COMMONWEALTH OF KENTUCKY
DEPARTMENT OF TRANSPORTATION
Division of Research
533 South Limestone
Lexington, KY 40508

CALVIN G. GRAYSON
SECRETARY

JULIAN M. CARROLL
GOVERNOR

H-3-73

May 10, 1977

MEMORANDUM TO: G. F. Kemper
State Highway Engineer
Chairman, Research Committee

SUBJECT: Research Report No. 471; "Traffic Accidents: Day versus Night;" KYP-75-73; HPR-PL-1(12), Part III-B

Norms or base statistics are first-order descriptors of sets of data which are otherwise too large to comprehend or to sort and analyze or compare mentally in meaningful ways. Base statistics may not directly identify or explain causes; only those sorting factors or attributes which sort purely and singularly would qualify in that way. Usually, more than one factor applies to the same happening. Multiple, interactive factors or variables are usually needed to account for and explain variances. Residuals remaining are unexplained and unaccountable. For instance, in the report submitted herewith, the accident data were treated rather clinically -- that is, without explanation or discussion relating to cause. The purpose was to determine critical rates of accidents for daytime and nighttime. Neither the driver's ability to see nor his implied sobriety were considered in the derivations.

Don Herd originated this study but transferred to the Division of Systems Planning last November 1. The other authors completed the work and finalized the report.

Respectfully submitted,

Jas. H. Havens
Director of Research

gd
Enclosures
cc's: Research Committee

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle	5. Report Date
Traffic Accidents: Day versus Night	May 1977
	6. Performing Orgonization Code
7. Author(s)	8. Performing Organization Report No.
D. R. Herd, K. R. Agent, and R. L. Rizenbergs	471
9. Performing Orgonization Nome and Address	10. Work Unit No. (TRAIS)
Division of Research Kentucky Bureau of Highways 533 South Limestone Street Lexington, Kentucky 40508	11. Contract or Grant No. KYP-75-73
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	Interim
	14. Sponsoring Agency Code

15. Supplementary Notes

Study Title: Investigations of Traffic Flow and Safety Characteristics, Relationships and Parameters

16. Abstract

A comparison of accidents during daylight and darkness was made for both rural and urban roads. Accident rates on all types of rural roads were higher during darkness than during daylight. Critical accident rates during darkness for various types of roads were calculated. In urban areas, a larger percentage of accidents occurred on wet pavements during darkness than during daylight, but there were no significant differences for rural roads. No significant difference was found between average speeds during conditions of daylight and darkness. On rural roads, imposition of the 55-mph (24.6-m/s) speed limit resulted in a reduction in accident rates for both daylight and darkness. However, there were changes in the percentages of wet-pavement accidents on rural roads. For the entire rural system, there was a decrease in the percentages of wet-pavement accidents during daylight and an increase during darkness.

17. Key Words	18. Distribution Statement
Accidents During Darkness Accidents During Daylight Accident Rate Wet-Pavement Accidents Accident Severity 55-mph (24.6-m/s) (Speed Limit	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price

Research Report
471

TRAFFIC ACCIDENTS: DAY VERSUS NIGHT

KYP-75-73; HPR-PL-1(12), Part III B

by

Donald R. Herd
Civil Engineer Senior

Kenneth R. Agent
Research Engineer Principal

and

Rolands L. Rizenbergs
Assistant Director of Research

Division of Research
Bureau of Highways
DEPARTMENT OF TRANSPORTATION
Commonwealth of Kentucky

May 1977

INTRODUCTION

Several sorting factors have been employed previously in deriving traffic accident statistics. Roadway geometrics *(1)* and factors related to the energy crisis *(2)* have been investigated. However, statistics related to day and night and dawn and dusk had not been derived. Average and critical accident rates have been calculated for various types of highways, but basic rates for daylight and darkness have not been determined. Accident records have now been searched and sorted to obtain those statistical indices. Others, elsewhere, have reported significant differences in accidents during daylight and darkness *(3, 4)*.

Accident experience since the 55-mph (24.6-m/s) speed limit was imposed was analyzed to determine the effect of increased speed on many highways during the hours of darkness. The speed limit in Kentucky was set at 55 mph (24.6 m/s) on March 1, 1974. This speed limit applied to all vehicles for both daylight and darkness driving conditions and all types of roads. Before that, the speed limit on interstate and four-lane, divided, toll systems has been 70 mph (31.3 m/s) during both daylight and darkness. The speed limit on most other rural roads was 60 mph (26.8 m/s) in daytime and 50 mph (22.4 m/s) at night. A dramatic decrease in the number of traffic accidents, injuries, fatalities, and rates followed the so-called energy crisis of late 1973 *(2)*. The biggest reductions coincided with speed reductions and the speed-limit change in March 1974. A major conclusion from those statistics was that vehicle speed was highly relatable to accident involvement. However, that study did not deal with the effects of an increase in posted speed on many roads during the hours of darkness.

PROCEDURE

Accident and volume data were obtained for both rural and urban roads. Accidents reported by State Police constituted the data sample from rural areas. Urban accident data were obtained from the city of Louisville. Data for 1973 and 1975 were used for the rural system, and data for 1973 and 1974 were used for the urban roads (1975 urban accident data was not available). The data from both years were used when comparing conditions before and after the 55-mph (24.6-m/s) speed limit. However, only 1975 data for the rural system and 1974 data for the urban system were used in most comparisons because those data better reflected current roadway environment.

