AN EVALUATION OF
THE MOVEMENT OF 14-FOOT WIDE
MANUFACTURED HOUSING UNITS IN VIRGINIA

REPORTED TO

THE GOVERNOR AND

THE GENERAL ASSEMBLY OF VIRGINIA

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AN EVALUATION OF THE MOVEMENT OF 14-FOOT WIDE MANUFACTURED HOUSING UNITS IN VIRGINIA

A Report to the Governor and General Assembly of Virginia

by

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Cheryl W. Lynn, Research Analyst
Jeffrey A. Spencer, Graduate Legal Assistant
Bernard J. Reilly, Graduate Legal Assistant
and
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(The opinions, findings, and conclusions expressed in this report are those of the authors and not necessarily those of the sponsoring agencies.)

Virginia Highway & Transportation Research Council
(A Cooperative Organization Sponsored Jointly by the Virginia Department of Highways & Transportation and the University of Virginia)

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Wayne S. Ferguson served as project coordinator and supervisor for the study. Questions concerning the report may be directed to him at the
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COMMONWEALTH of VIRGINIA

DEPARTMENT OF HIGHWAYS & TRANSPORTATION
1221 EAST BROAD STREET
RICHMOND, 23219

December 16, 1976

The Honorable Mills E. Godwin, Jr.
Governor of Virginia
Richmond, Virginia 23219

Dear Governor Godwin:

In accordance with House Joint Resolution No. 41, I am pleased to transmit herewith the results of the study of the movement of 14-foot wide manufactured housing units. At my request, and with the concurrence of the several agencies and organizations involved, the study was conducted by staff members of the Virginia Highway and Transportation Research Council. The Council staff was assisted by a project steering committee composed of representatives from each of the agencies and organizations named in the resolution. The steering committee met six times during the course of the project and offered helpful suggestions and comments to the staff throughout the study period.

The evaluation included an analysis of traffic and safety data collected during the movement of 12 and 14-foot wide housing units on 3,782 miles of Virginia highways, and a motorist opinion survey. Generally, in terms of the safety and convenience of the motoring public, no major differences were found between the traffic and safety characteristics of 12-foot units and those of 14-foot units.

This report is being presented to the Highway and Transportation Commission at its meeting of December 16, 1976. It is anticipated that the members of the Commission will study the report and consider the matter at their January 20, 1977 meeting.

Respectfully submitted,

John E. Harwood, Commissioner

cc: Honorable Wayne A. Whitham
Members of the General Assembly

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ACKNOWLEDGEMENTS

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Wayne S. Ferguson served as project coordinator and directed the research activities. Martin R. Parker, Jr. was the principal investigator and participated in all phases of the project with emphasis on the design, data collection, and analysis of the traffic and safety field data. Cheryl W. Lynn designed the motorist opinion survey and authored the sections of the report pertaining to motorist interviews and accident analysis. Jeffrey A. Spencer analyzed the responses to the questionnaire sent to other states and prepared the section on regulations. Bernard J. Reilly interviewed officials of adjacent states and was responsible for the discussion of the information obtained in the interviews. John W. Reynolds assisted with traffic and safety data collection, reduction, and analysis, and coauthored that section of the report.

Special acknowledgement is due W. D. Glauz, B. M. Hutchinson, and D. R. Kobett of the Midwest Research Institute. Their report entitled "Economic Evaluation of Mobile and Modular Housing Shipments by Highway" provided guidance throughout the design and developmental phases of this research.

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ABSTRACT

In response to House Joint Resolution #41, an evaluation of the movement of 14-foot wide manufactured housing units was conducted on Virginia highways. The purpose of the study was to provide information concerning the transportation characteristics of wide housing units by highway which, along with other data such as economic and societal factors, could be used by decision makers to determine whether or not 14-foot wide units should be allowed on the highways in Virginia. The study was conducted with the guidance of a steering committee composed of representatives of the Housing Study Commission, the Office of Housing, the Highway Safety Division, the Department of State Police, the Division of Motor Vehicles, the Department of Highways & Transportation, and the manufactured housing industry. The evaluation included a literature review, a questionnaire designed to obtain information on the wide load practices and experience in other states, personal interviews with enforcement and transportation officials in states adjacent to Virginia, an analysis of traffic and safety data collected during the movement of 12- and 14-foot wide housing units on 3,782 miles of Virginia highways, and a motorist opinion survey. Generally, in terms of the safety and convenience of the motoring public no major differences were found between the traffic and safety characteristics of 12-foot units and those of 14-foot units.

