OSTERGAARD ACOUSTICAL ASSOCIATES

EVALUATION OF SITE SOUND EMISSIONS

PROPOSED WAREHOUSE
Mendon, MA

Prepared for: **Bluewater Property Group**

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INTRODUCTION

Ostergaard Acoustical Associates (OAA) was asked to assist with evaluation of potential sound emissions from a speculative warehouse to be located at the west terminus of Whitten Street in the Town of Mendon, Worcester County, Massachusetts. The site is currently undeveloped, and plans call for a warehouse building with the potential for 24-hour operation. The vicinity of the site is mixed-use in nature, commercial uses and non-noise-sensitive uses to the north and east; residential neighborhoods are located to the west and south. This report addresses the onsite noise radiated to nearby noise-sensitive off-site receptors.

The purpose of this sound study is to analyze future site sound emissions for comparison with applicable State and local noise code limits and to evaluate compatibility of the proposed use with the surroundings. Such ordinances regulate site sound relative to existing ambient sound levels in order to minimize the potential acoustical impact of new noise sources. The site will contribute steady sound from rooftop HVAC equipment. The site will also produce intermittent sound from truck and car[1] movements.

Since future tenants are not known, the extent of heavy trucking activity was conservatively estimated, assuming the potential for nighttime activity. Traditional use of such buildings will primarily see activity during daytime hours; nighttime activity, if any, is expected to be lower in quantity and sporadic. Nevertheless, potential nighttime operations are of most interest since residential receptors are potentially more sensitive during this period.

Work by OAA was overseen by Benjamin C. Mueller, P.E., with assistance from OAA Staff. The representative at Bluewater Property Group coordinating the project is Joshua Garofano. OAA coordinated survey requirements and presentation of results based on feedback from and coordination with the Town's acoustical consultant, Christopher Menge of HMMH.

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[1] Note that throughout this report, the term "car" collectively refers to personal passenger vehicles including automobiles, vans, pick-ups, or SUVs. The term "truck" refers to heavy trucks such as over-the-road or line-haul trucks.

SITE AND VICINITY

Figure 1 is an aerial image obtained from Google Earth outlining the site in red. Figure 1 also shows ambient survey locations, which are discussed in a subsequent section.

The site is located west of the intersection of Whitten Street and Cape Road (Route 140) in the Town of Mendon, Massachusetts, in the HB, Highway Business, zone. Abutting the site to the north is undeveloped wooded land and grassland. Sporadic residences front on Hartford Avenue East in this direction. The site is in line with the Hopedale Airport runway about 900 feet away to the north. Properties east of the site are generally non-noise sensitive, commercial properties, including restaurants, an auto repair shop, and a carwash. Also east is the Bethany Christian Academy and Community Church fronting on Cape Road, which is potentially noise sensitive during daytime hours. Properties abutting the site to the south are also non noise sensitive and include a solar farm and the New England Futbol Club; single family residences fronting on Edward Street are beyond. Lastly, to the west are additional single-family residences along Talbott Farm Drive. Adjacent properties to the east and south are also within the HB zone, while the residences to the north, south, and west are within the RR, Rural Residential, zone. Nearby residences are of most concern acoustically given their potential for noise sensitivity. Minimizing the potential acoustical impact on speech communication at the school/church is also of interest.

Plans call for the construction of an approximately 205,445 ft^2 building to be located in the center of the irregularly shaped parcel. Access will be provided via Whitten Street for all vehicles, and the onsite driveway will circle the building. Heavy truck docks are located along the west façade of the building, while ancillary trailer parking areas are provided near the eastern property line. Personnel vehicles have dedicated parking areas along the east side of the building. OAA's analysis includes the proposed 12-foot-tall, 854-foot-long noise control barrier, located around the truck yard to shield nearby residences from onsite activity. This barrier is discussed in more detail in subsequent sections.

Specific traffic counts depend on the end user tenant. While the extent of onsite traffic and the hours of operation are unknown, the sound study has followed the same conservative assumptions made in the traffic study. Typical warehouses operate 24/7 with much of the activity during the daytime hours; nighttime operations are generally used to prepare for the next day. The focus of this study is to analyze potential nighttime activity as this is generally when residential receptors are most sensitive.

Figure 1 — Google Earth image showing the proposed warehouse site and vicinity in Mendon, MA. The site property line is approximated in red. Ambient survey Locations 1 through 3 are also shown.

REGULATIONS/GOALS

When developing a site of this type, it is appropriate to consider how sound from the facility will likely be received, especially by noise-sensitive receptors. Sound produced by a typical warehouse is characterized by car and truck parking lot activity, such as idling and vehicle movement, as well as steady HVAC equipment. The noise from these sources was evaluated and compared to applicable noise code limits as well as acoustical goals based on professional experience. As a general practice, when motor vehicles are onsite, they are considered part of a site's sound emissions; when vehicles are on public roads, they are not.

State, county, and local noise codes were reviewed. The State of Massachusetts code, Division of Air Quality Control Policy 90-001, requires sound emissions to not exceed background ambient sound levels at the nearest residence by 10 dB(A). The background sound level is defined as the level present 90% of the time during a measurement period when equipment is in operation. The Town of Mendon does not have a noise ordinance. Despite this, there is language found in the zoning bylaws that may require applicants before the Town planning board to provide proof that a site will not produce unreasonable noise. Section J: *Performance Criteria* of the zoning bylaws states that "no persistent noise shall be detectable beyond the property line in excess of the average level of street and traffic noise generally heard at the point of observation". No additional information is provided though. Lastly, there are no Worcester County noise codes that could be found.

A discussion of relevant codes is warranted. The Massachusetts noise code takes the approach to compare new sound to existing, which is appropriate for minimizing the acoustical impact of new noise sources. It is traditionally applied to stationary noise sources. The code language unfortunately does not specify a measurement period or provide details on how to address the inherent variability of ambient sound; background sound levels are themselves dynamic and constantly changing in the area. There is little question that the State noise code regulates stationary noise sources however it is less clear on whether it includes mobile noise sources; motor vehicles can travel off-site and produce variable sound themselves. OAA finds in practice that receptors are more tolerant of short duration excursions than a steady sound of the same magnitude. Hence, the public would be less tolerant of a steady sound that was 10 dB higher than existing sound levels than for an occasional intermittent one. OAA agrees with allowing intermittent site sounds to approach 10 dB higher than existing sounds in the area provided they are in line with other maximum sound levels that might occur. Steady HVAC sound on the other hand, should be well below the code limit and more aligned with existing ambient background sound levels in the area to minimize the potential for any acoustical impact. Existing ambient sound is discussed in the next section. Meeting the State noise code will help limit site sound emissions, protect public welfare, and meet the intent of the provisions found in the Mendon zoning bylaws.

Ambient Sound Survey

To determine the appropriate State noise code limit for this site, an ambient sound survey was carried out to document existing sound in the area. Three measurement locations were selected to characterize the ambient of specific areas of nearby existing receptors. Locations 1 and 2 were placed along the tree line near the northwest and southwest corners of the site, respectively, to typify residential receptors in these directions. Location 3 was in the wooded area between commercial parking lots east of the site, about 80 feet from Cape Road and typifies ambient sound levels for eastern receptors. OAA staff deployed the monitors on the morning of 20 January 2023 and retrieved them nine days later on 29 January 2023. Per the Town's acoustical consultant, an effort was made to obtain a week's worth of ambient data.

For each Location, a Soft dB Piccolo II sound level meter was used. All monitors were placed within a weather enclosure affixed to a tree; the microphone associated with the meters were located outside the enclosure and utilized a windscreen. Monitors were instructed to record detailed octave band time history data and statistical data at one-minute intervals for the duration of the survey. In the end, a minimum of 167 hours of sound data were recorded from 1100 hours on 20 January through 0900 hours on 27 January. The batteries for Locations 1 and 3 lasted slightly longer and recorded an additional 20 and 36 hours, respectively. All sound levels meters were calibrated before and after deployment using a HBK Model 4231 sound level calibrator, which is calibrated by an outside calibration service annually. Calibration certificates for the equipment used is provided in the Appendix. It was observed upon deployment and retrieval of the monitors that the acoustical environment was dominated by steady distant traffic flow, which included both automobiles and heavy trucks. Intermittent fauna noise was also prominent at Locations 1 and 2.

Weather conditions were appropriate during the survey based on field notes and a review of historical data obtained from the nearest weather station at Worcester Regional Airport, about 20 miles northwest of the site. Temperatures ranged from 26-to-45°F throughout the survey with occasional light snow. According to weather station data, there were occasions of high winds between 2000 hours on 22 January and 1200 hours on 23 January; there was also freezing rain and high winds that spanned from 2000 hours on 25 January until 0600 hours on 26 January. Elevated sound levels from this weather can be seen in the data during these periods. It is also worth mentioning is that while the weather station may record high wind speeds at times, these are generally not realized at the height of the microphones. Of most interest in understanding the existing ambient is to scrutinize the lulls, which is absent of any abnormal weather conditions and any interference they might contribute.

Acquisition of ambient sound data over the course of multiple days results in a large amount of data. As a result, it is helpful to review data statistics to assist with observing ambient sound level trends. Important statistics include the equivalent sound level (L_{eq}) and the background sound level (L_{90}), or level that occurs over 90 percent of the time, which is best used to evaluate continuous noise sources such as project HVAC sound. The L_{10}, or level that occurs over 10 percent of the time, indicates the extent of intermittent noise sources in the area, such as dog barks, surges in traffic noise, or aircraft passbys; this is best used to evaluate intermittent motor vehicle noise from the proposed project. These data are important for use in establishing specific project noise goals to ensure no negative acoustical impact.

A summary of the average hourly statistical sound levels recorded over the almost 7-day period of the survey is provided in Table 1. All data in Table 1 exclude the periods of inclement weather discussed above.

Table 1 – Average hourly statistical sound levels recorded at Locations 1 through 3 across the measurement period of 20-to-28 January 2023.

Location	L_{max}	L_{10}	L_{eq}	L_{90}	L_{min}
1	49	45	44	40	39
2	48	43	42	39	38
3	67	63	60	54	50

A time history showing 1-minute average sound levels across the entire measurement period is shown below in Figures 2 through 4 below for Locations 1 through 3, respectively. A review of survey results reveals the following:

- Average L_{eq} sound levels were dependent on the distance from well-travelled roads. Locations 1 and 2 are more remote from local and distant traffic flow sound, and resulted in period average L_{eq} sound levels in the low-to-mid 40's on an A-weighted scale, as shown in Table 1. Location 3 was influenced by traffic sound; the average L_{eq} sound level across the survey period was 60 dB(A) at this Location. For all Locations, lulls occurred during the nighttime hours. Sound levels start to increase around 0600 hours as rush-hour begins.

- Background sound levels (L_{90}) followed similar trends as the average sound levels. Average L_{90} sound levels across the measurement period were 3-to-6 dB lower in level than average sound level trends. The lowest L_{90}, averaged across the survey period, was 39 dB(A) at Location 2. During the week, the lowest hourly L_{90} was only measured for one hour across the entire survey; from Saturday into Sunday, the L_{90} hovered around 30 dB(A) for several hours across the overnight period.

- Average L_{10} sound levels, on the other hand, were a few decibels higher than the average sound levels. For Locations 1 and 2, this is another indicator of generally steady sound in the western portion of the site. The L_{10} typically hovered between 40 and 50 dB(A). Average L_{10} sound levels at Location 3, were only 3 dB higher than average L_{eq} sound levels documented there, confirming that local roads are well travelled at all hours of the day.

- A review of hourly maximum sound levels during the survey show that maximum sound levels generally ranged from 45-to-60 dB(A) at Locations 1 and 2 and ranged from 60-to-80 dB(A) at Location 3. The lowest hourly maximum sound level of 33 dB(A) was documented at Location 2. This low level was only observed once during a single hour at 0400 hours on Sunday. Most hours documented regular maximum sound levels approaching 50 dB(A) even during the night; a maximum sound level of 52 dB(A) was recorded at 0200 hours on Sunday, just 2 hours before the lowest maximum discussed above. Data show that occasional levels of this magnitude currently exist in this area and are assumed to be tolerable by the community.

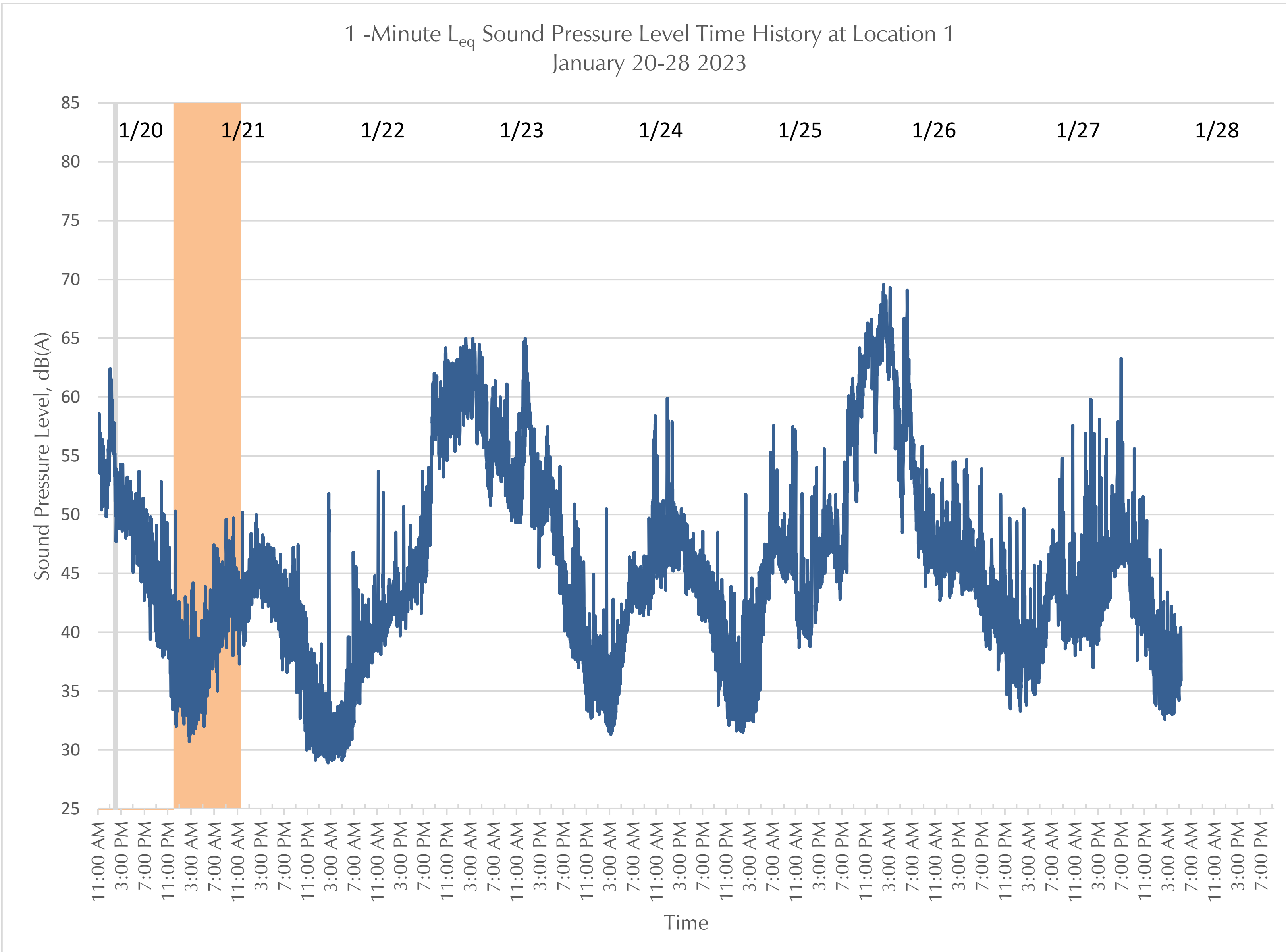


Figure 2 — Time history plot at Location 1 showing 1 minute average sound levels across the period of 20-to-28 January 2023.

