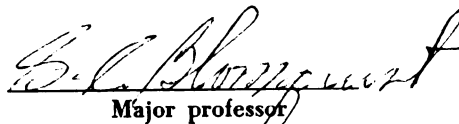




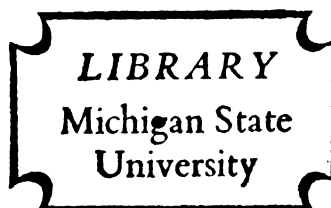
A RE-EVALUATION OF HIGHWAY  
NO-PASSING ZONES

Thesis for the Degree of M. S.  
MICHIGAN STATE UNIVERSITY  
David Chapman Bacon  
1963

This is to certify that the  
thesis entitled  
**A RE-EVALUATION OF HIGHWAY  
NO PASSING ZONES**  
presented by  
**David Chapman Bacon**  
has been accepted towards fulfillment  
of the requirements for  
M.S. degree in Civil Engineering

  
Major professor

Date 11/17/63



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## ABSTRACT

### A RE-EVALUATION OF HIGHWAY NO-PASSING ZONES

by David Chapman Bacon

A re-evaluation of the no-passing zones on two-lane rural roads was made in an effort to update some of the present design criteria.

A questionnaire was designed in an effort to better understand the driver, his passing and driving practices, and his acceptance of current and proposed practices for marking no-passing zones.

The required distances, necessary to pass, were computed from present day acceleration data and compared with existing design criteria.

Accidents in no-passing zones, in the areas covered by the questionnaire, were checked in an effort to find the most hazardous passing maneuver.

The changes in required passing distances with current acceleration data are compared with increases in required passing distances due to the lower silhouetted vehicles.

Results show that there should be a lowering of the driver eye height, used in marking no-passing zones, as well as an increase in the length of the minimum passing sight distance, used in both design and marking of crest vertical curves.

**A RE-EVALUATION OF HIGHWAY NO-PASSING ZONES**

**By**

**DAVID CHAPMAN BACON**

**A THESIS**

**Submitted to**

**Michigan State University**

**in partial fulfillment of the requirements**

**for the degree of**

**MASTER OF SCIENCE**

**Department of Civil Engineering**

**1963**

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To Dr. Siegfried Breuning, my advisor for the first part of my graduate program, special thanks is extended for his assistance in developing the necessary equations for computing passing distances and guidance in the writing of this thesis.

THESE



General Motors Corporation and The Ford Motor Company  
supplied the acceleration data for present day vehicles.

Dr. Gail Blomquist, my advisor, for his assistance in the  
completion of this thesis.

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## CHAPTER I

### INTRODUCTION

The purpose of this thesis was to re-evaluate no-passing zones on two lane rural roads, with special emphasis on; 1) Driver passing practices and understanding of marking techniques, 2) Changes in vehicle performance characteristics, 3) Driver eye height as effected by vehicle design. The effect of these factors on design and marking practices will be discussed. Marking policy completeness and clarity of meaning was also considered, but only as a by-product of the re-evaluation.

The rationale for marking no-passing zones was developed in 1938-1941 and has been used by engineers for the past twenty years, with the tacit assumption that it was and is adequately understood by the driver. There is no evidence, however, that the acceptance and understanding of the fairly complex no-passing zone policies, by the public, has ever been analyzed. It was felt that a check of the driver's actual passing practices and observance of marking techniques, would not only be highly desirable, but actually, be necessary as a basis upon which to evaluate the present policies. Furthermore, the national standards <sup>(a)</sup> for marking no-passing zones are still based on acceleration rates, driver eye height and driver characteristics determined in 1938-1941. These existing standards

---

(a) This number indicates the author's reference in the bibliography, unless a footnote is given. Ref. here is No. 1.

are outdated for some present day vehicle characteristics. It was recognized that vehicle dimensions, acceleration rates, driver characteristics and passing practices would have to be studied and brought up to date. Recent research concerning vehicle dimensions and driver eye height<sup>(b)</sup> has shown ever-increasing numbers of lower silhouetted vehicles on our highways, made up of both imported foreign cars and our own domestic cars. A check of the up-dated marking criteria<sup>8,9</sup> showed very little consideration given to the lower silhouetted vehicles or to the increases in acceleration rates.

This thesis concentrates on updating some of the design criteria. The following methods were used to obtain this goal;

- 1) A questionnaire was designed in an effort to better understand the driver, his passing and driving practices, and his acceptance of current and proposed practices for marking no-passing zones,
- 2) Required passing distances were computed from present day acceleration data and compared with existing design criteria,
- 3) Accidents in no-passing zones, in the areas covered by the questionnaire, were checked in an effort to find the most hazardous passing maneuver,
- 4) The changes in required passing distances with current acceleration data are compared with the increases in required passing distances due to the lower silhouetted vehicles.

---

(b) Research includes Ref's. 3, 5, 7, 10, 13, 14, 15.

## CHAPTER II

### REVIEW OF LITERATURE

The present national policy<sup>(c)</sup> to determine safe passing sight distances on two-lane rural highways is based on work done by C. W. Prisk<sup>12</sup> from 1938-1941 and published by the Highway Research Board in 1941. These figures were based on extensive field observations of driver behavior during passing maneuvers. The minimum passing sight distances for no-passing zones are listed in Table 1. Using these distances and the driver eye height, the no-passing zones are marked on the highway<sup>(d)</sup>. The national policy<sup>(e)</sup>, as well as most state policies, says that the driver eye height should be taken to be 54 inches. These conclusions are based on work done up to 1951. Since that time, much has been published concerning the driver eye height and its effect on highway design, the most extensive coverage is by K. A. Stonex<sup>(f)</sup>. He published an article<sup>13</sup> on driver eye height and no-passing zones, in 1958, along with others in the traffic field and in 1960 another article<sup>14</sup> concerned with vehicle dimensions and performance characteristics. His latest published article<sup>15</sup> deals with vehicle dimensions and highway design. In all of these articles, Stonex expressed growing concern over the increasing number of lower

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(c) Ref. 1 pp.117-121  
(d) Ref. 9 p. 347  
(e) Ref. 1 p. 25  
(f) Ref.13,14,15

TABLE 1

MINIMUM PASSING SIGHT DISTANCE  
FOR DESIGN OF TWO-LANE HIGHWAYS

|                                             |     |      |      |      |      |
|---------------------------------------------|-----|------|------|------|------|
| Design Speed (MPH)                          | 30  | 40   | 50   | 60   | 70   |
| Assumed passing speed                       | 30  | 40   | 48   | 55   | 60   |
| <hr/>                                       |     |      |      |      |      |
| Minimum passing sight<br>distance (in feet) |     |      |      |      |      |
| Figure III-2                                | 810 | 1265 | 1675 | 2040 | 2310 |
| Rounded                                     | 800 | 1300 | 1700 | 2000 | 2300 |

Source of Table: "A policy of Geometric Design of Rural Highways",  
by American Association of State Highway Officials, Washington D.C.,  
1954, p. 121

silhouetted vehicles. His findings show a potential minimum eye height of 42-43 inches, in contrast to the average of 47 inches in 1961.

D. W. Loutzenheiser and E. R. Haile Jr.<sup>7</sup> have done work along the same lines as Stonex, yet don't express as much concern about the decreasing vehicle height. But C. E. Lee<sup>5</sup>, who did an extensive study in Texas on driver eye height, was concerned when he found that 15 percent of all the vehicles he studied had a driver eye height of less than 48 inches. Lee reworked the design charts for passing and non-passing crest vertical curves. He suggested that the marking of no-passing zones be based on a more representative driver eye height than that used to date. Based on this work done by Lee, Stonex and others, some states have adopted lower driver eye heights in their marking practices. The new Manual on Uniform Traffic Control Devices<sup>8</sup>, suggests the use of 48 inches in the marking of no-passing zones, as does the revised version of the Michigan Manual<sup>9</sup>.

The need for uniform standards for no-passing zone markings is demonstrated drastically in an article by L. W. Corder<sup>2</sup>, in the October 1959 Edition of "Traffic Engineering", which lists the driver eye heights used by various states, as the height of instrument (HI), as follows; "For instance, 30 states survey no-passing zones by using a 4 foot 6 inch HI at both the beginning and end of the zone. One state used a 5 foot HI at both ends; 7 states used 4 foot 6 inch HI at the beginning of the zone but

varied from 3 foot 6 inches to a 4 inch HI at the end of the zone; 6 states used a 3 foot 8 inch HI at both ends; One state uses a 4 foot HI at the beginning and a 1 foot HI at the end of the zone, and one state had no policy." The article also listed the minimum sight distances used by the various states to determine if a no-passing zone is necessary; "One state was reported as using a 1600 foot minimum overtaking and passing sight distance; 9 states use 1000 feet; one state uses 950 feet; 8 states use 800 feet; one state uses 750 feet; 2 states use 700 feet; one state uses 660 feet; 3 states use 600 feet; 10 states use 500 feet; one state uses 400 feet; and 11 states vary the distance with design or posted speeds." This shows a great deal of inconsistency among the states with regard to the national code, even if there have been improvements since the introduction of the new national Manual.

Some work has been done on measurement of passing maneuvers. O. K. Norman published an article<sup>11</sup> that discusses a repeat of the passing study done by Prisk<sup>12</sup> in the period 1938-1941. This latest study was performed in 1957, and shows that the present day vehicles spend a shorter time in the left-hand lane, but use a greater distance to complete the passing maneuver. Table 2 shows a comparison of the 1938 and 1957 studies. This article was the only published work on passing practices that could be found.

A search of the literature revealed only one article dealing with driving questionnaires. E. Levonian and H. W. Case<sup>6</sup> did a study in 1960 on the responses to a driving questionnaire by

TABLE 2

## COMPARISON OF PASSING PRACTICES IN 1938 AND 1957

| Study<br>Section                                             | 1938 Study | 1957 S t u d y            |                     |
|--------------------------------------------------------------|------------|---------------------------|---------------------|
|                                                              |            | 1954 or Older<br>Vehicles | 1955-57<br>Vehicles |
| Number of passings studied                                   |            |                           |                     |
| Total                                                        | 608        | 160                       | 316                 |
| Average speed of passed vehicle                              |            |                           |                     |
| Average<br>(MPH)                                             | 35         | 38                        | 39                  |
| Average speed of passing vehicle while in left-hand lane     |            |                           |                     |
| Average<br>(MPH)                                             | 45         | 51                        | 52                  |
| Average time passing vehicles were in the left-hand lane     |            |                           |                     |
| Average<br>(sec)                                             | 10.2       | 10.1                      | 9.7                 |
| Average distance passing vehicles were in the left-hand lane |            |                           |                     |
| Average<br>(Feet)                                            | 640        | 760                       | 740                 |
| Average speed of free moving vehicles                        |            |                           |                     |
| Average<br>(MPH)                                             | 41         | 45                        | 45                  |

Source of Table: "Driver Passing Practices", by O. K. Norman,  
Highway Research Board Bul. 195, 1958, p. 10

Los Angeles high school students. This study was mainly concerned with the responses given by the different sexes, social groups, and the vehicle code and penal code violators. It did not deal with driver passing practices.

In a recent report on highway safety<sup>16</sup>, J. C. Young<sup>17</sup> and H. E. Hilts<sup>4</sup> showed comparisons of "Accident rates related to sight distance on two-lane roads", and "Accident rates related to frequency of sight distance restrictions". The results of these two reports are shown on Tables 3 and 4. They show a higher accident rate when the sight distance of the crest vertical curve is less than 800 feet and also when the frequency of the restriction is between 1 and 2 per mile of roadway, thus supporting the contention that changes are needed in marking practices for no-passing zones, when compared to the article by L. W. Corder<sup>2</sup>, where 26 states use 800 feet or less.

TABLE 3

ACCIDENT RATES RELATED TO  
SIGHT DISTANCES ON TWO-LANE ROADS

| Sight Distance<br>(Feet) | Accident rate (Per<br>Million Vehicle-miles) |
|--------------------------|----------------------------------------------|
| Less than 800            | 2.4                                          |
| 800-1500                 | 1.9                                          |
| 1500-2500                | 1.5                                          |
| 2500-Over                | 1.1                                          |

Source of Table: "Building Safety into Our Road System", by J. C. Young, California Traffic Safety Conference, Proceedings, 1950

TABLE 4

ACCIDENT RATES RELATED TO FREQUENCY  
OF SIGHT RESTRICTIONS

| Frequency of Restrictions<br>(Number per mile) | Accident Rate (Per<br>Million Vehicle-miles) |
|------------------------------------------------|----------------------------------------------|
| Less than 1                                    | 3.5                                          |
| 1 - 1.9                                        | 4.1                                          |
| 2 - 2.9                                        | 3.8                                          |
| 3 - 3.9                                        | 3.2                                          |
| 4 - 4.9                                        | 2.8                                          |

Source of Table: "Safety an Essential Element of Highway Engineering Design Practices", by H. E. Hilts, Highway Engineering Conference, University of Utah, Proceedings, 1947

## CHAPTER III

### METHOD OF STUDY

#### Driver Characteristics and Passing Practices

When considering any type of re-evaluation of the present design and marking criteria for crest vertical curves, some consideration must be given to the driver himself. What does the yellow line and the roadside "Do Not Pass" sign mean to the driver? Considerable thought was given to find a method by which one could learn something about the driver's understanding of the marking techniques and his passing practices. A self-administered, questionnaire survey was finally decided upon. Questionnaires were filled out at the time of driver license renewal. This form of distribution was considered to be the most favorable, since it was expected to give a representative sample of age, sex, and occupation within the test area. Questions were asked on; 1) Driver characteristics, 2) Driver passing practices, 3) Driver understanding of present and proposed marking techniques. The development, distribution, coding and possible analysis of the questionnaire are discussed in detail in Appendix A. The final form of the questionnaire is shown as Form 1.

The analysis of the questionnaire provided a listing of the total percents that answered each question and also each question compared against every other question. This form of analysis supplied so much data concerning the driver and his passing

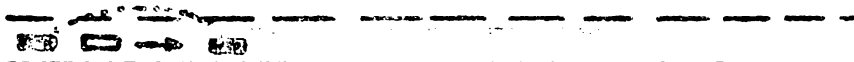
FORM 1

To the Driver:

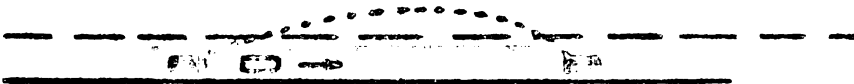
These questions are asked as part of a graduate research project at Michigan State University. This study is concerned with the driver's understanding of highway No-passing zones. This questionnaire in no way will affect your license renewal. Please help by answering the following questions as they apply to your normal driving habits.

1. Have you ever had a class in driver education? yes ☐ no ☐
2. Sex male or female Age years Approximate years you have driven number
3. Do you like to drive? yes ☐ no ☐ depends on time and place ☐
4. Do you usually feel uneasy about passing another car? yes ☐ no ☐
5. When approaching a No-passing zone, most drivers know what the yellow line means. We wish to know how the drivers react to this line. In the following sketches, the dotted line shows the path of your car while passing. The solid red line is the yellow line. The dashed line is the centerline. Consider each of the four cases.

