Acoustic Associates
Specialists in Hearing and Acoustics

12172 Route 47 - #218, Huntley, Illinois 60142
Office: *847-359-1068* • Fax: *847-359-1207*
Website: www.AcousticAssociates.com

Tom Thunder, AuD, FAAA, INCE – *Principal*
Greg Andorka, BSEE - *Senior Field Engineer*
E-mail: info@AcousticAssociates.com

Noise Emissions
At the Chicago Fuller Car Wash

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We visited the Fuller Car Wash at 2146 Rockwell in Chicago to conduct sound level testing. This testing was performed to obtain data that could be used to project sound levels at residential locations near similar car washes at other locations.

The blowers used to dry the cars dominate the car wash noise. The sound emissions of the spray nozzles and conveyor mechanisms are secondary and radiate much lower sound levels. In addition, the sprayers and conveyor emit a higher frequency sound that decays more rapidly outside the car wash due to air absorption. Accordingly, our focus was on blower noise.

Figure 1 is an aerial view of the car wash on Rockwell and Cermak. The entrance faces Rockwell to the east while the exit faces a 3-story, brick building to the west. The doorways are roughly 10x10 feet.

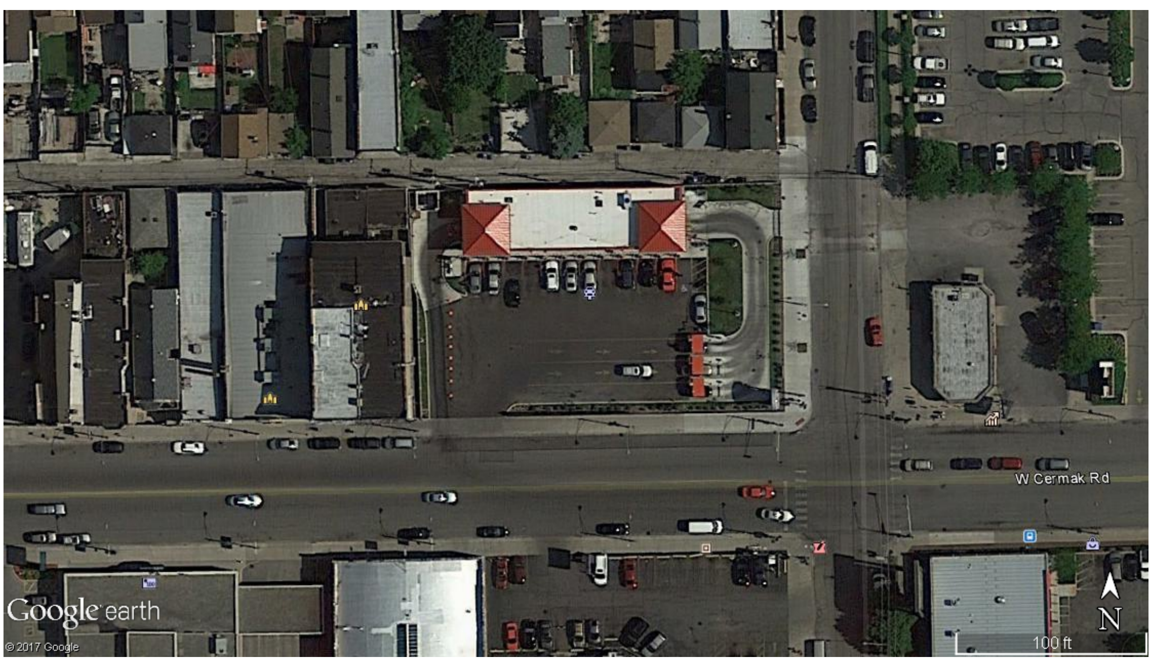

Figure 1 – An aerial view of the car wash. The entrance faces Rockwell to the east.

Figure 2 shows a view of the car wash tunnel from the exit door. There are ten (10) centrifugal blowers attached to steel poles. Two (2) blowers are located on each side and are the closest to the exit door. They are only several feet from the exit doorway. Six (6) blowers are located on overhead poles. The inlets are open inlets with no ductwork. Each blower has its own discharge nozzle so there is no discharge ductwork.

