# VEHICLE NOISE SURVEY IN KENTUCKY

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Individual noise measurements were obtained for 10,500 motor vehicles operating on Kentucky highways. The roadways were selected to represent various geometric and environmental conditions and posted speed limits. Percentages of automobiles and trucks exceeding a given noise level were determined. As expected, noise levels of trucks were significantly higher than those for automobiles, and larger trucks produced higher noise levels than smaller trucks. For any vehicle type, noise increased as speed limit increased.

•STUDIES in several major American and European cities have shown that, despite the noise produced by aircraft, surface traffic, including automobiles, buses, trucks, and motorcycles, is the predominant and most widespread source of noise. Traffic noise, although recognized in the past as a nuisance by those subjected to it, has reached such levels in some urban areas that it is considered a major pollutant of the environment. It has been shown (1) that noise levels in certain areas are increasing at the rate of 1 decibel (dB) per year, a result of increasing traffic flow. Increased traffic volumes and construction of high-speed highways within densely populated areas in particular have aroused public concern. The rural resident, as well, has been concerned about the disruptive effects to the environment as a result of the location of major highways nearby. Therefore, while satisfying the needs and demands for improved transportation facilities, the highway engineer must consider the consequences of added noise on the community in the design, location, and construction of highways.

Highway-generated traffic noise emanates primarily from vehicle engine exhausts and from tire-pavement interaction. Under normal operating conditions, an automobile generates as much noise from the tire-pavement interface as from engine exhaust. Large diesel trucks are much noisier than automobiles and, even with maximum muffling, would be expected to produce significantly higher noise levels than automobiles at the same running speed because of the larger contact area under the tires. Noise produced at the tire-pavement interface, in particular, depends on speed and varies with pavement texture. Coarse-textured pavements are noisier than fine-textured pavements. Very smooth, glassy, nonporous surfaces tend to generate air noises, squeal, and reflect sound. The noise level at a particular highway site depends on the traffic speed, distribution of vehicle types, traffic density, roadway characteristics (e.g., grade, intersections, elevated or depressed roadway), noise attenuation barriers such as trees and shrubs, and distance from the traffic stream.

Abatement and control of noise within an environment involves the direct control of noise emitted by individual vehicles, traffic routing, and highway design. The highway engineer is primarily concerned with the last two categories since some degree of control can be exerted. Limiting or controlling vehicular engine and exhaust noise, however, remains in the hands of vehicle designers and manufacturers and is subject to possible legislative control. Several states (2) have enacted legislation that sets limits on noise levels for motor vehicles. When Congress passed the Noise Control Act of 1972, the federal government took an active role in promulgating noise emission standards for motor vehicles.

A study was conducted by the Bureau of Highways, Kentucky Department of Transportation, to determine noise levels generated by individual automobiles and trucks operating on Kentucky highways. A total of 10,500 noise measurements were made on roadways representing various geometric and environmental conditions and posted speed limits, and percentages of each vehicle type exceeding a given noise level were calculated.

## PROCEDURES

Individual automobile and truck noise levels were measured in dBA with a Bruel and Kjaer precision sound level meter (type 2203). All measurements were taken at a distance of 50 ft (15.2 m) from the center of the traffic lane and approximately 4 ft (1.2 m) above the roadbed. The data were recorded manually by the operator as a vehicle passed. Measurements were taken only when the noise emitted by a single vehicle could be clearly isolated or distinguished from the noise of the traffic stream. The operator and the meter were stationed on the same horizontal plane as the traffic lane, but locations were varied to represent different geometric conditions: level roadways, plus or minus grades, and straight or curved sections. Roadways were also selected on the basis of posted speed limits ranging from 35 to 70 mph (56 to 113 km/h). Vehicle speeds were not measured. Truck noise data (500 trucks) were obtained at locations with posted speed limits of 70 mph (113 km/h) to distinguish between various classes of trucks.

## FINDINGS

The noise survey was conducted in 1972 and 1973 and involved 8,000 automobiles (including four-wheel pickup trucks) and 2,500 trucks (55 of which were analyzed by truck type), as given below. A few motorcycle noise measurements were also obtained. The speeds refer to the posted speed limit, not to the speed at which the vehicles were operating (1 mph = 1.6 km/h).

| Speed (mph) | Automobiles | Trucks |
|---|---|---|
| 70 | 2,000 | 1,250 |
| 60 | 2,000 | 665 |
| 50 | 1,000 | 335 |
| 45 | 1,000 | 100 |
| 35 | 2,000 | 150 |

### Automobiles

Influence of speed on automobile-generated noise is clearly shown in Figure 1, which shows the percentage of automobiles at or below a certain noise level. The lowest reading was 60 dBA in a 35-mph (56-km/h) speed zone, and the highest was 90 dBA on a 70-mph (113-km/h) road. The median levels ranged between 67 and 77 dBA. On highways with the same speed limit, ranges in noise levels were rather small and may be indicative of uniform traffic speed.