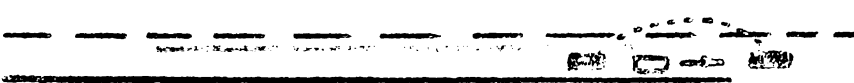
A. Have you ever passed here? yes ☐ no ☐ only in rare cases ☐



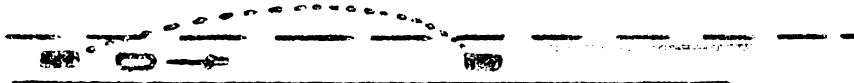
B. Have you ever passed here? yes ☐ no ☐ only in rare cases ☐



C. Have you ever passed here? yes ☐ no ☐ only in rare cases ☐



D. Have you ever passed here? yes ☐ no ☐ only in rare cases ☐



6. When approaching a No-passing zone, which do you notice first? (check one per group)

During the daytime:

- a. The yellow line ☐
- b. The No Not sign ☐
- c. I don't know ☐

During the night:

- a. The yellow line ☐
- b. The No Not sign ☐
- c. I don't know ☐

7. Do you feel that the present system of marking No-passing zones is adequate?

yes ☐ no ☐

8. Would a large yellow sign like this one



placed on the left-hand

side of the road, at the start of the yellow line, be helpful? yes ☐ no ☐

practices, that it will be published separately. Parts of this report, dealing with passing practices and marking techniques are used in this thesis. A discussion of the results of the questionnaire follows in Chapter IV.

#### Required Passing Distances

In order to check the present minimum sight distances used for design of crest vertical curves against those required for present day vehicles, the formulas used for determining these distances were re-evaluated. Requests were sent to the leaders of the automotive industry for passenger vehicle acceleration data. From acceleration rates, or curves of the acceleration performance for present day passenger vehicles, new minimum sight distances required for various vehicle lengths, starting speeds, and headways were computed. Passing distances were computed on Michigan State University's Control Data 160-A Computer. These computations produced time and distance required to complete a passing maneuver and the final speed upon completion of this maneuver. It was necessary to assume the vehicle length, starting gap, and starting speed. For the purpose of this thesis, the initial speed and starting gap were considered to be of the same numerical value, or 40 MPH initial speed and a 40 foot starting gap. The passing distances for a number of representative vehicles were computed. The speed-time curves for these various vehicles are shown in Appendix B as Graph 1. The length of the vehicle being passed was varied from 20 feet to 60 feet and the starting speed from 30 to 40 MPH and up. It was also

assumed that the passed vehicle would remain at a constant speed. The distances associated with the passing maneuver are shown in Figure 1. The acceleration data used, method of computing the new distances, and the theory behind the formulas are discussed in Appendix B. The results of the computations are discussed in Chapter IV.

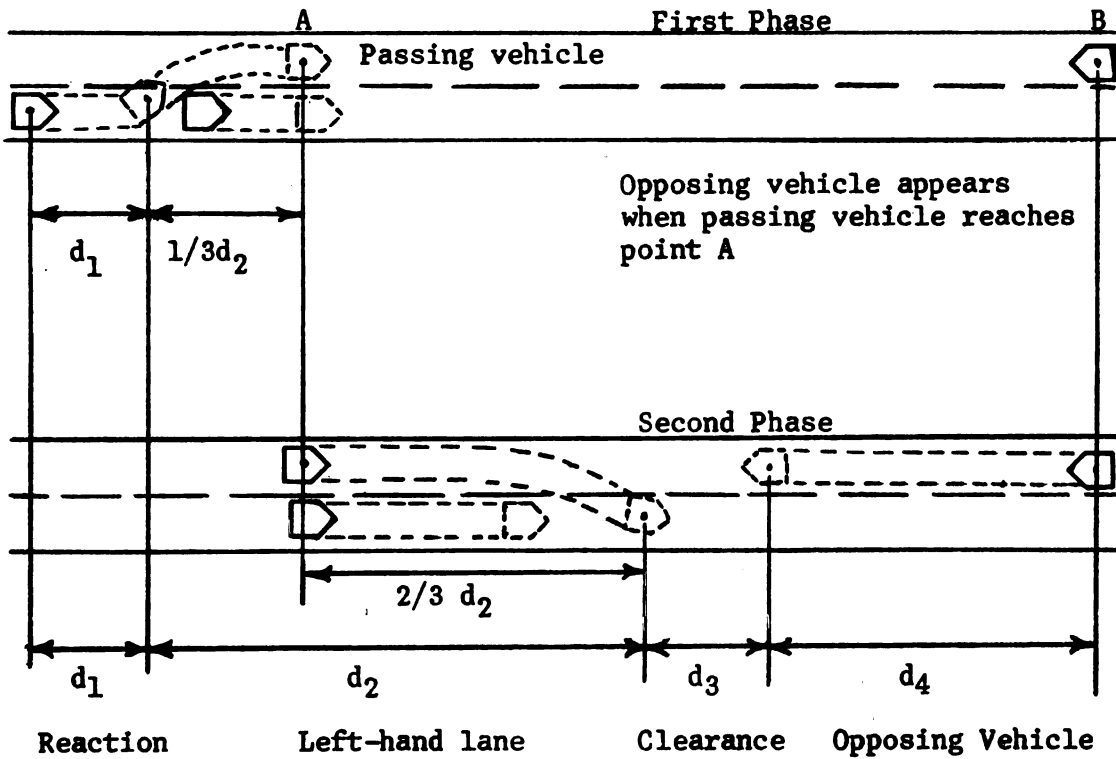
#### No-Passing Zone Accident Study

In considering the driver characteristics in the counties chosen for distribution of the questionnaire, it was felt that a check of the no-passing zone accidents would give some idea which passing maneuver characteristic was the most hazardous. After checking with the Traffic Division of the Michigan State Police, it was found that the accidents were filed by year, township, and county, and this classification would lend itself readily to the analysis desired. The development of the analysis forms and the results of one county are discussed in Appendix C. This analysis proved to be not feasible because of the difficulty in determining if the accident had actually happened in a no-passing zone.

No-passing zone accidents were also explored on a state-wide basis, using the IBM card filing system of the Michigan State Highway Department's Traffic Division. This analysis was also not carried out because there seemed to be too few incidents, incomplete coverage, and no relation to the counties used in the study. A discussion of the study and recommendations for further work are found in Appendix C.

FIGURE 1

## PASSING MANEUVER DISTANCES



## CHAPTER IV

### ANALYSIS OF RESULTS

#### Driver Passing Practices and Observance of Marking Techniques

The percentages of the total sample that answered each question on the questionnaire and the percents that did not answer (NA) are shown on Form 2. The distribution of the percents, on question 5A or passing at the beginning of the no-passing zone, shows that many people do cut the start of the yellow line, considering both "only in rare cases" and "yes" as affirmative responses. This type of passing maneuver has been performed by 62% of those who answered the questionnaire.

The majority of the drivers, 81%, will not pass entirely within the zone, but when asked if they would pass at the end of the zone, 42% said they have, when the "rare" and "yes" responses are totaled. This lack of observance of the end of the no-passing zone should cause serious concern of the present standards, especially in view of the variability of standards among the different states.

A major point to be considered is the combination of driver responses to the passing questions, especially in relationship to the evaluation of the marking policy. Table 5 is a grouping of some of the interesting combinations that were found when studying passing practices. Only 40% of the drivers indicated what could be considered the correct driving practice. This allows that "rare"

FORM 2

To the Driver

These questions are asked as part of a graduate research project at Michigan State University. This study is concerned with the driver's understanding of highway No-passing zones. This questionnaire in no way will affect your license renewal. Please help by answering the following questions as they apply to your normal driving habits.

1. Have you ever had a class in driver education? yes ☐ no ☐ 26.83% 72.22% 0.95% NA  
2.63% NA

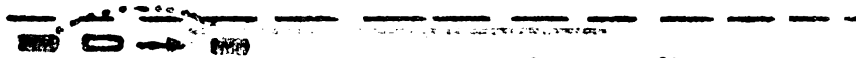
2. Sex 61.55% 35.82% Age \* Approximate years you have driven \*  
male or female years number  
84.65% 2.12% 12.57% 0.66% NA

3. Do you like to drive? yes ☐ no ☐ depends on time and place ☐ 16.45% 92.24% 1.32% NA

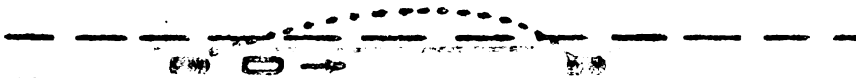
4. Do you usually feel uneasy about passing another car? yes ☐ no ☐

5. When approaching a No-passing zone, most drivers know what the yellow line means. We wish to know how the drivers react to this line. In the following sketches, the dotted line shows the path of your car while passing. The solid red line is the yellow line. The dashed line is the centerline. Consider each of the four cases.

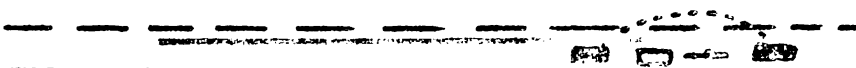
A. Have you ever passed here? yes ☐ no ☐ only in rare cases ☐ 23.61% 34.65% 38.96% 2.78% NA



B. Have you ever passed here? yes ☐ no ☐ only in rare cases ☐ 9.14% 81.80% 5.12% 3.95% NA



C. Have you ever passed here? yes ☐ no ☐ only in rare cases ☐ 23.03% 52.70% 19.59% 4.68% NA



D. Have you ever passed here? yes ☐ no ☐ only in rare cases ☐ 83.04% 8.33% 6.21% 2.41% NA



6. When approaching a No-passing zone, which do you notice first? (check one per group)

During the daytime:

- a. The yellow line ☐ 49.49%  
b. The ☐ Do ☐ Not ☐ sign ☐ 45.47%  
c. I don't know ☐ 5.04%

During the night:

- a. The yellow line ☐ 36.55%  
b. The ☐ Do ☐ Not ☐ sign ☐ 54.39%  
c. I don't know ☐ 8.85%

7. Do you feel that the present system of marking No-passing zones is adequate?  
78.00% 19.23% 2.78% NA  
yes ☐ no ☐

8. Would a large yellow sign like this one



placed on the left-hand side of the road, at the start of the yellow line, be helpful? yes ☐ no ☐ 68.86% 28.72% 2.92% NA

\* Not in suitable form to be placed here.

TABLE 5

## PASSING PRACTICES OF DRIVERS

| Group | Response Combination                    |     |      |     | Heading of Group                            | Number     | Percent of Total Number |
|-------|-----------------------------------------|-----|------|-----|---------------------------------------------|------------|-------------------------|
|       | 5A                                      | 5B  | 5C   | 5D  |                                             |            |                         |
| 1     | Rare                                    | No  | No   | Yes | Correct                                     | 216        | 40.64%                  |
|       | No                                      | No  | No   | Yes | Driving                                     | 208        |                         |
|       | Rare                                    | No  | Rare | Yes | Practice                                    | 132        |                         |
|       |                                         |     |      |     |                                             | <u>556</u> |                         |
| 2     | No                                      | No  | No   | No  | Never Pass                                  | 29         | 3.58%                   |
|       |                                         |     |      |     |                                             | <u>49</u>  |                         |
| 3     | Yes                                     | Yes | Yes  | Yes | Always Pass                                 | 29         | 2.12%                   |
|       |                                         |     |      |     |                                             | <u>29</u>  |                         |
| 4     | Yes                                     | No  | No   | Yes | Pass at start, but not in or at end of zone | 98         | 7.16%                   |
|       |                                         |     |      |     |                                             | <u>98</u>  |                         |
| 5     | Yes                                     | No  | Yes  | Yes | Pass at start and                           | 75         | 13.16%                  |
|       |                                         |     |      |     | end, but not                                | 12         |                         |
|       |                                         |     |      |     | in zone                                     | 65         |                         |
|       |                                         |     |      |     |                                             | 28         |                         |
|       |                                         |     |      |     |                                             | <u>180</u> |                         |
| 6     | No                                      | No  | Yes  | Yes | Pass at end, but not in                     | 65         | 8.19%                   |
|       | No                                      | No  | Rare | Yes | or at start of zone                         | 47         |                         |
|       |                                         |     |      |     |                                             | <u>112</u> |                         |
| 7     |                                         |     |      |     | Sub Total                                   | 1024       | 74.85%                  |
| 8     | Any combination not covered above       |     |      |     | Unexplained patterns                        | 236        | 17.25%                  |
|       |                                         |     |      |     |                                             | <u>236</u> |                         |
| 9     | One or more no-answer responses in each |     |      |     | No-answer patterns                          | 108        | 7.90%                   |
|       |                                         |     |      |     |                                             | <u>108</u> |                         |
| 10    |                                         |     |      |     | Total                                       | 1368       | 100.00%                 |

violations of the beginning and end of the no-passing zone be considered good driving. Group 8 in Table 5 are those response patterns that had no apparent logical arrangement. Group 9 includes all patterns which had one or more blanks. Adding the percent that never pass to those that pass correctly, and subtracting from 100%, leaves about 56% of the driving population that don't pass the way the highway engineers intend them to pass. This makes the placement and lengths of the no-passing zone a critical part of the highway design and marking, because when considering length alone, any distance removed from the required distance increases the chances for head-on collisions. The required distance mentioned here is that distance required in the left-hand lane to complete the passing maneuver. The lack of observance and its effect on the re-evaluation of no-passing zones will be discussed in the next chapter.

Additional data on driver passing practices and observance of marking techniques is given in a number of tables in Appendix D. Tables 14 through 20 show an analysis run between the different responses to the four passing questions, and Tables 21 through 25 show responses to questions about the adequacy of the marking techniques. It is interesting to note that in Table 21, 80% of the drivers feel that the present marking system for no-passing zones is adequate, yet 70% of the drivers feel that the Iowa Pennant sign would be a help. A closer look at this in Table 25 shows that 52% of the total respondents said "yes" to both questions. In other words, these drivers feel the present system is adequate, but another sign would help.

### Required Passing Distances

Using the equations developed in Appendix B, and car performance data supplied by car manufacturers for vehicles in their test fleets, passing times and distances, as a function of initial speed for two critical car lengths of the vehicle passed, were computed. Nine representative vehicle performance curves were used in the computations, with the characteristics listed below:

| Car No. | Year | Source | Characteristics           |
|---------|------|--------|---------------------------|
| 1       | 1951 | G.M.   | Best performing car 1951  |
| 2       | 1951 | G.M.   | Poorest performing 1951   |
| 3       | 1962 | G.M.   | Poor performing foreign   |
| 4       | 1958 | G.M.   | Average of 1958 cars      |
| 5       | 1962 | G.M.   | Best performing car 1962  |
| 6       | 1960 | Ford   | Low performance car       |
| 7       | 1959 | Ford   | Foreign small car         |
| 8       | 1963 | Ford   | Foreign small present car |
| 9       | 1963 | Ford   | Medium performance car    |

Note that the source of this information is not identical or even related to the make of the cars used. The make is not known and should only represent typical cars on the road today.