SUMMARY OF FINDINGS

1. A review of the literature indicated that 43 states permit the movement of 14-foot wide housing units; however, little research has been conducted to determine the effect of these units on other traffic. The literature survey indicated the need for a comprehensive evaluation of the movement of over-size housing units over highways.

2. Responses to a survey questionnaire showed that 38 of the 43 states that allow the movement of 14-foot wide units regulate the movement by issuing single trip permits. There was very little indication from the states that 14-foot loads created safety problems; however, little data on the subject are available.

3. Most of the state highway and transportation officials personally interviewed in five states adjacent to Virginia felt that the movement of 14-foot housing units created safety hazards, but they did not have data to support their opinions.

4. An analysis of the speed and volume data collected on 3,782 miles of Virginia highways indicated that the 12- and 14-foot housing units were evaluated under similar traffic conditions.

5. The traffic volume data suggested that there were few vehicle-load interactions on interstate, four-lane divided, and secondary facilities; however, a higher number of interactions occurred on four-lane undivided and two-lane roads. The high number of interactions on four-lane undivided highways can be attributed to the urban location of test sections.

6. No statistically significant differences were found between the mean running speeds of 12- and 14-foot units on the highway systems studied.

7. The drivers of some firms strictly complied with the speed limits imposed on wide loads, while the drivers for other companies frequently exceeded the speed limits.

8. A preliminary analysis of speed, volume, impedance, and conflict data suggested that the safety and convenience of the motoring public could be enhanced if the wide load speed was close to the mean speed of the traffic stream.

9. Fourteen-foot wide units were found to produce significantly greater vehicle displacements than did 12-foot units. In meeting or passing other vehicles, a 14-foot unit used the shoulder more frequently than did a 12-foot unit.

10. On four-lane undivided highways, motorists passing 12- and 14-foot units crossed the double yellow line and encroached on the opposing traffic lane.

11. Wide housing units traveling on traffic lanes less than 12 feet wide used the shoulder when meeting other traffic. Also, other vehicles frequently used the shoulder when meeting wide loads on narrow roads.

12. There was a tendency for 14-foot units to encroach into the adjacent traffic lanes more frequently than did 12-foot units; however, the difference was significant for only the interstate and two-lane primary highways. On the interstate facilities the difference can be attributed to narrow structures. On two-lane primary highways encroachment was attributed to narrow structures, narrow pavement and shoulders, and sharp curves.

13. On narrow two-lane facilities 12- and 14-foot units continuously encroached into the adjacent lane.

14. There were no statistically significant differences in the total impedance times (delay to traffic) or queue sizes created by 12- and 14-foot loads.

15. Queuing caused by wide loads occurred frequently on two-lane primary highways.

16. No significant differences were found between the times required for vehicles to pass the 12-foot as compared with those required for the 14-foot units.

17. There were no significant differences between the times required by the 12- and the 14-foot units to pass other vehicles.

18. Maneuverability problems were encountered on narrow roads by both the 12- and the 14-foot wide loads; however, the problems were more frequent with 14-foot units. The major cause of the increased problems for the 14-foot units was the low clearance of the units.

19. There were violations of permit regulations with both 12- and 14-foot units; among the most frequent were speeding and improper use of escort vehicles.

20. Substandard escort vehicle operations were commonplace during the study, especially on two-lane highways.

21. Use of the traffic conflicts technique to evaluate the accident potential of wide loads indicated that there were no significant differences between traffic conflicts observed during the movement for the 12- and the 14-foot loads.

22. The traffic conflicts data indicated that the greatest number of conflicts occurred on two-lane primary facilities.

23. Several safety incidences, e.g., offset loads, unbalanced loads, and wheel failures, were observed during the tests.

24. The results of a motorist opinion survey indicated that the respondents perceived no significant differences between the 12- and 14-foot wide housing units as sources of delay or as safety hazards.

25. An analysis of state permit regulations indicated an absence of uniformity in the regulations used by the states for governing the movement of 14-foot wide loads.

CONCLUSIONS

The results of an evaluation of the movement of oversized manufactured housing units on 3,782 miles of Virginia highways indicated no major differences between 12- and 14-foot wide units in terms of safety and convenience to the motoring public. An analysis of the traffic and safety data collected indicated no statistically significant differences between 12- and 14-foot wide housing units in terms of average running speeds, delays to traffic, vehicle passing times, and accident potentials as measured by the traffic conflicts technique. Statistically significant differences were found between 12- and 14-foot wide units in terms of vehicle displacements and encroachments due to narrow structures and narrow pavement.