The rural highway system was sorted into the following:

1. two-lane (including three-lane) roads,
2. expressways (interstate and parkway (toll road)), and
3. four-lane (undivided and divided, no access control) roads.

Accidents in the urban area were not classified by type of road.

To accurately determine periods of daylight and darkness, the hours of sunrise and sunset were obtained from the Weather Bureau *(5)*. After accounting for the two different time zones within the state and daylight savings time, the hours of daylight and darkness were defined for each month *(6, 7)*. Dawn was defined as the hour before sunrise (rounded to the nearest hour); dusk was defined as the hour after sunset. Accidents were obtained on an hourly basis and then summarized by those times (APPENDIX A).

Total vehicle-miles (vehicle-kilometers) of travel on the rural system had been obtained earlier *(2)*. Using several, representative, 24-hour counts, the hourly volume distribution was determined (APPENDIX B). Accident rates for each period were calculated. Rates during darkness were calculated for each type of rural road. Total vehicle miles traveled in the urban area was not known, and only the percentages of accidents and traffic volumes in the respective periods could be compared.

RESULTS

RURAL ACCIDENTS

Accident Rates – Twenty-two percent of the rural accidents occurred during darkness. Table 1 shows also that 31.9 percent of accidents on expressways occurred during darkness. This higher percentage was probably due to the higher traffic volumes on these routes during the hours of darkness. The highest rate was on two-lane highways during darkness (412 accidents per 100 MVM (160 MVkm)). These statistics are given in Table 2. The rate during dusk for two-lane roads was also high (317 accidents per 100 MVM (160 MVkm)). The rates during darkness were the highest on each highway type. The overall rate during darkness on the rural system was 1.6 times greater than the rate during daylight. As expected, expressways had the lowest rates. The rate during dusk was surprisingly high compared to the rate at dawn.

Critical Accident Rates during Darkness -- Using the average rates for periods of darkness as previously determined, critical rates can be calculated for any given section length, annual average daily traffic, and probability level *(8)*. Resulting critical rate curves may be used to determine if an accident problem exists during darkness and whether safety improvements may be warranted. Critical rates were calculated for each type of rural road using

$$A_c = A_a + K\sqrt{A_a/M} + 1/2M,$$

where A_c = critical accident rate,
A_a = average accident rate,
K = constant related to level of statistical significance selected; for P = 0.95, K = 1.645; for P = 0.995, K = 2.576, and
M = annual 100 million vehicle miles (160 million vehicle kilometers).

A probability level of 0.95 was selected. Calculations were based on data for one year. The resulting, critical rate curves are presented in Figures 1 through 3. Critical rates were determined for section lengths ranging from 1 mile (1.6 km) to 20 miles (32.2 km). A different set of graphs could be developed for two or more years of accident data. Increasing the number of years of data would result in lower critical rates.

To determine if the nighttime accident rate of a section is critical, the section length, annual average daily traffic (AADT), and the accident rate during the period of darkness must be known. The critical rate is determined using the AADT and section length. If the rate is above the critical rate, the location should be investigated.

Wet or Dry Conditions -- The distribution of accidents by wet or dry conditions is given in Table 3. Accidents are presented as a percentage of the total during each of the periods. There were no significant differences in the percentages of accidents on wet pavements. Slightly under 19 percent of the accidents were on wet pavements during darkness; this compared to 19.3 percent during daylight. The ratio of wet- to dry-pavement accidents showed that the only significant difference occurred at dawn when the ratio was significantly higher. The hours of precipitation had to be considered before valid comparisons could be made. Rainfall data were obtained from the Weather Bureau. Using this information, the ratio of wet to dry time was calculated for each part of the 24-hour period. No significant differences were found (Table 3).

Severity -- Table 4 compares severity of accidents during darkness and daylight hours. Accidents were more severe during darkness on all roads. Fatal accidents were 2.3 times more likely to occur during darkness than during daylight. Injury-type accidents during darkness increased only slightly.

Effect of Speed -- No significant differences were observed between average day and night speeds (Table 5). However, speed measurements were not taken during early morning hours. Table 5 shows average speeds before and after the speed limit on interstate routes were reduced. Average speeds, there, decreased from 66.9 mph (29.9 m/s) to 58.9 mph (26.3 m/s). Average speeds on two-lane roads was 53.2 mph (23.8 m/s) after the 1974 reduction in speed limit.

Table 6 shows how accidents during times of darkness were affected by the change in speed limit. As expected, the percent of accidents during darkness increased slightly on two-lane roads in 1975. Contrary to what was expected, the percent of accidents on expressways increased significantly.

The percentages of wet-pavement accidents before and after the speed limit change are compared in Table 7. There were significant changes in the percent of wet-pavement accidents. For all highways, there was a decrease in the percentage of wet-pavement accidents during daylight but an increase during darkness. This increase resulted solely from the increase on two-lane roads and corresponded with an increase in speed limit during darkness. This finding was significant and represents true increase in percent accidents because the before and after periods experienced equal time of rainfall.

Accident rates before and after the speed change are given in Table 8. There were similar changes in the accident rate for both daylight and darkness. The ratio of daylight rates to darkness rates before and after the speed limit change (Table 9) also showed no change for the total system. The larger ratio after the speed limit change for four-lane highways reflects the larger decrease during darkness than daylight. On expressways, the rate during daylight decreased more than the rate during darkness.