Procedure

Measurements were made at both the exit and the entrance to quantify the difference in noise emissions due to the long tunnel effect. We also made measurements at 0^o azimuth (on axis) and 90^o azimuth to quantify the difference due to the directivity of the tunnel.

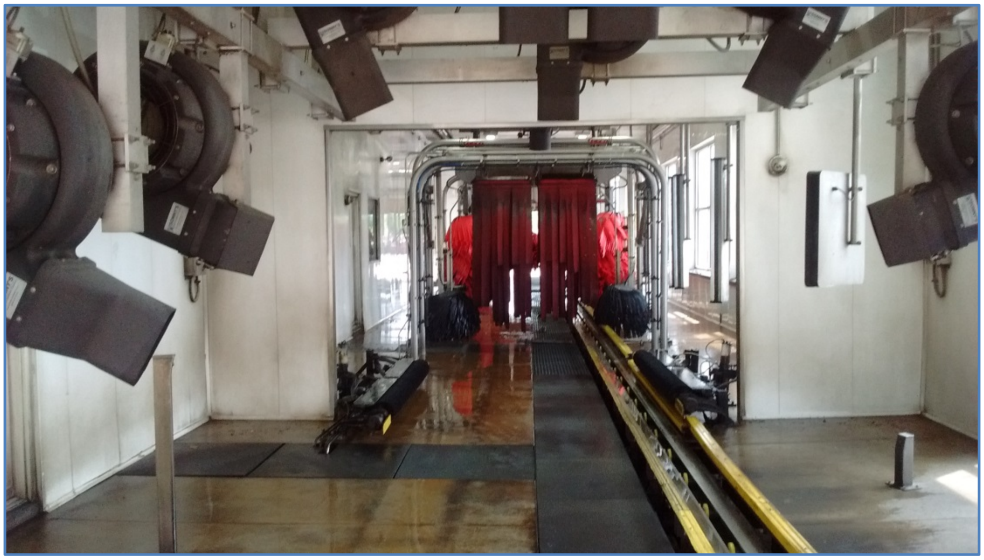

Figure 2 - View of the car wash exit showing the blowers, which are positioned a few feet from the exit door.

While a measurement distance of 25-50 feet is optimum for acoustical reasons, measurement locations at this site were constrained because of building and site configuration elements. Consequently the actual distances ranged from 10 to 33 feet.

We recorded the noise using a precision microphone and a professional grade digital recorder. A calibration tone was placed on the recording to ensure a proper analysis. Professional sound editing software was used to listen to the recording, document the annotations, and evaluate the temporal variations in noise.

We used professional grade software to analyze the recording to generate the overall sound level at 1-second intervals. **Figure 3** gives a plot of these 1-second sound level measurements from the exit and entrance doors and at 0^o and 90^o azimuth angles to the doors. This graph shows the rise and fall of the blower noise as they turn on and off. The figure also shows the fluctuation of blower noise as the car moves through the blower area.

We used the same sound analysis software to generate sound spectra; specifically, we generated the sound level at each of 11 different frequencies across the audible frequency range. A spectral analysis is important because the noise from the blower varies as a function of frequency. Also, how sound decays over distance varies as a function of frequency. **Figure 4** shows the results of this analysis. In this chart, we normalized all the data to a distance of 50 feet for easy comparison. We also corrected the exit data since it was confounded by reflections from the nearby building. The entrance data at 90 degrees was corrected to extract the influence of background noise. Finally, we smoothed the spectra slightly because there was some jaggedness that was likely a result of building reflections or tunnel resonance.