It was desired to check the newly computed distances with those used in the national standards<sup>1</sup> and the most recent research<sup>11</sup>, and an attempt was made to match the conditions of this earlier work. Since the newly computed distances were not in a form that

the average passing speed could easily be computed, it would be very difficult to match the earlier work.

Initial speeds of 45, 55, 65 MPH were used to determine the distances required to complete the passing maneuver. This assumed that the passed vehicle travels at or near the posted speed and the passing vehicle starts his passing maneuver a distance behind the passed vehicle equal to the posted speed in feet. The most critical case to be considered is when the passing vehicle is confronted with opposing traffic. Therefore, the passing vehicle was assumed to remain at full acceleration until back in the right-hand lane. The results of the computations are shown as Table 6. Some of the vehicles were unable to complete the passing maneuver in a reasonable length in the higher speed ranges. The distances shown are from the point of beginning acceleration, to the point of returning to the right-hand lane. This distance is normally called " $d_2$ " or the distance covered while in the left-hand lane. The times are also associated with this distance. As stated above, the final speeds are based on the assumption that the passing vehicle remains at full acceleration until it is completely back in the right-hand lane.

To determine the required passing sight distance for the various posted speeds, there must be three other distances added:

- 1) The driver decision time or " $d_1$ ", which is a function of speed;  $S=vt$  where  $v$ =initial speed,  $t$ =reaction time which is 2-4 seconds (will be taken as 3 seconds here),
- 2) The vehicle clearance at the point of returning to the right-hand lane, or " $d_3$ ", which varies

TABLE 6

## ELEMENTS OF REQUIRED PASSING DISTANCES

| Vehicle<br>Group | Initial Speed<br>45 MPH                           |                            |                              |                       | Initial Speed<br>55 MPH    |                              |                       |                            | Initial Speed<br>65 MPH |                            |                              |                       |
|------------------|---------------------------------------------------|----------------------------|------------------------------|-----------------------|----------------------------|------------------------------|-----------------------|----------------------------|-------------------------|----------------------------|------------------------------|-----------------------|
|                  | Final<br>Speed<br>MPH                             | Time Re-<br>quired<br>SEC. | Distance<br>Required<br>FEET | Final<br>Speed<br>MPH | Time Re-<br>quired<br>SEC. | Distance<br>Required<br>FEET | Final<br>Speed<br>MPH | Time Re-<br>quired<br>SEC. | Final<br>Speed<br>MPH   | Time Re-<br>quired<br>SEC. | Distance<br>Required<br>FEET | Final<br>Speed<br>MPH |
| 1                | 64.63                                             | 8.31                       | 680.55                       | 73.45                 | 10.08                      | 966.32                       | 81.43                 | 12.43                      | 81.43                   | 12.43                      | 1357.98                      | 81.43                 |
| 2                | 59.18                                             | 11.18                      | 870.90                       | 67.25                 | 15.01                      | 1363.96                      |                       |                            |                         |                            |                              |                       |
| 3                | 58.99                                             | 11.19                      | 874.65                       | 66.62                 | 15.75                      | 1424.27                      |                       |                            |                         |                            |                              |                       |
| 4                | 67.13                                             | 7.49                       | 626.18                       | 76.00                 | 8.83                       | 864.86                       | 84.89                 | 10.92                      | 84.89                   | 10.92                      | 1214.33                      | 84.89                 |
| 5                | 72.06                                             | 6.06                       | 528.00                       | 81.26                 | 7.12                       | 727.16                       | 89.22                 | 8.36                       | 89.22                   | 8.36                       | 969.43                       | 89.22                 |
| 6                | 59.43                                             | 11.03                      | 360.41                       |                       |                            |                              |                       |                            |                         |                            |                              |                       |
| 7                | Output showed highest initial speed was 38.10 MPH |                            |                              |                       |                            |                              |                       |                            |                         |                            |                              |                       |
| 8                | 56.88                                             | 13.12                      | 998.68                       |                       |                            |                              |                       |                            |                         |                            |                              |                       |
| 9                | 62.63                                             | 8.98                       | 724.95                       | 70.93                 | 11.63                      | 1092.00                      |                       |                            |                         |                            |                              |                       |

with the speed and will be taken from the national standards<sup>1</sup>,  
 3) The distance covered by the opposing vehicle or " $d_4$ ", which will be taken as the posted speed times two-thirds of the time required to complete the passing maneuver. The new required passing sight distances for the various posted speeds are shown in Table 7. These values are shown for the vehicle groups and also for the speed groups. At the bottom of the table are the values taken from the existing standards<sup>1</sup>.

In trying to develop some comparison between the newly computed distances and the present standards, a number of difficulties arise. The two minimum passing sight distances are not computed in the same manner and the test vehicles vary greatly. To use only the poorest performing vehicles would give unduly restricted passing characteristics. To use an average of the characteristics for the various speed ranges is too conservative for the best, but inadequate for the poorest performing vehicles. An average also assumes equal numbers of each vehicle group on the highway. But in order to get at least a basis for some preliminary comparison, the average of those vehicles that could complete a pass in each speed range was used. The comparison of the minimum passing sight distance thus obtained with that given in the national standards is shown in Table 8. The percent increase, in each group is fairly close to the findings of Norman<sup>11</sup>, who showed increases in the average distances passing vehicles were in the left-hand lane of 17%. The effect of these newly computed distances will be discussed in Chapter V.

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TABLE 7

## ELEMENTS OF SAFE PASSING SIGHT DISTANCE

| Vehicle Group                                            | Initial Speed | Distances in Feet |                |                |                |       | Total Distance for Speed Groups |        |        |
|----------------------------------------------------------|---------------|-------------------|----------------|----------------|----------------|-------|---------------------------------|--------|--------|
|                                                          |               | d <sub>1</sub>    | d <sub>2</sub> | d <sub>3</sub> | d <sub>4</sub> | Total | 45 MPH                          | 55 MPH | 65 MPH |
| 1                                                        | 45            | 198               | 681            | 180            | 366            | 1425  | 1425                            | 2002   | 2747   |
|                                                          | 55            | 243               | 966            | 250            | 534            | 2002  |                                 |        |        |
|                                                          | 65            | 287               | 1358           | 310            | 792            | 2747  |                                 |        |        |
| 2                                                        | 45            | 198               | 871            | 180            | 493            | 1742  | 1742                            | 2666   |        |
|                                                          | 55            | 243               | 1364           | 250            | 809            | 2666  |                                 |        |        |
| 3                                                        | 45            | 198               | 875            | 180            | 493            | 1746  | 1746                            | 2766   |        |
|                                                          | 55            | 243               | 1424           | 250            | 849            | 2766  |                                 |        |        |
| 4                                                        | 45            | 198               | 626            | 180            | 330            | 1334  | 1334                            | 1834   | 2507   |
|                                                          | 55            | 243               | 865            | 250            | 476            | 1834  |                                 |        |        |
|                                                          | 65            | 287               | 1214           | 310            | 696            | 2507  |                                 |        |        |
| 5                                                        | 45            | 198               | 528            | 180            | 267            | 1173  | 1173                            | 1604   | 2099   |
|                                                          | 55            | 243               | 727            | 250            | 384            | 1604  |                                 |        |        |
|                                                          | 65            | 287               | 969            | 310            | 533            | 2099  |                                 |        |        |
| 6                                                        | 45            | 198               | 860            | 180            | 486            | 1724  | 1724                            |        |        |
| 7                                                        | See Table 6   |                   |                |                |                |       |                                 |        |        |
| 8                                                        | 45            | 198               | 999            | 180            | 578            | 1955  | 1955                            |        |        |
| 9                                                        | 45            | 198               | 725            | 180            | 396            | 1499  | 1499                            | 2212   |        |
|                                                          | 55            | 243               | 1092           | 250            | 627            | 2212  |                                 |        |        |
| AASHO Standards for the various design or Posted Speeds. |               |                   |                |                |                |       | 1470                            | 1857   | 2175   |

TABLE 8

**COMPARISON BETWEEN PRESENT STANDARDS & NEWLY COMPUTED  
PASSING SIGHT DISTANCES**

| <b>Design Speed</b>                                | <b>45 MPH</b> | <b>55 MPH</b> | <b>65 MPH</b> |
|----------------------------------------------------|---------------|---------------|---------------|
| <b>Present Standards<br/>Ref. 1<br/>(Feet)</b>     | 1470          | 1857          | 2175          |
| <b>Newly Computed<br/>Average Value<br/>(Feet)</b> | 1575          | 2181          | 2451          |
| <b>Difference in<br/>(Feet)</b>                    | 105           | 324           | 276           |
| <b>Percent Increase</b>                            | 7.14%         | 17.46%        | 12.70%        |

## CHAPTER V

### CONCLUSIONS & RECOMMENDATIONS

#### Conclusions

When considering the increases required in the lengths of passing crest vertical curves due to the decreases in vehicle silhouettes, the lower silhouetted vehicles require longer curves. A decrease of the driver eye height from 54 inches to 42 inches (potential minimum) requires an increase of 13.42% in the length of the vertical curve<sup>(g)</sup>. This increase is caused by the lower silhouetted vehicle having to be much closer to the crest of the curve in order to see an approaching vehicle. Since the main concern of this thesis is a re-evaluation of the marking of the present zones, the effect on design will be covered lightly. This increase of 13.42% makes many of the present summit curves unsafe. For instance, a passing crest vertical curve, surveyed with a driver eye height of 54 inches, and just having the required minimum sight distance of 1000 feet, would require a vehicle having a driver eye height of 42 inches to travel 134.2 feet further to have the sight distance necessary to pass. This is assuming the critical case of two vehicles approaching each other, both having the driver eye height of 42 inches. In order to make this crest vertical curve safe, a re-survey with the driver eye height of 42 inches would be necessary.

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(g) From formulas developed in Ref. 7.

This decrease in the driver eye height, or HI, would make the curve a non-passing summit. This case is even critical when the curve is already marked "No-Passing", and using the same basis (54 inch HI and sight distance of 1000 feet, with curve just under). The lower silhouetted vehicle, timing his passing maneuver to return just before the yellow line, cannot see the approaching vehicle for 134 feet when the taller vehicle can, and should have been given the yellow line sooner. Considering this along with the lack of observance by the driving population, of the ends of the yellow line or no-passing zone, makes this situation one for grave concern. These factors, coupled with the increases in minimum required passing sight distances for present day vehicles, make the present standards unsafe for much of the motoring public.

As discussed in Chapter IV, the increases of 7%-17% in the minimum required passing sight distances for the various speed ranges, give an average of about 13% in the newly computed distances. These values are in addition to the increases needed for the lower silhouetted vehicles.

### Recommendations

Since most of the highway no-passing zones are marked by surveying the curve with a given driver eye height and a minimum sight distance<sup>8,9</sup>, there must be changes in the criteria used with the field procedure. Since there is an extensive lack of observance of the ends of the no-passing zone, the full required sight distance should be given the driver. The national average driver eye height

was 47 inches in 1961, and a potential minimum is thought to be 42 inches; therefore, the lower value should be used to insure safe roads for all the motoring public. To design for 85% of the drivers, and to say "The small sports car and foreign cars don't amount to much, so let's forget them", is not sound nor safe engineering practice. The driver of the small vehicle should be given the same consideration as the largest vehicle. Therefore the standard should be such as to insure safe passing or adequate marking, as the case may be. The driver eye height used for marking no-passing zones and determining lengths of vertical curves, should be taken as 42 inches

The minimum passing sight distances should also be adjusted for modern vehicle characteristics. These newly computed distances are shown in Table 9. The full value of these distances should be used, and not only a portion as done by some states. The driver has shown that he rarely will pass within the zone, but often will violate both ends. The zone seems to mean to the driver that "I don't have adequate sight distance once I'm at the yellow line, but before and after I do". Therefore, the line should be placed to denote this fact. To assume the driver will not pass in an area 500 feet from the yellow line, marked on the basis of 1000 feet, for a road and speed calling for 1500 feet, is not very sound when considering the results of the driving questionnaire. For this reason, the full distance should be used in marking. Using these newly computed distances does not mean that the no-passing zones will be as long as these distances, but only that whenever the driver

TABLE 9

RECOMMENDED MINIMUM PASSING SIGHT DISTANCES  
FOR RURAL TWO-LANE ROADS

|                             | Posted Speeds |        |        |
|-----------------------------|---------------|--------|--------|
|                             | 45 MPH        | 55 MPH | 65 MPH |
| Distance Computed<br>(Feet) | 1575          | 2181   | 2451   |
| Distance Rounded<br>(Feet)  | 1600          | 2200   | 2500   |

does not have this minimum passing sight distance he will be given a yellow line.

It is also felt that the Iowa Pennant sign would greatly decrease the violation of the start of the yellow line. This sign is large enough to be seen at some distance prior to the start of the zone and being placed on the left-hand side of the road would not be blocked from view when passing trucks, as is the case with the present "Do Not Pass" sign. The motoring public seems to feel that this sign would help, for 68% said yes to question 8 on the questionnaire. The Michigan State Highway Department obtained very favorable results with the field test of the sign.

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**APPENDIX A**  
**Questionnaire Development**

## Questionnaire Development

### Design of Questionnaire

In the design of this questionnaire, it was felt that the following information would be advantageous: 1) Driver's sex, 2) Driver's age, 3) Formal driving education, 4) Driver's reactions in various passing situations. The first attempt at a questionnaire is shown as Form 3. After discussion and a sample questioning, there were changes made in the general form and also in the arrangement of the third question. The result of this change is shown as Form 4. In this new form the question about driver education is placed first in an attempt to make the questionnaire less formal. Question 3C was omitted, but added again in the final forms of the questionnaire as a check of the driver understanding. It was also felt that Question 3 on Form 3 should be made into two questions to limit the confusion that could arise. Form 4 was then field tested, by handing out a small number of questionnaires to local drivers, and was also discussed with personnel of Michigan State University's Driver Education Course. It was felt that the lead paragraph should state that the following questionnaire in no way would affect the respondent's license renewal. The number of years driven was considered useful information and was added as a question. Discussion lead to the adding of questions asking whether the driver liked to drive, and if he felt uneasy about passing another car. A question about the adequacy of the present marking system and a fill-in to find if the driver did notice that the color of the

delineators changed in the no-passing zone, was added at this time. The result of the above is shown as Form 5. Form 5 was then field tested and it was found that the fill-in or Question 9, would have to be omitted because of the difficulty in coding the results. After a discussion with personnel from the Bureau of Social and Political Research and the School of Psychology, it was felt that there should be further regrouping of the questions and some changes in the style used. If the responses were to be the truthful ones we required, the respondent would have to be in a relaxed state of mind when answering. Therefore, the questions were rewritten a number of times and sketches were added to the questions about passing maneuvers. The result is shown as Form 6. After a small sampling with this form, it was found that some color would have to be added to denote the yellow line. This is shown as Form 7. A sampling with this form showed that the added response of "Only in Rare Cases", would be necessary for all parts of Question 5, to give the driver who would only pass once in a great while, and only under rare conditions, a chance to answer more truthfully. This change is shown as Form 8. Before the final sampling, Question 5 was changed from "Would you pass here", to "Have you ever passed here", in order to obtain the actual driving habits without the influence of a right and wrong type choice. The final questionnaire is shown as Form 9.