The movement of wide housing units was found to be most favorable in terms of the safety and convenience of the public on interstate and four-lane divided highways. The safety of the motoring public would be enhanced if wide load movements were made on these facilities with as little movement as possible being made on narrow two-lane roads.

The study data indicate that there is a need to amend the current regulations governing the movement of wide loads; specifically, the speed limits on interstate and four-lane divided highways and the use of escort vehicles on the two-lane facilities. As recommended by the project steering committee, a special committee composed of representatives of the Department of Highways and Transportation, the Division of Motor Vehicles, the Department of State Police, the Highway Safety Division, and industry should be formed to revise the existing regulations on the movement of wide loads to further enhance the safety of the motoring public.

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INTRODUCTION

During the past 20 years manufactured housing has played an increasingly important role in providing adequate housing for Americans. During the current economic recession the number of housing starts has decreased due to the rising cost of land, labor, building materials, and financing. To meet the present and future need for housing, manufactured housing units are becoming an increasingly attractive alternative to conventional site-built housing.(1)

As consumer needs for economical housing that provides living space comparable to that of site-built housing have increased, the widths of manufactured units have also increased. Prior to 1956, 91% of all mobile homes manufactured were 8-foot wide.(2) By Virginia statute, 8-foot units can legally be transported with no special restrictions or safety precautions.(3) By 1958, 10-foot units were replacing the 8-foot units. As the 10-foot unit exceeded the 8-foot legal width limitation, the Virginia Highway Commission imposed safety restrictions on the movement of these extralegal width units for the safety of the traveling public and to prevent damage to the highway system. In 1962, 12-foot units began replacing the 10-foot units. In December 1968, the Virginia Highway Commission adopted a policy permitting the transportation of 12-foot units with special safety precautions.(4) By 1968, 8 states permitted the movement of 14-foot wide housing units. As shown in Figure 1, since 1968 the number of states that authorize the movement of 14-foot units has rapidly increased. Currently 43 states allow the movement of 14-foot units on their highway systems. The 7 states that don't are California, Hawaii, Florida, Georgia, South Carolina, North Carolina, and Virginia.