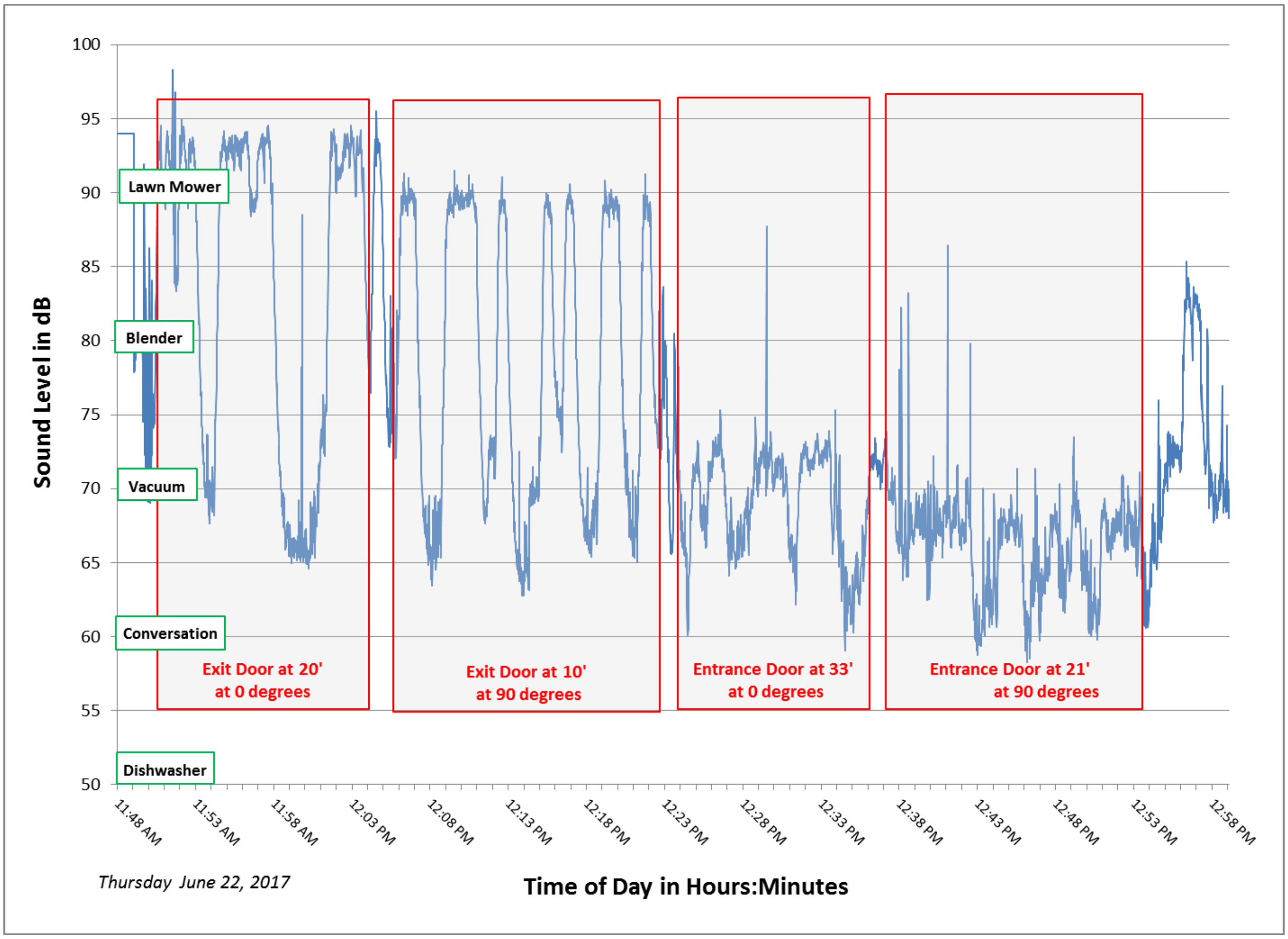

Figure 3 - Time series sound level of the recorded sample taken at the car wash.

Findings

As seen in **Figure 4**, all of the noise spectra show a prominence in the 500-2000 Hz range. For reference, a tea kettle whistle is about 1000 Hz. Because the fans are not large fans, there is not much low frequency energy. And because there is no ductwork, there is not much high frequency noise from aerodynamic flow.

The most important finding is the overall (total) A-weighted level shown on the left-hand side of **Figure 4**. The graph clearly shows that the exit side generates 14 dB greater noises than the entrance. This means the exit is three times louder than the entrance. This fact is important in orientating the exit toward less sensitive receivers.

