MINIMUM TIME PERIODS—ORIGIN AND DESTINATION SURVEYS

GRADY CARLISLE, *Senior Traffic Engineer* AND W. T. TAYLOR, JR., *Head Transportation Analyst*, *Louisiana Department of Highways*

SYNOPSIS

The hours for conducting origin and destination surveys are governed generally by two considerations; the time and money available. An examination of origin and destination surveys conducted by the traffic engineering divisions of different States shows that a large percentage of these surveys cover periods from 12 to 16 hours. In keeping with the policy of an 8-hr. working day, some states have recently conducted surveys for an 8-hr. period.

This paper marks the first attempt to determine the accuracy that can be expected from these less costly and time saving short-time surveys, and to determine if certain short-time surveys yield more accurate results than others. Time periods ranging from 1 hr. to 16 hrs. were selected for study. The interviews from all of the short-time surveys were expanded to a 24-hr. total and compared to the known 24-hr. volume interchange to each zone. Findings are based on origin and destination data collected at Opelousas and Alexandria, Louisiana and Lansing, Michigan. Factors that might influence results have been discussed. All results are empirical values.

The 16-hr. study, (6 am–10 pm), was found to be the most accurate. This study will provide data comparable to that found in the 24-hr. survey.

The 8-hr. period, (10 am–6 pm), supplied more reliable data than the 12-hr. the 10-hr., or other 8-hr. periods included in this study.

Results from the 12-hr., 10-hr. and other 8-hr. studies provided data considered stable enough to meet the requirements of the planning section.

When origin and destination surveys are conducted for periods of 4 hrs. or less, the accuracy of results is reduced to such a degree that recommendations based on these results may prove erroneous.

Maximum error limits occur in the lower volumes; as larger volume ranges are considered the error limits decrease.

Whenever the construction of new highway facilities is contemplated, many data are required by the planning section before final construction plans are completed. Traveling characteristics of the motoring public should be known in order to justify, economically and socially, the planning of improvements and the construction of street and highway systems. Origin and destination data serve as the key to make much of this information available to highway officials.

With the realization that the origin and destination survey is such an important instrument in planning, it is only natural that certain operating procedures be adopted as standard. These standard procedures are results of continuous studies conducted by the Public Roads Administration to determine what kind of information is necessary and the most favorable methods of obtaining such information. Each year new ideas are brought forth with the ultimate objective of obtaining as complete coverage as possible. An example of this is the comparatively recent development of a modified parking study in conjunction with an origin and destination survey. However, in all of these studies the paramount phase of the origin and destination survey remains the rural external study. It is with this rural external study that this paper deals.

Unless the origin and destination survey is conducted for the full 24 hours of a day consideration should be given to those hours which represent the passing of a majority of the traffic. Surveys will continue to be conducted for varying time periods dependent to a great extent upon the time and money available. In the past, origin and destination surveys conducted by different States generally cover periods of from 12 to 16 hours. The acceptance of the 8-hr. working day has resulted in some States staging these studies for an 8-hr. period. Although many conjectures have been advanced as to the most favorable time periods that should be in-

cluded in the survey, no factual data are available to verify them. A measure that would definitely establish a relationship between error limits that occur with various survey hours and traffic volumes would be a beneficial asset to the planning section as well as a basis for future recommendations in origin and destination studies.

The purpose, then, of the study reported in this paper was to determine the minimum time period in which a rural origin and destination survey, utilizing direct interviewing methods, can be conducted and results obtained that will compare favorably to the 24-hr. vehicular movement. To realize this objective two factors had to be determined:

1. The choice of time periods to obtain maximum efficiency.
2. The variation expected for varying station to zone interchange volumes.

DATA COLLECTION

The Louisiana Department of Highways conducted several rural origin and destination surveys. The direct interview method was used. At three of these stations, one in Alexandria, and two in Opelousas, the Department conducted studies for a 24-hr. period. All traffic moving in each direction was stopped simultaneously for interviews. The Michigan Highway Department[1] conducted 24-hr. origin and destination at several stations during the Lansing—East Lansing survey. Data from one of these stations were collected for this study.

The total interviews from these four stations form the basis of the results as shown in this paper.