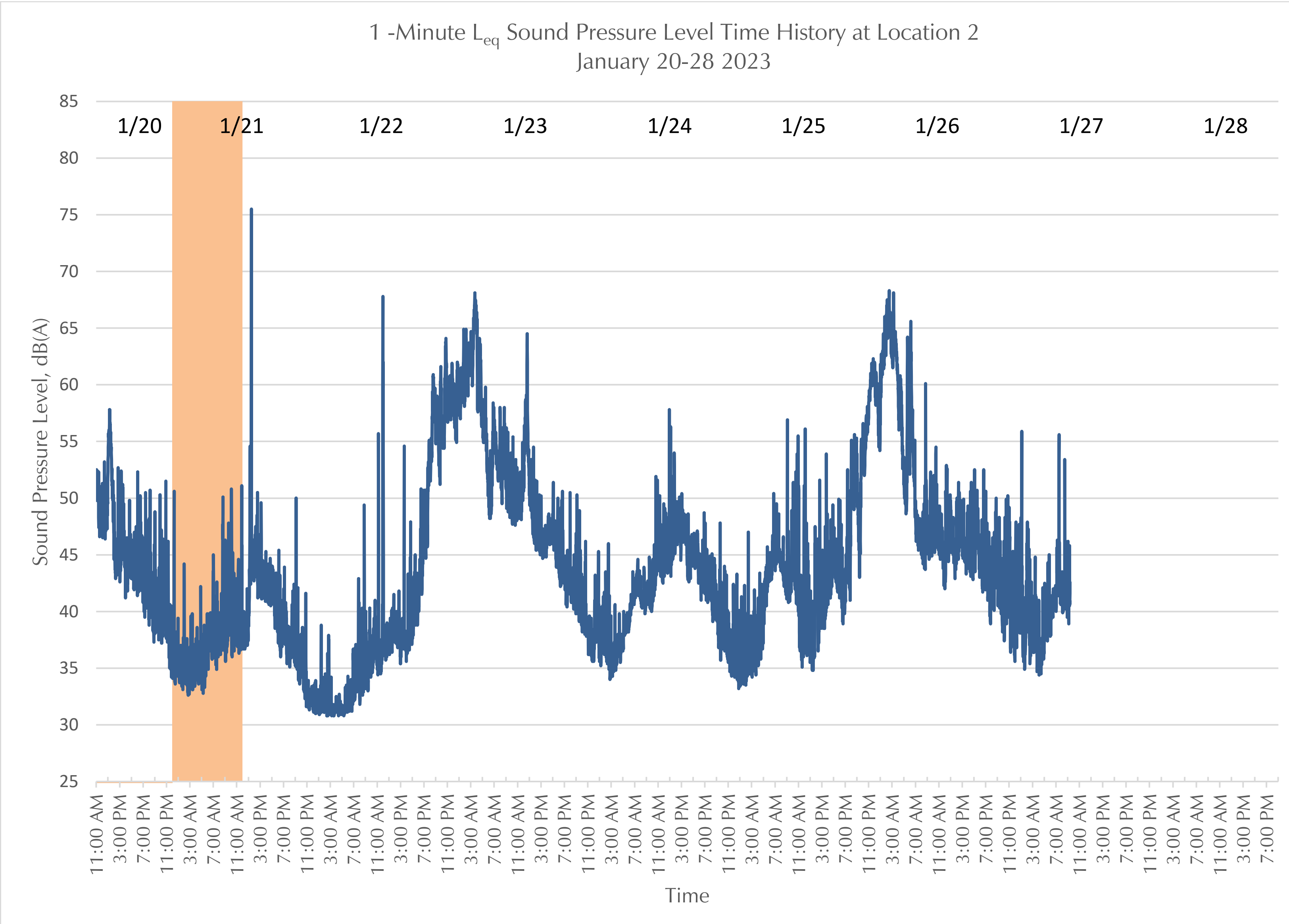


Figure 3 — Time history plot at Location 2 showing 1 minute average sound levels across the period of 20-to-28 January 2023.

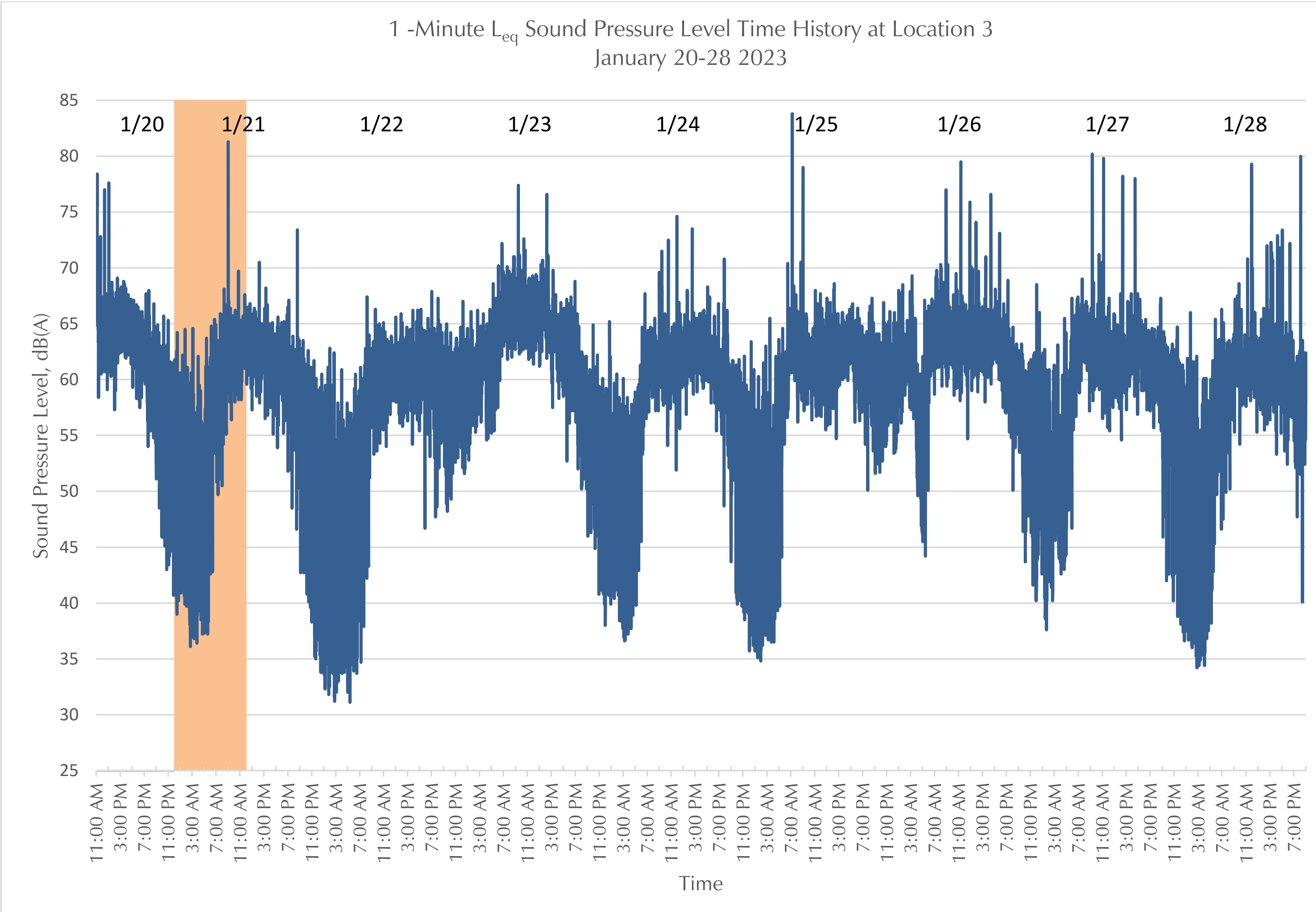


Figure 4 — **Time history plot at Location 3 showing 1 minute average sound levels across the period of 20-to-28 January 2023.**

Project Noise Goals

The State's approach to regulating site sound based on existing conditions has merit and is designed to prevent dramatic increases in sound levels and minimize the acoustical impact. The biggest challenge with evaluating and enforcing the State code is that fact that the ambient sound level, including the background sound level, is constantly varying over time. Because of this, OAA favors using the average background sound level measured across the period, and then adding 10 dB to this to determine an appropriate State noise code limit. Using average background sound levels ensures that the criteria are based on the "big picture" and take into consideration the ebb and flow of ambient sound. This also ensures that different consultants would inevitably obtain similar criteria. Using the results from Table 1 above, OAA recommends using 52 dB(A) as the project criteria, based on lowest average background sound level of 42 dB(A) documented at Location 2.

The Town's consultant, HMMH, has requested that OAA follow the methodology of a similar project in nearby Hopedale, and look at periods of lowest hourly L_{90} that occur across a 24-hour period. This approach is acceptable provided that each hour is then compared to the quantity of trucks expected on site during the associated hour; this is possible using data available from the traffic study and ITE Trip Generation Manual. Based on the 7-day survey period, the quietest 24-hour period selected was from 1700 hours on Saturday, 21 January, through 1600 hours on Sunday, 22 January. The hourly L_{90} sound levels for each hour during this period are shown in Table 2 below. The lowest level across all 3 Locations is highlighted in Table 2; the State code limit for nearby residences was determined by adding 10 dB to that value.

The limits in Table 2 are appropriate for the residential receptors west and south of the site, which are the focus of this study. The other potentially noise-sensitive use in the area is the school/church to the east. The school/chruch fronts on Cape Road, and hence, it is most appropriate to look Location 3 data. Most hours of the day, which is when school or church are in use, sound levels are over 50 dB(A); an appropriate project goal for the school/church becomes to not exceed levels of 60 dB(A) at the building façade while in use.

It is important to note that HVAC sound is steady in nature and will generally not vary across the day. Given this and because the lowest code limit shown in Table 2 is 39 dB(A), HVAC sound should not exceed this limit at residences. Lastly, State limits in Table 2 are aligned with average sound levels documented in the area. Meeting these project goals will minimize the acoustical impact of the site and meet the performance criteria of the Mendon Zoning By-Law.

Table 2 – Average hourly L_{90} sound levels recorded at Locations 1 through 3 across the measurement period of 20-to-28 January 2023 and code limits for each hour.

Date / Time	Loc 1	Loc 2	Loc 3	Code Limit (Lowest +10 dB)
1/21/2023 17:00	42	39	59	49
1/21/2023 18:00	40	37	58	47
1/21/2023 19:00	38	36	57	46
1/21/2023 20:00	39	36	54	46
1/21/2023 21:00	36	34	53	44
1/21/2023 22:00	33	33	46	43
1/21/2023 23:00	31	32	39	41
1/22/2023 0:00	30	31	35	40
1/22/2023 1:00	30	31	35	40
1/22/2023 2:00	29	31	34	39
1/22/2023 3:00	29	31	34	39
1/22/2023 4:00	30	31	35	40
1/22/2023 5:00	30	31	34	40
1/22/2023 6:00	31	31	37	41
1/22/2023 7:00	35	33	42	43
1/22/2023 8:00	36	33	53	43
1/22/2023 9:00	38	34	56	44
1/22/2023 10:00	38	35	58	45
1/22/2023 11:00	39	35	58	45
1/22/2023 12:00	40	36	59	46
1/22/2023 13:00	41	37	59	47
1/22/2023 14:00	41	37	58	47
1/22/2023 15:00	41	37	58	47
1/22/2023 16:00	42	37	58	47

Based on professional experience, noise code limits apply throughout the receptor's property but are most commonly assessed and enforced at the location of reception. Inaccessible or uninhabited portions of the property are generally not scrutinized. Because this sound study is focused on sound emissions during the nighttime at residences, residential receptor locations were selected at the façade of dwellings where receptors are sleeping during these hours and thus receiving sound. Similarly, the school/church was assessed at the façade where student instruction or church services are occurring inside during the daytime hours.

In summary, steady HVAC sound should not exceed 39 dB(A) at any receptor. Intermittent truck activity should not exceed hourly code limits shown in Table 2 at any residential receptor. Intermittent truck activity should not exceed 60 dB(A) at the school and church.

EXPECTED SOUND EMISSIONS

Acoustical modelling software, specifically CadnaA, was used to create and analyze site sound emissions for the site. The model takes into account relevant parameters between the noise source and receptor positions of interest to predict how sound will propagate. In addition to distance attenuation, the model accounts for the effects of terrain, various types of ground cover, shielding by structures, and reflections from buildings. In all models the buildings are white, contour lines are teal, the site property line is outlined in red, and the proposed 12-foot-tall noise control barrier is shown in light blue. These features are shown in all model results; some Figure titles have been shortened to highlight important elements. North is pointing up in all Figures. Elevation changes exterior to the site were obtained from MassGIS and incorporated into the model.

The acoustical model shows the results graphically as A-weighted sound level contours, in 1 dB increments, and tabulates the summed A-weighted sound levels at seven discrete locations, labeled Locations A through G, typifying nearby receptors of interest. Locations A through F are nearby residences while Location G is the school/church to the east. Sound level contours are at ear height, 5 feet above grade. All discrete Locations are at the façade of nearby residences and school/church are located at height of 15 feet above grade, typifying an upper-story receptor.

Rooftop HVAC Sound

Rooftop HVAC equipment produces noise that is nominally steady in nature, and hence will not vary significantly over time. Based on a recently completed similar project, a good approximation for this type of a facility is to assume 1 ton of cooling capacity for 550 ft^2 of building area. This roughly equates to nineteen (19) 20-ton HVAC units distributed on the rooftop of the facility. The sound power level for each of these was modelled to be 82 dB(A) re 1 picowatt based on York Sun Choice rooftop unit (RTU) sound data. Nine exhaust fans (EF) are also assumed ranging from 1,500 cfm up to 21,000 cfm. The smaller EFs serve spaces such as the mechanical and electrical rooms. The larger EFs circulate fresh air in the warehouse space An excerpt of the manufacturer's sound data are provided in the Appendix. The octave band data and model symbols are provided in Table 3.

Table 3 – Maximum octave band sound power levels for HVAC noise sources used in all acoustical models in this report. All sound power levels given in dB re 1 picowatt.

		Octave Band Center Frequency (Hz)								
Source	**Model**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**A-wt**
York Sun Choice 20-Ton	Blue +	95	88	80	78	77	74	72	68	82
ACME PRN135 – 1500 cfm	Pink +	77	78	76	70	66	65	58	46	73
ACME PV165 – 3400 cfm	Green +	78	87	83	76	70	69	65	57	79
Greenheck CUBE480 – 21000 cfm	Red +	91	89	82	75	71	67	60	55	79

The noise from the nineteen 20-ton rooftop units and four exhaust fans was included in the HVAC sound model. Rooftop units are shown as a blue +, two 1,500 cfm exhaust fans are shown as a pink +, two 3,400 cfm exhaust fans are shown as a green +, and five 21,000 cfm exhaust fans are shown as a red +. RTU sources were placed 4 feet above the rooftop and EF sources were placed 2 feet above the rooftop. Figure 5 shows the results of HVAC sound emissions graphically and tabulates the summed A-weighted sound levels of all equipment operating simultaneously at their maximum sound level at the nearby receptor locations of concern. The results show that with all rooftop units operating, HVAC sound levels at off-site residential receptors are in the 29-to-32 dB(A) range.