Figure 4 also reveals that there is a significant directivity character to the car wash. In other words, the tunnel radiated sound significantly along its axis (at 0^{o} azimuth) and 10 dB less to the side (at 90^{o}). A 10 dB reduction means that the noise is half as loud to the side as it is directly in front. This fact has important implications in siting the car wash tunnel relative to receivers near the facility.

The **total A-weighted sound level** is the overall sound level with a filter applied to the noise measurement that diminishes the levels in the low frequencies below 500 Hz. The A-weighting filter is the most commonly used metric in noise assessment because it mimics the low-frequency roll-off of the ear.

Table 1 below, summarizes our findings.

Table 1 - Sound level emissions from a car wash with ten centrifugal blowers

Measurement Location	Sound Level at 50 feet
Exit at 0 degrees	83 dB
Exit at 90 degrees	73 dB
Entrance at 0 degrees	68 dB
Entrance at 90 degrees	58 dB

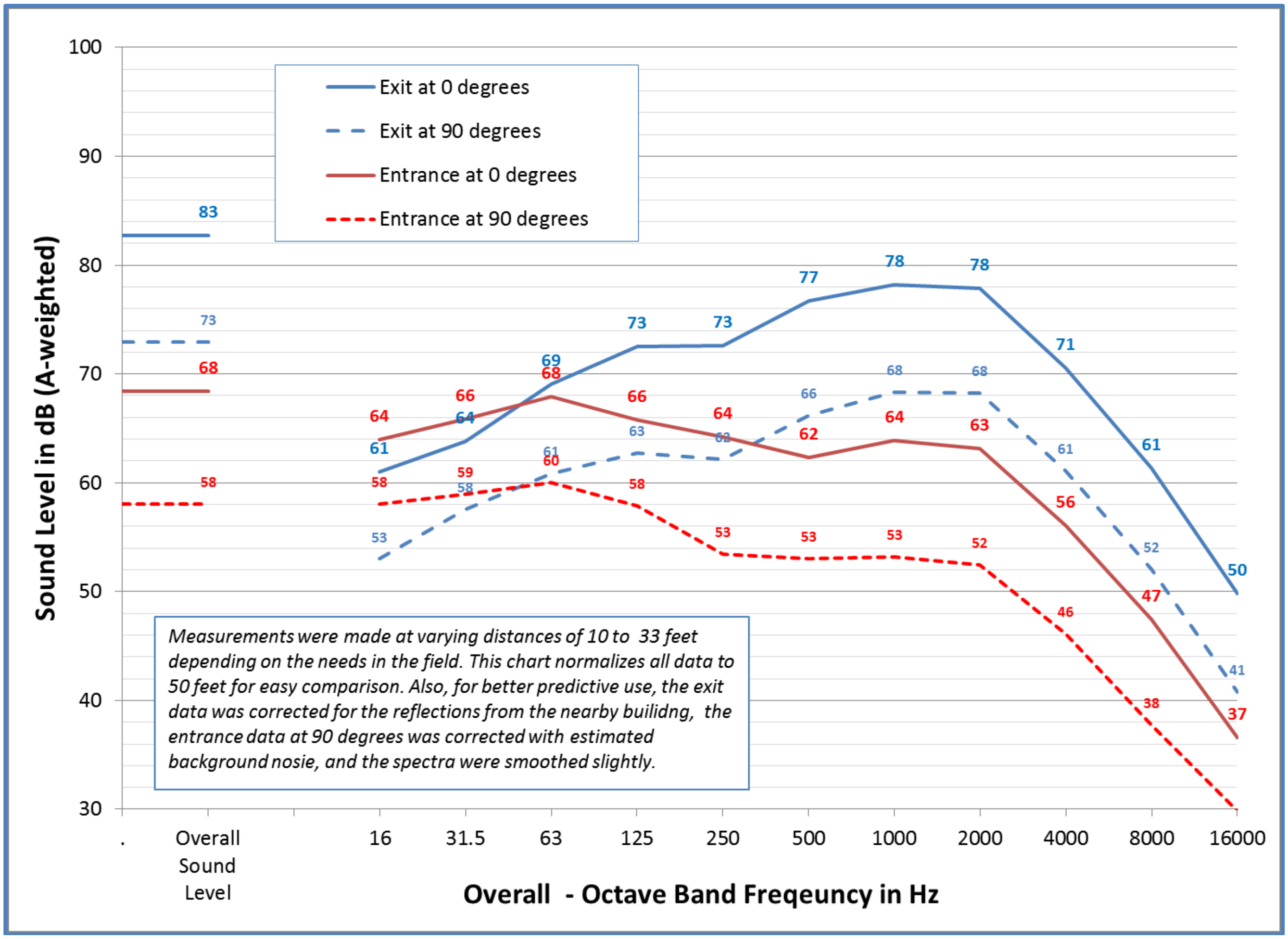

Figure 4- Overall sound level and octave band sound levels measured at the car wash.

Design Considerations

The loudness of the sound heard by residents near a car wash will depend on the following:

1. **Ambient noise** – Hi ambient background noise often prevents a car wash from being heard or annoying. Fortunately, most car washes are located along heavily traveled roads where the ambient noise is high. In most cases, it is helpful to measure the ambient across a full day to help village boards understand the real (not perceived) impact of a car wash.

2. **Distance –** The farther the residents, the lower the sound level. Distance is a major factor in hearing a car wash. Sound drops off at 6 dB per doubling of distance. For example, a car wash at 200 feet is 12 dB lower – or half as loud – than the same was is at 50 feet.

3. **Fences –** A fence can help reduce the intensity of car wash emissions. Unfortunately, the typical board-on-board fence offers minimal attenuation. To be effective, it must be solid. Also, the typical 6-foot fence is ineffective. Heights of 10-15 feet are usually required to achieve a significant noise reduction.

4. **Orientation –** As indicated above, it is best to "point" the exit away from sensitive areas. Based on our data, the exit is triple the loudness for residents facing the entrance at the same distance.