Accident Summary by Hour of Day -- An accident summary by hour of day for the entire rural system is presented in Table 10. It shows an increase in accident rate and severity during darkness (particularly early morning hours). The highest hourly accident rate was between 1 and 2 a.m. The hours between 9 p.m. and 4 a.m. generally had the highest accident rates. These same hours also had the highest percentage of injury and fatal accidents.

URBAN ACCIDENTS

Accidents and Traffic Volume -- Since the total vehicle-miles (vehicle-kilometers) traveled in the urban area were not known, accidents rates for urban roads could not be calculated. A number of 24-hour traffic volume counts were obtained, and the percentage of accidents and volume during the various light conditions were compared (Table 11). For both daytime and night, the percentage of accidents and volume was very similar. There were distinct differences in accidents during dawn and dusk. The percentage of accidents at dawn were abnormally low compared to other times during the day.

Wet or Dry Conditions -- Data in Table 12 show that accidents during wet-pavement conditions comprise a greater proportion of accidents during darkness than during daylight. The slightly higher ratio of wet- to dry-time pavement conditions during darkness does not account for the difference in the rates of wet- and dry-pavement accidents. As was seen for rural accidents, a higher ratio of wet- to dry-pavement accidents occurred during dawn.

In an effort to alleviate the problem of rainy, nighttime accidents, a recent safety program in urban areas involved the installation of raised, pavement markers. Their effect on wet, nighttime accidents has not yet been determined.

Severity: The severity of accidents was found to increase during the hours of darkness (Table 13). The percentage of injury accidents showed an increase, but the largest increase involved fatal accidents. The percentage of fatal accidents during nighttime was almost four times that during daytime. Accidents at dawn and dusk were more severe than daytime accidents but less severe than accidents during nighttime.

Effect of Energy Crisis -- The effects of the energy crisis on accidents (primarily the 55-mph (24.6-m/s) speed limit) are summarized in Table 14. The reduction in the speed limit, of course, involved primarily roads in rural areas and should have a smaller effect in urban areas because the speed limits there were already under 55 mph (24.6 m/s). Considering all accidents, there were no significant changes in the percentage of injury and fatal accidents. The data showed that the energy crisis had a greater overall effect on accidents during nighttime than during daytime.

SUMMARY AND CONCLUSIONS

On rural roads the accident rate at night was higher than during day. The ratio of the night and day accident rates was greatest for rural expressways (1.98) and least for four-lane roads (1.47). Generally, the accident rates during dusk were higher than during dawn, which may be due to higher traffic volumes associated with the hours of dusk. Twenty-two percent of the accidents occurred during darkness. Rural expressways had the highest percentage of accidents during darkness (31.9 percent).

Critical rates of accidents during darkness for various types of rural roads were calculated. Graphs presenting the critical rate as a function of volume and section length were prepared for each type of rural road. The critical rate curves may be used to determine if an accident problem exists during darkness.

In the urban area, wet-pavement accidents were more of a problem during darkness than during daylight, but there was no significant difference between the percentage during darkness and daylight on rural roads. At dawn, both urban and rural roads had a higher incidence of wet-pavement accidents than dry-pavement accidents. Both urban and rural accidents were more severe at night. The rate of fatal accidents was much higher at night, and there was a slightly higher incidence of injury accidents.

No significant differences were observed between average speeds during daylight and darkness.

On rural roads, the 55-mph (24.6-m/s) speed limit resulted in similar changes in the accident rates for both daylight and darkness. However, there were significant changes in the percentage of wet-pavement accidents after the speed limit change. Throughout the rural system, there was a decrease in the percentage of wet-pavement accidents during daylight but an increase during darkness. This nighttime increase resulted from the increase in the percentage of accidents on the two-lane roads. On these roads, the nighttime speed limit was raised from 50 mph (22.4 m/s) to 55 mph (24.6 m/s). Considering all accidents in the urban areas, there were no significant changes in accident occurrence after the 55-mph (24.6-m/s) speed limit change; however, there was a greater overall increase of accidents during darkness than during daylight hours.

REFERENCES

1. Agent, K. R., *Relationships between Roadway Geometrics and Accidents (An Analysis of Kentucky Records),* Division of Research, Kentucky Bureau of Highways, April 1974.
2. Agent, K. R.; Herd, D. R.; and Rizenbergs, R. L., *First Year Effects of the Energy Crisis on Traffic in Kentucky (Rural Highways),* Division of Research, Kentucky Bureau of Highways, May 1975.
3. Sabey, B. E., *Road Accidents in Darkness,* Transport and Road Research Laboratory Report LR 536, 1973.
4. Gillespie, R. H., *Kentucky Highway Accidents,* Report S-120, Spindletop Research, December 1965.
5. *Sunrise and Sunset at Louisville, Kentucky,* No. 1118, Nautical Almanac Office, United States Naval Observatory.
6. *The World Almanac,* The Courier-Journal, 1976.
7. The Courier-Journal, January 4, 1974.
8. Zegeer, C. V., *Identification of Hazardous Locations on Rural Highways in Kentucky,* Division of Research, Kentucky Bureau of Highways, June 1974.