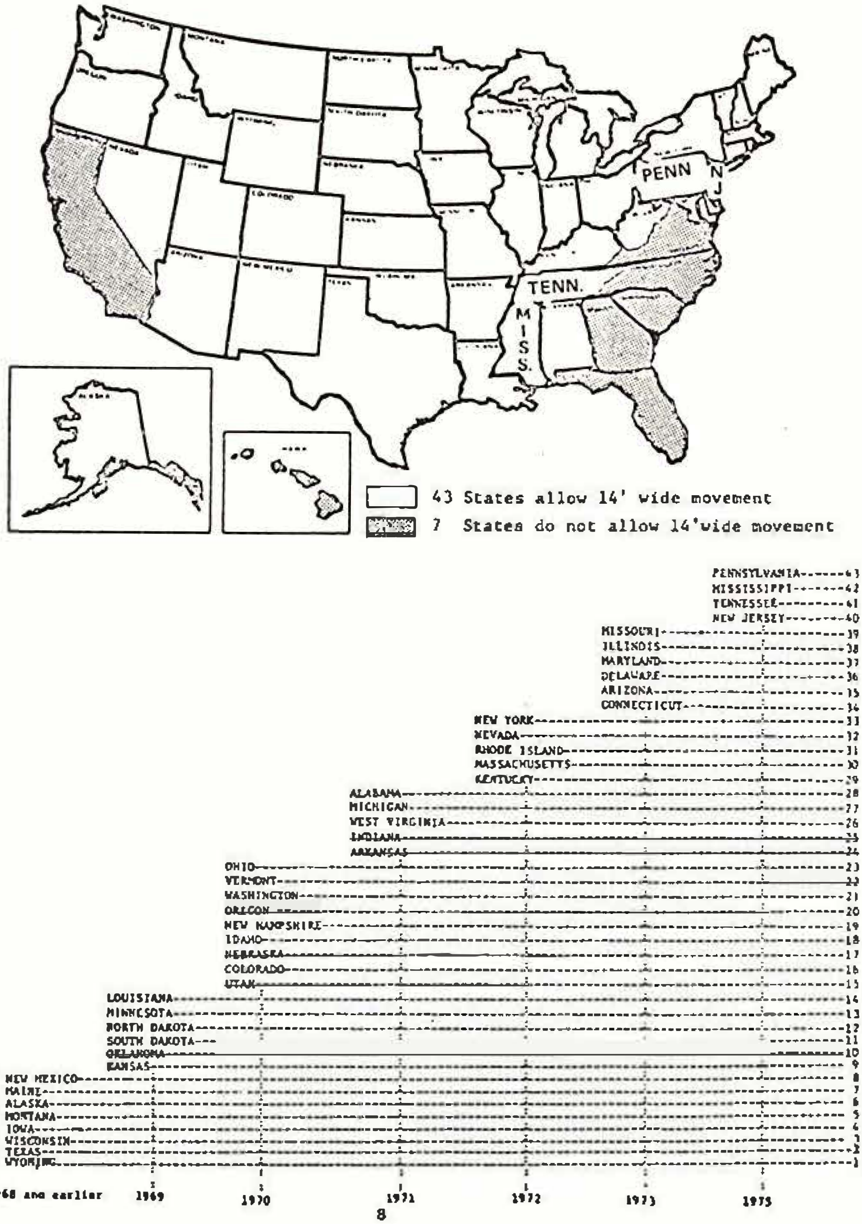

Figure 1. List of states permitting the movement of 14-foot wide housing units in order of authorization. (Based on data from Manufactured Housing Industry, Reference 6.)

Because of changing economic conditions and housing needs, the Florida Department of Transportation recently implemented a program to reevaluate its long-standing position against the movement of 14-foot wide housing units.(5) The Florida program consists of studies of the movement of 14-foot wide units that are being allowed to be transported under special permit regulations.

In its 1975 report to the Governor and General Assembly of Virginia, the Virginia Housing Study Commission endorsed the transportation of 14-foot wide housing units on Virginia highways.(1) The reasons for the Commission's endorsement were to (1) provide economical and adequate housing for the state's growing population, (2) provide parity for the Virginia manufactured housing industry in its competition with the industries of other states, and (3) attract new industries and encourage plant expansion to create more job opportunities and provide additional tax revenues for Virginia governments.

On January 29, 1976, House Joint Resolution No. 41 was introduced in the Virginia General Assembly. The purpose of the resolution was to request that the Department of Highways and Transportation and the Division of Motor Vehicles "... authorize procedures to allow the transportation of fourteen foot wide mobile and modular housing units on the highways of the Commonwealth, with proper safety precautions." The resolution was supported by the Housing Study Commission, the Office of Housing, and the manufactured housing industry, who cited the need to provide adequate housing for Virginia citizens and the adverse effect the restriction on the movement of 14-foot units would have on the economy of the Commonwealth. Opponents of the resolution included the Department of Highways and Transportation, the Highway Safety Division of Virginia, and the Department of State Police. The opponents suggested that as the 14-foot units were wider than the standard 12-foot traffic lanes, they would encroach on the adjacent traffic lane and shoulder and create safety hazards for other Virginia motorists. Although the measure passed the House, the Senate was divided on the issue. While 43 states permitted the movement of 14-foot wide housing units, only a few studies had been conducted on the subject. These studies were limited in methodology and scope (for further details see the Literature Survey section of this report) and a complete evaluation of the effects of 14-foot wide loads on other traffic and the highway system was not available for the legislators to use as a basis for decision. After compromise and amendment, on March 13, 1976, the General Assembly passed House Joint Resolution No. 41 as shown in Appendix A.

The engrossed resolution requested the Department of Highways and Transportation to conduct a study to evaluate the movement of test 14-foot wide mobile and modular housing units over the highways of the Commonwealth. The resolution requested the Department to conduct the evaluation together with the Housing Study Commission, the Office of Housing, the Division of Highway Safety, the Department of State Police, the Division of Motor Vehicles, and representatives from the manufactured housing industry. For the purpose of the evaluation, the manufactured housing industry was requested to transport 14-foot units from Virginia plants to destinations in other states. The test units were to be moved on highways selected by the Department in cooperation with the industry. As part of the study, films were to be taken of the movement of 14-foot wide housing units and selected motorists passing the units were to be interviewed. The Department was requested to summarize the results of the study and make a final report to the Governor and General Assembly by December 1, 1976. As a result of meetings and discussions between officials of the Virginia Department of Highways and Transportation and other agencies and interest groups named in House Joint Resolution No. 41, the Virginia Highway and Transportation Research Council was designated to perform the evaluation. A project steering committee composed of members of the agencies and interest groups was formed to provide assistance and guidance. This report is the result of the study conducted by the Research Council.