TREATMENT OF DATA

At each station all inbound vehicles for a 24-hr. period were stopped and drivers interviewed to determine their destination. Short-time samples composed of certain pre-selected hours, and interviews for these respective hours as obtained in the 24-hr. survey, were expanded to the 24-hr. trip volumes to each zone. The known 100 percent volumes to each zone were the measures used in determining the accuracy .of expanded totals to that zone.

[1] Mr. J. Carl McMonagle, Director, Planning and Traffic Division, Michigan Highway Department, supplied data from this survey.

TRIP VERSUS TRAFFIC

All traffic was reduced to trip values and appears as such throughout this report. A trip may be considered the one-way travel from an origin to a destination.

A parking study conducted in conjunction with the rural origin and destination surveys in Louisiana provided a check on the accuracy of the inbound trips. For this reason the inbound trip interviews are analyzed.

Before presenting the findings an effort will be made to orient the reader and familiarize him with some of the more important variables that may exert an influence on the findings.

CHARACTERISTICS OF CITIES WHERE STUDIES WERE CONDUCTED

Opelousas, a town of 15,000, is located in south central Louisiana, and forms the cross roads of U. S. 190, an important east-west road, and State Route 5. No by-pass facilities are afforded with the result that all traffic, regardless of destination, enters the municipality. Opelousas was divided into three zones. The central business district was designated as zone two, with zones one and three representing residential areas.

Surveys at station 1, located on U. S. 190 at the east urban limits, and station 2, located on State Route 5 at the south urban limits, were conducted for 24-hr. periods.

During the 24 hr. of interviewing, data on 1,087 inbound trips were collected at station 1. Of this total, 42 percent had both origin and destination outside the study area, with 58 percent bound for some destination within the boundaries of the study. This clearly indicated the large percentage of trips entering station 1, that must pass through Opelousas with no desire to stop. Figure 1 shows by bands plotted to scale, the distribution of trips to internal zones and to external stations for all vehicles entering station 1 during a 24-hr. period.

This trend is carried out to some extent at station 2 where 903 inbound trips were interviewed. Thirty percent of these trips were classified as through trips with 70 percent bound for some destination within the urban limits. Figure 2 shows by bands plotted to scale the distribution of trips to internal zones and to external stations for all vehicles entering station 2 during a 24-hr. period.