### Distribution of the Questionnaire

When first considering a questionnaire as a method of obtaining driver characteristics and passing practices, a number of methods were considered and discussed, and the use of driver license renewal offices was considered the best suited location for distribution. The counties of Kent, Genesee, Ingham and Clinton were chosen to give a cross section of the industrial, educational, political, and rural communities in Mid-Michigan. A sample of the final questionnaire was shown to the Chief Examiner for the office of the Secretary of State. This office approved the questionnaire and wrote letters to the local sheriff and police departments concerned requesting that they give all assistance they could without disturbing their normal operations. The Chief Examiner also supplied the total renewals of operating licenses for all of the seven locations for the year 1962. These values, along with the percentage breakdown, total forms issued and returned are shown in Table 10. The number of questionnaires to be issued was chosen at 2000 to give a comparable sample to the smaller renewal offices. The number of unanswered questionnaires is fairly high in Genesee County because their office was moved to a new location during the test period and an added delay in analysis would have resulted if the remaining questionnaires had been administered.

### Questionnaire Coding

When the questionnaires were returned, it was decided that a coding arrangement that could easily be placed on IBM cards would

greatly aid the analysis, since a bivariate program was available on MISTIC<sup>(h)</sup> for card type data. A coding scheme such as shown in Table 11 was used to expediate the coding operation. It was found that an overlay with these code numbers located at the holes cut for viewing the responses, greatly aided the coding process. This data was then placed on standard code sheets to assist in the card punch operation. The computer program dictated that there be one card per questionnaire and therefore the final was 1368 cards, plus the necessary parameters. The age and years driven did not appear in a suitable form to be compared with the other responses and had to be placed in one digit form. The data deck was run to give the comparison of the first digit of age against the second and then an equal group breakdown was used in the recode of both age and years driven. This breakdown is shown as Table 12.

#### Questionnaire Analysis Available

The computer program that was available could supply the total numbers and percentages that answered each question and the way that it was answered. It also was possible to compare each question's results against the results of each of the remaining questions. The row percentages, means, and standard deviations; the column percentages, means, and standard deviations; the total percentages in each row, cell and column; and the "chi square" ( $\chi^2$ )

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(h) Michigan State University's Computer in 1962

distribution of each cell and the total table; the expected frequencies of the cells; and the total table correlation could easily be found with the computer program available.

QUESTIONNAIRE, ORIGINAL FIRST FORM

FORM 3

DRIVER:

IN THE INTEREST OF BETTER HIGHWAY SAFETY, MICHIGAN STATE UNIVERSITY  
NEEDS YOUR COOPERATION IN THE ANSWERING OF A FEW QUESTIONS ABOUT HIGHWAY  
BEHAVIORS.

PLEASE ANSWER THE QUESTIONS AS THEY PERTAIN TO YOUR DRIVING HABITS.

THANK YOU;

TRAFFIC ENGINEERING STAFF  
CIVIL ENGINEERING DEPARTMENT  
MICHIGAN STATE UNIVERSITY

1. SEX \_\_\_\_\_ AGE \_\_\_\_\_  
male or female years

2. HAVE YOU EVER HAD A CLASS IN DRIVER EDUCATION \_\_\_\_\_?  
yes or no

3. IS IT SAFE FOR YOU TO PASS ANOTHER CAR IF:

a. YOU CROSS THE YELLOW LINE ON RETURNING TO YOUR LANE?(check one) YES ☐ NO ☐

b. YOU CROSS THE YELLOW LINE TO BEGIN YOUR PASSING MANEUVER?(check one) YES ☐ NO ☐

c. YOU RETURN BEFORE THE YELLOW LINE IS IN YOUR LANE?(check one) YES ☐ NO ☐

4. UNDER NORMAL DRIVING CONDITIONS, WHICH DO YOU NOTICE FIRST WHEN YOU ARE PASSING  
ANOTHER CAR? (check one)

a. THE YELLOW LINE ☐

b. THE "NO-PASSING" SIGN ☐

5. WOULD A SIGN LIKE THIS ONE



PLACED ON THE LEFTHAND SIDE OF THE

ROAD, AT THE START OF THE YELLOW LINE, AID YOU IN DETERMINING WHEN YOU COULD  
SAFELY PASS?(check One) YES ☐ NO ☐

# QUESTIONNAIRE, ORIGINAL SECOND FORM

## FORM 4

TO THE STUDENT:

THE TRAFFIC ENGINEERING STUDENT SAFETY MICHIGAN STATE UNIVERSITY  
 TRAFFIC ENGINEERING STUDENT SAFETY MICHIGAN STATE UNIVERSITY  
 TRAFFIC ENGINEERING STUDENT SAFETY MICHIGAN STATE UNIVERSITY

THANK YOU;

TRAFFIC ENGINEERING STAFF

CIVIL ENGINEERING DEPARTMENT

MICHIGAN STATE UNIVERSITY

1. HAVE YOU EVER HAD A CLASS IN DRIVER EDUCATION (check one)? yes ☐ no ☐

2. SEX                      AGE                       
     male or female              years

3. DO YOU EVER PASS ANOTHER CAR IF YOU MUST CROSS THE YELLOW LINE ON RETURNING TO YOUR LANE? (check one) YES ☐ NO ☐

4. DO YOU EVER PASS ANOTHER CAR IF YOU MUST CROSS THE YELLOW LINE TO BEGIN YOUR PASSING MANEUVER? (check one) YES ☐ NO ☐

5. UNDER NORMAL CONDITIONS, WHICH DO YOU NOTICE FIRST WHEN YOU ARE PASSING ANOTHER CAR? (check one)

a. THE YELLOW LINE ☐

b. THE "NO-PASSING" SIGN ☐

6. WOULD A YELLOW SIGN LIKE THIS ONE  PLACED ON THE LEFTHAND SIDE OF THE ROAD, AT THE START OF THE YELLOW LINE, AID YOU IN DETERMINING WHEN YOU COULD SAFELY PASS? (check one) YES ☐ NO ☐

1. DO YOU HAVE A CAR? ☒ YES ☐ NO

2. DO YOU LIKE TO DRIVE? (check one) ☒ YES ☐ NO

3. DO YOU EVER WORRY ABOUT PASSING ANOTHER CAR? (check one) ☒ YES ☐ NO

4. IF YOU SAW ANOTHER CAR IF YOU SAW THAT YOU MUST CROSS THE YELLOW LINE OR ENTERING TO YOUR LANE? (check one) ☒ YES ☐ NO

5. DO YOU PASS ANOTHER CAR IF YOU SAW THAT YOU MUST CROSS THE YELLOW LINE TO BEGIN YOUR PASSING MANEUVER? (check one) ☒ YES ☐ NO

6. DURING THE DAYTIME, WHICH DO YOU NOTICE FIRST? (check one)

- a. THE YELLOW LINE ☒
- b. THE ☒ DO NOT PASS SIGN ☐

7. NOW WHAT ABOUT DURING THE NIGHT, WHICH DO YOU NOTICE FIRST? (check one)

- a. THE YELLOW LINE ☒
- b. THE ☒ DO NOT PASS SIGN ☐

8. IS THERE ANYTHING ELSE DURING THE NIGHT THAT YOU NOTICE WHEN YOU GO TO PASS? \_\_\_\_\_

9. DO YOU FEEL THAT THE PRESENT SYSTEM OF MARKING NO-PASSING ZONES IS ALPHABETIC? (check one) ☒ YES ☐ NO

10. WOULD A LARGE YELLOW SIGN LIKE THIS ONE



PLACED ON THE

OPPOSITE SIDE OF THE ROAD, AT THE START OF THE YELLOW LINE, BE BETTER? (check one) ☒ YES ☐ NO

THANK YOU,

FORM 6

These questions are asked as part of a roadside research project at Michigan State University. This study is concerned with the driver's understanding of highway marking zones. This questionnaire in no way will affect your license renewal. Please help by answering the following questions as they apply to your normal driving habits.

1. Have you ever had a driver education? yes ☐ no ☐

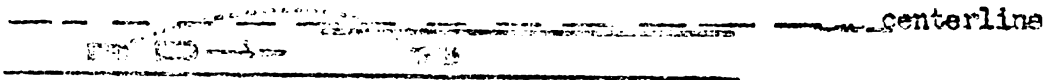
2. Sex male or female Age years Approximate years you have driven months

3. Do you like to drive? yes ☐ no ☐

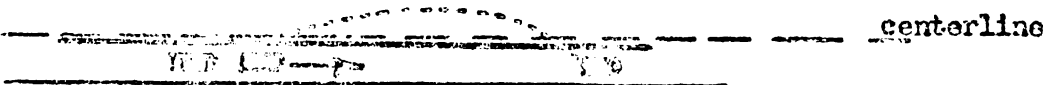
4. Do you usually feel uneasy about passing another car? yes ☐ no ☐

5. When approaching a No-passing zone, most drivers know what the yellow line means. We wish to know how the drivers react to this line. In the following sketches the dotted line shows the path of your car while passing. The solid line is the yellow line. The dashed line is the centerline. Consider each of the four cases.

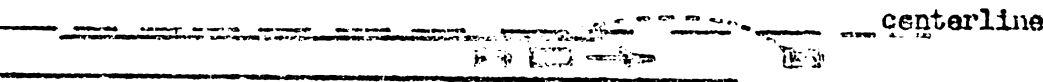
A. Would you pass here? yes ☐ no ☐



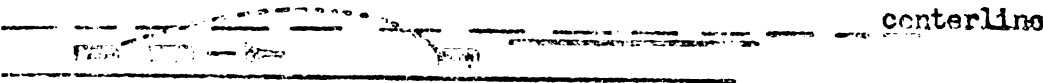
B. Would you pass here? yes ☐ no ☐



C. Would you pass here? yes ☐ no ☐



D. Would you pass here? yes ☐ no ☐



6. When approaching a No-passing zone, which do you notice first? (check one per group)

During the daytime

- a. The yellow line ☐  
 b. The 

Do  
Not  
Pass

 sign ☐  
 c. I don't know ☐

During the night

- a. The yellow line ☐  
 b. The 

Do  
Not  
Pass

 sign ☐  
 c. I don't know ☐

7. Do you feel that the present system of marking No-passing zones is adequate?

yes ☐ no ☐

8. Would a large yellow sign like this one  placed on the left-hand side of the road, at the start of the yellow line, be helpful? yes ☐ no ☐

This survey is a part of a project to study the effects of the No-passing zone. The study is concerned with the effects of the No-passing zone on the passing process. This questionnaire in no way will affect your driving record. Please help by answering the following questions as they apply to your personal habits.

1. Have you ever been in an auto accident? yes ☐ no ☐

2. Sex male or female Age years Approximate years you have driven number

3. Do you like to drive? yes ☐ no ☐

4. Do you usually feel uneasy about passing another car? yes ☐ no ☐

5. When approaching a No-passing zone, most drivers know what the yellow line means. We wish to know how the drivers react to this line. In the following sketches the dotted line shows the path of your car while passing. The solid red line is the yellow line. The dashed line is the center line. Consider each of the four cases.

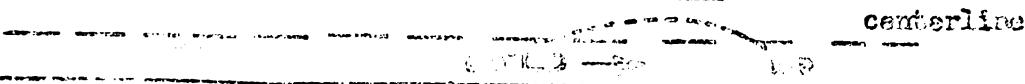
A. Would you pass here? yes ☐ no ☐



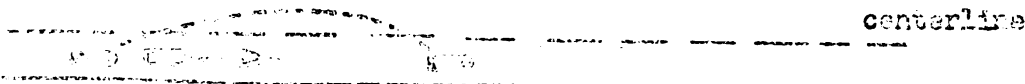
B. Would you pass here? yes ☐ no ☐



C. Would you pass here? yes ☐ no ☐



D. Would you pass here? yes ☐ no ☐



6. When approaching a No-passing zone, what do you notice first? (check one per row)

During the daytime

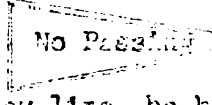
- a. The yellow line ☐  
b. The ☐ sign ☐  
c. I don't know ☐

During the night

- a. The yellow line ☐  
b. The ☐ sign ☐  
c. I don't know ☐

7. Do you feel that the present system of marking No-passing zones is adequate?

yes ☐ no ☐

8. Would a large yellow sign like this one  placed on the left-hand side of the road, at the start of the yellow line, be helpful? yes ☐ no ☐

# QUESTIONNAIRE, ORIGINAL SIXTH FORM

THIS IS NOT AN EXAMINATION

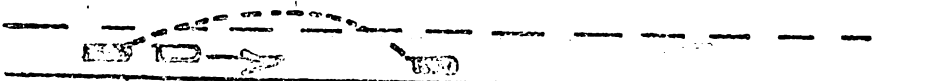
to the Driver

## FORM 8

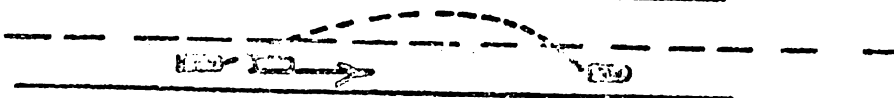
These questions are asked as part of a graduate research project at Michigan State University. This study is concerned with the driver's understanding of legal No-passing zones. This questionnaire in no way will affect your license renewal. Please help by answering the following questions as they apply to your normal driving habits.

