Appendix 19-2:

Pre-Construction Sound Level Measurement Program

GARNET ENERGY CENTER

PRE-CONSTRUCTION SOUND LEVEL MEASUREMENT PROGRAM

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1.0 BASELINE SOUND LEVEL MONITORING PROGRAM

To characterize the existing soundscape of the Project area, an ambient (baseline) monitoring program was conducted in accordance with the NYS Article 10 Exhibit 19 requirements and the Project's Stipulation 19 filed with DPS on February 8, 2021. This section outlines the structure of the ambient program.

1.1 Sensitive Receptors

All residences [including participating, non-participating, full-time and seasonal], outdoor public facilities and areas, State Forest Lands, places of worship, hospitals, schools, cemeteries, campsites, summer camps, Public Parks, Federal and NY State Lands, any of these within one mile of the solar project were included as sensitive receptors. Seasonal receptors included cabins and hunting camps identified by property tax codes and any other seasonal residence known to have septic systems or running water. All sensitive receptors are shown in Figure 1-1.

1.2 Sound Level Measurement Locations

In accordance with ANSI S12.9-1992/Part 2 (R2013), the deterministic spatial sampling technique was used to select measurement locations. In other words, sound monitoring locations were selected to be representative of nearby residences in various directions from the solar project. Thus, the selected locations are representative of potentially impacted receptors. The program was intended to measure total ambient sound in the area which includes all noise sources.

Two sound level measurement programs were conducted; one during the winter season ("leaf-off"), and one in summer ("leaf-on"). Figure 1-1 shows the measurement locations for the measurement program. The ambient measurement locations are representative of the general vicinity of the Project. Each sound level monitoring location is described in the following subsections.

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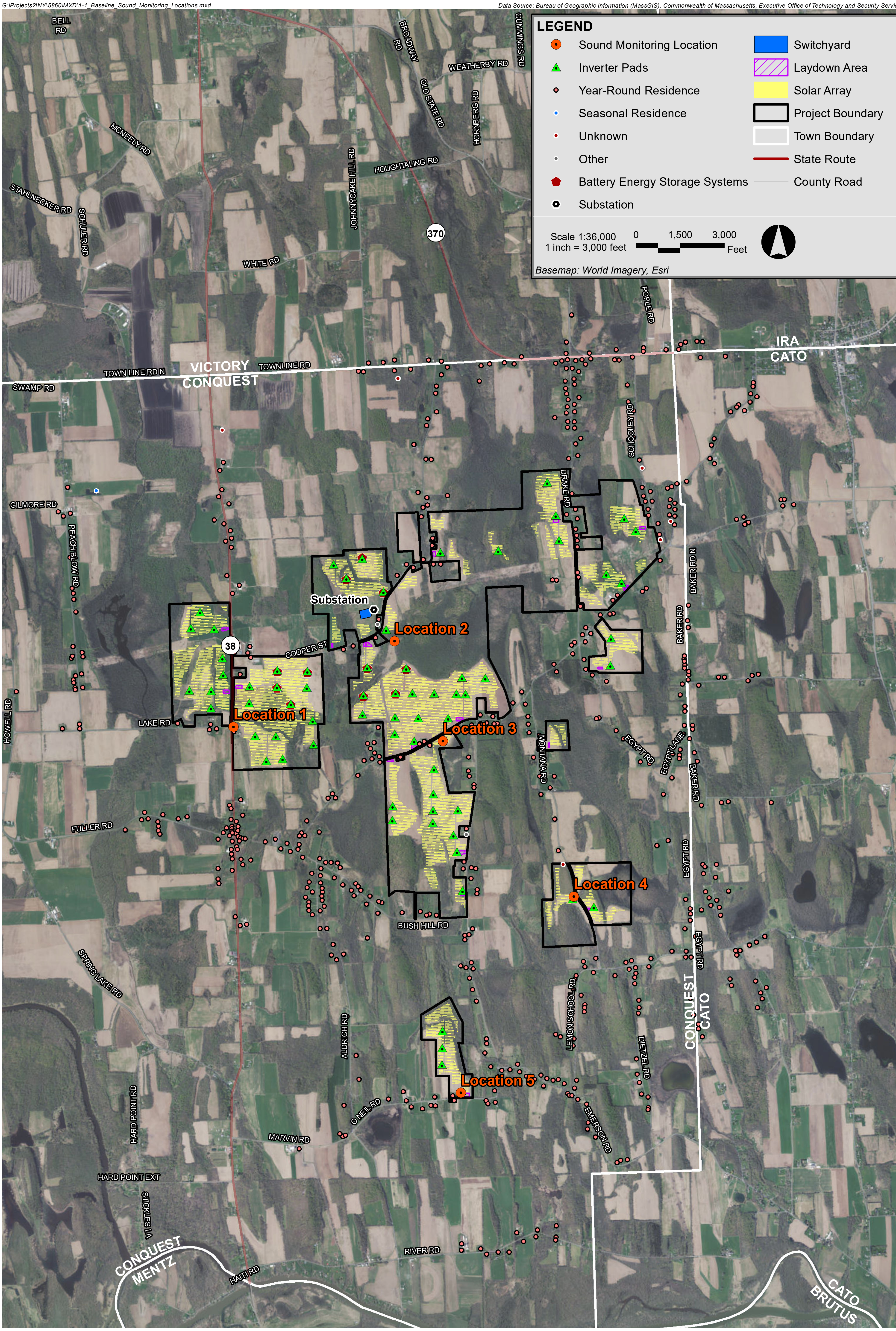
Data Source: Bureau of Geographic Information (MassGIS), Commonwealth of Massachusetts, Executive Office of Technology and Security Services



Garnet Energy Center Cayuga County, New York

Epsilon ASSOCIATES INC.

Figure 1-1

Baseline Sound Monitoring Locations

The coordinates for the sound level measurement locations are listed in Table 1-1, which were slightly adjusted as needed from the field-measured Global Positioning System (GPS) points for refined accuracy.

The NYS DOT website was checked for Annual Average Daily Traffic (AADT) counts in the vicinity of the sound level meters (SLM). The New York Route 38 through the project had an AADT of 918 vehicles in 2019. The next closest road to the project which has AADT data is New York Route 370 and is about two miles north-northeast from the nearest monitoring location and about one mile north of the project area at its closest point. This road had an AADT of 2,733 in 2019. Other roads in the Project Area generally carry less traffic than these roads.

Table 1-1 GPS Coordinates – Sound Level Measurement Locations

Location	Latitude	Longitude
Location 1	43.1315°	-76.6483°
Location 2	43.1398°	-76.6281°
Location 3	43.1305°	-76.6217°
Location 4	43.1163°	-76.6047°
Location 5	43.0979°	-76.6185°

1.2.1 Location 1—NY Route 38

One continuous programmable, unattended sound level meter was placed near NY Route 38 in the Town of Conquest. The meter was placed approximately 85 feet east of the road near a corn field and a lightly brushed area on a residential property. This location is representative of existing sound levels in the western area of the project site and along NY Route 38. Refer to Figures 1-2 and 1-3 for a photo of the monitoring setup during the summer and winter seasons, respectively.

The meter continuously measured and stored broadband (A-weighted) and one-third octave band sound level statistics during the summer season from 10:10 a.m. Wednesday, August 12, 2020 until 2:30 p.m. on Wednesday, August 19, 2020. In total, 1,035 10-minute measurement periods were recorded during the summer measurement program.

The meter continuously measured and stored broadband (A-weighted) and one-third octave band sound level statistics during the winter season from 11:10 a.m. on Tuesday, November 10, 2020 until 11:30 a.m. on Thursday, November 19, 2020. In total, 1,300 10-minute measurement periods were recorded during the winter measurement program.

Figure 1-2 Location 1-- Sound Level Meter; Summer

Figure 1-3 Location 1-- Sound Level Meter; Winter

1.2.2 Location 2—Cooper Street

One continuous programmable, unattended sound level meter was placed near Cooper Street in the Town of Conquest. The meter was placed approximately 650 feet southeast of the road and is representative of existing sound levels in the northern area of the Project Site and along Cooper Street. Refer to Figures 1-4 and 1-5 for a photo of the monitoring setup during the summer and winter seasons, respectively.

The meter continuously measured and stored broadband (A-weighted) and one-third octave band sound level statistics during the summer season from 11:40 a.m. Wednesday, August 12, 2020 until 3:00 p.m. on Wednesday, August 19, 2020. In total, 1,028 10-minute measurement periods were recorded during the summer measurement program.

The meter continuously measured and stored broadband (A-weighted) and one-third octave band sound level statistics during the winter season from 10:20 a.m. on Tuesday, November 10, 2020 until 10:00 a.m. on Thursday, November 19, 2020. In total, 1,294 10-minute measurement periods were recorded during the winter measurement program.

In addition to sound data collection, continuous ground-level wind speed data were collected at this location during both monitoring programs. The meteorological equipment setup is shown in Figures 1-6 and 1-7 for the respective seasons.

Figure 1-4 Location 2 - Sound Level Meter; Summer

Figure 1-5 Location 2 - Sound Level Meter; Winter

Figure 1-6 Location 2 - Meteorological Tower; Summer

Figure 1-7 Location 2 - Meteorological Tower; Winter

1.2.3 Location 3 – Slayton Road

One continuous programmable, unattended sound level meter was placed near Slayton Road in the Town of Conquest. The meter was placed approximately 220 feet south southeast of the road and is representative of existing sound levels in the central area of the Project Site and along Slayton Road. Refer to Figures 1-8 and 1-9 for a photo of the monitoring setup during the summer and winter seasons, respectively.

The meter continuously measured and stored broadband (A-weighted) and one-third octave band sound level statistics during the summer season from 6:20 p.m. Tuesday, August 11, 2020 until 2:00 p.m. on Wednesday, August 19, 2020. In total, 1,126 10-minute measurement periods were recorded during the summer measurement program.

The meter continuously measured and stored broadband (A-weighted) and one-third octave band sound level statistics during the winter season from 12:00 p.m. on Tuesday, November 10, 2020 until 10:50 a.m. on Thursday, November 19, 2020. In total, 1,288 10-minute measurement periods were recorded during the winter measurement program.

Figure 1-8 Location 3-- Sound Level Meter; Summer

Figure 1-9 Location 3-- Sound Level Meter; Winter

1.2.4 Location 4 – Montana Road

One continuous programmable, unattended sound level meter was placed near Montana Road in the Town of Conquest. The meter was placed approximately 105 feet west of Montana Road and is representative of existing sound levels in the eastern area of the Project Site and along Montana Road. Refer to Figures 1-10 and 1-11 for a photo of the monitoring setup during the summer and winter seasons, respectively.

The meter continuously measured and stored broadband (A-weighted) and one-third octave band sound level statistics during the summer season from 6:40 p.m. Tuesday, August 11, 2020 until 1:00 p.m. on Wednesday, August 19, 2020. In total, 1,130 10-minute measurement periods were recorded during the summer measurement program.

The meter continuously measured and stored broadband (A-weighted) and one-third octave band sound level statistics during the winter season from 12:50 p.m. on Tuesday, November 10, 2020 until 12:00 p.m. on Thursday, November 19, 2020. In total, 1,291 10-minute measurement periods were recorded during the winter measurement program. Due to an unstable microphone connection, some data were discarded for this location.

In addition to sound data collection, continuous ground-level wind speed data were collected at this location during both monitoring programs. The meteorological equipment setup is shown in Figures 1-12 and 1-13 for the respective seasons.

Figure 1-10 Location 4 -- Sound Level Meter; Summer

Figure 1-11 Location 4 -- Sound Level Meter; Winter

Figure 1-12 Location 4 - Meteorological Tower; Summer

Figure 1-13 Location 4 - Meteorological Tower; Winter

1.2.5 Location 5 – Court 19B, O'Neil

One continuous programmable, unattended sound level meter was placed near Court 19B, O'Neil in the Town of Conquest. The meter was placed approximately 180 feet north of Court 19B, O'Neil and is representative of existing sound levels in the southern area of the Project Site and along Court 19B, O'Neil. Refer to Figures 1-14 and 1-15 for a photo of the monitoring setup during the summer and winter seasons, respectively.

The meter continuously measured and stored broadband (A-weighted) and one-third octave band sound level statistics during the summer season from 3:40 p.m. Tuesday, August 11, 2020 until 12:20 p.m. on Wednesday, August 19, 2020. In total, 1,132 10-minute measurement periods were recorded during the summer measurement program.

The meter continuously measured and stored broadband (A-weighted) and one-third octave band sound level statistics during the winter season from 13:20 p.m. on Tuesday, November 10, 2020 until 1:30 p.m. on Thursday, November 19, 2020. In total, 1,294 10-minute measurement periods were recorded during the winter measurement program.

Figure 1-14 Location 5-- Sound Level Meter; Summer

Figure 1-15 Location 5 -- Sound Level Meter; Winter

1.3 Sound Level Measurement Instrumentation

Each of the monitoring locations used either a Larson Davis (LD) model 831[1] sound level meter (SLM) or a Norsonic model Nor140[2] SLM to measure both A-weighted (dBA) and one third octave bands from 6.3Hz to 20,000Hz. Each instrument was equipped with a LD PRM 831 preamplifier and a PCB 377B20 or a PCB 377C20 half-inch microphone, or a Norsonic Nor1290 preamplifier and a G.R.A.S 40AN half-inch microphone along with an environmental protection kit. The kit included a 7-inch open cell wind screen to reduce wind-induced noise over the microphone. A peer-reviewed study presenting the windscreen insertion loss data by one-third octave band for each wind screen used in the background monitoring is provided in Appendix A. Since all measured sound level results are presented in terms of ANS weighting (see discussion in section 2.1), frequencies above 1250Hz are not included, and thus the minor microphone insertion losses at higher frequencies are not relevant.

1 Noise floor specified in manufacturer's manual with use of PRM831 preamplifier and 377B02 microphone for A-weighted sound pressure levels is 18dBA at a 0dB gain and 17dBA at a 20dB gain. Noise floor specified for Z-weighted sound pressure levels is 23dBA at a 0dB gain and 21dBA at a 20dB gain.

2 Noise floor specified in manufacturer's manual A-weighted sound pressure levels is 25dBA with self-noise of the SLM at 15dBA.

Microphones were tripod-mounted at a height of approximately five feet (1.5 meters) above ground level in accordance with ANSI S12.9-1992/Part 2 (R2013). Horizontal microphone placements near roadways were in accordance with ANSI S12.9-1992/Part 2 (R2013) for open land.

The LD831 and Nor140 meters meet Type 1 ANSI/ASA S1.4, ANSI S1.43-1997 (R2007), and IEC 61672 Class 1 standards for sound level meters and were calibrated and certified as accurate to standards set by the National Institute of Standards and Technology. The octave band filters for all instrumentation meet ANSI S1.11-2004 (R2009). These calibrations were conducted by an independent laboratory within 12 months of field placement and certificates of calibration are provided in Appendix B. All measurement equipment was calibrated in the field before and after the surveys with the manufacturer's acoustical calibrator which meets the standards of IEC 60942-2003 Class 1L and ANSI/ASA S1.40-2006 (R2016).

1.4 Meteorological Instrumentation

1.4.1 Ground Level Winds

Wind speed can have a strong influence on ambient sound levels. In order to understand how the existing sound levels are influenced by wind speed, a HOBO H21-002 or a HOBO H21-USB micro-weather station (manufactured by Onset Computer Corporation) with tripod and data logger was used to record continuous wind speed data at Location 2 and Location 5 during both seasons.

The HOBO wind instruments have a measurement range of 0 to 44 m/s (99 mph) or 0 to 45 m/s (100 mph) and an accuracy of +/- 0.5 m/s (1.1 mph) or +/- 1.1 m/s (2.4 mph). The starting threshold is 0.5 m/s (1.1 mph) or ≤1.0 m/s (2.2 mph).

1.4.2 Precipitation, Temperature, and Relative Humidity

Meteorological data from the New York State Mesonet system were used for both the winter and summer measurements. The New York State Mesonet consists of 125 state-of-the-art environmental monitoring stations and serves as the foundation of an Early Warning Severe Weather Detection network for the entire State of New York. The New York State Mesonet was developed by research scientists at the State University of New York (SUNY) at Albany's Atmospheric Sciences Research Center, and Department of Atmospheric and Environmental Sciences. Mesonet sites are distributed statewide with every county across New York having at least one or more sites. The Mesonet collects measurements of several surface and atmospheric variables, such as temperature, relative humidity, wind speed and direction, surface pressure, soil moisture, soil temperature, solar radiation, and precipitation amounts for rainfall and snow accumulation. These data are archived and available to the public.

The Jordan Mesonet station is located approximately 7.5 miles northeast from the closest Garnet measurement location. This station is the closest to the Project site that contained valid data for both measurement programs. As a result, the Jordan Mesonet station was used for the analysis of both the summer and winter measurement programs. The SUNY Mesonet data from the Jordan station is provided in Appendix C of this report.

1.5 Low Frequency and Infrasound Monitoring

All monitoring locations were equipped to monitor infrasound as low as 6.3 Hz. Each meter collected continuous broadband and one-third octave-band ambient sound pressure level data. The meter logged data every 10-minutes with statistical data for the following parameters: $L_{eq,}$ L_{10}, L_{50}, L_{90}, L_{max}, and L_{min}. A one-second time history data collection using the “fast” response setting was also implemented.

2.0 BASELINE SOUND LEVEL MONITORING RESULTS

This chapter discusses the results from the detailed ambient (baseline) monitoring program outlined in the previous chapter. Specifically, the logic for data validity, and sound level result descriptions for the monitoring locations are explained.

2.1 Data Formatting Overview

Sound level data were collected at 10-minute intervals[3] at five strategically selected locations around the proposed solar energy project during both the summer and winter seasons. Monitoring periods that experienced elevated ground-level wind speeds or precipitation were excluded from the data analysis per Method #1 in ANSI S12.18-1994. According to this standard, "No sound level measurement shall be made when the average wind velocity exceeds 5 m/s when measured at a height of 2±0.2 m above the ground". In addition, "Measurement during precipitation […] is highly discouraged". Precipitation events identified at the SUNY MesoNet station in Jordan, NY defined periods for which sound level data were excluded from the analysis for the summer and winter measurement programs.

The sound level equipment used in ambient monitoring have specifications regarding operative ranges under certain air conditions, e.g., temperature and relative humidity.[4,5] Data from the Jordan MesoNet station was additionally referenced for the range exceedances during all measurement timeframes. Sound levels during these exceedances were excluded from further processing.

As per Stipulation 19, intermittent noise was filtered by using the L_{90}. Seasonal noise was removed from the ambient sound level measurements regardless of season. A high-frequency natural sound (HFNS) filter was therefore applied to the measured one-third octave-band data from which a broadband sound level was calculated for both the summer and winter monitoring seasons. This technique removes all sound energy above the 1,250 Hertz frequency band. The methodology for the filtration process is as specified in ANSI/ASA S12.100-2014 and the sound pressure levels presented in this report using this methodology are indicated as ANS-weighted

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3 It should be noted that all sound level instrumentation data, ground level meteorological instrumentation data and on-site meteorological tower data records were time-correlated for appropriate alignment of monitoring periods.

4 Periods measured outside the temperature range of 14°F to 122°F were considered invalid due to the Larson Davis Model 831 SLM and specifications.

5 Periods measured outside the relative humidity range of 1 to 99% were considered invalid based on microphone specifications. The accuracy of sound levels measured with a Larson Davis Model 831 SLM outside the relative humidity range of 25% to 90% is unknown; however, the data are not considered invalid and are included in the data summaries. The same is relevant for sound levels measured with a Norsonic Nor140 SLM outside the range of 5% to 90% relative humidity.

levels (presented in dBA). The calculated broadband ANS-weighted (dBA) average L_{eq} and L_{90} ambient sound levels are presented for the winter and summer seasons for each location in the following subsections.

As per the Exhibit 19 regulations 1001.19(f)(1) daytime is defined as the period from 7 a.m. to 10 p.m. Respectively, nighttime is defined as the period from 10 p.m. to 7 a.m. (1001.19(f)(2)).

2.2 Location 1 – NY Route 38

Sound levels at Location 1 were influenced by vehicular traffic on NY Route 38 and Lake Road, vegetation rustle, wind, homeowner activity, insects, birds, dogs, wall air conditioner unit, farming equipment, and occasional propeller and jet aircraft. Sound level-versus-time graphs are provided in this section. This includes L_{eq} and L_{90} sound pressure levels and ground-level wind speeds measured at Location 1. Data that were excluded from further analysis and calculations due to ground-level winds exceeding 5 m/s as recorded by the HOBO wind instrumentation at Location 2 for both seasons; or due to precipitation or instrumentation operative exceedances as recorded at the Jordan MesoNet station are identified in the figures.

2.2.1 Summer Monitoring

The ranges of measured A-weighted sound levels during the summer season are summarized below and presented graphically in Figure 2-1. A total of 173 10-minute periods were excluded from the summer season. The resulting dataset includes a total of 862 10-minute periods of valid data.

- The valid steady-state level (L_{90}) measurements ranged from 38 to 59 dBA;
- The valid equivalent level (L_{eq}) measurements ranged from 45 to 66 dBA.

The ranges of calculated ANS-weighted sound levels during the summer season are summarized below.

- The valid, calculated steady-state (L_{90}) ANS-weighted broadband sound levels ranged from 21 to 50 dBA;
- The valid, calculated equivalent (L_{eq}) ANS-weighed broadband sound levels ranged from 23 to 64 dBA.

2.2.2 Winter Monitoring

The ranges of measured A-weighted sound levels during the winter season are summarized below and presented graphically in Figure 2-2. A total of 68 10-minute periods were excluded from the winter season. The resulting dataset includes a total of 1,232 10-minute periods of valid data.

- The valid steady-state level (L_{90}) measurements ranged from 17 to 57 dBA;

- The valid equivalent level (L_{eq}) measurements ranged from 19 to 61 dBA.

The ranges of calculated ANS-weighted sound levels during the winter season are summarized below.

- The valid, calculated steady-state (L_{90}) ANS-weighted broadband sound levels ranged from 13 to 54 dBA;

- The valid, calculated equivalent (L_{eq}) ANS-weighed broadband sound levels ranged from 16 to 61 dBA.

2.2.3 Spectral Sound Level Data

In addition to broadband sound levels, spectral sound level data were measured during each 10-minute period at Location 1 for both the winter and summer measurement periods. Using only valid measurement periods, octave-band and one-third octave-band data are summarized in Figures 2-3 and 2-4, respectively, as logarithmic averages of the equivalent (L_{eq}) sound levels; separated by daytime and nighttime. Octave-band levels are displayed from 16 Hz to 16,000 Hz in Figure 2-3 for both L_{eq} and L_{90}. The one-third octave-band data in Figure 2-4 span the frequencies from 12.5 Hz to 16,000 Hz and were analyzed for prominent discrete tones[6]. Prominent discrete tones were present at the 8000 Hz octave band for the summer daytime measurement period, and 2000 Hz and 5000 Hz octave bands for the summer nighttime measurement period. This is likely due to bird and insect activity, as well as the wall air conditioner unit.

2.3 Location 2 – Cooper Street

Sound levels at Location 2 were influenced by vehicular traffic on Cooper Street, insects, vegetation rustle, birds, other wildlife, creaking tree branches, wind, dogs, chainsaws, and occasional aircraft. Sound level-versus-time graphs are provided in this section. This includes L_{eq} and L_{90} sound pressure levels and ground-level wind speeds measured at Location 2. Data that were excluded from further analysis and calculations due to ground-level winds exceeding 5 m/s as recorded by the HOBO wind instrumentation at Location 2 for both seasons; or due to precipitation or instrumentation operative exceedances as recorded at the Jordan MesoNet station are identified in the figures.

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6 Prominent discrete tones as defined by the ANSI S12.9 Part 3 standard. The lowest frequency in the Annex B.1 tone test is 25 Hz. 20 Hz data are presented for informational purposes.

2.3.1 *Summer Monitoring*

The ranges of measured A-weighted sound levels during the summer season are summarized below and presented graphically in Figure 2-5. A total of 173 10-minute periods were excluded from the summer season. The resulting dataset includes a total of 855 10-minute periods of valid data.

- The valid steady-state level (L_{90}) measurements ranged from 35 to 57 dBA;
- The valid equivalent level (L_{eq}) measurements ranged from 38 to 70 dBA.

The ranges of calculated ANS-weighted sound levels during the summer season are summarized below.

- The valid, calculated steady-state (L_{90}) ANS-weighted broadband sound levels ranged from 14 to 51 dBA;
- The valid, calculated equivalent (L_{eq}) ANS-weighed broadband sound levels ranged from 16 to 69 dBA.

2.3.2 *Winter Monitoring*

The ranges of measured A-weighted sound levels during the winter season are summarized below and presented graphically in Figure 2-6. A total of 68 10-minute periods were excluded from the winter season. The resulting dataset includes a total of 1,226 10-minute periods of valid data.

- The valid steady-state level (L_{90}) measurements ranged from 17 to 55 dBA;
- The valid equivalent level (L_{eq}) measurements ranged from 18 to 60 dBA.

The ranges of calculated ANS-weighted sound levels during the winter season are summarized below.

- The valid, calculated steady-state (L_{90}) ANS-weighted broadband sound levels ranged from 12 to 55 dBA;
- The valid, calculated equivalent (L_{eq}) ANS-weighed broadband sound levels ranged from 14 to 59 dBA.

2.3.3 *Spectral Sound Level Data*

In addition to broadband sound levels, spectral sound level data were measured during each 10-minute period at Location 2. Using only valid measurement periods, octave-band and one-third octave-band data are summarized in Figures 2-7 and 2-8, respectively, as logarithmic averages of the equivalent (L_{eq}) sound levels; separated by daytime and nighttime. Octave-band levels are displayed from 16 Hz to 16,000 Hz in Figure 2-7 for both L_{eq} and L_{90}. The one-third octave-band data in Figure 2-8 span the frequencies from 12.5 Hz to 16,000 Hz and were analyzed for prominent discrete tones[7]. Prominent discrete tones were present at the 5000 Hz octave band for both the summer daytime measurement period and for the summer nighttime measurement period. This is likely due to bird and insect activity.

2.4 Location 3 – Slayton Road

Sound levels at Location 3 were influenced by vehicular traffic on Slayton Road, distant vehicular traffic, insects, vegetation rustle, wind, birds, frogs, other wildlife, dogs, machinery from a nearby farming facility, a wind chime, and occasional aircraft. Sound level-versus-time graphs are provided in this section. This includes L_{eq} and L_{90} sound pressure levels and ground-level wind speeds measured at Location 2. Data that were excluded from further analysis and calculations due to ground-level winds exceeding 5 m/s as recorded by the HOBO wind instrumentation at Location 2 for both seasons; or due to precipitation or instrumentation operative exceedances as recorded at the Jordan MesoNet station are identified in the figures.

2.4.1 Summer Monitoring

The ranges of measured A-weighted sound levels during the summer season are summarized below and presented graphically in Figure 2-9. A total of 173 10-minute periods were excluded from the summer season. The resulting dataset includes a total of 953 10-minute periods of valid data.

- The valid steady-state level (L_{90}) measurements ranged from 32 to 52 dBA;
- The valid equivalent level (L_{eq}) measurements ranged from 38 to 65 dBA.

The ranges of calculated ANS-weighted sound levels during the summer season are summarized below.

- The valid, calculated steady-state (L_{90}) ANS-weighted broadband sound levels ranged from 15 to 46 dBA;
- The valid, calculated equivalent (L_{eq}) ANS-weighed broadband sound levels ranged from 18 to 65 dBA.

2.4.2 Winter Monitoring

The ranges of measured A-weighted sound levels during the winter season are summarized below and presented graphically in Figure 2-10. A total of 68 10-minute periods were excluded from the winter season. The resulting dataset includes a total of 1,220 10-minute periods of valid data.

[7] Prominent discrete tones as defined by the ANSI S12.9 Part 3 standard. The lowest frequency in the Annex B.1 tone test is 25 Hz. 20 Hz data are presented for informational purposes.

- The valid steady-state level (L_{90}) measurements ranged from 15 to 55 dBA;
- The valid equivalent level (L_{eq}) measurements ranged from 17 to 67 dBA.

The ranges of calculated ANS-weighted sound levels during the winter season are summarized below.

- The valid, calculated steady-state (L_{90}) ANS-weighted broadband sound levels ranged from 11 to 52 dBA;
- The valid, calculated equivalent (L_{eq}) ANS-weighed broadband sound levels ranged from 15 to 61 dBA.

2.4.3 Spectral Sound Level Data

In addition to broadband sound levels, spectral sound level data were measured during each 10-minute period at Location 3. Using only valid measurement periods, octave-band and one-third octave-band data are summarized in Figures 2-11 and 2-12, respectively, as logarithmic averages of the equivalent (L_{eq}) sound levels; separated by daytime and nighttime. Octave-band levels are displayed from 16 Hz to 16,000 Hz in Figure 2-11 for both L_{eq} and $L_{90.}$ The one-third octave-band data in Figure 2-12 span the frequencies from 12.5 Hz to 16,000 Hz and were analyzed for prominent discrete tones[8]. Prominent discrete tones were detected at the 5,000 Hz and 8,000 Hz octave bands for summer daytime measurements as well as the 5,000 Hz octave band for summer nighttime measurements. These are likely due to bird and insect activity.

2.5 Location 4 – Montana Road

Sound levels at the Location 4 monitor were influenced by vehicular traffic on Montana Road, distant traffic, wind, vegetation rustle, birds, dogs, frogs, a chainsaw, a metal roof clattering in the wind, occasional propeller and jet aircraft, and occasional train horns. Sound level-versus-time graphs are provided in this section. This includes L_{eq} and L_{90} sound pressure levels and ground-level wind speeds measured at Location 4. Data that were excluded from further analysis and calculations due to ground-level winds exceeding 5 m/s as recorded by the HOBO wind instrumentation at Location 4 for the summer season, and the HOBO wind instrumentation at Location 2 for the winter season; or due to precipitation or instrumentation operative exceedances as recorded at the Jordan MesoNet station are identified in the figures.

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8 Prominent discrete tones as defined by the ANSI S12.9 Part 3 standard. The lowest frequency in the Annex B.1 tone test is 25 Hz. 20 Hz data are presented for informational purposes.

2.5.1 *Summer Monitoring*

The ranges of measured A-weighted sound levels during the summer season are summarized below and presented graphically in Figure 2-13. A total of 175 10-minute periods were excluded from the summer season. The resulting dataset includes a total of 955 10-minute periods of valid data.

- The valid steady-state level (L_{90}) measurements ranged from 32 to 54 dBA;
- The valid equivalent level (L_{eq}) measurements ranged from 34 to 70 dBA.

The ranges of calculated ANS-weighted sound levels during the summer season are summarized below.

- The valid, calculated steady-state (L_{90}) ANS-weighted broadband sound levels ranged from 12 to 49 dBA;
- The valid, calculated equivalent (L_{eq}) ANS-weighed broadband sound levels ranged from 16 to 68 dBA.

2.5.2 *Winter Monitoring*

The ranges of measured A-weighted sound levels during the winter season are summarized below and presented graphically in Figure 2-14. A total of 256 10-minute periods were excluded from the winter season. The resulting dataset includes a total of 1,035 10-minute periods of valid data.

- The valid steady-state level (L_{90}) measurements ranged from 16 to 50 dBA;
- The valid equivalent level (L_{eq}) measurements ranged from 18 to 64 dBA.

The ranges of calculated ANS-weighted sound levels during the winter season are summarized below.

- The valid, calculated steady-state (L_{90}) ANS-weighted broadband sound levels ranged from 12 to 49 dBA;
- The valid, calculated equivalent (L_{eq}) ANS-weighed broadband sound levels ranged from 15 to 56 dBA.

2.5.3 *Spectral Sound Level Data*

In addition to broadband sound levels, spectral sound level data were measured during each 10-minute period at Location 4. Using only valid measurement periods, octave-band and one-third octave-band data are summarized in Figures 2-15 and 2-16, respectively, as logarithmic averages of the equivalent (L_{eq}) sound levels; separated by daytime and nighttime. Octave-band levels are displayed from 16 Hz to 16,000 Hz in Figure 2-15 for both L_{eq} and L_{90}. The one-third octave-band data in Figure 2-16 span the frequencies from 12.5 Hz to 16,000 Hz and were analyzed for prominent discrete tones[9]. Prominent discrete tones were present at the 5,000 Hz frequency for the summer daytime and nighttime measurement period. These are likely due to bird and insect activity.

2.6 Location 5 – Court 19B, O'Neil

Sound levels at Location 5 were influenced by vehicular traffic on Court 19B, O'Neil and distant traffic, vegetation rustle, wind, metal chains, insects, homeowner activity, lawn mower, music, birds, roosters, pressure washer, chainsaw, leaf blower, and occasional aircraft. Sound level-versus-time graphs are provided in this section. This includes L_{eq} and L_{90} sound pressure levels and ground-level wind speeds measured at Location 4. Data that were excluded from further analysis and calculations due to ground-level winds exceeding 5 m/s as recorded by the HOBO wind instrumentation at Location 4 for the summer season, and the HOBO wind instrumentation at Location 2 for the winter season; or due to precipitation and instrumentation operative exceedances as recorded at the Jordan MesoNet station are identified in the figures.

2.6.1 Summer Monitoring

The ranges of measured A-weighted sound levels during the summer season are summarized below and presented graphically in Figure 2-17. A total of 175 10-minute periods were excluded from the summer season. The resulting dataset includes a total of 957 10-minute periods of valid data.

- The valid steady-state level (L_{90}) measurements ranged from 31 to 58 dBA;
- The valid equivalent level (L_{eq}) measurements ranged from 35 to 63 dBA.

The ranges of calculated ANS-weighted sound levels during the summer season are summarized below.

- The valid, calculated steady-state (L_{90}) ANS-weighted broadband sound levels ranged from 20 to 46 dBA;
- The valid, calculated equivalent (L_{eq}) ANS-weighed broadband sound levels ranged from 22 to 59 dBA.

2.6.2 Winter Monitoring

The ranges of measured A-weighted sound levels during the winter season are summarized below and presented graphically in Figure 2-18. A total of 68 10-minute periods were excluded from the winter season. The resulting dataset includes a total of 1,226 10-minute periods of valid data.

[9] Prominent discrete tones as defined by the ANSI S12.9 Part 3 standard. The lowest frequency in the Annex B.1 tone test is 25 Hz. 20 Hz data are presented for informational purposes.

- ♦ The valid steady-state level (L_{90}) measurements ranged from 19 to 52 dBA;
- ♦ The valid equivalent level (L_{eq}) measurements ranged from 22 to 75 dBA.

The ranges of calculated ANS-weighted sound levels during the winter season are summarized below.

- ♦ The valid, calculated steady-state (L_{90}) ANS-weighted broadband sound levels ranged from 16 to 51 dBA;
- ♦ The valid, calculated equivalent (L_{eq}) ANS-weighed broadband sound levels ranged from 19 to 74 dBA.

2.6.3 Spectral Sound Level Data

In addition to broadband sound levels, spectral sound level data were measured during each 10-minute period at Location 5. Using only valid measurement periods, octave-band and one-third octave-band data are summarized in Figures 2-19 and 2-20, respectively, as logarithmic averages of the equivalent (L_{eq}) summer sound levels; separated by daytime and nighttime. Octave-band levels are displayed from 16 Hz to 16,000 Hz in Figure 2-19 for both L_{eq} and L_{90}. The one-third octave-band data in Figure 2-20 span the frequencies from 12.5 Hz to 16,000 Hz and were analyzed for prominent discrete tones[10]. Prominent discrete tones were present at the 5,000 Hz summer nighttime measurement period. This is likely due to bird and insect activity.

[10] Prominent discrete tones as defined by the ANSI S12.9 Part 3 standard. The lowest frequency in the Annex B.1 tone test is 25 Hz. 20 Hz data are presented for informational purposes.