5. **Angle –** The data show that if there are nearby residents, it is best to orientate the wash so that its axis is perpendicular to the line-of-sight to the residents. This takes advantage of the directivity of a car wash where emissions are substantially reduced at angles greater than 60^{o}.

Considerations For future Projects

The sound levels in Table 1 give the sound level emissions to be used for future projects that have similar equipment. The table shows that the emissions would be the highest for residents on the exit side of the car wash – especially those on axis with the wash tunnel. For residents at 90^{o} off axis (from the exit or entrance), the sound level drops 10 dB (half as loud). You can interpolate the sound level for residents at angles between 0^{o} and 90^{o}.

The levels in Table 1 are given for 50 feet. For residents at greater distances, the level drops off at 6 dB per doubling of distance. So a resident at 100 feet would be 6 dB less than at 50 feet.

Most noise codes have a limit of 55 dB for daytime operations. So if the emissions are higher than this, you should consider reorienting the exit toward a commercial building of the street. If this is difficult, then you can achieve a 10 dB reduction with a well-designed sound fence. Finally, you can search for quieter equipment or reduce the number or speed of the blowers. A door or mass-loaded vinyl strips at the exit would work well and reduce the noise 10-20 dB. But the wash tunnel would need to be designed to allow the door to remain closed while the blowers are on.

If a town is most interested in the impact a wash has on residential neighbors, then an ambient noise study is recommended. In many cases, since car washes are near busy streets, the ambient noise is higher than the towns 55 dB limit. In this case, there is no sense in designing a car wash to meet the stricter 55 dB limit when the ambient noise is already higher. A noise study is also recommended to justify a wash being open later than when the town wants it to close. This is because the ambient noise in the area may not actually drop until after 9:00 PM or even as late as 11:00 PM.

Submitted,

Thomas Thunder, AuD, FAAA, INCE Bd. Cert.
Principal Audiologist and Acoustical Specialist
Adjunct Faculty – Northern Illinois University and Rush University