1. Have you ever had a class in driver education? yes ☐ no ☐
2. Sex male or female Age years Approximate years you have driven number
3. Do you like to drive? yes ☐ no ☐ depends on time and place ☐
4. Do you usually feel uneasy about passing another car? yes ☐ no ☐
5. When approaching a No-passing zone, most drivers know what the yellow line means. We wish to know how the drivers react to this line. In the following sketches, the dotted line shows the path of your car while passing. The solid red line is the yellow line. The dashed line is the centerline. Consider each of the four cases

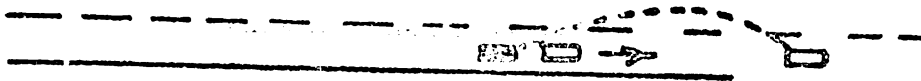
A. Would you pass here? yes ☐ no ☐ only in rare cases ☐



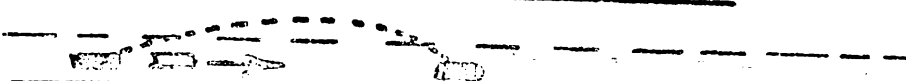
B. Would you pass here? yes ☐ no ☐ only in rare cases ☐



C. Would you pass here? yes ☐ no ☐ only in rare cases ☐



D. Would you pass here? yes ☐ no ☐ only in rare cases ☐



6. When approaching a No-passing zone, which do you notice first? (check one per group)

During the daytimes:

- a. The yellow line ☐
- b. The 

Do Not Pass

 sign ☐
- c. I don't know ☐

During the night:

- a. The yellow line ☐
- b. The 

Do Not Pass

 sign ☐
- c. I don't know ☐

7. Do you feel that the present system of marking No-passing zones is adequate?

yes ☐ no ☐

8. Would a large yellow sign like this one  placed on the left-hand side of the road, at the start of the yellow line, be helpful? yes ☐ no ☐

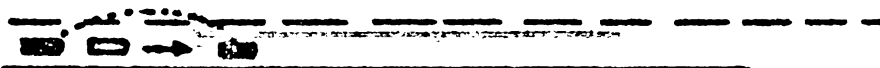
To the Driver:

FORM 9

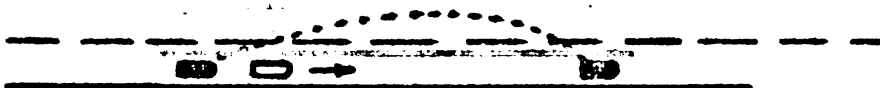
These questions are asked as part of a graduate research project at Michigan State University. This study is concerned with the driver's understanding of highway No-passing zones. This questionnaire in no way will affect your license renewal. Please help by answering the following questions as they apply to your normal driving habits.

1. Have you ever had a class in driver education? yes ☐ no ☐
2. Sex male or female Age years Approximate years you have driven number
3. Do you like to drive? yes ☐ no ☐ depends on time and place ☐
4. Do you usually feel uneasy about passing another car? yes ☐ no ☐
5. When approaching a No-passing zone, most drivers know what the yellow line means. We wish to know how the drivers react to this line. In the following sketches, the dotted line shows the path of your car while passing. The solid red line is the yellow line. The dashed line is the centerline. Consider each of the four cases.

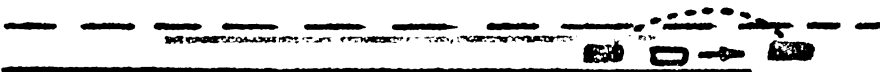
- A. Have you ever passed here? yes ☐ no ☐ only in rare cases ☐



- B. Have you ever passed here? yes ☐ no ☐ only in rare cases ☐



- C. Have you ever passed here? yes ☐ no ☐ only in rare cases ☐



- D. Have you ever passed here? yes ☐ no ☐ only in rare cases ☐



6. When approaching a No-passing zone, which do you notice first? (check one per group)

During the daytime:

- a. The yellow line ☐
- b. The 

Do  
Not  
Pass

 sign ☐
- c. I don't know ☐

During the night:

- a. The yellow line ☐
- b. The 

Do  
Not  
Pass

 sign ☐
- c. I don't know ☐

7. Do you feel that the present system of marking No-passing zones is adequate?

yes ☐ no ☐

8. Would a large yellow sign like this one



placed on the left-hand

side of the road, at the start of the yellow line, be helpful? yes ☐ no ☐

TABLE 10

## DISTRIBUTION OF QUESTIONNAIRE

| No.   | Location                          | Renewals<br>1962 | Percent<br>of Total<br>Renewals | Ratio of<br>Total<br>Issued | Number<br>Issued | Number<br>Returned | Lost or<br>Not<br>Answered |
|-------|-----------------------------------|------------------|---------------------------------|-----------------------------|------------------|--------------------|----------------------------|
| 1     | Kent<br>Sheriff                   | 14,100           | 9.56                            | 191.2                       | 190              | 183                | 7                          |
| 2     | Kent<br>Police<br>(Gr.Rapids)     | 29,800           | 20.22                           | 404.4                       | 405              | 390                | 15                         |
| 3     | Genesee<br>Sheriff<br>(Flint)     | 60,200           | 40.84                           | 816.8                       | 810              | 347                | 463                        |
| 4     | Clinton<br>Sheriff<br>(St. Johns) | 5,700            | 3.86                            | 77.2                        | 80               | (51)*              | 80                         |
| 5     | Ingham<br>Sheriff<br>(Mason)      | 7,900            | 5.36                            | 107.2                       | 110              | 108                | 2                          |
| 6     | Ingham<br>Police<br>(Lansing)     | 23,200           | 15.74                           | 314.8                       | 315              | 287                | 28                         |
| 7     | Ingham<br>Police<br>(E.Lansing)   | 6,500            | 4.42                            | 88.4                        | 90               | 53                 | 37                         |
| TOTAL |                                   |                  |                                 |                             | 2000             | 1368               | 632                        |

\* These questionnaires were not returned in time to be added to the analysis runoff on the computer and therefore must be considered lost.

TABLE 11  
CODING SCHEME USED ON RETURNED QUESTIONNAIRES

| COLUMNS<br>ON<br>CARDS | DATA<br>COVERED<br>BY CODE | C O D E U S E D                         |                                                   |                      |         |
|------------------------|----------------------------|-----------------------------------------|---------------------------------------------------|----------------------|---------|
| 1                      | Location                   | Genesee-1<br>Clinton-2<br>Kent Police-3 | Kent Sheriff-4<br>Lansing-----5<br>E. Lansing---6 | Ingham-7             |         |
| 2                      | Respondent                 | 0 through 3                             | ie 2                                              |                      |         |
| 3                      | "                          | 0 through 9                             | 4 = 247 th                                        |                      |         |
| 4                      | "                          | 0 through 9                             | 7                                                 |                      |         |
| 5                      | Study                      | 6 = 19 (63)                             |                                                   |                      |         |
| 6                      | "                          | 3                                       |                                                   |                      |         |
| 7                      | Deck                       | 1                                       |                                                   |                      |         |
| 8                      | Blank                      |                                         |                                                   |                      |         |
| 9                      | Question 1                 | No answer<br>0                          | Yes<br>1                                          | No<br>2              |         |
| 10                     | Question 2a                | 0                                       | Male<br>1                                         | Female<br>2          |         |
| 11                     | Question 2b                | First digit in age                      |                                                   |                      |         |
| 12                     | "                          | Second digit in age                     |                                                   |                      |         |
| 13                     | Question 2c                | First digit in years driven             |                                                   |                      |         |
| 14                     | "                          | Second digit in years driven            |                                                   |                      |         |
| 15                     | Question 3                 | No answer<br>0                          | Yes<br>1                                          | Depends<br>2         | No<br>3 |
| 16                     | Question 4                 | 0                                       | Yes<br>1                                          | No<br>2              |         |
| 17                     | Question 5A                | 0                                       | Yes<br>1                                          | Rare<br>2            | No<br>3 |
| 18                     | Question 5B                | 0                                       | 1                                                 | 2                    | 3       |
| 19                     | Question 5C                | 0                                       | 1                                                 | 2                    | 3       |
| 20                     | Question 5D                | 0                                       | 1                                                 | 2                    | 3       |
| 21                     | Question 6A                | Yellow line<br>1                        | Sign<br>2                                         | Don't Know & NA<br>3 |         |
| 22                     | Question 6B                | 1                                       | 2                                                 | 3                    |         |
| 23                     | Question 7                 | No answer<br>0                          | Yes<br>1                                          | No<br>2              |         |
| 24                     | Question 8                 | 0                                       | 1                                                 | 2                    |         |

TABLE 12

## BREAKDOWN ON DRIVER'S AGE AND NUMBER OF YEARS DRIVEN

| Age Grouping | Code Used | Years Driven<br>Grouping |
|--------------|-----------|--------------------------|
| 0            | 0         | 0                        |
| 15-21        | 1         | 1-4                      |
| 22-25        | 2         | 5-8                      |
| 26-30        | 3         | 9-12                     |
| 31-35        | 4         | 13-17                    |
| 36-40        | 5         | 18-22                    |
| 41-45        | 6         | 23-27                    |
| 46-50        | 7         | 28-34                    |
| 51-55        | 8         | 35-39                    |
| 56 +         | 9         | 40 +                     |

**APPENDIX B**  
**Required Passing Distance**  
**Theory & Data**

## Required Passing Distance, Theory & Data

### Theory

A passing maneuver, as discussed here, begins when a driver who desires to travel at a certain speed is slowed down by another vehicle traveling in front of him at a slower speed than the first driver is willing to accept. The first driver will then pass the slower vehicle at the first adequate opportunity he gets. The case in point should be the worst possible case, called herein the "critical" case. The engineer should tailor his design and other considerations to this case.

Before defining the critical case, it will be helpful to assess the entire normal passing process and separate it into logical components and define all parameters involved. The components are shown in Figure 2. The passing vehicle gains on the slower vehicle until the gap between the two induces the faster vehicle's driver either to begin the passing maneuver, or, if this is not possible, to reduce speed and maintain an adequate distance between himself and the vehicle in front. Since this last case is less critical in the sense discussed here, it will be omitted from further discussion. When the driver decides to pass, he accelerates at maximum or near maximum acceleration and pulls out into the passing lane. He first covers the gap between himself and the slower vehicle, then he overtakes the slower vehicle, travels side by side, and stays in the left-hand lane until he thinks he has sufficient clearance between

the rear of his car and the front of the slower vehicle. Then he returns into the right-hand lane and resumes the speed at which he normally travels.

In all passing maneuvers, various factors enter into the determination of the distance and time required for passing. These factors are listed below:

1. Initial speed of passed vehicle
2. Initial speed of passing vehicle
3. Gap between vehicles when passing begins
4. Gap between vehicles at end of passing
5. Acceleration of passing vehicle
6. Speed change of passed vehicle
7. Length of passed vehicle
8. Length of passing vehicle
9. Grade of roadway.

The critical case to be discussed here is one in which most or all of the conditions are adverse to the passing maneuver but not such that passing is undesirable. In the critical case, the acceleration of the passing vehicle is relatively low, either for low performance cars at moderate speeds or for high performance cars at high speeds. What makes it critical is the fact that the passing vehicle takes a long time to accelerate and overtake the passed vehicle. Other factors in the critical case are long gaps at the beginning and end of the maneuver, long vehicles being passed and passing, adverse speed changes of the vehicle being passed, and down grade.

The distance required for a passing maneuver is the distance traveled by the passing vehicle. For the vehicle that begins its passing maneuver at the same speed as the vehicle being passed, but accelerates at full throttle until the maneuver is completed, the distance traveled during the passing maneuver is:

$$D = \int_{t=0}^T v_t dt \quad (1)$$

Since  $v_t$  is changing at full throttle at a rate  $a = dv_t/dt$  which is not constant at high speeds, the distance equation (1) is changed.

$$v_t = v_o + \int_{t=0}^t a_t dt \quad (2)$$

$$D = v_o T + \int_{t=0}^T \int_{t=0}^t a_t dt \quad (3)$$

In equation (3) both  $D$  and  $T$  are unknowns to be solved for. Another expression for  $D$  can be written using the distance traveled by the car being passed, as shown in Figure 2,

$$D = H_1 + L_1 + v_2 T + L_2 + H_2 \quad (4)$$

where:

- $H_1$  = Gap before passing
- $H_2$  = Gap at end of passing
- $L_1$  = Length of passing vehicle
- $L_2$  = Length of passed vehicle
- $v_2$  = Speed of passed vehicle

Equating equations (4) and (3), we get:

$$H_1 + H_2 + L_1 + L_2 + v_2 T = v_o T + \int_{t=0}^T \int_{t=0}^t a_t dt \quad (5)$$

It is now assumed, as is acceptable for the critical case, that the speed of the car being passed ( $V_2$ ) remains constant and also is the initial speed of the passing car ( $V_0$ ), the equation (5) reduces to:

$$H_1 + H_2 + L_1 + L_2 = \int_{t=0}^T \int_{t=0}^t a_t dt \quad (6)$$

In this equation, the left side is the sum of the car lengths and the gaps, or in other words, the distance that the passing car has to gain during the maneuver. The right side of the equation is the integral of the distances gained by acceleration of the passing vehicle. The speed for which this equation holds true is only implied in the parameters which depend on speed. The equation therefore holds for vehicles standing still or traveling at any speed for which the parameters are defined. Since  $a_t$  is not given in the form of a function useable in an analytical solution, but rather in the form of data obtained from field observation of speed vs. time for various cars, it appears best to solve the above equation by numerical integration in the computer. The data fed into the computer was the speed attained in one-second intervals ( $V_t, \Delta t = 1$ ). Interpreting the first integral of acceleration with time as the speed attained up to that time:

$$\int_{t=0}^t a_t dt = \sum_{t=0}^t \frac{(V_t - V_{t-1}) \Delta t}{\Delta t} = V_t - V_0$$

and converting the second integral to a summation:

$$\int_{t=0}^T \int_{t=0}^t a_t dt = \int_{t=0}^T V_t dt = \sum_{t=0}^T (V_t - V_0) \Delta t$$

Equation (6) becomes now:

$$H_1 + H_2 + L_1 + L_2 = \sum_{t=0}^T (v_t - v_0) \Delta t \quad (7)$$

where:  $v_t - v_0 = \Delta v$  speed differences from  $t = 0$

$t =$  constant time interval (one second)

Equation (7) gives a rectangular summation. For closer approximation and better interpolation possibilities, the trapezoidal rule can replace the term in the summation as follows:

$$v_t = (v_t + v_{t-1}) / 2$$

Inserting this expression in the summation the result is:

$$H_1 + H_2 + L_1 + L_2 = \sum_{t=0}^T ((v_t + v_{t-1})/2 - v_0) \Delta t = \sum_{t=0}^T \Delta v_t \quad (8)$$

In the computer the solution for  $T$  is effected through summation of the right side until the value of the left side is reached.

Interpolation for the final value of  $T$  is made linearly:

$$T = t - t_c \text{ where } t_c \text{ is less than } 1$$

$$t_c = \frac{\sum_{t=0}^t \Delta v_t - (H_1 + H_2 + L_1 + L_2)}{\sum_{t=0}^t \Delta v_t - \sum_{t=0}^{t-1} \Delta v_t} \quad (9)$$

**Assumptions:** Values for the parameters used in the equations are assumed as follows:

- 1)  $v_t = f(t)$  is given from the car performance data
- 2)  $L_i$  = Vehicle lengths are assumed for the extreme cases, 20 feet for passenger cars, and 60 feet for truck combinations

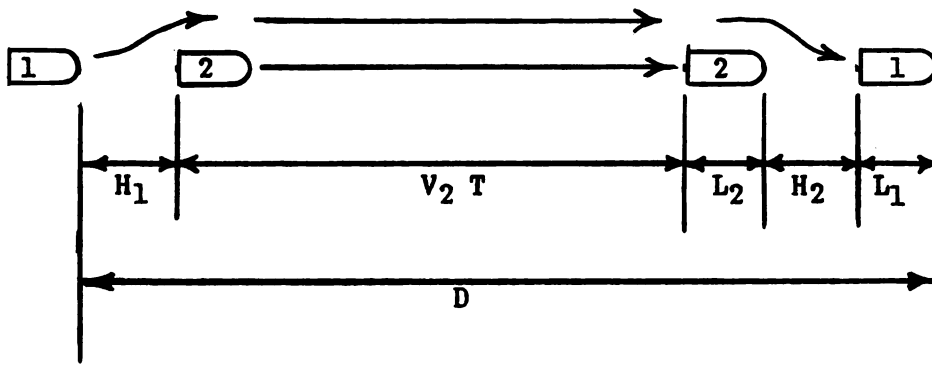
- 3)  $H_i$  = Gaps at the beginning and end of the passing maneuver are highly variable and controversial. Since minimum gaps do not produce critical values, the conventional, although generous, gap size proportional to travel speed in MPH are used initially.  $H_i = c V_i$
- 4)  $V_o$  = Initial speed and speed of passed vehicle are varied in the computations (independent variable). It is assumed, however, that the passed vehicle maintains his speed throughout the maneuver.