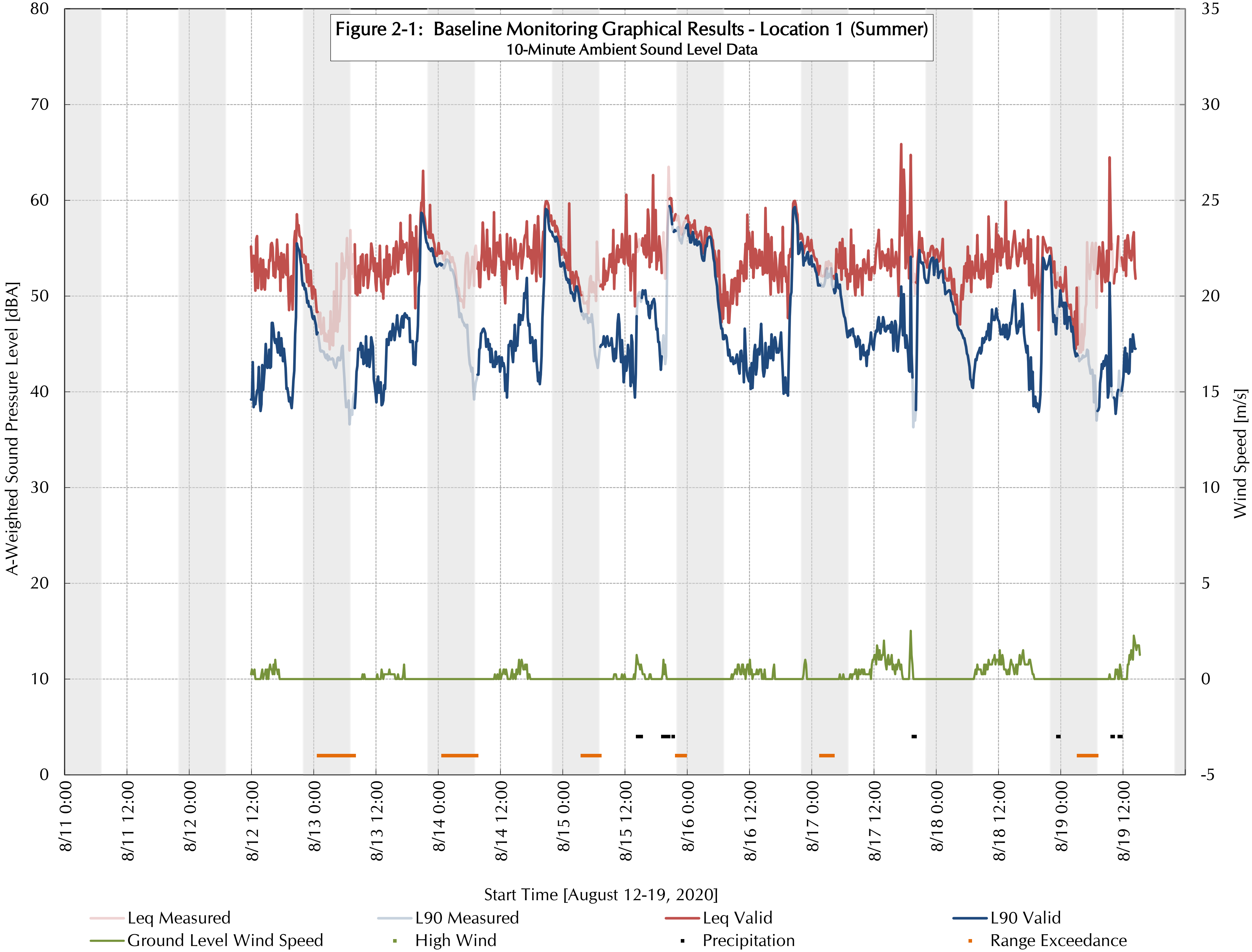


Figure 2-1: Baseline Monitoring Graphical Results - Location 1 (Summer)
10-Minute Ambient Sound Level Data
A-Weighted Sound Pressure Level [dBA]
Wind Speed [m/s]
80
70
60
50
40
30
20
10
0
35
30
25
20
15
10
5
0
-5
8/11 0:00
8/11 12:00
8/12 0:00
8/12 12:00
8/13 0:00
8/13 12:00
8/14 0:00
8/14 12:00
8/15 0:00
8/15 12:00
8/16 0:00
8/16 12:00
8/17 0:00
8/17 12:00
8/18 0:00
8/18 12:00
8/19 0:00
8/19 12:00
Start Time [August 12-19, 2020]
Leq Measured
L90 Measured
Leq Valid
L90 Valid
Ground Level Wind Speed
High Wind
Precipitation
Range Exceedance

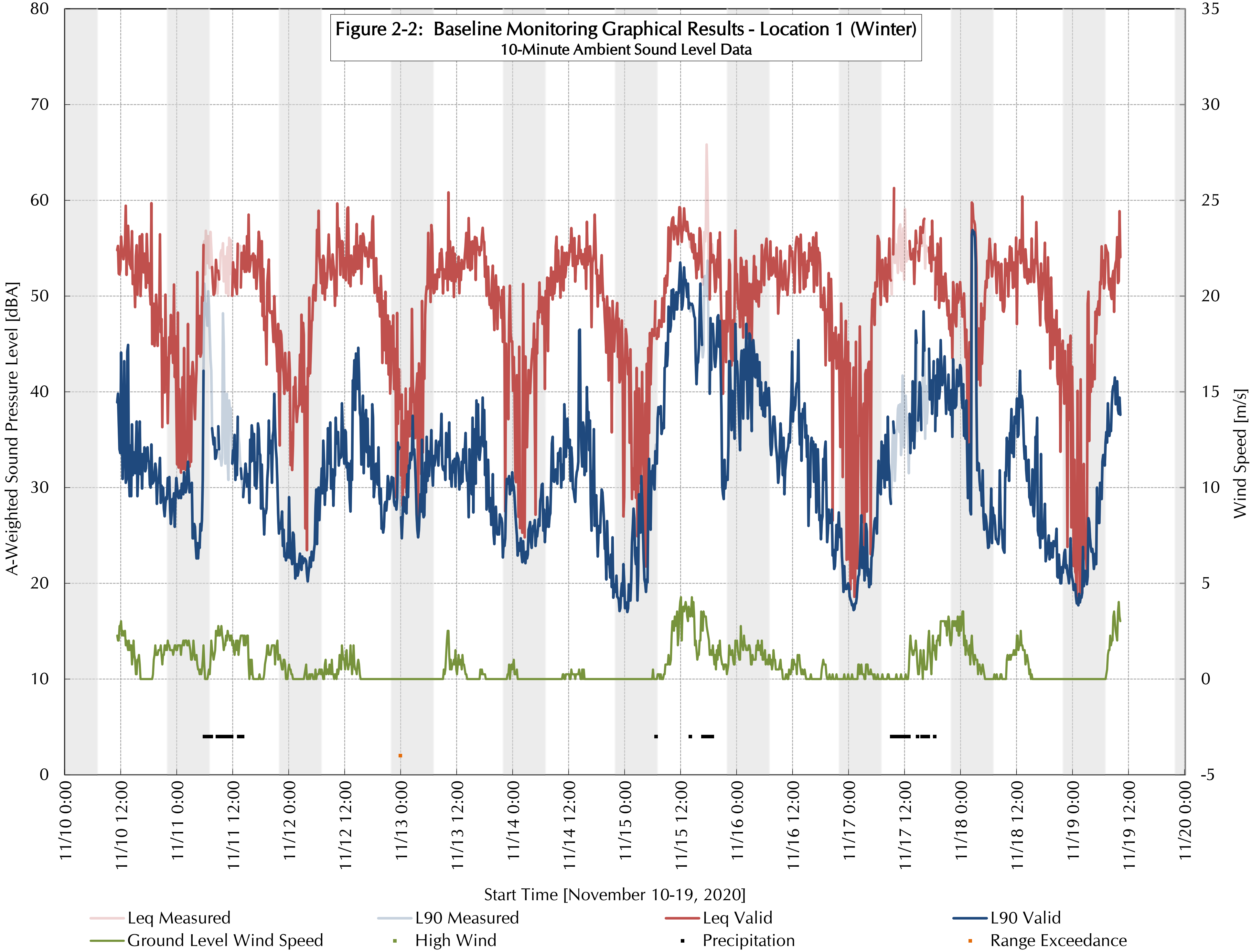


Figure 2-2: Baseline Monitoring Graphical Results - Location 1 (Winter)
10-Minute Ambient Sound Level Data
A-Weighted Sound Pressure Level [dBA]
80
70
60
50
40
30
20
10
0
Wind Speed [m/s]
35
30
25
20
15
10
5
0
-5
11/10 0:00
11/10 12:00
11/11 0:00
11/11 12:00
11/12 0:00
11/12 12:00
11/13 0:00
11/13 12:00
11/14 0:00
11/14 12:00
11/15 0:00
11/15 12:00
11/16 0:00
11/16 12:00
11/17 0:00
11/17 12:00
11/18 0:00
11/18 12:00
11/19 0:00
11/19 12:00
11/20 0:00
Start Time [November 10-19, 2020]
Leq Measured
L90 Measured
Leq Valid
L90 Valid
Ground Level Wind Speed
High Wind
Precipitation
Range Exceedance

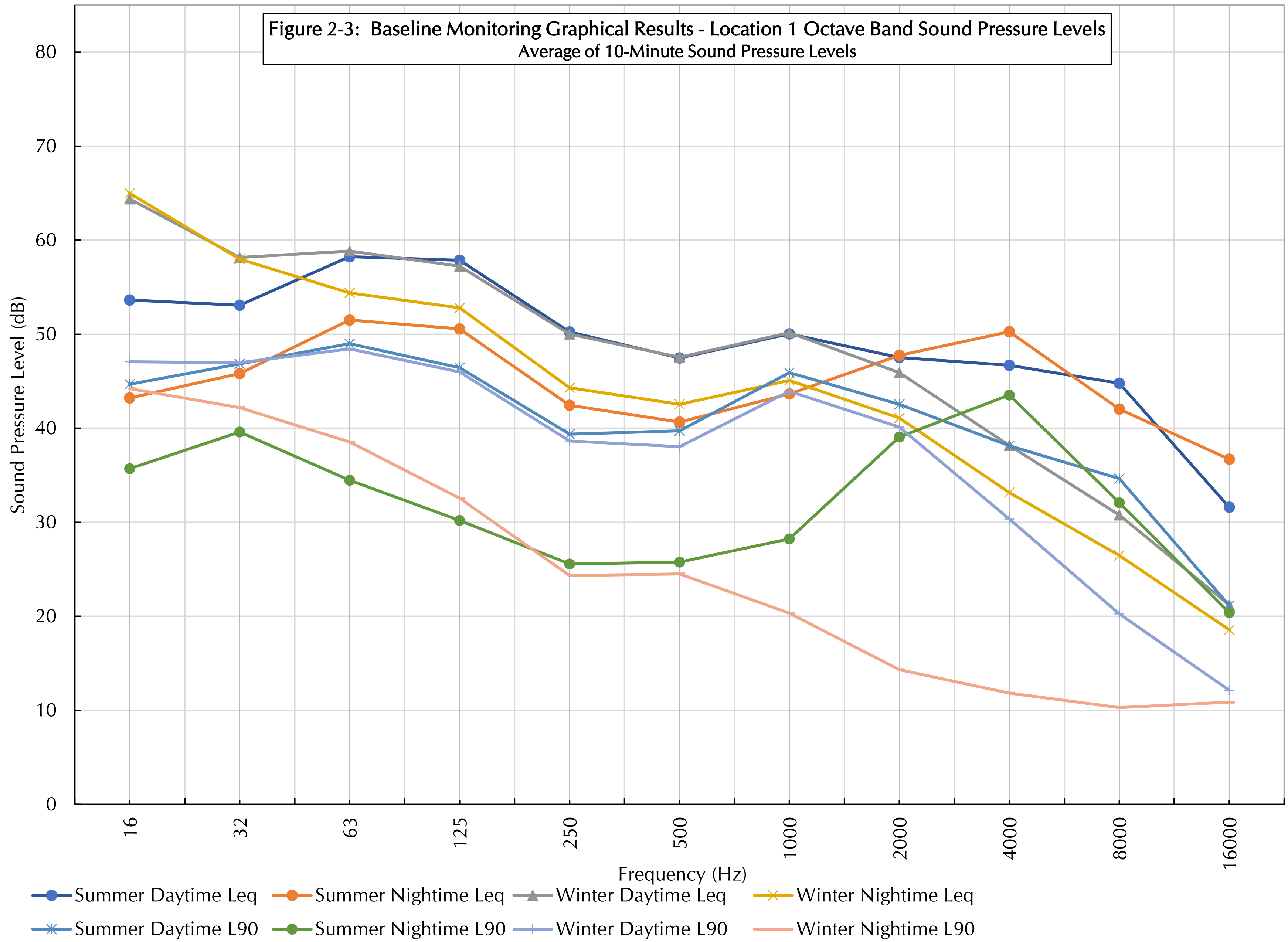
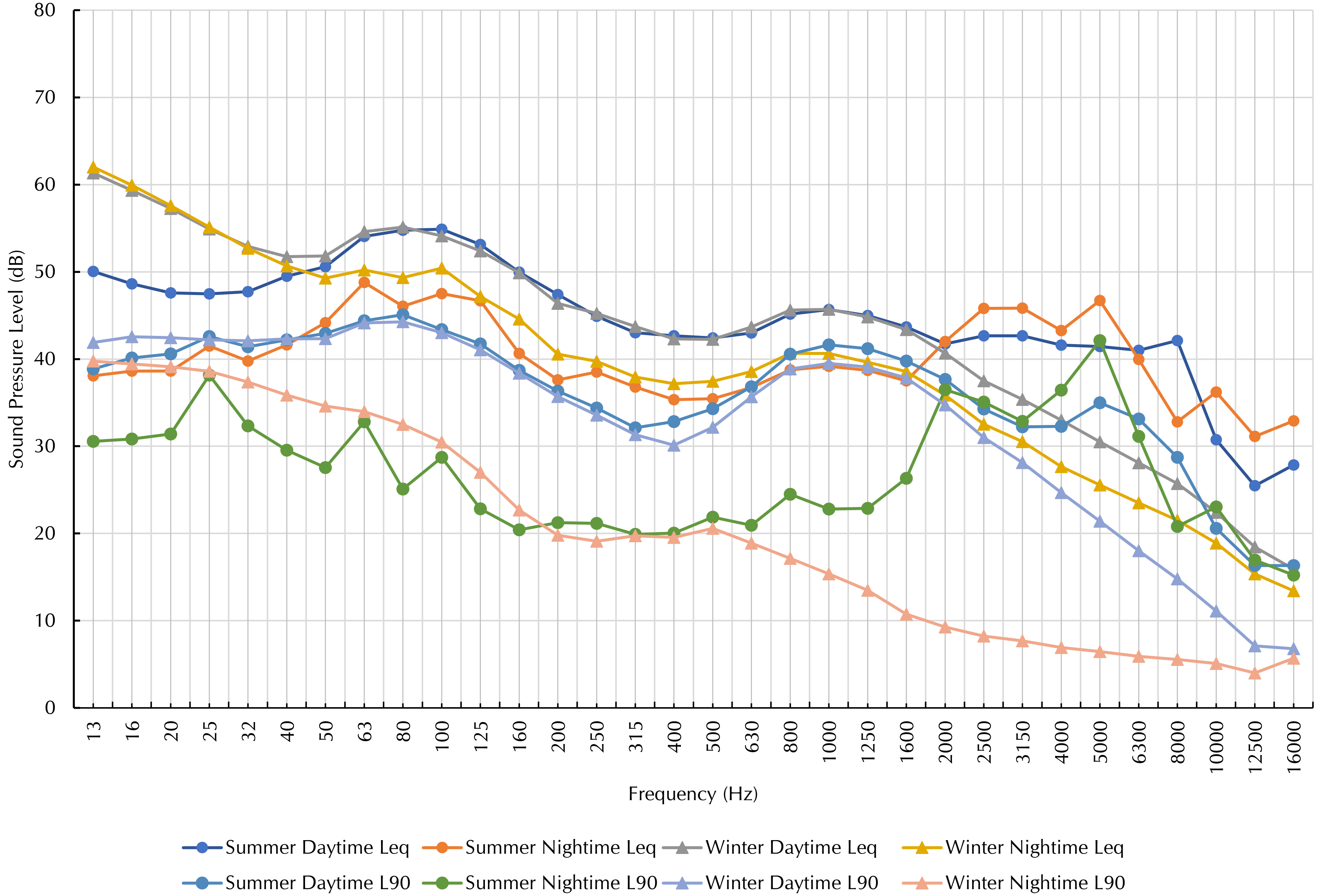


Figure 2-3: Baseline Monitoring Graphical Results - Location 1 Octave Band Sound Pressure Levels
Average of 10-Minute Sound Pressure Levels
Sound Pressure Level (dB)
0
10
20
30
40
50
60
70
80
16
32
63
125
250
500
1000
2000
4000
8000
16000
Frequency (Hz)
Summer Daytime Leq
Summer Nightime Leq
Winter Daytime Leq
Winter Nightime Leq
Summer Daytime L90
Summer Nightime L90
Winter Daytime L90
Winter Nightime L90

Figure 2-4: Baseline Monitoring Graphical Results - Location 1-Third Octave Band Sound Pressure Levels
Average of 10-Minute Sound Pressure Levels



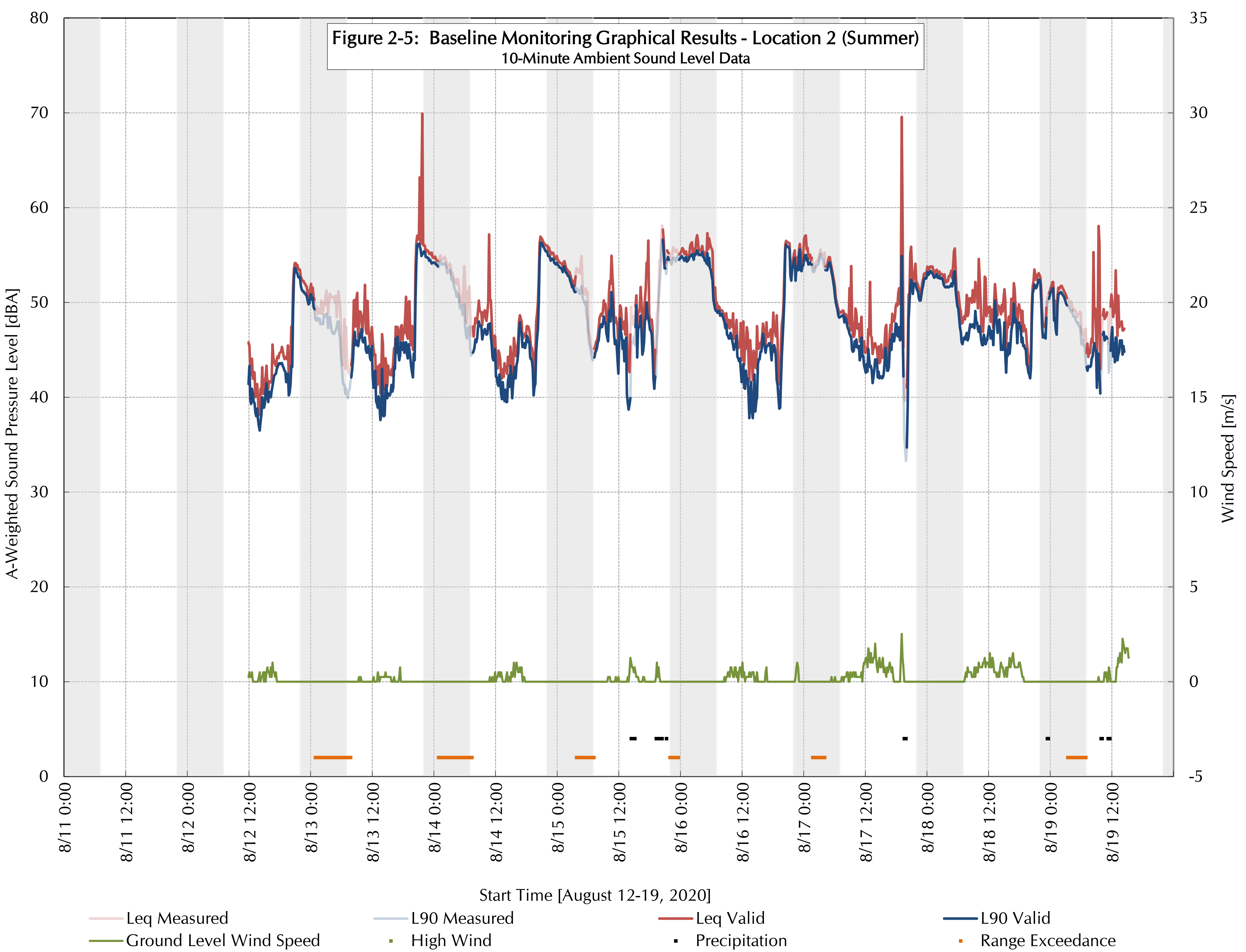


Figure 2-5: Baseline Monitoring Graphical Results - Location 2 (Summer)
10-Minute Ambient Sound Level Data
A-Weighted Sound Pressure Level [dBA]
Wind Speed [m/s]
80
70
60
50
40
30
20
10
0
35
30
25
20
15
10
5
0
-5
8/11 0:00
8/11 12:00
8/12 0:00
8/12 12:00
8/13 0:00
8/13 12:00
8/14 0:00
8/14 12:00
8/15 0:00
8/15 12:00
8/16 0:00
8/16 12:00
8/17 0:00
8/17 12:00
8/18 0:00
8/18 12:00
8/19 0:00
8/19 12:00
Start Time [August 12-19, 2020]
Leq Measured
L90 Measured
Leq Valid
L90 Valid
Ground Level Wind Speed
High Wind
Precipitation
Range Exceedance

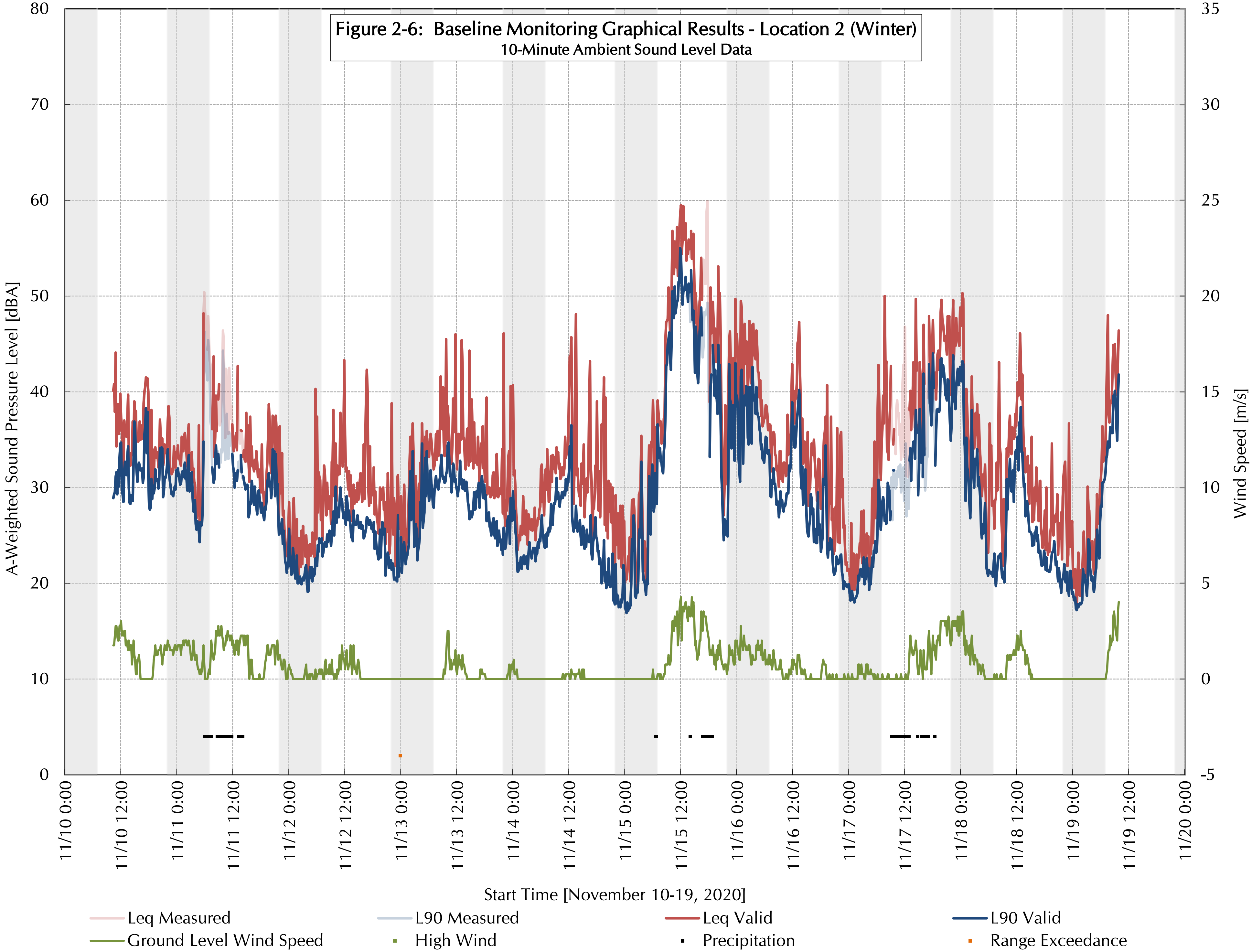


Figure 2-6: Baseline Monitoring Graphical Results - Location 2 (Winter)
10-Minute Ambient Sound Level Data
A-Weighted Sound Pressure Level [dBA]
Wind Speed [m/s]
80
70
60
50
40
30
20
10
0
35
30
25
20
15
10
5
0
-5
11/10 0:00
11/10 12:00
11/11 0:00
11/11 12:00
11/12 0:00
11/12 12:00
11/13 0:00
11/13 12:00
11/14 0:00
11/14 12:00
11/15 0:00
11/15 12:00
11/16 0:00
11/16 12:00
11/17 0:00
11/17 12:00
11/18 0:00
11/18 12:00
11/19 0:00
11/19 12:00
11/20 0:00
Start Time [November 10-19, 2020]
Leq Measured
L90 Measured
Leq Valid
L90 Valid
Ground Level Wind Speed
High Wind
Precipitation
Range Exceedance

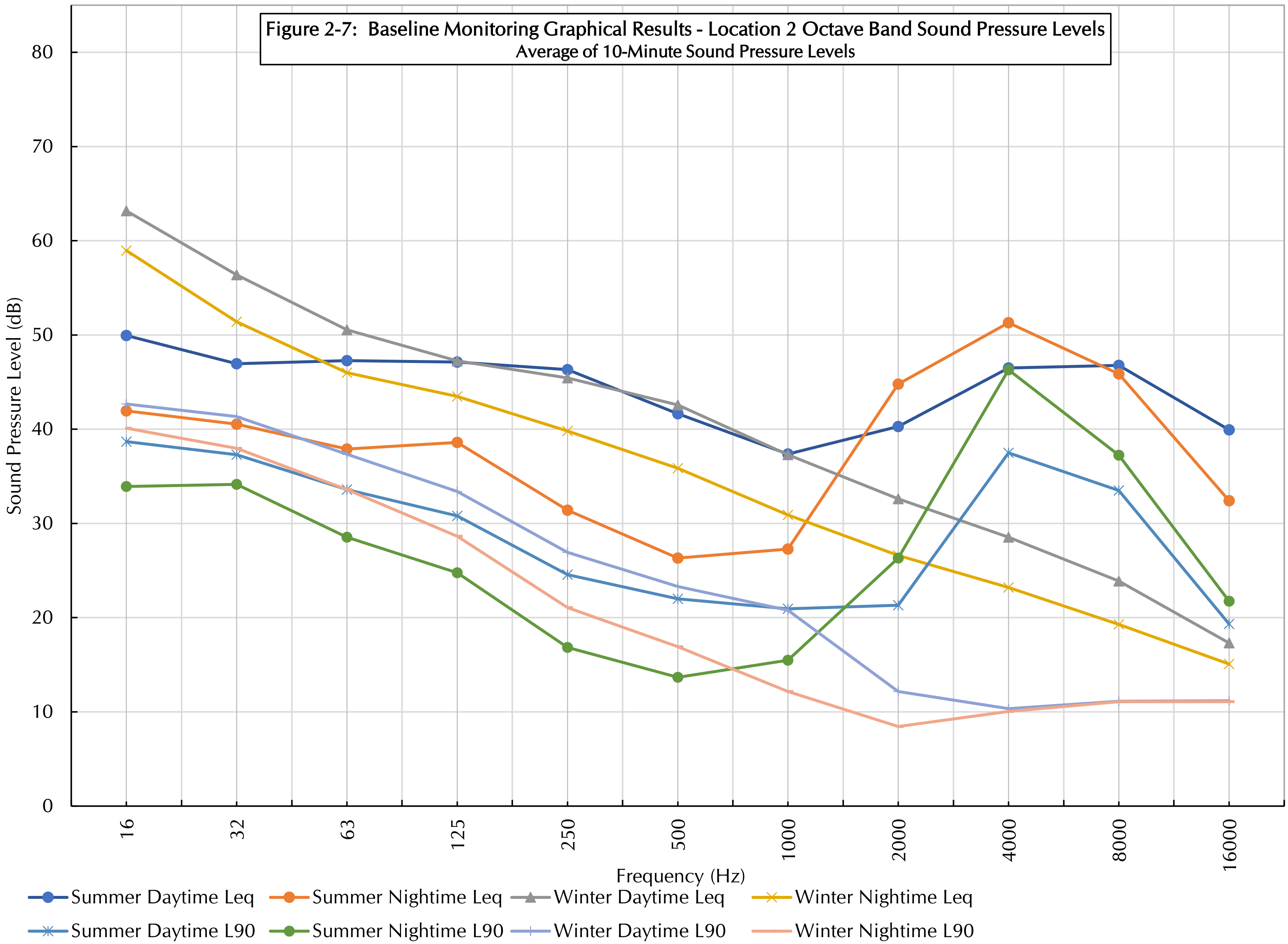
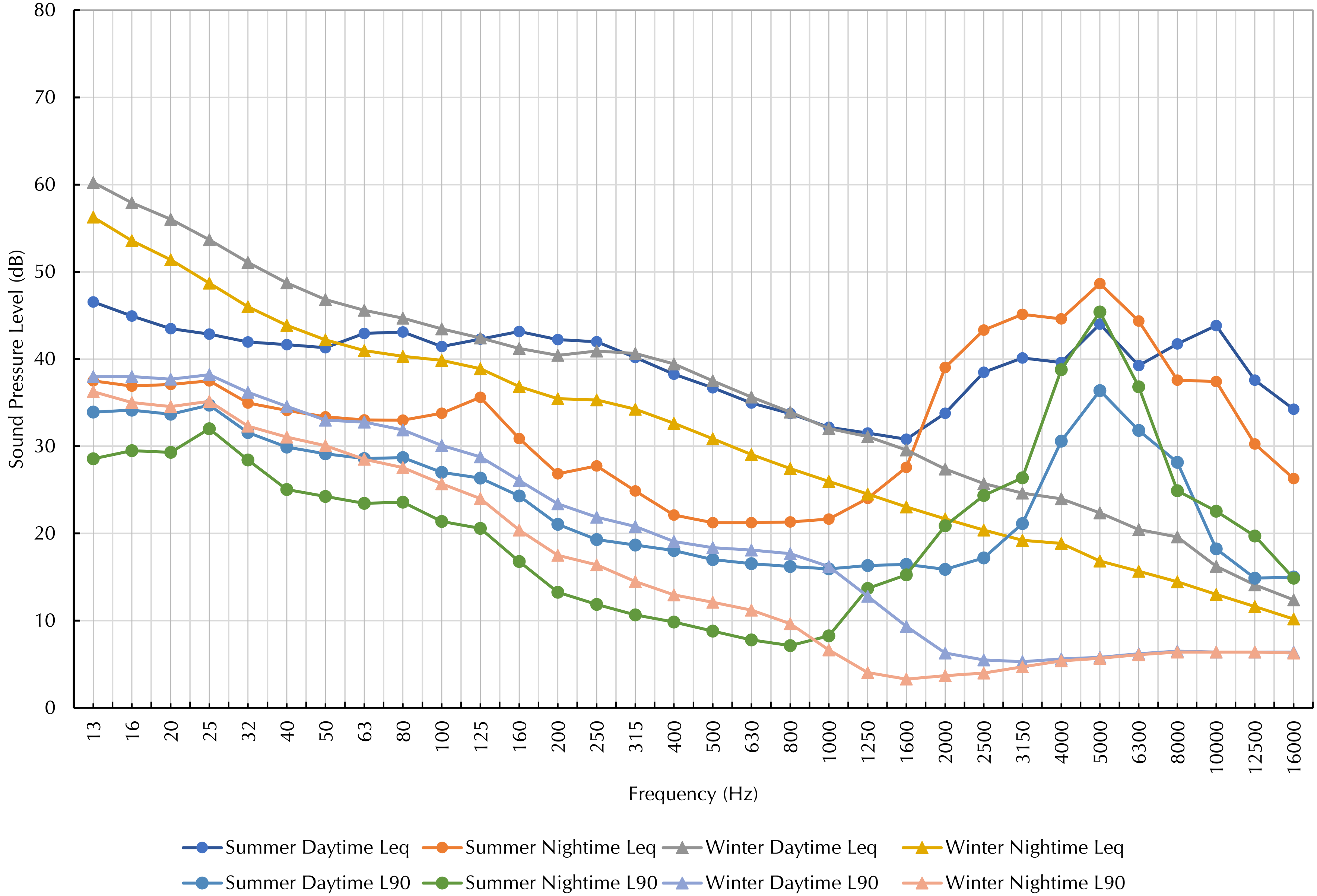


Figure 2-7: Baseline Monitoring Graphical Results - Location 2 Octave Band Sound Pressure Levels
Average of 10-Minute Sound Pressure Levels
Sound Pressure Level (dB)
0
10
20
30
40
50
60
70
80
16
32
63
125
250
500
1000
2000
4000
8000
16000
Frequency (Hz)
Summer Daytime Leq
Summer Nightime Leq
Winter Daytime Leq
Winter Nightime Leq
Summer Daytime L90
Summer Nightime L90
Winter Daytime L90
Winter Nightime L90

Figure 2-8: Baseline Monitoring Graphical Results - Location 2-Third Octave Band Sound Pressure Levels
Average of 10-Minute Sound Pressure Levels



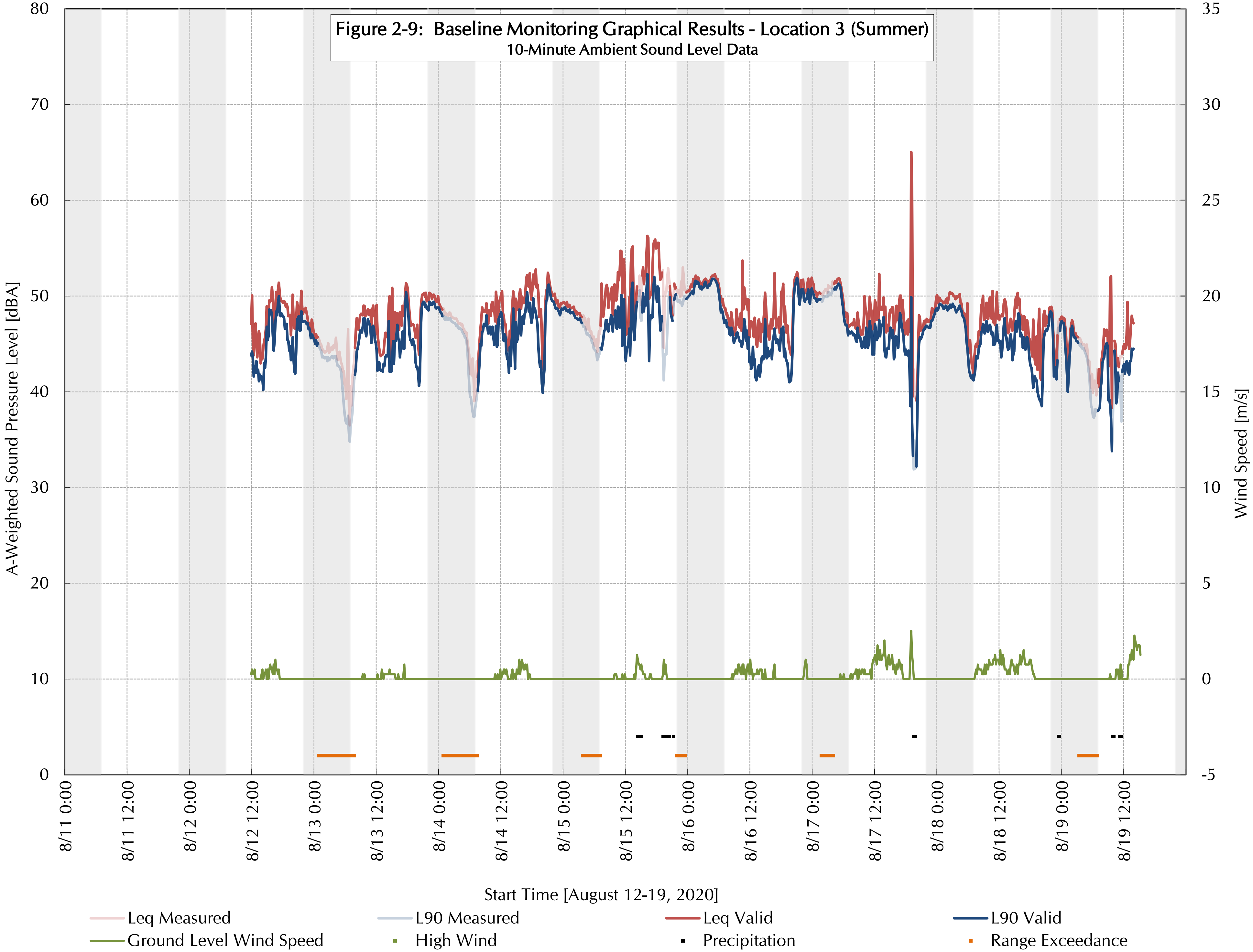


Figure 2-9: Baseline Monitoring Graphical Results - Location 3 (Summer)
10-Minute Ambient Sound Level Data
A-Weighted Sound Pressure Level [dBA]
Wind Speed [m/s]
80
70
60
50
40
30
20
10
0
35
30
25
20
15
10
5
0
-5
8/11 0:00
8/11 12:00
8/12 0:00
8/12 12:00
8/13 0:00
8/13 12:00
8/14 0:00
8/14 12:00
8/15 0:00
8/15 12:00
8/16 0:00
8/16 12:00
8/17 0:00
8/17 12:00
8/18 0:00
8/18 12:00
8/19 0:00
8/19 12:00
Start Time [August 12-19, 2020]
Leq Measured
L90 Measured
Leq Valid
L90 Valid
Ground Level Wind Speed
High Wind
Precipitation
Range Exceedance

