML-2	321518	5109850	Day	33	33	33	32	32	32	33	33	33	33
			Night	31	32	32	32	33	33	34	34	34	34
ML-3	328433	5104539	Day	48	48	47	47	47	47	47	47	47	47
			Night	42	43	44	45	46	46	47	48	48	48
ML-4	343329	5108162	Day	38	38	39	39	39	40	40	40	40	40
			Night	36	37	37	38	38	38	39	39	39	39
ML-5	310369	5112039	Day	45	45	45	45	44	44	44	44	45	45
			Night	39	39	39	39	39	39	40	40	41	41
All Monitoring Locations			Day	38	39	39	39	39	39	40	40	40	40
			Night	37	37	37	38	38	38	39	39	40	40

As expected, ambient sound levels fluctuate constantly during both daytime and nighttime hours; however, generally typical diurnal variation (i.e., daytime levels being higher than nighttime levels) is observed with the exception of ML-1, which on average has a fairly homogeneous ambient acoustic environment. Increases in daytime ambient sound levels at ML-1 can be attributed to the agricultural activities occurring on-site. Ambient sound levels at ML-2 are consistently low, especially during nighttime hours when levels would be in and around 30 dBA. While some sporadic on-site activity and roadway noise contributed to daytime sound levels, the ambient acoustic environment at ML-2 is fairly quiet. Existing conditions at ML-3 are relatively higher due to its proximity to the I-82. Ambient sound levels at ML-4 range from 38 to 40 dBA during the day and 36 to 39 dBA during the night, which is of particular interest because that monitoring location is near the more densely populated community of Finley, to the northeast of the Project Lease Boundary. Ambient sound levels at ML-5 exhibited typical diurnal variation but were affected by both nearby agricultural activity as well as traffic-related noise occurring on S. Travis Road.

5 REFERENCES

Beranek, L. 1988. Noise and Vibration Control, Chapter 7 - Sound Propagation Outdoors. Institute of Noise Control Engineering, Washington, DC.

EPA (United States Environmental Protection Agency). 1971. Community Noise. NTID300.3 (N-96-01 IIA-231). Prepared by Wylie Laboratories.

ATTACHMENT A
CALIBRATION DOCUMENTATION

Certificate of Calibration and Conformance

This document certifies that the instrument referenced below meets published specifications per Procedure PRD-P263; ANSI S1.4-1983 (R 2006) Type 1; S1.4A-1985; S1.43-1997 Type 1; S1.11-2004 Octave Band Class 0; S1.25-1991; IEC 61672-2002 Class 1; 60651-2001 Type 1; 60804-2000 Type 1; 61260-2001 Class 0; 61252-2002.

Manufacturer:	Larson Davis	Temperature:	72.6	°F
Model Number:	831		22.56	°C
Serial Number:	2984	Rel. Humidity:	47.6	%
Customer:	TMS Rental	Pressure:	999.5	mbars
Description:	Sound Level Meter		999.5	hPa
Note:	As Found/As Left: In Tolerance			

Upon receipt for testing, this instrument was found to be:

Within the stated tolerance of the manufacturer's specification.

Calibration Date: 16-Mar-20 Calibration Due:

Calibration Standards Used:

Manufacturer	Model	Serial Number	Cal Due
Stanford Research Systems	DS360	123270	5/6/2020

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at The Modal Shop and/or Larson Davis Corporate Headquarters. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. Calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of The Modal Shop.

Technician: William Kellner Signature: William Kellner

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Manufacturer:	Larson Davis	Temperature:	69.2	°F
Model Number:	831		20.67	°C
Serial Number:	2985	Rel. Humidity:	31.2	%
Customer:	TMS Rental	Pressure:	995.1	mbars
Description:	Sound Level Meter		995.1	hPa
Note:	As Found/As Left: In Tolerance			

Upon receipt for testing, this instrument was found to be:

Within the stated tolerance of the manufacturer's specification.

Calibration Date: 1-Feb-20 Calibration Due:

Calibration Standards Used:

Manufacturer	Model	Serial Number	Cal Due
Stanford Research Systems	DS360	123270	5/6/2020

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Manufacturer:	Larson Davis	Temperature:	72.6	°F
Model Number:	831		22.56	°C
Serial Number:	3386	Rel. Humidity:	47.6	%
Customer:	TMS Rental	Pressure:	999.5	mbars
Description:	Sound Level Meter		999.5	hPa
Note:	As Found / As Left: In Tolerance			

Upon receipt for testing, this instrument was found to be:

Within the stated tolerance of the manufacturer's specification.

Calibration Date: 15-Sep-20 Calibration Due:

Calibration Standards Used:

Manufacturer	Model	Serial Number	Cal Due
Stanford Research Systems	DS360	123270	5-May-21

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at The Modal Shop and/or Larson Davis Corporate Headquarters. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. Calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of The Modal Shop.

Technician: Ed Devlin Signature:

THE MODAL SHOP
AN MTS COMPANY

10310 Aerohub Blvd.
Cincinnati, OH. 45215
Phone: (513) 351-9919
(800) 860-4867
www.modalshop.com

Certificate of Calibration and Conformance

This document certifies that the instrument referenced below meets published specifications per Procedure PRD-P263; ANSI S1.4-1983 (R 2006) Type 1; S1.4A-1985; S1.43-1997 Type 1; S1.11-2004 Octave Band Class 0; S1.25-1991; IEC 61672-2002 Class 1; 60651-2001 Type 1; 60804-2000 Type 1; 61260-2001 Class 0; 61252-2002.

Manufacturer:	Larson Davis	Temperature:	70.4	°F
Model Number:	831		21.33	°C
Serial Number:	3547	Rel. Humidity:	32.1	%
Customer:	TMS Rental	Pressure:	995.2	mbars
Description:	Sound Level Meter		995.2	hPa
Note:	As Found/As Left: In Tolerance			

Upon receipt for testing, this instrument was found to be:

Within the stated tolerance of the manufacturer's specification.

Calibration Date: 1-Feb-20 Calibration Due:

Calibration Standards Used:

Manufacturer	Model	Serial Number	Cal Due
Stanford Research Systems	DS360	123270	5/6/2020

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at The Modal Shop and/or Larson Davis Corporate Headquarters. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. Calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of The Modal Shop.