Table 1 gives the percentage of automobiles that exceeded a given noise level. For example, in 35-mph (56-km/h) zones, only 0.4 percent of the automobiles had noise levels above 76 dBA, and 65 percent of the automobiles exceeded this level on 70-mph (113-km/h) roads.

### Trucks

Noise emitted by trucks ranged between 64 and 102 dBA. The higher noise levels were associated with the higher posted speed limits, as shown in Figure 2. The median

**Figure 1. Cumulative percentages of automobiles versus noise levels for roadways with various posted speed limits.**

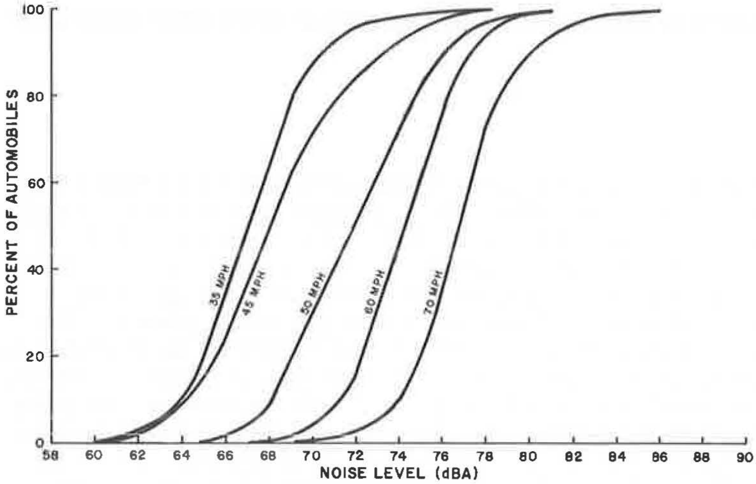


**Table 1. Percentage of automobiles exceeding given noise level at various speeds.**

| Noise Level (dBA) | 35 mph | 45 mph | 50 mph | 60 mph | 70 mph |
|---|---|---|---|---|---|
| 90 | | | | | 0 |
| 89 | | | | | 0.1 |
| 88 | | | | | 0.2 |
| 87 | | | | | 0.3 |
| 86 | | | | | 0.2 |
| 85 | | | | | 0.3 |
| 84 | | | | 0 | 0.6 |
| 83 | | | | 0.1 | 1.6 |
| 82 | | | 0 | 0.2 | 2.9 |
| 81 | | | 0.4 | 0.6 | 5.2 |
| 80 | | 0 | 0.8 | 1.4 | 9.9 |
| 79 | 0 | 0.1 | 1.3 | 2.7 | 17.7 |
| 78 | 0.1 | 0.2 | 2.2 | 5.2 | 27.2 |
| 77 | 0.2 | 0.7 | 5.7 | 11.6 | 45.4 |
| 76 | 0.4 | 1.5 | 9.8 | 22.0 | 65.1 |
| 75 | 0.7 | 2.9 | 19.2 | 37.4 | 79.2 |
| 74 | 1.1 | 7.1 | 26.9 | 55.0 | 92.2 |
| 73 | 2.3 | 12.6 | 37.9 | 73.8 | 96.8 |
| 72 | 3.7 | 15.9 | 46.9 | 85.3 | 98.4 |
| 71 | 6.4 | 21.8 | 57.7 | 93.8 | 99.0 |
| 70 | 12.2 | 28.1 | 69.8 | 96.6 | 99.4 |

Note: 1 mph = 1.6 km/h.

**Table 2. Percentage of trucks exceeding given noise level at various speeds.**

| Noise Level (dBA) | 35 mph | 45 mph | 50 mph | 60 mph | 70 mph |
|---|---|---|---|---|---|
| 100 | | | | 0.3 | 0 |
| 99 | | | | 0.5 | 0.2 |
| 98 | | | | 0.6 | 0.2 |
| 97 | | | | 0.8 | 0.3 |
| 96 | | | 0 | 1.4 | 0.8 |
| 95 | | | 0.6 | 1.8 | 2.0 |
| 94 | | | 0.9 | 2.7 | 3.5 |
| 93 | 0 | | 2.1 | 3.8 | 7.7 |
| 92 | 0.7 | | 2.4 | 4.5 | 11.8 |
| 91 | 0.7 | | 3.9 | 7.3 | 20.0 |
| 90 | 0.7 | | 6.0 | 11.1 | 26.6 |
| 89 | 0.7 | 0 | 10.1 | 17.3 | 38.8 |
| 88 | 0.7 | 2.0 | 12.5 | 24.5 | 47.6 |
| 87 | 0.7 | 2.0 | 21.5 | 31.6 | 57.3 |
| 86 | 0.7 | 2.0 | 29.3 | 39.4 | 65.0 |
| 85 | 2.0 | 6.0 | 39.1 | 49.3 | 72.6 |
| 84 | 2.7 | 8.0 | 48.1 | 57.5 | 78.8 |
| 83 | 3.3 | 15.0 | 58.5 | 67.4 | 72.5 |
| 82 | 4.7 | 15.0 | 65.1 | 73.4 | 75.8 |
| 81 | 6.7 | 21.0 | 72.2 | 78.7 | 90.6 |
| 80 | 8.7 | 23.0 | 78.2 | 82.9 | 93.2 |

Note: 1 mph = 1.6 km/h.