PURPOSE

The purpose of the study was to evaluate the movement of 14-foot wide mobile and modular housing units on the highways of the Commonwealth. As mentioned in the INTRODUCTION, although 43 states permit the movement of 14-foot wide housing units, little research has been undertaken to evaluate the effects of wide loads on other traffic and the highway system.

It should be emphasized that the study was specifically designed to determine the operational and safety effects associated with the transportation of 14-foot wide housing units. This report and the 16-mm color film obtained during the movement of the test units provide a summary of the research. It was not the purpose of the study to assess the advantages and disadvantages of 14-foot wide housing units and formulate a decision regarding whether or not the units should be transported on Virginia highways. The study was intended to provide information concerning the transportation aspects of wide housing units which, along with other data such as economic and societal factors, must be weighed by decision makers to determine whether or not 14-foot wide loads should be allowed on the highways in Virginia.

The specific objectives of the study were to —

1. identify the type and frequency of operational and safety factors that occur during the transportation of 14-foot wide housing units, including factors that affect the traveling public, the wide load, and the highway system;

2. determine if significant differences exist between the transportation characteristics of 12- and 14-foot wide housing units on Virginia highways;

3. examine wide load practices and experiences in other states; and

4. assess public opinion of wide load movement.

SCOPE

The research required to address the project objectives was broad. The scope of the study was limited, however, primarily because of time constraints. When the research working plan was adopted on June 28, 1976, only four and one-half months were available for research as the draft report was due on November 15, 1976, in order for the report to be submitted to the Governor and General Assembly on December 1, 1976.(7) A further time restriction was occasioned by a one-month delay in the collection of the field data to allow training of the data collection team and to permit a sufficient number of manufacturers time to begin production of 14-foot wide test units. Collection of the field data began on August 16, 1976, and was completed in 8 weeks; data reduction consumed 3 weeks; and the analysis of the data, including report writing, was accomplished in only 2 weeks.

The restrictive schedule permitted only a broad overview of the characteristics of wide load movement and limited the number of basic relationships that could be developed in time to be included in this report. The time restrictions also limited the sample size for several variables, which made the formulation of conclusive results impossible in some cases. These limitations are discussed further in the ANALYSIS section of this report.

Because of the broad scope of the project, it is necessary to outline specific areas that are and are not addressed in this report. The activities included in the scope of the study are outlined below.

1. A state of the art literature review was conducted.

2. Information on wide load practices and experiences in other states was obtained through the use of a questionnaire.

3. Personal interviews were held with representatives of states bordering Virginia that permit movement of 14-foot wide housing units.

4. An analysis of empirical data collected during the transportation of 12- and 14-foot housing units on Virginia highways was made.

5. A motorist opinion survey was conducted by interviewing motorists who were observed to interact with 12- and 14-foot units.

6. The feasibility of conducting an analysis of accidents associated with wide loads was investigated.

7. A comparison was made between the regulations and safety precautions employed during the research period and the regulations employed by other states.

8. A 16-mm color movie was made to outline the study technique and summarize the significant findings associated with the movement of wide loads.

It should be reiterated that the stated purpose of the study was to evaluate the movement of 14-foot wide manufactured housing units on Virginia highways. As shown in Figures 2 through 4, the types of manufactured housing units included in the investigation were (1) mobile homes, (2) double-wide mobile homes, and (3) modular housing and industrial units. The mobile units typically are of wood and metal construction and are fully equipped to provide family living space, and quarters for banks, schools, and other facilities. As shown in Figures 5 and 6, the modular sections included in the study were composed of wood and wood by-products and were joined to provide a home or an industrial or school facility. It is important that the manufactured units included in the evaluation be properly identified because the study did not include manufactured units composed of structural steel, concrete, or similar materials. While these units could be confined to a 14-foot width for transportation to the job site, the length, height, weight and maneuverability characteristics of the loads could be significantly different from those of the manufactured mobile and modular sections described above. Thus, the findings given in this report do not necessarily apply for other types of industrialized units. Also, the study scope did not include other wide loads such as boats, tanks, and construction equipment. Other factors not included in the scope of the study are specified below.

1. An economic evaluation assessing the benefits to the manufactured housing industry and to the state of allowing the movement of 14-foot wide units was not made. The results of economic evaluations conducted in other states, as well as a January 1976 study made in Virginia,[8] indicate that there would be benefits to the industry and the Commonwealth.

2. The study did not include a comprehensive statewide analysis of accidents involving wide loads. The existing traffic records system does not permit the identification of wide load accidents, and a manual summary of the data could not be accomplished within the time limitations of the project. As discussed further in the Accident Analysis section of this report, it is doubtful if a statewide accident analysis would have produced meaningful results.