Technician: William Kellner Signature: William Kellner

THE MODAL SHOP
A PCB GROUP CO.

3149 East Kemper Road
Cincinnati, OH. 45241
Phone: (513) 351-9919
(800) 860-4867
www.modalshop.com

Certificate of Calibration and Conformance

This document certifies that the instrument referenced below meets published specifications per Procedure PRD-P263; ANSI S1.4-1983 (R 2006) Type 1; S1.4A-1985; S1.43-1997 Type 1; S1.11-2004 Octave Band Class 0; S1.25-1991; IEC 61672-2002 Class 1; 60651-2001 Type 1; 60804-2000 Type 1; 61260-2001 Class 0; 61252-2002.

Manufacturer:	Larson Davis	Temperature:	69.2	°F
Model Number:	831		20.67	°C
Serial Number:	3556	Rel. Humidity:	16.2	%
Customer:	TMS Rental	Pressure:	990.5	mbars
Description:	Sound Level Meter		990.5	hPa
Note:	As Found/As Left: In Tolerance			

Upon receipt for testing, this instrument was found to be:

Within the stated tolerance of the manufacturer's specification.

Calibration Date: 5-Feb-20 Calibration Due:

Calibration Standards Used:

Manufacturer	Model	Serial Number	Cal Due
Stanford Research Systems	DS360	123270	5/6/2020

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at The Modal Shop and/or Larson Davis Corporate Headquarters. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. Calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of The Modal Shop.

Technician: William Kellner Signature: William Kellner

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AN MTS COMPANY

10310 Aerohub Boulevard
Cincinnati, OH 45215
Ph: 513.351.9919
Fax: 513.458.2172
www.modalshop.com

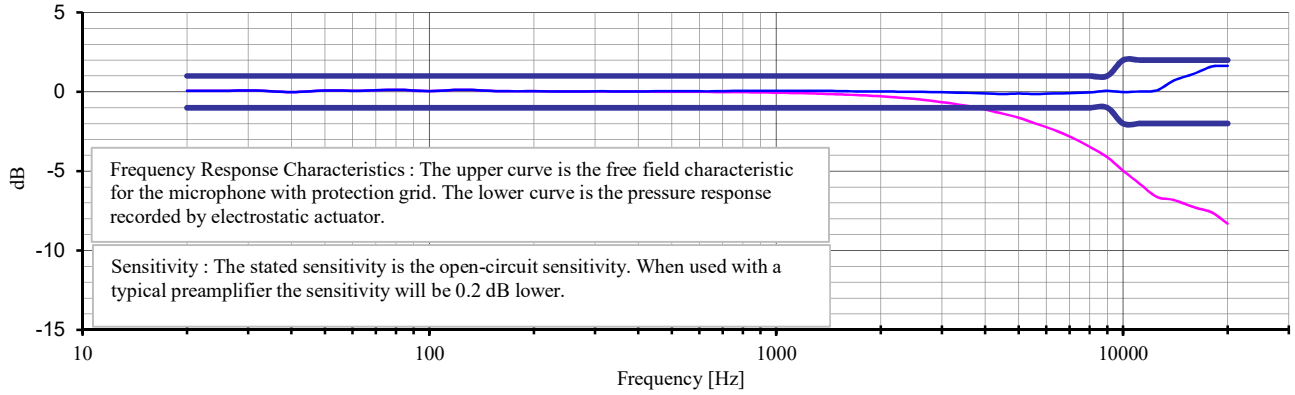
~Certificate of Calibration~

Manufacturer:	PCB	**Customer:**	TMS Rental
Model Number:	377B02	**Address:**	
Serial Number:	305688		
Asset ID:		**Cal Date / Cal ID:**	Oct 02, 2020 09:23:05
Description:	Free-Field Microphone	**Due Date:**	

Sensitivity:	**250 Hz**	**1 kHz**		**Temperature:**	72 (22)	°F (°C)
	-25.61	-25.67	dB re. 1V/Pa	**Humidity:**	40	%
	52.40	52.09	mV/Pa	**Ambient Pressure:**	1000.1	mbar

Reference Sens: In Tolerance
Freq. Response: In Tolerance

Polarization Voltage: 0 VDC



Traceability: The calibration is traceable through NIST Project A2007.

Notes:
Calibration results relate only to the items calibrated.
This certificate may not be reproduced, except in full, without written permission.
This calibration is performed in compliance with ISO 9001, ISO 17025 and ANSI Z540.
Measurement uncertainty (250 Hz sensitivity calibration) at 95% confidence level: 0.30 dB
Calibrated per procedure PRD-P204.

User Note: As Found / As Left: In Tolerance.

Frequency Response with reference to level at 250 Hz

Frequency (Hz)	Upper (dB)	Frequency (Hz)	Upper (dB)	Frequency (Hz)	Upper (dB)	Frequency (Hz)	Upper (dB)
20	0.07	**630**	0.03	**4500**	-0.13		
25	0.06	**800**	0.07	**5000**	-0.11		
31.5	0.09	**1000**	0.06	**5600**	-0.14		
40	-0.02	**1120**	0.06	**6300**	-0.10		
50	0.08	**1250**	0.06	**7100**	-0.09		
63	0.06	**1400**	0.06	**8000**	-0.03		
80	0.13	**1600**	0.04	**9000**	0.06		
100	0.05	**1800**	0.03	**10000**	-0.02		
125	0.13	**2000**	0.03	**11200**	0.03		
160	0.04	**2240**	0.01	**12500**	0.09		
200	0.03	**2500**	0.01	**14000**	0.71		
250	0.03	**2800**	-0.01	**16000**	1.14		
315	0.03	**3150**	-0.03	**18000**	1.59		
400	0.03	**3550**	-0.07	**20000**	1.64		
500	0.05	**4000**	-0.10				

Technician: Ed Devlin

Approval: Edward A. Devlin

Reference Equipment Used:

Manuf.	*Model*	*Serial*	*Cal. Date*	*Due Date*
GRAS	40AG	58094	2/19/2020	2/19/2021

