Research Report
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VEHICLE NOISE SURVEY IN KENTUCKY

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ABSTRACT

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

INTRODUCTION

Studies in several major American and European cities have shown that, despite the noise produced by aircraft, surface traffic, which includes automobiles, buses, trucks, and motorcycles, is the predominant and most widespread source of noise. Traffic noise, while 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 has aroused public concern. The rural dweller, as well, has shown concern in the disruptive effects to his environment as a result of locating major highways nearby. The highway engineer, therefore, is called upon to consider the consequences of added noise upon the community in the design, location, and construction of highways while satisfying the needs and demands for improved transportation facilities.

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 road speed due to the larger contact areas under the tires. Noise produced at the tire-pavement interface, in particular, is speed dependent and varies with pavement texture. Coarse-textured pavements are noisier than fine-textured pavements. Very smooth, glassy, non-porous surfaces tend to generate air noises and squeal and to reflect the 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 he can exert some degree of control. Limiting or controlling vehicular engine and exhaust noise, however, remains in the hands of vehicle designers and manufacturers, subject to possible legislative control. Several states *(2)* have enacted legislation which sets limits on noise levels for motor vehicles. With the passage of the **Noise Control Act of 1972** *(3)* by Congress, the federal government has taken an active role in promulgating noise emission standards for motor vehicles.

A study was conducted by the Division of Research, Kentucky Bureau of Highways, 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 varied geometric and environmental conditions and posted speed limits. Percentages of each vehicle type exceeding a given level of noise were calculated. The findings are presented in this report.

PROCEDURES

Data collection consisted of the measurement of individual automobile and truck noise levels with a Bruel and Kjaer precision sound level meter (Type 2203) employing the A-weighting network in the meter. All measurements were taken at a distance of 50 ft (15 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 at the same horizontal plane as the traffic lane, but locations were varied to represent different geometric conditions -- that is, level roadways, plus or minus grades, straight or curved sections. Roadways were also selected on the basis of posted speed limits ranging from 35 mph (15 m/s) to 70 mph (31 m/s). Vehicle speeds were not measured. A set of truck noise data (500 trucks) were obtained at locations with posted speed limits of 70 mph (31 m/s) to distinguish between various classes of trucks.

FINDINGS

The noise survey was conducted in 1972 and 1973 and involved 8,000 automobiles and 2,500 trucks, as shown in Table 1. A few motorcycle noise measurements were also obtained. The speeds refer to the speed limit, not the speed at which the vehicles were operating.

AUTOMOBILES

Influences of speed on automobile-generated noise is clearly evident 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 (16-m/s) speed zone and the highest was 90 dBA on a 70-mph (31-m/s) road. The median levels ranged between 67 dBA 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 2 shows the percentage of automobiles which exceeded a given noise level. For example, in 35-mph (16-m/s) zones, only 0.4 percent of the automobiles gave noise levels above 76 dBA while 65 percent of the automobiles exceeded this level on roads with posted speed limits of 70 mph (31 m/s).

TRUCKS

Noise emitted by trucks ranged between 64 dBA and 102 dBA. The higher noise levels were associated with the higher posted speed limits, as shown in Figure 2. The median noise level was 73 dBA in 35-mph (16-m/s) speed zones and 88 dBA on 70-mph (31-m/s) roads. Oddly, truck noise on roadways with 50-mph (22-m/s) and 60-mph (27-m/s) posted speed limits exhibited a difference of only 1 dBA. Apparently the difference in average truck speeds were less than 10 mph. 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 are cited in Table 3. Less than one percent of the trucks produced noise levels exceeding 86 dBA in 35-mph (16-m/s) speed zones. On roads with the high speed limits, 97 dBA was exceeded by less than one percent of the trucks operating under a 60-mph (27-m/s) speed limit. However, truck sizes determined generated noise levels. The larger trucks generated more noise. This is clearly evident from Figure 3 displaying data for trucks operating on interstate roads (70-mph (31-m/s) speed limit). About half of the five-axle, tractor-semitrailer combination vehicles exceeded 90 dBA, but less than one percent of two-axle, single unit trucks exceeded this level of noise. Table 4 presents the percentage of various classes of trucks which exceeded a given level of noise.