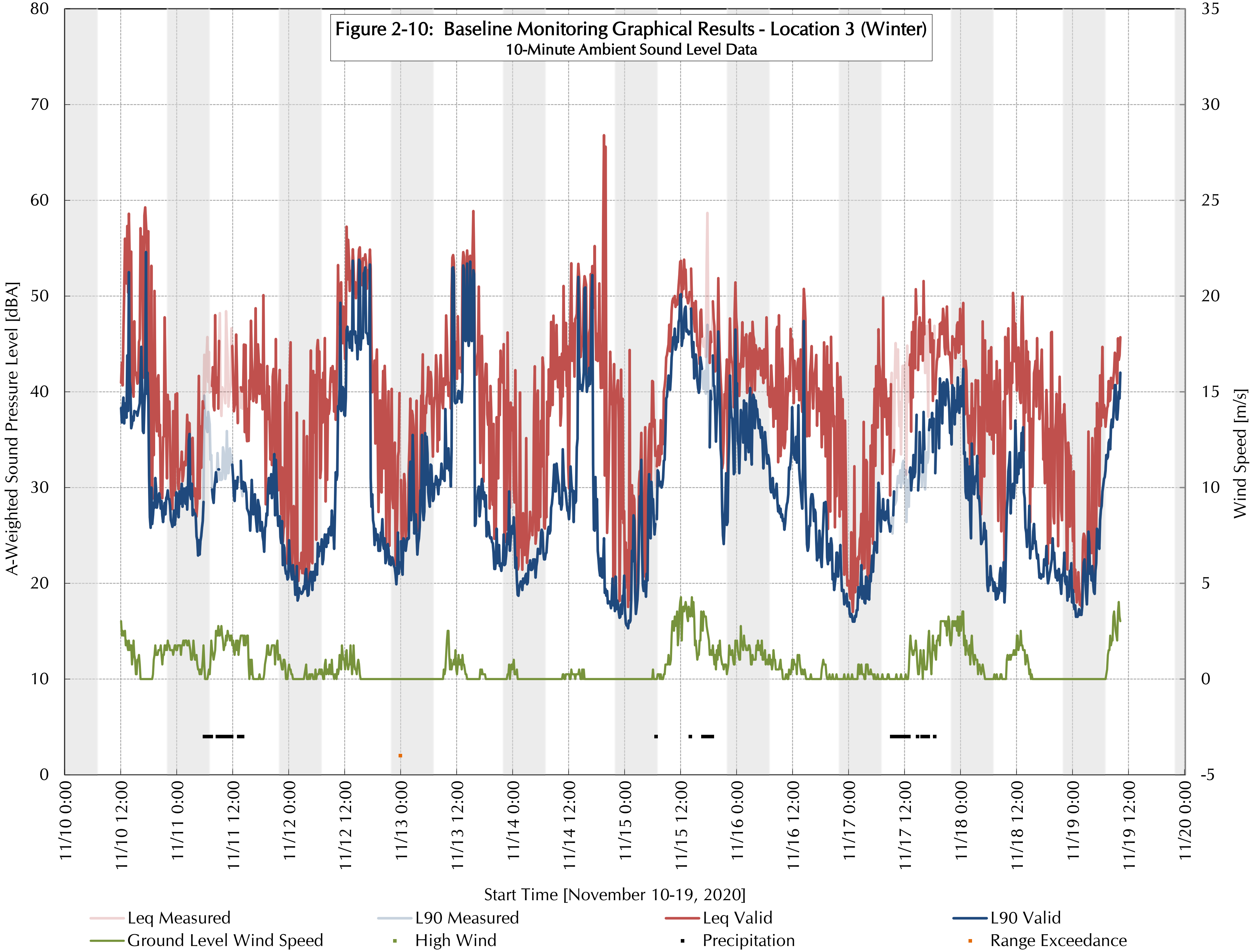


Figure 2-10: Baseline Monitoring Graphical Results - Location 3 (Winter)
10-Minute Ambient Sound Level Data
A-Weighted Sound Pressure Level [dBA]
Wind Speed [m/s]
Start Time [November 10-19, 2020]
11/10 0:00
11/10 12:00
11/11 0:00
11/11 12:00
11/12 0:00
11/12 12:00
11/13 0:00
11/13 12:00
11/14 0:00
11/14 12:00
11/15 0:00
11/15 12:00
11/16 0:00
11/16 12:00
11/17 0:00
11/17 12:00
11/18 0:00
11/18 12:00
11/19 0:00
11/19 12:00
11/20 0:00
Leq Measured
L90 Measured
Leq Valid
L90 Valid
Ground Level Wind Speed
High Wind
Precipitation
Range Exceedance

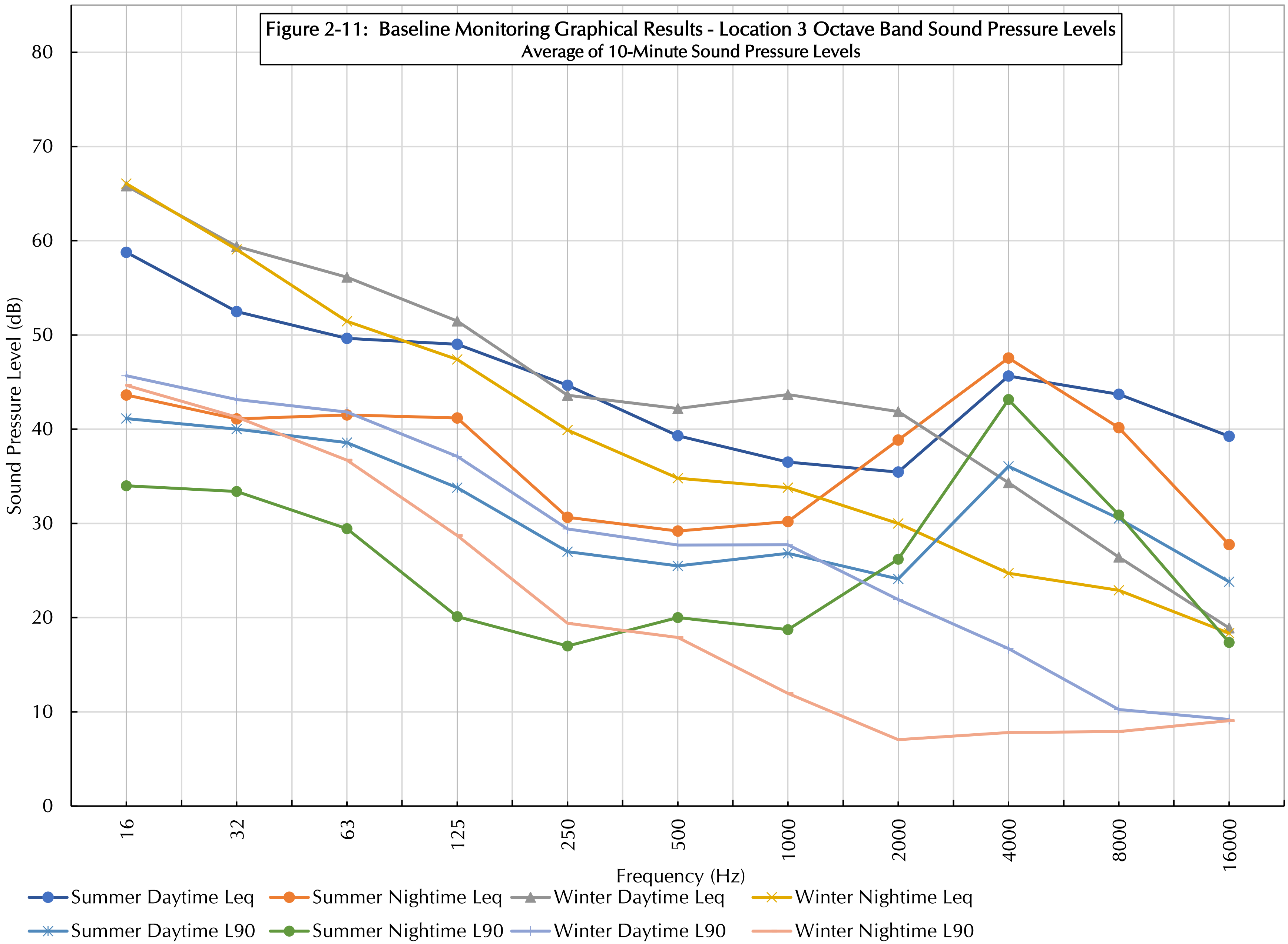
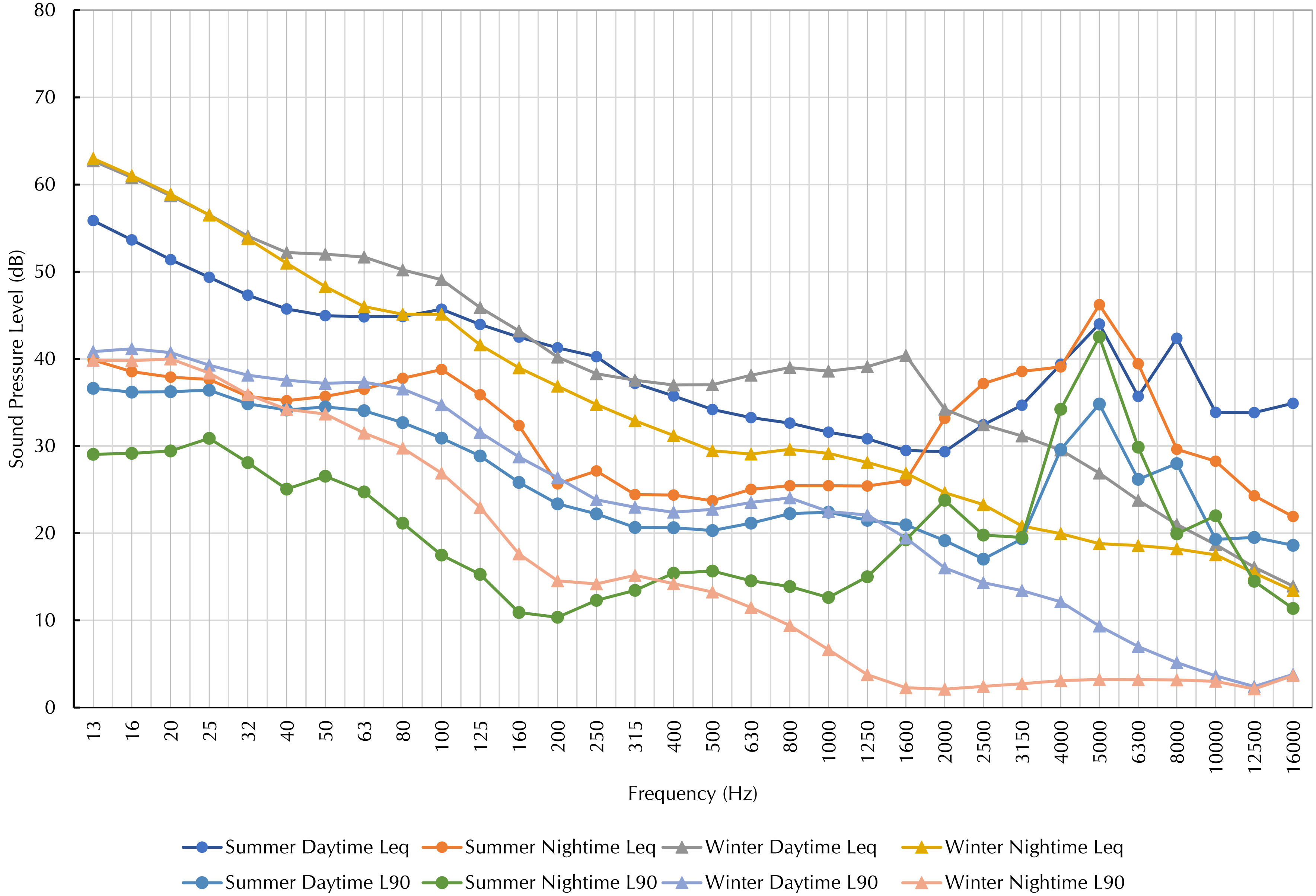


Figure 2-11: Baseline Monitoring Graphical Results - Location 3 Octave Band Sound Pressure Levels
Average of 10-Minute Sound Pressure Levels
Sound Pressure Level (dB)
0
10
20
30
40
50
60
70
80
16
32
63
125
250
500
1000
2000
4000
8000
16000
Frequency (Hz)
Summer Daytime Leq
Summer Nightime Leq
Winter Daytime Leq
Winter Nightime Leq
Summer Daytime L90
Summer Nightime L90
Winter Daytime L90
Winter Nightime L90

Figure 2-12: Baseline Monitoring Graphical Results - Location 3-Third Octave Band Sound Pressure Levels
Average of 10-Minute Sound Pressure Levels



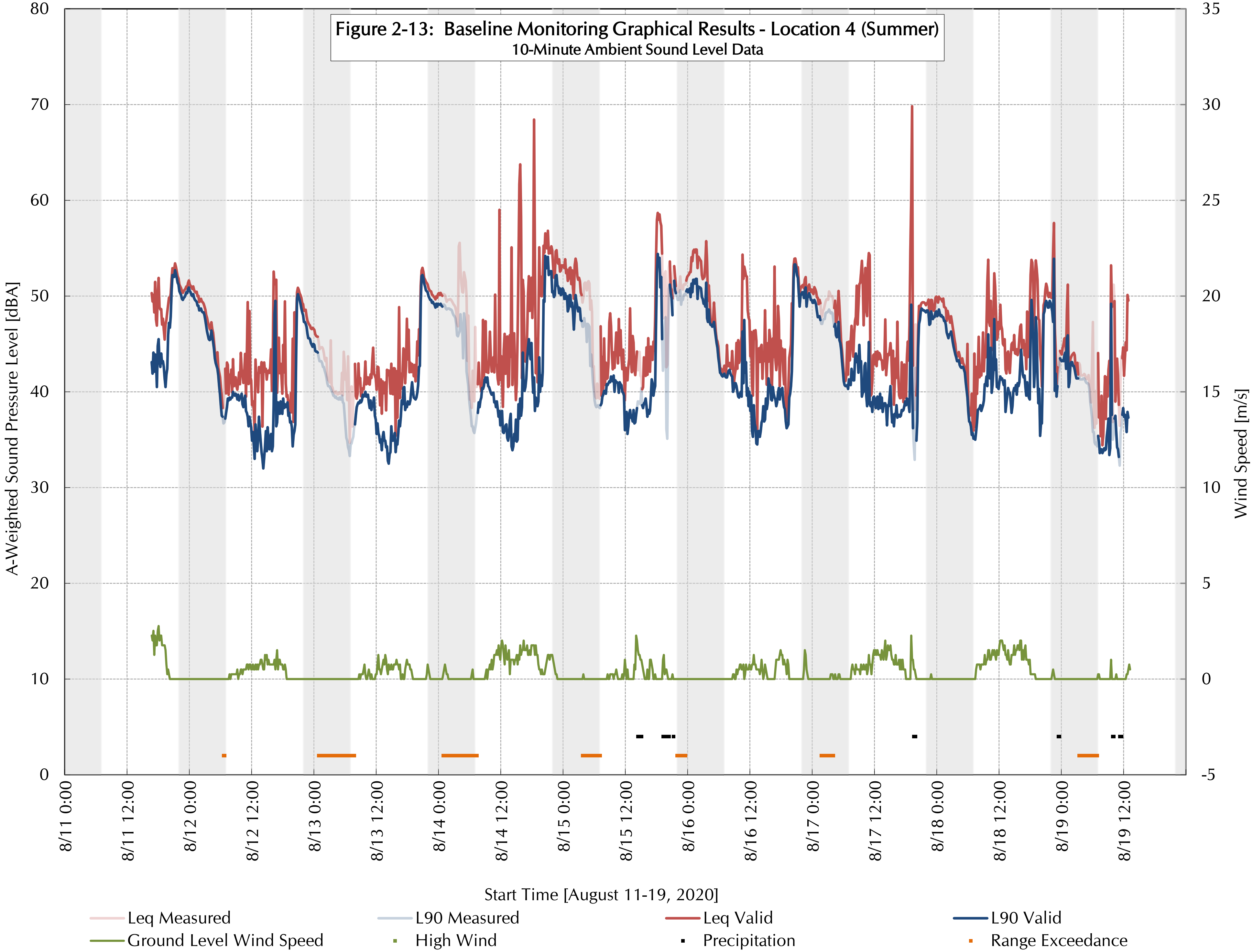


Figure 2-13: Baseline Monitoring Graphical Results - Location 4 (Summer)
10-Minute Ambient Sound Level Data
A-Weighted Sound Pressure Level [dBA]
Wind Speed [m/s]
80
70
60
50
40
30
20
10
0
35
30
25
20
15
10
5
0
-5
8/11 0:00
8/11 12:00
8/12 0:00
8/12 12:00
8/13 0:00
8/13 12:00
8/14 0:00
8/14 12:00
8/15 0:00
8/15 12:00
8/16 0:00
8/16 12:00
8/17 0:00
8/17 12:00
8/18 0:00
8/18 12:00
8/19 0:00
8/19 12:00
Start Time [August 11-19, 2020]
Leq Measured
L90 Measured
Leq Valid
L90 Valid
Ground Level Wind Speed
High Wind
Precipitation
Range Exceedance

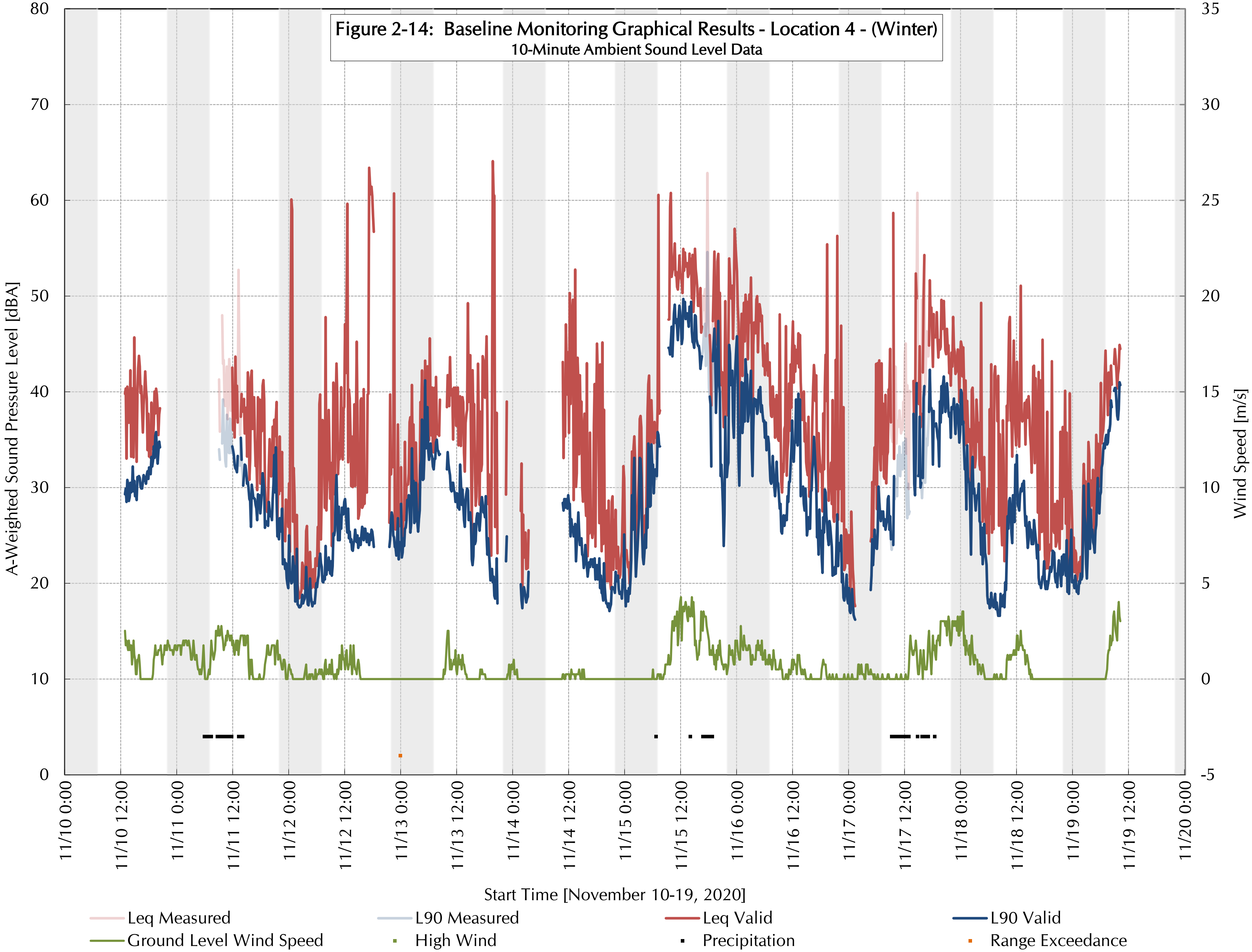


Figure 2-14: Baseline Monitoring Graphical Results - Location 4 - (Winter)
10-Minute Ambient Sound Level Data
A-Weighted Sound Pressure Level [dBA]
Wind Speed [m/s]
80
70
60
50
40
30
20
10
0
35
30
25
20
15
10
5
0
-5
11/10 0:00
11/10 12:00
11/11 0:00
11/11 12:00
11/12 0:00
11/12 12:00
11/13 0:00
11/13 12:00
11/14 0:00
11/14 12:00
11/15 0:00
11/15 12:00
11/16 0:00
11/16 12:00
11/17 0:00
11/17 12:00
11/18 0:00
11/18 12:00
11/19 0:00
11/19 12:00
11/20 0:00
Start Time [November 10-19, 2020]
Leq Measured
L90 Measured
Leq Valid
L90 Valid
Ground Level Wind Speed
High Wind
Precipitation
Range Exceedance

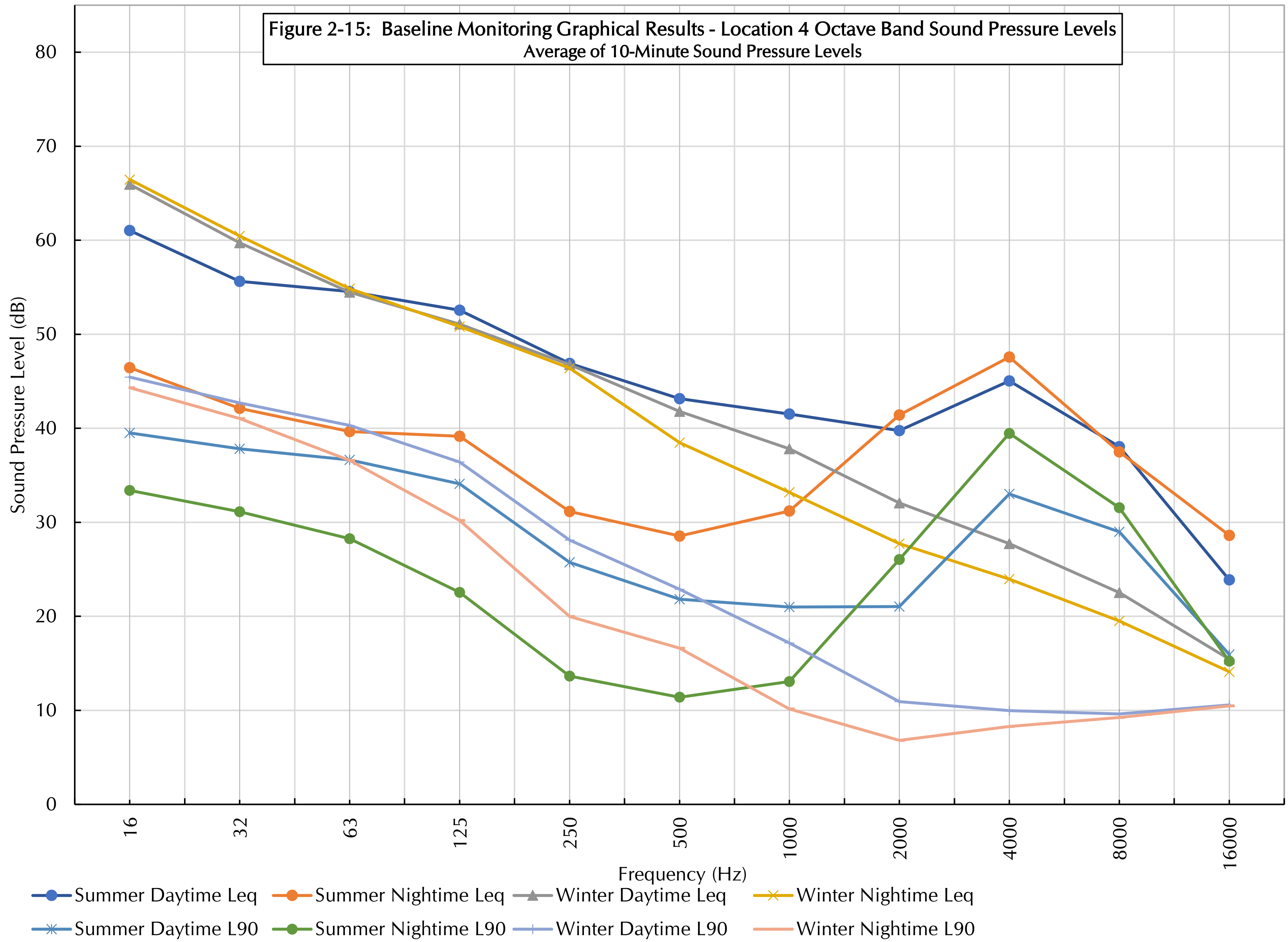
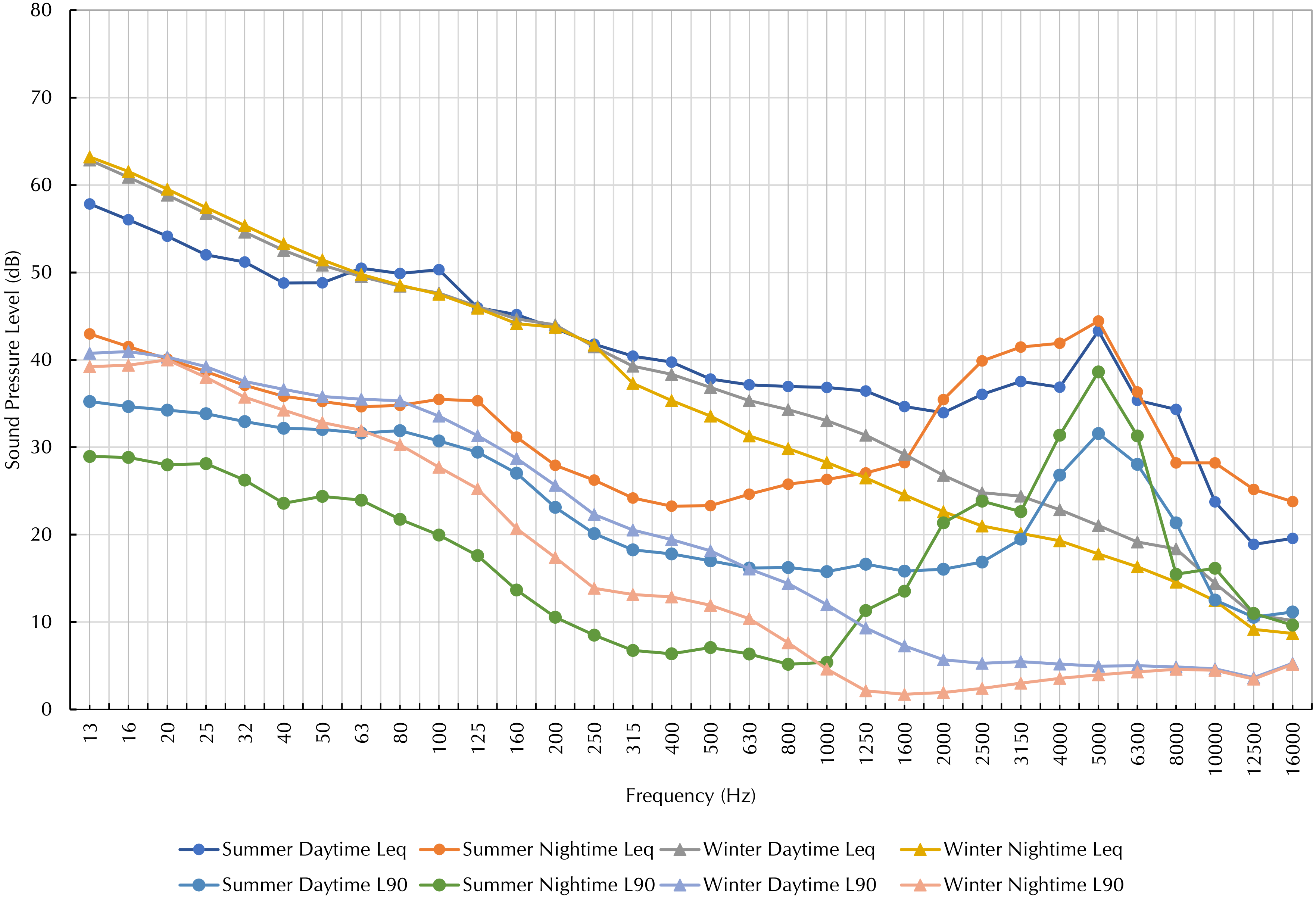


Figure 2-15: Baseline Monitoring Graphical Results - Location 4 Octave Band Sound Pressure Levels
Average of 10-Minute Sound Pressure Levels
Sound Pressure Level (dB)
0
10
20
30
40
50
60
70
80
Frequency (Hz)
16
32
63
125
250
500
1000
2000
4000
8000
16000
Summer Daytime Leq
Summer Nightime Leq
Winter Daytime Leq
Winter Nightime Leq
Summer Daytime L90
Summer Nightime L90
Winter Daytime L90
Winter Nightime L90

Figure 2-16: Baseline Monitoring Graphical Results - Location 4-Third Octave Band Sound Pressure Levels
Average of 10-Minute Sound Pressure Levels



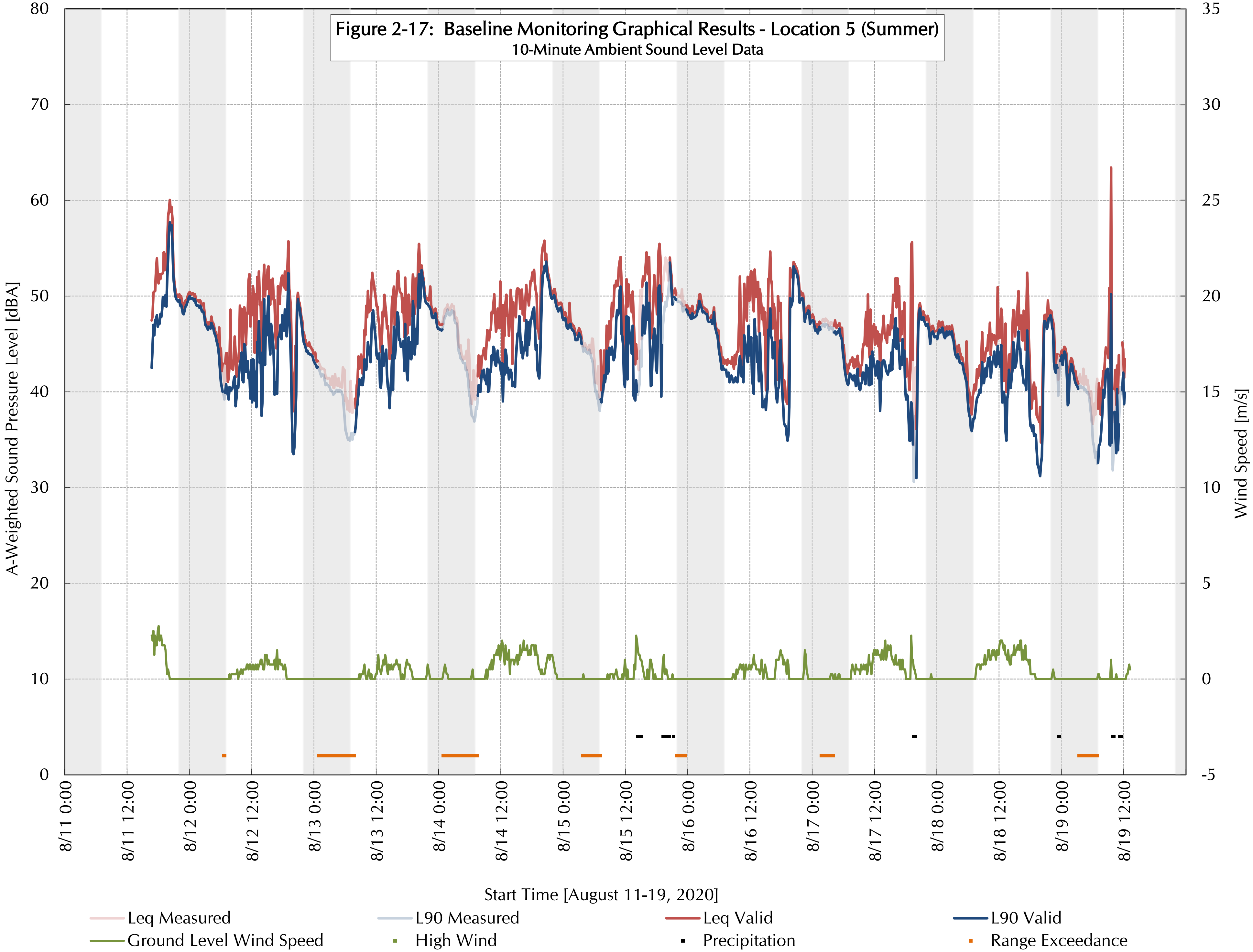


Figure 2-17: Baseline Monitoring Graphical Results - Location 5 (Summer)
10-Minute Ambient Sound Level Data
A-Weighted Sound Pressure Level [dBA]
Wind Speed [m/s]
80
70
60
50
40
30
20
10
0
35
30
25
20
15
10
5
0
-5
8/11 0:00
8/11 12:00
8/12 0:00
8/12 12:00
8/13 0:00
8/13 12:00
8/14 0:00
8/14 12:00
8/15 0:00
8/15 12:00
8/16 0:00
8/16 12:00
8/17 0:00
8/17 12:00
8/18 0:00
8/18 12:00
8/19 0:00
8/19 12:00
Start Time [August 11-19, 2020]
Leq Measured
L90 Measured
Leq Valid
L90 Valid
Ground Level Wind Speed
High Wind
Precipitation
Range Exceedance

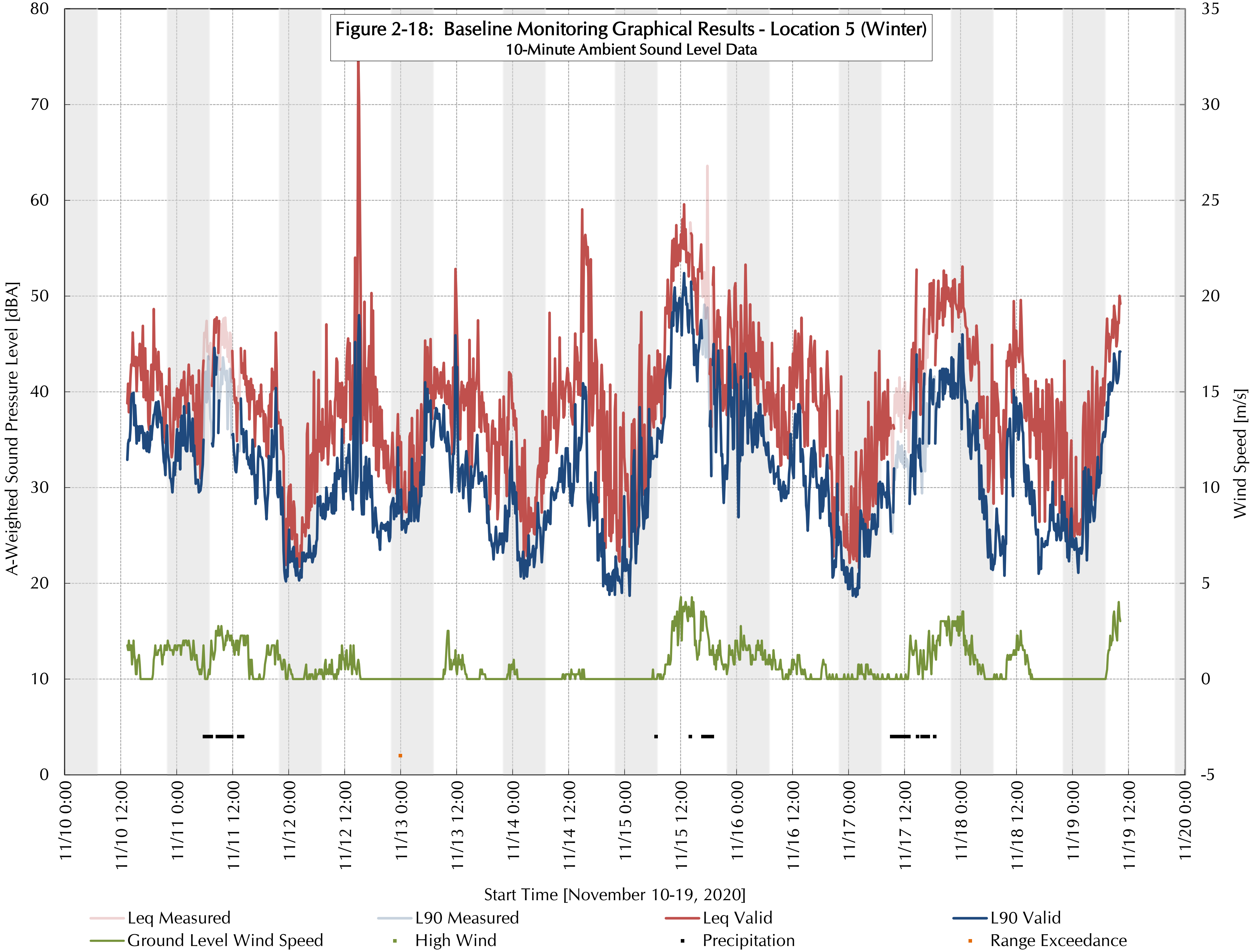


Figure 2-18: Baseline Monitoring Graphical Results - Location 5 (Winter)
10-Minute Ambient Sound Level Data
A-Weighted Sound Pressure Level [dBA]
Wind Speed [m/s]
Start Time [November 10-19, 2020]
11/10 0:00
11/10 12:00
11/11 0:00
11/11 12:00
11/12 0:00
11/12 12:00
11/13 0:00
11/13 12:00
11/14 0:00
11/14 12:00
11/15 0:00
11/15 12:00
11/16 0:00
11/16 12:00
11/17 0:00
11/17 12:00
11/18 0:00
11/18 12:00
11/19 0:00
11/19 12:00
11/20 0:00
Leq Measured
L90 Measured
Leq Valid
L90 Valid
Ground Level Wind Speed
High Wind
Precipitation
Range Exceedance