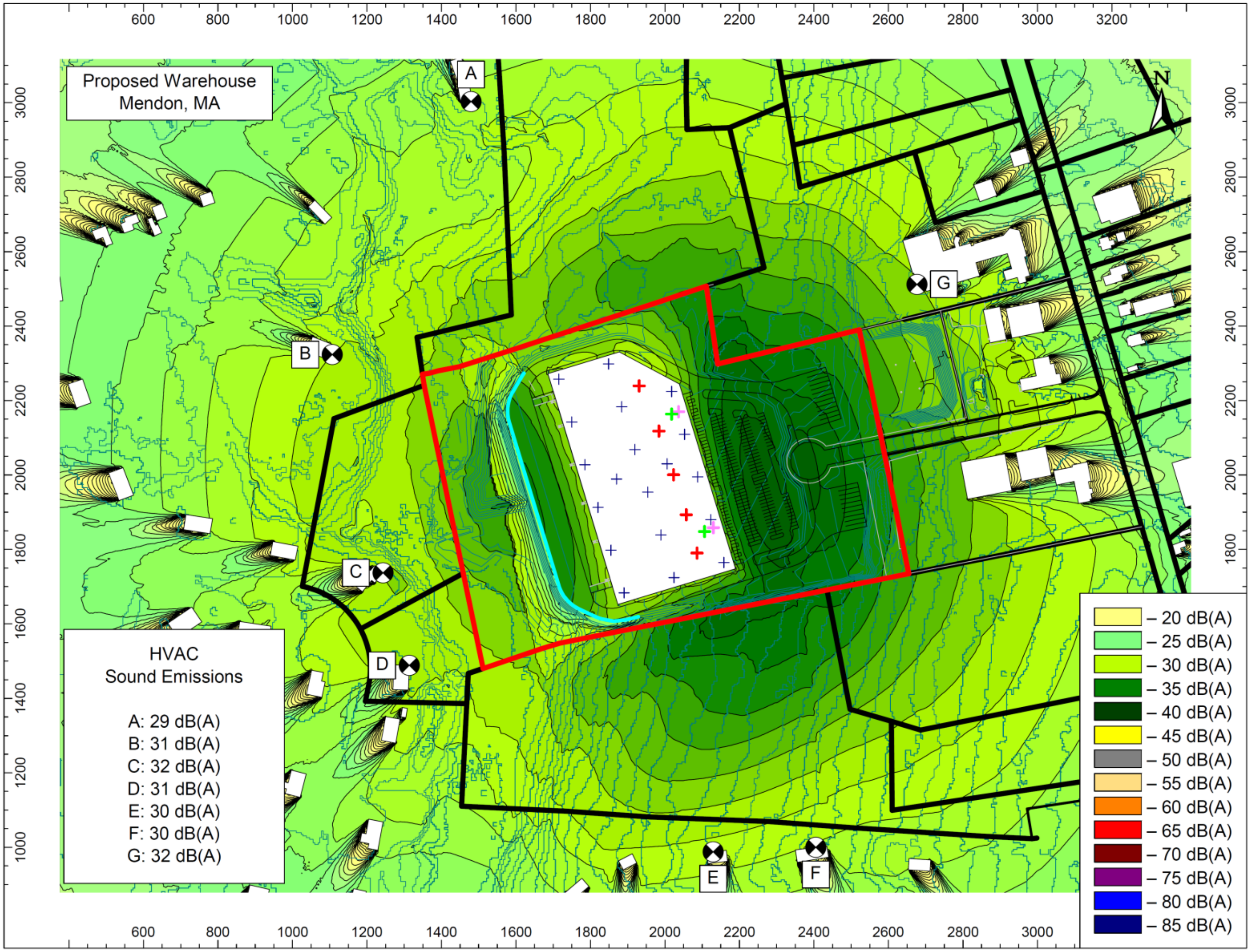


Figure 5 — Maximum A-weighted sound emission contours, 5 feet above grade, from all rooftop HVAC equipment operating. Rooftop units shown as a colored + as discussed in Table 3. Buildings shown in white; site property line outlined in red. A-weighted sound emissions tabulated at 15 feet above grade for all Locations.

This analysis shows that there is little concern about HVAC sound. HVAC sound is sufficiently controlled via distance and roof shielding effects so that this noise is well below the lowest State noise code limit of 39 dB(A) by a wide margin. HVAC sound emissions are more in line with the lowest hourly L_{90} sound documented during the ambient survey. Based on the ambient survey, levels of this magnitude are expected to blend in with existing conditions and be difficult to discern off-site. Note that for these model results to be realized, acoustical performance of HVAC equipment must be aligned with what was modelled.

Heavy Truck Activity

OAA has had the opportunity to visit various logistics facilities over the years to survey and document the sounds of truck activity. In order to evaluate the intermittent activity that is expected to occur on site, OAA modeled both driving trucks and idling truck activity at the site. A variety of models were compiled to look at different quantities of trucks expected at different hours. Based on the traffic study and Land Use Code 150 Warehouse, a total of 62 daily trucks, or 124 daily truck trips, are expected to visit each day based on the size of this site. Since one truck can enter and exit the site and thereby generate sound at two different times, it is more conservative to evaluate the number of truck trips rather than number of trucks. Hourly truck trips were estimated using the Hourly Distribution of Entering and Existing Truck Trips by Land Use table found in the ITE Trip Generation Manual (11th Edition). These data are based on counts taken at existing Land Use Code 150 sites. Given 124 truck trips a day, hourly truck trips range between 0 and 14. The highest activity occurs from 0900 hours through 1600 hours. Throughout most of the nighttime hours, truck trips reduce to between 0 and 5, indicating 1 or 2 trucks are expected during a typical nighttime hour. For illustrative purposes, the worst-case condition of 14 truck trips from 1100-to-1200 hours was added to the HVAC CadnaA model, nevertheless. This model includes a road source of truck travel circulating around the site using the RLS-90 Standard, which is a widely recognized standard for evaluating traffic noise. Input data comprised 14 trucks in an hour period, with 100% being heavy vehicles. Road speed was set to 15 miles per hour, and the road surface was set to smooth pavement. The results of this model are shown in Figure 6.

Figure 7 shows the maximum sound level results of eight trucks idling at the same time, added to the HVAC sound model. Idling trucks were modeled using a sound power level of 94 dB(A) at an engine height of 4 feet above grade. Octave band data for this source is provided later in this report. It is unlikely that this condition is ever realized given that State idling laws restrict the duration of idling.

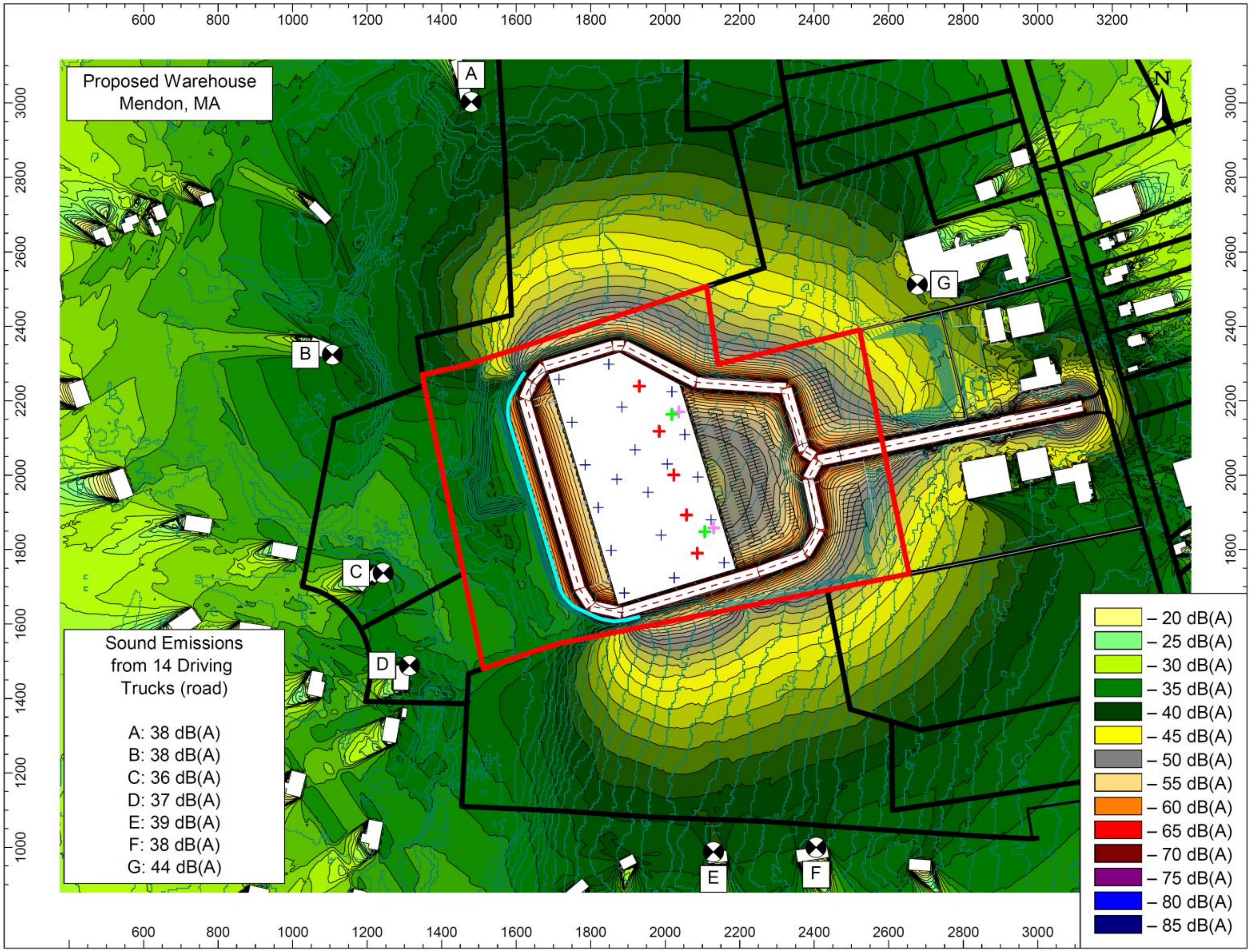


Figure 6 — L_{eq} A-weighted sound level contours, 5 feet above grade, for sound from all rooftop HVAC and 14 driving trucks during the worst-case hour. Rooftop units shown as a colored + on white building. Site property line outlined in red. A-weighted sound emissions tabulated at 15 feet above grade for all Locations.

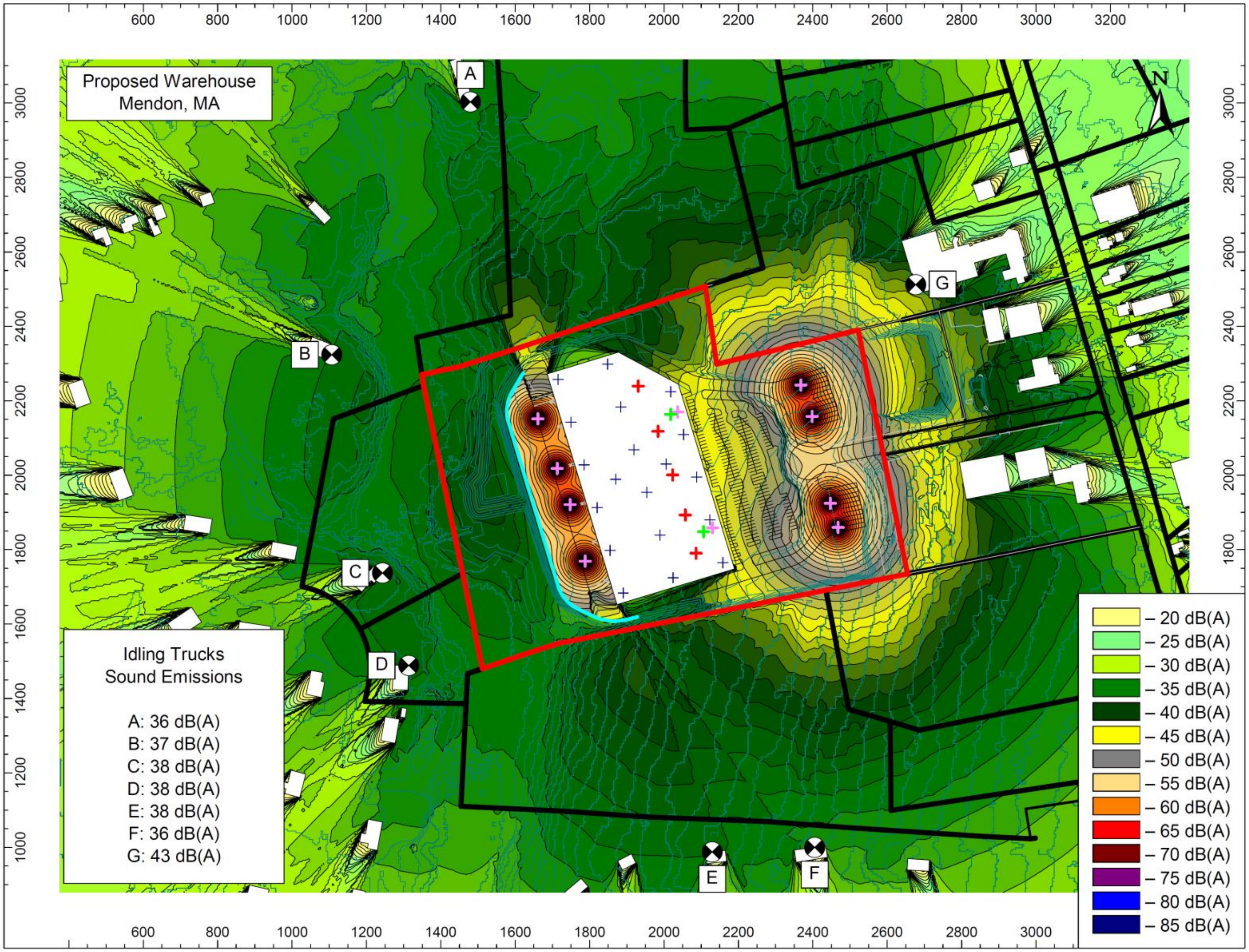


Figure 7 — Maximum A-weighted sound level contours, 5 feet above grade, for sound from rooftop HVAC and eight idling trucks. Rooftop units shown as a colored + on white building; idling trucks are shown with a pink + in truck areas. A-weighted sound emissions tabulated at 15 feet above grade for all Locations.

The technique used for Figure 6 was repeated for a variety of hourly truck trips. In lieu of presenting every model, the results are presented in Table 4 to be concise. Data for only HVAC sound is shown when truck counts are zero. Each hourly truck count is compared to the respective code limit shown in Table 2. Note that the 24-hour truck trip count in Table 4 equals 125 due to rounding. Sound levels for each Location and the associated code limit per hour shown are in dB(A) re 20μPa.

Table 4 – Summary of A-weighted L_{eq} sound level modelling results for hourly truck trip counts for each receptor Location. Massachusetts noise code limit per hour also provided.