MOTORCYCLES

No attempt was made in this study to collect a large sample of motorcycle noise data, but their noise levels were recorded at every opportunity. Table 5 lists the readings obtained. Even though the sample size was extremely small, the values may be indicative of noise levels peculiar to motorcycles.

SUMMARY AND DISCUSSION

A considerable number of 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 varied geometric and environmental conditions and posted speeds. The findings cited here, therefore, reasonably reflect noise levels of vehicles operating on Kentucky highways.

As expected, noise levels of trucks were significantly higher than for automobiles, and noise increased with increases in posted speed limit, as summarized in Table 6. The lowest recorded reading was 60 dBA (automobiles in 35-mph (16-m/s) speed limit zones) and the highest was 102 dBA (a single truck on a 60-mph (27-m/s) road). Also, trucks consistently yielded a wider range in noise levels for a given speed limit than automobiles (shown in 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 present data and to cite findings on vehicle noise rather than to recommend or to suggest specific limits. The information contained here, however, may guide in the consideration and establishment of noise standards to the extent that undue burden will not befall automobile or truck owners and operators or destroy commerce and travel in Kentucky. In this regard, the following suggestions and comments may 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 upon 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 (16 m/s), a single but higher noise limit may suffice. As evident from Table 2 and Table 3, however, the practical consequences would be that the higher limit would largely affect those vehicle operators using roadways with a posted speed limit of 70 mph (31 m/s) (interstate and parkway roads). Perhaps a separate limit is warranted for 70-mph (31-m/s) roads and another limit for all roadways having posted speed limits between 40 mph (18 m/s) and 60 mph (27 m/s).

ACKNOWLEDGEMENT

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REFERENCES

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2. Foss, R. N., *Vehicle Noise Study*, Washington State Highway Commission, June 30, 1972.
3. *Noise Control Act of 1972 - Public Law 92-574,* **Congressional Record -- Senate**, October 18, 1972.

TABLE 1

NUMBER OF INDIVIDUAL AUTOMOBILES AND TRUCKS MEASURED

POSTED SPEED LIMIT (mph)	(m/s)	NUMBER OF AUTOMOBILES*	NUMBER OF TRUCKS
70	31	2000	1250**
60	27	2000	665
50	22	1000	335
45	20	1000	100
35	16	2000	150
Totals:		8000	2500

*Includes pick-up trucks (four-wheeled)
**500 by truck type

TABLE 2

PERCENTAGE OF AUTOMOBILES EXCEEDING A GIVEN NOISE LEVEL

NOISE LEVEL (dBA)	PERCENTAGE OF AUTOMOBILES				
	35 mph (16 m/s)	45 mph (20 m/s)	50 mph (22 m/s)	60 mph (27 m/s)	70 mph (31 m/s)
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

TABLE 3

PERCENTAGE OF TRUCKS EXCEEDING A GIVEN NOISE LEVEL

NOISE LEVEL (dBA)	PERCENTAGE OF TRUCKS				
	35 mph (16 m/s)	45 mph (20 m/s)	50 mph (22 m/s)	60 mph (27 m/s)	70 mph (31 m/s)
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

TABLE 4

PERCENTAGES OF VARIOUS TRUCK TYPES EXCEEDING A GIVEN NOISE LEVEL (70-mph (31-m/s) POSTED SPEED LIMIT)

NOISE LEVEL (dBA)	PERCENTAGE OF TRUCKS				
	SU 2-Axle*	SU 3-Axle	TT 3-Axle**	TT 4-Axle	TT 5-Axle
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

*SU -- Single unit trucks
**TT -- Tractor-semitrailer trucks

TABLE 5

MOTORCYCLE NOISE DATA

POSTED SPEED LIMIT (mph)	(m/s)	NOISE LEVEL (dBA)
70	31	91, 89, 86
60	27	90, 83, 82, 82
50	22	79, 78
45	20	76
35	16	79, 76, 75, 72

TABLE 6

SUMMARY OF VEHICLE NOISE LEVELS

POSTED SPEED LIMIT (mph)	(m/s)	MEDIAN NOISE LEVEL (dBA) AUTOMOBILES	TRUCKS
35	16	67	73
45	20	68	76
50	22	72	84
60	27	74	85
70	31	77	88