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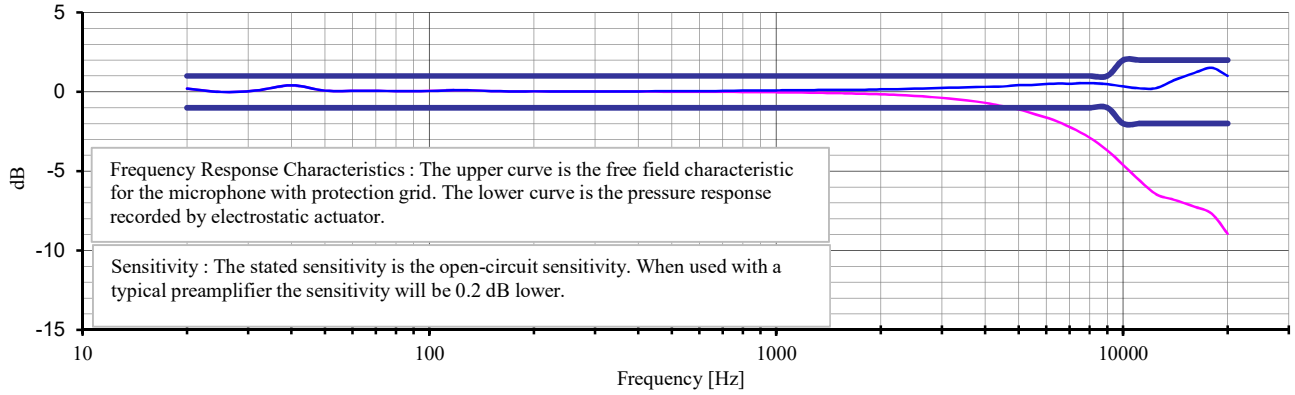
Fax: 513.458.2172
www.modalshop.com

~Certificate of Calibration~

Manufacturer:	PCB		**Customer:**	TMS Rental	
Model Number:	377B02		**Address:**		
Serial Number:	307792				
Asset ID:			**Cal Date / Cal ID:**	Oct 02, 2020 09:59:59	
Description:	Free-Field Microphone		**Due Date:**		
Sensitivity:	**250 Hz**	**1 kHz**	**Temperature:**	72 (22)	°F (°C)
	-24.71	-24.74 dB re. 1V/Pa	**Humidity:**	39	%
	58.12	57.96 mV/Pa	**Ambient Pressure:**	1000.1	mbar
Reference Sens:	In Tolerance				
Freq. Response:	In Tolerance		**Polarization Voltage:**	0	VDC



Traceability: The calibration is traceable through NIST Project A2007.

Notes:
Calibration results relate only to the items calibrated.
This certificate may not be reproduced, except in full, without written permission.
This calibration is performed in compliance with ISO 9001, ISO 17025 and ANSI Z540.
Measurement uncertainty (250 Hz sensitivity calibration) at 95% confidence level: 0.30 dB
Calibrated per procedure PRD-P204.

User Note: As Found / As Left: In Tolerance.

Frequency Response with reference to level at 250 Hz

Frequency (Hz)	Upper (dB)	Frequency (Hz)	Upper (dB)	Frequency (Hz)	Upper (dB)	Frequency (Hz)	Upper (dB)
20	0.20	**630**	0.04	**4500**	0.34		
25	-0.01	**800**	0.08	**5000**	0.42		
31.5	0.07	**1000**	0.09	**5600**	0.44		
40	0.41	**1120**	0.10	**6300**	0.51		
50	0.07	**1250**	0.11	**7100**	0.52		
63	0.07	**1400**	0.12	**8000**	0.55		
80	0.05	**1600**	0.12	**9000**	0.48		
100	0.05	**1800**	0.13	**10000**	0.34		
125	0.10	**2000**	0.16	**11200**	0.21		
160	0.04	**2240**	0.17	**12500**	0.24		
200	0.03	**2500**	0.20	**14000**	0.73		
250	0.03	**2800**	0.22	**16000**	1.18		
315	0.03	**3150**	0.26	**18000**	1.51		
400	0.03	**3550**	0.28	**20000**	1.00		
500	0.05	**4000**	0.32				

Technician: Ed Devlin

Approval: Edward A. Devlin

Reference Equipment Used:

Manuf.	*Model*	*Serial*	*Cal. Date*	*Due Date*
GRAS	40AG	58094	2/19/2020	2/19/2021

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Cincinnati, OH 45241
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~Certificate of Calibration~

Manufacturer: PCB
Model Number: 377B02
Serial Number: 307396
Asset ID:
Description: Free-Field Microphone

Customer: TMS Rental
Address:

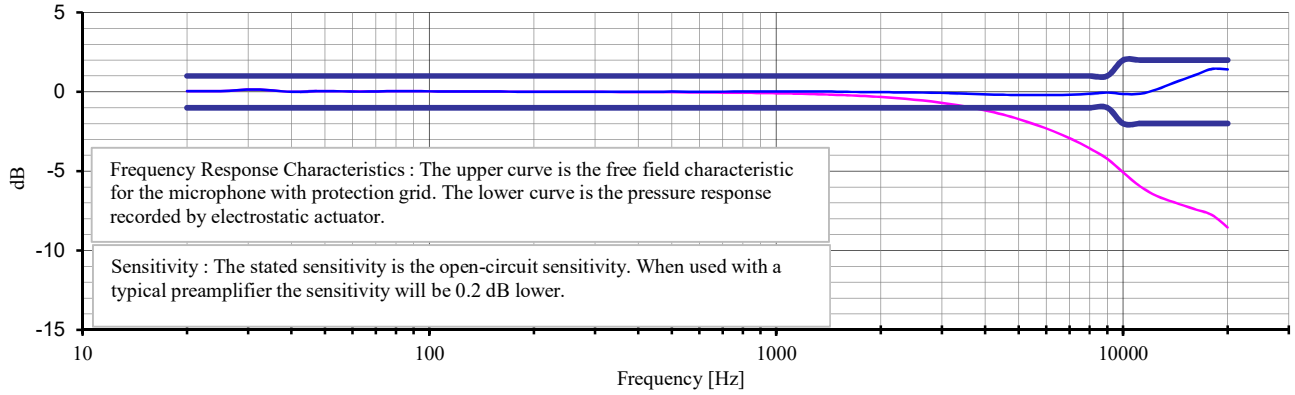
Cal Date / Cal ID: Mar 09, 2020 11:22:25
Due Date:

Sensitivity:	**250 Hz**	**1 kHz**	
	-25.96	-26.05	dB re. 1V/Pa
	50.34	49.82	mV/Pa

Temperature:	71 (22)	°F (°C)
Humidity:	26	%
Ambient Pressure:	1006.5	mbar

Reference Sens: In Tolerance
Freq. Response: In Tolerance

Polarization Voltage: 0 VDC



Traceability: The calibration is traceable through NIST Project A2007.
Notes: Calibration results relate only to the items calibrated.
This certificate may not be reproduced, except in full, without written permission.
This calibration is performed in compliance with ISO 9001, ISO 17025 and ANSI Z540.
Measurement uncertainty (250 Hz sensitivity calibration) at 95% confidence level: 0.30 dB
Calibrated per procedure PRD-P204.

User Note: As Found / As Left: In Tolerance.

Frequency Response with reference to level at 250 Hz

Frequency (Hz)	Upper (dB)	Frequency (Hz)	Upper (dB)	Frequency (Hz)	Upper (dB)	Frequency (Hz)	Upper (dB)
20	0.04	**630**	0.00	**4500**	-0.18		
25	0.05	**800**	0.03	**5000**	-0.20		
31.5	0.15	**1000**	0.03	**5600**	-0.20		
40	0.00	**1120**	0.03	**6300**	-0.20		
50	0.05	**1250**	0.02	**7100**	-0.19		
63	0.01	**1400**	0.02	**8000**	-0.12		
80	0.05	**1600**	0.00	**9000**	-0.05		
100	0.03	**1800**	-0.01	**10000**	-0.13		
125	0.02	**2000**	-0.02	**11200**	-0.12		
160	0.01	**2240**	-0.04	**12500**	0.16		
200	0.01	**2500**	-0.04	**14000**	0.57		
250	0.00	**2800**	-0.06	**16000**	1.03		
315	0.00	**3150**	-0.08	**18000**	1.44		
400	0.00	**3550**	-0.12	**20000**	1.41		
500	0.01	**4000**	-0.16				

Technician: Ed Devlin

Approval: Edward A. Devlin

Reference Equipment Used:

Manuf.	*Model*	*Serial*	*Cal. Date*	*Due Date*
GRAS	40AG	58094	2/19/2020	2/19/2021

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CALIBRATION CERT 2649.01

Calibration Certificate

Certificate Number 2020003029

Customer:
The Modal Shop
3149 East Kemper Road
Cincinnati, OH 45241, United States

Model Number	CAL200	***Procedure Number***	D0001.8386		
Serial Number	17758	***Technician***	Scott Montgomery		
Test Results	**Pass**	***Calibration Date***	5 Mar 2020		
Initial Condition	As Manufactured	***Calibration Due***			
		Temperature	24	°C	± 0.3 °C
Description	Larson Davis CAL200 Acoustic Calibrator	***Humidity***	30	%RH	± 3 %RH
		Static Pressure	101.3	kPa	± 1 kPa

Evaluation Method The data is aquired by the insert voltage calibration method using the reference microphone's open circuit sensitivity. Data reported in dB re 20 µPa.

Compliance Standards Compliant to Manufacturer Specifications per D0001.8190 and the following standards:
IEC 60942:2017 ANSI S1.40-2006

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Agilent 34401A DMM	08/15/2019	08/15/2020	001021
Larson Davis Model 2900 Real Time Analyzer	04/02/2019	04/02/2020	001051
Microphone Calibration System	03/03/2020	03/03/2021	005446
1/2" Preamplifier	09/17/2019	09/17/2020	006506
Larson Davis 1/2" Preamplifier 7-pin LEMO	08/06/2019	08/06/2020	006507
1/2 inch Microphone - RI - 200V	05/21/2019	05/21/2020	006510
Pressure Transducer	06/24/2019	06/24/2020	007310

Output Level

Nominal Level [dB]	Pressure [kPa]	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
114	101.3	114.00	113.80	114.20	0.14	Pass
94	101.3	94.00	93.80	94.20	0.15	Pass

-- End of measurement results--

Frequency

Nominal Level [dB]	Pressure [kPa]	Test Result [Hz]	Lower limit [Hz]	Upper limit [Hz]	Expanded Uncertainty [Hz]	Result
114	101.3	1,000.14	990.00	1,010.00	0.20	Pass
94	101.3	1,000.15	990.00	1,010.00	0.20	Pass

-- End of measurement results--

Total Harmonic Distortion + Noise (THD+N)

Nominal Level [dB]	Pressure [kPa]	Test Result [%]	Lower limit [%]	Upper limit [%]	Expanded Uncertainty [%]	Result
114	101.3	0.43	0.00	2.00	0.25 ‡	Pass
94	101.3	0.45	0.00	2.00	0.25 ‡	Pass

-- End of measurement results--

Level Change Over Pressure

Tested at: 114 dB, 23 °C, 31 %RH

Nominal Pressure [kPa]	Pressure [kPa]	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
108.0	108.1	-0.02	-0.30	0.30	0.04 ‡	Pass
101.3	101.3	0.00	-0.30	0.30	0.04 ‡	Pass
92.0	91.9	0.03	-0.30	0.30	0.04 ‡	Pass
83.0	83.3	0.03	-0.30	0.30	0.04 ‡	Pass
74.0	73.8	0.02	-0.30	0.30	0.04 ‡	Pass
65.0	65.2	-0.03	-0.30	0.30	0.04 ‡	Pass

-- End of measurement results--

Frequency Change Over Pressure

Tested at: 114 dB, 23 °C, 31 %RH

Nominal Pressure [kPa]	Pressure [kPa]	Test Result [Hz]	Lower limit [Hz]	Upper limit [Hz]	Expanded Uncertainty [Hz]	Result
108.0	108.1	0.00	-10.00	10.00	0.20 ‡	Pass
101.3	101.3	0.00	-10.00	10.00	0.20 ‡	Pass
92.0	91.9	0.00	-10.00	10.00	0.20 ‡	Pass
83.0	83.3	-0.01	-10.00	10.00	0.20 ‡	Pass
74.0	73.8	-0.01	-10.00	10.00	0.20 ‡	Pass
65.0	65.2	-0.01	-10.00	10.00	0.20 ‡	Pass