	Hourly	Location							
Date and Time	**trips**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**Code**
1/21/2023 17:00	5	35	35	34	34	35	35	40	**49**
1/21/2023 18:00	1	31	32	33	32	32	31	35	**47**
1/21/2023 19:00	1	31	32	33	32	32	31	35	**46**
1/21/2023 20:00	2	32	33	33	33	33	32	37	**46**
1/21/2023 21:00	1	31	32	33	32	32	31	35	**44**
1/21/2023 22:00	0	29	31	32	31	30	30	32	**43**
1/21/2023 23:00	0	29	31	32	31	30	30	32	**41**
1/22/2023 0:00	0	29	31	32	31	30	30	32	**40**
1/22/2023 1:00	0	29	31	32	31	30	30	32	**40**
1/22/2023 2:00	2	32	33	33	33	33	32	37	**39**
1/22/2023 3:00	2	32	33	33	33	33	32	37	**39**
1/22/2023 4:00	3	33	34	33	33	34	33	38	**40**
1/22/2023 5:00	4	34	35	34	34	34	34	39	**40**
1/22/2023 6:00	5	35	35	34	34	35	35	40	**41**
1/22/2023 7:00	7	36	36	35	35	36	36	41	**43**
1/22/2023 8:00	7	36	36	35	35	36	36	41	**43**
1/22/2023 9:00	12	38	38	36	36	38	37	43	**44**
1/22/2023 10:00	12	38	38	36	36	38	37	43	**45**
1/22/2023 11:00	14	38	38	36	37	39	38	44	**45**
1/22/2023 12:00	8	36	37	35	35	37	36	41	**46**
1/22/2023 13:00	10	37	37	35	36	37	37	42	**47**
1/22/2023 14:00	8	36	37	35	35	37	36	41	**47**
1/22/2023 15:00	12	38	38	36	36	38	37	43	**47**
1/22/2023 16:00	9	37	37	35	35	37	36	42	**47**

Results in Table 4 show that all activity complies with the State noise code limits. The analysis of idling trucks shown in Figure 7 has the same conclusion since maximum off-site sound levels at Locations A through F do not exceed 39 dB(A) at any residential receptor. Maximum sound levels of 43 dB(A) are shown for the school/church receptor, Location G, which are well below the project goal of 60 dB(A) for this receptor. Analyses show that State noise code limits are met at all receptors.

While not regulated by noise codes, off-site truck routes were examined for potential acoustical impacts. It is logical to assume that most, if not all, truck traffic will come from Interstate-495 to the east and use Hartford Avenue (Route 126) and Cape Road to travel to and from the site. While there are sporadic residences along these roads, they are major roads in the area, and hence, are already well travelled by cars and trucks alike. Given this, no negative acoustical impact is expected and off-site trucks from this site will blend in with existing activity already in the area.

Pure Tone Analysis

A separate analysis was carried out to evaluate the presence of pure tones per State regulations. A model was generated similar to Figure 6 except that the 14 driving trucks over an hour period were modeled as a moving point source along a line within the truck court area. The line source was modelled at engine height, 4 feet above grade, with trucks travelling 15 mph. This metric produces overall sound levels slightly lower than using the RLS-90 standard; however, the model is able to provide spectra content of the driving truck to allow for evaluation of tones. In addition to the 14 trucks driving over an hour, two idling trucks were placed in the truck court and are shown as a pink +. All HVAC units are included. Model results are shown graphically in Figure 8 and in table form in Table 5. Table 6 provides octave band results for HVAC only model shown in Figure 5 for comparison to pure tone code limits. Table 7 provides the octave band sound power levels for truck noise sources used in this report. HVAC octave band sound power levels were previously provided in Table 3. Results in Tables 5 and 6 show that no single octave band at any receptor is elevated by more than 3 dB above the adjacent two bands, which indicates that the site will not produce any pure tones.

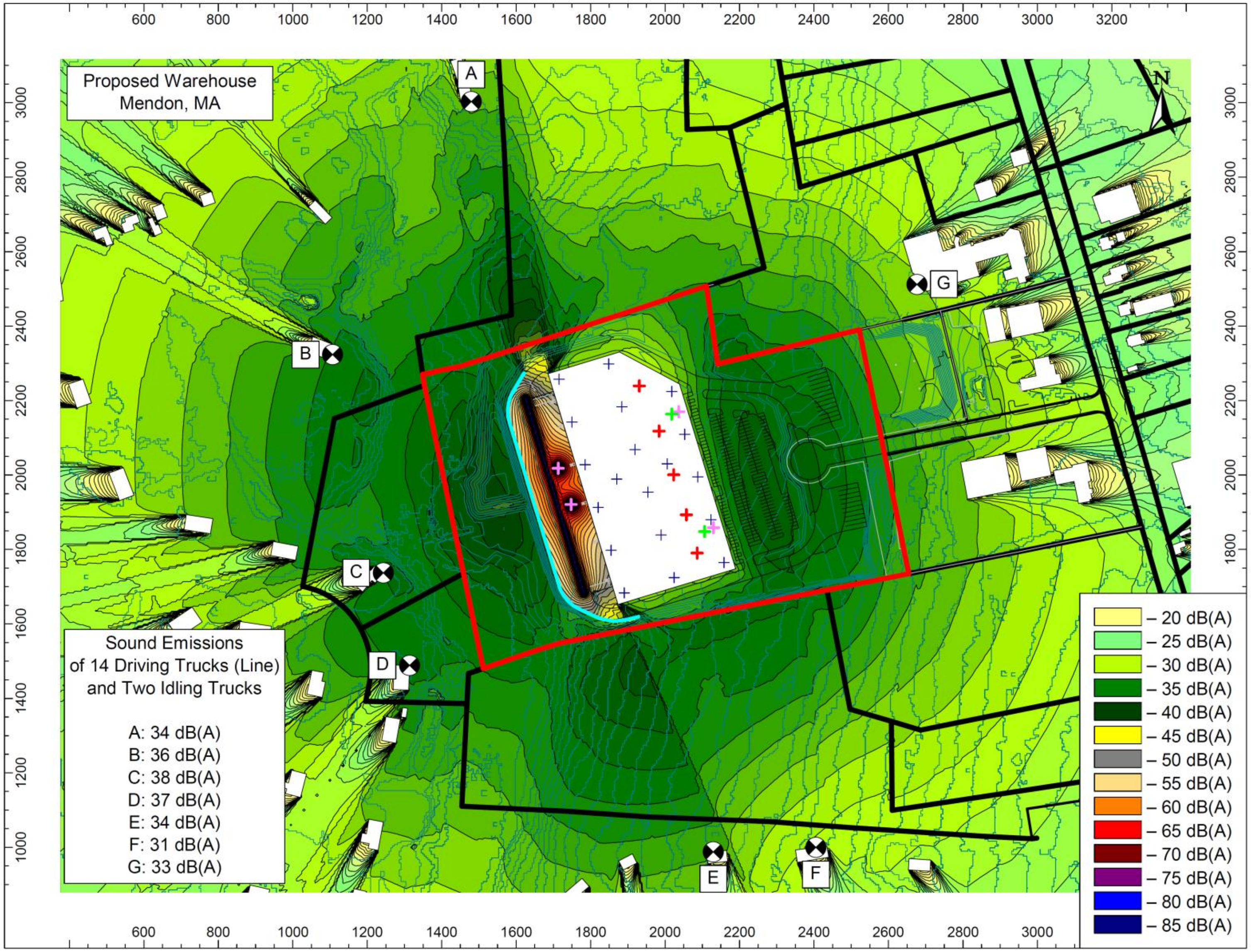


Figure 8 — **L_{eq} A-weighted sound level contours, 5 feet above grade, for all HVAC, two idling trucks, and 14 trucks operating over an hour period in the truck court. Rooftop units shown with a blue +; idling trucks are shown with a pink +. Buildings shown in white; site property line outlined in red. A-weighted sound emissions tabulated at 15 feet above grade for all Locations.**

Table 5 – L_{eq} Octave band results from Figure 8 pure tone analysis for all HVAC operating, two idling trucks, and fourteen trucks operating over an hour period, modelled as a moving point source along a line. Octave band center frequencies and A-weighted overall sound level given in dB re 20μPa.

	Octave Band Center Frequency (Hz)								
Location	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**A-wt**
A	43	39	31	29	30	25	17	-	34
B	45	41	34	32	33	27	19	-	36
C	47	43	36	35	34	28	20	-	38
D	46	42	35	34	33	27	19	-	37
E	44	39	32	30	31	26	18	-	34
F	44	38	31	28	26	22	14	-	31
G	44	39	32	29	28	25	16	-	33

Table 6 – L_{eq} Octave band results from Figure 5 pure tone analysis for all HVAC operating. Octave band center frequencies and A-weighted overall sound level given in dB re 20μPa.

	Octave Band Center Frequency (Hz)								
Location	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**A-wt**
A	43	36	29	25	24	20	40	-	29
B	44	38	30	27	25	23	15	-	31
C	45	39	31	28	27	24	17	-	32
D	45	38	31	27	26	24	16	-	31
E	43	37	30	27	25	21	13	-	30
F	42	37	30	27	25	22	13	-	30
G	44	38	31	29	28	25	16	-	32

Table 7 – Maximum octave band sound power levels for truck noise sources used in this report. All sound power levels given in dB re 1 picowatt.

	Octave Band Center Frequency (Hz)								
Source	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**A-wt**
Idling Truck	94	94	89	89	92	85	83	74	94
Driving Truck	111	109	107	104	99	97	96	90	107

Back-up Alarm Discussion

Since one of the common topics of discussion for warehouse sites is the sound of back-up alarms, a more detailed discussion is helpful. The traditional tonal "beeper" back-up alarm, which is purposefully designed to attract attention, has historically caused noise concerns at construction sites during the nighttime hours. This is because all construction equipment is required by law to be outfitted with these devices for safety. While purposeful, vehicles like front-end-loaders and excavators conduct a significant amount of back-up movements at construction sites resulting in an almost continuous presence of tonal alarm sound. For an over-the-road line haul tractor trailer, operation is much different. The installation of a back-up alarm on these vehicles is not mandatory by law and an individual truck visiting the site typically only carries out a single back-up movement per visit. Despite this, the trucking industry has generally adopted back-up alarms as offering added safety to protect employees walking in the vicinity of tractor trailers.

OAA finds that use of "beeper" back-up alarms in the truck industry is not as widespread as assumed, and the type of alarm per truck can vary from user to user. Based on our observations at dozens of warehouse-style facilities, OAA finds that about 1/3 of tractor trailers will have the traditional style tonal back-up alarm. Another one-third of trucks use a more modern broadband "shusher" alarm. These alarms emit a warning sound across multiple frequencies rather than using just one; the result is more of a *shush* sound than a *beep*. Lastly, the remain one-third of trucks that are observed by OAA are seen to not have a back-up alarm. Based on our experience, trucks using the standard tonal alarm are the minority at a typical warehouse facility

The use of broadband alarms is gaining popularity as they are just as effective at alerting nearby receptors, but because sound is in multiple frequency bands and not just one, the emitted sound blends in better with ambient sound at a distance. It should be noted that both styles of alarms come in either a constant level version or a self-adjusting version. Constant level alarms typically produce sound pressure levels of 102 dB(A) at 3 feet from the alarm. Self-adjusting versions of back-up alarms typically produce sound levels in the range of 77-to-97 dB(A), 3 feet from the alarm. The self-adjusting version uses a sensor which evaluates the sound pressure level in the vicinity of the truck and generates an alarm signal 10 dB above the measured sound level. Self-adjusting, or "smart", alarms ensure that the sound level is only as high as it needs to be to be effective.

An acoustical model of a traditional tonal alarm rated for 102 dB(A) at 3 feet, is shown to produce intermittent sound levels as high as 46 dB(A) at the nearest residence. This includes attenuation provided by distance and the proposed sound barrier but does not take into account directivity that might occur from the truck backing up and facing away from western residences. Levels of this magnitude are expected to be audible during lulls in the ambient, especially during the nighttime hours. Despite being audible, these events are not expected to have any negative impact on the nearby residences for the following reasons:

- Table 1 shows that average intermittent sound levels (L_{10}) in the area are currently in the mid-40's on an A-weighted scale.

- This magnitude is low enough to not disrupt sleep. The World Health Organization (WHO) has extensively evaluated sleep disturbance and has issued various guidelines for community noise. To avoid sleep disturbance the WHO recommends that average bedroom sound levels not exceed 30 dB(A) and that individual noise events not exceed 45 dB(A). Predicted intermittent site sound levels of 46 dB(A) outside of a bedroom window are attenuated by at least 10 dB from an open window; closed windows can attenuate outdoor sound by 25 dB or more. Exterior back-up alarm events are reduced to interior sound levels ranging from 21-to-36 dB(A) which fully conform with WHO guidelines and hence are not expected to disrupt sleeping and generate complaints.

- The ITE Trip Generation Manual provides historic data that support low truck volume during the night. For Warehouse Land Use Code 150, only 9% of truck traffic is expected to occur between 2200 hours and 0600 hours. For this size facility this equates to 6 trucks over this eight hour period. Most hours will only see 1 or 2 trucks in a typical nighttime hour. This low volume minimizes the potential for adverse effects due to back-up alarm events.

RECOMMENDATIONS

1. In order to achieve the modelled reductions shown in this report, the proposed 12-foot-tall barrier needs to meet the following requirements:

    - The barrier needs to be solid, without openings, and be of sufficient surface weight to force sound to travel over or around the barrier and not leak through it. A recommended minimum surface weight for the barrier is 3 lbs/ft^2. Water drainage can be provided along the bottom of the barrier provided it is backfilled with gravel.

- A wide variety of materials meet this weight requirement and include $^5/_8$-inch thick sheet steel piling, precast or poured-in-place concrete, acoustical metal panels, or engineered wood. Other hybrid system specifically manufactured for the purpose are also available with an internal absorptive face, but this feature is not necessary for this site.

- The barrier, being solid, must be designed to resist wind load. Hence it is a structure that requires engineered footings, the design of which will need to be overseen by structural professionals.

2. Proceed with HVAC equipment plans, keeping in mind acoustical performance to ensure modelled results are realized. The acoustical performance of the rooftop units and exhaust fans is provided in Table 5 as a guideline. Note that strict adherence to Table 5 sound power levels is not warranted as the quantity and type of final units is most critical. The overall intent of the HVAC model should be met by the final HVAC design.

3. Analyses in this report have shown that standard single-frequency back-up alarms are expected to be acceptable and not cause noise complaints. To minimize any potential for back-up alarms complaints, to the extent feasible we recommend outfitting trucks owned and controlled by the site with smart, ambient sensing, multi-frequency back-up alarms. This is especially effective for on-site terminal tractors/yard jockeys as these trucks are responsible for majority of back-up movements on site. These are available from a variety of manufacturers such as Ecco, specifically Model EA9724. These devices reduce annoyance generated from constant level, pure tone, "beeping" back-up alarms. The reduction in annoyance is accomplished in two ways:

   - A broadband "shushing" sound is less intrusive and annoying than a pure tone "beeping" sound since, at a distance, it can blend in easier with other ambient sounds.

   - The smart, ambient-sensing feature allows back-up alarms to operate safely and effectively at far lower sound levels than typical brute-force, constant level devices.

The smart alarms sample ambient background noise and adjust the warning signal to be 5-to-10 dB higher than the background sound level, therefore reducing sound levels nearby and off-site.

CONCLUSION

A warehouse is planned in Mendon, MA. In most directions, the immediate abutting receptors are commercial in nature or not sensitive to noise. There are residential neighborhoods bordering the site to the west and beyond the non-sensitive receptors in other directions. A thorough ambient sound survey was conducted to determine State and local noise code criteria.

Based on results of analyses, steady HVAC site noise is expected to fall well below allowable noise code limits and be more aligned with existing lulls in the area. Proposed HVAC equipment arrangements can proceed; however, keep in mind that any modification to the arrangement may affect site sound emissions. For heavy truck activity on-site, modelling results indicate that, with the inclusion of a 12-foot-tall sound barrier, all code limits will be met. The sound barrier will block line-of-sight of intermittent dock activity to residences to the west and south and minimize potential impacts. Lastly, review of HVAC only, and activity with driving and idling truck sound levels, shows no pure tone conditions were found.