3. It was anticipated in the research working plan that traffic and safety data would be collected for 8-foot loads and compared to similar data collected for 12- and 14-foot loads. Due to time limitations the 8-foot comparative data were eliminated from the scope of the project.

4. Regulations governing the movement of 14-foot test units during the study period were developed utilizing the existing 12-foot regulations as a guideline. Special emphasis was given to making the regulations compatible with those of states bordering Virginia. On the basis of a literature review, it appears that most of the regulations are based on historical development and have not been thoroughly investigated to ascertain if, in fact, they do enhance safety.(9) It was hoped that an investigation of the major test regulations could be conducted; however, this activity was not possible due to time limitations.

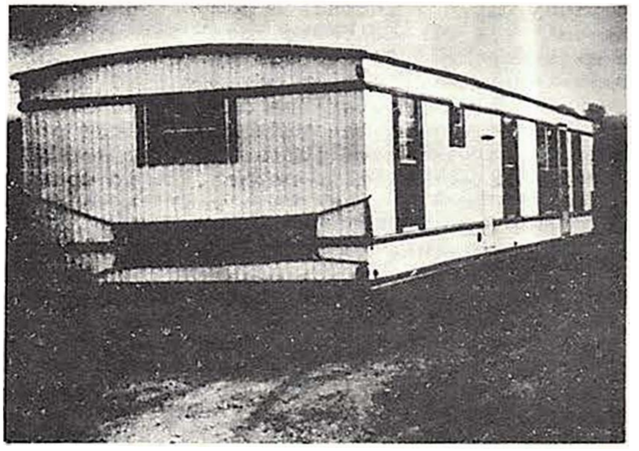

Figure 2. Typical 14-foot wide mobile home.

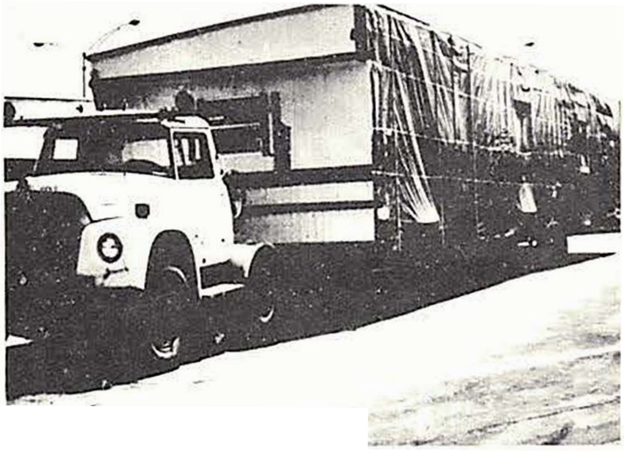

Figure 3. Typical 12-foot wide double-wide mobile home.

Figure 4. Typical 14-foot wide modular section.

Figure 5. Two modular sections joined to form top floor of home.

Figure 6. School designed to utilize 56 modular sections.

METHODOLOGY

The primary objective of House Joint Resolution No. 41 was to provide Virginia legislators with information that could be used to determine whether or not 14-foot housing units should be allowed on the state's highways. The resolution explicitly called for an evaluation of the movement of 14-foot wide units on Virginia highways, and specifically requested that the evaluation include the taking of movies of the movement of 14-foot units and interviews with passing motorists.

On June 22, 1976, the Virginia Housing Study Commission Committee on the Movement of 14-foot Wide Housing Units met with representatives of the Office of Housing, the manufactured housing industry, the Department of Highways and Transportation, and the Highway and Transportation Research Council to formulate and approve a working plan designed to meet the requirements of House Joint Resolution No. 41.(10) The committee approved the following method for conducting the evaluation:

1. A project steering committee consisting of representatives of the Housing Study Commission, the Office of Housing, the Highway Safety Division, the Department of State Police, the Division of Motor Vehicles, the manufactured housing industry, and the Department of Highways and Transportation was selected to provide project guidance and assistance.

2. The 14-foot units could only be sold and transported out of state. Intrastate movement and movement from one state through Virginia to another state were not permitted.

3. The 14-foot units would be transported on a single trip permit basis and the number of units transported was not restricted.

4. The 14-foot units could be transported during the period July 15 through December 1, 1976, for the purpose of evaluation. Continuance of movement beyond December 1 would depend on the results of the evaluation.