-- End of measurement results--

Certificate Number 2020003029

Total Harmonic Distortion + Noise (THD+N) Over Pressure

Tested at: 114 dB, 23 °C, 31 %RH

Nominal Pressure [kPa]	Pressure [kPa]	Test Result [%]	Lower limit [%]	Upper limit [%]	Expanded Uncertainty [%]	Result
108.0	108.1	0.44	0.00	2.00	0.25 ‡	Pass
101.3	101.3	0.43	0.00	2.00	0.25 ‡	Pass
92.0	91.9	0.40	0.00	2.00	0.25 ‡	Pass
83.0	83.3	0.38	0.00	2.00	0.25 ‡	Pass
74.0	73.8	0.36	0.00	2.00	0.25 ‡	Pass
65.0	65.2	0.35	0.00	2.00	0.25 ‡	Pass

-- End of measurement results--

Signatory: Scott Montgomery

LARSON DAVIS - A PCB PIEZOTRONICS DIV.
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

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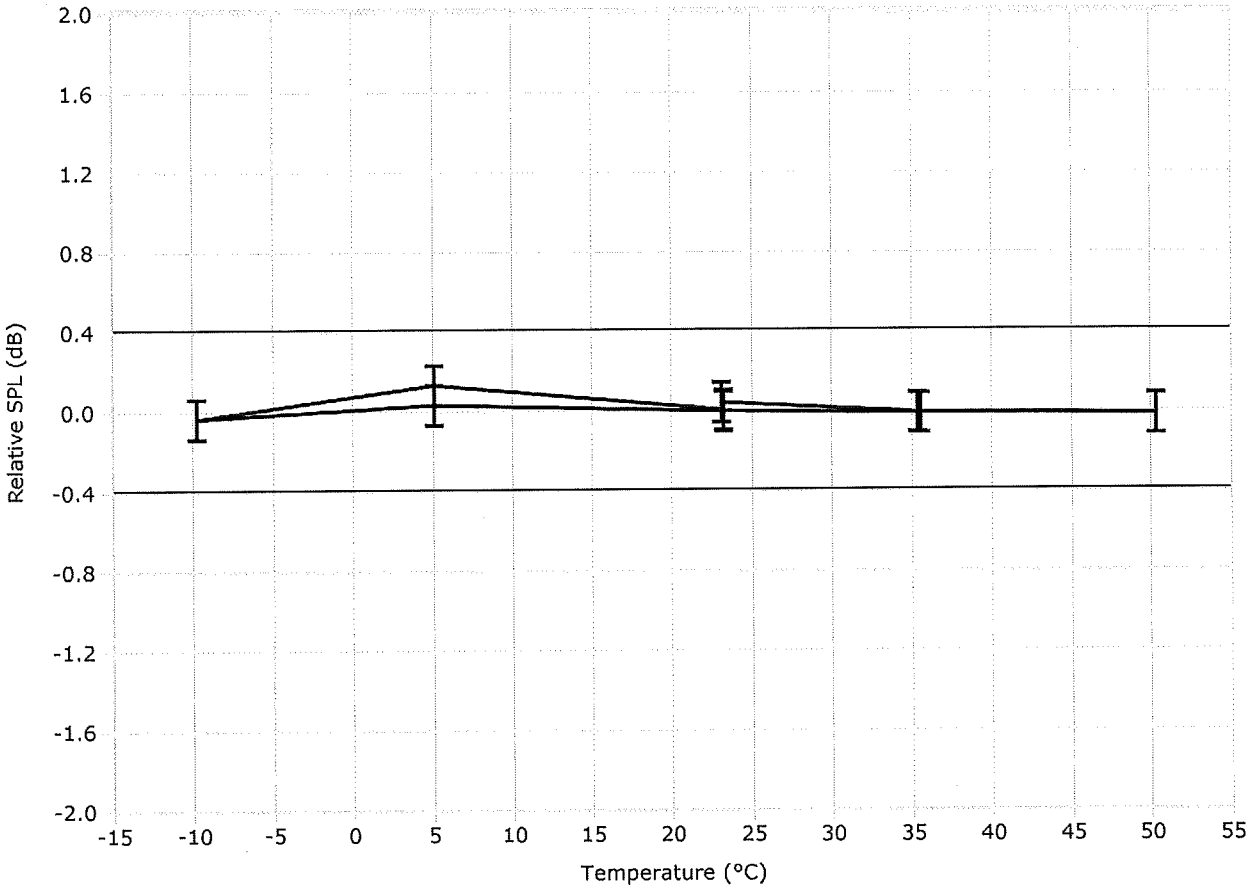
LARSON DAVIS A PCB PIEZOTRONICS DIV.

Model CAL200 Relative SPL vs. Temperature

Larson Davis Model CAL200 Serial Number: 17758

Model CAL200 Relative SPL vs. Temperature at 50% RH.
A 2559 Mic (SN: 3008) with a PRM902 Preamp (SN: 5789), station 23 was used to check the levels.

Test Date: 03 Feb 2020 7:56:54 AM



0.1dB expanded uncertainty at ~95% confidence level (k=2)