The site layout represents good acoustical planning, and the noise control barrier will put the site in the best position to be a good neighbor. No negative acoustical impact is anticipated from site operations, and results support that site sound will conform and blend in with existing sound in the vicinity.

APPENDIX

West Caldwell Calibration Laboratories Inc.

Certificate of Calibration

for

SOUND CALIBRATOR

Manufactured by:	BRUEL & KJAER
Model No:	4231
Serial No:	2583372
Calibration Recall No:	33259

Submitted By:

Customer:	BENJAMIN C. MUELLER
Company:	OSTERGAARD ACOUSTICAL ASSOCIATES
Address:	1460 US HIGHWAY 9 NORTH
	WOODBRIDGE NJ 07095

The subject instrument was calibrated to the indicated specification using standards traceable to the SI through the National Institute of Standards and Technology or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the submitter.

West Caldwell Calibration Laboratories Procedure No. 4231 BRUE

Upon receipt for Calibration, the instrument was found to be:

Within (X)

tolerance of the indicated specification. See attached Report of Calibration.
The information supplied certifies that the item listed above meets acceptance criteria under the decision rule: A=(L-(U95)), where A is the acceptance criteria, L is manufacturer specifications, and U95 is confidence level of 95% at k=2. The decision rule has been communicated and approved by customer during contract review. Measurements marked with (*) are not covered by the scope of current A2LA accreditation.

West Caldwell Calibration Laboratories' calibration control system meets the following requirements: ANSI/NCSL Z540-1, ISO 9001, and ISO 17025.

Note: With this Certificate, Report of Calibration is included.

Approved by:

James Zhu

Quality Manager

Calibration Date:	22-Jul-22
Certificate Issue Date:	25-Jul-22
Certificate No:	33259 - 13

QA Doc. #1051 Rev. 3.0 5/29/20

ISO/IEC 17025

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor, NY 14564, U.S.A.

ACCREDITED

Calibration Lab. Cert. # 1533.01

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor NY 14564

ISO/IEC 17025
ACCREDITED
Calibration Lab. Cert. # 1533.01

REPORT OF CALIBRATION

for

Brüel & Kjær Sound Calibrator **Model No.: 4231** **Serial No.: 2583372**
Company: Ostergaard Acoustical Associates **ID No.: XXXX**

Calibration results:

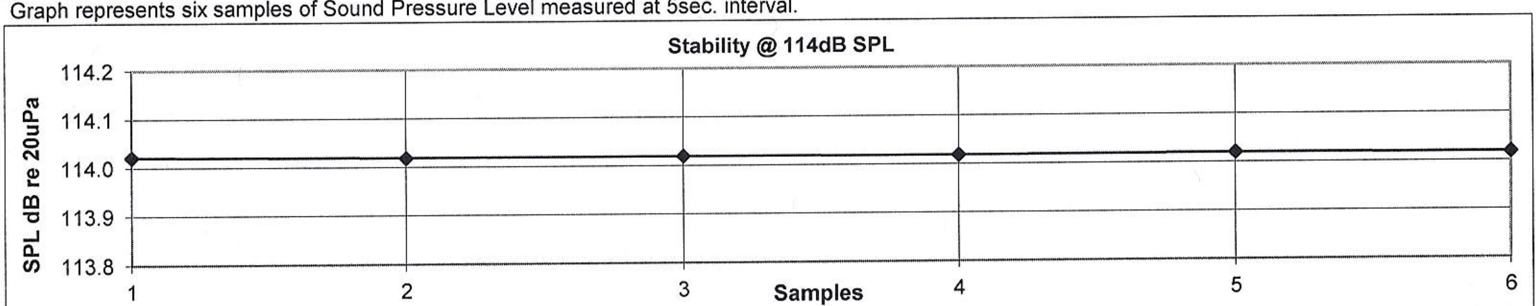
Before data: .... After data: ....
Before & after data same: ...X...
Sound Pressure Level at 1000.0 Hz and pressure of 1013 hPa (mbar) was 114.02 dB re 20μPa
(Calibrator tested with ½" adaptor UC 0210)
IEC 1094-4 Type WS 2 P Microphone was used for measurement.

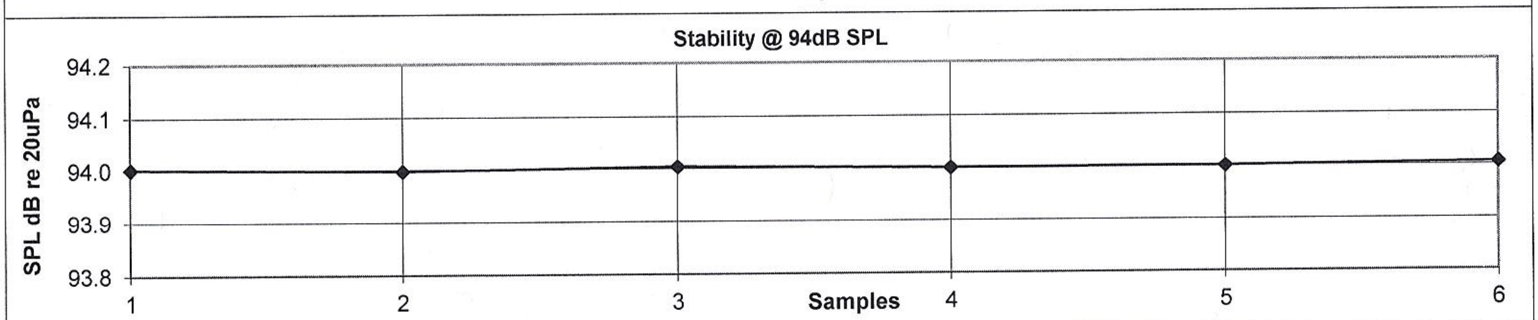
	114dB	94dB
Sound Pressure Level:	Pass	Pass
Frequency:	Pass	Pass
Distortion:	Pass	Pass
Stability:	Pass	Pass
All tested parameters:		Pass

The above listed instrument meets or exceeds the tested manufacturer's specifications
The IEC 60942:2003 Class 1 specifications, passed.
The ANSI S1.4-1984 specifications, passed.
This Calibration is traceable through NIST test numbers: CAS-535222-R8K0R7-704
The absolute uncertainty of calibration: See last page. Unless otherwise noted, the reported values are both "as found" and "as left" data.

Laboratory Environment:		
Ambient Temperature:	20.9	°C
Ambient Humidity:	40.2	% RH
Ambient Pressure:	98.823	kPa
Calibration Date:	22-Jul-2022	
Calibration Due:	22-Jul-2023	
Report Number:	33259 -13	
Control Number:	33259	

Graph represents six samples of Sound Pressure Level measured at 5sec. interval.





The above listed instrument was checked using calibration procedure documented in West Caldwell Calibration Laboratories Inc. procedure : **Rev. 7.0 Jan. 24, 2014 Doc. # 1038 4231B&K**

Calibration was performed by West Caldwell Calibration Laboratories Inc. under Operating Procedures intended to implement the requirements of ANSI/NCSL Z540-1, ISO 9001, and ISO 17025.

Cal. Date: 22-Jul-2022

Measurements performed by: ....
James Zhu

Calibrated on WCCL system type 9700

Rev. 7.0 Jan. 24, 2014 Doc. # 1038 4231B&K

West Caldwell Calibration Laboratories Inc.
1575 State Route 96, Victor NY 14564
Tel. (585) 586-3900 FAX (585) 586-4327

Calibration Data Record

for

Brüel & Kjær Sound Calibrator **Model No.: 4231** **Serial No.: 2583372**
Company: Ostergaard Acoustical Associates

All tested parameters: Pass

Measured Sound Pressure Level (Six samples measured at 5 sec. interval)

Sample	1	114.02 dB re 20μPa	94.00 dB re 20μPa	
	2	114.02	94.00	
	3	114.02	94.00	
	4	114.02	94.00	
	5	114.02	94.00	
	6	114.02	94.01	
	Average	**114.02** Spec. 114dB ± 0.2dB	**94.00**	Spec. 94dB ± 0.2dB

Frequency measured (Three samples at 30 sec. Interval)

Sample	1	999.97 Hz	999.96 Hz	
	2	999.97	999.99	
	3	999.97	999.99	
	Average	**999.97**	**999.98**	Spec. 1000Hz ±0.1%

Distortion measured	-48.2 dB	-49.3 dB	Spec. ≤-40dB

The expanded uncertainty of calibration at 95% confidence level with a coverage factor of k=2.

Parameter	Test Instrumentation Uncertainty	DUT Uncertainty	Total DUT Uncertainty
Acoustic Level ([114 & 94] @ 1 kHz):	**0.14**	**0.1**	**0.24**
Attenuator accuracy (Attenuation Measure):	**0.17**	**0.1**	**0.27**
Frequency Measure (DC to 10 MHz):	**6.0 parts in [10^8] Hz**		

Instruments used for calibration:			Date of Cal.	Traceability No.	Re-cal. Due Date
Brüel & Kjær	4231	S/N 2205493	28-Jun-2022	CAS-535222-R8K0R7-704	28-Jun-2023
Brüel & Kjær	4134	S/N 1591022	28-Jun-2022	CAS-535222-R8K0R7-704	28-Jun-2023
Brüel & Kjær	2669	S/N 1835082	28-Jun-2022	,682636	28-Jun-2023
HP	34401A	S/N US360641	24-Jun-2022	,682636	24-Jun-2023
Brüel & Kjær	2636	S/N 1107902	27-Jun-2022	,682636	27-Jun-2023
HP	33120A	S/N US360437	24-Jun-2022	,682636	24-Jun-2023

Cal. Date: 22-Jul-2022 **Tested by: James Zhu**

Calibrated on WCCL system type 9700

Rev. 7.0 Jan. 24, 2014 Doc. # 1038 4231B&K

IEC 61672-3 – Section 17 – Level Linearity including Range Control

Range	Level	Applied	Measure	Error	Tolerance	PASS / FAIL
Low	Ref.	94,0	94,0	---	---	---
Low	UR+5dB	37,3	37,4	0,1	1,1	Pass
High	Ref.	94,0	93,9	0,1	1,1	Pass
High	UR+5dB	53,3	53,3	0,0	1,1	Pass

IEC 61672-3 – Section 18 – ToneBurst Response

Tb(ms)	Data	Applied	Measure	Meas. Diff.	Target Diff.	Error	Tolerance	PASS / FAIL
200	LASmax	107,2	99,8	-7,4	-7,4	0,0	±1,0	Pass
2	LASmax	107,2	80,1	-27,1	-27,0	-0,1	1,0; -5,0	Pass
200	LAFmax	107,2	106,1	-1,1	-1,0	-0,1	±1,0	Pass
2	LAFmax	107,2	89,1	-18,1	-18,0	-0,1	1,0; -2,5	Pass
0,25	LAFmax	107,2	80,0	-27,2	-27,0	-0,2	1,5; -5,0	Pass
200	LAE	107,2	100,3	-6,9	-7,0	0,1	±1,0	Pass
2	LAE	107,2	80,2	-27,0	-27,0	0,0	1,0; -2,5	Pass
0,25	LAE	107,2	71,2	-36,0	-36,0	0,0	1,5; -5,0	Pass

IEC 61672-3 – Section 19 – C-Weighted Peak Sound Level

Freq.	Cycle	Applied	Meas.	Meas. Diff.	Target Diff.	Error	Tolerance	PASS / FAIL
31,5Hz	1 (Full)	122,2	125,2	3,0	2,5	0,5	±3,0	Pass
500Hz	1 (Full)	125,3	128,9	3,6	3,5	0,1	±2,0	Pass
8kHz	1 (Full)	122,2	125,1	2,9	3,4	-0,5	±3,0	Pass
500Hz	½ (Pos.)	125,3	127,1	1,8	2,4	-0,6	±2,0	Pass
500Hz	½ (Neg.)	125,3	127,1	1,8	2,4	-0,6	±2,0	Pass

IEC 61672-3 – Section 20 – Overload Indication

Low Range

Data	Freq.	Overload (+)	Overload (-)	Error	Tolerance	PASS / FAIL
LZE	4kHz	70,7	70,6	0,1	±1,5	Pass
LCE	4kHz	70,1	70,0	0,1	±1,5	Pass
LAE	4kHz	70,9	70,8	0,1	±1,5	Pass
LZpk	4kHz	112,2	112,3	0,1	±1,5	Pass
LCpk	4kHz	111,4	111,4	0,0	±1,5	Pass

High Range

Data	Freq.	Overload (+)	Overload (-)	Error	Tolerance	PASS / FAIL
LZE	4kHz	90,8	90,6	0,2	±1,5	Pass
LCE	4kHz	90,2	90,0	0,2	±1,5	Pass
LAE	4kHz	91,1	90,9	0,2	±1,5	Pass
LZpk	4kHz	132,3	132,2	0,1	±1,5	Pass
LCpk	4kHz	131,5	131,4	0,1	±1,5	Pass

IEC 61672-3 – Section 21 – High-level Stability

Initial	Final	Error	Tolerance	PASS / FAIL
128,2	128,2	0,0	0,3	Pass

Soft dB
WWW.SOFTDB.COM

1040, Avenue Belvedere, Suite 215
Quebec, Qc, Canada, G1S 3G3
1 (418) 686-0993
Email: info@softdb.com
www.softdb.com

Calibration Certificate No. P02QC2022022804

22/02/28

Instrument

Type:	Integrating Averaging Sound Level Meter
Model:	Piccolo-II
SN:	P0222022804
Class:	2
Mic Sensitivity:	13,67mV/Pa (-2,3 dB from nominal)

Standards

Tested in accordance with procedures from ANSI/ASA S1.4-3 (2014) / IEC 61672-3 (2013) Electroacoustics - Sound Level Meters - Part 3: Periodic tests

Calibration Instruments

Description	Manufacturer	Model	Serial Number
Function Generator	Stanford Research Systems	DS360	33623
Multi-function Calibrator	Brüel & Kjær	4226	1551588

Environmental Conditions

Temperature	Barometric Pressure	Humidity
22,1°C	101,4kPa	49%

Personnel

Calibrated by: Simon Couture, Tech Date : 22/02/28

Summary

Description	PASS / FAIL
Section 11.1 – Self-generated noise (Microphone)	Pass
Section 11.2 – Self-generated noise (Electrical input)	Pass
Section 12 – Acoustical signal tests of frequency weightings	Pass
Section 13 – Electrical signal tests of frequency weightings	Pass
Section 14 – Frequency and time weightings at 1 kHz	Pass
Section 15 – Long-term stability	Pass
Section 16 – Level linearity on the reference level range	Pass
Section 17 – Level linearity including range control	Pass
Section 18 – Toneburst response	Pass
Section 19 – C-weighted peak sound level	Pass
Section 20 – Overload indication	Pass
Section 21 – High-level stability	Pass

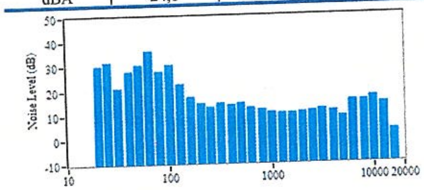
Declaration of Conformity

The sound level meter submitted for testing has successfully completed the Class 2 tests of ANSI/ASA S1.4-3 (2014) / IEC 61672-3 (2013) (limited to sections 11, 12 , 13, 14, 15, 16, 17, 18, 19, 20 and 21), for the environment conditions under which the tests were performed.