TABLE 1. PERCENT ACCIDENTS FOR VARIOUS LIGHT CONDITIONS (RURAL ROADS)[a]

ROADS	PERCENT OF ACCIDENTS			
	DAYLIGHT	DARKNESS	DAWN	DUSK
Two-Lane	71.6	21.2	1.9	5.3
Four-Lane	72.8	18.2	3.6	5.4
Expressway	60.2	31.9	3.9	4.0
All	70.8	21.9	2.1	5.2

[a]1975 State Police accidents

TABLE 2. ACCIDENT RATES FOR VARIOUS LIGHT CONDITIONS (RURAL ROADS)[a]

ROADS	ACCIDENT RATE (ACCIDENTS/100 MVM)				
	DAYLIGHT	DARKNESS	DAWN	DUSK	COMBINED
Two-Lane	238	412	175	317	263
Four-Lane	102	150	140	135	111
Expressway	55	109	95	68	67
All	192	309	156	256	211

[a]1975 State Police accidents

TABLE 3. ACCIDENTS DURING VARIOUS LIGHT AND PAVEMENT-SURFACE CONDITIONS (RURAL ROADS)[a]

LIGHT CONDITIONS	PERCENT OF ACCIDENTS ON WET PAVEMENTS	PERCENT OF ACCIDENTS ON SNOW OR ICE	RATIO OF WET- TO DRY-PAVEMENT ACCIDENTS	RATIO OF WET- TO DRY-TIME CONDITIONS
Daylight	19.3	3.3	.25	.19
Dawn	25.7	15.0	.43	.22
Dusk	19.8	3.8	.26	.20
Darkness	18.7	5.1	.24	.21

[a] 1975 State Police accidents

TABLE 4. PERCENT OF INJURY AND FATAL ACCIDENTS DURING DAYLIGHT AND DARKNESS (RURAL ROADS)[a]

ROADS	PERCENT INJURY ACCIDENTS		PERCENT FATAL ACCIDENTS	
	DAYLIGHT	DARKNESS	DAYLIGHT	DARKNESS
Two-Lane	31.7	37.7	1.6	3.7
Four-Lane	31.7	33.8	1.1	3.9
Expressway	34.9	36.6	2.1	3.5
All	31.9	37.5	1.6	3.7

[a]1975 State Police accidents

TABLE 5. AVERAGE SPEEDS ON RURAL ROADS DURING DAYLIGHT AND DARKNESS

		AVERAGE SPEED (mph)								
		DAYLIGHT			DARKNESS			BOTH		
		CAR	TRUCK	ALL	CAR	TRUCK	ALL	CAR	TRUCK	ALL
Interstate Roads	Before 55 mph (24.6 m/s) Speed Limit	69.6	62.8	67.0	68.8	63.0	66.7	69.6	62.8	66.9
	After 55 mph (24.6 m/s) Speed Limit	59.0	58.5	58.9	59.3	58.3	59.0	59.2	58.4	58.9
Two-Lane Roads	After 55 mph (24.6 m/s) Speed Limit	53.3	51.8	53.1	53.4	53.2	53.4	53.4	52.3	53.2

TABLE 6. PERCENT OF ACCIDENTS DURING DARKNESS BEFORE AND AFTER 55 mph (24.6 m/s) SPEED-LIMIT CHANGE (RURAL ROADS)

ROADS	PERCENT OF ACCIDENTS DURING DARKNESS		
	BEFORE (1973)	AFTER (1975)	PERCENT CHANGE
Two-Lane	20.0	21.2	+6.0
Four-Lane	23.2	18.2	-21.6
Expressway	28.5	31.9	+11.9
All	21.0	21.9	+4.3

TABLE 7. PERCENT OF WET-PAVEMENT ACCIDENTS BEFORE AND AFTER 55 mph (24.6 m/s) SPEED-LIMIT CHANGE (RURAL ROADS)

ROADS	PERCENT WET-PAVEMENT ACCIDENTS					
	BEFORE (1973)		AFTER (1975)		PERCENT CHANGE	
	DAYLIGHT	DARKNESS	DAYLIGHT	DARKNESS	DAYLIGHT	DARKNESS
Two-Lane	23.0	16.4	19.6	19.0	-14.8	+15.9
Four-Lane	26.0	21.6	21.9	20.3	-15.8	-6.0
Expressway	29.0	17.6	14.7	15.1	-49.3	-14.2
All	23.7	16.7	19.3	18.7	-18.6	+12.0

TABLE 8. ACCIDENT RATES DURING DAYLIGHT AND DARKNESS BEFORE AND AFTER 55 mph (24.6 m/s) SPEED-LIMIT CHANGE (RURAL ROADS)

ROADS	ACCIDENT RATE (ACCIDENTS/100 MVM)					
	BEFORE (1973)		AFTER (1975)		PERCENT CHANGE	
	DAYLIGHT	DARKNESS	DAYLIGHT	DARKNESS	DAYLIGHT	DARKNESS
Two-Lane	250	433	238	412	-4.7	-5.0
Four-Lane	129	259	102	150	-21.2	-42.0
Expressway	86	144	55	109	-35.7	-24.8
All	207	333	192	309	-7.4	-7.2

TABLE 9. RATIO OF DAYLIGHT TO DARKNESS ACCIDENT RATES BEFORE AND AFTER 55 mph (24.6 m/s) SPEED-LIMIT CHANGE (RURAL ROADS)