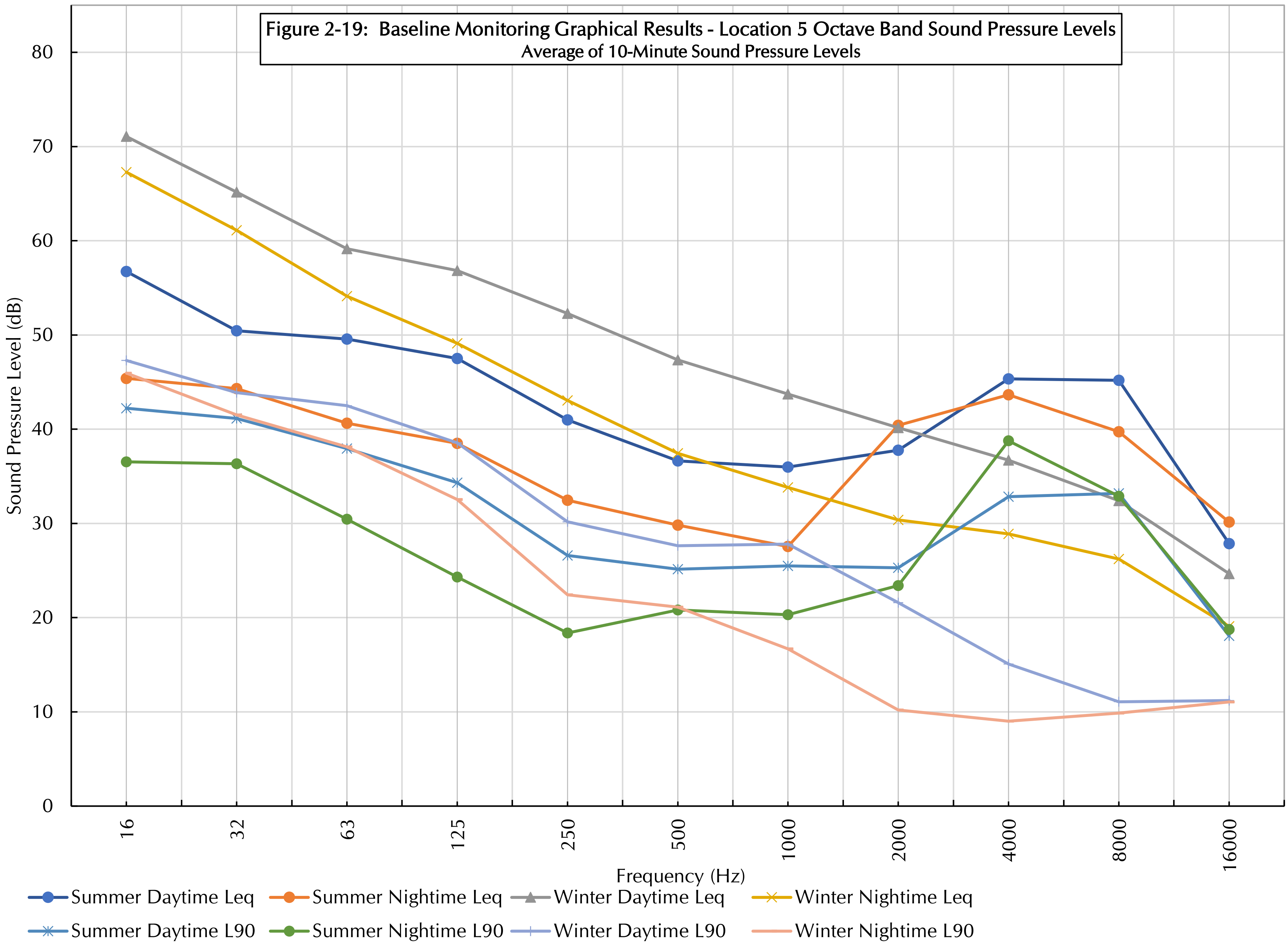


Figure 2-19: Baseline Monitoring Graphical Results - Location 5 Octave Band Sound Pressure Levels
Average of 10-Minute Sound Pressure Levels
Sound Pressure Level (dB)
0
10
20
30
40
50
60
70
80
16
32
63
125
250
500
1000
2000
4000
8000
16000
Frequency (Hz)
Summer Daytime Leq
Summer Nightime Leq
Winter Daytime Leq
Winter Nightime Leq
Summer Daytime L90
Summer Nightime L90
Winter Daytime L90
Winter Nightime L90

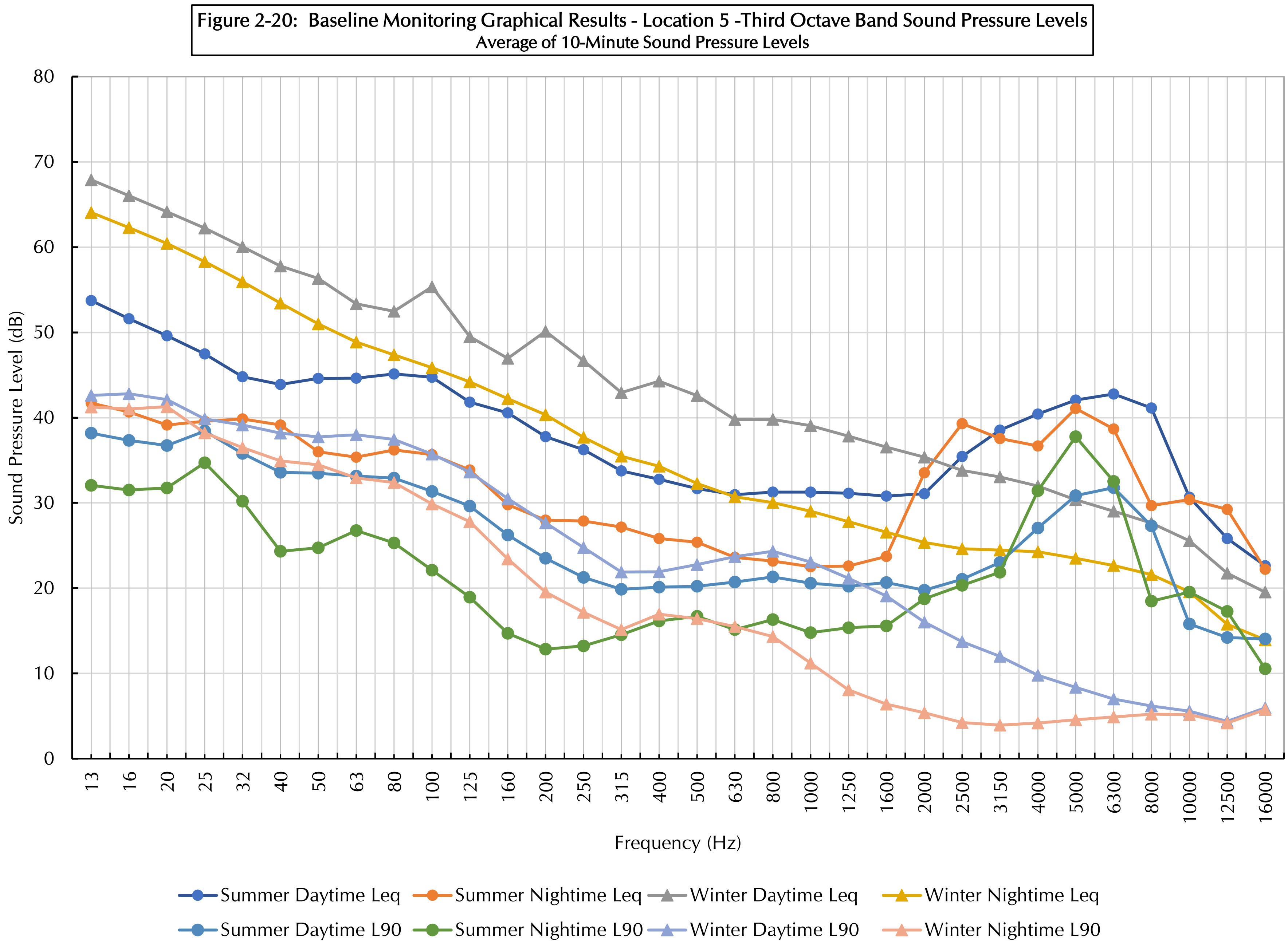


Figure 2-20: Baseline Monitoring Graphical Results - Location 5 -Third Octave Band Sound Pressure Levels
Average of 10-Minute Sound Pressure Levels
Sound Pressure Level (dB)
Frequency (Hz)
0
10
20
30
40
50
60
70
80
13
16
20
25
32
40
50
63
80
100
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
10000
12500
16000
Summer Daytime Leq
Summer Nightime Leq
Winter Daytime Leq
Winter Nightime Leq
Summer Daytime L90
Summer Nightime L90
Winter Daytime L90
Winter Nightime L90

3.0 SEASONAL SOUND LEVEL MONITORING SUMMARY

A two-season baseline monitoring program was performed for the proposed Garnet Energy Center in 2020 to characterize the existing sound level environment around the Project area. The sound levels measured during the winter and summer monitoring periods are summarized in the following subsections as tabular data by location. Respective ANS-weighted broadband sound levels calculated for the desired summary of interest are tandemly provided with the measured broadband levels within each table. Only valid[11] 10-minute measurement periods are included in the summary tables. Daytime is defined as the period from 7 AM to 10 PM. Nighttime is defined as the period from 10 PM to 7 AM.

3.1 Daytime Ambient – Lower Tenth Percentile

Measured daytime ambient L_{90} sound levels are shown below in Table 3-1, as per 1001.19(f)(1). Values are separated by monitoring season as well as for both seasons combined. These values represent the L_{90} of the measured L_{90} values.

Table 3-1 Daytime Ambient L_{90} (dBA) Sound Pressure Level Summary

Location	Overall (dBA)		Winter (dBA)		Summer (dBA)	
	Measured	ANS	Measured	ANS	Measured	ANS
Location 1	40	33	34	33	46	33
Location 2	38	28	30	29	45	26
Location 3	39	28	32	31	45	24
Location 4	35	27	29	28	40	26
Location 5	39	29	33	31	44	27

3.2 Nighttime Ambient – Lower Tenth Percentile

Measured nighttime ambient L_{90} sound levels are presented below in Table 3-2, as per 1001.19(f)(2) (summer) and (f)(3) (winter). Values are separated by monitoring season as well as for both seasons combined. These values represent the L_{90} of the measured L_{90} values.

Table 3-2 Nighttime Ambient L_{90} (dBA) Sound Pressure Level Summary

Location	Overall (dBA)		Winter (dBA)		Summer (dBA)	
	Measured	ANS	Measured	ANS	Measured	ANS
Location 1	40	28	28	27	51	29
Location 2	39	23	26	24	52	22
Location 3	37	22	25	24	48	19
Location 4	37	23	27	26	47	19
Location 5	38	26	29	28	46	24

[11] Refer to Chapter 2 for details concerning valid periods.

3.3 Daytime Ambient - Average

Measured daytime average ambient levels are presented in Table 3-3, as per 1001.19(f)(7). The daytime ambient average noise level was calculated by logarithmically averaging sound pressure levels (Leq) (after exclusions) from the background sound level measurements over the daytime period at each monitoring location. These calculations include both summer and winter data combined.

Table 3-3 Daytime Ambient L_{eq} (dBA) Sound Pressure Level Summary

Location	Overall (dBA)		Winter (dBA)		Summer (dBA)	
	Measured	ANS	Measured	ANS	Measured	ANS
Location 1	53	51	52	51	54	51
Location 2	45	33	35	34	48	32
Location 3	46	39	42	41	48	36
Location 4	43	37	38	37	45	36
Location 5	45	38	41	40	47	36

3.4 Nighttime Ambient - Average

Measured nighttime average ambient levels are presented in Table 3-4. The nighttime ambient average noise level was calculated by logarithmically averaging sound pressure levels (Leq) (after exclusions) from the background sound level measurements over the nighttime period at each monitoring location. These calculations include both summer and winter data combined.

Table 3-4 Nighttime Ambient L_{eq} (dBA) Sound Pressure Level Summary

Location	Overall (dBA)		Winter (dBA)		Summer (dBA)	
	Measured	ANS	Measured	ANS	Measured	ANS
Location 1	50	41	43	41	53	40
Location 2	50	28	30	29	53	27
Location 3	46	31	33	32	49	29
Location 4	45	30	33	32	48	25
Location 5	44	32	35	34	47	29

3.5 Temporal Accuracy

The temporal accuracy section of the ANSI S12.9-1992/Part 2 document requires that the data collection must be long enough to achieve the desired confidence interval. The goal of the sound measurement program is to achieve a 95% confidence interval which would allow for a statement of 95% confidence that the true long-term average sound level falls within the given interval. The size of this confidence interval places the data set into one of three categories referred to as Class A, Class B, and Class C, listed here from most precise to least precise.

To determine the temporal accuracy, the mean square average sound level must be obtained using equation 2 of section 9.5 of the ANSI S12.9-1992/Part 2 document. In this equation, the sample standard deviation and average are used to determine the mean square average. These pieces of information are then combined with the information presented in Table 1 of section 9.5 of the standard to determine the upper and lower bounds of the 95% confidence interval. The equations for the upper and lower bound of the confidence interval are equations 3 and 4 of section 9.5 of the standard respectively. If there are data sets where the number of samples was outside the range covered by the information in Table 1, the source data presented in the Crow et al. document cited in the standard is used to calculate the necessary 'k1' and 'k2' values. A two-tailed 't' interval function is used to generate the necessary 't' value.

To use the equations in the Temporal Accuracy section, the raw data set must be shown to be approximately normal. This can be obtained by following the directions laid out in Appendix D of the standard. The method used in the standard is the Kolmogorov-Smirnov test for normality of data. In general, the Kolmogorov-Smirnov test takes the actual repetition of a measurement and compares it to the expected repetition based on the average and standard deviation of the sample. The difference between the actual and expected recurrence is then compared to a critical value that is based on the number of samples and desired confidence level. If any measured value has a difference between expected and actual recurrence that exceeds the critical value, the data shall not be approximated as normal.

Tables 3-5 through 3-10 present the 95% CI of the valid measured L_{90} sound level data at each site for Summer Daytime, Summer Nighttime, Winter Daytime, Winter Nighttime, Yearly Daytime, and Yearly Nighttime periods, respectively. The "Yearly Daytime" and "Yearly Nighttime" are composed of the summer and winter data combined for each time period (day or night). Each sample represents one full daytime (7 a.m. – 10 p.m.) or nighttime (10 p.m. – 7 a.m.) period in which more than 50% of the 10-minute records were valid. The same information is presented in Tables 3-11 to 3-16 for the measured L_{eq} sound levels at each site. All sound levels in Tables 3-5 to 3-16 are ANS-filtered.

Table 3-5 Temporal Accuracy Summary – Summer Daytime L90

Location	# of Samples	95% CI Mean (dBA)	Lower CI (dBA)	Upper CI (dBA)	Measurement Class	Normality
Location 1	6	29.13	2.50	3.05	Class C	Normal
Location 2	6	22.42	0.56	0.57	Class A	Normal
Location 3	6	20.32	0.78	0.80	Class A	Normal
Location 4	7	22.31	2.36	2.88	Class B	Normal
Location 5	6	23.66	1.05	1.10	Class A	Normal

Table 3-6 Temporal Accuracy Summary – Summer Nighttime L90

Location	# of Samples	95% CI Mean (dBA)	Lower CI (dBA)	Upper CI (dBA)	Measurement Class	Normality
Location 1	5	26.73	4.12	6.02	Worse than Class C	Normal
Location 2	5	19.26	3.31	4.39	Class C	Normal
Location 3	5	16.79	1.44	1.54	Class A	Normal
Location 4	6	16.64	2.38	2.88	Class B	Normal
Location 5	5	22.49	1.36	1.45	Class A	Normal

Table 3-7 Temporal Accuracy Summary – Winter Daytime L90

Location	# of Samples	95% CI Mean (dBA)	Lower CI (dBA)	Upper CI (dBA)	Measurement Class	Normality
Location 1	8	28.96	3.95	5.84	Worse than Class C	Normal
Location 2	8	25.18	4.55	7.14	Worse than Class C	Normal
Location 3	8	24.62	3.80	5.53	Worse than Class C	Normal
Location 4	8	24.81	4.99	8.14	Worse than Class C	Normal
Location 5	8	26.83	3.67	5.26	Worse than Class C	Normal

Table 3-8 Temporal Accuracy Summary – Winter Nighttime L90

Location	# of Samples	95% CI Mean (dBA)	Lower CI (dBA)	Upper CI (dBA)	Measurement Class	Normality
Location 1	9	26.83	6.08	10.60	Worse than Class C	Normal
Location 2	9	22.18	5.22	8.60	Worse than Class C	Normal
Location 3	9	22.82	5.12	8.39	Worse than Class C	Normal
Location 4	7	24.91	7.83	15.60	Worse than Class C	Normal
Location 5	9	25.45	4.21	6.39	Worse than Class C	Normal

Table 3-9 Temporal Accuracy Summary – Yearly Daytime L90

Location	# of Samples	95% CI Mean (dBA)	Lower CI (dBA)	Upper CI (dBA)	Measurement Class	Normality
Location 1	14	29.02	2.26	2.80	Class B	Normal
Location 2	14	23.91	2.26	2.81	Class B	Normal
Location 3	14	22.87	2.06	2.50	Class B	Normal
Location 4	15	23.51	2.51	3.20	Class C	Normal
Location 5	14	25.46	1.92	2.29	Class B	Normal

Table 3-10 Temporal Accuracy Summary – Yearly Nighttime L90

Location	# of Samples	95% CI Mean (dBA)	Lower CI (dBA)	Upper CI (dBA)	Measurement Class	Normality
Location 1	14	27.00	3.98	5.82	Worse than Class C	Normal
Location 2	14	20.99	3.17	4.33	Class C	Normal
Location 3	14	20.70	3.08	4.18	Class C	Normal
Location 4	13	21.11	3.84	5.58	Worse than Class C	Normal
Location 5	14	24.31	2.47	3.14	Class C	Normal

Table 3-11 Temporal Accuracy Summary - Summer Daytime Leq

Location	# of Samples	95% CI Mean (dBA)	Lower CI (dBA)	Upper CI (dBA)	Measurement Class	Normality
Location 1	6	51.99	0.75	0.77	Class A	Normal
Location 2	6	42.61	7.18	14.02	Worse than Class C	Normal
Location 3	6	41.60	4.07	6.02	Worse than Class C	Normal
Location 4	7	45.82	5.42	9.21	Worse than Class C	Normal
Location 5	6	39.24	1.78	2.00	Class A	Normal

Table 3-12 Temporal Accuracy Summary - Summer Nighttime Leq

Location	# of Samples	95% CI Mean (dBA)	Lower CI (dBA)	Upper CI (dBA)	Measurement Class	Normality
Location 1	5	45.27	1.85	2.07	Class B	Normal
Location 2	5	30.76	3.48	4.71	Class C	Normal
Location 3	5	32.68	1.98	2.97	Class B	Normal
Location 4	6	34.11	5.22	8.70	Worse than Class C	Normal
Location 5	5	31.61	1.97	2.24	Class B	Normal

Table 3-13 Temporal Accuracy Summary - Winter Daytime Leq

Location	# of Samples	95% CI Mean (dBA)	Lower CI (dBA)	Upper CI (dBA)	Measurement Class	Normality
Location 1	8	52.02	0.83	0.86	Class A	Normal
Location 2	8	42.49	6.48	11.76	Worse than Class C	Normal
Location 3	8	45.57	2.93	3.86	Class C	Normal
Location 4	8	43.75	4.09	6.13	Worse than Class C	Normal
Location 5	8	48.90	5.98	10.50	Worse than Class C	Normal

Table 3-14 Temporal Accuracy Summary - Winter Nighttime Leq

Location	# of Samples	95% CI Mean (dBA)	Lower CI (dBA)	Upper CI (dBA)	Measurement Class	Normality
Location 1	9	46.97	2.39	2.97	Class B	Normal
Location 2	9	36.71	5.16	8.46	Worse than Class C	Normal
Location 3	9	37.98	2.90	3.83	Class C	Normal
Location 4	7	41.02	6.23	11.26	Worse than Class C	Normal
Location 5	9	39.91	3.96	5.87	Worse than Class C	Normal

Table 3-15 Temporal Accuracy Summary - Yearly Daytime Leq

Location	# of Samples	95% CI Mean (dBA)	Lower CI (dBA)	Upper CI (dBA)	Measurement Class	Normality
Location 1	14	52.00	0.49	0.50	Class A	Normal
Location 2	14	42.21	4.30	6.42	Worse than Class C	Normal
Location 3	14	44.31	2.53	3.24	Class C	Normal
Location 4	15	44.55	2.98	3.99	Class C	Normal
Location 5	14	45.54	3.68	5.26	Worse than Class C	Normal

Table 3-16 Temporal Accuracy Summary - Yearly Nighttime Leq

Location	# of Samples	95% CI Mean (dBA)	Lower CI (dBA)	Upper CI (dBA)	Measurement Class	Normality
Location 1	14	46.35	1.51	1.71	Class A	Normal
Location 2	14	34.67	3.32	4.60	Class C	Normal
Location 3	14	36.52	2.22	2.74	Class B	Normal
Location 4	13	38.43	4.19	6.24	Worse than Class C	Normal
Location 5	14	37.91	3.16	4.31	Class C	Normal

3.6 Infrasound and Low Frequency

Infrasound and low frequency sound pressure levels were measured at all locations in both the summer and winter seasons. The frequency range of these data is from 6.3 Hz to 200 Hz. The sound levels were summarized by averaging[12] sound level data from all valid[13] winter daytime 10-minute periods, winter nighttime 10-minute periods, summer daytime 10-minute periods, and summer nighttime 10-minute periods within each one-third octave band. Winter and summer infrasound data collected at Location 3 are presented in Figure 3-1. This location was chosen for its centralized location within the project area.

[12] Logarithmic (energy) average of equivalent (Leq) sound pressure levels.

[13] Refer to Chapter 2 for details concerning valid periods.

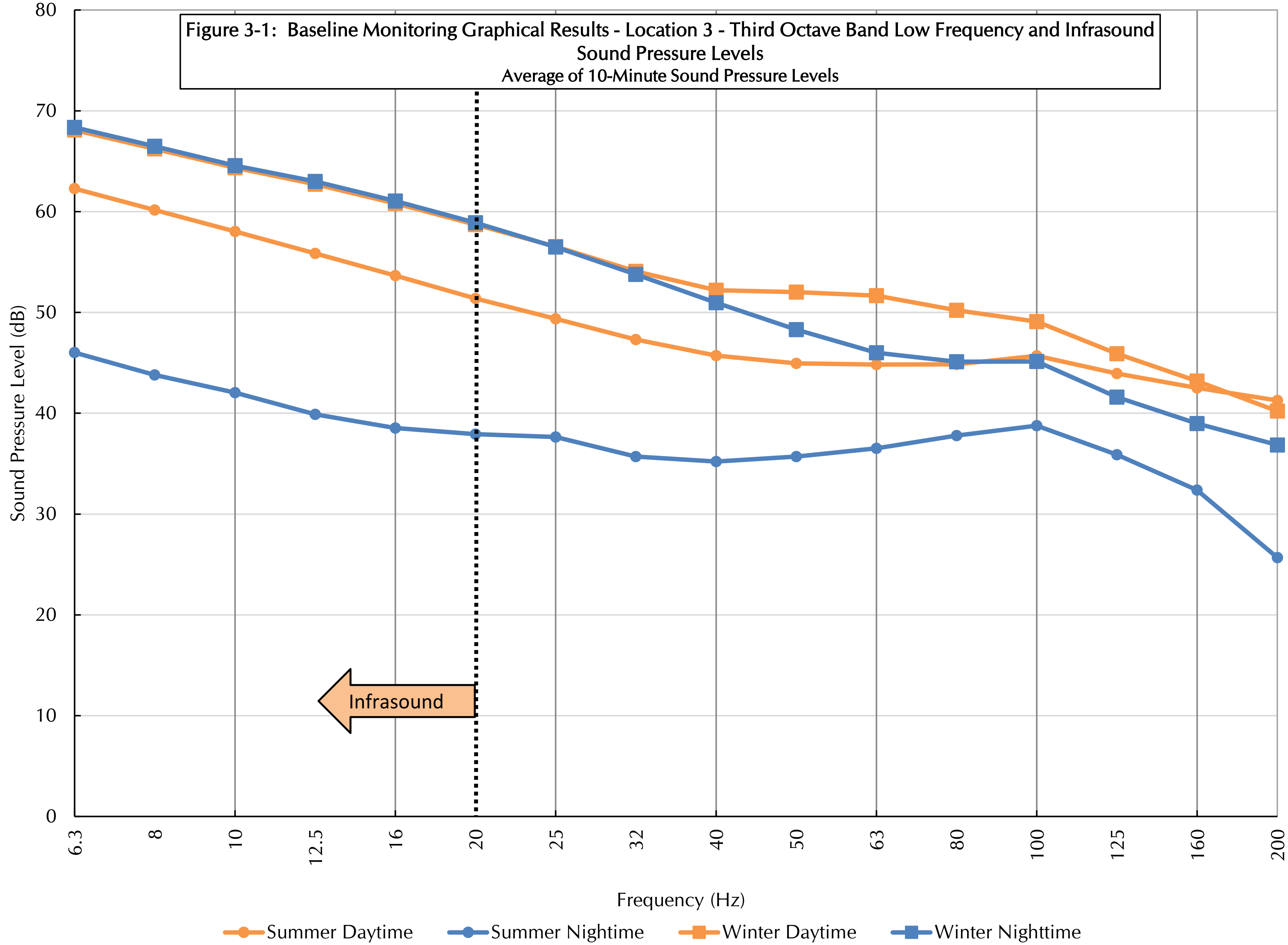


Figure 3-1: Baseline Monitoring Graphical Results - Location 3 - Third Octave Band Low Frequency and Infrasound Sound Pressure Levels
Average of 10-Minute Sound Pressure Levels
Sound Pressure Level (dB)
0
10
20
30
40
50
60
70
80
Infrasound
6.3
8
10
12.5
16
20
25
32
40
50
63
80
100
125
160
200
Frequency (Hz)
Summer Daytime
Summer Nighttime
Winter Daytime
Winter Nighttime

Appendix A

Windscreen Insertion Loss

Experimental study to determine wind-induced noise and windscreen attenuation effects on microphone response for environmental wind turbine and other applications

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Despite the use of windscreens, the measurement of ambient sound levels or noise emissions in quiet environments can be adversely affected by wind blowing over the microphone. This is especially true when environmental impact assessments are being carried out for proposed wind turbine power projects - where the objective is to determine the level of background masking noise available as a function of wind speed, since any potential noise impact from the project will only occur under moderately windy conditions. Under calm conditions the project will produce no noise at all. A number of windscreen products are commercially available for short and long-term sound level monitoring in adverse weather conditions. Generally, these windscreens vary by physical size and the method of preventing water from reaching the microphone. High frequency attenuation effects are usually available from the product suppliers but, in general, low frequency turbulence effects are not available. Consequently, a controlled laboratory test program was carried out in a state-of-the-art wind tunnel at the Fraunhofer Institut für Bauphysik in Stuttgart, Germany to quantify the level of low frequency interference (down to 6.3 Hz) associated with a number of different foam windscreens and an aerodynamic microphone nose cone. A total of nine configurations were tested with "quiet" airflow only, artificial noise only and noise plus airflow to evaluate both low frequency wind induced noise and high frequency attenuation effects. The test program demonstrated that the largest size foam-based windscreens provided the most protection from flow induced noise due to wind. Flow induced noise by air flow alone was estimated from the study results and compared to community noise measurements at a typical wind turbine site. It was determined that flow induced wind noise does not have a significant or detrimental effect on the measurement of A-weighted sound levels under wind conditions of concern as long as the suggested measurement techniques described herein are followed.

Primary subject classification: 71.1.1; Secondary subject classification: 21.6

1 INTRODUCTION

It is a challenge to measure ambient or background levels in quiet, rural environments. Such areas are usually devoid of any major noise sources, such as highways, industrial facilities or airports. Except for occasional, usually man-made, noise events the sound level in rural environments is normally dominated by the rustling of tree leaves or branches in the wind or by the high frequency sounds of insects during the warmer months of the year. For wind turbine power project assessments, ambient sound levels when the wind is blowing in the 3 to 10 m/s range (measured at 10 m above the surface) is very relevant because that is when typical wind turbines first begin to generate significant noise. At higher wind speeds turbine sound levels remain largely constant while the background sound continues to increase. Consequently, background sound

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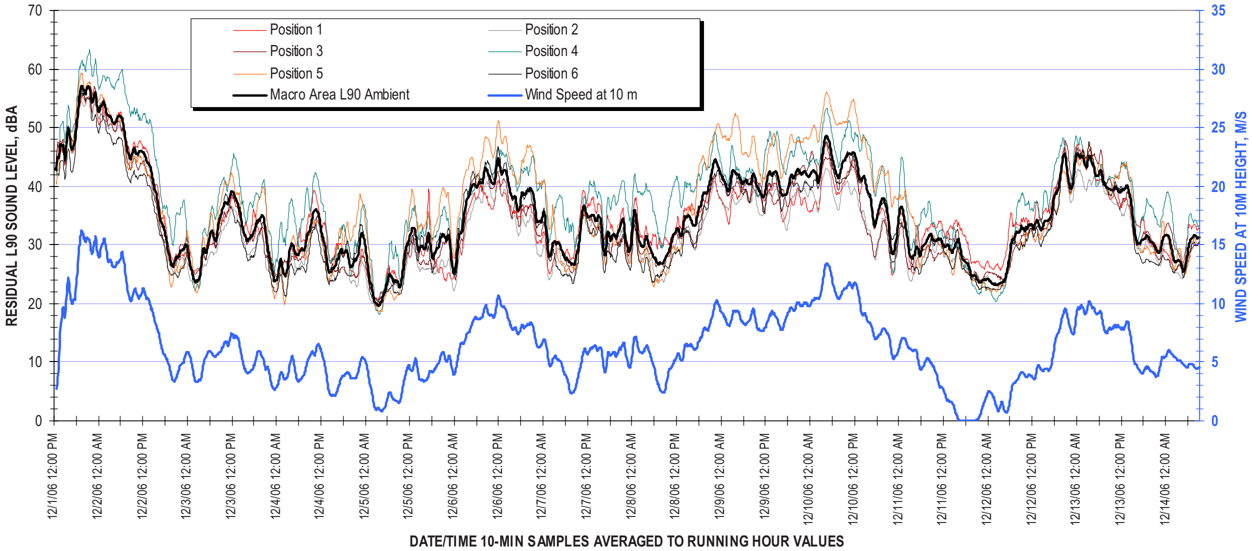

Fig. 1—Measured residual LA90 ambient sound levels at six widely spaced locations in a quiet rural area compared to wind speed over a 13 day period.

levels that occur during moderate winds are of the most interest. Reference 1 offers techniques for measuring wind turbine sources using a ground plane microphone setup to eliminate wind induced noise, but background baseline measurements are made above grade with wind.

In general, experience with (insect-free) wintertime surveys at rural sites indicates that there is normally an

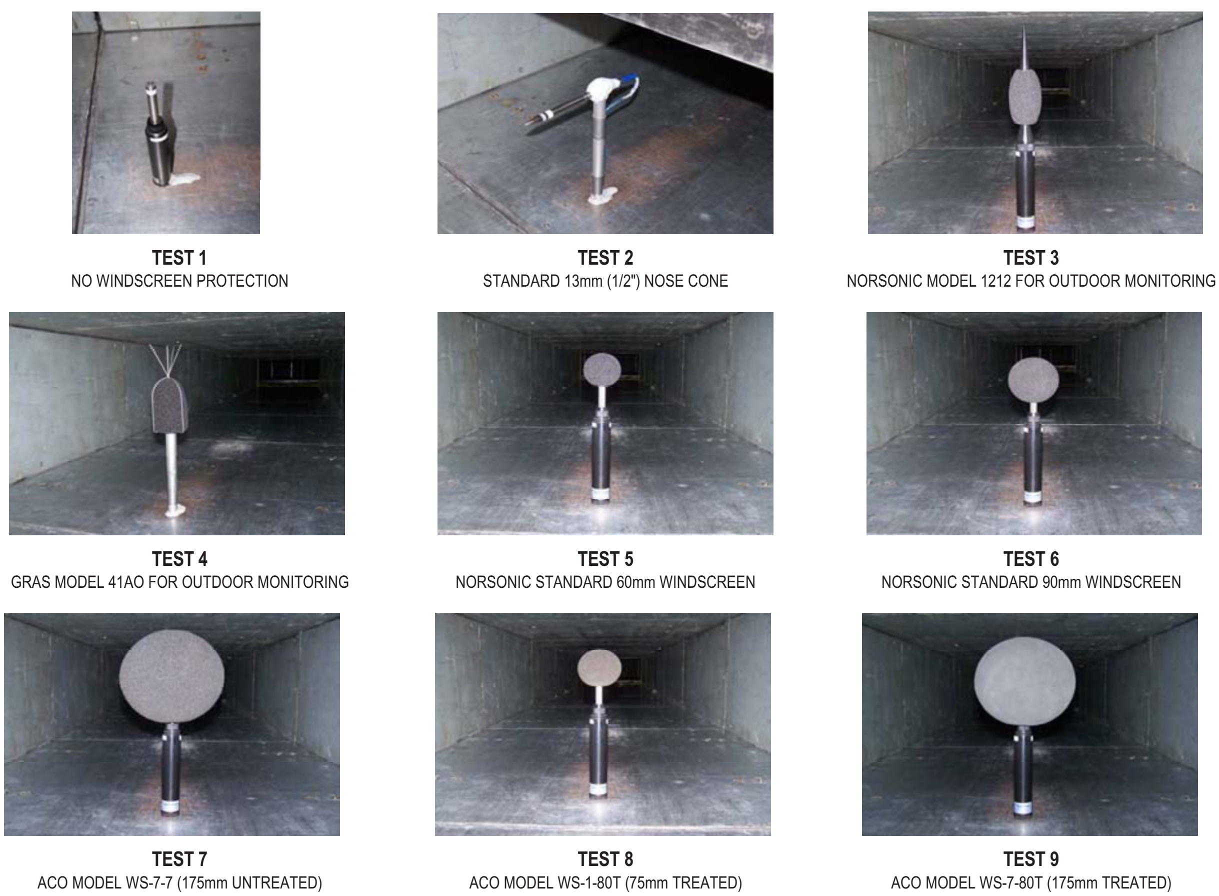

Fig. 2—Photographs of nine microphone test configurations.

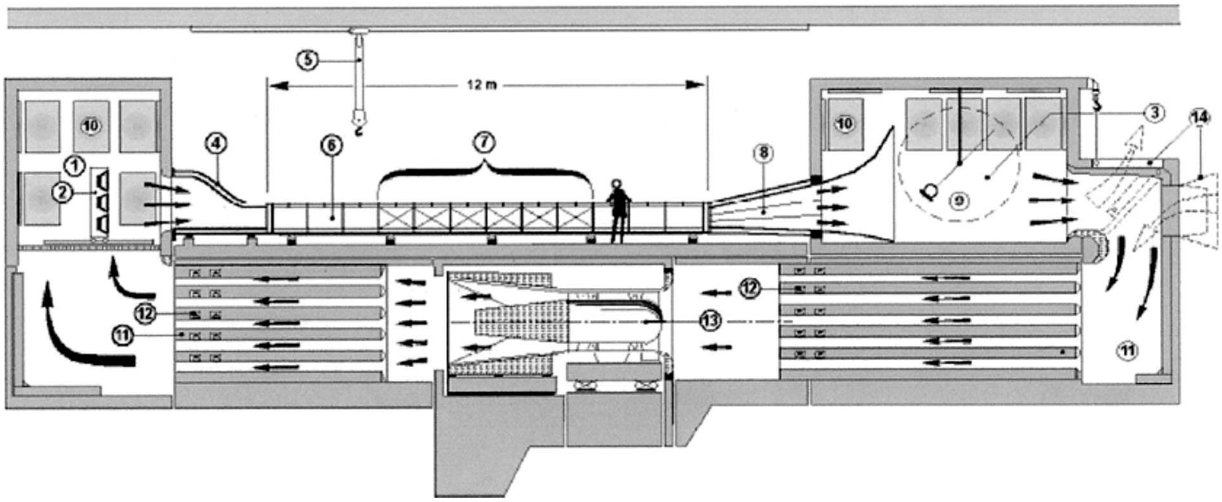

Fig. 3—Cross sectional elevation view of silencer test facility.

excellent correlation between wind speeds and the ambient residual (L90) sound levels as shown on Fig. 1. Of course, such a high degree of correlation could result if the microphone response was dominated by wind-induced turbulence effects around the microphone as opposed to the true ambient sound level signal. Hence, the purpose of this study is to quantitatively address this uncertainty and determine, for a number of common windscreens types, if/when any substantial contamination occurs over a range of wind speeds.

Nine microphone configurations, as illustrated in Fig. 2, were tested under controlled conditions in a wind tunnel duct using quiet airflow only, artificial noise only (at three volumes) and airflow plus artificial noise. Ninety degree incidence is used to duplicate ambient sound measurement survey techniques, but the nose cone (B&K model UA 0386) was aimed into the flow stream. Windscreens for tests 3, 4, 8 and 9 are products available for long-term outdoor monitoring. The foam ball ACO Pacific models (tests 8 and 9) are specifically treated to shed rain water while the other foam balls are not intended for outdoor rain exposure. Measurements were carried out at duct velocities of 2.5, 5, 10, 20 and 30 m/s (8, 16, 33, 66 and 98 ft/s, or 6, 11, 22, 45 and 67 mph). The test results are also useful for determining flow turbulence effects when measuring industrial noise sources in the presence of airflow, as well as for outdoor environmental measurements.

The test program was carried out at the Fraunhofer Institute of Building Physics located in Stuttgart, Germany at their aero-acoustic wind tunnel illustrated on Fig. 3. Note the large silencers on the inlet and exhaust path of the airflow fan and the structural isolation of the test duct. The airflow delivered to the duct test section is essentially free of fan noise or is “quiet” air. The airflow in the duct cross section has an even distribution without swirl or turbulences as it is supplied through a stilling chamber and an air inlet profile. The duct cross section of 1 m by 0.5 m was held constant over the complete length for all measurements. In this way re-generated noise was kept at a minimum. Measurements were made with a Norsonic 840 Analyzer, Norsonic Model 1201 preamp and 1/2 inch (13 mm) diameter Model 1225 microphone.

2 LOW FREQUENCY TURBULENCE EFFECTS - FLOW MEASUREMENTS

The raw measured data for all configurations at the five airflow speeds are plotted on Fig. 4. It is certainly not news, but the data clearly demonstrate that even the most modest foam windscreen should always be used when outdoors, since it dramatically improves the low and mid frequency microphone response. Because the extreme low frequencies are significantly affected by flow induced noise even at fairly low wind speeds, these plots also show that whenever low level very low frequency or C-weighted sound levels must be measured outdoors such measurements should only be carried out under completely calm conditions.