### Data

The data fed into the computer was from the speed vs. time curves supplied by the automotive industry. Rather than show all of the curves obtained, only those for the nine groups listed on page 20 are included here. These curves are shown as Graph 1.

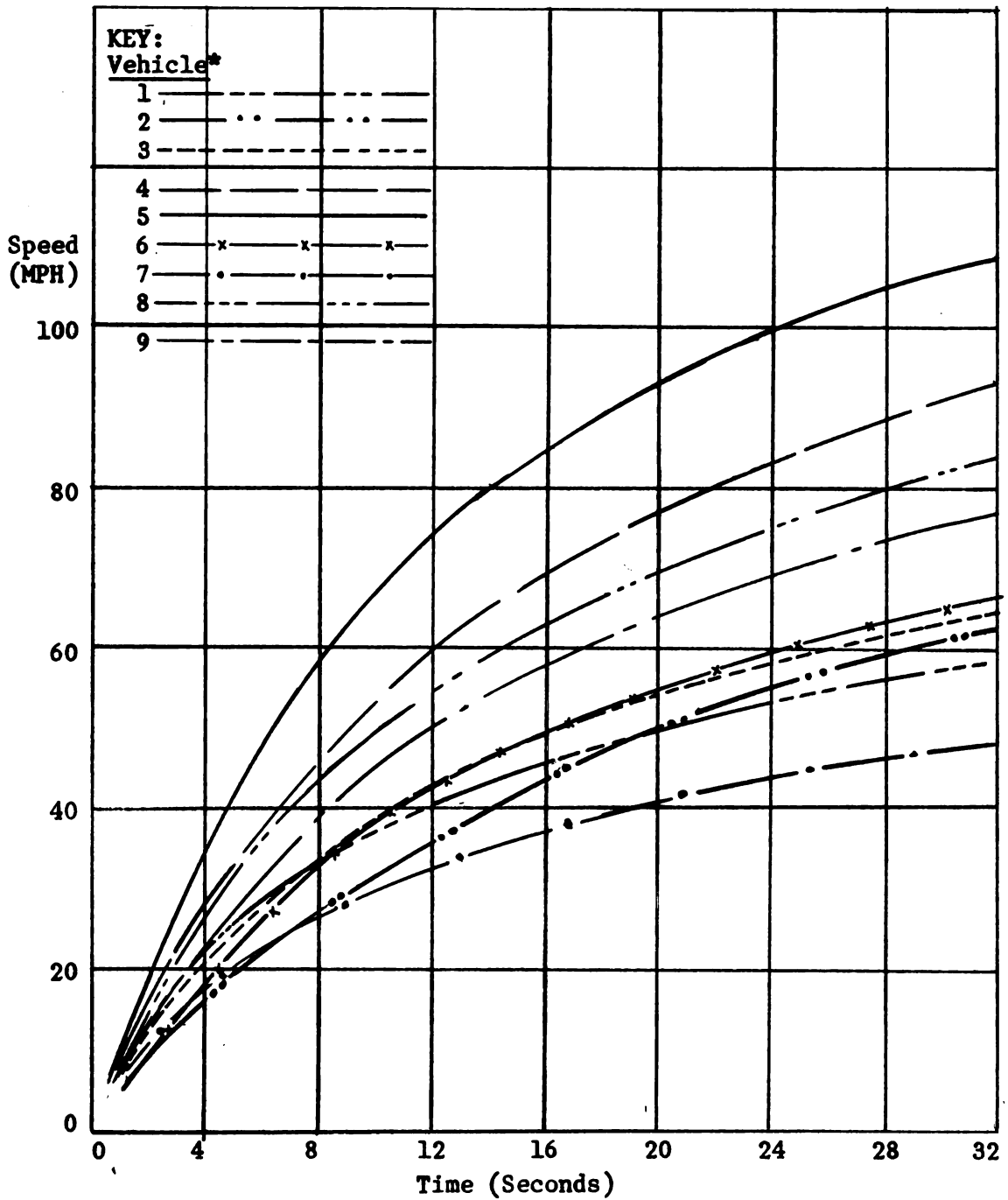
FIGURE 2

## COMPONENTS OF PASSING DISTANCES



GRAPH 1

## TIME-SPEED COMPARISONS OF VEHICLES FOR SELECTED MODEL YEARS



**APPENDIX C**

**Accident Study Development**

## Accident Study Development

### Accident Data Collection

In the gathering of the data for the accident study, the accidents on two-lane rural highways were singled out for analysis. Of these accidents, only those that occurred in a no-passing zone would be placed on Form 10, and a tally sheet would be used for the remaining. A check of the accidents in the counties chosen involved a check of the filed forms such as shown as Form 11. To determine if the accident had occurred in a no-passing zone a check of the Traffic Control section, on the second page of the form, had to be made. The words "No-passing Zone" had to be added under "Other". It was found that this made it very difficult, since this required the investigating officer to make a special entry.

A check of the accident records for all of the rural townships in Kent County was made and the results are shown as Table 13. Of the total 1579 accidents in 1962 that occurred on rural two-lane roads, there were only 18 No-passing zone accidents. Of these 18, only 4 were actually a result of improper passing and the other just happened in the no-passing zone. Since reporting of accidents is not a rigidly controlled operation, and the type of information required for such analysis requires a special notation and is not readily available, further analysis of the accident records for the remaining counties was dropped from the study. It was felt that the added effort required to check each accident form would not add enough to the analysis to justify the time required.

### Recommendations for An Accident Analysis

In order to make a study of this type worth while for analysis, it would be necessary to know the major cause of all accidents filed. Since the entry to cover no-passing zone accidents was not always made, a careful reading of the form must be made to determine the cause of the accident. To cover the counties that were chosen for distribution of the questionnaire would have meant over a month of man hours spent viewing the filed reports. The Michigan State Highway Department's Traffic Division maintains a file on all accidents and this data has been stored on IBM cards. In discussing the analysis with the personnel of the Highway Department, it was learned that the accident records are not stored by counties, but are on a state-wide basis. This would mean that all of the cards would have to be run and the counties chosen sorted out. Then, these cards would have to be rerun to sort out the rural two-lane road accidents and again for passing accidents. This type of analysis would be much faster and more accurate than the manual sorting of forms. Since the time involved to prepare the cards and to obtain the results would have delayed this thesis, it was felt that only a discussion of the method would be included.

TRUNKLINE NO. \_\_\_\_\_ COUNTY RD. NO. \_\_\_\_\_

NO. 1 VEHICLE YEAR \_\_\_\_\_ MAKE \_\_\_\_\_ TYPE \_\_\_\_\_

DRIVER SEX \_\_\_\_\_ AGE \_\_\_\_\_ EYE HEIGHT \_\_\_\_\_

NO. 2 VEHICLE YEAR \_\_\_\_\_ MAKE \_\_\_\_\_ TYPE \_\_\_\_\_

DRIVER SEX \_\_\_\_\_ AGE \_\_\_\_\_ EYE HEIGHT \_\_\_\_\_

NO. 3 VEHICLE YEAR \_\_\_\_\_ MAKE \_\_\_\_\_ TYPE \_\_\_\_\_

DRIVER SEX \_\_\_\_\_ AGE \_\_\_\_\_ EYE HEIGHT \_\_\_\_\_

LIGHT CONDITION DAY \_\_\_\_\_ DUSK OR DAWN \_\_\_\_\_ DARK \_\_\_\_\_

ROAD CHARACTER STRAIGHT \_\_\_\_\_ LEVEL \_\_\_\_\_  
CURVE \_\_\_\_\_ ON GRADE \_\_\_\_\_  
HILLCREST \_\_\_\_\_

ROAD TYPE LANES 1 \_\_\_\_\_ 2 \_\_\_\_\_ 3 \_\_\_\_\_ 4 \_\_\_\_\_

VIOLATION IMPROPER PASSING \_\_\_\_\_ TRAFFIC CONTROL NO-PASS ZONE \_\_\_\_\_

NO. \_\_\_\_\_ COUNTY \_\_\_\_\_ TWP. \_\_\_\_\_ SECTION \_\_\_\_\_

TRUNKLINE NO. \_\_\_\_\_ COUNTY RD. NO. \_\_\_\_\_

NO. 1 VEHICLE YEAR \_\_\_\_\_ MAKE \_\_\_\_\_ TYPE \_\_\_\_\_

DRIVER SEX \_\_\_\_\_ AGE \_\_\_\_\_ EYE HEIGHT \_\_\_\_\_

NO. 2 VEHICLE YEAR \_\_\_\_\_ MAKE \_\_\_\_\_ TYPE \_\_\_\_\_

DRIVER SEX \_\_\_\_\_ AGE \_\_\_\_\_ EYE HEIGHT \_\_\_\_\_

NO. 3 VEHICLE YEAR \_\_\_\_\_ MAKE \_\_\_\_\_ TYPE \_\_\_\_\_

DRIVER SEX \_\_\_\_\_ AGE \_\_\_\_\_ EYE HEIGHT \_\_\_\_\_

LIGHT CONDITION DAY \_\_\_\_\_ DUSK OR DAWN \_\_\_\_\_ DARK \_\_\_\_\_

ROAD CHARACTER STRAIGHT \_\_\_\_\_ LEVEL \_\_\_\_\_  
CURVE \_\_\_\_\_ ON GRADE \_\_\_\_\_  
HILLCREST \_\_\_\_\_

ROAD TYPE LANES 1 \_\_\_\_\_ 2 \_\_\_\_\_ 3 \_\_\_\_\_ 4 \_\_\_\_\_

VIOLATION IMPROPER PASSING \_\_\_\_\_ TRAFFIC CONTROL NO-PASS ZONE \_\_\_\_\_

# STATE OF MICHIGAN

## OFFICIAL TRAFFIC ACCIDENT REPORT

UD-10C

of sheets attached ..... Department ..... Complaint No. ....

Date ..... 19 ..... Day of Week ..... at ..... A.M. .... P.M. .... File Class Number .....

County ..... City ..... Twp. .... Sec. ....

Highway or street on which accident occurred (Name) ..... Trunkline No. .... County Road No. ....

AT ITS INTERSECTION WITH (street, highway or R. R. crossing) .....

OR

IF NOT AT INTERSECTION: (feet or miles or fractions thereof) .....

|   |   |   |   |
|---|---|---|---|
| N | S | E | W |
|---|---|---|---|

of (intersecting street, highway, city, village, county line or R.R.) .....

Special reference ..... Use to indicate more precise location: (alley, house number, stream, milepost, underpass, or other landmark) .....

ge to property other than vehicles ..... Name object and state nature of damage .....

 way ☐ , or ..... feet from 

|   |   |   |   |
|---|---|---|---|
| N | S | E | W |
|---|---|---|---|

 edge of roadway .....

and address of owner of object struck .....

## CODE OF INJURY

(Use only the most serious one in each space for injury.)

K - Dead before report made.

A - Visible signs of injury, as bleeding wound or distorted member, or had to be carried from scene.

B - Other visible injury, as bruises, abrasions, swelling, limping, etc.

C - No visible injury but complaint of pain or momentary unconsciousness.

O - No indication of injury.

Year ..... Make ..... Type ..... Year, No., &amp; State of Reg ..... ICC No. .... MPSC No. ....

Parts of vehicle damaged ..... Vehicle removed to: ..... By: .....

Owner (FULL Name) ..... Street or RFD ..... City ..... State .....

Driver (FULL Name) ..... Street or RFD .....

 Driver's License ..... Regular Operator's License ☐ ..... City, County, State ..... AGE SEX INJURY  
 License ..... State ..... Number ..... Other Type License ☐ ..... Date of Birth ..... Month, Day, Year .....

OCCUPANTS .....

Front Center ..... Address .....

Front Right ..... Address .....

Rear Left ..... Address .....

Rear Center ..... Address .....

Rear Right ..... Address .....

Name ..... Street or RFD ..... City and State .....

Year ..... Make ..... Type ..... Year, No., &amp; State of Reg ..... ICC No. .... MPSC No. ....

Parts of vehicle damaged ..... Vehicle removed to: ..... By: .....

Owner (FULL Name) ..... Street or RFD ..... City ..... State .....

Driver (FULL Name) ..... Street or RFD .....

 Driver's License ..... Regular Operator's License ☐ ..... City, County, State ..... AGE SEX INJURY  
 License ..... State ..... Number ..... Other Type License ☐ ..... Date of Birth ..... Month, Day, Year .....

OCCUPANTS .....

Front Center ..... Address .....

Front Right ..... Address .....

Rear Left ..... Address .....

Rear Center ..... Address .....

Rear Right ..... Address .....

Name ..... Street or RFD ..... City and State .....

taken to ..... By .....

| WEATHER<br>(Check one) | LIGHT<br>CONDITION<br>(Check one)     | KIND OF LOCALITY<br>(Check one)               | ROADWAY                                  |                                          |                                        |                                            |
|------------------------|---------------------------------------|-----------------------------------------------|------------------------------------------|------------------------------------------|----------------------------------------|--------------------------------------------|
| Clear or cloudy        | <input type="checkbox"/> Daylight     | <input type="checkbox"/> Mfg. or industrial   | CONSTRUCTION<br>(Check one)              | SURFACE<br>(Check one)                   | CHARACTER<br>(Check two)               | CONDITION<br>(Check one)                   |
| Fogging                | <input type="checkbox"/> Dusk or dawn | <input type="checkbox"/> Shopping or business | <input type="checkbox"/> Concrete        | <input type="checkbox"/> Dry             | <input type="checkbox"/> Straight road | <input type="checkbox"/> Defect (describe) |
| Blowing                | <input type="checkbox"/> Darkness     | <input type="checkbox"/> Apartments           | <input type="checkbox"/> Blacktop        | <input type="checkbox"/> Wet             | <input type="checkbox"/> Curve         |                                            |
| Light (specify)        |                                       | <input type="checkbox"/> School or playground | <input type="checkbox"/> Gravel          | <input type="checkbox"/> Snowy or icy    | <input type="checkbox"/> Level         |                                            |
|                        |                                       | <input type="checkbox"/> One family homes     | <input type="checkbox"/> Dirt or sand    | <input type="checkbox"/> Other (specify) | <input type="checkbox"/> On grade      | Low shoulder, slippery when wet, etc.      |
|                        |                                       | <input type="checkbox"/> Farms, fields        | <input type="checkbox"/> Other (specify) |                                          | <input type="checkbox"/> Hillcrest     | <input type="checkbox"/> No defect         |
|                        |                                       | <input type="checkbox"/> Not developed        |                                          |                                          |                                        |                                            |

Name ..... Address ..... Age ..... Sex .....