Sequence File: CAL200.SEQ

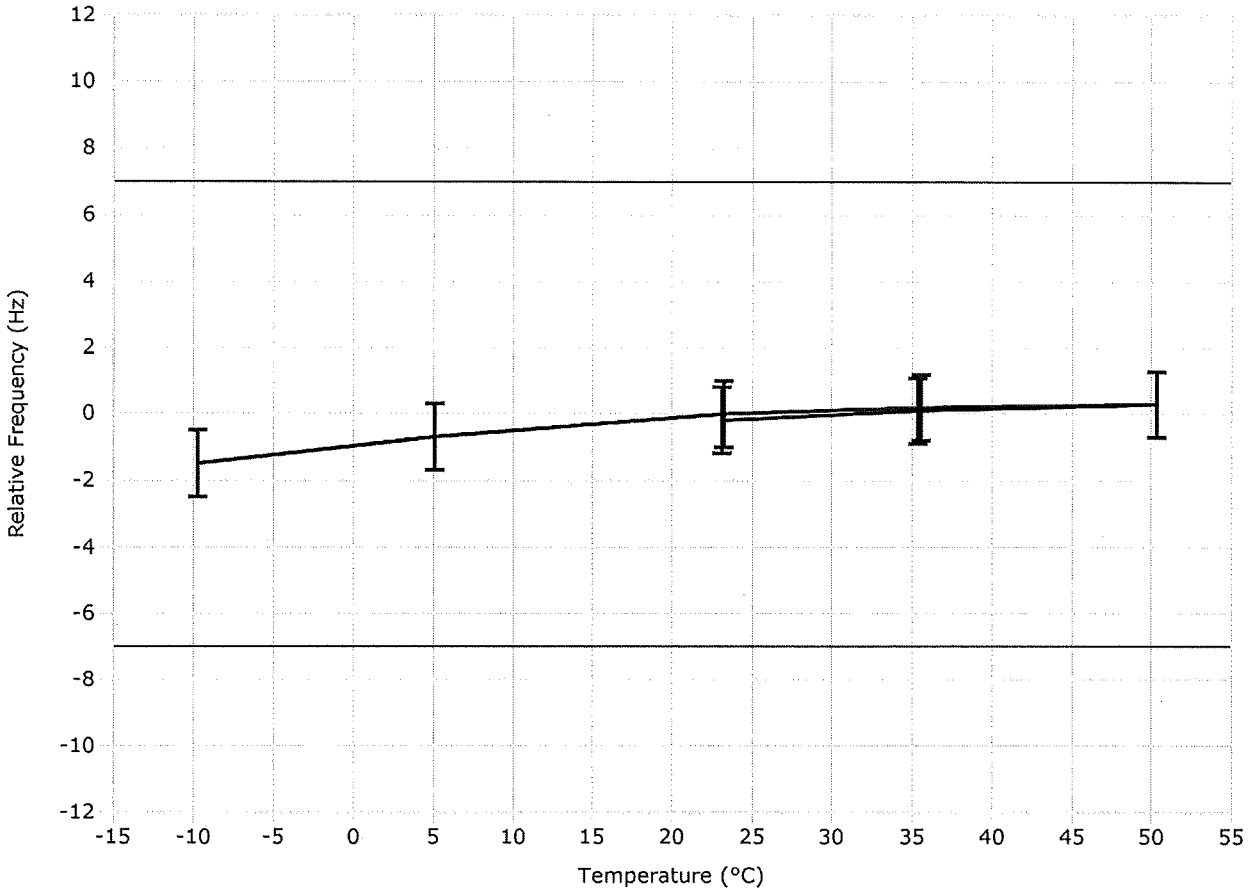
Test Location: Larson Davis, a division of PCB Piezotronics, Inc.
1681 West 820 North, Provo, Utah 84601
Tel: 716 684-0001 www.LarsonDavis.com

Model CAL200 Relative Frequency vs. Temperature

Larson Davis Model CAL200 Serial Number: 17758

Model CAL200 Relative Frequency vs. Temperature at 50% RH.
A 2559 Mic (SN: 3008) with a PRM902 Preamp (SN: 5789), station 23 was used to check the levels.

Test Date: 03 Feb 2020 7:56:54 AM



1.0 Hz expanded uncertainty at ~95% confidence level (k=2)

Sequence File: CAL200.SEQ

Test Location: Larson Davis, a division of PCB Piezotronics, Inc.
1681 West 820 North, Provo, Utah 84601
Tel: 716 684-0001 www.LarsonDavis.com

~ Certificate of Calibration and Compliance ~

Microphone Model: 377B02 Serial Number: 323599 Manufacturer: PCB

Calibration Environmental Conditions

Environmental test conditions as printed on microphone calibration chart.

Reference Equipment

Manufacturer	Model #	Serial #	PCB Control #	Cal Date	Due Date
National Instruments	PCIe-6351	1896F08	CA1918	10/18/19	10/16/20
Larson Davis	PRM915	134	CA2114	11/11/19	11/11/20
Larson Davis	PRM902	5352	CA1247	11/12/19	11/12/20
Larson Davis	PRM916	140	CA2129	11/25/19	11/25/20
Larson Davis	CAL250	4118	TA463	1/31/20	1/29/21
Larson Davis	2201	143	CA1206	2/13/20	2/12/21
Bruel & Kjaer	4192	2764626	CA1636	8/20/19	8/21/20
Larson Davis	GPRM902	5281	CA1595	11/20/19	11/20/20
Newport	iTHX-SD/N	1080002	CA1511	2/6/20	2/5/21
Larson Davis	PRA951-4	234	CA1154	11/8/19	11/6/20
Larson Davis	PRM915	123	CA866	11/20/19	11/20/20
PCB	68510-02	N/A	CA2672	2/13/20	2/12/21
0	0	0	0	not required	not required
0	0	0	0	not required	not required
0	0	0	0	not required	not required

Frequency sweep performed with B&K UA0033 electrostatic actuator.

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration of reference equipment is traceable to one or more of the following National Labs; NIST, PTB or DFM.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI/NCSL Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Open Circuit Sensitivity is measured using the insertion voltage method following procedure AT603-5.
6. Measurement uncertainty (95% confidence level with coverage factor of 2) for sensitivity is +/-0.20 dB.
7. Unit calibrated per ACS-20.

