

# IDENTIFYING LOCALIZED NOISE SOURCES DURING INDUSTRIAL VEHICLE PASS-BYS

Jordan Reniak <sup>†1</sup>

<sup>1</sup>BKL Consultants Ltd., Vancouver, British Columbia, Canada

## 1 Introduction

Certain sections of roads will invoke certain noises from industrial transport vehicles. In our study, we were specifically looking to determine how the localized noise sources on an industrial transport vehicle contribute to roadside pass-by noise and to locate the source of trailer clanging noise from unloaded trailers passing over uneven road sections. Using the Norsonic Nor848 acoustic camera, we used representative snapshots of roadside truck pass-bys to identify the location and contribution of localized noise sources contribute to roadside pass-by noise. From our measurements, we found that tire noise made up 81% of the roadside pass-by noise during coasting, and 26% of noise during acceleration. Engine noise contributed to 66% of roadside pass-by noise during acceleration and 13% of roadside pass-by noise during coasting pass-bys. We also found out that exhaust noise contributed between 6-8% of the total roadside pass-by noise. Using the acoustic camera, we were also able to determine that engine noise received from the accelerating trucks comes directly from a reflection off the roadway directly beneath the engine housing. This means that the majority of the noise received at the roadside from truck pass-bys comes from ground level noise sources (engine and tire noise) which, could be an important consideration when determining appropriate noise mitigation.

## 2 Method

### 2.1 Location

The studied roadway section included both even and uneven lengths of roadway. We used the even section of roadway to determine the composition of the roadside pass-by noise from noise sources such as engine, tires, exhaust etc. We studied the uneven length of roadway to locate and identify the source of the impulsive trailer clanging noise. Both roadway sections had a 50 km/hr speed limit.

### 2.2 Equipment

To determine and quantify the noise sources from industrial transport vehicles, we used a Norsonic Nor848 acoustic camera (the acoustic camera). The acoustic camera is a one-metre diameter solid disc that is embedded with 256 microphones and is paired with software developed by Norsonic to process the data from the microphone array. The software coupled with the acoustic camera gives the user the capability to view and capture live noise events, and to review and study logged events.

## 3 Measurement

We recorded several different scenarios, which included accelerating and coasting trucks on even (flat) pavement, and loaded and unloaded trucks on uneven pavement. Recording these scenarios enabled us to determine how the loading of an industrial truck affected the noise emission of the vehicle during typical roadside pass-bys.

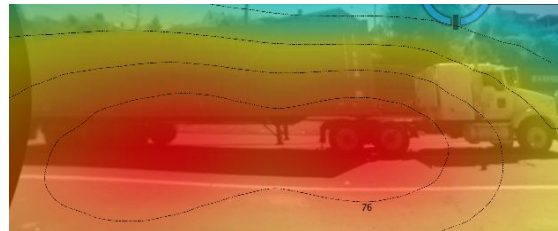


Figure 1: Showing a coasting roadside pass-by

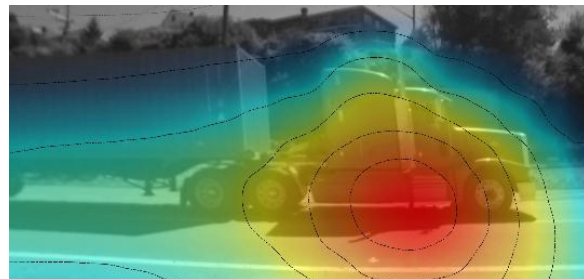


Figure 2: Accelerating truck pass-by showing engine noise

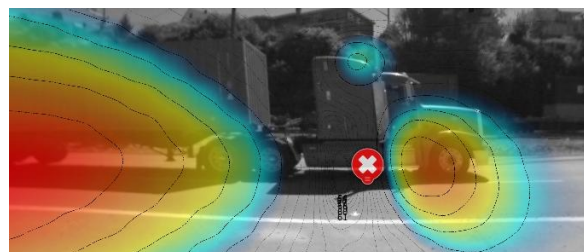


Figure 3: Accelerating pass-by with engine noise suppressed

### 3.1 Calculation

The Norsonic software paired to the acoustic camera provides the user with the measured sound pressure level, as well as the ability to determine the sound pressure level received from localized sources within the cameras field of view. Using the snapshots captured from the acoustic camera, we were able to approximate how the different noise sources contributed to the vehicle pass-by noise. Our approximations were based on a captured snapshot of what we felt was representative of the scenario that we were