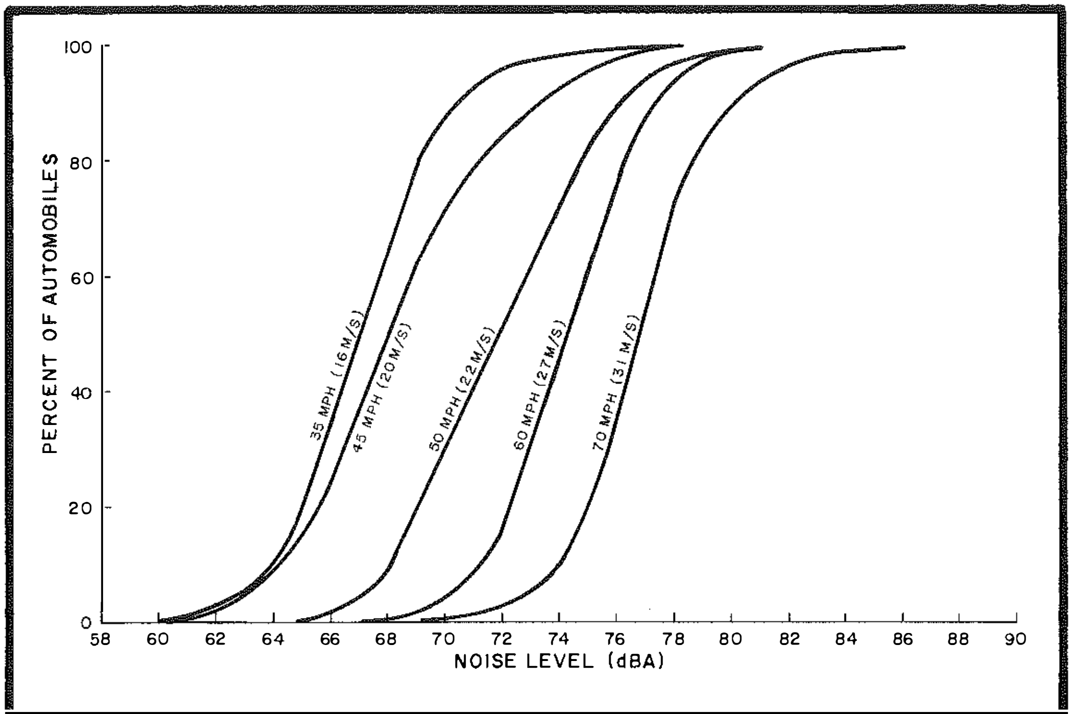
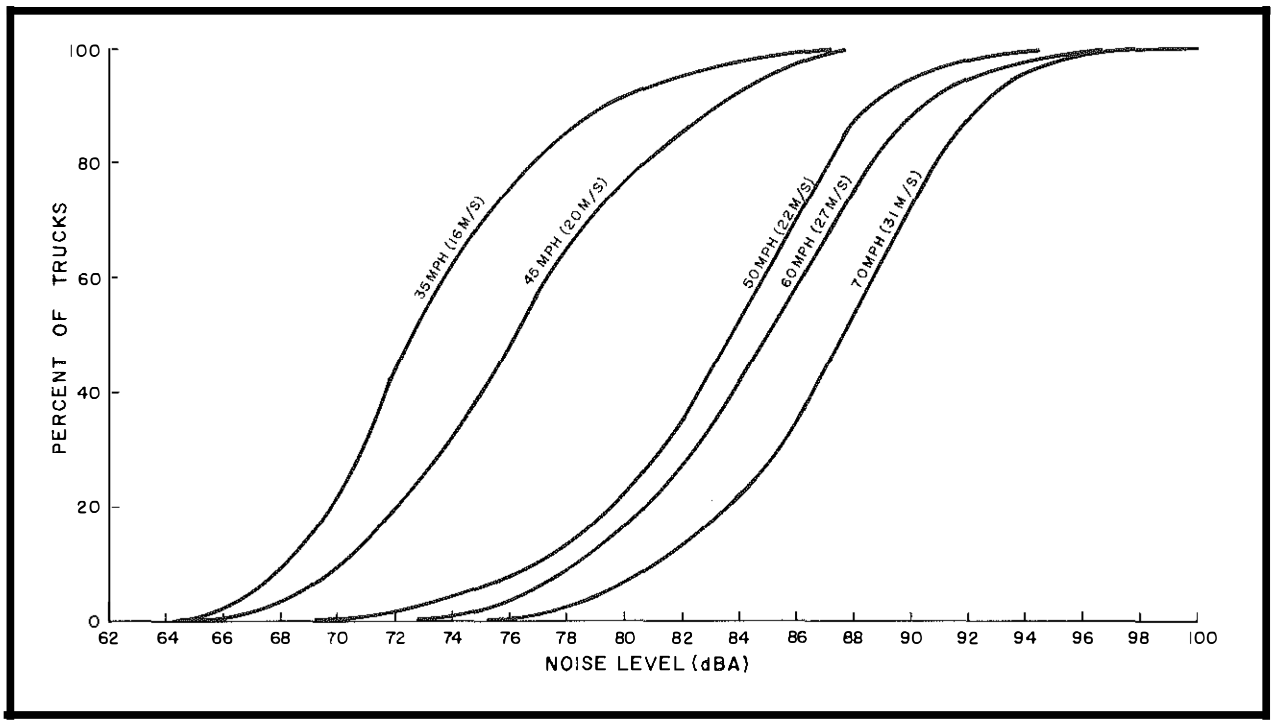