IEC 61672-3 – Section 11.1 – Self-generated noise (Microphone)

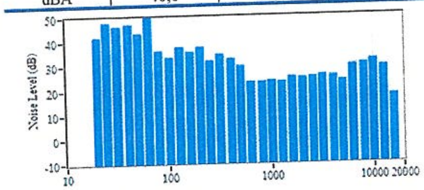
Low Range

Value	Measure	Limit	PASS / FAIL
dBZ	40,4	---	---
dBC	38,8	---	---
dBA	24,8	32,3	Pass



High Range

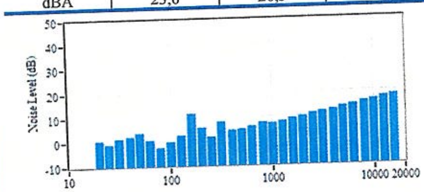
Value	Measure	Limit	PASS / FAIL
dBZ	60,0	---	---
dBC	58,4	---	---
dBA	40,0	42,3	Pass



IEC 61672-3 – Section 11.2 – Self-generated noise (Electric)

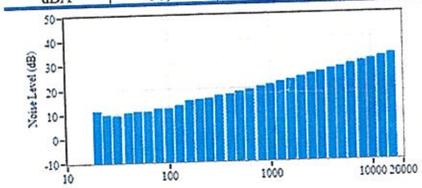
Low Range

Value	Measure	Limit	PASS / FAIL
dBZ	26,1	---	---
dBC	22,8	---	---
dBA	23,6	26,3	Pass

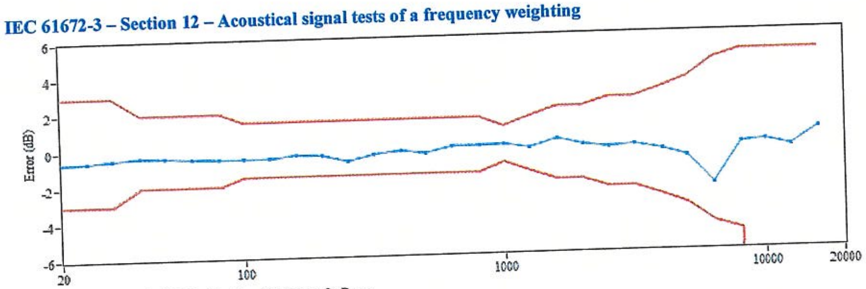


High Range

Value	Measure	Limit	PASS / FAIL
dBZ	40,6	---	---
dBC	36,9	---	---
dBA	38,3	42,3	Pass

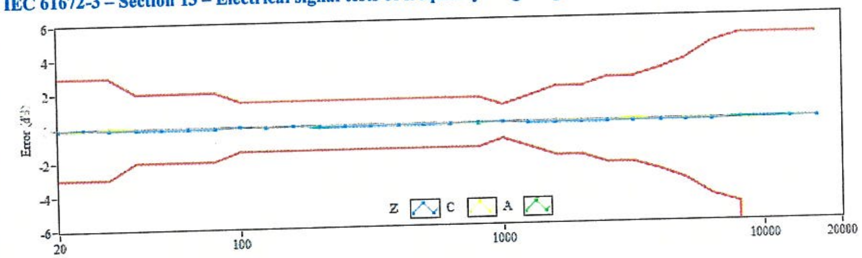


IEC 61672-3 – Section 12 – Acoustical signal tests of a frequency weighting



Conformity to IEC 61672-3 – Section 12, Class 2: Pass

IEC 61672-3 – Section 13 – Electrical signal tests of frequency weightings



Conformity to IEC 61672-3 – Section 12, Class 2: Pass

IEC 61672-3 – Section 14 – Frequency and time weightings at 1 kHz

Data	Measure	Error	Tolerance	PASS / FAIL
LAF	94,0	---	---	---
LCF	94,0	0,0	±0,1	Pass
LZF	94,0	0,0	±0,1	Pass
LAS	94,0	0,0	±0,2	Pass
LCS	94,0	0,0	±0,1	Pass
LZS	94,0	0,0	±0,1	Pass
LAeq	93,9	0,1	±0,2	Pass
LCeq	93,9	0,0	±0,1	Pass
LZeq	93,9	0,0	±0,1	Pass

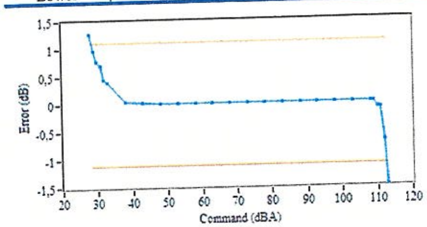
IEC 61672-3 – Section 15 – Long-term Stability

Initial	Final	Error	Tolerance	PASS / FAIL
94,0	94,0	0,0	0,3	Pass

IEC 61672-3 – Section 16 – Level Linearity (at 4 kHz)

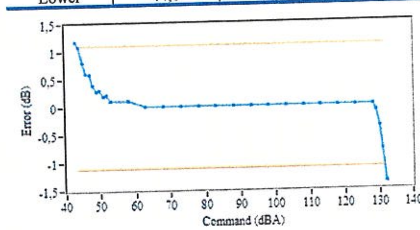
Low Range

Boundary	Measure (dBA)	Limit (dBA)	PASS / FAIL
Upper	112,0	108,1	Pass
Lower	29,0	32,3	Pass



High Range

Boundary	Measure (dBA)	Limit (dBA)	PASS / FAIL
Upper	131,0	128,1	Pass
Lower	44,0	48,3	Pass



IEC 61672-3 – Section 17 – Level Linearity including Range Control

Range	Level	Applied	Measure	Error	Tolerance	PASS / FAIL
Low	Ref.	94,0	94,0	---	---	---
Low	UR+5dB	36,4	36,6	0,2	1,1	Pass
High	Ref.	94,0	94,0	0,0	1,1	Pass
High	UR+5dB	52,4	52,5	0,1	1,1	Pass

IEC 61672-3 – Section 18 – ToneBurst Response

Tb(ms)	Data	Applied	Measure	Meas. Diff.	Target Diff.	Error	Tolerance	PASS / FAIL
200	LASmax	106,3	98,8	-7,5	-7,4	-0,1	±1,0	Pass
2	LASmax	106,3	79,2	-27,1	-27,0	-0,1	1,0; -5,0	Pass
200	LAFmax	106,3	105,2	-1,1	-1,0	-0,1	±1,0	Pass
2	LAFmax	106,3	87,5	-18,8	-18,0	-0,8	1,0; -2,5	Pass
0,25	LAFmax	106,3	78,9	-27,4	-27,0	-0,4	1,5; -5,0	Pass
200	LAE	106,3	99,3	-7,0	-7,0	0,0	±1,0	Pass
2	LAE	106,3	79,3	-27,0	-27,0	0,0	1,0; -2,5	Pass
0,25	LAE	106,3	70,2	-36,1	-36,0	-0,1	1,5; -5,0	Pass

IEC 61672-3 – Section 19 – C-Weighted Peak Sound Level

Freq.	Cycle	Applied	Meas.	Meas. Diff.	Target Diff.	Error	Tolerance	PASS / FAIL
31,5Hz	1 (Full)	101,3	104,3	3,0	2,5	0,5	±3,0	Pass
500Hz	1 (Full)	104,4	108,0	3,6	3,5	0,1	±2,0	Pass
8kHz	1 (Full)	101,3	104,5	3,2	3,4	-0,2	±3,0	Pass
500Hz	½ (Pos.)	104,4	106,2	1,8	2,4	-0,6	±2,0	Pass
500Hz	½ (Neg.)	104,4	106,0	1,6	2,4	-0,8	±2,0	Pass

IEC 61672-3 – Section 20 – Overload Indication

Low Range

Data	Freq.	Overload (+)	Overload (-)	Error	Tolerance	PASS / FAIL
LZE	4kHz	69,9	69,8	0,1	±1,5	Pass
LCE	4kHz	69,2	69,1	0,1	±1,5	Pass
LAE	4kHz	70,1	70,0	0,1	±1,5	Pass
LZpk	4kHz	111,4	111,4	0,0	±1,5	Pass
LCpk	4kHz	110,6	110,5	0,1	±1,5	Pass

High Range

Data	Freq.	Overload (+)	Overload (-)	Error	Tolerance	PASS / FAIL
LZE	4kHz	90,0	89,9	0,1	±1,5	Pass
LCE	4kHz	89,4	89,2	0,2	±1,5	Pass
LAE	4kHz	90,2	90,1	0,1	±1,5	Pass
LZpk	4kHz	131,3	131,4	0,1	±1,5	Pass
LCpk	4kHz	130,7	130,6	0,1	±1,5	Pass

IEC 61672-3 – Section 21 – High-level Stability

Initial	Final	Error	Tolerance	PASS / FAIL
127,4	127,4	0,0	0,3	Pass

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1 (418) 686-0993
Email: info@softdb.com
www.softdb.com

Calibration Certificate No. P02QC2022022805

22/02/28

Instrument

Type: Integrating Averaging Sound Level Meter
Model: Piccolo-II
SN: P0222022805
Class: 2
Mic Sensitivity: 15,17mV/Pa (-1,4 dB from nominal)

Standards

Tested in accordance with procedures from ANSI/ASA S1.4-3 (2014) / IEC 61672-3 (2013) Electroacoustics - Sound Level Meters - Part 3: Periodic tests

Calibration Instruments

Description	Manufacturer	Model	Serial Number
Function Generator	Stanford Research Systems	DS360	33623
Multi-function Calibrator	Brüel & Kjær	4226	1551588

Environmental Conditions

Temperature	Barometric Pressure	Humidity
23,6°C	103,0kPa	54%

Personnel

Calibrated by: Simon Couture

Simon Couture, Tech

Date : 22/02/28

Summary

Description	PASS / FAIL
Section 11.1 – Self-generated noise (Microphone)	Pass
Section 11.2 – Self-generated noise (Electrical input)	Pass
Section 12 – Acoustical signal tests of frequency weightings	Pass
Section 13 – Electrical signal tests of frequency weightings	Pass
Section 14 – Frequency and time weightings at 1 kHz	Pass
Section 15 – Long-term stability	Pass
Section 16 – Level linearity on the reference level range	Pass
Section 17 – Level linearity including range control	Pass
Section 18 – Toneburst response	Pass
Section 19 – C-weighted peak sound level	Pass
Section 20 – Overload indication	Pass
Section 21 – High-level stability	Pass

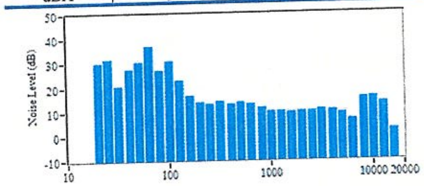
Declaration of Conformity

The sound level meter submitted for testing has successfully completed the Class 2 tests of ANSI/ASA S1.4-3 (2014) / IEC 61672-3 (2013) (limited to sections 11, 12 , 13, 14, 15, 16, 17, 18, 19, 20 and 21), for the environment conditions under which the tests were performed.

IEC 61672-3 – Section 11.1 – Self-generated noise (Microphone)

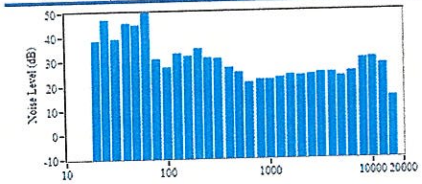
Low Range

Value	Measure	Limit	PASS / FAIL
dBZ	40,6	---	---
dBC	39,1	---	---
dBA	23,9	31,4	Pass



High Range

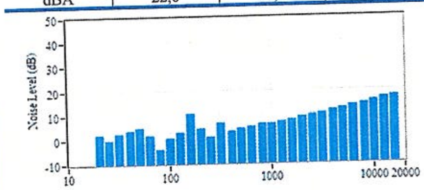
Value	Measure	Limit	PASS / FAIL
dBZ	61,5	---	---
dBC	60,0	---	---
dBA	39,0	41,4	Pass



IEC 61672-3 – Section 11.2 – Self-generated noise (Electric)

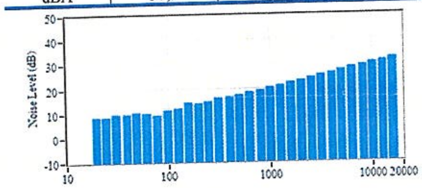
Low Range

Value	Measure	Limit	PASS / FAIL
dBZ	25,0	---	---
dBC	21,9	---	---
dBA	22,6	25,4	Pass

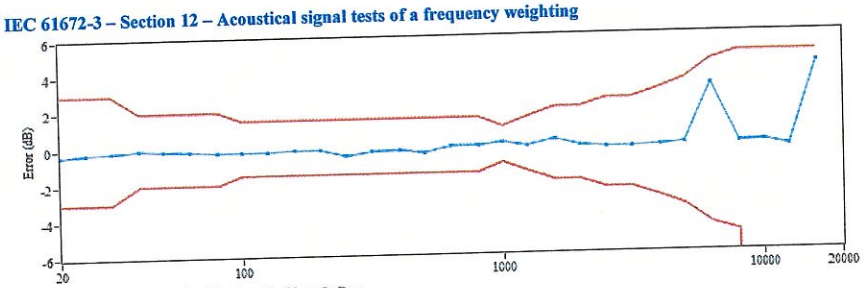


High Range

Value	Measure	Limit	PASS / FAIL
dBZ	39,7	---	---
dBC	36,0	---	---
dBA	37,3	41,4	Pass

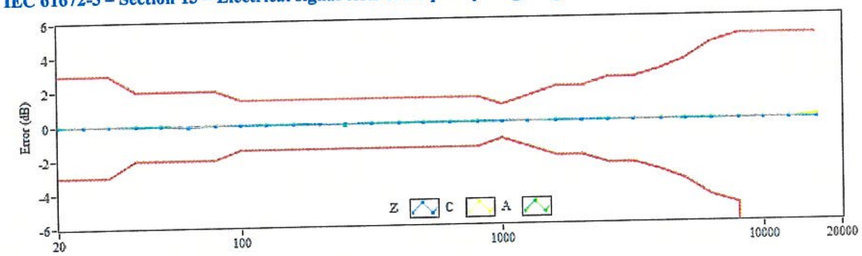


IEC 61672-3 – Section 12 – Acoustical signal tests of a frequency weighting



Conformity to IEC 61672-3 – Section 12, Class 2: Pass

IEC 61672-3 – Section 13 – Electrical signal tests of frequency weightings



Conformity to IEC 61672-3 – Section 12, Class 2: Pass

IEC 61672-3 – Section 14 – Frequency and time weightings at 1 kHz

Data	Measure	Error	Tolerance	PASS / FAIL
LAF	94,0	---	---	---
LCF	94,0	0,0	±0,1	Pass
LZF	94,0	0,0	±0,1	Pass
LAS	94,0	0,0	±0,2	Pass
LCS	94,0	0,0	±0,1	Pass
LZS	94,0	0,0	±0,1	Pass
LAeq	94,0	0,0	±0,2	Pass
LCeq	94,0	0,0	±0,1	Pass
LZeq	94,0	0,0	±0,1	Pass

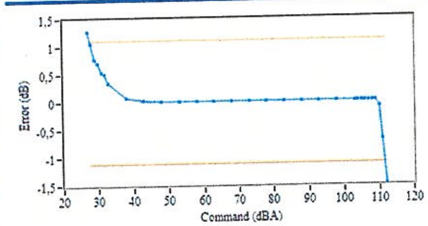
IEC 61672-3 – Section 15 – Long-term Stability

Initial	Final	Error	Tolerance	PASS / FAIL
94,0	94,0	0,0	0,3	Pass

IEC 61672-3 – Section 16 – Level Linearity (at 4 kHz)

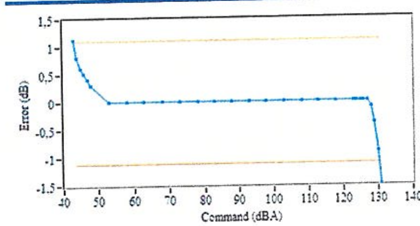
Low Range

Boundary	Measure (dBA)	Limit (dBA)	PASS / FAIL
Upper	111,0	107,2	Pass
Lower	28,0	31,4	Pass