<sup>†</sup>reniak@bkl.ca

interested in. For example, if we were looking for how the noise is distributed during the acceleration of a truck to maintain speed, we would record several pass-bys and replay the recording until we found a pass-by that had the sound characteristics of an accelerating truck. Figure 1 shows a snapshot of a coasting truck pass-by, and Figure 2 shows a moderately accelerating truck pass-by. The types of pass-bys that we were interested in were pass-bys that included trailer clanging (from uneven road surfaces), accelerating, and coasting. To quantify and locate non-dominant noise sources during vehicle pass-bys, we used the suppress feature shown in Figure 3. We then used the energy levels from each source to determine the respective proportion of the total received sound level

## 4 Results

### 4.1 Engine noise

We observed that the engine noise from an accelerating industrial truck pass-by came primarily from ground reflections as shown in Figure 2. The engine noise from the truck pass-by constituted approximately 66% of the total noise generated by a moderately accelerating truck pass-by.

### 4.2 Exhaust Noise

To quantify this noise source, we needed to use the suppress feature in the acoustic camera software to suppress the more significant noise sources so that an approximate sound pressure level could be assigned to the exhaust noise. We found that exhaust noise typically accounted for around 6% of the total noise during a coasting pass-by and 8% for an accelerating pass-by.

### 4.3 Tire Noise

Tire noise is a primary contributor to the immersion of roadside pass-by noise. As shown in Figure 1, tire noise is easily identifiable and was a significant contributor to the overall noise from the truck pass-by. Tire noise contributed approximately 26% if all truck noise during an acceleration, and 81% if truck noise during coasting.

### 4.4 Trailer Clanging

Trailer clanging is a highly impulsive sound that primarily comes from the moving components of the unloaded trailer suspension and the worn landing gear. The landing gear was easy to isolate because as the truck passed over the uneven section of roadway, the landing gear clanging would become the most dominant noise source as shown in Figure 5. The rear suspension, located at the back of the trailer, would also become the most dominant noise source as the rear set of wheels would pass over the uneven road section. The rear suspension clanging was only identifiable as trailer body noise because the source was not easily identifiable as it was hidden behind the rear trailer tires. Figure 5 shows what the rear suspension clanging noise looked like when identified by the acoustic camera.

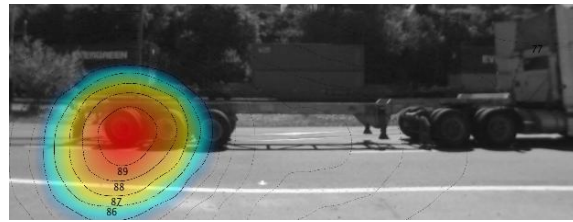


Figure 4: Rear suspension clanging over uneven road

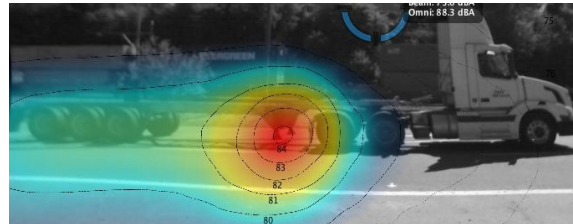


Figure 5: Trailer landing gear clanging over uneven roadway

### 4.5 Noise Distribution

We determined that noise from accelerating truck pass-bys is 66% engine noise, 26% tire noise, and 8% exhaust noise. We also determined that coasting truck pass-by noise is comprised of 13% engine noise, 81% tire noise, and 6% exhaust noise.

## 5 Discussion

When investigating noise sources to determine what mitigation strategies would be most effective, understanding how the noise from industrial vehicles is emitted can greatly aid the design and effectiveness of the noise mitigation.

As an example, if noise mitigation is considered for an uphill road section, one would expect the vehicles on one side of the road to be coasting, and vehicles on the other side to be accelerating. Knowing that the majority of noise from accelerating and coasting transport vehicles is generated at ground level, one could deduce that the majority of roadside pass-by noise could be mitigated by the installation of a low roadside barrier. It would also be important to know a barrier of this type would not be able to mitigate higher elevation noise sources like exhaust noise. A barrier intended to mitigate exhaust noise would likely have to be quite tall and may not be feasible or cost effective. Especially since exhaust noise only makes up 6-8% of the roadside pass-by noise.

## 6 Conclusion

Engine, tire, and exhaust noise are the primary contributors to industrial vehicle pass-by noise. Knowing that engine and tire noise both emanate from ground level, and are the two largest contributors to roadside pass-by noise, designers of roadside noise mitigation will be able to effectively design barriers to mitigate the majority of roadside truck pass-by noise.