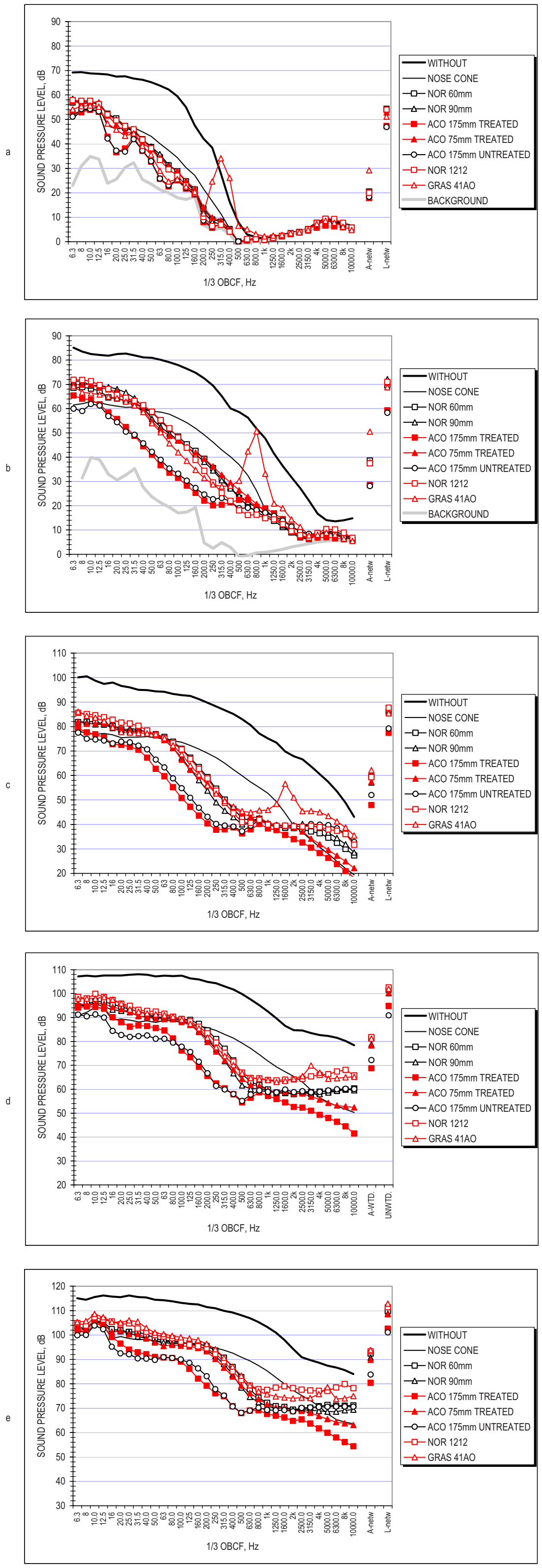

Fig. 4—Measured microphone response at five velocities (2.5, 5. 10, 20 and 30 m/s, *graph a through e).*

The second trend immediately noticeable is that the two larger (175 mm diameter) windscreens are significantly better at reducing flow induced noise at low and

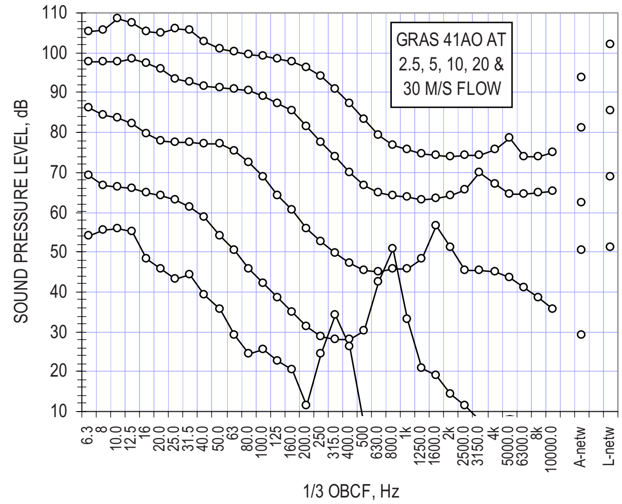

Fig. 5—Graph showing flow generated tonal noise associated with the gap between foam and wire.

mid frequencies. Flow-induced noise levels are on the order of 10 dB lower for this type of windscreen than they are for all others. Prior studies have shown this relationship and an excellent analytical study and summary of microphone response to turbulence is presented by van den Berg in Ref. 2. This testing quantifies the improvement and low frequency performance for readily available current wind protection products.

All of the plots, but particularly the lower wind speed cases, show a tonal aberration for the GRAS model 41AO windscreen. A frequency shift with wind velocity can clearly be seen in Fig. 5, which shows only the results for this model windscreen at all five wind speeds. This behavior was initially attributed to vortex shedding from the bird spike wires (each 1.5 mm in diameter) where the frequency may be calculated by the well known equation:

$$f = Sv/d \tag{1}$$

where,
S=the Strouhal number of 0.2
v=velocity, m/s
d=diameter, m
This calculation indicated that the 315, 630, 1250, 2500 and 5000 Hz 1/3 octave bands would be excited by vortex shedding, but the actual measurements showed that the affected bands were 315, 800, 1600, 3150 and 5000 Hz. Further diagnostic testing demonstrated that the peaks are caused by the gap between the

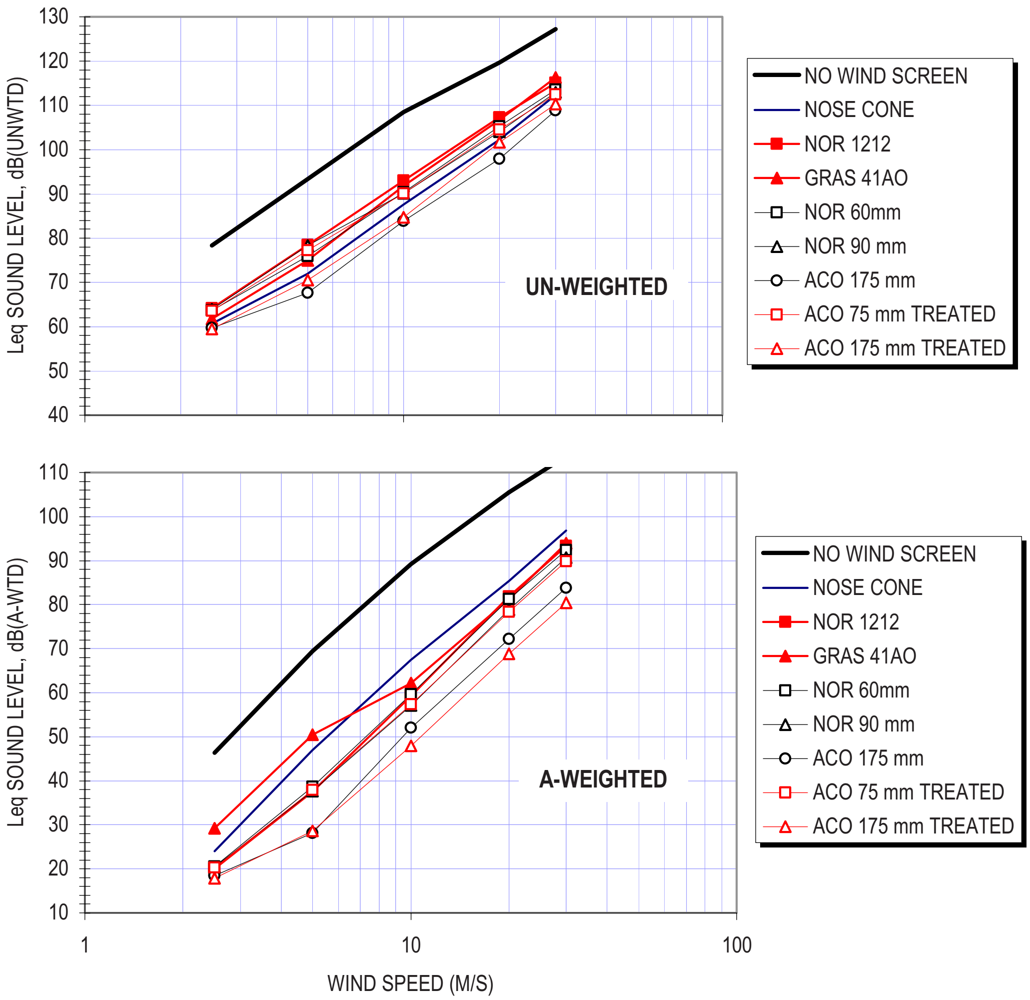

Fig. 6—Plot of overall flow noise response for windscreen models. Upper: Un-weighted level, Lower: A-weighted level.

wire bird spike base and the top of the windscreen. Apparently small mini-jets are created by this gap and it was found that this noise could be reduced by a closer fit between the foam screen and the wire. The gap should be eliminated when employing this model for monitoring.

Figure 6 plots the overall measured values of flow-generated noise as a function of air flow velocity. When plotted on a logarithmic scale, the data show a linear increase with velocity for all models. The overall, un-weighted sound level slope is a v^5 relationship, or approximately a 15 dB increase for each doubling of velocity, whereas the A-weighted results are a v^6 relationship, or approximately 18 dBA increase per doubling. Table 1 tabulates the overall measured values at each velocity for each model windscreen. These data can be used to derive a logarithmic expression for the self-generated noise level as a function of wind speed for any of the tested windscreens. For example, data for the treated ACO 175 mm windscreen leads to the following approximate equation for estimating the A-weighted flow induced noise level for the wind speed at the microphone location. Wind speed at 10 m elevation is the standardized elevation for rating wind turbines as given in Ref. 1 but this equation applies at the microphone location.

$$L_{fin} = 27.4\ln(v) - 10.7,\ \text{dBA} \qquad (2)$$

where,

L_{fin}=the A-weighted flow-induced-noise level due only to wind

v=the wind speed at the microphone, m/s

Table 1—Measured overall levels for microphone response with and without windscreens at five velocity settings. Lowest response results are for the 175 mm *size windscreens.*

		FLOW SPEED M/S (MPH)				
A-WTD		2.5	5	10	20	30
T1	NO WIND SCREEN	46	69	89	106	114
T2	NOSE CONE	24	47	68	85	97
T3	NOR 1212	20	38	59	82	93
T4	GRAS 41AO	29	51	62	81	94
T5	NOR 60 mm	21	39	60	81	92
T6	NOR 90 mm	20	38	57	79	91
T7	ACO 175 mm	18	28	52	72	84
T8	ACO 75 mm TREATED	20	38	57	78	90
T9	ACO 175 mm TREATED	18	29	48	69	80
UNWTD		FLOW SPEED M/S (MPH)				
		2.5	5	10	20	30
T1	NO WIND SCREEN	78	93	109	120	127
T2	NOSE CONE	61	72	88	102	112
T3	NOR 1212	64	79	93	107	115
T4	GRAS 41AO	62	75	92	107	116
T5	NOR 60 mm	64	76	90	105	114
T6	NOR 90 mm	64	78	90	104	113
T7	ACO 175 mm	60	68	84	98	109
T8	ACO 75 mm TREATED	64	77	90	105	113
T9	ACO 175 mm TREATED	60	71	85	102	110

3 ATTENUATION EFFECTS – ARTIFICIAL NOISE MEASUREMENTS

The measured sound levels in the duct at three volumes of artificial loud speaker noise (without any airflow) are plotted in Fig. 7. The fairly significant response variances at frequencies below 50 Hz are attributable to longitudinal in-duct resonances. Variable levels of external low frequency background noise outside the test duct at the facility may have also contributed to the scatter and loudspeaker output is poor at frequencies below 20 Hz. An improved signal to background noise ratio is suspected as the reason for better data grouping at the highest volume. There is no reason to believe that windscreens have any attenuation or amplification effects at these low frequencies. To verify this, testing was repeated in the facilities anechoic free-field environment. Figure 8 plots the raw data for this test and it is readily apparent that the low frequency variations are absent for a free progressive wave in an anechoic room as opposed to the wave front in a duct containing lateral reflections.

At the high end of the frequency spectrum the plots consistently show the same, model-dependent trends such as the significant attenuation of the ACO 175 mm treated windscreen at all frequencies above about 1250 Hz. Figure 9 shows the averaged attenuation for the three volumes in 1/3 octave bands for all windscreen models tested. Negative attenuation, or amplification of the signal, is significant for the nose cone and Nor 1212 outdoor windscreen. Table 2 tabulates the measured attenuations.

In general, the relatively large high frequency attenuation associated with the ACO 175 mm treated windscreen means that any un-corrected measurements made with it would be somewhat lower on an overall A-weighted basis than the actual value and therefore conservative in background survey applications. The overall noise reduction of this windscreen would depend on the frequency spectrum shape of the sound being measured but appears to be in 2 to 5 dBA range (neglecting any possible counteracting increases due to wind-induced effects). This low-pass filter quality could actually be beneficial in cases where unwanted summertime insect noise (generally above 2 kHz) is present. This contamination would be automatically

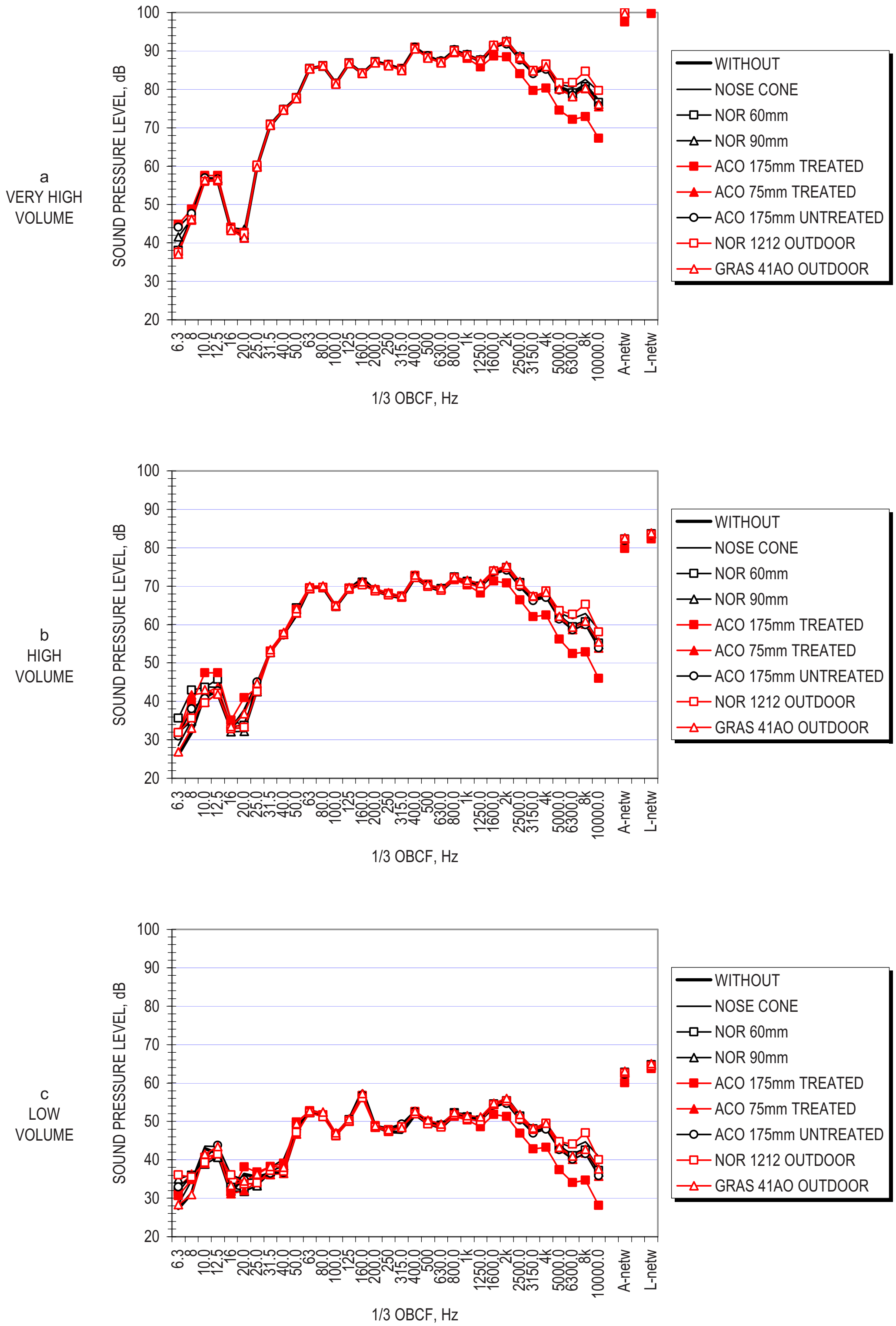

Fig. 7—Measured response with three volumes of artificial noise in the duct.

minimized, though not necessarily eliminated, through the use of this windscreen

4 FLOW AND NOISE MEASUREMENTS

The combined flow and noise measurements serve to illustrate the accuracy of the measurements and the benefits of using windscreens. Figure 10 plots the flow only, noise only and the combined flow and noise measurements for three cases: no windscreen, minimum diameter and maximum diameter foam windscreens. The point where the flow only and noise only traces cross essentially defines the minimum

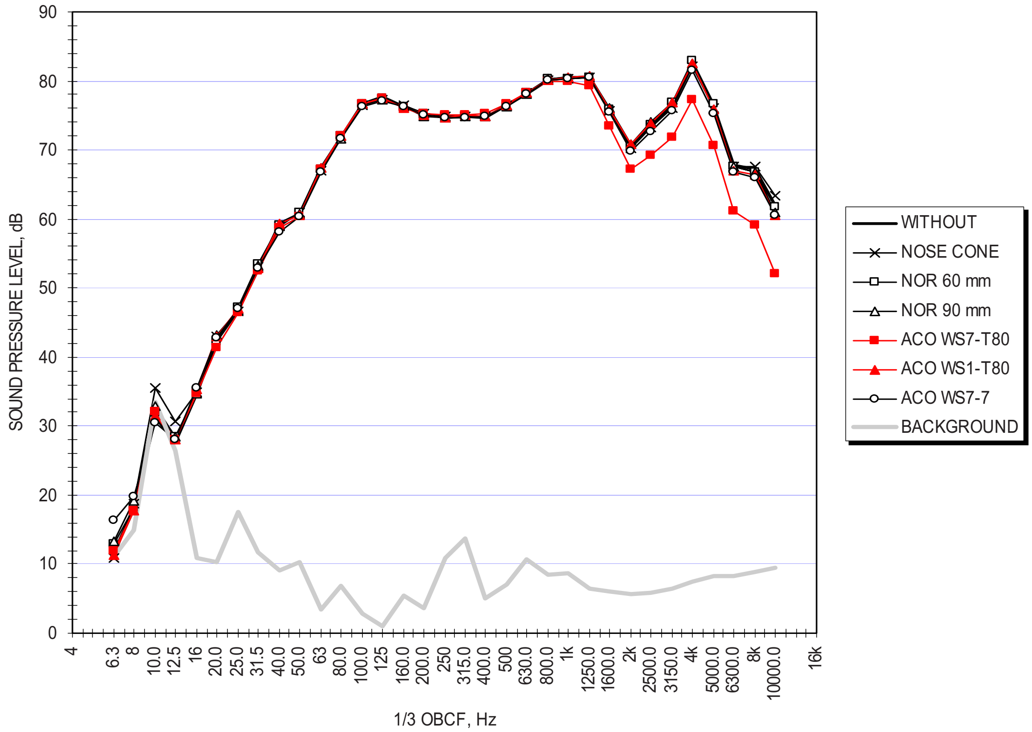

Fig. 8—Measured sound pressure spectra for five windscreen models in an anechoic chamber.

frequency at which valid data can be measured during, in this case, a 10 m/s wind. Without a windscreen, almost the entire spectrum (0 to 6300 Hz) is dominated by the 10 m/s flow noise. At the same 10 m/s flow speed; however, accurate measurements can be made in all bands above 125 Hz using only a 60 mm windscreen. The frequency response is improved to above 50 Hz using the largest (175 mm) windscreen.

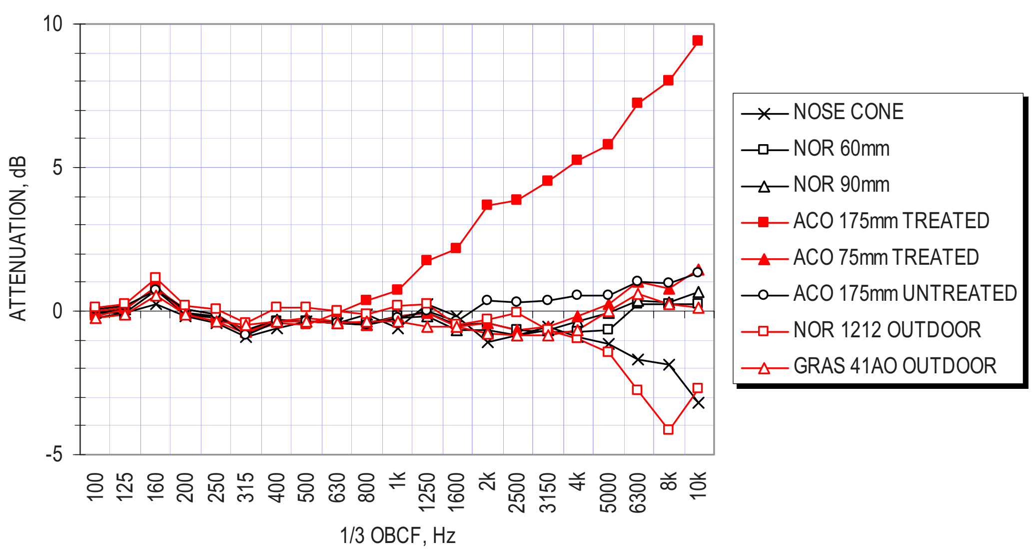

Fig. 9—Measured microphone response attenuation for windscreen models for 90 degree sound incidence.

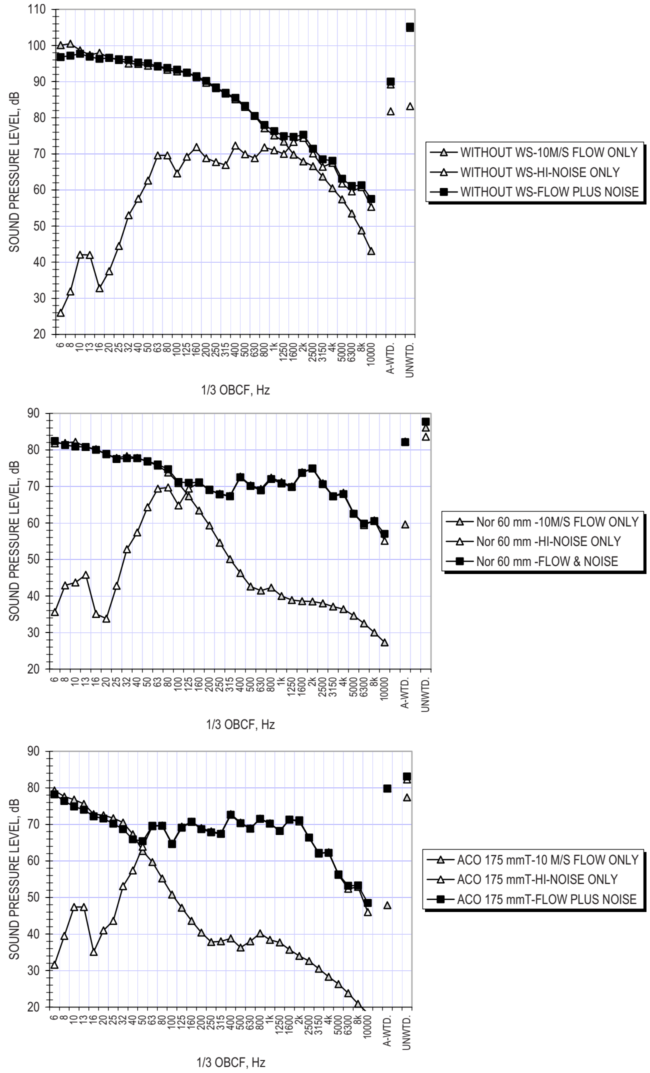

Fig. 10—Flow only, noise only and flow and noise measurements.

5 CONCLUSIONS AND RECOMMENDATIONS

The data show that reasonably good results when measuring in low to moderate wind conditions are possible even with conventional 60 mm windscreens, but that a larger (175 mm) diameter windscreen offers significantly better performance in the lower frequencies.

In the special case of background sound level surveys for wind turbine projects, where the objective is to determine the environmental sound level/masking level as a function of wind speed, the suggested practice based on this lab study is to use a large 175 mm windscreen and mount the microphone at a maximum elevation of about 1 m above grade. This latter step helps ensure that the microphone is exposed to relatively low wind speeds, since the nominal wind velocity profile, Eqn. (7) in Ref. 1 has a parabolic shape where the velocity decreases rapidly near the ground – theoretically going to zero at the surface. For example, a wind speed of 10 m/s (22.4 mph) measured at a standardized elevation of 10 m would translate to a nominal speed of 5.6 m/s (12.5 mph) at only 1 m above the surface. The wind speed range of most relevance to wind turbine analyses is usually in the 5 to 8 m/s range as measured at 10 m; consequently, a microphone at 1 m would be exposed to nominal flow velocities of 2.8 m/s (6.3 mph) to 4.5 m/s (10.1 mph) where the A-weighted flow induced noise levels would

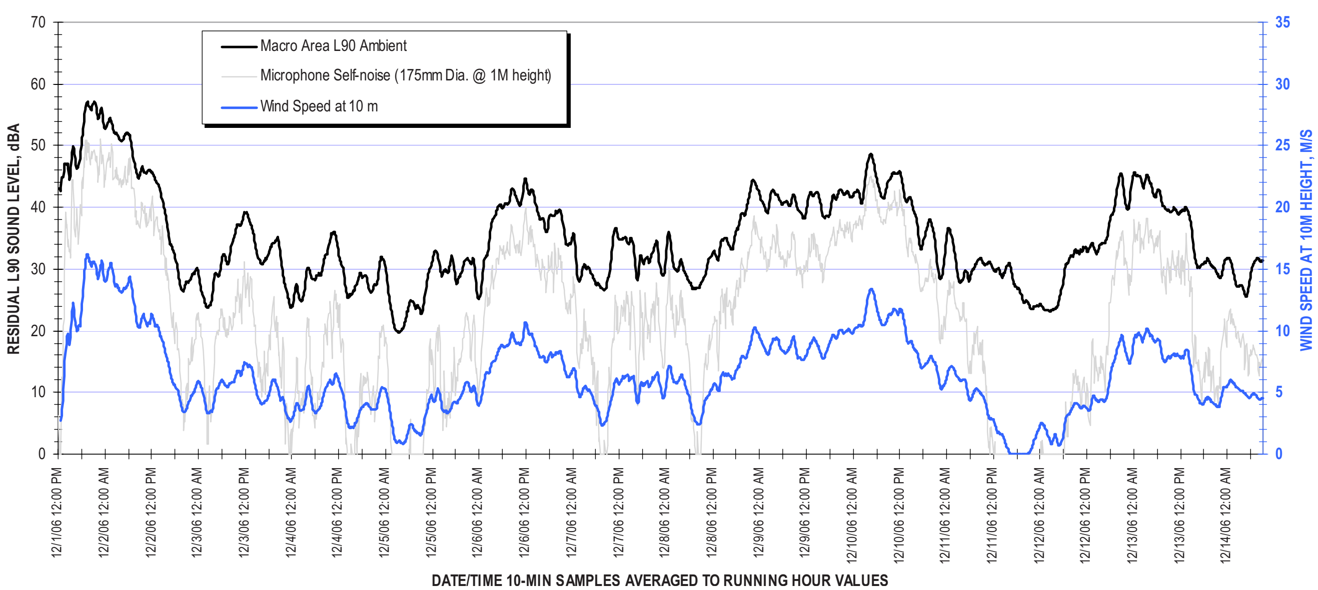

Fig. 11—Measured community ambient level compared to estimated microphone response to wind.

Table 2—Measured attenuation for windscreen models, 90 degree sound incidence.

1/3 OBCF, Hz	NOR 60 mm	NOR 90 mm	ACO 175 mm TREATED	ACO 75 mm TREATED	ACO 175 mm UNTREATED	NOR1212 OUTDOOR	GRAS41AO OUTDOOR	NOSE CONE
100	0.0	−0.1	−0.2	0.0	0.1	0.1	−0.2	−0.2
125	−0.1	0.1	0.1	0.1	0.2	0.3	−0.1	−0.1
160	0.7	0.9	0.8	0.8	0.7	1.2	0.5	0.2
200	−0.1	0.0	−0.1	0.0	0.1	0.2	−0.1	−0.2
250	−0.2	−0.2	−0.4	−0.1	−0.1	0.0	−0.3	−0.4
315	−0.7	−0.6	−0.8	−0.7	−0.8	−0.4	−0.5	−0.9
400	−0.4	−0.3	−0.4	−0.3	−0.4	0.1	−0.4	−0.6
500	−0.3	−0.3	−0.5	−0.2	−0.3	0.1	−0.3	−0.3
630	−0.4	−0.4	0.0	−0.4	−0.4	0.0	−0.4	−0.4
800	−0.4	−0.5	0.4	−0.5	−0.5	−0.1	−0.3	−0.1
1K	−0.2	−0.2	0.7	−0.2	−0.2	0.2	−0.3	−0.6
1250	0.0	−0.2	1.8	−0.1	0.0	0.3	−0.5	0.3
1600	−0.5	−0.6	2.2	−0.6	−0.3	−0.5	−0.6	−0.2
2K	−0.4	−0.7	3.7	−0.4	0.3	−0.3	−0.8	−1.1
2500	−0.6	−0.8	3.8	−0.7	0.3	0.0	−0.8	−0.8
3150	−0.7	−0.6	4.5	−0.5	0.3	−0.7	−0.8	−0.6
4K	−0.7	−0.3	5.3	−0.2	0.5	−1.0	−0.7	−0.9
5K	−0.6	−0.1	5.8	0.2	0.6	−1.5	0.0	−1.1
6300	0.2	0.3	7.2	1.0	1.0	−2.8	0.6	−1.7
8K	0.2	0.3	8.0	0.8	1.0	−4.1	0.2	−1.9
10K	0.3	0.7	9.4	1.5	1.3	−2.7	0.1	−3.2

range from 18 to 31 dBA. Such levels are low to insignificant even compared to the quiet environmental sound levels that commonly exist in rural areas.

As an example, the self-noise sound levels associated with the field data illustrated in Figure 1 have been calculated from Eqn. (2) above (based on the 10 m wind data converted to 1 m) and used to correct the sound levels actually measured. The measured and corrected sound levels are plotted in Fig. 11. Since the microphone flow induced noise response alone is frequently 8 to 10 dBA below the measured levels, the adjustment is minimal in most instances (=< 0.5 dBA) and therefore considered insignificant.

6 ACKNOWLEDGEMENTS

The author wishes to acknowledge both the technical and financial assistance provided by the Norsonic in Germany, Scantek, Inc., GRAS and ACO Pacific in the U.S.

7 REFERENCES

1. International Standard IEC 61400-11, *Wind turbine generator systems – Part 11: "Acoustic noise measurement techniques"*, 2nd edition 2002–12, (2002).
2. G. P. van den Berg, "The sound of high winds: the effect of atmospheric stability on wind turbine sound and microphone noise." Ph.D. Thesis, National University of Groningen, The Netherlands, (2006).

Appendix B

Certificates of Sound Level Instrument Calibration

Scantek, Inc.

CALIBRATION LABORATORY

ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.45008

Instrument:	**Acoustical Calibrator**	*Date Calibrated:* **7/15/2020** *Cal Due:* **7/15/2021**		
Model:	**CAL200**	*Status:*	**Received**	**Sent**
Manufacturer:	**Larson Davis**	*In tolerance:*	**X**	**X**
Serial number:	**2853**	*Out of tolerance:*		
Class (IEC 60942):	**1**	*See comments:*		
Barometer type:		*Contains non-accredited tests:* __Yes _X_ No		
Barometer s/n:				
Customer:	**Epsilon Associates, Inc.**	*Address:*	**3 Mill & Main Place, Suite 250, Maynard, MA 01754**	
Tel/Fax:	**978-461-6235 / choyt@epsilonassociates.com**			

Tested in accordance with the following procedures and standards:
Calibration of Acoustical Calibrators, Scantek Inc., Rev. 10/1/2010

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 31, 2019	Scantek, Inc./ NVLAP	Oct 31, 2020
DS-360-SRS	Function Generator	33584	Oct 23, 2019	ACR Env./ A2LA	Oct 23, 2021
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Oct 22, 2019	ACR Env. / A2LA	Oct 22, 2020
HM30-Thommen	Meteo Station	1040170/39633	Oct 24, 2019	ACR Env./ A2LA	Oct 24, 2020
140-Norsonic	Real Time Analyzer	1406423	Oct 31, 2019	Scantek / NVLAP	Oct 31, 2020
PC Program 1018 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
4134-Brüel&Kjær	Microphone	173368	Oct 23, 2019	Scantek, Inc. / NVLAP	Oct 23, 2020
1203-Norsonic	Preamplifier	14059	March 3, 2020	Scantek, Inc./ NVLAP	March 3, 2021

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK)

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	William D. Gallagher
Signature	*Lydon Dawkins*	Signature	*William D. Gallagher*
Date	7/15/2020	Date	7/17/2020

Document stored as: Y:\Calibration Lab\Cal 2020\LDCAL200_2853_M1.doc

Results summary: Device was tested and complies with following clauses of mentioned specifications:

CLAUSES[1] FROM STANDARDS REFERENCED IN PROCEDURES:	MET[2]	NOT MET	COMMENTS
Manufacturer specifications			
Manufacturer specifications: Sound pressure level	X		
Manufacturer specifications: Frequency	X		
Manufacturer specifications: Total harmonic distortion	X		
Current standards			
ANSI S1.40:2006 B.3 / IEC 60942: 2003 B.2 - Preliminary inspection	X		
ANSI S1.40:2006 B.4.4 / IEC 60942: 2003 B.3.4 - Sound pressure level	X		
ANSI S1.40:2006 A.5.4 / IEC 60942: 2003 A.4.4 - Sound pressure level stability	-	-	
ANSI S1.40:2006 B.4.5 / IEC 60942: 2003 B.3.5 - Frequency	X		
ANSI S1.40:2006 B.4.6 / IEC 60942: 2003 B.3.6 - Total harmonic distortion	X		

1 The results of this calibration apply only to the instrument type with serial number identified in this report.

2 The tests marked with (*) are not covered by the current NVLAP accreditation.

Main measured parameters [3]:

Measured[4]/Acceptable[5] Tone frequency (Hz):	Measured[4]/Acceptable[5] Total Harmonic Distortion (%):	Measured [4]/Acceptable Level[5] (dB):
1000.30 ± 1.0/1000.0 ± 10.0	0.37 ± 0.10/ < 3	93.96 ± 0.13/94.0 ± 0.4
1000.29 ± 1.0/1000.0 ± 10.0	0.37 ± 0.10/ < 3	113.89 ± 0.12/114.0 ± 0.4

3 The stated level is valid at measurement conditions.

4 The above expanded uncertainties for frequency and distortion are calculated with a coverage factor k=2; for level k=2.00

5 Acceptable parameters values are from the current standards

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
23.2 ± 1.0	100.48 ± 0.000	40.7 ± 2.0

Tests made with following attachments to instrument:

Calibrator ½" Adaptor Type:	
Other:	

Adjustments: Unit was not adjusted.
Comments: The instrument was tested and met all specifications found in the referenced procedures.

Note: The instrument was tested for the parameters listed in the table above, using the test methods described in the listed standards. All tests were performed around the reference conditions. The test results were compared with the manufacturer's or with the standard's specifications, whichever are larger.
Compliance with any standard cannot be claimed based solely on the periodic tests.

Measured Data: in Acoustical Calibrator Test Report # 45008 of two pages.

Place of Calibration: Scantek, Inc.
6430 Dobbin Road, Suite C
Columbia, MD 21045 USA

Ph/Fax: 410-290-7726/ -9167
callab@scantekinc.com

Calibration Certificate

Certificate Number 2020006682

Customer:
Epsilon Associates Inc
Suite 250
3 Mill and Main Place
Maynard, MA 01754, United States

Model Number	377C20	***Procedure Number***	D0001.8387			
Serial Number	317482	***Technician***	Scott Montgomery			
Test Results	**Pass**	***Calibration Date***	16 Jun 2020			
Initial Condition	As Manufactured	***Calibration Due***	16 Jun 2021			
		Temperature	23.6	°C	± 0.01 °C	
Description	1/2 inch Microphone - RI - 0V	***Humidity***	35.7	%RH	± 0.5 %RH	
		Static Pressure	101.51	kPa	± 0.03 kPa	

Evaluation Method Tested electrically using an electrostatic actuator.

Compliance Standards Compliant to Manufacturer Specifications.

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 ‡ 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.

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Standards Used

Description	Cal Date	Cal Due	Cal Standard
Larson Davis Model 2900 Real Time Analyzer	07/01/2019	07/01/2020	001230
Microphone Calibration System	08/27/2019	08/27/2020	001233
1/2" Preamplifier	12/17/2019	12/17/2020	001274
Agilent 34401A DMM	12/06/2019	12/06/2020	001329
Larson Davis CAL250 Acoustic Calibrator	12/23/2019	12/23/2020	003030
1/2" Preamplifier	04/13/2020	04/13/2021	006506
Larson Davis 1/2" Preamplifier 7-pin LEMO	07/08/2019	07/08/2020	006507
1/2 inch Microphone - RI - 200V	12/06/2019	12/06/2020	006511
1/2 inch Microphone - RI - 200V	08/06/2019	08/06/2020	006519
Larson Davis 1/2" Preamplifier 7-pin LEMO	07/08/2019	07/08/2020	006530
Larson Davis 1/2" Preamplifier 7-pin LEMO	08/14/2019	08/14/2020	006531

Sensitivity

Measurement	Test Result [mV/Pa]	Lower limit [mV/Pa]	Upper limit [mV/Pa]	Expanded Uncertainty [mV/Pa]	Result
Open Circuit Sensitivity	49.26	42.17	59.57	1.11	Pass

-- End of measurement results--

Capacitance

Measurement	Test Result [pF]	
Capacitance	14.00	‡

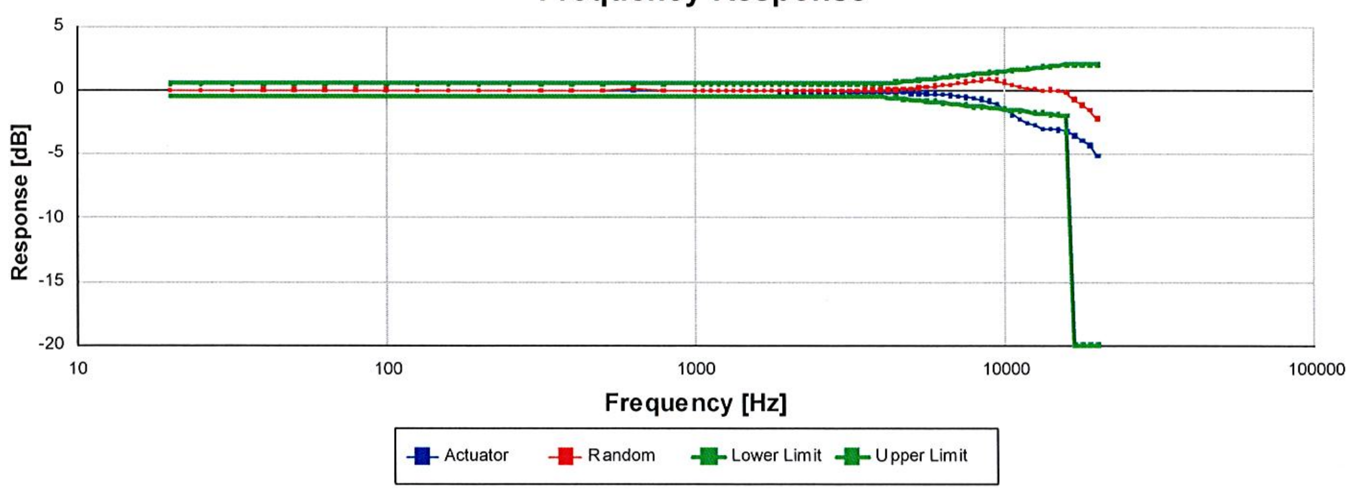
-- End of measurement results--

Lower Limiting Frequency

Measurement	Test Result [Hz]	Lower limit [Hz]	Upper limit [Hz]	Result
-3 dB Frequency	1.57	1.00	2.40	Pass ‡

-- End of measurement results--

Frequency Response



Data is normalized for 0 dB @ 251.19 Hz.