**Figure 2. Cumulative percentage of trucks versus noise levels for roadways with various posted speed limits.**

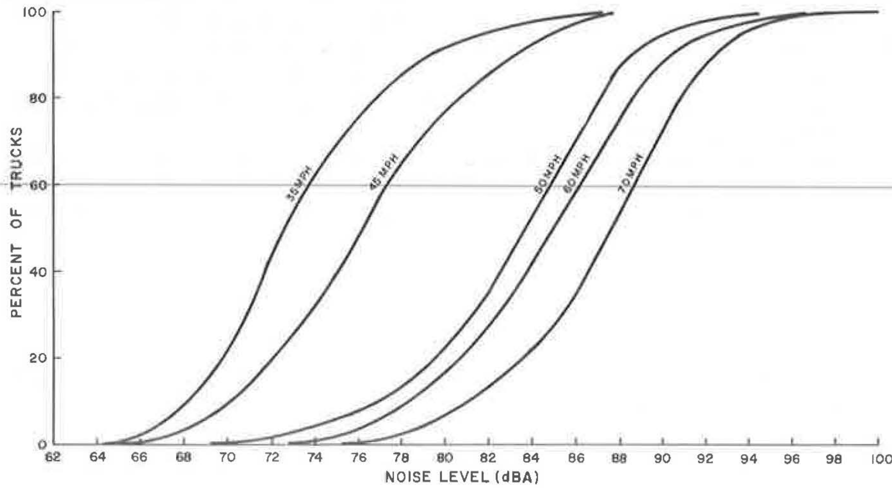

**Figure 3. Cumulative percentage of trucks (by classification) versus noise levels for Interstate roads.**

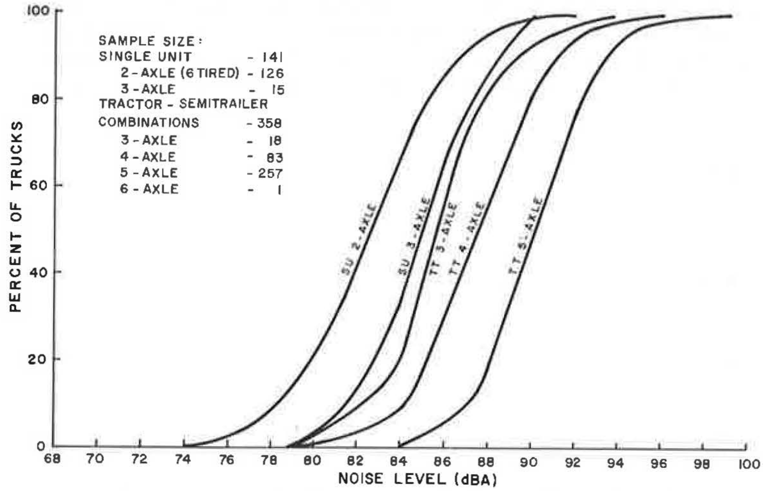


**Table 3. Percentage of various truck types exceeding given noise level.**

| Noise Level (dBA) | SU Two-Axle[a] | SU Three-Axle[a] | TT Three-Axle[b] | TT Four-Axle[b] | TT Five-Axle[b] |
|---|---|---|---|---|---|
| 100 | | | | | 0 |
| 99 | | | | | 0.4 |
| 98 | | | | | 0.8 |
| 97 | | | | 0 | 1.2 |
| 96 | | | | 1.2 | 1.6 |
| 95 | | | | 1.2 | 3.5 |
| 94 | | | 0 | 2.4 | 6.2 |
| 93 | | | 5.6 | 3.6 | 14.0 |
| 92 | 0 | | 5.6 | 6.0 | 22.6 |
| 91 | 0.8 | | 5.6 | 14.5 | 35.8 |
| 90 | 0.8 | 0 | 5.6 | 19.3 | 48.2 |
| 89 | 3.2 | 13.3 | 11.1 | 33.8 | 69.3 |
| 88 | 4.8 | 13.3 | 16.7 | 43.4 | 81.3 |
| 87 | 6.3 | 20.0 | 27.8 | 61.4 | 87.5 |
| 86 | 12.7 | 33.3 | 44.4 | 69.9 | 94.6 |
| 85 | 27.0 | 46.7 | 72.2 | 77.2 | 98.8 |
| 84 | 38.1 | 66.7 | 83.3 | 91.2 | 100.0 |
| 83 | 46.8 | 73.3 | 83.3 | 96.4 | 100.0 |
| 82 | 54.0 | 86.7 | 88.9 | 97.6 | 100.0 |