5. The study methodology outlined in the research working plan was approved.(7)

During the development of the research working plan, several methodological approaches were considered sufficient to meet the requirements of the resolution. It was apparent from a previous study that little information was available concerning the transportation of wide loads, including 14-foot housing units.(11) To provide a basis for evaluation, the methodology selected for the study required that data be taken for 12- (standard product) and 14-foot (product being evaluated) units. With this procedure, the transportation characteristics of the units could be analyzed and the differences compared for statistical and practical significance.

The study consisted of a survey of previous experience with 14-foot movement and an evaluation of the movement of 14-foot units on Virginia highways. The survey of previous experience included a literature review, a questionnaire sent to other states, and personal interviews with officials of states bordering Virginia that permit 14-foot movement. The evaluation of 14-foot units consisted of the collection of traffic and safety field data, a survey of motorist opinions, an accident analysis, and a review of wide load safety regulations. The procedures used to conduct the specific tasks of the evaluation are described below.

Literature Survey

A review of the literature was conducted to examine the state of the art of 14-foot wide movement. The literature survey was initiated through the services of the Highway Research Information Service. In addition, state governments, research agencies and industry officials were contacted to obtain copies of published and unpublished reports on studies relating to the movement of wide loads. The literature was compiled and is summarized in the ANALYSIS section of this report.

Questionnaire for Other States

Since 43 states allow the movement of 14-foot wide manufactured housing units, it was felt that information concerning their experience with wide load movement would be useful. Therefore, a questionnaire was designed to ascertain the experience of other states with regard to accidents, public complaints, other problems, and any benefits resulting from the movement of 14-foot units. The questionnaire was distributed to the officials in each state who had direct authority over the movement of 14-foot wide loads. A copy of this questionnaire and the accompanying cover letter appear in Appendix B. Respondents were asked to use the questionnaire to supply information concerning how wide load travel was originally approved in their states, how this travel was authorized, whether their recent experiences with wide loads had been good or bad, and how these experiences had changed their states' regulations. They were also asked to supply a copy of current regulations applying to the movement of 14-foot wide units along with copies of any studies of the topic conducted in their states. Those respondents not enclosing a copy of these regulations were contacted by telephone,while those persons not responding to the questionnaire were contacted by telephone and sent a second mailing of the survey materials. Once responses were received from all the states, the data were keypunched and computer tabulated. Hand tabulations of permit regulations were also performed.

Visits to Adjacent States

To obtain firsthand knowledge of the experience of 14-foot wide load movement, interviews were conducted with officials of the states of Kentucky, Maryland, Pennsylvania, Tennessee, and West Virginia. The interview team consisted of a representative from the Virginia Office of Housing, the state permit engineer from the Virginia Department of Highways and Transportation, and a representative from the Research Council. Each state was contacted several weeks before the interview and was asked to make available permit and enforcement personnel who were knowledgeable of wide load hauling.

The interviews were informal and lasted from 2 to 3 hours. The Research Council representative relayed a series of questions, generated by the principal authors of the study, that were not included in the written questionnaire or raised by the replies of the various states to the questionnaire. The observers posed questions to clarify answers as the interviews progressed, and at the end of each interview they asked any other questions they felt appropriate. The questions involved the following issues: informal studies made by the states but not reported in published documents, safety problems envisioned and realized, reasons for approving or denying permits, regulations deemed essential or useless, driver training requirements, regulation compliance rates, enforcement mechanisms and efficacy, citizen complaint mechanisms, scope of state transportation agency control and control by other state units, problems with road shoulders, road closings, and other inconveniences to motorists.

Traffic and Safety Field Studies

The primary objective of the study was to evaluate the movement of 14-foot manufactured housing units on Virginia highways. The procedure for conducting the field studies consisted of the phases discussed under the subheads below.

Test Regulations

On July 1, 1976, the Department of Highways and Transportation submitted a list of suggested regulations and safety precautions governing the movement of 14-foot wide test units to the manufactured housing industry. After comments were received from the industry, the test regulations were amended and approved by the Highway and Transportation Commission.

The regulations were based on those used in states that permit transportation of 14-foot wide loads. Special consideration was given to making the regulations compatible with those of states bordering Virginia.

Study Routes

In accordance with the provisions of House Joint Resolution No. 41, the routes chosen for study were selected in cooperation with the manufactured housing industry. In most cases, the test routes selected were those frequently used for the transport of 12-foot housing units because it was felt that should 14-foot wide units be permitted to travel in Virginia, their origins and destinations would likely be similar to those of 12-foot units. In order to make the study results applicable to most sections of Virginia, the specific study routes were chosen to provide a broad range of traffic, geometric, land use, and environmental characteristics.