Frequency [Hz]	Actuator [dB]	Random [dB]	Lower limit [dB]	Upper limit [dB]	Result
19.95	-0.06	-0.06	-0.50	0.50	Pass ‡
25.12	-0.02	-0.02	-0.50	0.50	Pass ‡
31.62	0.00	0.00	-0.50	0.50	Pass ‡
39.81	0.02	0.02	-0.50	0.50	Pass ‡
50.12	0.01	0.01	-0.50	0.50	Pass ‡
63.10	0.01	0.01	-0.50	0.50	Pass ‡
79.43	0.01	0.01	-0.50	0.50	Pass ‡
100.00	0.01	0.01	-0.50	0.50	Pass ‡
125.89	0.00	0.00	-0.50	0.50	Pass ‡
158.49	0.00	0.00	-0.50	0.50	Pass ‡
199.53	0.00	0.00	-0.50	0.50	Pass ‡

Frequency [Hz]	Actuator [dB]	Random [dB]	Lower limit [dB]	Upper limit [dB]	Result
251.19	0.00	0.00	-0.50	0.50	Pass ‡
316.23	-0.01	-0.01	-0.50	0.50	Pass ‡
398.11	-0.02	-0.01	-0.50	0.50	Pass ‡
501.19	-0.02	-0.01	-0.50	0.50	Pass ‡
630.96	-0.03	0.15	-0.50	0.50	Pass ‡
794.33	-0.03	-0.01	-0.50	0.50	Pass ‡
1,000.00	-0.04	-0.01	-0.50	0.50	Pass ‡
1,059.25	-0.04	-0.01	-0.50	0.50	Pass ‡
1,122.02	-0.04	-0.01	-0.50	0.50	Pass ‡
1,188.50	-0.04	-0.01	-0.50	0.50	Pass ‡
1,258.93	-0.04	-0.01	-0.50	0.50	Pass ‡
1,333.52	-0.05	-0.01	-0.50	0.50	Pass ‡
1,412.54	-0.05	-0.01	-0.50	0.50	Pass ‡
1,496.24	-0.05	-0.01	-0.50	0.50	Pass ‡
1,584.89	-0.06	-0.02	-0.50	0.50	Pass ‡
1,678.80	-0.06	-0.02	-0.50	0.50	Pass ‡
1,778.28	-0.06	-0.02	-0.50	0.50	Pass ‡
1,883.65	-0.07	-0.02	-0.50	0.50	Pass ‡
1,995.26	-0.07	-0.02	-0.50	0.50	Pass ‡
2,113.49	-0.07	-0.02	-0.50	0.50	Pass ‡
2,238.72	-0.08	-0.02	-0.50	0.50	Pass ‡
2,371.37	-0.08	-0.02	-0.50	0.50	Pass ‡
2,511.89	-0.08	-0.01	-0.50	0.50	Pass ‡
2,660.73	-0.09	-0.02	-0.50	0.50	Pass ‡
2,818.38	-0.09	-0.01	-0.50	0.50	Pass ‡
2,985.38	-0.10	-0.01	-0.50	0.50	Pass ‡
3,162.28	-0.12	-0.01	-0.50	0.50	Pass ‡
3,349.65	-0.12	0.00	-0.50	0.50	Pass ‡
3,548.13	-0.13	0.01	-0.50	0.50	Pass ‡
3,758.37	-0.14	0.02	-0.50	0.50	Pass ‡
3,981.07	-0.15	0.04	-0.50	0.50	Pass ‡
4,216.97	-0.17	0.06	-0.63	0.56	Pass ‡
4,466.84	-0.20	0.08	-0.60	0.63	Pass ‡
4,731.51	-0.22	0.11	-0.70	0.69	Pass ‡
5,011.87	-0.24	0.15	-0.80	0.75	Pass ‡
5,308.84	-0.25	0.21	-0.80	0.81	Pass ‡
5,623.41	-0.28	0.26	-0.90	0.88	Pass ‡
5,956.62	-0.30	0.33	-0.90	0.94	Pass ‡
6,309.57	-0.35	0.39	-1.00	1.00	Pass ‡
6,683.44	-0.41	0.45	-1.10	1.06	Pass ‡
7,079.46	-0.46	0.54	-1.10	1.13	Pass ‡
7,498.94	-0.53	0.63	-1.20	1.19	Pass ‡
7,943.28	-0.62	0.71	-1.30	1.25	Pass ‡
8,413.95	-0.74	0.78	-1.30	1.31	Pass ‡
8,912.51	-0.88	0.84	-1.40	1.38	Pass ‡
9,440.61	-1.13	0.79	-1.40	1.43	Pass ‡
10,000.00	-1.50	0.64	-1.50	1.50	Pass ‡
10,592.54	-1.90	0.45	-1.60	1.56	Pass ‡
11,220.19	-2.31	0.25	-1.60	1.63	Pass ‡
11,885.02	-2.61	0.13	-1.70	1.68	Pass ‡
12,589.25	-2.76	0.14	-1.80	1.75	Pass ‡
13,335.21	-3.02	0.00	-1.80	1.81	Pass ‡
14,125.38	-3.03	0.04	-1.90	1.87	Pass ‡

Frequency [Hz]	Actuator [dB]	Random [dB]	Lower limit [dB]	Upper limit [dB]	Result
14,962.36	-3.10	-0.03	-1.93	1.93	Pass ‡
15,848.93	-3.23	-0.22	-2.00	2.00	Pass ‡
16,788.04	-3.53	-0.75		2.00	Pass ‡
17,782.80	-3.91	-1.13		2.00	Pass ‡
18,836.49	-4.30	-1.57		2.00	Pass ‡
19,952.62	-5.15	-2.25		2.00	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

ilac-MRA ACCREDITED Cert. #3622.01

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

Calibration Certificate

Certificate Number 2020005077
Customer:
Epsilon Associates Inc
Suite 250
3 Mill and Main Place
Maynard, MA 01754, United States

Model Number	PRM831	***Procedure Number***	D0001.8383
Serial Number	015260	***Technician***	Jason Grace
Test Results	**Pass**	***Calibration Date***	22 Apr 2020
Initial Condition	AS RECEIVED same as shipped	***Calibration Due***	22 Apr 2021
		Temperature	23.83 °C ± 0.01 °C
Description	Larson Davis 1/2" Preamplifier for Model 831 Type 1	***Humidity***	51 %RH ± 0.5 %RH
		Static Pressure	86.47 kPa ± 0.03 kPa

Evaluation Method Tested electrically using a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 μPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications

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
Larson Davis Model 2900 Real Time Analyzer	03/06/2020	03/06/2021	003003
Hart Scientific 2626-S Humidity/Temperature Sensor	07/18/2019	07/18/2020	006946
Agilent 34401A DMM	07/01/2019	07/01/2020	007165
SRS DS360 Ultra Low Distortion Generator	10/03/2019	10/03/2020	007167

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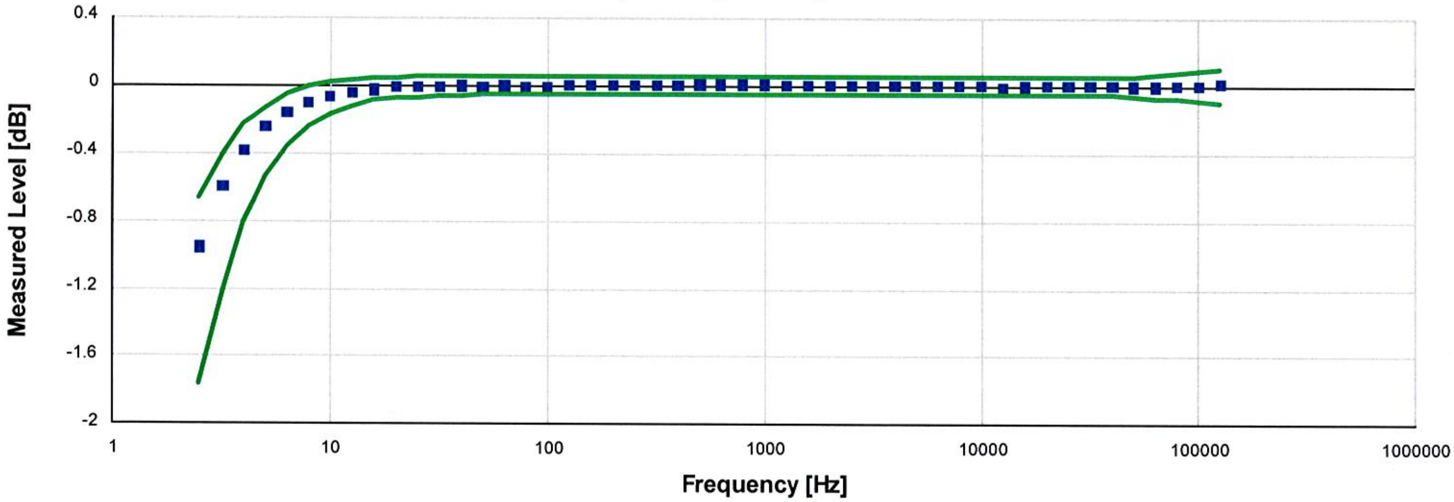
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ACCREDITED Cert. #3622.01

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

Frequency Response



Frequency response electrically tested at 120.0 dB re 1 µV

Frequency [Hz]	Test Result [dB re 1 kHz]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
2.50	-0.96	-1.76	-0.66	0.12	Pass
3.20	-0.59	-1.20	-0.40	0.12	Pass
4.00	-0.38	-0.81	-0.23	0.12	Pass
5.00	-0.25	-0.53	-0.13	0.12	Pass
6.30	-0.16	-0.36	-0.05	0.12	Pass
7.90	-0.11	-0.24	-0.01	0.12	Pass
10.00	-0.07	-0.17	0.03	0.12	Pass
12.60	-0.05	-0.13	0.04	0.12	Pass
15.80	-0.03	-0.09	0.04	0.12	Pass
20.00	-0.01	-0.08	0.05	0.12	Pass
25.10	-0.01	-0.07	0.05	0.12	Pass
31.60	-0.01	-0.07	0.05	0.12	Pass
39.80	0.00	-0.06	0.05	0.12	Pass
50.10	-0.01	-0.06	0.05	0.12	Pass
63.10	0.00	-0.05	0.05	0.12	Pass
79.40	-0.01	-0.05	0.05	0.12	Pass
100.00	-0.01	-0.05	0.05	0.12	Pass
125.90	0.01	-0.05	0.05	0.12	Pass
158.50	0.01	-0.05	0.05	0.12	Pass
199.50	0.00	-0.05	0.05	0.12	Pass
251.20	0.00	-0.05	0.05	0.12	Pass
316.20	0.00	-0.05	0.05	0.12	Pass
398.10	0.00	-0.05	0.05	0.12	Pass
501.20	0.01	-0.05	0.05	0.12	Pass
631.00	0.01	-0.05	0.05	0.12	Pass
794.30	0.01	-0.05	0.05	0.12	Pass
1,000.00	0.01	-0.05	0.05	0.12	Pass
1,258.90	0.00	-0.05	0.05	0.12	Pass
1,584.90	0.00	-0.05	0.05	0.12	Pass
1,995.30	0.00	-0.05	0.05	0.12	Pass
2,511.90	0.00	-0.05	0.05	0.12	Pass
3,162.30	0.00	-0.05	0.05	0.12	Pass

Frequency [Hz]	Test Result [dB re 1 kHz]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
3,981.10	0.00	-0.05	0.05	0.12	Pass
5,011.90	0.00	-0.05	0.05	0.12	Pass
6,309.60	0.00	-0.05	0.05	0.12	Pass
7,943.30	0.00	-0.05	0.05	0.12	Pass
10,000.00	0.00	-0.05	0.05	0.12	Pass
12,589.30	-0.01	-0.05	0.05	0.12	Pass
15,848.90	0.00	-0.05	0.05	0.12	Pass
19,952.60	0.00	-0.05	0.05	0.12	Pass
25,118.90	0.00	-0.05	0.05	0.12	Pass
31,622.80	0.00	-0.05	0.05	0.12	Pass
39,810.70	0.00	-0.05	0.05	0.12	Pass
50,118.70	0.00	-0.06	0.06	0.12	Pass
63,095.70	0.00	-0.07	0.07	0.12	Pass
79,432.80	0.00	-0.08	0.08	0.12	Pass
100,000.00	0.00	-0.09	0.09	0.12	Pass
125,892.50	0.02	-0.10	0.10	0.26	Pass

Gain Measurement

Measurement	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
Output Gain @ 1 kHz	-0.16	-0.45	-0.03	0.12	Pass

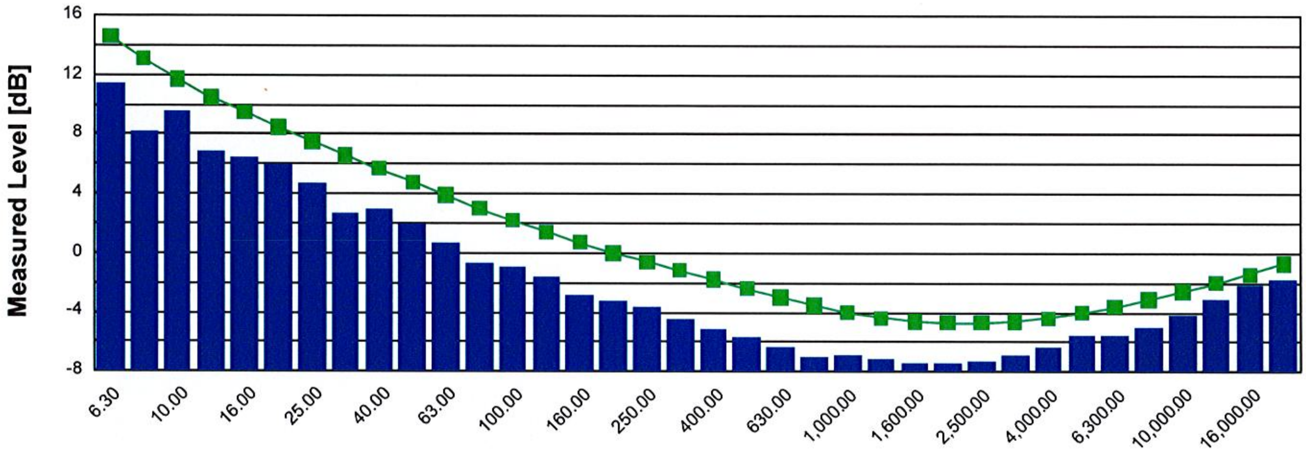
-- End of measurement results--

DC Bias Measurement

Measurement	Test Result [V]	Lower limit [V]	Upper limit [V]	Expanded Uncertainty [V]	Result
DC Voltage	18.02	15.50	19.50	0.04 ‡	Pass

-- End of measurement results--

1/3-Octave Self-Generated Noise



Frequency [Hz]	Test Result [dB re 1 µV]	Upper limit [dB re 1 µV]	Result
6.30	11.40	14.60	Pass
8.00	8.20	13.10	Pass
10.00	9.60	11.70	Pass
12.50	6.80	10.50	Pass
16.00	6.50	9.50	Pass
20.00	6.10	8.50	Pass
25.00	4.70	7.50	Pass
31.50	2.70	6.60	Pass
40.00	2.90	5.70	Pass
50.00	2.00	4.80	Pass
63.00	0.70	3.90	Pass
80.00	-0.70	3.00	Pass
100.00	-1.00	2.20	Pass
125.00	-1.70	1.40	Pass
160.00	-2.80	0.70	Pass
200.00	-3.30	0.00	Pass
250.00	-3.70	-0.60	Pass
315.00	-4.50	-1.20	Pass
400.00	-5.20	-1.80	Pass
500.00	-5.70	-2.40	Pass
630.00	-6.30	-3.00	Pass
800.00	-7.00	-3.50	Pass
1,000.00	-6.90	-4.00	Pass
1,250.00	-7.20	-4.40	Pass
1,600.00	-7.50	-4.60	Pass
2,000.00	-7.40	-4.70	Pass
2,500.00	-7.30	-4.70	Pass
3,150.00	-6.90	-4.60	Pass
4,000.00	-6.30	-4.40	Pass
5,000.00	-5.50	-4.00	Pass
6,300.00	-5.60	-3.60	Pass
8,000.00	-5.00	-3.10	Pass
10,000.00	-4.20	-2.60	Pass
12,500.00	-3.10	-2.00	Pass
16,000.00	-2.20	-1.40	Pass
20,000.00	-1.80	-0.70	Pass

-- End of measurement results--

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716-684-0001

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Self-generated Noise

Bandwidth	Test Result [µV]	Test Result [dB re 1 µV]	Upper limit [dB re 1 µV]	Result
A-weighted (1 Hz - 20 kHz)	1.97	5.90	8.00	Pass
Broadband (1 Hz - 20 kHz)	4.37	12.80	15.50	Pass

-- End of measurement results--

Signatory: *Jason Grace*

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Calibration Certificate

Certificate Number 2020005080

Customer:

Epsilon Associates Inc
Suite 250
3 Mill and Main Place
Maynard, MA 01754, United States

Model Number	831
Serial Number	0001993
Test Results	**Pass**
Initial Condition	Inoperable
Description	Larson Davis Model 831 Class 1 Sound Level Meter Firmware Revision: 2.402

Procedure Number	D0001.8378		
Technician	Jason Grace		
Calibration Date	22 Apr 2020		
Calibration Due	22 Apr 2021		
Temperature	23.9	°C	± 0.25 °C
Humidity	50.6	%RH	± 2.0 %RH
Static Pressure	86.48	kPa	± 0.13 kPa

Evaluation Method Tested electrically using Larson Davis PRM831 S/N 015260 and a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 μPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8384:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

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 International System of Units (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.

Correction data from Larson Davis Model 831 Sound Level Meter Manual, I831.01 Rev S, 2019-09-10

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 μPa; Reference Range: 0 dB gain

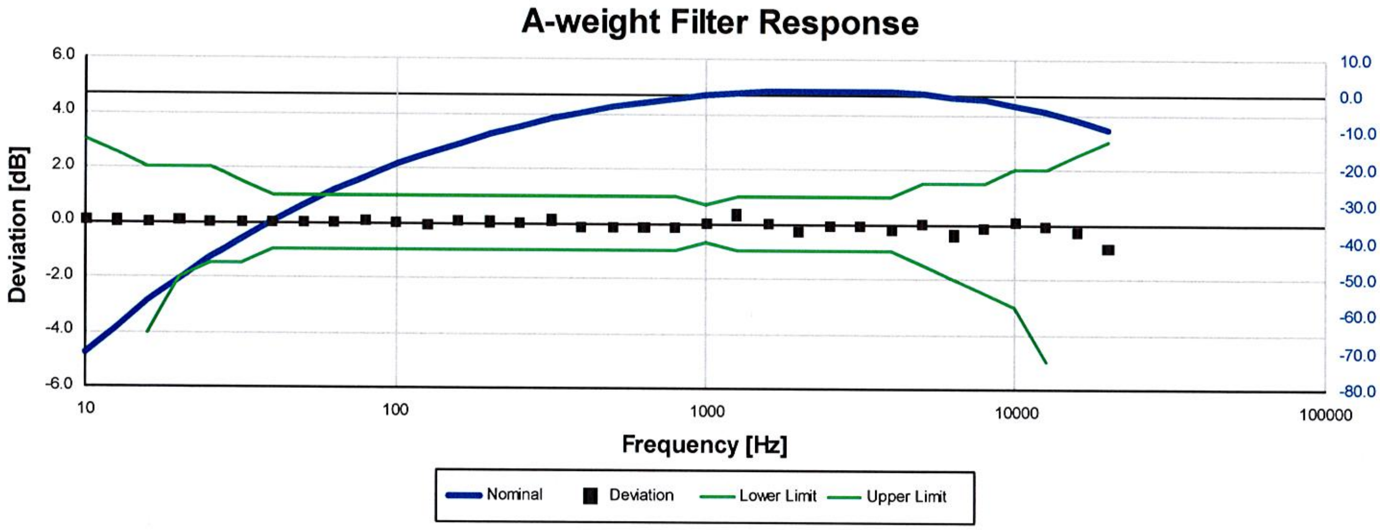
Periodic tests were performed in accordance with precedures from IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part3.

Pattern approval for IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 successfully completed by Physikalisch-Technische Bundesanstalt (PTB) on 2016-02-24 certificate number DE-15-M-PTB-0056.

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3, for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organization responsible for approving the results of pattern-evaluation tests performed in accordance with IEC 61672-2:2013 / ANSI/ASA S1.4-2014/Part 2, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1; the sound level meter submitted for testing conforms to the class 1specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Hart Scientific 2626-S Humidity/Temperature Sensor	2019-07-18	2020-07-18	006946
SRS DS360 Ultra Low Distortion Generator	2020-04-14	2021-04-14	007635



Electrical signal test of frequency weighting performed according to IEC 61672-3:2013 13 and ANSI S1.4-2014 Part 3: 13 for compliance to IEC 61672-1:2013 5.5; IEC 60651:2001 6.1 and 9.2.2; IEC 60804:2000 5; ANSI S1.4:1983 (R2006) 5.1 and 8.2.1; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Deviation [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
10.00	-70.29	0.11	-inf	3.00	0.25	Pass
12.59	-63.35	0.05	-inf	2.50	0.25	Pass
15.85	-56.67	0.03	-4.00	2.00	0.25	Pass
19.95	-50.39	0.11	-2.00	2.00	0.25	Pass
25.12	-44.67	0.03	-1.50	2.00	0.25	Pass
31.62	-39.38	0.02	-1.50	1.50	0.25	Pass
39.81	-34.60	0.00	-1.00	1.00	0.25	Pass
50.12	-30.22	-0.02	-1.00	1.00	0.25	Pass
63.10	-26.17	0.03	-1.00	1.00	0.25	Pass
79.43	-22.45	0.05	-1.00	1.00	0.25	Pass
100.00	-19.12	-0.02	-1.00	1.00	0.25	Pass
125.89	-16.15	-0.05	-1.00	1.00	0.25	Pass
158.49	-13.32	0.08	-1.00	1.00	0.25	Pass
199.53	-10.86	0.04	-1.00	1.00	0.25	Pass
251.19	-8.61	-0.01	-1.00	1.00	0.25	Pass
316.23	-6.48	0.12	-1.00	1.00	0.25	Pass
398.11	-4.91	-0.11	-1.00	1.00	0.25	Pass
501.19	-3.34	-0.14	-1.00	1.00	0.25	Pass
630.96	-2.06	-0.16	-1.00	1.00	0.25	Pass
794.33	-0.95	-0.15	-1.00	1.00	0.25	Pass
1,000.00	0.00	0.00	-0.70	0.70	0.25	Pass
1,258.93	0.93	0.33	-1.00	1.00	0.25	Pass
1,584.89	1.00	0.00	-1.00	1.00	0.25	Pass
1,995.26	0.94	-0.26	-1.00	1.00	0.25	Pass
2,511.89	1.20	-0.10	-1.00	1.00	0.25	Pass
3,162.28	1.16	-0.04	-1.00	1.00	0.25	Pass
3,981.07	0.78	-0.22	-1.00	1.00	0.25	Pass
5,011.87	0.51	0.01	-1.50	1.50	0.25	Pass
6,309.57	-0.49	-0.39	-2.00	1.50	0.25	Pass
7,943.28	-1.21	-0.11	-2.50	1.50	0.25	Pass
10,000.00	-2.42	0.08	-3.00	2.00	0.25	Pass
12,589.25	-4.37	-0.07	-5.00	2.00	0.25	Pass
15,848.93	-6.87	-0.27	-16.00	2.50	0.25	Pass
19,952.62	-10.16	-0.86	-inf	3.00	0.25	Pass

-- End of measurement results--

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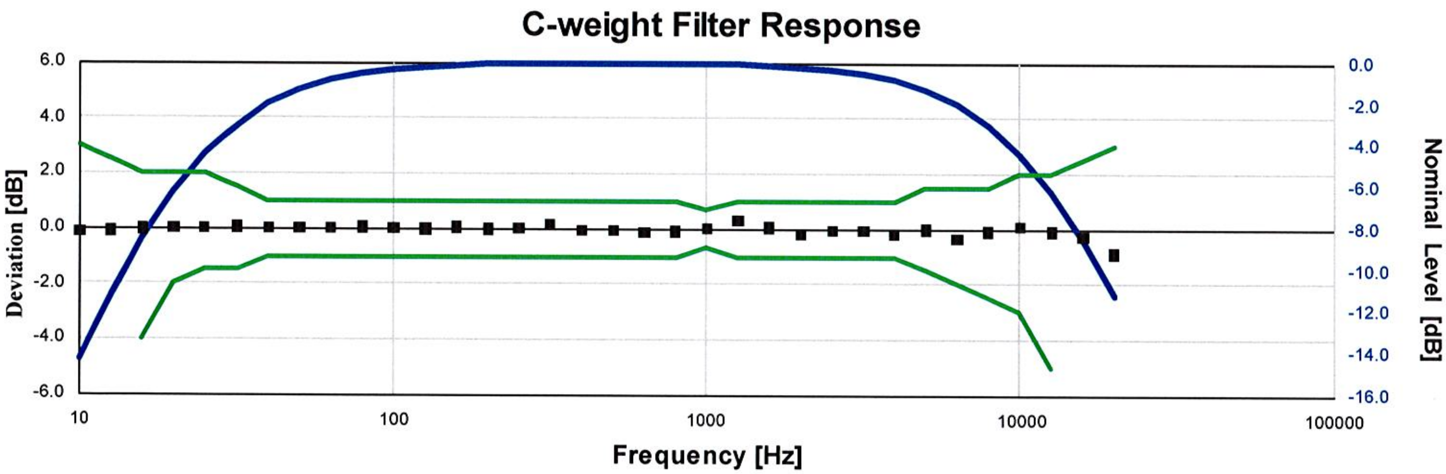
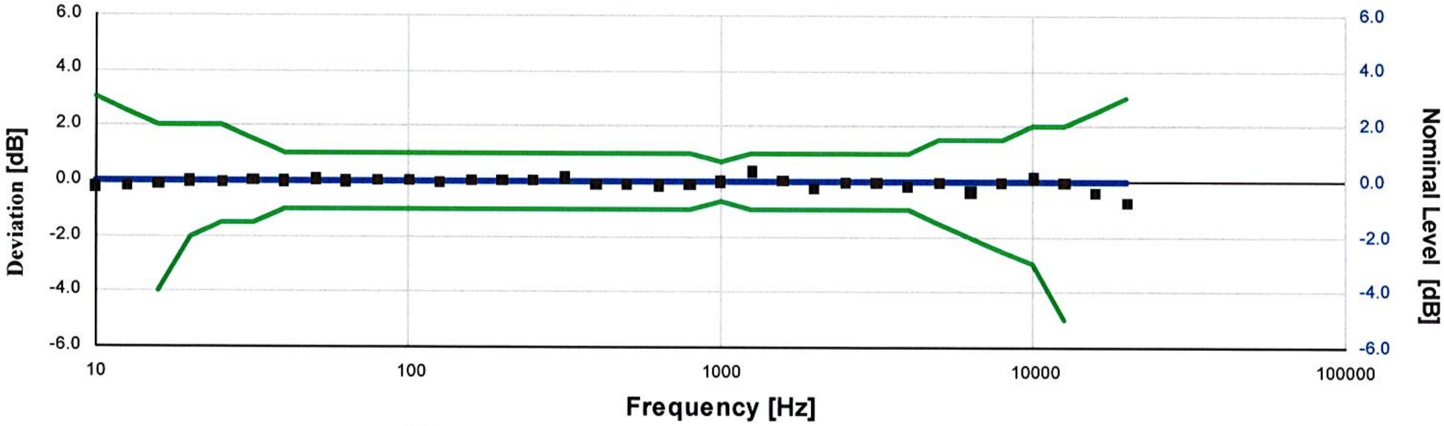


Electrical signal test of frequency weighting performed according to IEC 61672-3:2013 13 and ANSI S1.4-2014 Part 3: 13 for compliance to IEC 61672-1:2013 5.5; IEC 60651:2001 6.1 and 9.2.2; IEC 60804:2000 5; ANSI S1.4:1983 (R2006) 5.1 and 8.2.1; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Deviation [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
10.00	-14.43	-0.13	-inf	3.00	0.25	Pass
12.59	-11.29	-0.09	-inf	2.50	0.25	Pass
15.85	-8.53	-0.03	-4.00	2.00	0.25	Pass
19.95	-6.18	0.02	-2.00	2.00	0.25	Pass
25.12	-4.37	0.03	-1.50	2.00	0.25	Pass
31.62	-2.95	0.05	-1.50	1.50	0.25	Pass
39.81	-1.97	0.03	-1.00	1.00	0.25	Pass
50.12	-1.30	0.00	-1.00	1.00	0.25	Pass
63.10	-0.79	0.01	-1.00	1.00	0.25	Pass
79.43	-0.45	0.05	-1.00	1.00	0.25	Pass
100.00	-0.26	0.04	-1.00	1.00	0.25	Pass
125.89	-0.22	-0.02	-1.00	1.00	0.25	Pass
158.49	-0.05	0.05	-1.00	1.00	0.25	Pass
199.53	-0.02	-0.02	-1.00	1.00	0.25	Pass
251.19	0.03	0.03	-1.00	1.00	0.25	Pass
316.23	0.15	0.15	-1.00	1.00	0.25	Pass
398.11	-0.07	-0.07	-1.00	1.00	0.25	Pass
501.19	-0.08	-0.08	-1.00	1.00	0.25	Pass
630.96	-0.13	-0.13	-1.00	1.00	0.25	Pass
794.33	-0.10	-0.10	-1.00	1.00	0.25	Pass
1,000.00	0.00	0.00	-0.70	0.70	0.25	Pass
1,258.93	0.32	0.32	-1.00	1.00	0.25	Pass
1,584.89	-0.06	0.04	-1.00	1.00	0.25	Pass
1,995.26	-0.42	-0.22	-1.00	1.00	0.25	Pass
2,511.89	-0.36	-0.06	-1.00	1.00	0.25	Pass
3,162.28	-0.53	-0.03	-1.00	1.00	0.25	Pass
3,981.07	-1.01	-0.21	-1.00	1.00	0.25	Pass
5,011.87	-1.33	-0.03	-1.50	1.50	0.25	Pass
6,309.57	-2.36	-0.36	-2.00	1.50	0.25	Pass
7,943.28	-3.10	-0.10	-2.50	1.50	0.25	Pass
10,000.00	-4.33	0.07	-3.00	2.00	0.25	Pass
12,589.25	-6.29	-0.09	-5.00	2.00	0.25	Pass
15,848.93	-8.79	-0.29	-16.00	2.50	0.25	Pass
19,952.62	-12.08	-0.88	-inf	3.00	0.25	Pass

-- End of measurement results--

Z-weight Filter Response



Electrical signal test of frequency weighting performed according to IEC 61672-3:2013 13 and ANSI S1.4-2014 Part 3: 13 for compliance to IEC 61672-1:2013 5.5; IEC 60651:2001 6.1 and 9.2.2; IEC 60804:2000 5; ANSI S1.4:1983 (R2006) 5.1 and 8.2.1; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Deviation [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
10.00	-0.22	-0.22	-inf	3.00	0.25	Pass
12.59	-0.18	-0.18	-inf	2.50	0.25	Pass
15.85	-0.10	-0.10	-4.00	2.00	0.25	Pass
19.95	-0.01	-0.01	-2.00	2.00	0.25	Pass
25.12	-0.02	-0.02	-1.50	2.00	0.25	Pass
31.62	0.01	0.01	-1.50	1.50	0.25	Pass
39.81	0.00	0.00	-1.00	1.00	0.25	Pass
50.12	0.07	0.07	-1.00	1.00	0.25	Pass
63.10	0.00	0.00	-1.00	1.00	0.25	Pass
79.43	0.05	0.05	-1.00	1.00	0.25	Pass
100.00	0.04	0.04	-1.00	1.00	0.25	Pass
125.89	-0.05	-0.05	-1.00	1.00	0.25	Pass
158.49	0.03	0.03	-1.00	1.00	0.25	Pass
199.53	0.02	0.02	-1.00	1.00	0.25	Pass
251.19	0.02	0.02	-1.00	1.00	0.25	Pass
316.23	0.14	0.14	-1.00	1.00	0.25	Pass
398.11	-0.10	-0.10	-1.00	1.00	0.25	Pass
501.19	-0.11	-0.11	-1.00	1.00	0.25	Pass
630.96	-0.15	-0.15	-1.00	1.00	0.25	Pass
794.33	-0.12	-0.12	-1.00	1.00	0.25	Pass
1,000.00	0.00	0.00	-0.70	0.70	0.25	Pass
1,258.93	0.35	0.35	-1.00	1.00	0.25	Pass
1,584.89	0.03	0.03	-1.00	1.00	0.25	Pass
1,995.26	-0.25	-0.25	-1.00	1.00	0.25	Pass
2,511.89	-0.07	-0.07	-1.00	1.00	0.25	Pass
3,162.28	-0.04	-0.04	-1.00	1.00	0.25	Pass
3,981.07	-0.20	-0.20	-1.00	1.00	0.25	Pass
5,011.87	-0.05	-0.05	-1.50	1.50	0.25	Pass
6,309.57	-0.36	-0.36	-2.00	1.50	0.25	Pass
7,943.28	-0.06	-0.06	-2.50	1.50	0.25	Pass
10,000.00	0.14	0.14	-3.00	2.00	0.25	Pass
12,589.25	-0.04	-0.04	-5.00	2.00	0.25	Pass
15,848.93	-0.39	-0.39	-16.00	2.50	0.25	Pass
19,952.62	-0.74	-0.74	-inf	3.00	0.25	Pass

-- End of measurement results--

High Level Stability

Electrical signal test of high level stability performed according to IEC 61672-3:2013 21 and ANSI S1.4-2014 Part 3: 21 for compliance to IEC 61672-1:2013 5.15 and ANSI S1.4-2014 Part 1: 5.15

Measurement	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
High Level Stability	0.00	-0.10	0.10	0.00 ‡	Pass

-- End of measurement results--

Long-Term Stability

Electrical signal test of long term stability performed according to IEC 61672-3:2013 15 and ANSI S1.4-2014 Part 3: 15 for compliance to ISC 61672-1:2013 5.14 and ANSI S1.4-2014 Part 1: 5.14

Test Duration [min]	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
33	0.00	-0.10	0.10	0.01 ‡	Pass

-- End of measurement results--

1 kHz Reference Levels

Frequency weightings and time weightings at 1 kHz (reference is A weighted Fast) performed according to IEC 61672-3:2013 14 and ANSI S1.4-2014 Part 3: 14 for compliance to IEC 61672-1:2013 5.5.9 and 5.8.3 and ANSI S1.4-2014 Part 1: 5.5.9 and 5.8.3

Measurement	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
C weight	114.00	113.80	114.20	0.15	Pass
Z weight	113.99	113.80	114.20	0.15	Pass
Slow	114.00	113.90	114.10	0.15	Pass
Impulse	114.00	113.90	114.10	0.15	Pass

-- End of measurement results--

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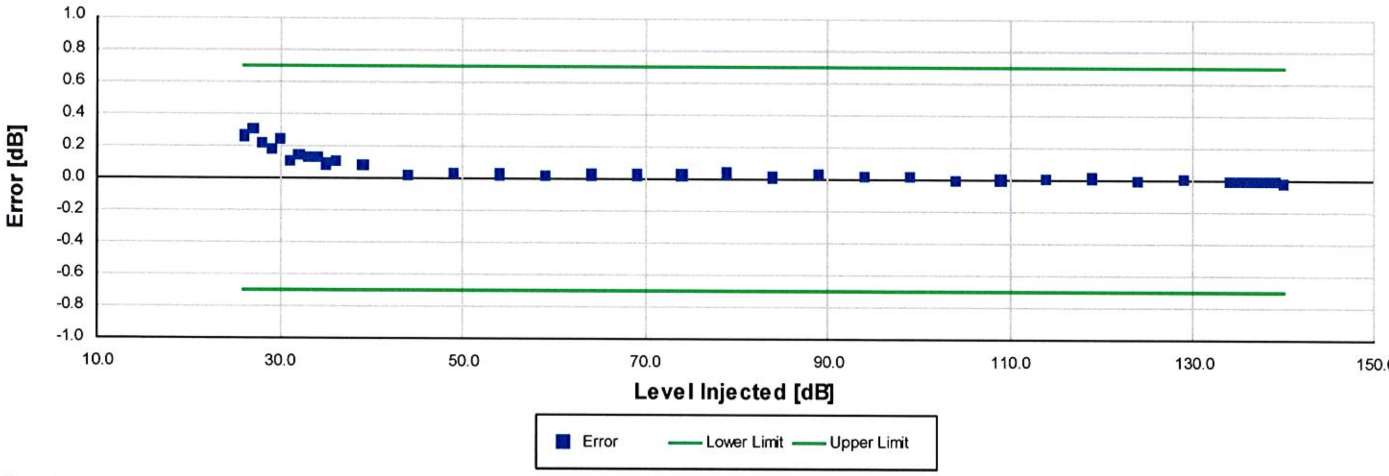
A-weighted 0 dB Gain Broadband Log Linearity: 8,000.00 Hz