Technician: Leonard Lukasik Date: July 29, 2020

ilac-MRA A2LA ACCREDITED

CALIBRATION CERT #1862.01

PCB PIEZOTRONICS INC
VIBRATION DIVISION
3425 Walden Avenue, Depew, New York, 14043
TEL: 888-684-0013 FAX: 716-685-3886 www.pcb.com

ID:CAL112-3678882611.556+0

~ Calibration Report ~

Microphone Model: 377B02 Serial Number: 323599 Description: 1/2" Free-Field Microphone

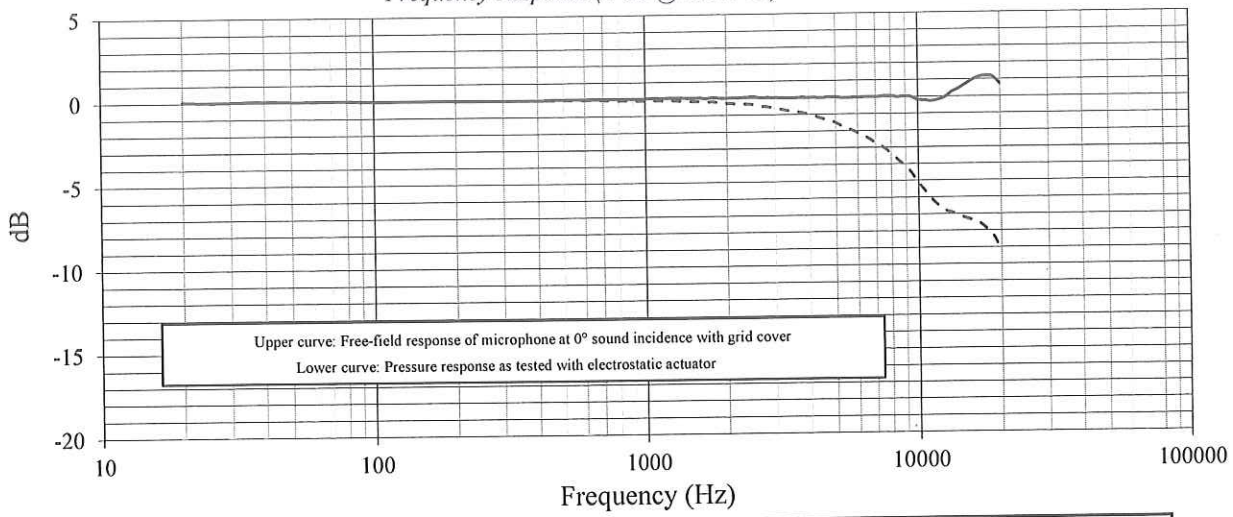
Calibration Data

Open Circuit Sensitivity @ 251.2 Hz: 57.00 mV/Pa
-24.88 dB re 1V/Pa

Polarization Voltage, External: 0 V
Capacitance: 13.7 pF

Temperature: 70 °F (21°C) Ambient Pressure: 987 mbar Relative Humidity: 48 %

Frequency Response (0 dB @ 251.2 Hz)



Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)
20.0	0.06	0.06	1679	-0.22	0.02	7499	-3.02	0.05	-	-	-
25.1	0.02	0.02	1778	-0.18	0.07	7943	-3.32	0.07	-	-	-
31.6	0.05	0.05	1884	-0.26	0.03	8414	-3.73	0.00	-	-	-
39.8	0.07	0.07	1995	-0.28	0.03	8913	-4.07	0.04	-	-	-
50.1	0.04	0.04	2114	-0.30	0.04	9441	-4.52	0.00	-	-	-
63.1	0.04	0.04	2239	-0.33	0.04	10000	-5.13	-0.18	-	-	-
79.4	0.04	0.04	2371	-0.34	0.07	10593	-5.62	-0.22	-	-	-
100.0	0.00	0.00	2512	-0.38	0.09	11220	-6.13	-0.27	-	-	-
125.9	0.01	0.01	2661	-0.49	0.02	11885	-6.51	-0.19	-	-	-
158.5	0.01	0.01	2818	-0.52	0.04	12589	-6.81	-0.04	-	-	-
199.5	0.00	0.00	2985	-0.60	0.02	13335	-6.93	0.26	-	-	-
251.2	0.00	0.00	3162	-0.68	0.01	14125	-7.13	0.46	-	-	-
316.2	-0.01	0.00	3350	-0.75	-0.01	14962	-7.26	0.71	-	-	-
398.1	-0.01	-0.01	3548	-0.82	0.00	15849	-7.38	0.97	-	-	-
501.2	0.00	0.04	3758	-0.88	0.02	16788	-7.58	1.14	-	-	-
631.0	-0.02	0.02	3981	-0.99	0.01	17783	-7.91	1.20	-	-	-
794.3	-0.05	0.04	4217	-1.10	0.01	18837	-8.38	1.13	-	-	-
1000.0	-0.08	0.04	4467	-1.24	-0.01	19953	-9.18	0.75	-	-	-
1059.3	-0.07	0.06	4732	-1.34	0.03	-	-	-	-	-	-
1122.0	-0.08	0.06	5012	-1.51	0.02	-	-	-	-	-	-
1188.5	-0.10	0.05	5309	-1.73	-0.03	-	-	-	-	-	-
1258.9	-0.09	0.07	5623	-1.91	-0.03	-	-	-	-	-	-
1333.5	-0.11	0.07	5957	-2.07	0.00	-	-	-	-	-	-
1412.5	-0.15	0.04	6310	-2.29	0.00	-	-	-	-	-	-
1496.2	-0.16	0.04	6683	-2.51	0.01	-	-	-	-	-	-
1584.9	-0.16	0.05	7080	-2.77	0.01	-	-	-	-	-	-

Technician: Leonard Lukasik Date: July 29, 2020

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CALIBRATION CERT #1862.01

PCB PIEZOTRONICS INC
VIBRATION DIVISION
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TEL: 888-684-0013 FAX: 716-685-3886 www.pcb.com

ID.CAL112-3678882611.556+0

~ Certificate of Calibration and Compliance ~

Microphone Model: 377B02 Serial Number: 323918 Manufacturer: PCB

Calibration Environmental Conditions

Environmental test conditions as printed on microphone calibration chart.

Reference Equipment

Manufacturer	Model #	Serial #	PCB Control #	Cal Date	Due Date
National Instruments	PCIe-6351	1896F08	CA1918	10/18/19	10/16/20
Larson Davis	PRM915	134	CA2114	11/11/19	11/11/20
Larson Davis	PRM902	5352	CA1247	11/12/19	11/12/20
Larson Davis	PRM916	140	CA2129	11/25/19	11/25/20
Larson Davis	CAL250	4118	TA463	1/31/20	1/29/21
Larson Davis	2201	143	CA1206	2/13/20	2/12/21
Bruel & Kjaer	4192	2764626	CA1636	8/20/19	8/21/20
Larson Davis	GPRM902	5281	CA1595	11/20/19	11/20/20
Newport	iTHX-SD/N	1080002	CA1511	2/6/20	2/5/21
Larson Davis	PRA951-4	234	CA1154	11/8/19	11/6/20
Larson Davis	PRM915	123	CA866	11/20/19	11/20/20
PCB	68510-02	N/A	CA2672	2/13/20	2/12/21
0	0	0	0	not required	not required
0	0	0	0	not required	not required
0	0	0	0	not required	not required

Frequency sweep performed with B&K UA0033 electrostatic actuator.