ROADS	RATIO OF DAYLIGHT TO DARKNESS ACCIDENT RATE	
	BEFORE (1973)	AFTER (1975)
Two-Lane	.58	.58
Four-Lane	.50	.68
Expressway	.59	.51
All	.62	.62

TABLE 10. ACCIDENT SUMMARY BY HOUR OF DAY (ALL RURAL ROADS)[a]

HOUR OF DAY	NUMBER OF ACCIDENTS	ACCIDENT RATE (ACCIDENTS/100 MVM)	PERCENT OF INJURY AND FATAL ACCIDENTS
1[b]	610	448	44.8
2	485	509	47.0
3	309	320	41.1
4	282	387	44.3
5	240	264	42.5
6	316	164	35.8
7	682	153	32.3
8	973	125	31.2
9	1148	168	30.3
10	1182	144	28.3
11	1276	153	29.8
12	1594	187	29.5
13	1627	198	31.6
14	1681	197	34.1
15	2104	236	34.1
16	2293	225	32.8
17	2441	222	32.7
18	1990	194	35.1
19	1725	248	36.1
20	1403	263	38.4
21	1108	274	37.7
22	992	304	42.5
23	857	313	42.6
24	425	218	43.6

[a]1975 State Police accidents

[b]Midnight to 1 a.m.

TABLE 11. PERCENT OF ACCIDENTS AND TRAFFIC VOLUMES FOR VAR OUS LIGHT CONDITIONS (URBAN ROADS)[a]

LIGHT CONDITIONS	PERCENT OF ACCIDENTS	PERCENT OF VOLUME
Daylight	71.8	72
Darkness	22.2	20
Dawn	1.4	4
Dusk	4.6	4
All	100.0	100

[a] Louisville 1974 accident data
Louisville 24-hour volume data

TABLE 12. ACCIDENTS DURING VARIOUS LIGHT AND PAVEMENT-SURFACE CONDITIONS (URBAN ROADS)[a]

LIGHT CONDITIONS	PERCENT ACCIDENTS ON WET PAVEMENTS	PERCENT ACCIDENTS ON SNOW OR ICE	RATIO OF WET- TO DRY-PAVEMENT ACCIDENTS	RATIO OF WET- TO DRY-TIME PAVEMENT CONDITIONS
Daylight	19.5	1.7	.25	.19
Dawn	32.1	10.0	.55	.22
Dusk	22.8	1.5	.30	.20
Darkness	26.7	4.6	.39	.21

[a]Louisville 1974 Accident Data

TABLE 13. SEVERITY OF ACCIDENTS DURING VARIOUS LIGHT CONDITIONS (URBAN ROADS)

LIGHT CONDITIONS	PERCENT INJURY ACCIDENTS	PERCENT FATAL ACCIDENTS
Daylight	9.7	0.14
Dawn	9.4	0.67
Dusk	11.6	0.22
Darkness	14.4	0.53

TABLE 14. EFFECT OF ENERGY CRISES ON ACCIDENTS DURING DAYLIGHT AND DARKNESS (URBAN ROADS)

	BEFORE ENERGY CRISES (1973)			AFTER ENERGY CRISES (1974)			PERCENT CHANGE		
	DAYLIGHT	DARKNESS	TOTAL	DAYLIGHT	DARKNESS	TOTAL	DAYLIGHT	DARKNESS	ALL
Number of Accidents	14,525	4,575	20,512	14,582	4,514	20,314	+0.4	-1.3	-1.0
Percent on Wet-Pavement	19.6	31.1	22.0	19.5	26.7	21.5	-0.5	-14.1	-2.3
Percent Injury and Fatal Accidents	9.8	15.6	11.3	9.8	14.9	11.1	0	-4.5	-1.8