Name ..... Address ..... Age ..... Sex .....

Name ..... Address ..... Age ..... Sex .....

WHAT DRIVERS WERE GOING TO DO BEFORE ACCIDENT

Driver No. 1 was headed ☐ N ☐ S ☐ E ☐ W on \_\_\_\_\_ at \_\_\_\_\_ MPH  
Street or Highway

Driver No. 2 was headed ☐ N ☐ S ☐ E ☐ W on \_\_\_\_\_ at \_\_\_\_\_ MPH

DRIVER  
1 2 (Check one for each driver)

- |                                            |                                                     |                                                         |
|--------------------------------------------|-----------------------------------------------------|---------------------------------------------------------|
| <input type="checkbox"/> Go straight ahead | <input type="checkbox"/> Make U turn                | <input type="checkbox"/> Back                           |
| <input type="checkbox"/> Overtake          | <input type="checkbox"/> Slow or stop               | <input type="checkbox"/> Remain stopped in traffic lane |
| <input type="checkbox"/> Make right turn   | <input type="checkbox"/> Start in traffic lane      | <input type="checkbox"/> Remain parked                  |
| <input type="checkbox"/> Make left turn    | <input type="checkbox"/> Start from parked position |                                                         |

ROAD TYPE (Check one or more for each driver)

- DRIVER  
1 2
- |                          |                          |                                  |
|--------------------------|--------------------------|----------------------------------|
| <input type="checkbox"/> | <input type="checkbox"/> | 1 driving lane                   |
| <input type="checkbox"/> | <input type="checkbox"/> | 2 driving lanes                  |
| <input type="checkbox"/> | <input type="checkbox"/> | 3 driving lanes                  |
| <input type="checkbox"/> | <input type="checkbox"/> | 4 or more lanes                  |
| <input type="checkbox"/> | <input type="checkbox"/> | Divided roadway (limited access) |
| <input type="checkbox"/> | <input type="checkbox"/> | Divided roadway (other)          |
| <input type="checkbox"/> | <input type="checkbox"/> | One way street                   |
| <input type="checkbox"/> | <input type="checkbox"/> | Unpaved - any width              |

WHAT PEDESTRIAN WAS DOING

Pedestrian was going ☐ N ☐ S ☐ E ☐ W ☐ Along ☐ Across or into \_\_\_\_\_ From \_\_\_\_\_ To \_\_\_\_\_  
Street Name, Highway No. N.E. corner to S.E. corner, or west to east side, etc.

(Check one)

- |                                                                   |                                                               |                                                        |                                           |
|-------------------------------------------------------------------|---------------------------------------------------------------|--------------------------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Crossing or entering at intersection     | <input type="checkbox"/> Walking in roadway - with traffic    | <input type="checkbox"/> Pushing or working on vehicle | <input type="checkbox"/> Other in roadway |
| <input type="checkbox"/> Crossing or entering not at intersection | <input type="checkbox"/> Walking in roadway - against traffic | <input type="checkbox"/> Other working in roadway      | <input type="checkbox"/> Not in roadway   |
| <input type="checkbox"/> Getting on or off vehicle                | <input type="checkbox"/> Standing in roadway                  | <input type="checkbox"/> Playing in roadway            |                                           |

VIOLATION INDICATED (Check one or more for each driver)

- DRIVER  
1 2
- |                                                       |                                                                  |
|-------------------------------------------------------|------------------------------------------------------------------|
| <input type="checkbox"/> Speed too fast               | <input type="checkbox"/> Made improper turn                      |
| <input type="checkbox"/> Failed to yield right of way | <input type="checkbox"/> Improper or no signal                   |
| <input type="checkbox"/> Drove left of center         | <input type="checkbox"/> Improper parking location               |
| <input type="checkbox"/> Improper overtaking          | <input type="checkbox"/> Other improper driving (describe) _____ |
| <input type="checkbox"/> Passed stop sign             |                                                                  |
| <input type="checkbox"/> Disregarded traffic signal   |                                                                  |
| <input type="checkbox"/> Followed too closely         | <input type="checkbox"/> No violation indicated                  |

APPARENT PHYSICAL CONDITION (Check one or more as applicable)

- DRIVER  
1 2 PED.
- |                                           |                                                                                    |
|-------------------------------------------|------------------------------------------------------------------------------------|
| <input type="checkbox"/> Ill              | <input type="checkbox"/> Normal                                                    |
| <input type="checkbox"/> Fatigued         | <input type="checkbox"/> Condition not known                                       |
| <input type="checkbox"/> Asleep           | <input type="checkbox"/> Restriction on license complied with                      |
| <input type="checkbox"/> Other impairment | <input type="checkbox"/> Restriction on license not complied with (describe) _____ |

DRINKING CONDITION (Check one)

- DRIVER  
1 2 PED. HAD BEEN DRINKING:
- |                          |                          |                          |                         |
|--------------------------|--------------------------|--------------------------|-------------------------|
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Under the influence     |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Not under the influence |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Influence not known     |

- |                          |                          |                          |                       |
|--------------------------|--------------------------|--------------------------|-----------------------|
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Had not been drinking |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Not known if drinking |

CHECK IF APPLICABLE:

- |                          |                          |                          |                     |
|--------------------------|--------------------------|--------------------------|---------------------|
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Chemical test given |
|--------------------------|--------------------------|--------------------------|---------------------|

VISION OBSTRUCTION (Check one or more for each driver)

- DRIVER  
1 2
- |                          |                          |                                                             |
|--------------------------|--------------------------|-------------------------------------------------------------|
| <input type="checkbox"/> | <input type="checkbox"/> | Windshield or windows                                       |
| (describe) _____         |                          |                                                             |
| <input type="checkbox"/> | <input type="checkbox"/> | Bldgs., signs, bushes, crops, embankment, parked cars, etc. |
| (describe) _____         |                          |                                                             |
| <input type="checkbox"/> | <input type="checkbox"/> | No vision obstruction                                       |

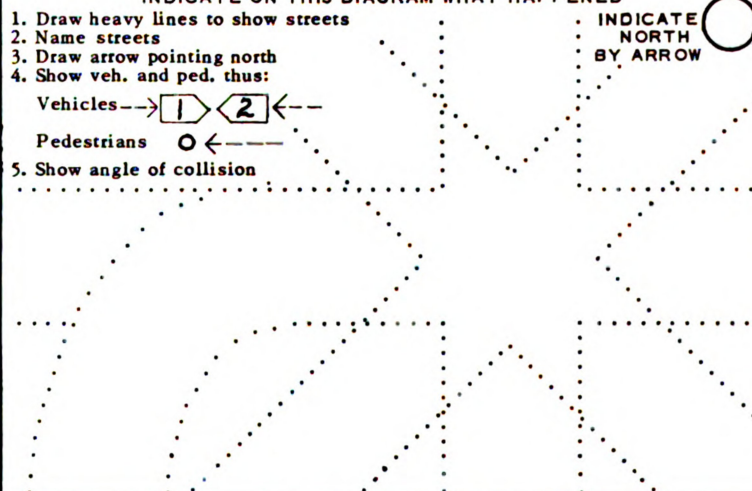
VEHICLE CONDITION (Check one or more)

- VEHICLE  
1 2
- |                          |                          |                           |
|--------------------------|--------------------------|---------------------------|
| <input type="checkbox"/> | <input type="checkbox"/> | Defective brakes          |
| <input type="checkbox"/> | <input type="checkbox"/> | Defective lights          |
| <input type="checkbox"/> | <input type="checkbox"/> | Defective steering        |
| <input type="checkbox"/> | <input type="checkbox"/> | Defective tires           |
| <input type="checkbox"/> | <input type="checkbox"/> | Other defective equipment |
| (specify) _____          |                          |                           |
| <input type="checkbox"/> | <input type="checkbox"/> | Not known if defective    |
| <input type="checkbox"/> | <input type="checkbox"/> | No defect                 |

TRAFFIC CONTROL (Check one or more)

- |                          |                                                 |
|--------------------------|-------------------------------------------------|
| <input type="checkbox"/> | Stop sign                                       |
| <input type="checkbox"/> | Stop and go signal                              |
| <input type="checkbox"/> | Officer or watchman                             |
| <input type="checkbox"/> | R.R. gates or signals                           |
| <input type="checkbox"/> | Other (specify) _____                           |
| <b>No-Passing Zone</b>   |                                                 |
| <input type="checkbox"/> | Control not functioning, inadequate or obscured |
| (describe) _____         |                                                 |
| <input type="checkbox"/> | No traffic control present                      |

INDICATE ON THIS DIAGRAM WHAT HAPPENED



REMARKS AND RECOMMENDATIONS

Inspect scene for need of traffic engineering? ☐ Yes (explain) \_\_\_\_\_  
Re-examine driver for license competency? ☐ #1 ☐ #2 (explain) \_\_\_\_\_

Use complaint form or sheet of paper for more extensive remarks or diagrams

POLICE RECORD

Arrest: Name \_\_\_\_\_ Charge \_\_\_\_\_  
Arrest: Name \_\_\_\_\_ Charge \_\_\_\_\_  
Reported by (name) \_\_\_\_\_ Address \_\_\_\_\_  
Date received \_\_\_\_\_ Time \_\_\_\_\_ ☐ AM ☐ PM Report received by (officer) \_\_\_\_\_  
Investigator \_\_\_\_\_ Signature and Rank \_\_\_\_\_ Badge No. \_\_\_\_\_ Station or Department \_\_\_\_\_  
Investigated at scene? ☐ Yes ☐ No Photographs taken? ☐ Yes ☐ No Complaint closed by: ☐ Arrest ☐ Other Date \_\_\_\_\_ Post No. \_\_\_\_\_

TABLE 13

## LIST OF ACCIDENTS IN TOWNSHIPS OF KENT COUNTY, MICHIGAN, FOR 1962

| TOWNSHIP        | NON FATAL                                          |                                  |                      | FATAL                                              |             |
|-----------------|----------------------------------------------------|----------------------------------|----------------------|----------------------------------------------------|-------------|
|                 | Total Accid.<br>1962 Not in<br>No-Passing<br>Zones | No-<br>Passing<br>Zone<br>Accid. | Form<br>11<br>Number | Total Accid.<br>1962 Not in<br>No-Passing<br>Zones | In<br>Zones |
| 1 Ada           | 80                                                 | None                             | --                   | --                                                 | 1           |
| 2 Algoma        | 91                                                 | None                             | --                   | --                                                 | --          |
| 3 Alpine        | 88                                                 | None                             | --                   | --                                                 | --          |
| 4 Bowne         | 11                                                 | None                             | --                   | --                                                 | --          |
| 5 Byron         | 90                                                 | None                             | --                   | 1                                                  | --          |
| 6 Caledonia     | 41                                                 | 1                                | 1                    | 1                                                  | --          |
| 7 Cannon        | 75                                                 | 1                                | 2                    | 1                                                  | --          |
| 8 Cascade       | 32                                                 | 2                                | 3-4                  | 1                                                  | --          |
| 9 Courtland     | 53                                                 | 2                                | 5-6                  | --                                                 | --          |
| 10 Gaines       | 44                                                 | None                             | --                   | --                                                 | --          |
| 11 Grand Rapids | 85                                                 | None                             | --                   | 4                                                  | --          |
| 12 Grattan      | 48                                                 | 1                                | 7                    | 1                                                  | --          |
| 13 Lowell       | 32                                                 | 2                                | 8-9                  | --                                                 | --          |
| 14 Nelson       | 37                                                 | 2                                | 10-11                | 1                                                  | --          |
| 15 Oakfield     | 43                                                 | 1                                | 12                   | 1                                                  | --          |
| 16 Paris        | 176                                                | None                             | --                   | 3                                                  | --          |
| 17 Plainfield   | 178                                                | 1                                | 13                   | 4                                                  | --          |
| 18 Solon        | 24                                                 | 1                                | 14                   | --                                                 | --          |
| 19 Sparta       | 81                                                 | 1                                | 15                   | 3                                                  | --          |
| 20 Spencer      | 17                                                 | None                             | --                   | 1                                                  | --          |
| 21 Tyrone       | 32                                                 | None                             | --                   | 1                                                  | --          |
| 22 Vergennes    | 24                                                 | None                             | --                   | --                                                 | --          |
| 23 Walker       | 153                                                | 2                                | 16-17                | 3                                                  | --          |
| 24 Wyoming      | All city                                           | None                             | --                   | --                                                 | --          |
| 1535            |                                                    | 17                               |                      | 26                                                 | 1           |

TOTAL 1579

**APPENDIX D**

**Tables of Questionnaire Results**

### Tables of Questionnaire Results

The passing practices of the drivers are shown in Tables 14 to 20. Table 14 shows the percents of the total that answered each of the four passing questions and the way they were answered. Tables 15 through 20 are a comparison between two of the four passing questions. These tables show the percent of the total that answered both of the questions with the responses shown at the top and side of the table (white bar), the percent of each row that answered the responses shown above (slash lines), and the percent of the column that answered the response shown at the side of the table (vertical lines).

The marking techniques are discussed in Tables 21 to 25. Table 21 is a listing of the total percents that answered and how they answered. Tables 22 through 25 are comparisons of the different questions. The cells have the same breakdown mentioned above.

## LEGEND FOR TABLES

15-20

22-25



Percent of the total number of respondents that answered both questions. All cell percents add to 100%.



Percent of those that answered the response shown at the far left of the row and then answered the response shown above. Each row will add to 100%.



Percent of those that answered the response shown at the top of that column and then answered the response shown at the left. Each column will add to 100%.