Figure 1. **Cumulative Percentages of Automobiles with Increasing Range of Noise Levels for Roadways with Differing Posted Speed Limits.**

Figure 2. **Cumulative Percentage of Trucks with Increasing Range of Noise Levels for Roadways with Differing Posted Speed Limits.**



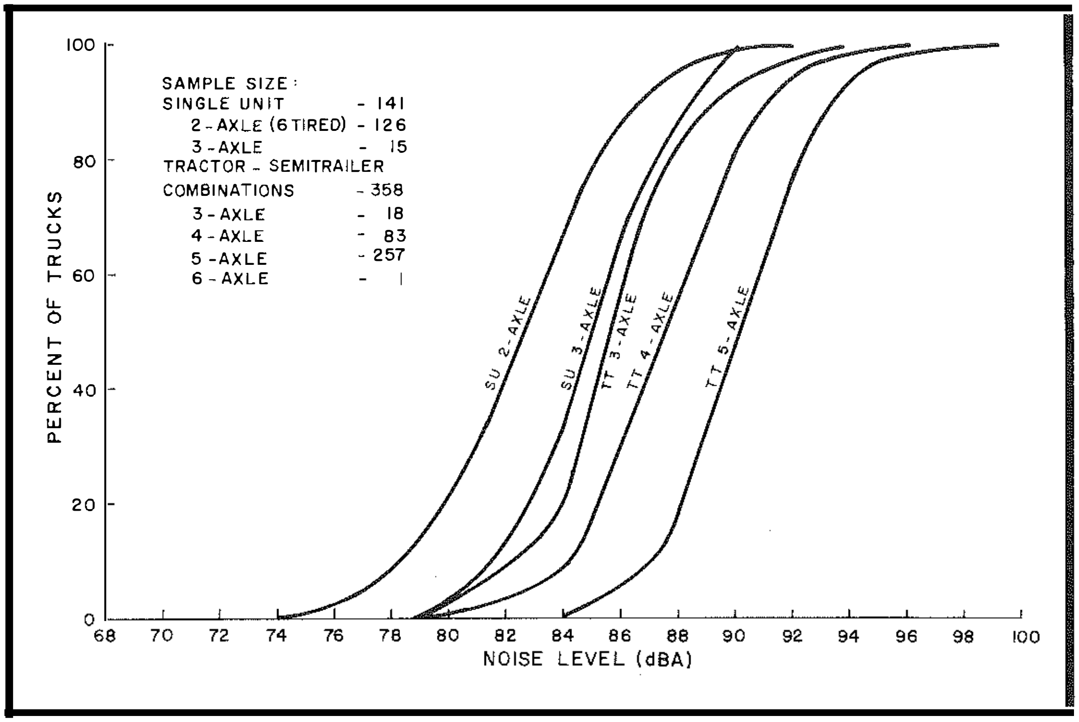


Figure 3. **Cumulative Percentage of Trucks (by Classification) with Increasing Range of Noise Levels for Interstate Roads (70-mph (31 m/s) Speed Limit).**