[a]SU = single-unit truck. [b]TT = tractor-semitrailer truck.

noise level was 73 dBA in 35-mph (56-km/h) speed zones and 88 dBA on 70-mph (113-km/h) roads. Oddly, truck noise on roadways with posted 50 and 60-mph (80 and 97-km/h) speed limits exhibited a difference of only 1 dBA. Apparently the difference in average truck speeds was less than 10 mph (16 km/h). However, in the absence of corresponding data on vehicle speeds, statements regarding running speed, particularly in contrast to posted speed limits, may be inappropriate.

Percentage of trucks exceeding a given noise level is given in Table 2. Less than 1 percent of the trucks produced noise levels exceeding 86 dBA in 35-mph (56-km/h) speed zones. On roads with the high speed limits, 97 dBA was exceeded by less than 1 percent of the trucks operating under a 60-mph (97-km/h) speed limit. However, truck sizes determined generated noise levels; the larger trucks generated more noise. Figure 3 shows data for trucks operating on Interstate roads [70-mph (113-km/h) speed limit]. About half of the five-axle, tractor-semitrailer combination vehicles exceeded 90 dBA, but less than 1 percent of two-axle, single-unit trucks exceeded this level of noise. Table 3 gives the percentage of various classes of trucks that exceeded a given noise level on a 70-mph (113-km/h) road.

Motorcycles

No attempt was made in this study to collect a large sample of motorcycle noise data, but motorcycle noise levels were recorded at every opportunity. The following noise level readings were obtained (1 mph = 1.6 km/h). Even though the sample size was extremely small, the values may be indicative of noise levels peculiar to motorcycles.

| Speed (mph) | Noise Level (dBA) |
|---|---|
| 70 | 91, 89, 86 |
| 60 | 90, 83, 82, 82 |
| 50 | 79, 78 |
| 45 | 76 |
| 35 | 79, 76, 75, 72 |

SUMMARY AND DISCUSSION

Many automobiles and trucks were included in this study to obtain representative data on noise associated with moving motor vehicles. The survey was conducted on roadways representing various geometric and environmental conditions and posted speeds. The findings therefore reasonably reflect noise levels of vehicles operating on Kentucky highways.

As expected, noise levels of trucks were significantly higher than those of automobiles, and noise increased as the posted speed limit increased. The median vehicle noise levels (dBA) are given below (1 mph = 1.6 km/h):

| Speed (mph) | Automobile | Truck |
|---|---|---|
| 35 | 67 | 73 |
| 45 | 68 | 76 |
| 50 | 72 | 84 |
| 60 | 74 | 85 |
| 70 | 77 | 88 |

The lowest recorded reading was 60 dBA for automobiles in 35-mph (56-km/h) speed limit zones and the highest was 102 dBA for a single truck on a 60-mph (97-km/h) road. In addition, trucks consistently had a wider range in noise levels for a given speed limit than automobiles (Figure 1 and Figure 2). However, slopes of the cumulative percentage curves for individual truck types (Figure 3) were similar to those for automobiles (Figure 1). Noise levels of vehicles, therefore, were primarily related to vehicle size and speed. Data collected on motorcycles, even though limited, clearly indicated that motorcycle noise levels were comparable to those for trucks.

The purpose for this report was to give data and cite findings on vehicle noise rather than to recommend or suggest specific limits. The information, however, may be used as a guide in the consideration and establishment of noise standards to the extent that undue burden will not be placed on automobile or truck owners and operators or destroy commerce and travel in Kentucky. Therefore, the following suggestions and comments might be helpful:

1. Separate noise limits are warranted for automobiles and trucks because of the vast difference in noise generated by each vehicle type.

2. Noise emitted by vehicles depends on the operating speed. The higher noise levels were associated with the higher running speeds; therefore, separate limits should be set for vehicles operating in various speed-limit zones.

3. On roadways with posted speed limits greater than 35 mph (56 km/h), a single but higher noise limit may suffice. However, the practical consequences would be that the higher limit would largely affect those vehicle operators using Interstate and parkway roads with a posted speed limit of 70 mph (113 km/h). Perhaps a separate limit is warranted for 70-mph (113-km/h) roads and another limit for all roadways having posted speed limits between 40 and 60 mph (64 and 97 km/h).

## ACKNOWLEDGMENT

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## REFERENCES

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