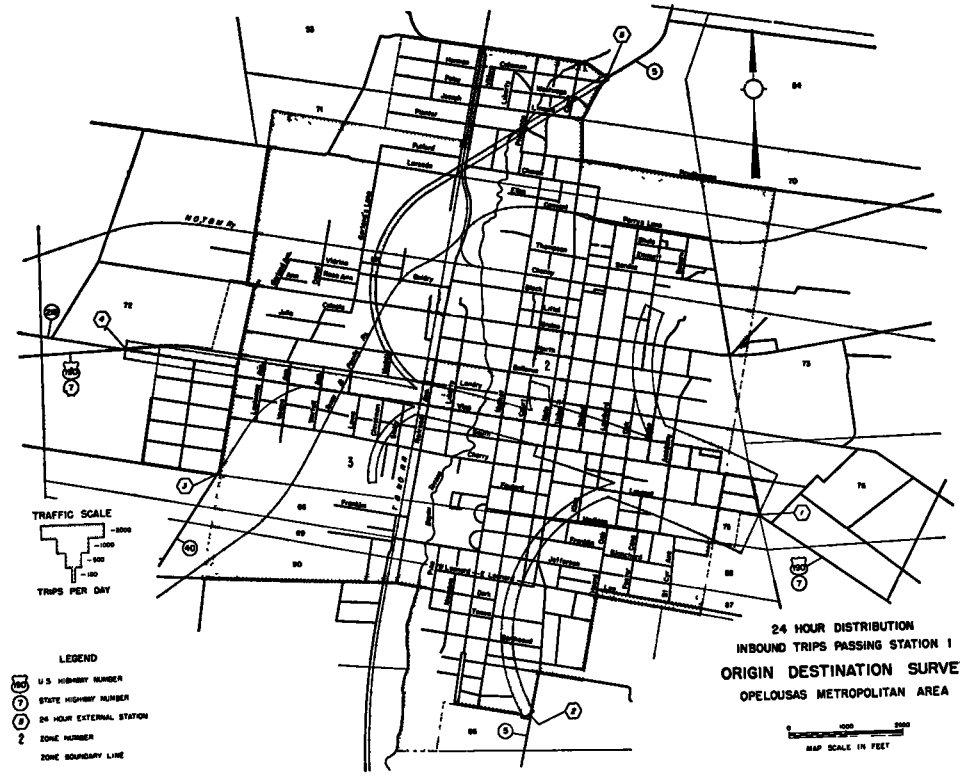

Figure 1

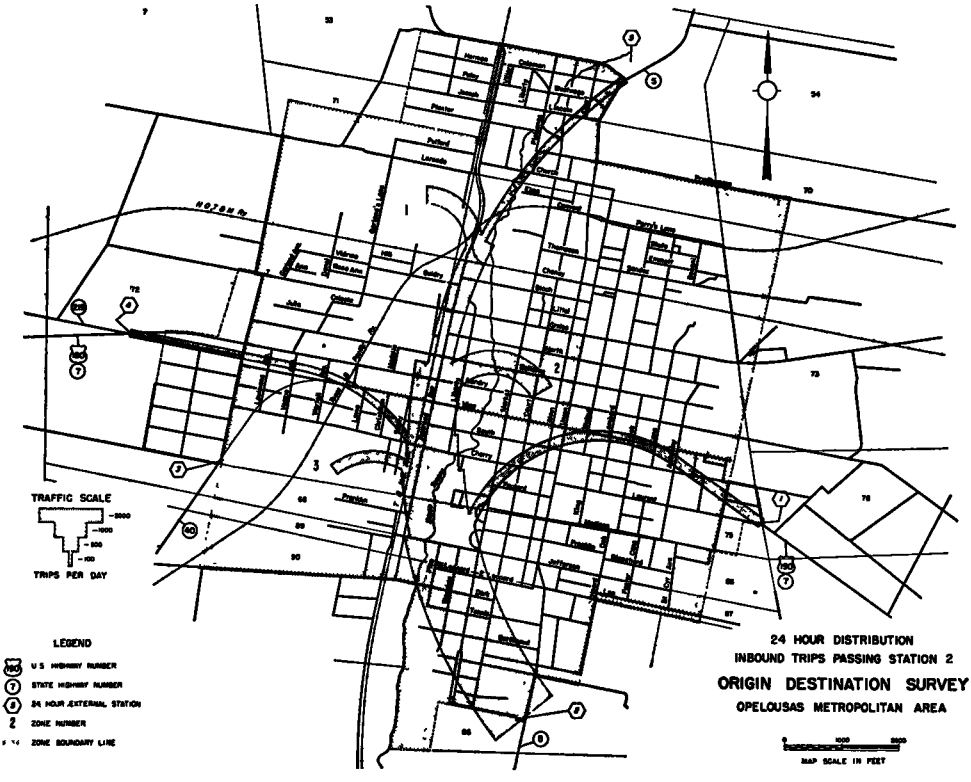

Figure 2

Alexandria, a town of 35,000 inhabitants, is located in central Louisiana. It is served by five main highways. An excellent by-pass is provided for all north-south traffic not desiring to enter the city. Of the ten origin and destination stations operated during this survey, only station 28, located on U. S. 165, was operated for 24 hr. The Alexandria urban area was divided into six zones. The central business district was designated as zone one, with the other zones being predominately residential.