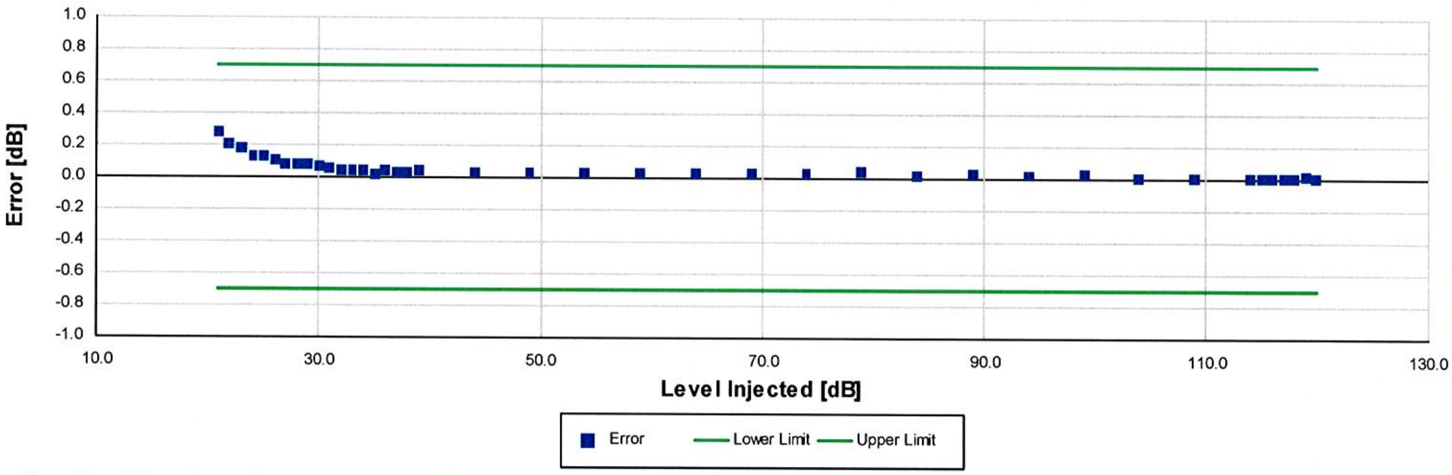
Broadband level linearity performed according to IEC 61672-3:2013 16 and ANSI S1.4-2014 Part 3: 16 for compliance to IEC 61672-1:2013 5.6, IEC 60804:2000 6.2, IEC 61252:2002 8, ANSI S1.4 (R2006) 6.9, ANSI S1.4-2014 Part 1: 5.6, ANSI S1.43 (R2007) 6.2

Level [dB]	Error [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
26.00	0.26	-0.70	0.70	0.16	Pass
27.00	0.30	-0.70	0.70	0.16	Pass
28.00	0.22	-0.70	0.70	0.16	Pass
29.00	0.18	-0.70	0.70	0.16	Pass
30.00	0.24	-0.70	0.70	0.16	Pass
31.00	0.10	-0.70	0.70	0.16	Pass
32.00	0.14	-0.70	0.70	0.16	Pass
33.00	0.13	-0.70	0.70	0.16	Pass
34.00	0.13	-0.70	0.70	0.16	Pass
35.00	0.09	-0.70	0.70	0.16	Pass
36.00	0.11	-0.70	0.70	0.16	Pass
39.00	0.08	-0.70	0.70	0.16	Pass
44.00	0.02	-0.70	0.70	0.16	Pass
49.00	0.03	-0.70	0.70	0.16	Pass
54.00	0.02	-0.70	0.70	0.16	Pass
59.00	0.02	-0.70	0.70	0.16	Pass
64.00	0.02	-0.70	0.70	0.16	Pass
69.00	0.02	-0.70	0.70	0.16	Pass
74.00	0.02	-0.70	0.70	0.16	Pass
79.00	0.04	-0.70	0.70	0.16	Pass
84.00	0.01	-0.70	0.70	0.16	Pass
89.00	0.03	-0.70	0.70	0.16	Pass
94.00	0.02	-0.70	0.70	0.16	Pass
99.00	0.02	-0.70	0.70	0.16	Pass
104.00	-0.01	-0.70	0.70	0.15	Pass
109.00	0.00	-0.70	0.70	0.15	Pass
114.00	0.00	-0.70	0.70	0.15	Pass
119.00	0.01	-0.70	0.70	0.15	Pass
124.00	-0.01	-0.70	0.70	0.15	Pass
129.00	0.00	-0.70	0.70	0.15	Pass
134.00	-0.01	-0.70	0.70	0.15	Pass
135.00	-0.01	-0.70	0.70	0.15	Pass
136.00	0.00	-0.70	0.70	0.15	Pass
137.00	0.00	-0.70	0.70	0.15	Pass
138.00	0.00	-0.70	0.70	0.15	Pass
139.00	-0.01	-0.70	0.70	0.15	Pass

Level [dB]	Error [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
140.00	-0.02	-0.70	0.70	0.15	Pass

-- End of measurement results--

A-weighted 20 dB Gain Broadband Log Linearity: 8,000.00 Hz



Broadband level linearity performed according to IEC 61672-3:2013 16 and ANSI S1.4-2014 Part 3: 16 for compliance to IEC 61672-1:2013 5.6, IEC 60804:2000 6.2, IEC 61252:2002 8, ANSI S1.4 (R2006) 6.9, ANSI S1.4-2014 Part 1: 5.6, ANSI S1.43 (R2007) 6.2

Level [dB]	Error [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
21.00	0.27	-0.70	0.70	0.16	Pass
22.00	0.21	-0.70	0.70	0.16	Pass
23.00	0.17	-0.70	0.70	0.16	Pass
24.00	0.13	-0.70	0.70	0.16	Pass
25.00	0.13	-0.70	0.70	0.16	Pass
26.00	0.10	-0.70	0.70	0.16	Pass
27.00	0.08	-0.70	0.70	0.16	Pass
28.00	0.07	-0.70	0.70	0.16	Pass
29.00	0.08	-0.70	0.70	0.16	Pass
30.00	0.06	-0.70	0.70	0.16	Pass
31.00	0.06	-0.70	0.70	0.16	Pass
32.00	0.04	-0.70	0.70	0.16	Pass
33.00	0.04	-0.70	0.70	0.16	Pass
34.00	0.04	-0.70	0.70	0.16	Pass
35.00	0.01	-0.70	0.70	0.16	Pass
36.00	0.04	-0.70	0.70	0.16	Pass
37.00	0.03	-0.70	0.70	0.16	Pass
38.00	0.03	-0.70	0.70	0.16	Pass
39.00	0.04	-0.70	0.70	0.16	Pass
44.00	0.03	-0.70	0.70	0.16	Pass
49.00	0.03	-0.70	0.70	0.16	Pass
54.00	0.03	-0.70	0.70	0.16	Pass
59.00	0.03	-0.70	0.70	0.16	Pass
64.00	0.03	-0.70	0.70	0.16	Pass
69.00	0.03	-0.70	0.70	0.16	Pass
74.00	0.03	-0.70	0.70	0.16	Pass
79.00	0.04	-0.70	0.70	0.16	Pass
84.00	0.01	-0.70	0.70	0.16	Pass
89.00	0.03	-0.70	0.70	0.16	Pass
94.00	0.02	-0.70	0.70	0.16	Pass
99.00	0.03	-0.70	0.70	0.16	Pass
104.00	0.00	-0.70	0.70	0.15	Pass
109.00	0.00	-0.70	0.70	0.15	Pass
114.00	0.00	-0.70	0.70	0.15	Pass
115.00	0.00	-0.70	0.70	0.15	Pass
116.00	0.00	-0.70	0.70	0.15	Pass

Level [dB]	Error [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
117.00	0.00	-0.70	0.70	0.15	Pass
118.00	0.00	-0.70	0.70	0.15	Pass
119.00	0.01	-0.70	0.70	0.15	Pass
120.00	0.00	-0.70	0.70	0.15	Pass

-- End of measurement results--

Slow Detector

Toneburst response performed according to IEC 61672-3:2013 18 and ANSI S1.4-2014 Part 3: 18 for compliance to IEC 61672-1:2013 5.9, IEC 60651:2001 9.4.2, ANSI S1.4:1983 (R2006) 8.4.2 and ANSI S1.4-2014 Part 1: 5.9

Amplitude [dB]	Duration [ms]	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
137.00	200	-7.53	-7.92	-6.92	0.15	Pass
	2	-27.16	-29.99	-25.99	0.15	Pass

-- End of measurement results--

Fast Detector

Toneburst response performed according to IEC 61672-3:2013 18 and ANSI S1.4-2014 Part 3: 18 for compliance to IEC 61672-1:2013 5.9, IEC 60651:2001 9.4.2, ANSI S1.4:1983 (R2006) 8.4.2 and ANSI S1.4-2014 Part 1: 5.9

Amplitude [dB]	Duration [ms]	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
137.00	200.00	-1.05	-1.48	-0.48	0.15	Pass
	2.00	-18.36	-19.49	-16.99	0.15	Pass
	0.25	-27.31	-29.99	-25.99	0.15	Pass

-- End of measurement results--

Sound Exposure Level

Toneburst response performed according to IEC 61672-3:2013 18 and ANSI S1.4-2014 Part 3: 18 for compliance to IEC 61672-1:2013 5.9, IEC 60651:2001 9.4.2, ANSI S1.4:1983 (R2006) 8.4.2 and ANSI S1.4-2014 Part 1: 5.9

Amplitude [dB]	Duration [ms]	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
137.00	200.00	-7.01	-7.49	-6.49	0.15	Pass
	2.00	-27.03	-28.49	-25.99	0.15	Pass
	0.25	-36.14	-39.02	-35.02	0.15	Pass

-- End of measurement results--

Peak C-weight

C-weighted peak sound level performed according to IEC 61672-3:2013 19 and ANSI S1.4-2014 Part 3: 19 for compliance to IEC 61672-1:2013 5.13 and ANSI S1.4-2014 Part 1: 5.13

Level [dB]	Frequency [Hz]	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
135.00	31.50	138.19	135.50	139.50	0.15	Pass
135.00	500.00	138.56	137.50	139.50	0.15	Pass
135.00	8,000.00	137.75	136.40	140.40	0.15	Pass
135.00, Negative	500.00	137.16	136.40	138.40	0.15	Pass
135.00, Positive	500.00	137.16	136.40	138.40	0.15	Pass

-- End of measurement results--

Peak Z-weight

Z-weighted peak sound level performed according to IEC 60651:2001 9.4.4 and ANSI S1.4:1983 (R2006) 8.4.4

Amplitude [dB]	Duration[µs]		Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
136.00	100	Negative Pulse	136.33	134.01	138.01	0.15	Pass
	100	Positive Pulse	136.34	134.01	138.01	0.15	Pass
126.00	100	Negative Pulse	126.31	123.99	127.99	0.15	Pass
	100	Positive Pulse	126.32	123.99	127.99	0.15	Pass
116.00	100	Negative Pulse	116.33	114.00	118.00	0.15	Pass
	100	Positive Pulse	116.33	114.00	118.00	0.15	Pass
106.00	100	Negative Pulse	106.29	103.95	107.95	0.15	Pass
	100	Positive Pulse	106.30	103.98	107.98	0.15	Pass

-- End of measurement results--

Overload Detector

Overload indication performed according to IEC 61672-3:2013 20 and ANSI S1.4-2014 Part 3: 20 for compliance to IEC 61672-1:2013 5.11, IEC 60804:2000 9.3.5, IEC 61252:2002 11, ANSI S1.4 (R2006) 5.8, and ANSI S1.4-2014 Part 1: 5.11, ANSI S1.25 (R2007) 7.6, ANSI S1.43 (R2007) 7

Measurement	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
Positive	141.00	140.00	142.00	0.15	Pass
Negative	140.90	140.00	142.00	0.15	Pass
Difference	0.10	-1.50	1.50	0.16	Pass

-- End of measurement results--

Peak Rise Time

Peak rise time performed according to IEC 60651:2001 9.4.4 and ANSI S1.4:1983 (R2006) 8.4.4

Amplitude [dB]	Duration [µs]		Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
139.00	40	Negative Pulse	135.95	134.51	136.51	0.15	Pass
		Positive Pulse	135.94	134.51	136.51	0.15	Pass
	30	Negative Pulse	134.98	134.51	136.51	0.15	Pass
		Positive Pulse	134.97	134.51	136.51	0.15	Pass

-- End of measurement results--

Positive Pulse Crest Factor

200 µs pulse tests at 2.0, 12.0, 22.0, 32.0 dB below Overload Limit

Crest Factor measured according to IEC 60651:2001 9.4.2 and ANSI S1.4:1983 (R2006) 8.4.2

Amplitude [dB]	Crest Factor	Test Result [dB]	Limits [dB]	Expanded Uncertainty [dB]	Result
138.00	3	OVLD	± 0.50	0.15 ‡	Pass
	5	OVLD	± 1.00	0.15 ‡	Pass
	10	OVLD	± 1.50	0.15 ‡	Pass
128.00	3	-0.13	± 0.50	0.15 ‡	Pass
	5	-0.12	± 1.00	0.15 ‡	Pass
	10	OVLD	± 1.50	0.15 ‡	Pass
118.00	3	-0.12	± 0.50	0.15 ‡	Pass
	5	-0.12	± 1.00	0.15 ‡	Pass
	10	-0.26	± 1.50	0.15 ‡	Pass
108.00	3	-0.13	± 0.50	0.18 ‡	Pass
	5	-0.11	± 1.00	0.15 ‡	Pass
	10	-0.24	± 1.50	0.15 ‡	Pass

-- End of measurement results--

Negative Pulse Crest Factor

200 µs pulse tests at 2.0, 12.0, 22.0, 32.0 dB below Overload Limit

Crest Factor measured according to IEC 60651:2001 9.4.2 and ANSI S1.4:1983 (R2006) 8.4.2

Amplitude [dB]	Crest Factor	Test Result [dB]	Limits [dB]	Expanded Uncertainty [dB]	Result
138.00	3	OVLD	± 0.50	0.15 ‡	Pass
	5	OVLD	± 1.00	0.15 ‡	Pass
	10	OVLD	± 1.50	0.15 ‡	Pass
128.00	3	-0.12	± 0.50	0.15 ‡	Pass
	5	-0.12	± 1.00	0.15 ‡	Pass
	10	OVLD	± 1.50	0.15 ‡	Pass
118.00	3	-0.13	± 0.50	0.15 ‡	Pass
	5	-0.11	± 1.00	0.15 ‡	Pass
	10	-0.25	± 1.50	0.15 ‡	Pass
108.00	3	-0.13	± 0.50	0.15 ‡	Pass
	5	-0.11	± 1.00	0.15 ‡	Pass
	10	-0.24	± 1.50	0.15 ‡	Pass

-- End of measurement results--

Tone Burst

2kHz tone burst tests at 2.0, 12.0, 22.0, 32.0 dB below Overload Limit

Tone burst response measured according to IEC 60651:2001 9.4.2 and ANSI S1.4:1983 (R2006) 8.4.2

Amplitude [dB]	Crest Factor	Test Result [dB]	Limits [dB]	Expanded Uncertainty [dB]	Result
138.00	3	OVLD	± 0.50	0.15	Pass
	5	OVLD	± 1.00	0.15	Pass
128.00	3	-0.07	± 0.50	0.17	Pass
	5	0.00	± 1.00	0.15	Pass
118.00	3	-0.08	± 0.50	0.15	Pass
	5	-0.05	± 1.00	0.15	Pass
108.00	3	-0.06	± 0.50	0.15	Pass
	5	-0.01	± 1.00	0.15	Pass

-- End of measurement results--

Impulse Detector - Repeat

Impulse Detector measured according to IEC 60651:2001 9.4.3 and ANSI S1.4:1983 (R2006) 8.4.3

Amplitude [dB]	Repitition Rate [Hz]	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
140	100.00	-2.75	-3.71	-1.71	0.15	Pass
	20.00	-7.68	-9.57	-5.57	0.15	Pass
	2.00	-8.86	-10.76	-6.76	0.15	Pass
Step	2.00	4.96	4.00	6.00	0.16	Pass

-- End of measurement results--

Impulse Detector - Single

Impulse Detector measured according to IEC 60651:2001 9.4.3 and ANSI S1.4:1983 (R2006) 8.4.3

Amplitude [dB]	Duration [ms]	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
140	20.00	-3.72	-5.11	-2.11	0.15	Pass
	5.00	-8.84	-10.76	-6.76	0.16	Pass
	2.00	-12.68	-14.55	-10.55	0.16	Pass
Step	2.00	10.02	9.00	11.00	0.16	Pass

-- End of measurement results--

Gain

Gain measured according to IEC 61672-3:2013 17.3 and 17.4 and ANSI S1.4-2014 Part 3: 17.3 and 17.4

Measurement	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
0 dB Gain	94.03	93.91	94.11	0.15	Pass
0 dB Gain, Linearity	29.18	28.31	29.71	0.16	Pass
20 dB Gain	94.03	93.91	94.11	0.15	Pass
20 dB Gain, Linearity	24.12	23.31	24.71	0.16	Pass
OBA Low Range	94.01	93.91	94.11	0.15	Pass
OBA Normal Range	94.01	93.20	94.80	0.15	Pass

-- End of measurement results--

Broadband Noise Floor

Self-generated noise measured according to IEC 61672-3:2013 11.2 and ANSI S1.4-2014 Part 3: 11.2

Measurement	Test Result [dB]	Upper limit [dB]	Result
A-weight Noise Floor	6.90	15.00	Pass
C-weight Noise Floor	11.76	17.30	Pass
Z-weight Noise Floor	20.35	24.50	Pass

-- End of measurement results--

Total Harmonic Distortion

Measured using 1/3-Octave filters

Measurement	Test Result [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
10 Hz Signal	137.55	137.20	138.80	0.15	Pass
THD	-69.80		-60.00	0.00 ‡	Pass
THD+N	-64.51		-60.00	0.00 ‡	Pass

-- End of measurement results--

-- End of Report--

Signatory: *Jason Grace*

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

ACCREDITED Cert. #3622.01

Calibration Certificate

Certificate Number 2020005088

Customer:

Epsilon Associates Inc
Suite 250
3 Mill and Main Place
Maynard, MA 01754, United States

Model Number	831
Serial Number	0001993
Test Results	**Pass**
Initial Condition	Inoperable
Description	Larson Davis Model 831 Class 1 Sound Level Meter Firmware Revision: 2.402

Procedure Number	D0001.8384		
Technician	Jason Grace		
Calibration Date	22 Apr 2020		
Calibration Due	22 Apr 2021		
Temperature	23.9	°C	± 0.25 °C
Humidity	50.9	%RH	± 2.0 %RH
Static Pressure	86.41	kPa	± 0.13 kPa

Evaluation Method ***Tested with:***

Larson Davis PRM831. S/N 015260
PCB 377B20. S/N 110889
Larson Davis CAL200. S/N 9079
Larson Davis CAL291. S/N 0108

Data reported in dB re 20 μPa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

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 International System of Units (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.

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Correction data from Larson Davis Model 831 Sound Level Meter Manual, I831.01 Rev O, 2016-09-19

For 1/4" microphones, the Larson Davis ADP024 1/4" to 1/2" adaptor is used with the calibrators and the Larson Davis ADP043 1/4" to

1/2" adaptor is used with the preamplifier.

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 μPa; Reference Range: 0 dB gain

Periodic tests were performed in accordance with precedures from IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part3.

Pattern approval for IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 successfully completed by Physikalisch-Technische Bundesanstalt (PTB) on 2016-02-24 certificate number DE-15-M-PTB-0056.

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3, for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organization responsible for approving the results of pattern-evaluation tests performed in accordance with IEC 61672-2:2013 / ANSI/ASA S1.4-2014/Part 2, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1; the sound level meter submitted for testing conforms to the class 1specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Larson Davis CAL291 Residual Intensity Calibrator	2019-09-18	2020-09-18	001250
SRS DS360 Ultra Low Distortion Generator	2019-06-14	2020-06-14	006311
Hart Scientific 2626-S Humidity/Temperature Sensor	2019-07-18	2020-07-18	006946
Larson Davis CAL200 Acoustic Calibrator	2019-07-22	2020-07-22	007027
Larson Davis Model 831	2020-03-02	2021-03-02	007182
PCB 377A13 1/2 inch Prepolarized Pressure Microphone	2020-03-05	2021-03-05	007185

Acoustic Calibration

Measured according to IEC 61672-3:2013 10 and ANSI S1.4-2014 Part 3: 10

Measurement	Test Result [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
1000 Hz	114.00	113.80	114.20	0.14	Pass

As Received Level: 112.53
Adjusted Level: 114.00

-- End of measurement results--

Acoustic Signal Tests, C-weighting

Measured according to IEC 61672-3:2013 12 and ANSI S1.4-2014 Part 3: 12 using a comparison coupler with Unit Under Test (UUT) and reference SLM using slow time-weighted sound level for compliance to IEC 61672-1:2013 5.5; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Expected [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
125	-0.17	-0.20	-1.20	0.80	0.23	Pass
1000	0.04	0.00	-0.70	0.70	0.23	Pass
8000	-1.69	-3.00	-5.50	-1.50	0.32	Pass

-- End of measurement results--

Self-generated Noise

Measured according to IEC 61672-3:2013 11.1 and ANSI S1.4-2014 Part 3: 11.1

Measurement	Test Result [dB]
A-weighted, 20 dB gain	43.67

-- End of measurement results--

-- End of Report--

Signatory: Jason Grace

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

ilac-MRA ACCREDITED Cert. #3622.01

LARSON DAVIS A PCB PIEZOTRONICS DIV.

Calibration Certificate

Certificate Number 2020000001
Customer:
Epsilon Associates Inc
Suite 250
3 Mill and Main Place
Maynard, MA 01754, United States

Model Number	PRM831	***Procedure Number***	D0001.8383		
Serial Number	016477	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	2 Jan 2020		
Initial Condition	AS RECEIVED same as shipped	***Calibration Due***	2 Jan 2021		
		Temperature	22.95	°C	± 0.01 °C
Description	Larson Davis 1/2" Preamplifier for Model 831 Type 1	***Humidity***	51.8	%RH	± 0.5 %RH
		Static Pressure	85.9	kPa	± 0.03 kPa

Evaluation Method Tested electrically using a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 µPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications

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.

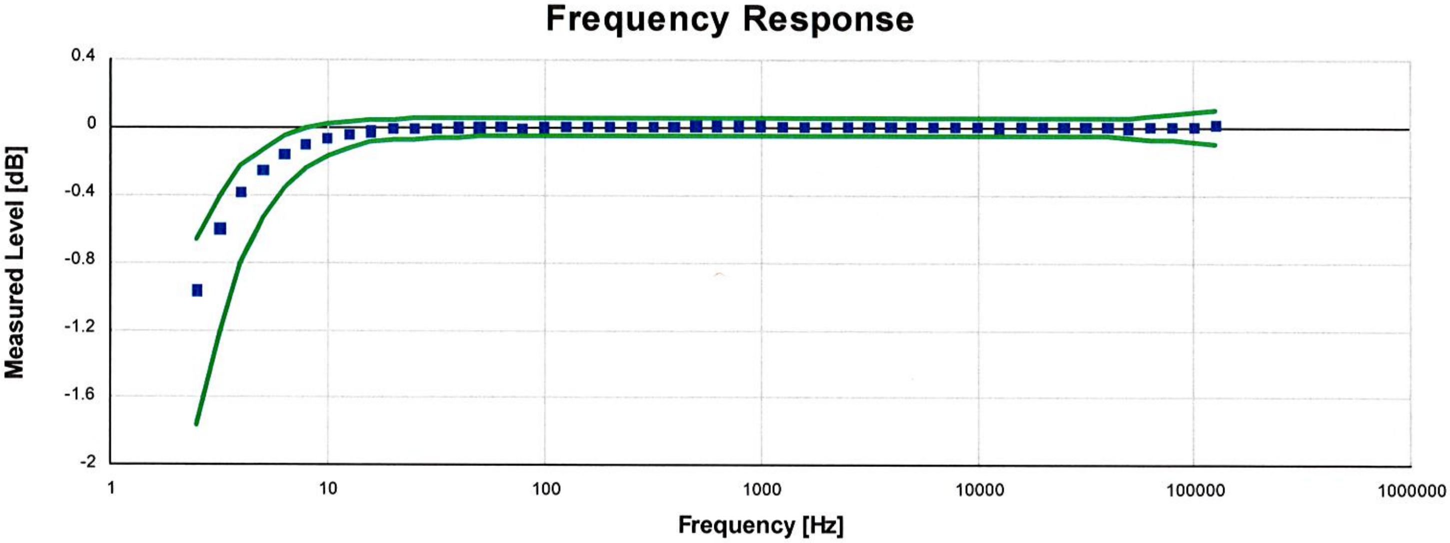
The quality system is registered to ISO 9001:2015.

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
Larson Davis Model 2900 Real Time Analyzer	03/07/2019	03/07/2020	003003
Hart Scientific 2626-S Humidity/Temperature Sensor	07/18/2019	07/18/2020	006946
Agilent 34401A DMM	07/01/2019	07/01/2020	007165
SRS DS360 Ultra Low Distortion Generator	10/03/2019	10/03/2020	007167



Frequency response electrically tested at 120.0 dB re 1 μV

Frequency [Hz]	Test Result [dB re 1 kHz]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
2.50	-0.97	-1.76	-0.66	0.12	Pass
3.20	-0.60	-1.20	-0.40	0.12	Pass
4.00	-0.39	-0.81	-0.23	0.12	Pass
5.00	-0.25	-0.53	-0.13	0.12	Pass
6.30	-0.16	-0.36	-0.05	0.12	Pass
7.90	-0.11	-0.24	-0.01	0.12	Pass
10.00	-0.07	-0.17	0.03	0.12	Pass
12.60	-0.05	-0.13	0.04	0.12	Pass
15.80	-0.03	-0.09	0.04	0.12	Pass
20.00	-0.01	-0.08	0.05	0.12	Pass
25.10	-0.01	-0.07	0.05	0.12	Pass
31.60	-0.01	-0.07	0.05	0.12	Pass
39.80	0.00	-0.06	0.05	0.12	Pass
50.10	0.00	-0.06	0.05	0.12	Pass
63.10	0.00	-0.05	0.05	0.12	Pass
79.40	-0.01	-0.05	0.05	0.12	Pass
100.00	0.00	-0.05	0.05	0.12	Pass
125.90	0.01	-0.05	0.05	0.12	Pass
158.50	0.01	-0.05	0.05	0.12	Pass
199.50	0.01	-0.05	0.05	0.12	Pass
251.20	0.00	-0.05	0.05	0.12	Pass
316.20	0.00	-0.05	0.05	0.12	Pass
398.10	0.00	-0.05	0.05	0.12	Pass
501.20	0.01	-0.05	0.05	0.12	Pass
631.00	0.01	-0.05	0.05	0.12	Pass
794.30	0.01	-0.05	0.05	0.12	Pass
1,000.00	0.01	-0.05	0.05	0.12	Pass
1,258.90	0.00	-0.05	0.05	0.12	Pass
1,584.90	0.00	-0.05	0.05	0.12	Pass
1,995.30	0.00	-0.05	0.05	0.12	Pass
2,511.90	0.00	-0.05	0.05	0.12	Pass
3,162.30	0.00	-0.05	0.05	0.12	Pass

Frequency [Hz]	Test Result [dB re 1 kHz]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
3,981.10	0.00	-0.05	0.05	0.12	Pass
5,011.90	0.00	-0.05	0.05	0.12	Pass
6,309.60	0.00	-0.05	0.05	0.12	Pass
7,943.30	0.00	-0.05	0.05	0.12	Pass
10,000.00	0.00	-0.05	0.05	0.12	Pass
12,589.30	0.00	-0.05	0.05	0.12	Pass
15,848.90	0.00	-0.05	0.05	0.12	Pass
19,952.60	0.00	-0.05	0.05	0.12	Pass
25,118.90	0.00	-0.05	0.05	0.12	Pass
31,622.80	0.00	-0.05	0.05	0.12	Pass
39,810.70	0.00	-0.05	0.05	0.12	Pass
50,118.70	0.00	-0.06	0.06	0.12	Pass
63,095.70	0.00	-0.07	0.07	0.12	Pass
79,432.80	0.00	-0.08	0.08	0.12	Pass
100,000.00	0.00	-0.09	0.09	0.12	Pass
125,892.50	0.02	-0.10	0.10	0.26	Pass

Gain Measurement

Measurement	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
Output Gain @ 1 kHz	-0.13	-0.45	-0.03	0.12	Pass

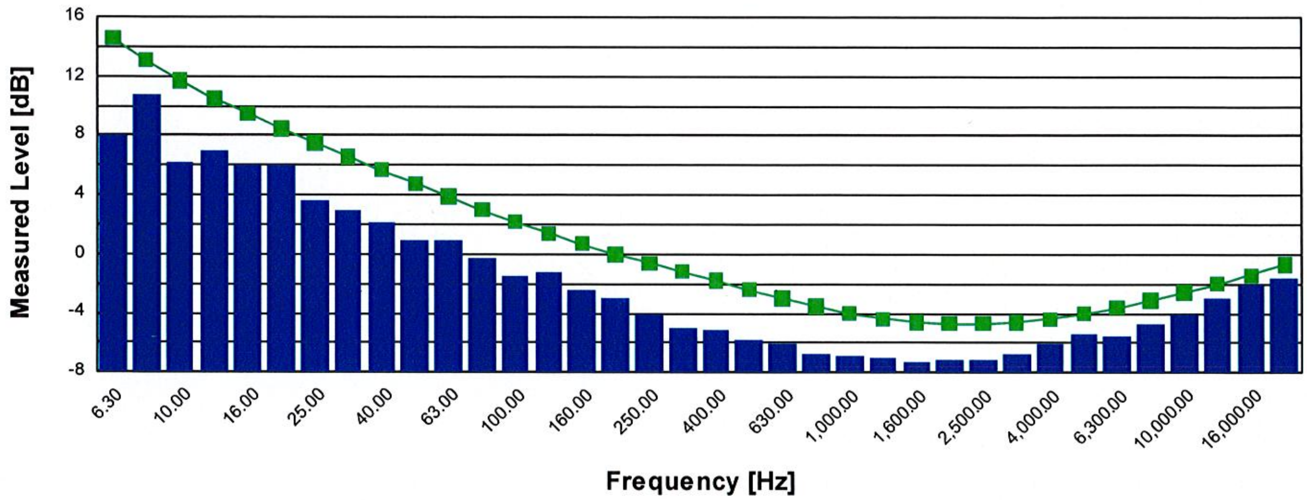
-- End of measurement results--

DC Bias Measurement

Measurement	Test Result [V]	Lower limit [V]	Upper limit [V]	Expanded Uncertainty [V]	Result
DC Voltage	17.96	15.50	19.50	0.04 ‡	Pass

-- End of measurement results--

1/3-Octave Self-Generated Noise



Frequency [Hz]	Test Result [dB re 1 µV]	Upper limit [dB re 1 µV]	Result
6.30	8.10	14.60	Pass
8.00	10.80	13.10	Pass
10.00	6.20	11.70	Pass
12.50	7.00	10.50	Pass
16.00	6.00	9.50	Pass
20.00	6.00	8.50	Pass
25.00	3.60	7.50	Pass
31.50	2.90	6.60	Pass
40.00	2.20	5.70	Pass
50.00	0.90	4.80	Pass
63.00	0.90	3.90	Pass
80.00	-0.30	3.00	Pass
100.00	-1.50	2.20	Pass
125.00	-1.20	1.40	Pass
160.00	-2.50	0.70	Pass
200.00	-3.00	0.00	Pass
250.00	-4.00	-0.60	Pass
315.00	-5.00	-1.20	Pass
400.00	-5.20	-1.80	Pass
500.00	-5.80	-2.40	Pass
630.00	-6.10	-3.00	Pass
800.00	-6.70	-3.50	Pass
1,000.00	-6.90	-4.00	Pass
1,250.00	-7.00	-4.40	Pass
1,600.00	-7.30	-4.60	Pass
2,000.00	-7.20	-4.70	Pass
2,500.00	-7.10	-4.70	Pass
3,150.00	-6.70	-4.60	Pass
4,000.00	-6.10	-4.40	Pass
5,000.00	-5.40	-4.00	Pass
6,300.00	-5.50	-3.60	Pass
8,000.00	-4.80	-3.10	Pass
10,000.00	-4.10	-2.60	Pass
12,500.00	-3.00	-2.00	Pass
16,000.00	-2.10	-1.40	Pass
20,000.00	-1.70	-0.70	Pass

-- End of measurement results--

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1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ACCREDITED Cert. #3622.01

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Self-generated Noise

Bandwidth	Test Result [µV]	Test Result [dB re 1 µV]	Upper limit [dB re 1 µV]	Result
A-weighted (1 Hz - 20 kHz)	2.00	6.00	8.00	Pass
Broadband (1 Hz - 20 kHz)	4.27	12.60	15.50	Pass

-- End of measurement results--

Signatory: *Ron Harris*

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716-684-0001

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LARSON DAVIS
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Calibration Certificate

Certificate Number 2020000028

Customer:

Epsilon Associates Inc
Suite 250
3 Mill and Main Place
Maynard, MA 01754, United States

Model Number	831	***Procedure Number***	D0001.8384		
Serial Number	0002154	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	2 Jan 2020		
Initial Condition	AS RECEIVED same as shipped	***Calibration Due***	2 Jan 2021		
		Temperature	23.65	°C	± 0.25 °C
Description	Larson Davis Model 831 Class 1 Sound Level Meter Firmware Revision: 2.402	***Humidity***	51.8	%RH	± 2.0 %RH
		Static Pressure	86.18	kPa	± 0.13 kPa

Evaluation Method ***Tested with:***

Larson Davis PRM831. S/N 016477
PCB 377B20. S/N 112245
Larson Davis CAL200. S/N 9079
Larson Davis CAL291. S/N 0108

Data reported in dB re 20 μPa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

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 International System of Units (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.

Correction data from Larson Davis Model 831 Sound Level Meter Manual, I831.01 Rev O, 2016-09-19

For 1/4" microphones, the Larson Davis ADP024 1/4" to 1/2" adaptor is used with the calibrators and the Larson Davis ADP043 1/4" to

1/2" adaptor is used with the preamplifier.

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 μPa; Reference Range: 0 dB gain

Periodic tests were performed in accordance with precedures from IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part3.

Pattern approval for IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 successfully completed by Physikalisch-Technische Bundesanstalt (PTB) on 2016-02-24 certificate number DE-15-M-PTB-0056.

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3, for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organization responsible for approving the results of pattern-evaluation tests performed in accordance with IEC 61672-2:2013 / ANSI/ASA S1.4-2014/Part 2, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1; the sound level meter submitted for testing conforms to the class 1specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Larson Davis CAL291 Residual Intensity Calibrator	2019-09-18	2020-09-18	001250
SRS DS360 Ultra Low Distortion Generator	2019-06-14	2020-06-14	006311
Hart Scientific 2626-S Humidity/Temperature Sensor	2019-07-18	2020-07-18	006946
Larson Davis CAL200 Acoustic Calibrator	2019-07-22	2020-07-22	007027
Larson Davis Model 831	2019-02-22	2020-02-22	007182
PCB 377A13 1/2 inch Prepolarized Pressure Microphone	2019-03-06	2020-03-06	007185

Acoustic Calibration

Measured according to IEC 61672-3:2013 10 and ANSI S1.4-2014 Part 3: 10

Measurement	Test Result [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
1000 Hz	114.01	113.80	114.20	0.14	Pass

As Received Level: 114.19
Adjusted Level: 114.00

-- End of measurement results--

Acoustic Signal Tests, C-weighting

Measured according to IEC 61672-3:2013 12 and ANSI S1.4-2014 Part 3: 12 using a comparison coupler with Unit Under Test (UUT) and reference SLM using slow time-weighted sound level for compliance to IEC 61672-1:2013 5.5; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Expected [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
125	-0.08	-0.20	-1.20	0.80	0.23	Pass
1000	0.07	0.00	-0.70	0.70	0.23	Pass
8000	-3.67	-3.00	-5.50	-1.50	0.32	Pass

-- End of measurement results--

Self-generated Noise

Measured according to IEC 61672-3:2013 11.1 and ANSI S1.4-2014 Part 3: 11.1

Measurement	Test Result [dB]
A-weighted, 20 dB gain	40.75

-- End of measurement results--

-- End of Report--

Signatory: Ron Harris

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

Calibration Certificate

Certificate Number 2020000002

Customer:

Epsilon Associates Inc
Suite 250
3 Mill and Main Place
Maynard, MA 01754, United States

Model Number	831	***Procedure Number***	D0001.8378		
Serial Number	0002154	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	2 Jan 2020		
Initial Condition	AS RECEIVED same as shipped	***Calibration Due***	2 Jan 2021		
		Temperature	23.26	°C	± 0.25 °C
Description	Larson Davis Model 831 Class 1 Sound Level Meter Firmware Revision: 2.402	***Humidity***	51.6	%RH	± 2.0 %RH
		Static Pressure	85.93	kPa	± 0.13 kPa

Evaluation Method Tested electrically using Larson Davis PRM831 S/N 016477 and a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 μPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8384:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

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 International System of Units (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.

Correction data from Larson Davis Model 831 Sound Level Meter Manual, I831.01 Rev S, 2019-09-10

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 μPa; Reference Range: 0 dB gain

Periodic tests were performed in accordance with precedures from IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part3.

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

ilac-MRA ACCREDITED Cert. #3622.01

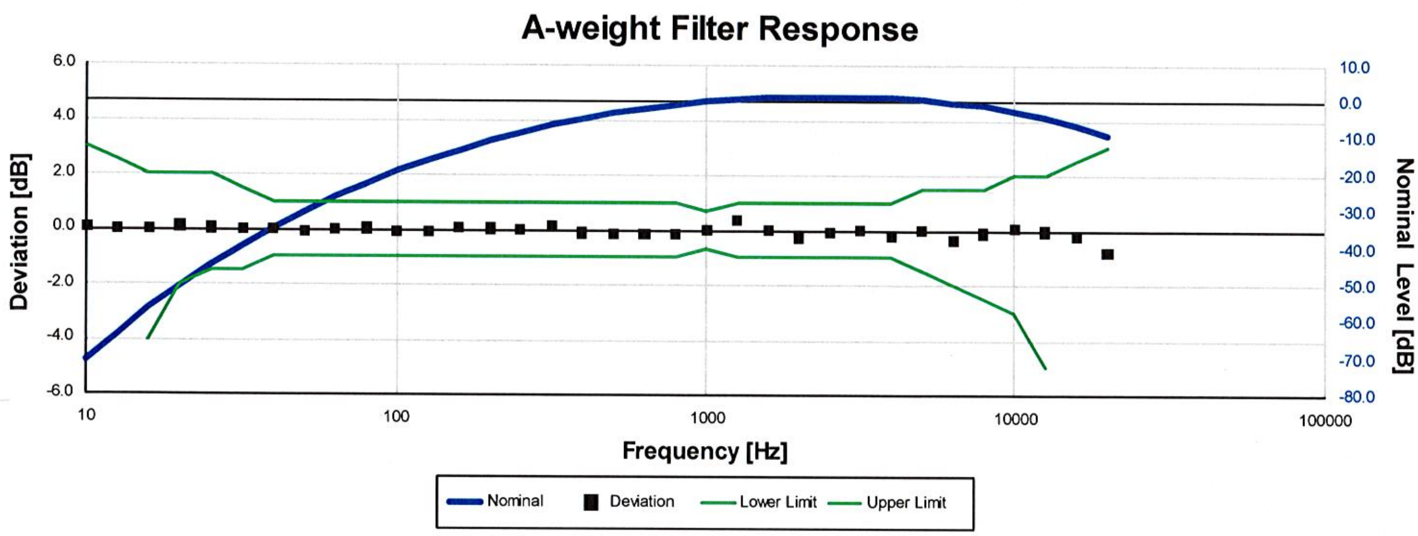
LARSON DAVIS A PCB PIEZOTRONICS DIV.