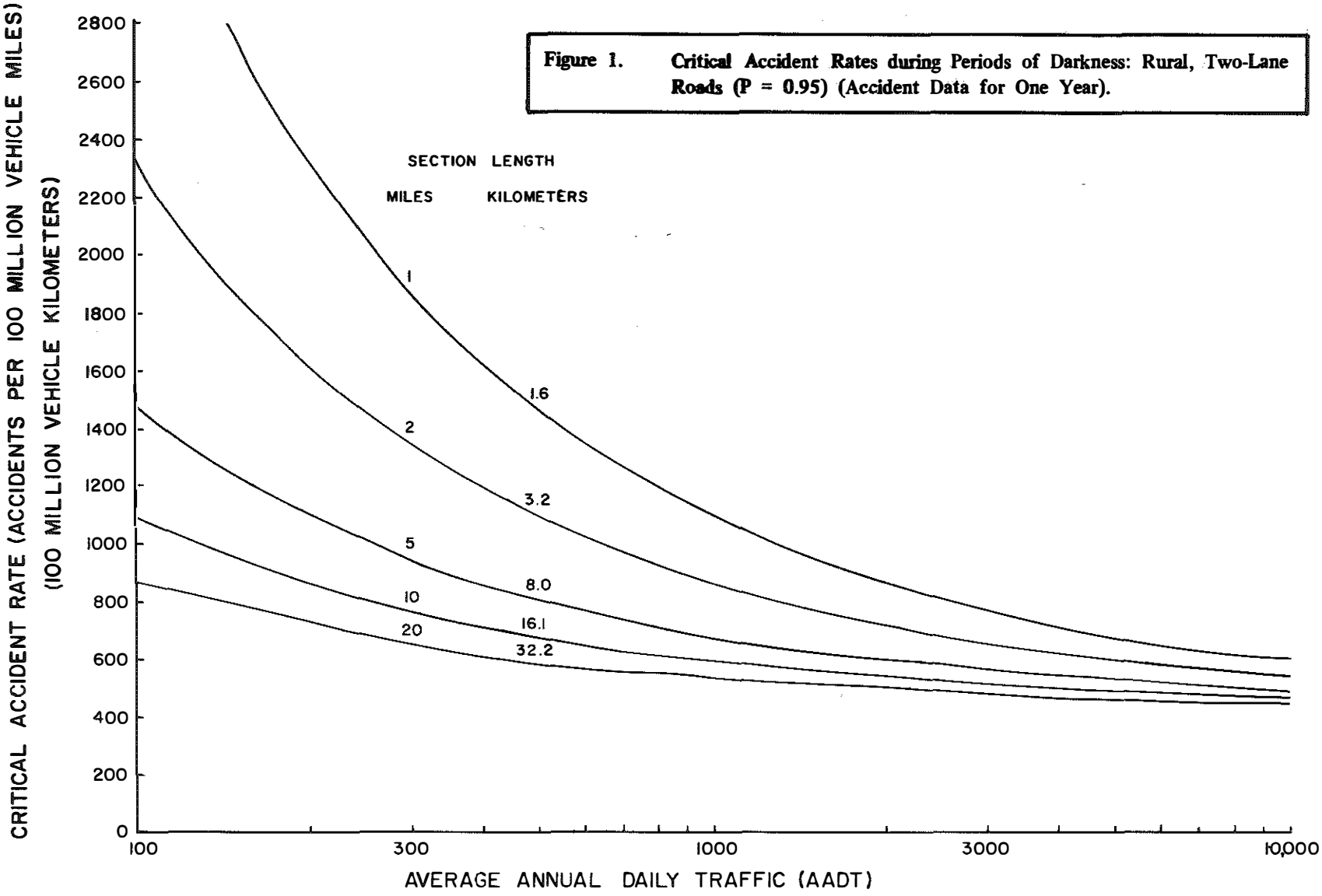


Figure 1. **Critical Accident Rates during Periods of Darkness: Rural, Two-Lane Roads (P = 0.95) (Accident Data for One Year).**