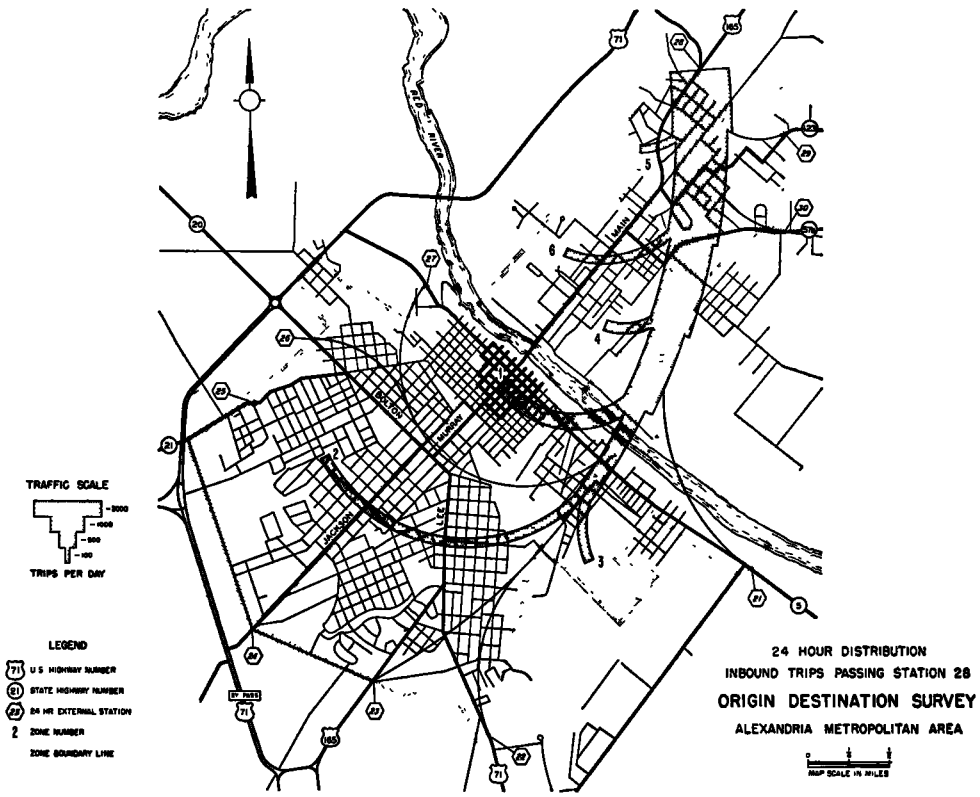

Figure 3

The influence of this by-pass produced a trip pattern for Alexandria that was quite different from the pattern observed in Opelousas. Of the 1,750 inbound trips interviewed at this station, and with nine other stations as possible destinations, only 8 percent of the trips were classified as through trips. The remaining 92 percent had a destination somewhere within the survey boundaries. Figure 3 shows by bands plotted to scale the distribution of trips to internal zones and to external stations for all vehicles entering station 28 in the 24-hr. period. Approximately 8 percent of the inbound trips by this station were through trips.

Lansing, a city of 110,000 inhabitants, is located in central Michigan. It is served by eight main highways. Only data from station 11 located on U. S. 127 were used in this study.

HOURS SELECTED FOR STUDY

Different hours or combinations of hours will produce results varying in accuracy. Since it was impossible to include all hours or all possible combinations of hours for analysis in this study, a most important consideration was the hours to be selected. The logical time to collect short-time survey-samples would appear to be during the periods of greatest traffic movement. This would re-

sult in the largest number of interviews being collected in the shortest possible time. Initially, hours that have been generally accepted as satisfactory in current origin and destination surveys were selected for study. They ranged from a maximum of 16 hr. to a minimum of 1 hr., as indicated in Table 1. It is pointed out that an effort was made to include either the morning or afternoon peak hour in each study hour group.

EFFECT OF TRIP PATTERN ON TIME PERIODS SELECTED

A logical deduction would be that the largest number of interview samples collected would yield the greatest accuracy when expanded. From this it would seem a fair assumption that the 16-hr. survey would produce more stable results than a 10-hr. survey, and the

TABLE 1

Number of Hours Studied	Hours Included in Study
16 hours	6 am to 10 pm
12 hours	6 am to 6 pm
10 hours	8 am to 6 pm
8 hours	6 am to 2 pm
8 hours	8 am to 12 n–2 pm to 6 pm
8 hours	10 am to 6 pm
4 hours	2 pm to 6 pm
4 hours	8 am to 12 n
3 hours	peak hour plus hour on either side
1 hour	peak hour

results of a 1-hr. survey would be expected to show little accuracy. If this proved true, then the results of any 8-hr. survey would yield like results providing the total number of interviews composing the sample was the same.

This would completely ignore the influence of the trip pattern. The character of traffic is such that interviews collected during different hours, when expanded, will give widely varying results. For example, during some hours of the day the majority of the vehicles will have destinations within the central business district; for other hours, the interviews may consist wholly of through trips or trips to residential areas.