High Range

Boundary	Measure (dBA)	Limit (dBA)	PASS / FAIL
Upper	130,0	127,2	Pass
Lower	44,0	47,4	Pass



IEC 61672-3 – Section 17 – Level Linearity including Range Control

Range	Level	Applied	Measure	Error	Tolerance	PASS / FAIL
Low	Ref.	94,0	94,0	---	---	---
Low	UR+5dB	37,5	37,7	0,2	1,1	Pass
High	Ref.	94,0	94,0	0,0	1,1	Pass
High	UR+5dB	53,5	53,6	0,1	1,1	Pass

IEC 61672-3 – Section 18 – ToneBurst Response

Tb(ms)	Data	Applied	Measure	Meas. Diff.	Target Diff.	Error	Tolerance	PASS / FAIL
200	LASmax	107,4	99,9	-7,5	-7,4	-0,1	±1,0	Pass
2	LASmax	107,4	80,4	-27,0	-27,0	0,0	1,0; -5,0	Pass
200	LAFmax	107,4	106,3	-1,1	-1,0	-0,1	±1,0	Pass
2	LAFmax	107,4	88,7	-18,7	-18,0	-0,7	1,0; -2,5	Pass
0,25	LAFmax	107,4	80,2	-27,2	-27,0	-0,2	1,5; -5,0	Pass
200	LAE	107,4	100,4	-7,0	-7,0	0,0	±1,0	Pass
2	LAE	107,4	80,4	-27,0	-27,0	0,0	1,0; -2,5	Pass
0,25	LAE	107,4	71,4	-36,0	-36,0	0,0	1,5; -5,0	Pass

IEC 61672-3 – Section 19 – C-Weighted Peak Sound Level

Freq.	Cycle	Applied	Meas.	Meas. Diff.	Target Diff.	Error	Tolerance	PASS / FAIL
31,5Hz	1 (Full)	122,4	125,4	3,0	2,5	0,5	±3,0	Pass
500Hz	1 (Full)	125,5	129,1	3,6	3,5	0,1	±2,0	Pass
8kHz	1 (Full)	122,4	125,5	3,1	3,4	-0,3	±3,0	Pass
500Hz	½ (Pos.)	125,5	127,3	1,8	2,4	-0,6	±2,0	Pass
500Hz	½ (Neg.)	125,5	127,3	1,8	2,4	-0,6	±2,0	Pass

IEC 61672-3 – Section 20 – Overload Indication

Low Range

Data	Freq.	Overload (+)	Overload (-)	Error	Tolerance	PASS / FAIL
LZE	4kHz	70,9	70,8	0,1	±1,5	Pass
LCE	4kHz	70,3	70,2	0,1	±1,5	Pass
LAE	4kHz	71,1	71,0	0,1	±1,5	Pass
LZpk	4kHz	112,5	112,4	0,1	±1,5	Pass
LCpk	4kHz	111,7	111,6	0,1	±1,5	Pass

High Range

Data	Freq.	Overload (+)	Overload (-)	Error	Tolerance	PASS / FAIL
LZE	4kHz	91,0	90,8	0,2	±1,5	Pass
LCE	4kHz	90,4	90,2	0,2	±1,5	Pass
LAE	4kHz	91,2	91,0	0,2	±1,5	Pass
LZpk	4kHz	132,4	132,5	0,1	±1,5	Pass
LCpk	4kHz	131,7	131,7	0,0	±1,5	Pass

IEC 61672-3 – Section 21 – High-level Stability

Initial	Final	Error	Tolerance	PASS / FAIL
128,4	128,4	0,0	0,3	Pass

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Email: info@softdb.com
www.softdb.com

Calibration Certificate No. P02QC2022022806

22/02/28

Instrument

Type:	Integrating Averaging Sound Level Meter
Model:	Piccolo-II
SN:	P0222022806
Class:	2
Mic Sensitivity:	13,36mV/Pa (-2,5 dB from nominal)

Standards

Tested in accordance with procedures from ANSI/ASA S1.4-3 (2014) / IEC 61672-3 (2013) Electroacoustics - Sound Level Meters - Part 3: Periodic tests

Calibration Instruments

Description	Manufacturer	Model	Serial Number
Function Generator	Stanford Research Systems	DS360	33623
Multi-function Calibrator	Brüel & Kjær	4226	1551588

Environmental Conditions

Temperature	Barometric Pressure	Humidity
23,4°C	99,6kPa	54%

Personnel

Calibrated by: Simon Couture, Tech Date : 22/02/28

Summary

Description	PASS / FAIL
Section 11.1 – Self-generated noise (Microphone)	Pass
Section 11.2 – Self-generated noise (Electrical input)	Pass
Section 12 – Acoustical signal tests of frequency weightings	Pass
Section 13 – Electrical signal tests of frequency weightings	Pass
Section 14 – Frequency and time weightings at 1 kHz	Pass
Section 15 – Long-term stability	Pass
Section 16 – Level linearity on the reference level range	Pass
Section 17 – Level linearity including range control	Pass
Section 18 – Toneburst response	Pass
Section 19 – C-weighted peak sound level	Pass
Section 20 – Overload indication	Pass
Section 21 – High-level stability	Pass

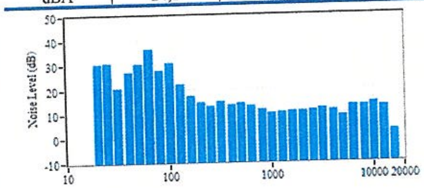
Declaration of Conformity

The sound level meter submitted for testing has successfully completed the Class 2 tests of ANSI/ASA S1.4-3 (2014) / IEC 61672-3 (2013) (limited to sections 11, 12 , 13, 14, 15, 16, 17, 18, 19, 20 and 21), for the environment conditions under which the tests were performed.

IEC 61672-3 – Section 11.1 – Self-generated noise (Microphone)

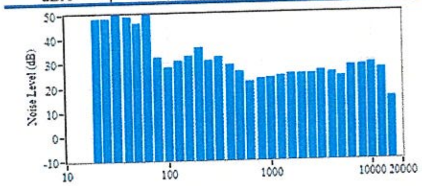
Low Range

Value	Measure	Limit	PASS / FAIL
dBZ	40,5	---	---
dBC	39,0	---	---
dBA	24,1	32,5	Pass



High Range

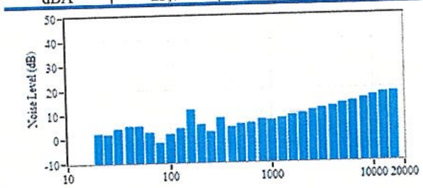
Value	Measure	Limit	PASS / FAIL
dBZ	63,9	---	---
dBC	61,9	---	---
dBA	39,8	42,5	Pass



IEC 61672-3 – Section 11.2 – Self-generated noise (Electric)

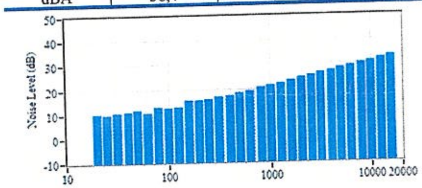
Low Range

Value	Measure	Limit	PASS / FAIL
dBZ	26,3	---	---
dBC	23,0	---	---
dBA	23,7	26,5	Pass

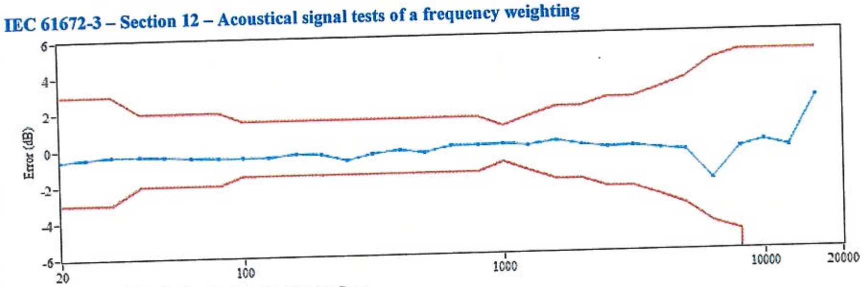


High Range

Value	Measure	Limit	PASS / FAIL
dBZ	41,2	---	---
dBC	37,1	---	---
dBA	38,4	42,5	Pass

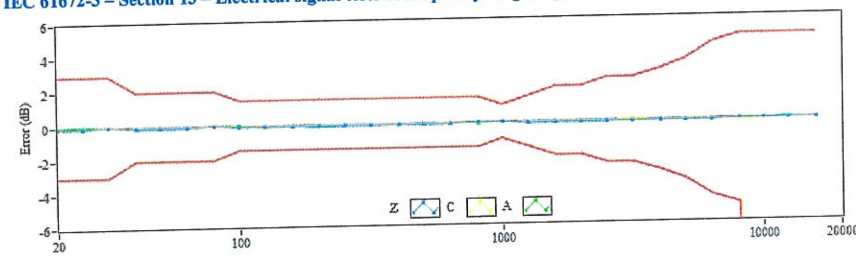


IEC 61672-3 – Section 12 – Acoustical signal tests of a frequency weighting



Conformity to IEC 61672-3 – Section 12, Class 2: Pass

IEC 61672-3 – Section 13 – Electrical signal tests of frequency weightings



Conformity to IEC 61672-3 – Section 12, Class 2: Pass

IEC 61672-3 – Section 14 – Frequency and time weightings at 1 kHz

Data	Measure	Error	Tolerance	PASS / FAIL
LAF	94,0	---	---	---
LCF	94,0	0,0	±0,1	Pass
LZF	94,0	0,0	±0,1	Pass
LAS	94,0	0,0	±0,2	Pass
LCS	94,0	0,0	±0,1	Pass
LZS	94,0	0,0	±0,1	Pass
LAeq	93,9	0,1	±0,2	Pass
LCeq	93,9	0,0	±0,1	Pass
LZeq	93,9	0,0	±0,1	Pass

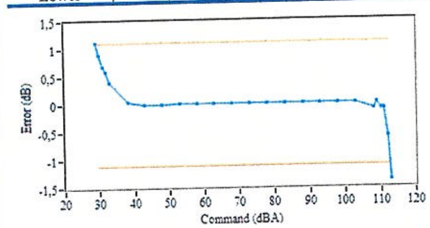
IEC 61672-3 – Section 15 – Long-term Stability

Initial	Final	Error	Tolerance	PASS / FAIL
94,0	94,0	0,0	0,3	Pass

IEC 61672-3 – Section 16 – Level Linearity (at 4 kHz)

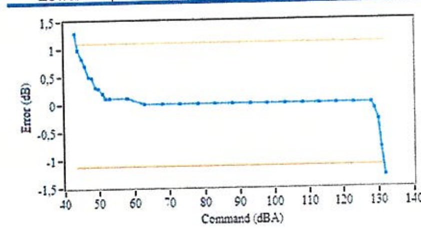
Low Range

Boundary	Measure (dBA)	Limit (dBA)	PASS / FAIL
Upper	112,0	108,3	Pass
Lower	30,0	32,5	Pass



High Range

Boundary	Measure (dBA)	Limit (dBA)	PASS / FAIL
Upper	131,0	128,3	Pass
Lower	44,0	48,5	Pass



Technical Guide: YORK® Sun™ Choice AV15 to AV28

York International Corporation, 5005 York Drive, Norman, OK 73069

www.york.com

2019-08-01

5782792-YTG-A-0819

Revision: A-0819

Johnson Controls Ducted Systems

Sound performance

Table 35: Indoor sound performance

Size (tons)	CFM	Type	Sound power, dB (10^{-12}) watts							
			Octave band centerline frequency (Hz)							
			63	125	250	500	1000	2000	4000	8000
AV15 (15)	6000	Ducted discharge	84	80	78	75	72	71	68	63
		Ducted inlet	85	77	75	73	72	69	64	60
AV18 (17.5)	7000	Ducted discharge	86	82	80	78	76	75	72	64
		Ducted inlet	86	76	73	70	69	66	62	59
AV20 (20)	8000	Ducted discharge	90	85	81	81	80	79	76	68
		Ducted inlet	89	75	71	63	64	59	56	48
AV25 (25)	10000	Ducted discharge	95	88	85	83	83	82	79	72
		Ducted inlet	93	80	73	68	68	63	58	47
AV28 (27.5)	11000	Ducted discharge	98	90	87	84	84	82	79	72
		Ducted inlet	96	82	72	69	68	62	57	46

Note:

- Tested in accordance with AHRI 260-2017.
- Ratings include duct end correction E1.
- Ratings include compressor noise.

Table 36: Outdoor sound performance

Size (tons)	Sound power, dB (10^{-12}) watts								
	Sound rating dB (A)	Octave band centerline frequency (Hz)							
		63	125	250	500	1000	2000	4000	8000
AV15 (15)	85	89	85.5	83	83.5	80.5	76	72.5	67.5
AV18 (17.5)	85	92.5	86.5	83	83	80	76.5	73	68.5
AV20 (20)	82	95	88	80	77.5	76.5	74	71.5	67.5
AV25 (25)	84	94	87	80	79.5	78.5	76.5	73	70.5
AV28 (27.5)	86	92.5	87.5	84.5	84	81	78	74	71

Note:

- Tested in accordance with AHRI 370-2015.
- Ratings include compressor noise.