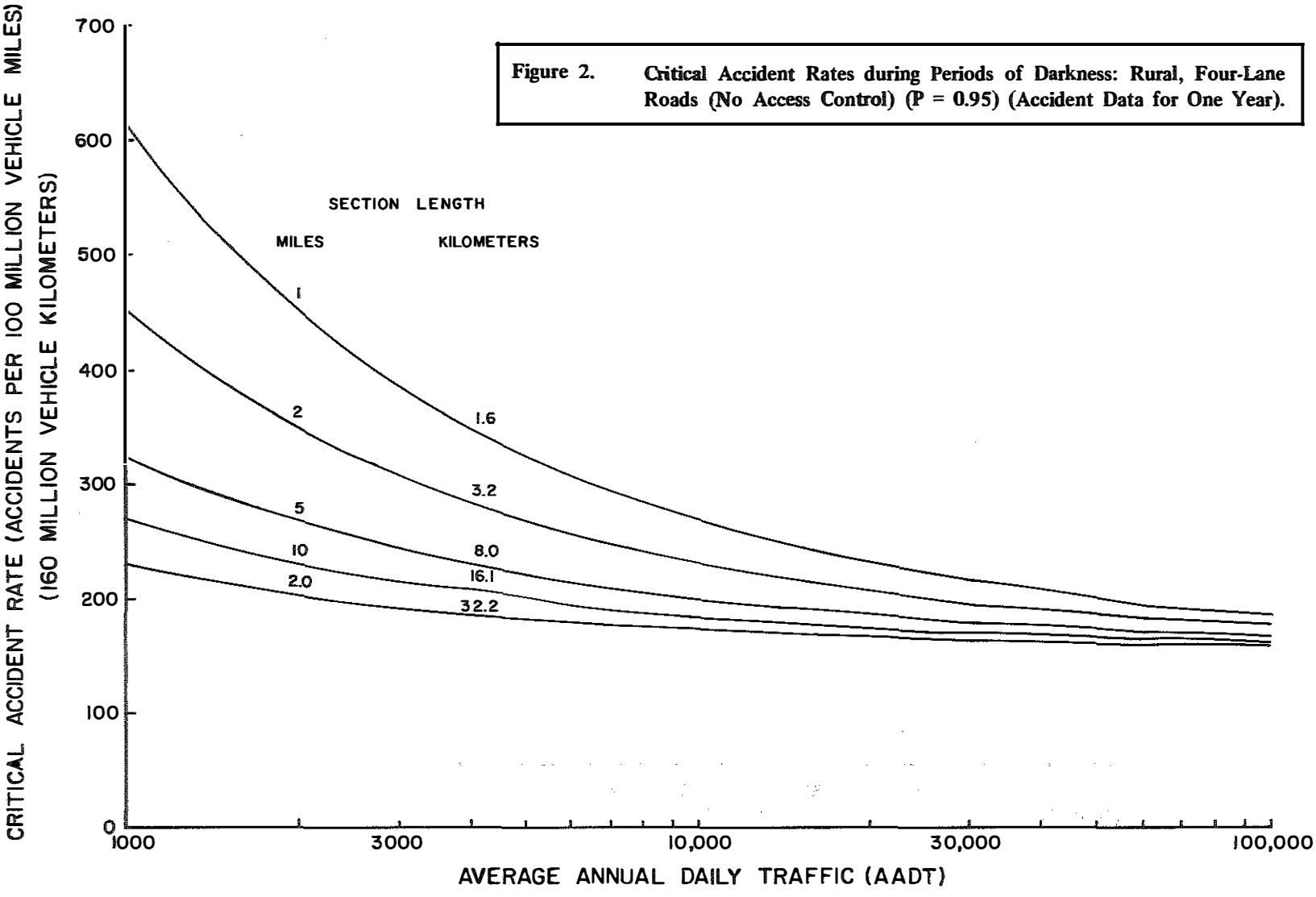
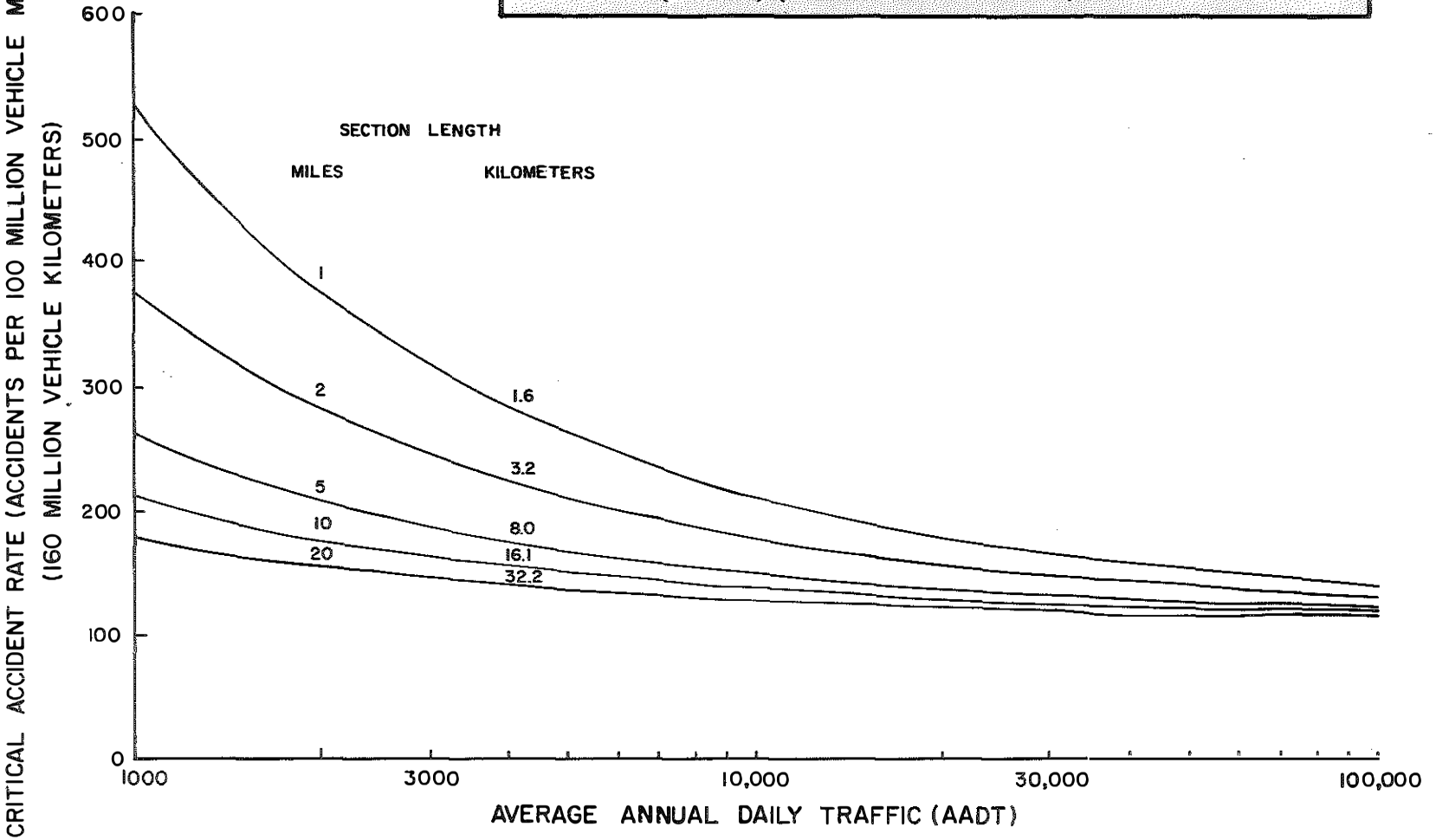


Figure 2. **Critical Accident Rates during Periods of Darkness: Rural, Four-Lane Roads (No Access Control) (P = 0.95) (Accident Data for One Year).**

Figure 3. Critical Accident Rates during Periods of Darkness: Rural Expressways (P = 0.95) (Accident Data for One Year).