With such diversified characteristics of trip patterns exerting their influence, it is quite possible that surveys staged for a few hours will produce more accurate results than a similar survey conducted over a long time period. This should definitely favor the stability found in some surveys, of say 8 hr., and conversely, this should have an unfavorable effect on others.

EFFECT OF TRIP PATTERN ON DIFFERENT INTERCHANGE VOLUMES

In the same manner, it seems only natural to expect the greatest accuracy to be found in long time samples containing the largest interchange volumes. But would this mean that large volume interchanges expanded from short-time samples (4 hr. or less) would show little accuracy, or would results be accurate regardless of the size of the sample? In what interchange volume ranges would this trend toward stability reach a leveling off point and produce results that would be consistently high?

METHOD OF PRESENTING FINDINGS

Instead of plotting the percent error for each observed volume interchange, a volume range of 100 was substituted. Errors for volumes falling within this 100 range were plotted at midpoint for that range. In this manner, errors occurring in the volume range 100 to 200 appear as errors for volumes of 150. The distance each sample-results appear above or below a base line (this base line being the 100 percent known values) is a direct measure of the accuracy obtained for that sample. Cognizance is taken of the fact that grouping of findings in range limits tends to cause some loss in the accuracy of the interpretation of the results. A method depicting all results as related to all volumes would be preferable. However, the lack of sufficient observations in all volumes makes this an impractical solution.

FINDINGS

Sixteen-Hour Results (6 am–10 pm). The results obtained from this 16-hr. period were found to be the most accurate. The greatest error noted for any volume interchange was 13 percent, (see Fig. 4). However, this occurred in the smallest volume group. As volume groups increased, a greater degree of accuracy was obtained. Results obtained in this 16-hr. period should prove accurate enough to satisfy requirements of the planning section.

Twelve-Hour Results (6 am–6 pm). The

results of the 12-hr. study, (see Fig. 5), indicates the decrease in accuracy that can be expected with a decrease in study hours. The maximum error of 28 percent noted here occurs

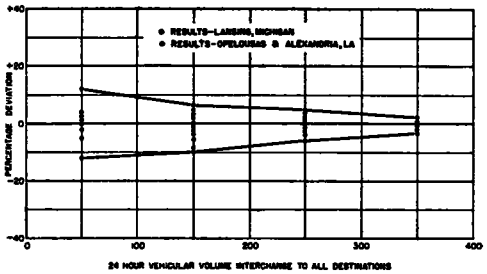

Figure 4. Percent Deviation Noted when 16-Hour Interviews (6 a.m.–10 p.m.) Are Expanded to 24-Hour Totals

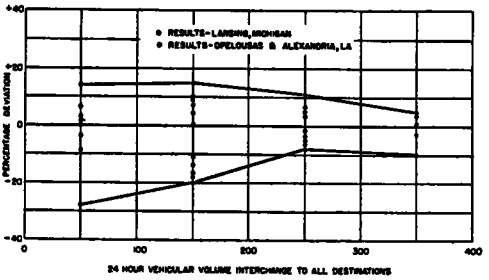

Figure 5. Percent Deviation Noted when 12-Hour Interviews (6 a.m.–6 p.m.) are Expanded to 24-Hour Totals

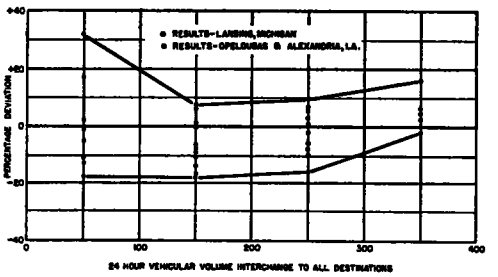

Figure 6. Percent Deviation Noted When 10-Hour Interviews (8 a.m.–6 p.m.) are Expanded to 24-Hour Totals

in the smaller volumes with a trend toward stability noted as the larger volumes are studied.

Ten-Hour Results (8 am–6 pm). Figure 6 shows the greatest variation occurring in the 10-hr. study to be 32 percent. Although this is only 4 percent greater than the maximum error noted in the 12-hr. study-results it is significant that the error in the greatest volume studied is 17 percent, or over three times as great as that found in the 16-hr. results. However, results of this time period compare favorably to those of the 12-hr. study.