Pattern approval for IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 successfully completed by Physikalisch-Technische Bundesanstalt (PTB) on 2016-02-24 certificate number DE-15-M-PTB-0056.

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3, for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organization responsible for approving the results of pattern-evaluation tests performed in accordance with IEC 61672-2:2013 / ANSI/ASA S1.4-2014/Part 2, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1; the sound level meter submitted for testing conforms to the class 1specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1.

Standards Used

Description	**Cal Date**	**Cal Due**	**Cal Standard**
Hart Scientific 2626-S Humidity/Temperature Sensor	2019-07-18	2020-07-18	006946
SRS DS360 Ultra Low Distortion Generator	2019-01-24	2020-01-24	007118

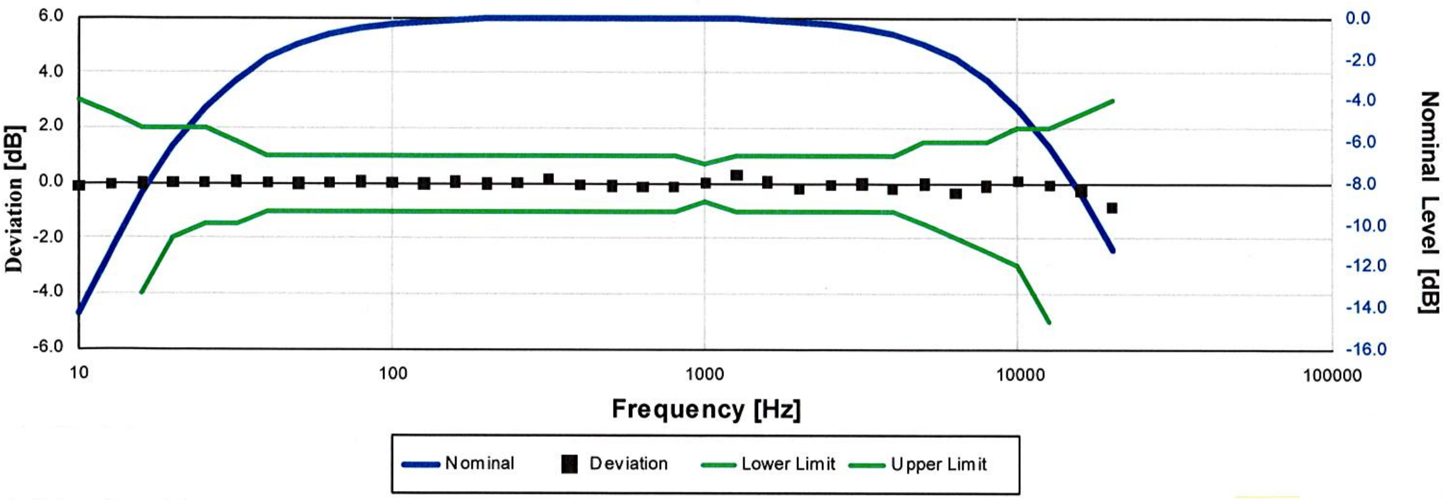


Electrical signal test of frequency weighting performed according to IEC 61672-3:2013 13 and ANSI S1.4-2014 Part 3: 13 for compliance to IEC 61672-1:2013 5.5; IEC 60651:2001 6.1 and 9.2.2; IEC 60804:2000 5; ANSI S1.4:1983 (R2006) 5.1 and 8.2.1; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Deviation [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
10.00	-70.31	0.09	-inf	3.00	0.25	Pass
12.59	-63.38	0.02	-inf	2.50	0.25	Pass
15.85	-56.67	0.03	-4.00	2.00	0.25	Pass
19.95	-50.39	0.11	-2.00	2.00	0.25	Pass
25.12	-44.66	0.04	-1.50	2.00	0.25	Pass
31.62	-39.39	0.01	-1.50	1.50	0.25	Pass
39.81	-34.60	0.00	-1.00	1.00	0.25	Pass
50.12	-30.25	-0.05	-1.00	1.00	0.25	Pass
63.10	-26.18	0.02	-1.00	1.00	0.25	Pass
79.43	-22.46	0.04	-1.00	1.00	0.25	Pass
100.00	-19.15	-0.05	-1.00	1.00	0.25	Pass
125.89	-16.15	-0.05	-1.00	1.00	0.25	Pass
158.49	-13.32	0.08	-1.00	1.00	0.25	Pass
199.53	-10.86	0.04	-1.00	1.00	0.25	Pass
251.19	-8.60	0.00	-1.00	1.00	0.25	Pass
316.23	-6.48	0.12	-1.00	1.00	0.25	Pass
398.11	-4.90	-0.10	-1.00	1.00	0.25	Pass
501.19	-3.35	-0.15	-1.00	1.00	0.25	Pass
630.96	-2.06	-0.16	-1.00	1.00	0.25	Pass
794.33	-0.95	-0.15	-1.00	1.00	0.25	Pass
1,000.00	0.00	0.00	-0.70	0.70	0.25	Pass
1,258.93	0.94	0.34	-1.00	1.00	0.25	Pass
1,584.89	1.01	0.01	-1.00	1.00	0.25	Pass
1,995.26	0.95	-0.25	-1.00	1.00	0.25	Pass
2,511.89	1.22	-0.08	-1.00	1.00	0.25	Pass
3,162.28	1.17	-0.03	-1.00	1.00	0.25	Pass
3,981.07	0.79	-0.21	-1.00	1.00	0.25	Pass
5,011.87	0.51	0.01	-1.50	1.50	0.25	Pass
6,309.57	-0.48	-0.38	-2.00	1.50	0.25	Pass
7,943.28	-1.20	-0.10	-2.50	1.50	0.25	Pass
10,000.00	-2.41	0.09	-3.00	2.00	0.25	Pass
12,589.25	-4.33	-0.03	-5.00	2.00	0.25	Pass
15,848.93	-6.82	-0.22	-16.00	2.50	0.25	Pass
19,952.62	-10.10	-0.80	-inf	3.00	0.25	Pass

-- End of measurement results--

C-weight Filter Response

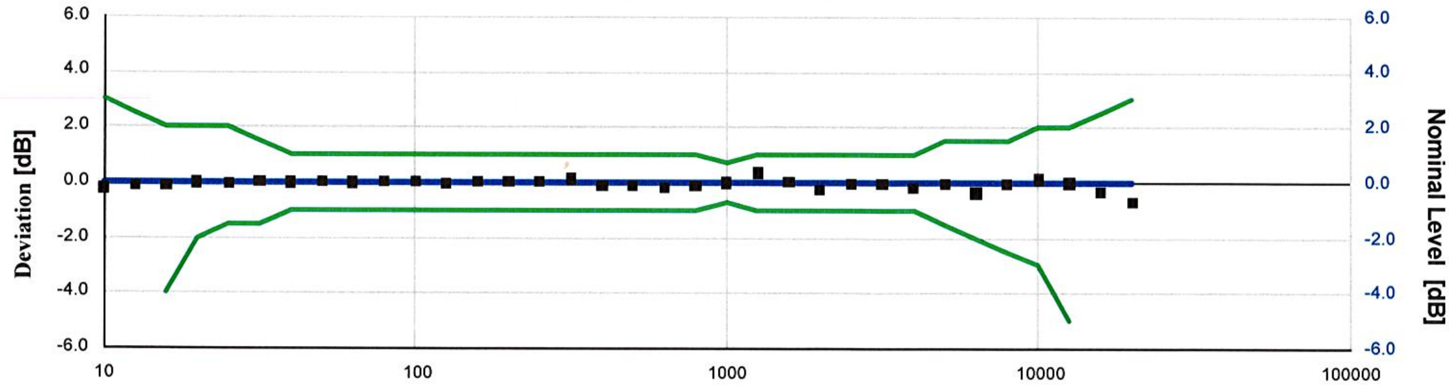


Electrical signal test of frequency weighting performed according to IEC 61672-3:2013 13 and ANSI S1.4-2014 Part 3: 13 for compliance to IEC 61672-1:2013 5.5; IEC 60651:2001 6.1 and 9.2.2; IEC 60804:2000 5; ANSI S1.4:1983 (R2006) 5.1 and 8.2.1; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Deviation [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
10.00	-14.43	-0.13	-inf	3.00	0.25	Pass
12.59	-11.27	-0.07	-inf	2.50	0.25	Pass
15.85	-8.52	-0.02	-4.00	2.00	0.25	Pass
19.95	-6.18	0.02	-2.00	2.00	0.25	Pass
25.12	-4.36	0.04	-1.50	2.00	0.25	Pass
31.62	-2.96	0.04	-1.50	1.50	0.25	Pass
39.81	-1.97	0.03	-1.00	1.00	0.25	Pass
50.12	-1.31	-0.01	-1.00	1.00	0.25	Pass
63.10	-0.80	0.00	-1.00	1.00	0.25	Pass
79.43	-0.46	0.04	-1.00	1.00	0.25	Pass
100.00	-0.31	-0.01	-1.00	1.00	0.25	Pass
125.89	-0.22	-0.02	-1.00	1.00	0.25	Pass
158.49	-0.05	0.05	-1.00	1.00	0.25	Pass
199.53	-0.01	-0.01	-1.00	1.00	0.25	Pass
251.19	0.03	0.03	-1.00	1.00	0.25	Pass
316.23	0.15	0.15	-1.00	1.00	0.25	Pass
398.11	-0.07	-0.07	-1.00	1.00	0.25	Pass
501.19	-0.09	-0.09	-1.00	1.00	0.25	Pass
630.96	-0.13	-0.13	-1.00	1.00	0.25	Pass
794.33	-0.11	-0.11	-1.00	1.00	0.25	Pass
1,000.00	0.00	0.00	-0.70	0.70	0.25	Pass
1,258.93	0.32	0.32	-1.00	1.00	0.25	Pass
1,584.89	-0.05	0.05	-1.00	1.00	0.25	Pass
1,995.26	-0.41	-0.21	-1.00	1.00	0.25	Pass
2,511.89	-0.35	-0.05	-1.00	1.00	0.25	Pass
3,162.28	-0.53	-0.03	-1.00	1.00	0.25	Pass
3,981.07	-1.00	-0.20	-1.00	1.00	0.25	Pass
5,011.87	-1.33	-0.03	-1.50	1.50	0.25	Pass
6,309.57	-2.36	-0.36	-2.00	1.50	0.25	Pass
7,943.28	-3.10	-0.10	-2.50	1.50	0.25	Pass
10,000.00	-4.32	0.08	-3.00	2.00	0.25	Pass
12,589.25	-6.25	-0.05	-5.00	2.00	0.25	Pass
15,848.93	-8.74	-0.25	-16.00	2.50	0.25	Pass
19,952.62	-12.03	-0.83	-inf	3.00	0.25	Pass

-- End of measurement results--

Z-weight Filter Response



Electrical signal test of frequency weighting performed according to IEC 61672-3:2013 13 and ANSI S1.4-2014 Part 3: 13 for compliance to IEC 61672-1:2013 5.5; IEC 60651:2001 6.1 and 9.2.2; IEC 60804:2000 5; ANSI S1.4:1983 (R2006) 5.1 and 8.2.1; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Deviation [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
10.00	-0.22	-0.22	-inf	3.00	0.25	Pass
12.59	-0.13	-0.13	-inf	2.50	0.25	Pass
15.85	-0.10	-0.10	-4.00	2.00	0.25	Pass
19.95	-0.01	-0.01	-2.00	2.00	0.25	Pass
25.12	-0.02	-0.02	-1.50	2.00	0.25	Pass
31.62	0.01	0.01	-1.50	1.50	0.25	Pass
39.81	-0.01	-0.01	-1.00	1.00	0.25	Pass
50.12	0.02	0.02	-1.00	1.00	0.25	Pass
63.10	-0.01	-0.01	-1.00	1.00	0.25	Pass
79.43	0.04	0.04	-1.00	1.00	0.25	Pass
100.00	0.02	0.02	-1.00	1.00	0.25	Pass
125.89	-0.05	-0.05	-1.00	1.00	0.25	Pass
158.49	0.03	0.03	-1.00	1.00	0.25	Pass
199.53	0.01	0.01	-1.00	1.00	0.25	Pass
251.19	0.03	0.03	-1.00	1.00	0.25	Pass
316.23	0.14	0.14	-1.00	1.00	0.25	Pass
398.11	-0.10	-0.10	-1.00	1.00	0.25	Pass
501.19	-0.12	-0.12	-1.00	1.00	0.25	Pass
630.96	-0.16	-0.16	-1.00	1.00	0.25	Pass
794.33	-0.13	-0.13	-1.00	1.00	0.25	Pass
1,000.00	0.00	0.00	-0.70	0.70	0.25	Pass
1,258.93	0.35	0.35	-1.00	1.00	0.25	Pass
1,584.89	0.03	0.03	-1.00	1.00	0.25	Pass
1,995.26	-0.25	-0.25	-1.00	1.00	0.25	Pass
2,511.89	-0.06	-0.06	-1.00	1.00	0.25	Pass
3,162.28	-0.04	-0.04	-1.00	1.00	0.25	Pass
3,981.07	-0.20	-0.20	-1.00	1.00	0.25	Pass
5,011.87	-0.05	-0.05	-1.50	1.50	0.25	Pass
6,309.57	-0.36	-0.36	-2.00	1.50	0.25	Pass
7,943.28	-0.06	-0.06	-2.50	1.50	0.25	Pass
10,000.00	0.14	0.14	-3.00	2.00	0.25	Pass
12,589.25	-0.01	-0.01	-5.00	2.00	0.25	Pass
15,848.93	-0.35	-0.35	-16.00	2.50	0.25	Pass
19,952.62	-0.69	-0.69	-inf	3.00	0.25	Pass

-- End of measurement results--

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High Level Stability

Electrical signal test of high level stability performed according to IEC 61672-3:2013 21 and ANSI S1.4-2014 Part 3: 21 for compliance to IEC 61672-1:2013 5.15 and ANSI S1.4-2014 Part 1: 5.15

Measurement	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
High Level Stability	0.00	-0.10	0.10	0.01 ‡	Pass

-- End of measurement results--

Long-Term Stability

Electrical signal test of long term stability performed according to IEC 61672-3:2013 15 and ANSI S1.4-2014 Part 3: 15 for compliance to ISC 61672-1:2013 5.14 and ANSI S1.4-2014 Part 1: 5.14

Test Duration [min]	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
35	0.00	-0.10	0.10	0.01 ‡	Pass

-- End of measurement results--

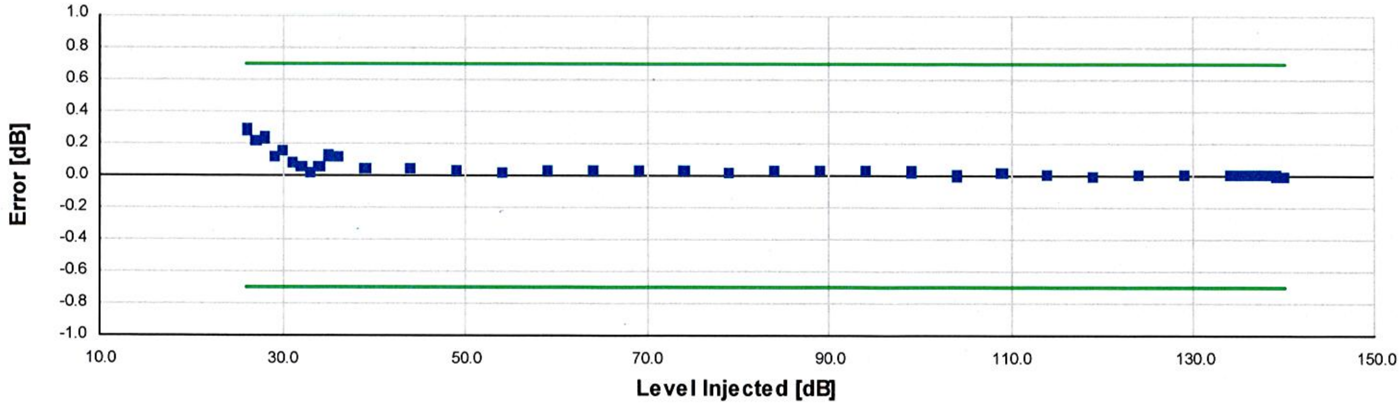
1 kHz Reference Levels

Frequency weightings and time weightings at 1 kHz (reference is A weighted Fast) performed according to IEC 61672-3:2013 14 and ANSI S1.4-2014 Part 3: 14 for compliance to IEC 61672-1:2013 5.5.9 and 5.8.3 and ANSI S1.4-2014 Part 1: 5.5.9 and 5.8.3

Measurement	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
C weight	114.00	113.80	114.20	0.15	Pass
Z weight	113.99	113.80	114.20	0.15	Pass
Slow	114.00	113.90	114.10	0.15	Pass
Impulse	114.00	113.90	114.10	0.15	Pass

-- End of measurement results--

A-weighted 0 dB Gain Broadband Log Linearity: 8,000.00 Hz



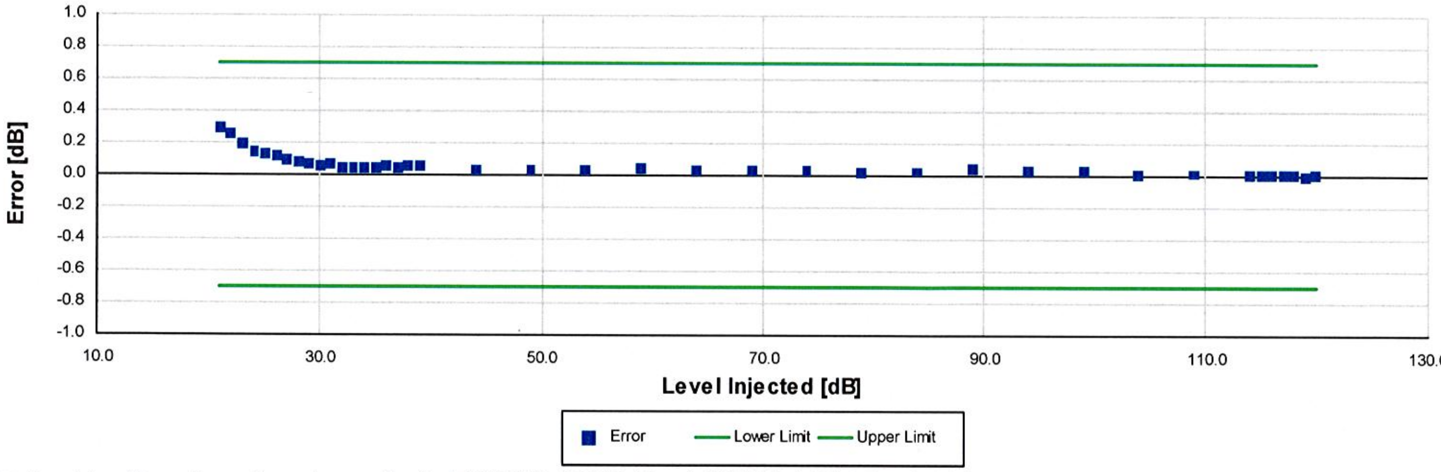
Broadband level linearity performed according to IEC 61672-3:2013 16 and ANSI S1.4-2014 Part 3: 16 for compliance to IEC 61672-1:2013 5.6, IEC 60804:2000 6.2, IEC 61252:2002 8, ANSI S1.4 (R2006) 6.9, ANSI S1.4-2014 Part 1: 5.6, ANSI S1.43 (R2007) 6.2

Level [dB]	Error [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
26.00	0.28	-0.70	0.70	0.16	Pass
27.00	0.22	-0.70	0.70	0.16	Pass
28.00	0.24	-0.70	0.70	0.16	Pass
29.00	0.12	-0.70	0.70	0.16	Pass
30.00	0.15	-0.70	0.70	0.16	Pass
31.00	0.08	-0.70	0.70	0.16	Pass
32.00	0.05	-0.70	0.70	0.16	Pass
33.00	0.02	-0.70	0.70	0.16	Pass
34.00	0.06	-0.70	0.70	0.16	Pass
35.00	0.12	-0.70	0.70	0.16	Pass
36.00	0.12	-0.70	0.70	0.16	Pass
39.00	0.05	-0.70	0.70	0.16	Pass
44.00	0.04	-0.70	0.70	0.16	Pass
49.00	0.03	-0.70	0.70	0.16	Pass
54.00	0.02	-0.70	0.70	0.16	Pass
59.00	0.03	-0.70	0.70	0.16	Pass
64.00	0.03	-0.70	0.70	0.16	Pass
69.00	0.03	-0.70	0.70	0.16	Pass
74.00	0.03	-0.70	0.70	0.16	Pass
79.00	0.02	-0.70	0.70	0.16	Pass
84.00	0.03	-0.70	0.70	0.16	Pass
89.00	0.03	-0.70	0.70	0.16	Pass
94.00	0.03	-0.70	0.70	0.16	Pass
99.00	0.02	-0.70	0.70	0.16	Pass
104.00	0.00	-0.70	0.70	0.15	Pass
109.00	0.01	-0.70	0.70	0.15	Pass
114.00	0.01	-0.70	0.70	0.15	Pass
119.00	0.00	-0.70	0.70	0.15	Pass
124.00	0.00	-0.70	0.70	0.15	Pass
129.00	0.01	-0.70	0.70	0.15	Pass
134.00	0.01	-0.70	0.70	0.15	Pass
135.00	0.01	-0.70	0.70	0.15	Pass
136.00	0.00	-0.70	0.70	0.15	Pass
137.00	0.01	-0.70	0.70	0.15	Pass
138.00	0.01	-0.70	0.70	0.15	Pass
139.00	0.00	-0.70	0.70	0.15	Pass

Level [dB]	Error [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
140.00	-0.01	-0.70	0.70	0.15	Pass

-- End of measurement results--

A-weighted 20 dB Gain Broadband Log Linearity: 8,000.00 Hz



Broadband level linearity performed according to IEC 61672-3:2013 16 and ANSI S1.4-2014 Part 3: 16 for compliance to IEC 61672-1:2013 5.6, IEC 60804:2000 6.2, IEC 61252:2002 8, ANSI S1.4 (R2006) 6.9, ANSI S1.4-2014 Part 1: 5.6, ANSI S1.43 (R2007) 6.2

Level [dB]	Error [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
21.00	0.29	-0.70	0.70	0.16	Pass
22.00	0.25	-0.70	0.70	0.16	Pass
23.00	0.19	-0.70	0.70	0.16	Pass
24.00	0.14	-0.70	0.70	0.16	Pass
25.00	0.13	-0.70	0.70	0.16	Pass
26.00	0.12	-0.70	0.70	0.16	Pass
27.00	0.09	-0.70	0.70	0.16	Pass
28.00	0.08	-0.70	0.70	0.16	Pass
29.00	0.07	-0.70	0.70	0.16	Pass
30.00	0.06	-0.70	0.70	0.16	Pass
31.00	0.07	-0.70	0.70	0.16	Pass
32.00	0.05	-0.70	0.70	0.16	Pass
33.00	0.04	-0.70	0.70	0.16	Pass
34.00	0.04	-0.70	0.70	0.16	Pass
35.00	0.04	-0.70	0.70	0.16	Pass
36.00	0.05	-0.70	0.70	0.16	Pass
37.00	0.05	-0.70	0.70	0.16	Pass
38.00	0.05	-0.70	0.70	0.16	Pass
39.00	0.05	-0.70	0.70	0.16	Pass
44.00	0.03	-0.70	0.70	0.16	Pass
49.00	0.03	-0.70	0.70	0.16	Pass
54.00	0.02	-0.70	0.70	0.16	Pass
59.00	0.04	-0.70	0.70	0.16	Pass
64.00	0.03	-0.70	0.70	0.16	Pass
69.00	0.03	-0.70	0.70	0.16	Pass
74.00	0.03	-0.70	0.70	0.16	Pass
79.00	0.02	-0.70	0.70	0.16	Pass
84.00	0.02	-0.70	0.70	0.16	Pass
89.00	0.03	-0.70	0.70	0.16	Pass
94.00	0.03	-0.70	0.70	0.16	Pass
99.00	0.03	-0.70	0.70	0.16	Pass
104.00	0.01	-0.70	0.70	0.15	Pass
109.00	0.01	-0.70	0.70	0.15	Pass
114.00	0.00	-0.70	0.70	0.15	Pass
115.00	0.01	-0.70	0.70	0.15	Pass
116.00	0.00	-0.70	0.70	0.15	Pass

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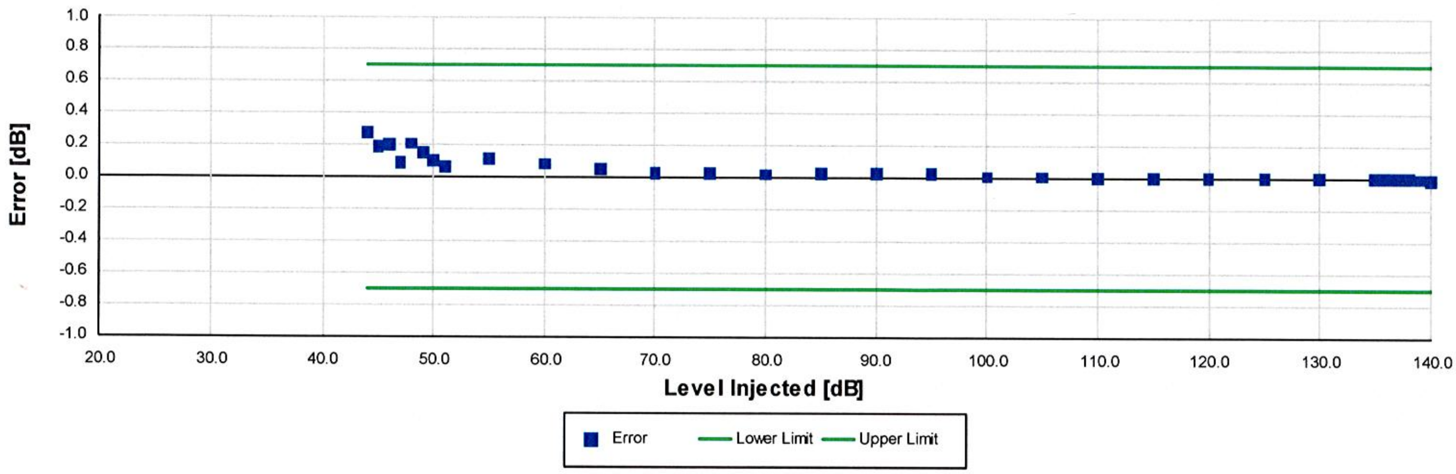
Level [dB]	Error [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
117.00	0.01	-0.70	0.70	0.15	Pass
118.00	0.01	-0.70	0.70	0.15	Pass
119.00	0.00	-0.70	0.70	0.15	Pass
120.00	0.01	-0.70	0.70	0.15	Pass

-- End of measurement results--

1/1 Octave Log Linearity: 1,000.00 Hz

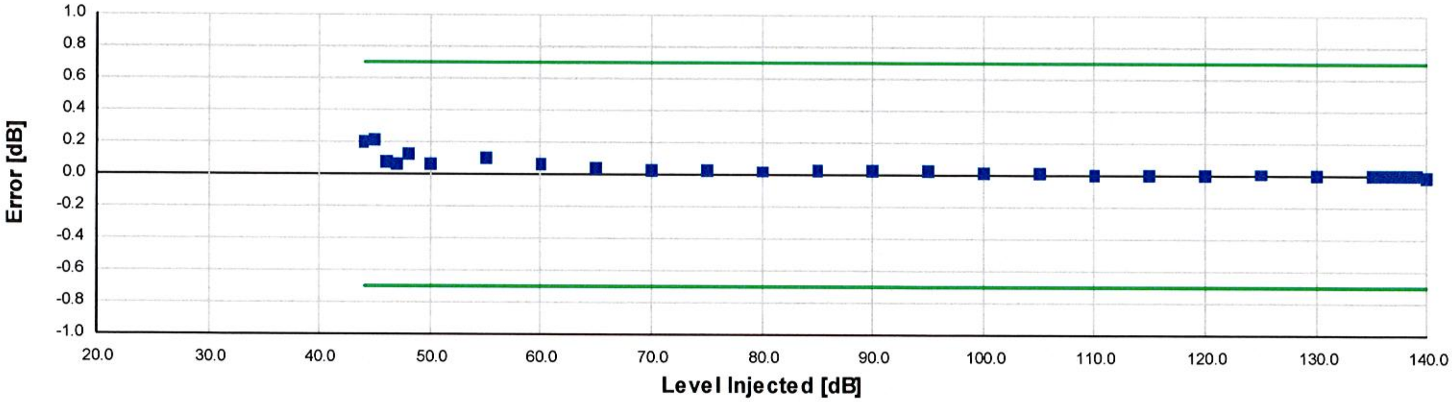


1/1 octave level linearity at normal range with 0 dB gain performed according to IEC 61260:2001 4.6, ANSI S.11 (R2009) 4.6

Level [dB]	Error [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
44.00	0.27	-0.70	0.70	0.16	Pass
45.00	0.19	-0.70	0.70	0.16	Pass
46.00	0.20	-0.70	0.70	0.16	Pass
47.00	0.09	-0.70	0.70	0.16	Pass
48.00	0.21	-0.70	0.70	0.16	Pass
49.00	0.15	-0.70	0.70	0.16	Pass
50.00	0.10	-0.70	0.70	0.16	Pass
51.00	0.06	-0.70	0.70	0.16	Pass
55.00	0.12	-0.70	0.70	0.16	Pass
60.00	0.08	-0.70	0.70	0.16	Pass
65.00	0.05	-0.70	0.70	0.16	Pass
70.00	0.03	-0.70	0.70	0.16	Pass
75.00	0.02	-0.70	0.70	0.16	Pass
80.00	0.02	-0.70	0.70	0.16	Pass
85.00	0.02	-0.70	0.70	0.16	Pass
90.00	0.02	-0.70	0.70	0.16	Pass
95.00	0.02	-0.70	0.70	0.16	Pass
100.00	0.01	-0.70	0.70	0.15	Pass
105.00	0.01	-0.70	0.70	0.15	Pass
110.00	0.00	-0.70	0.70	0.15	Pass
115.00	0.00	-0.70	0.70	0.15	Pass
120.00	0.00	-0.70	0.70	0.15	Pass
125.00	0.00	-0.70	0.70	0.15	Pass
130.00	0.00	-0.70	0.70	0.15	Pass
135.00	0.00	-0.70	0.70	0.15	Pass
136.00	0.00	-0.70	0.70	0.15	Pass
137.00	0.00	-0.70	0.70	0.15	Pass
138.00	0.00	-0.70	0.70	0.15	Pass
139.00	-0.01	-0.70	0.70	0.15	Pass
140.00	-0.01	-0.70	0.70	0.15	Pass

-- End of measurement results--

1/3 Octave Log Linearity: 1,000.00 Hz



1/3 octave level linearity at normal range with 0 dB gain performed according to IEC 61260:2001 4.6, ANSI S.11 (R2009) 4.6

Level [dB]	Error [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
44.00	0.20	-0.70	0.70	0.16	Pass
45.00	0.21	-0.70	0.70	0.16	Pass
46.00	0.07	-0.70	0.70	0.16	Pass
47.00	0.07	-0.70	0.70	0.16	Pass
48.00	0.12	-0.70	0.70	0.16	Pass
50.00	0.06	-0.70	0.70	0.16	Pass
55.00	0.10	-0.70	0.70	0.16	Pass
60.00	0.06	-0.70	0.70	0.16	Pass
65.00	0.04	-0.70	0.70	0.16	Pass
70.00	0.02	-0.70	0.70	0.16	Pass
75.00	0.03	-0.70	0.70	0.16	Pass
80.00	0.02	-0.70	0.70	0.16	Pass
85.00	0.02	-0.70	0.70	0.16	Pass
90.00	0.02	-0.70	0.70	0.16	Pass
95.00	0.02	-0.70	0.70	0.16	Pass
100.00	0.01	-0.70	0.70	0.15	Pass
105.00	0.01	-0.70	0.70	0.15	Pass
110.00	0.00	-0.70	0.70	0.15	Pass
115.00	0.00	-0.70	0.70	0.15	Pass
120.00	0.00	-0.70	0.70	0.15	Pass
125.00	0.00	-0.70	0.70	0.15	Pass
130.00	0.00	-0.70	0.70	0.15	Pass
135.00	0.00	-0.70	0.70	0.15	Pass
136.00	0.00	-0.70	0.70	0.15	Pass
137.00	0.00	-0.70	0.70	0.15	Pass
138.00	0.00	-0.70	0.70	0.15	Pass
139.00	-0.01	-0.70	0.70	0.15	Pass
140.00	-0.01	-0.70	0.70	0.15	Pass

-- End of measurement results--

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Slow Detector

Toneburst response performed according to IEC 61672-3:2013 18 and ANSI S1.4-2014 Part 3: 18 for compliance to IEC 61672-1:2013 5.9, IEC 60651:2001 9.4.2, ANSI S1.4:1983 (R2006) 8.4.2 and ANSI S1.4-2014 Part 1: 5.9

Amplitude [dB]	Duration [ms]	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
137.00	200	-7.54	-7.92	-6.92	0.15	Pass
	2	-27.14	-29.99	-25.99	0.15	Pass

-- End of measurement results--

Fast Detector

Toneburst response performed according to IEC 61672-3:2013 18 and ANSI S1.4-2014 Part 3: 18 for compliance to IEC 61672-1:2013 5.9, IEC 60651:2001 9.4.2, ANSI S1.4:1983 (R2006) 8.4.2 and ANSI S1.4-2014 Part 1: 5.9

Amplitude [dB]	Duration [ms]	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
137.00	200.00	-1.07	-1.48	-0.48	0.15	Pass
	2.00	-18.24	-19.49	-16.99	0.15	Pass
	0.25	-27.47	-29.99	-25.99	0.15	Pass

-- End of measurement results--

Sound Exposure Level

Toneburst response performed according to IEC 61672-3:2013 18 and ANSI S1.4-2014 Part 3: 18 for compliance to IEC 61672-1:2013 5.9, IEC 60651:2001 9.4.2, ANSI S1.4:1983 (R2006) 8.4.2 and ANSI S1.4-2014 Part 1: 5.9

Amplitude [dB]	Duration [ms]	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
137.00	200.00	-7.01	-7.49	-6.49	0.15	Pass
	2.00	-27.03	-28.49	-25.99	0.15	Pass
	0.25	-36.15	-39.02	-35.02	0.15	Pass

-- End of measurement results--

Peak C-weight

C-weighted peak sound level performed according to IEC 61672-3:2013 19 and ANSI S1.4-2014 Part 3: 19 for compliance to IEC 61672-1:2013 5.13 and ANSI S1.4-2014 Part 1: 5.13

Level [dB]	Frequency [Hz]	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
135.00	31.50	138.21	135.50	139.50	0.15	Pass
135.00	500.00	138.57	137.50	139.50	0.15	Pass
135.00	8,000.00	137.73	136.40	140.40	0.15	Pass
135.00, Negative	500.00	137.17	136.40	138.40	0.15	Pass
135.00, Positive	500.00	137.18	136.40	138.40	0.15	Pass

-- End of measurement results--

Peak Z-weight

Z-weighted peak sound level performed according to IEC 60651:2001 9.4.4 and ANSI S1.4:1983 (R2006) 8.4.4

Amplitude [dB]	Duration[µs]		Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
136.00	100	Negative Pulse	136.35	134.00	138.00	0.15	Pass
	100	Positive Pulse	136.35	134.01	138.01	0.15	Pass
126.00	100	Negative Pulse	126.34	124.00	128.00	0.15	Pass
	100	Positive Pulse	126.35	124.00	128.00	0.15	Pass
116.00	100	Negative Pulse	116.35	114.00	118.00	0.15	Pass
	100	Positive Pulse	116.35	114.00	118.00	0.15	Pass
106.00	100	Negative Pulse	106.33	103.99	107.99	0.15	Pass
	100	Positive Pulse	106.34	104.01	108.01	0.15	Pass

-- End of measurement results--

Overload Detector

Overload indication performed according to IEC 61672-3:2013 20 and ANSI S1.4-2014 Part 3: 20 for compliance to IEC 61672-1:2013 5.11, IEC 60804:2000 9.3.5, IEC 61252:2002 11, ANSI S1.4 (R2006) 5.8, and ANSI S1.4-2014 Part 1: 5.11, ANSI S1.25 (R2007) 7.6, ANSI S1.43 (R2007) 7

Measurement	Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
Positive	141.10	140.00	142.00	0.15	Pass
Negative	141.00	140.00	142.00	0.15	Pass
Difference	0.10	-1.50	1.50	0.16	Pass

-- End of measurement results--

Peak Rise Time

Peak rise time performed according to IEC 60651:2001 9.4.4 and ANSI S1.4:1983 (R2006) 8.4.4

Amplitude [dB]	Duration [µs]		Test Result [dB]	Lower limit [dB]	Upper limit [dB]	Expanded Uncertainty [dB]	Result
139.00	40	Negative Pulse	138.49	137.00	139.00	0.15	Pass
		Positive Pulse	138.49	137.00	139.00	0.15	Pass
	30	Negative Pulse	137.50	137.00	139.00	0.15	Pass
		Positive Pulse	137.50	137.00	139.00	0.15	Pass

-- End of measurement results--

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