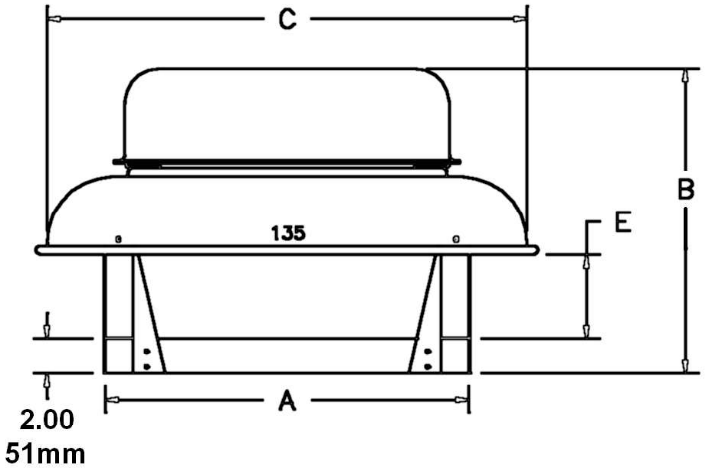
TAG:

Acme Engineering and Manufacturing Corporation

P.O. Box 978, Muskogee, OK 74402

Boston Air Products LLC

Project:
Location:
Customer:
Architect:
Engineer:
Contractor:
Submitted by:



PRN

Direct Drive Centrifugal Roof Exhauster

Standard Construction Features

- Integral Heavy Gauge Aluminum Bird Screen
- Heavy gauge aluminum housing
- Conduit Post Through Bases Curb Cap
- Aluminum hood
- Corrosion resistant fasteners
- Centrifugal backwardly inclined non-overloading aluminum hollow airfoil blades
- Motor bearings are permanently lubricated
- 2 Year Fan/Motor Warranty

Options & Accessories

- SSC Mounted And Wired 115 V
- NEMA 1 Disconnect Switch Mounted & Wired
- AR 16 x 16 Damper
- C 19.5 x 19.5 Galvanized Curb -- Self Flashing -- Curb Height 12"

Listed Power Ventilator 263L

Elevation View

A	B	C	E
21.00	16.38	27.75	4.81

DIMENSIONS (inches)

Rough Opening: 16.50 X 16.50

PRN135 1/2 Hp 115/ Single Phase/ 60 Hz/ ODP 1 Speed w/TOL Standard Efficiency Motor RPM: 1625 -- SSC Mounted And Wired 115 V -- NEMA 1 Disconnect Switch Mounted & Wired

PERFORMANCE (Altitude = 0 ft, Temp = 68 Degrees F, Density = 0.075 lb/ft3)

Qty	Model Size
1	PRN135

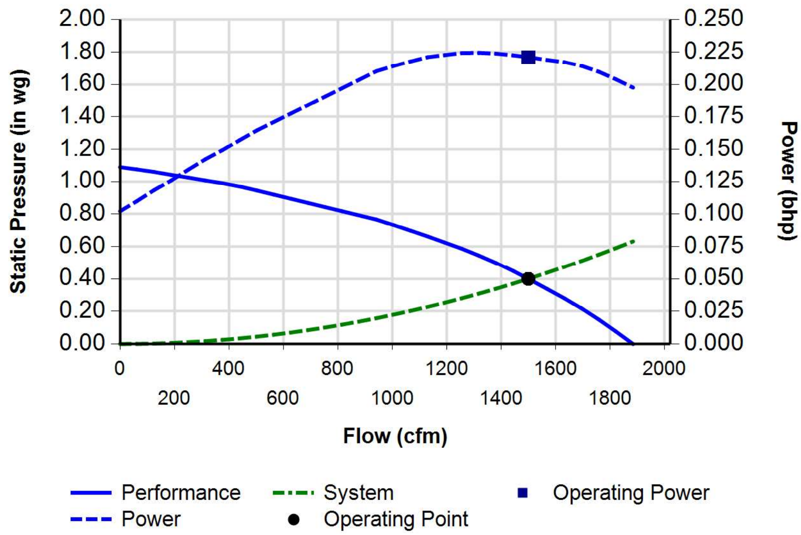
Volume (cfm)	SP (in wg)	Power (bhp)	Speed (rpm)	TS (fpm)	OV (fpm)	Weight (lbs)
1500	0.400	0.221	1420	5019	872	2.00

Motor Info.	Fan Rating: 705 705c					
HP	Volts	Phase	Hz	Encl	RPM	Sp/Wdg
1/2 Hp	115	1	60	ODP	1625	1SPD

Sound Pressure			Sound Power Octave Values								Static	Total
Sones*	LwA	dBA*	1	2	3	4	5	6	7	8	Eff	Eff
9.2	73.2	61.7	77.1	78.3	75.5	70.0	66.1	64.7	58.2	46.0	42.80	47.90

*in free space @5 feet/1.5 Meters

The sound ratings shown are loudness values in hemispherical sones at 1.5 m (5ft) in a hemispherical free field calculated per AMCA Standard 301. Values are shown for Installation Type A: free inlet hemispherical sone levels. The AMCA certified ratings seal applies to sone ratings only.



6/22/2022

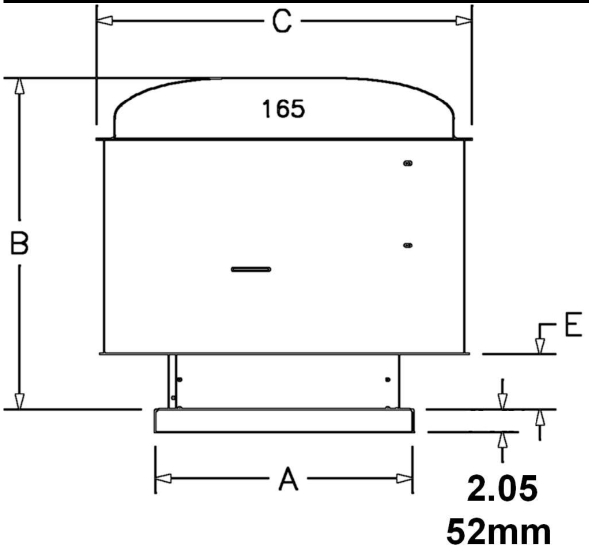
TAG:

Acme Engineering and Manufacturing Corporation

P.O. Box 978, Muskogee, OK 74402

Boston Air Products LLC

Project:
Location:
Customer:
Architect:
Engineer:
Contractor:
Submitted by:



PV

Belt Drive Centrifugal Roof Downblast Exhauster

Standard Construction Features

- Lifting points located on motor base frame
- Vibration isolation
- Aluminum Bird Screen
- Conduit Post Through Bases Curb Cap
- Backward inclined non-overloading aluminum wheel
- 5 Year Warranty-Maintenance Free Bearings-Patented-Steel Shaft-Rated at L-50 life of 200,000 hours
- Variable pitch drives designed for 1.5 Service Factor
- NEMA 1 Disconnect Switch Mounted & Wired
- Motor bearings are permanently lubricated
- 2 Year Fan/Motor Warranty

Options & Accessories

- ARQ18 x 18 Damper
- C 22.5 x 22.5 Galvanized Curb -- Self Flashing -- Curb Height 12"

Listed Power Ventilator 263L

Elevation View

A	B	C	E
24.00	31.00	35.00	5.20

DIMENSIONS (inches)

Rough Opening: 20.70 X 20.70

PV165 1 Hp 460/ Three Phase/ 60 Hz/ ODP 1 Speed Standard Efficiency Motor RPM: 1750

PERFORMANCE (Altitude = 0 ft, Temp = 68 Degrees F, Density = 0.075 lb/ft3)

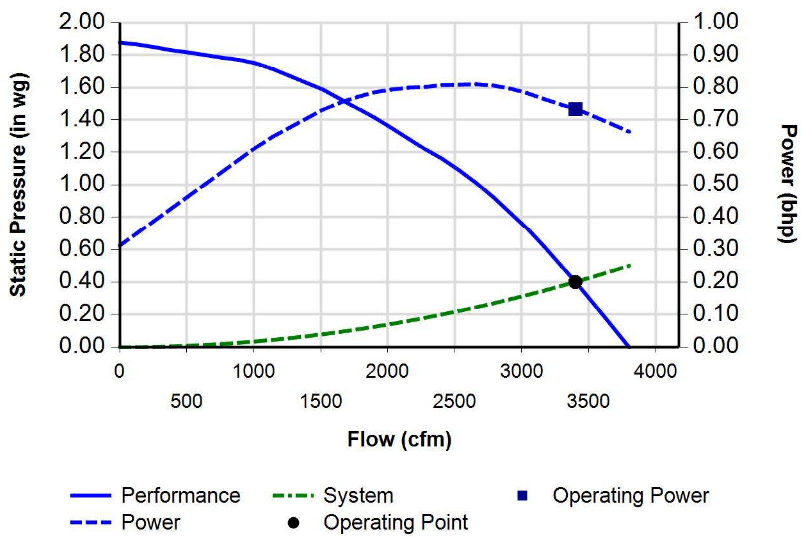
Qty	Model Size	Volume (cfm)	SP (in wg)	Power (bhp)	Speed (rpm)	TS (fpm)	OV (fpm)	Weight (lbs)
1	PV165	3400	0.400	0.734	1439	6363	1677	143.00

Motor Info.	Fan Rating: 705 705c					
HP	Volts	Phase	Hz	Encl	RPM	Sp/Wdg
1 Hp	460	3	60	ODP	1750	1SPD

Sound Pressure			Sound Power Octave Values								Static Eff	Total Eff
Sones*	LwA	dBA*	1	2	3	4	5	6	7	8		
17.0	79.4	67.9	78.0	87.3	83.1	76.0	69.6	69.2	64.8	56.9	29.20	42.00

*in free space @5 feet/1.5 Meters

The sound ratings shown are loudness values in hemispherical sones at 1.5 m (5ft) in a hemispherical free field calculated per AMCA Standard 301. Values are shown for Installation Type A free inlet hemispherical sone levels. The AMCA certified ratings seal applies to sone ratings only.



6/22/2022

GREENHECK
Building Value in Air.

Model: CUBE-480

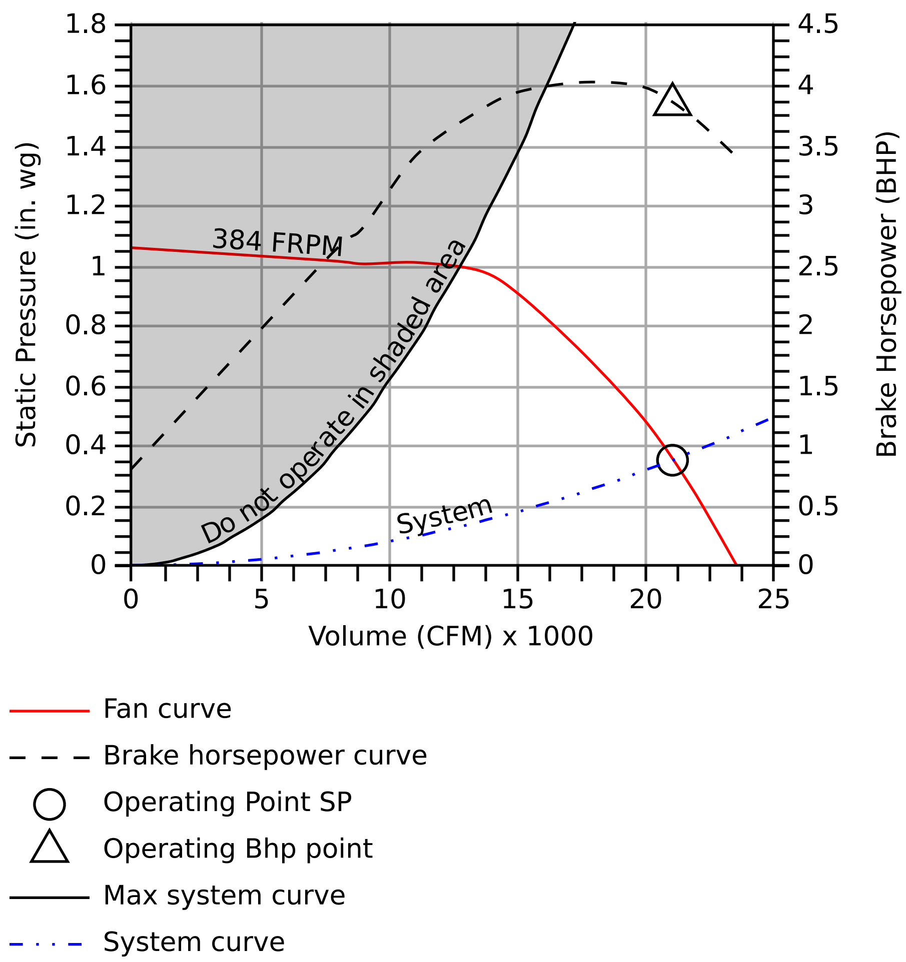
Belt Drive Upblast Centrifugal Roof Exhaust Fan

Standard Construction Features: Aluminum housing. Centrifugal backward inclined aluminum wheel. Belt driven motor mounted on vibration isolation.

Fan Configuration	
Drive type	Belt

Performance	
Requested Volume (CFM)	21,000
Actual Volume (CFM)	21,000
Total External SP (in. wg)	0.35
Fan RPM	384
Drive Loss (%)	6
Operating Power (bhp)	3.8
Startup Power (bhp)	3.8
FEI	1.16
Air Stream Temp (F)	70
Start-up Temp (F)	70
Air Density (lbs/ft^3)	0.075
Elevation (ft)	100
Static Efficiency (%)	32
Outlet Velocity (ft/min)	1,792

Motor	
Size (hp)	5
V/C/P	460/60/3
NEC FLA (Amps)	7.6

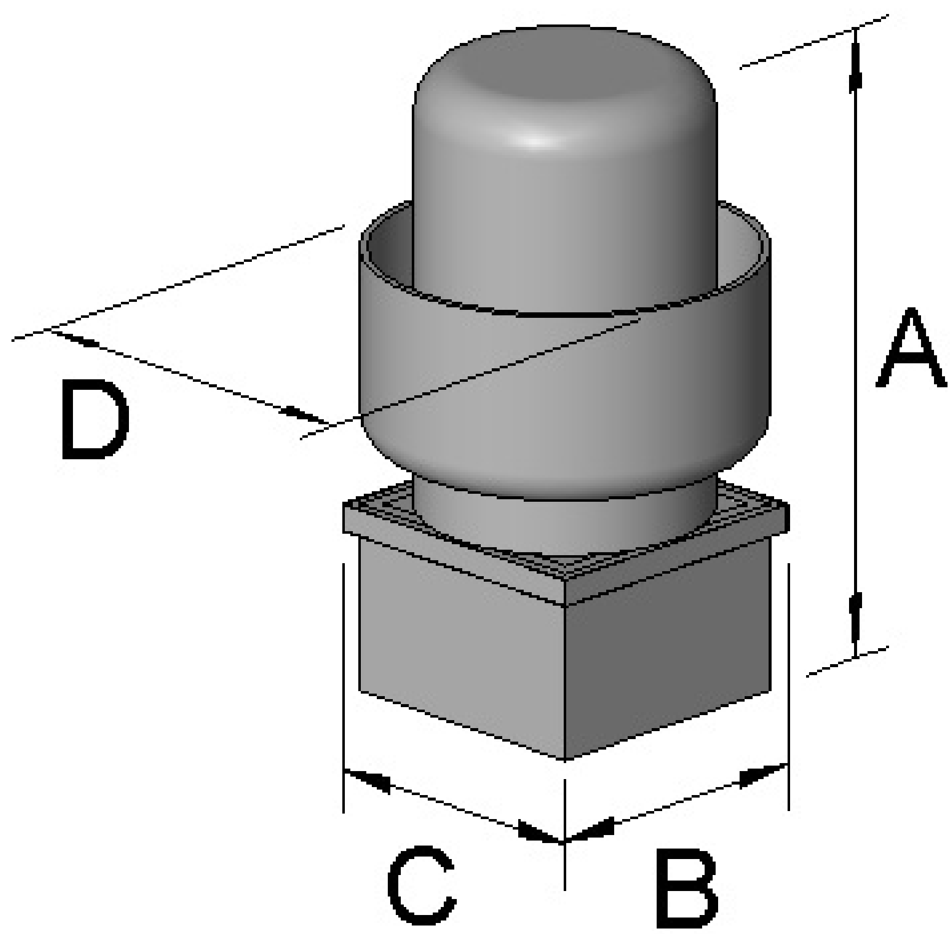


Sound

	Octave Bands (hz)								LwA	dBA	Sones
	62.5	125	250	500	1000	2000	4000	8000			
Inlet	91	89	82	75	71	67	60	55	79	68	18.3

Greenheck Fan Corporation certifies that the model shown herein is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 311 and comply with the requirements of the AMCA Certified Ratings Program.The AMCA certified ratings seal applies to sound and air performance and FEI ratings only.Performance certified is for installation type A: Free inlet, free outlet.Power rating includes transmission losses.Performance ratings do not include the effects of appurtenances.The sound ratings shown are loudness values in hemispherical sones at 1.5 m (5 ft) in a hemispherical free field calculated per ANSI/AMCA Standard 301.Values shown are for Installation Type A: free inlet hemispherical sone levels.dBA levels are not licensed by AMCA International. The AMCA Certified Ratings Seal for Sound applies to inlet sone ratings only.

Dimensions and Weights		
Label	**Value**	**Description**
-	419	Weight w/o accessories (lbs)
A	60	Overall Height (in)
D	74	Overall Width (in)
B	58	Curb Cap Width (in)
C	58	Curb Cap Length (in)
-	52	Duct / Damper Width (in)
-	52	Duct / Damper Length (in)
-	54.5	Roof Opening Width (in)
-	54.5	Roof Opening Length (in)



*All dimensions are in inches.