APPENDIX A

SUMMARY OF 1975 ACCIDENT DATA BY MONTH AND HOUR

SUMMARY OF 1975 TRAFFIC ACCIDENT DATA BY MONTH AND HOUR

	HOUR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
DARKNESS	1	38*	45	47	46	69	50	52	61	46	61	52	43
	2	39	44	31	32	35	43	30	41	29	42	61	58
	3	42	31	20	15	18	19	29	15	21	25	33	41
	4	26	37	29	12	22	17	32	17	15	21	28	26
	5	9	21	17	17	24	22	19	26	23	16	25	21
	6	11	19	31	18	23	38	30	29	27	30	30	30
	7	26	33	86	57	76	65	44	69	67	66	47	46
DAWN	8	88	55	94	65	94	59	72	65	105	107	82	87
DAYLIGHT	9	90	79	107	78	104	97	73	79	100	106	114	121
	10	83	74	89	100	102	102	106	114	85	122	96	109
	11	96	86	118	83	121	121	105	112	109	115	96	114
	12	112	86	136	108	140	143	133	124	149	127	135	151
	13	108	113	117	100	162	175	153	155	106	132	138	168
	14	117	107	125	115	173	165	156	158	140	148	124	153
	15	143	128	168	160	216	209	181	197	169	204	148	181
	16	168	117	167	176	205	223	202	234	217	242	157	185
	17	150	149	163	185	256	212	215	223	202	211	216	220
	18	149	144	132	135	178	193	202	181	156	182	164	174
DUSK	19	145	100	115	102	166	147	169	150	119	138	203	171
DARKNESS	20	109	130	98	77	134	103	138	110	106	129	137	132
	21	59	71	90	83	128	94	100	98	90	102	91	102
	22	61	69	74	78	99	73	102	86	78	89	96	87
	23	57	61	75	60	71	78	76	73	81	82	70	73
	24	63	42	26	23	29	24	24	38	23	22	81	80

*Number of accidents

APPENDIX B

SUMMARY OF 1975 TRAFFIC VOLUME DATA BY MONTH AND HOUR

SUMMARY OF 1975 TRAFFIC VOLUME DATA BY MONTH AND HOUR

	HOUR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
DARKNESS	1	9.3*	9.4	10.7	11.2	12.1	12.6	13.5	13.3	11.2	11.4	10.9	10.6
	2	6.5	6.5	7.6	7.8	8.4	8.8	9.5	9.4	7.8	8.0	7.6	7.4
	3	6.6	6.7	7.7	8.0	8.5	8.9	9.6	9.5	7.9	8.1	7.7	7.5
	4	4.9	5.0	5.8	6.0	6.4	6.7	7.3	7.2	5.9	6.1	5.8	5.7
	5	6.2	6.2	7.2	7.5	8.0	8.4	9.0	8.9	7.4	7.6	7.3	7.1
	6	13.2	13.3	15.1	15.8	17.1	17.8	19.0	18.7	15.8	16.1	15.4	15.0
	7	30.8	31.0	34.6	36.7	39.9	41.3	43.7	42.9	37.1	37.6	35.9	34.6
DAWN	8	54.0	54.5	59.9	64.1	70.0	72.1	76.1	74.6	65.3	65.9	62.8	60.4
	9	47.1	47.5	53.0	56.2	61.1	63.2	67.0	65.8	56.9	57.6	55.0	53.0
	10	56.6	57.1	63.6	67.5	73.4	75.9	80.4	79.0	68.3	69.2	66.0	63.7
	11	57.6	58.1	64.8	68.7	74.7	77.3	81.9	80.5	69.5	70.5	67.2	64.9
DAYLIGHT	12	57.0	57.5	64.3	68.0	73.9	76.5	81.1	79.8	68.8	69.7	66.6	64.2
	13	56.8	57.2	63.9	67.7	73.6	76.1	80.7	79.3	68.5	69.4	66.2	63.9
	14	59.0	59.5	66.2	70.3	76.5	79.0	83.7	82.2	71.1	72.1	68.8	66.3
	15	61.6	62.1	69.2	73.4	79.8	82.6	87.5	85.9	74.3	75.3	71.8	69.3
	16	70.4	71.0	78.9	83.8	91.2	94.3	99.8	98.0	84.9	86.0	82.0	79.1
	17	76.1	76.7	85.1	90.5	98.7	101.9	107.7	105.7	91.9	93.0	98.7	85.4
	18	71.0	71.5	79.1	84.3	92.0	94.9	100.2	98.3	85.7	86.6	82.6	79.5
DUSK	19	48.0	48.4	53.7	57.1	62.2	64.3	68.0	66.8	57.9	58.6	55.9	53.9
	20	36.8	37.1	41.2	43.8	47.7	49.3	52.1	51.2	44.4	44.9	42.9	41.3
DARKNESS	21	27.8	28.0	31.3	33.2	36.1	37.3	39.5	38.8	33.5	34.0	32.4	31.3
	22	22.5	22.7	25.4	26.9	29.1	30.2	32.1	31.5	27.1	27.5	26.3	25.4
	23	18.8	19.0	21.3	22.5	24.4	25.3	26.5	26.4	22.7	23.0	22.0	21.3
	24	13.4	13.5	15.3	16.0	17.3	18.0	19.2	18.9	16.1	16.4	15.7	15.2

*Million vehicle miles