Eight Hour Results (6 am–2 pm). Figure 7 shows the results obtained from an 8-hr. study which included the morning peak hour. The accuracy pattern noted here fluctuates a great deal more than that observed in the

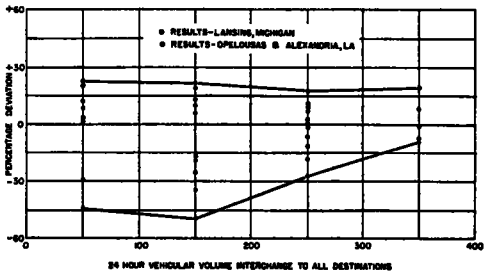

Figure 7. Percent Deviation Noted When 8-Hour Interviews (6 a.m.–2 p.m.) Are Expanded to 24-hour totals

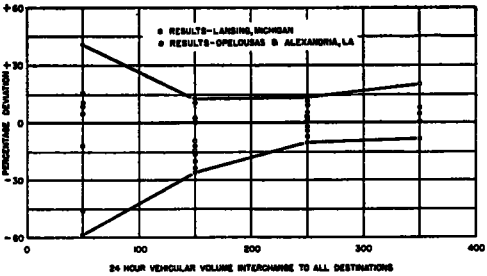

Figure 8. Percent Deviation Noted When 8-Hour Interviews (8 a.m.–12 m.) (2 p.m.–6 p.m.) are Expanded to 24-Hour Totals

previous studies. The trend toward stability in larger volumes is also present here. However, results in all volumes studied show some decrease in accuracy.

Eight Hour Results (8 am–12 n and 2 pm–6 pm). The morning and afternoon peak hours are included in this 8-hr. study. Some trend is noted toward stability as larger volumes are studied (See Fig. 8). However, the maximum error of 21 percent in the 300 to 400 volume range would seem to indicate that these figures are approaching the limits of accuracy that could be accepted by a planning section.

Eight Hour Results (10 am–6 pm). Knowledge of the trip pattern and the ability to capitalize on this knowledge to obtain desired results are indicated by a study of the stability found in this 8-hr. study. Figure 9 shows the maximum error which occurs in the lower volume range to be 44 percent. However, as the other volumes are studied more stability is noted. This becomes increasingly apparent as the plotted results become more closely grouped around the 100 percent base line. The most significant feature of this 8-hr. study is the low error limits that are found in all but the smallest volume ranges. Although the number of interviews comprising each 8-hr. study is practically the same, the results of the 10 am to 6 pm survey provide far more stable data.

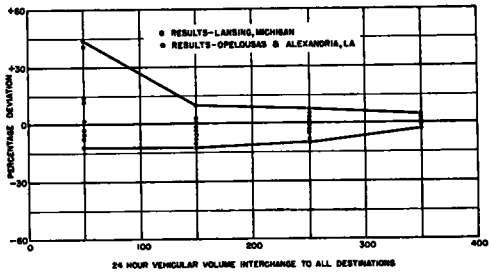

Figure 9. Percent Deviation Noted When 8-Hour Interviews (10 a.m.–6 p.m.) are Expanded to 24-Hour Totals

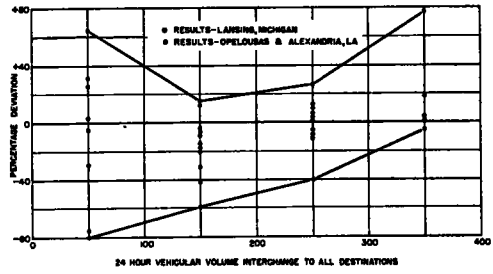

Figure 10. Percent Deviation Noted When 4-Hour Interviews (8 am—12 m) are Expanded to 24-Hour Totals

Four Hour Results (8 am–12 n). As the study hours are decreased, there is a corresponding reduction in the accuracy of the data. Figure 10 shows the greatest deviation in this 4-hr. study to be 80 percent, and it occurs in the smaller volumes. However, the important fact here is the magnitude of the error noted in the larger volumes. Even the minimum error of 40 percent is considered too great to prove of value in planning.