TABLE 14

## RESPONSES TO PASSING QUESTIONS

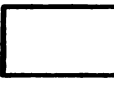
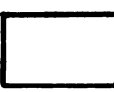
| P A S S I N G   P R A C T I C E S                                                                                                                                                                |                                                                                               |                                                                                               |                                                                                               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Q U E S T I O N S   A S K E D                                                                                                                                                                    | R E S P O N S E S                                                                             |                                                                                               |                                                                                               |
|                                                                                                                                                                                                  | Y E S                                                                                         | only in rare cases                                                                            | N O                                                                                           |
| 5A. Have you ever passed when you must cross the yellow line when returning to your lane?<br>                 | 24.31%<br>   | 39.98%<br>   | 35.70%<br>   |
| 5B. Have you ever passed when your entire passing movement is within the no-passing zone?<br>                 | 9.55%<br>    | 5.39%<br>    | 85.07%<br>   |
| 5C. Have you ever passed when you must cross the yellow line at the end of the no-passing zone?<br>         | 24.23%<br> | 20.67%<br> | 55.11%<br> |
| 5D. Have you ever passed when you will be able to complete your passing before coming to a yellow line?<br> | 85.70%<br> | 5.96%<br>  | 8.33%<br>  |

TABLE 15

## COMPARISON BETWEEN PASSING AT THE START OF ZONE AND PASSING IN THE ZONE

| 5A. Have you ever passed when you must cross the yellow line when returning to your lane? |                    | 5B. Have you ever passed when your entire passing movement is within the no-passing zone? |                             |                                |
|-------------------------------------------------------------------------------------------|--------------------|-------------------------------------------------------------------------------------------|-----------------------------|--------------------------------|
|                                                                                           |                    | YES                                                                                       | ONLY IN RARE CASES          | NO                             |
| 5A. Have you ever passed when you must cross the yellow line when returning to your lane? | YES                | 4.16<br><br>4.16 17.20 43.55                                                              | 1.92<br><br>1.92 7.96 35.71 | 18.09<br><br>18.09 74.84 21.27 |
|                                                                                           | ONLY IN RARE CASES | 3.16<br><br>3.16 7.85 33.06                                                               | 2.54<br><br>2.54 6.32 47.14 | 34.49<br><br>34.49 85.82 40.54 |
|                                                                                           | NO                 | 2.23<br><br>2.23 6.26 23.39                                                               | 0.92<br><br>0.92 2.59 17.14 | 32.49<br><br>32.49 91.14 38.19 |

TABLE 16

## COMPARISON BETWEEN PASSING AT THE START OF THE ZONE AND AT THE END OF THE ZONE

| 5C. Have you ever passed when you must cross the yellow line at the end of a no-passing zone? |                    |                                                   |                                                    |                                                    |
|-----------------------------------------------------------------------------------------------|--------------------|---------------------------------------------------|----------------------------------------------------|----------------------------------------------------|
|                                                                                               | YES                | ONLY IN RARE CASES                                | NO                                                 |                                                    |
| 5A. Have you ever passed when you must cross the yellow line when returning to your lane?     | YES                | <div>9.60</div> <div>40.13</div> <div>39.62</div> | <div>3.25</div> <div>13.59</div> <div>15.73</div>  | <div>11.07</div> <div>46.28</div> <div>20.08</div> |
|                                                                                               | ONLY IN RARE CASES | <div>7.59</div> <div>18.85</div> <div>31.31</div> | <div>12.69</div> <div>31.54</div> <div>61.42</div> | <div>19.97</div> <div>49.62</div> <div>36.24</div> |
|                                                                                               | NO                 | <div>7.04</div> <div>19.65</div> <div>29.07</div> | <div>4.72</div> <div>13.17</div> <div>22.85</div>  | <div>24.07</div> <div>67.17</div> <div>43.68</div> |

TABLE 17

## COMPARISON BETWEEN PASSING AT THE START OF THE ZONE AND WELL BEFORE THE ZONE

| 5D. Have you ever passed when you must cross the yellow line when returning to your lane? |    | 5D. Have you ever passed when you will be able to complete your passing before coming to a yellow line? |                                             |
|-------------------------------------------------------------------------------------------|----|---------------------------------------------------------------------------------------------------------|---------------------------------------------|
| YES                                                                                       | NO | YES                                                                                                     | ONLY IN RARE CASES                          |
| YES                                                                                       |    | YES<br>90.57<br>22.02<br>25.69                                                                          | ONLY IN RARE CASES<br>0.69<br>11.54<br>2.83 |
| ONLY IN RARE CASES                                                                        |    | ONLY IN RARE CASES<br>91.40<br>36.54<br>42.64                                                           | ONLY IN RARE CASES<br>2.22<br>37.18<br>5.54 |
| NO                                                                                        |    | NO<br>76.02<br>27.14<br>31.67                                                                           | NO<br>3.06<br>51.28<br>8.57                 |
|                                                                                           |    | YES<br>1.61<br>19.27                                                                                    | NO<br>1.22<br>14.68                         |
|                                                                                           |    | YES<br>5.50<br>66.06                                                                                    | NO<br>15.42<br>66.06                        |

TABLE 18

## COMPARISON BETWEEN PASSING IN THE ZONE AND AT THE END OF THE ZONE

| 5C. Have you ever passed when you must cross the yellow line at the end of a no-passing zone? |                    |                                                        |                                    |                             |
|-----------------------------------------------------------------------------------------------|--------------------|--------------------------------------------------------|------------------------------------|-----------------------------|
|                                                                                               | YES                | ONLY IN RARE CASES                                     | NO                                 |                             |
| 5B. Have you ever passed when your entire passing movement is within a no-passing zone?       | YES                | <br>4.36<br>45.53<br>18.06<br>39.84<br>6.93            | <br>1.40<br>14.63<br>6.77<br>3.82  | <br>3.82<br>39.84<br>6.93   |
|                                                                                               | ONLY IN RARE CASES | <br>1.87<br>36.92<br>7.74<br>21.54<br>1.98             | <br>2.10<br>41.54<br>10.15<br>1.09 | <br>1.09<br>21.54<br>1.98   |
|                                                                                               | NO                 | <br>17.93<br>21.00<br>74.19<br>50.19<br>58.81<br>91.09 | <br>17.23<br>20.18<br>83.08        | <br>50.19<br>58.81<br>91.09 |

TABLE 19

## COMPARISON BETWEEN PASSING IN THE ZONE AND WELL BEFORE THE ZONE

| 5D. Have you ever passed when you will be able to complete your passing before coming to a yellow line? |                    | ONLY IN RARE CASES      |                        | NO                    |    |
|---------------------------------------------------------------------------------------------------------|--------------------|-------------------------|------------------------|-----------------------|----|
| 5B. Have you ever passed when your entire passing movement is within a no-passing zone?                 | YES                | YES                     | ONLY IN RARE CASES     |                       | NO |
|                                                                                                         | YES                | 84.68<br>8.10           | 0.69<br>7.26<br>11.69  | 0.77<br>8.06<br>9.09  |    |
|                                                                                                         | ONLY IN RARE CASES | 70.59<br>3.70           | 0.85<br>16.18<br>14.29 | 0.69<br>13.24<br>8.18 |    |
| 5B. Have you ever passed when your entire passing movement is within a no-passing zone?                 | NO                 | 73.77<br>86.59<br>86.20 | 4.40<br>5.16<br>74.03  | 7.02<br>8.24<br>82.73 |    |

TABLE 20

## COMPARISON BETWEEN PASSING AT THE END OF THE ZONE AND WELL BEFORE THE ZONE

| 5D. Have you ever passed when you will be able to complete your passing before coming to a yellow line? |                                 | 5C. Have you ever passed when you must cross the yellow line at the end of a no-passing zone? |                                  |
|---------------------------------------------------------------------------------------------------------|---------------------------------|-----------------------------------------------------------------------------------------------|----------------------------------|
| YES                                                                                                     | NO                              | ONLY IN RARE CASES                                                                            | NO                               |
| <p>YES</p> <p>91.64<br/>22.13<br/>25.86</p>                                                             | <p>1.16<br/>4.82<br/>13.64</p>  | <p>ONLY IN RARE CASES</p> <p>0.85<br/>3.54<br/>14.47</p>                                      | <p>0.93<br/>4.48<br/>10.91</p>   |
| <p>ONLY IN RARE CASES</p> <p>88.06<br/>18.32<br/>21.42</p>                                              | <p>6.44<br/>11.71<br/>75.45</p> | <p>NO</p> <p>3.49<br/>6.35<br/>59.21</p>                                                      | <p>45.11<br/>52.72<br/>81.95</p> |

TABLE 21

## RESPONSES TO MARKING QUESTIONS

| NO PASSING ZONE MARKINGS                                                                                                                                |                                                                                               |                                                                                             |                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| QUESTIONS ASKED                                                                                                                                         | RESPONSES                                                                                     |                                                                                             |                                                                                               |
|                                                                                                                                                         | Yellow Line                                                                                   | Do Not Pass Sign                                                                            | I Don't Know                                                                                  |
| 6A. When approaching a no-passing zone, which do you notice first during the daytime?                                                                   | 49.45%<br>   | 45.46%<br> | 5.09%<br>    |
| 6B. When approaching a no-passing zone, which do you notice first during the night?                                                                     | 36.83%<br>   | 54.29%<br> | 8.88%<br>    |
|                                                                                                                                                         | Yes                                                                                           |                                                                                             | No                                                                                            |
| 7. Do you feel that the present system of marking no-passing zones is adequate?                                                                         | 80.33%<br> |                                                                                             | 19.67%<br> |
| 8. Would a large yellow sign like this one <del>No Passing</del> placed on the left hand side of the road, at the start of the yellow line, be helpful? | 70.80%<br> |                                                                                             | 29.20%<br> |

**TABLE 22**  
**COMPARISON BETWEEN OBSERVANCE OF MARKINGS DURING THE DAYTIME AND DURING THE NIGHT**

| 6A. When approaching a no-passing zone, which do you notice first during the daytime? |                  | 6B. When approaching a no-passing zone, which do you notice first during the night? |                                |                               |
|---------------------------------------------------------------------------------------|------------------|-------------------------------------------------------------------------------------|--------------------------------|-------------------------------|
|                                                                                       |                  | Yellow Line                                                                         | Do Not Pass Sign               | I Don't Know                  |
| 6A. When approaching a no-passing zone, which do you notice first during the daytime? | Yellow Line      | <p>23.81    48.08    65.00</p>                                                      | <p>22.78    46.01    41.80</p> | <p>2.93    5.92    33.06</p>  |
|                                                                                       | Do Not Pass Sign | <p>12.53    27.58    34.20</p>                                                      | <p>30.62    67.42    56.18</p> | <p>2.27    5.00    25.62</p>  |
|                                                                                       | I Don't Know     | <p>0.22    5.80    0.80</p>                                                         | <p>1.10    21.74    2.02</p>   | <p>3.66    72.46    41.32</p> |

TABLE 23

## COMPARISON BETWEEN OBSERVANCE OF MARKINGS DURING THE DAYTIME AND USE OF THE IOWA SIGN

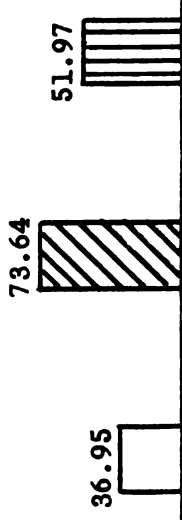
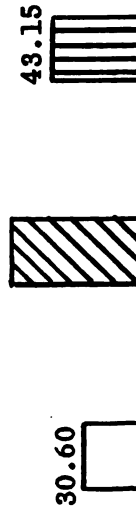
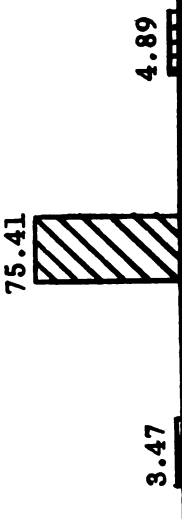
| 8. Would a large yellow sign like this one  placed on the left hand side of the road, at the start of the yellow line, be helpful? |                  |                                                                                                                     |                                                                                                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                     |                  | YES                                                                                                                 | NO                                                                                                                |
| 6A. When approaching a no-passing zone, which do you notice first, during the daytime?                                                                                                                              | Yellow Line      | <br>36.95      73.64      51.97  | <br>13.19      26.36      45.34  |
|                                                                                                                                                                                                                     | Do Not Pass Sign | <br>30.60      67.44      43.15 | <br>14.77      32.56      50.78 |
|                                                                                                                                                                                                                     |                  | <br>3.47      75.41      4.89  | <br>1.13      24.59      3.89  |

TABLE 24

## COMPARISON BETWEEN OBSERVANCE OF MARKINGS DURING THE NIGHT AND USE OF THE IOWA SIGN

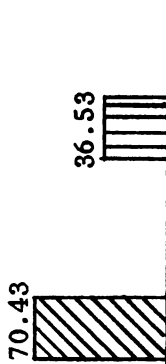
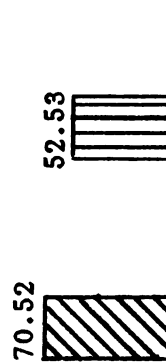
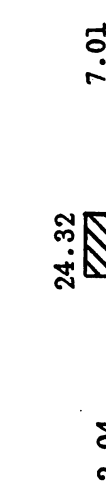
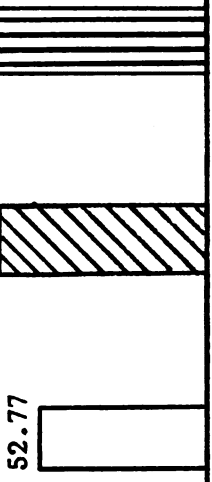
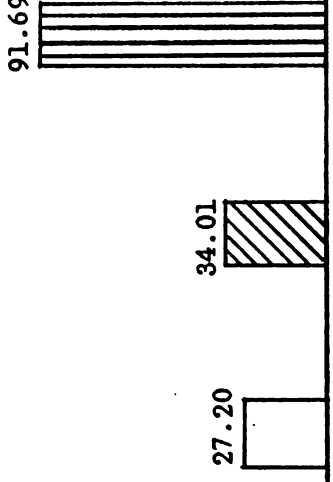
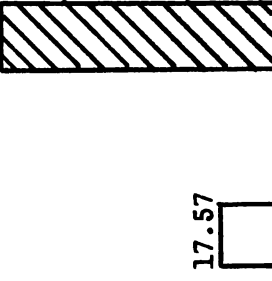
| 8. Would a large yellow sign like this one  placed on the left hand side of the road, at the start of the yellow line, be helpful? |                  |                                                                                                                    |                                                                                                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                     |                  | YES                                                                                                                | NO                                                                                                                |
| 6B. When approaching a no-passing zone, which do you notice first, during the night?                                                                                                                                | Yellow Line      | <br>25.91      70.43      36.53  | <br>10.88      29.57      37.40  |
|                                                                                                                                                                                                                     | Do Not Pass Sign | <br>38.67      70.52      52.53 | <br>16.16      29.48      55.58 |
|                                                                                                                                                                                                                     | I Don't Know     | <br>6.34      75.68      8.95  | <br>2.04      24.32      7.01  |

TABLE 25

COMPARISON BETWEEN ADEQUACY OF MARKINGS AND USE OF THE IOWA SIGN

| 8. Would a large yellow sign like this one  placed on the left hand side of the road, at the start of the yellow line, be helpful? |     |                                                                                                                              |                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                     |     | YES                                                                                                                          | NO                                                                                                                       |
| 7. Do you feel that the present system of marking no-passing zones is adequate?                                                                                                                                     | YES |  <p>52.77</p> <p>65.99</p> <p>75.03</p>   |  <p>27.20</p> <p>34.01</p> <p>91.69</p> |
|                                                                                                                                                                                                                     | NO  |  <p>17.57</p> <p>87.69</p> <p>24.97</p> |  <p>2.47</p> <p>12.31</p> <p>8.31</p> |

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