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration of reference equipment is traceable to one or more of the following National Labs; NIST, PTB or DFM.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI/NCSL Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Open Circuit Sensitivity is measured using the insertion voltage method following procedure AT603-5.
6. Measurement uncertainty (95% confidence level with coverage factor of 2) for sensitivity is +/-0.20 dB.
7. Unit calibrated per ACS-20.

Technician: Leonard Lukasik Date: July 29, 2020

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~ Calibration Report ~

Microphone Model: 377B02 Serial Number: 323918 Description: 1/2" Free-Field Microphone

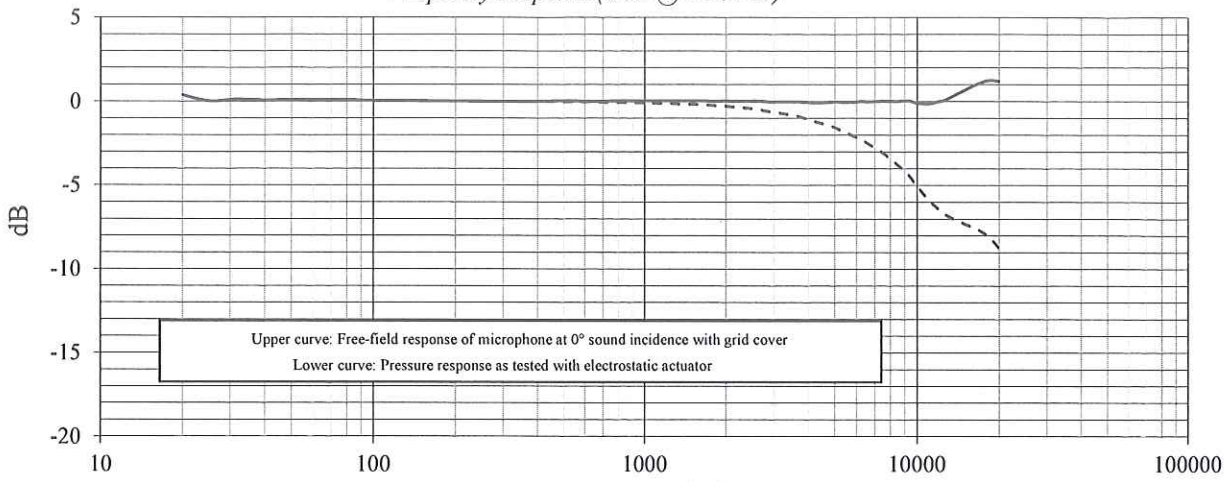
Calibration Data

Open Circuit Sensitivity @ 251.2 Hz: 47.64 mV/Pa
-26.44 dB re 1V/Pa

Polarization Voltage, External: 0 V
Capacitance: 13.7 pF

Temperature: 70 °F (21°C) Ambient Pressure: 986 mbar Relative Humidity: 49 %

Frequency Response (0 dB @ 251.2 Hz)



Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)
20.0	0.37	0.37	1679	-0.20	0.03	7499	-3.06	0.01	-	-	-
25.1	0.01	0.01	1778	-0.24	0.01	7943	-3.38	0.01	-	-	-
31.6	0.12	0.12	1884	-0.27	0.02	8414	-3.74	-0.01	-	-	-
39.8	0.07	0.07	1995	-0.28	0.03	8913	-4.07	0.04	-	-	-
50.1	0.09	0.09	2114	-0.34	0.00	9441	-4.51	0.02	-	-	-
63.1	0.09	0.09	2239	-0.36	0.01	10000	-5.05	-0.10	-	-	-
79.4	0.09	0.09	2371	-0.41	0.01	10593	-5.53	-0.13	-	-	-
100.0	0.04	0.04	2512	-0.44	0.02	11220	-5.99	-0.13	-	-	-
125.9	0.03	0.03	2661	-0.50	0.01	11885	-6.35	-0.03	-	-	-
158.5	0.02	0.02	2818	-0.58	-0.02	12589	-6.71	0.06	-	-	-
199.5	0.01	0.01	2985	-0.65	-0.03	13335	-6.93	0.26	-	-	-
251.2	0.00	0.00	3162	-0.70	-0.02	14125	-7.12	0.47	-	-	-
316.2	-0.01	0.00	3350	-0.77	-0.03	14962	-7.31	0.66	-	-	-
398.1	0.00	0.00	3548	-0.84	-0.02	15849	-7.47	0.89	-	-	-
501.2	-0.02	0.03	3758	-0.94	-0.04	16788	-7.66	1.06	-	-	-
631.0	-0.04	0.00	3981	-1.06	-0.06	17783	-7.91	1.20	-	-	-
794.3	-0.07	0.02	4217	-1.19	-0.08	18837	-8.27	1.24	-	-	-
1000.0	-0.09	0.03	4467	-1.31	-0.08	19953	-8.74	1.19	-	-	-
1059.3	-0.10	0.03	4732	-1.43	-0.06	-	-	-	-	-	-
1122.0	-0.12	0.02	5012	-1.56	-0.03	-	-	-	-	-	-
1188.5	-0.11	0.04	5309	-1.75	-0.05	-	-	-	-	-	-
1258.9	-0.12	0.04	5623	-1.94	-0.06	-	-	-	-	-	-
1333.5	-0.15	0.03	5957	-2.11	-0.04	-	-	-	-	-	-
1412.5	-0.15	0.04	6310	-2.30	-0.01	-	-	-	-	-	-
1496.2	-0.18	0.02	6683	-2.55	-0.03	-	-	-	-	-	-
1584.9	-0.19	0.03	7080	-2.79	-0.01	-	-	-	-	-	-

Technician: Leonard Lukasik Date: July 29, 2020

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