Four Hour Results (2 pm–6 pm). This study was conducted to include the afternoon peak hour. An examination of the results, (see Fig. 11), shows them to be superior to those obtained in a morning study. Again the trend toward stability is noted when considering the larger volumes. In this study the results are not grouped around the 100 percent line, but rather seem to be scattered over the entire area.

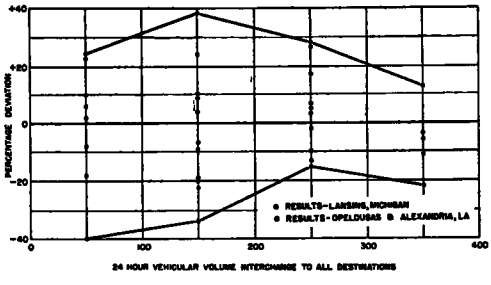

Figure 11. Percent Deviation Noted When 4-Hour Interviews (2 pm–6 pm) are Expanded to 24-Hour Totals

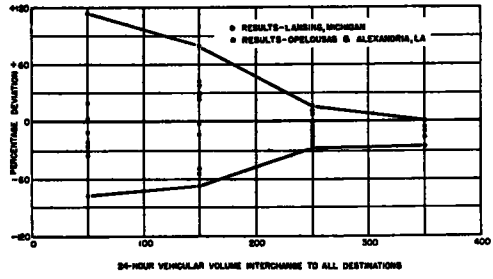

Figure 12. Percent Deviation Noted When 3-Hour Interviews (Peak Hour Plus Hour on Either Side) are Expanded to 24-Hour Totals

Three Hour Results (peak hour plus hour on either side). The results of this 3-hr. study (Fig. 12) show an even greater percentage error than that noted in the 4-hr. study. The same general trend toward stability found in larger volume ranges is present in these results.

One Hour Results (peak hour). Figure 13 depicts the results for an origin and destination study staged for a peak hour. Even though the maximum error is 80 percent, it is interesting to note that the results of this 1-hr. study are as reliable as the results ob-

tained from the 3-hr. and the 4-hr. studies. However, the results of all the studies conducted for less than 8 hr. are subject to large maximum error limits and, as such, should be avoided.

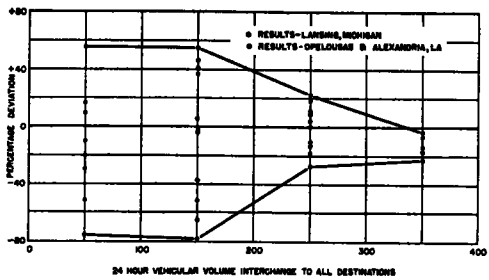

Figure 13. Percent Deviation Noted When 1-Hour Interviews (Peak Hour) are Expanded to 24-Hour Totals

CONCLUSIONS

1. A 16-hr. origin and destination study will provide data comparable to that found in a 24-hr. study.

2. An 8-hr. study, (10 am–6 pm), supplies more reliable data than studies conducted for the 12-hr. period, the 10-hr. period, and other 8-hr. periods included in this study.

3. Although the results collected from other studies of 8 hr. to 12 hr. were not as stable as the 8-hr. period (10 am–6 pm), the results from these studies can be considered satisfactory.

4. Results of the peak hour study prove to be as reliable as results obtained from 3- and 4-hr. studies.

5. When origin and destination surveys are conducted for periods of 4 hr. or less, the accuracy of the results is reduced to such a degree that recommendations based on these results may prove erroneous.

This paper does not set forth any limits in which to conduct surveys, but rather presents the findings as they actually occur. It is felt that these findings will be a helpful guide in determining how many hours and which hours should be included in a rural external origin and destination survey.

DISCUSSION

H. G. VAN RIPER, *Pennsylvania Department of Highways.* In Pennsylvania we have been conducting a State-wide truck survey and it has been found that a considerable volume of the heavy truck traffic does not start to roll over the highways until after dark. In fact, in a number of the night-hour-periods the volume of truck traffic exceeds the passenger car traffic. The reason for this heavy truck traffic during the night hours is not apparent, unless it be that trucks can make better time because of less traffic on the roads.

Another reason has been advanced, that the 45,000 lb. gross weight limit in Pennsylvania may not be as much of a trade barrier during the night hours as during the daylight hours.