During the test period (July 15 through December 1, 1976) 101 permits were issued for the movement of 14-foot housing units. Of the 101 permits issued, 82 were for units that were transported for sale out of state; 19 were issued specifically for study purposes, and were issued for routes designated by the Department and approved by the industry. During the 8-week data collection phase (August 16 through October 7, 1976) traffic and safety data were collected on 3,782 miles of Virginia highways. The distribution of the data collection effort by type of highway system is shown in Table 1. Almost 75% of the mileage studied consisted of interstate and four-lane divided facilities. In contrast, only 3% of the data were

TABLE 1

TRAFFIC AND SAFETY DATA COLLECTION SUMMARY

SYSTEM	12-FOOT LOAD NO. TRIPS	12-FOOT LOAD MILES	14-FOOT LOAD NO. TRIPS	14-FOOT LOAD MILES	TOTAL MILES FILMED	PERCENTAGE OF MILEAGE FILMED
Interstate	12	507.24	16	658.08	1165.32	30.8
Primary						
4-Lane Divided	30	795.04	34	830.79	1625.83	43.0
4-Lane Undiv.	7	76.90	9	102.33	179.23	4.7
2-Lane	27	312.50	33	381.80	694.30	18.4
Secondary	12	58.79	12	58.79	117.58	3.1
TOTAL	88	1750.47	104	2031.79	3782.26	100.0

collected on secondary routes. Based on experience gained during the study, it is felt that the study data are representative of current manufactured housing movement in Virginia. It is apparent that the basic pattern of travel chosen by the industry is to move wide housing units over the best highway systems available between the origin and destination. A typical wide load movement would encompass only short sections of secondary highways, usually near the point of destination. Thus the 3% of mileage studied on the secondary system is felt to be representative of the volume of wide loads on that system.

The 3,782 miles of travel shown in Table 1 were distributed on highways throughout the state. The only regions where wide load data were not collected were the area east of I-95 and the Eastern Shore. The project time constraints prohibited data collection in those areas; however, data collected on highways in Central and Southern Virginia represent typical conditions found in those regions. Thus, it is felt that the study results would be applicable to them.

Study data were also collected in urban areas. Major cities included in the evaluation were Richmond, Roanoke, Alexandria, and Martinsville. Smaller cities and towns studied were Collinsville, Clarksville, Rustburg, Boydton, and Brookneal.

The study routes were selected to provide a variety of geometrical and traffic conditions. For example, the interstate data were obtained from travel on I-64 over Afton Mountain, I-81 in the Shenandoah Valley, I-85 between South Hill and Petersburg, and the heavily traveled section of I-95 between Richmond and Washington, D. C.

Study Approach

To provide a comparative evaluation, data were collected on 12- and 14-foot units as they traveled on the study routes under similar traffic conditions. For example, one test route selected for study was Route 220 northbound between Martinsville and Roanoke. On a typical survey day, data were collected for a 12-foot unit in the morning and a 14-foot unit in the afternoon. The next day, data were collected for a 14-foot unit in the morning and a 12-foot unit in the afternoon. By alternating travel times of the test units, the population characteristics of interacting traffic should be made similar for both 12- and 14-foot units. By using the same road, environmental, geometrical, and land use characteristics were made constant for any given route. When test runs were completed for a given route, volume and speed data were statistically tested to determine if there was a difference between the mean volumes and mean speeds of the 12- and 14-foot wide loads. A finding of no difference between the variables was taken to mean that traffic conditions were not different for the units being tested. On some routes sample sizes were too small to allow a statistical comparison. In order to increase the sample size, data for those routes were combined with data taken on similar highway systems.

By using the same travel routes for 12- and 14-foot units, it was felt that any statistically significant difference in any of the variables relating to wide load movement could be attributed to the width of the load. The null hypothesis assumed no difference between the characteristics associated with 12- and 14-foot units. Acceptance of the null hypothesis was interpreted as suggesting that no statistical difference existed between the variables being tested, while rejection of the hypothesis suggested that a difference existed. In either case, the results were carefully examined to determine if other factors could have influenced the findings. Also, the statistical results were examined for practical significance.

Data Collection

The only study of wide housing units noted in the literature which included an extensive data collection effort was conducted by the Midwest Research Institute.(9) The primary objective of the Midwest Research investigation was to identify factors relating to safety, inconvenience, and costs involved in wide load movement. While the study identified several major aspects of wide load movement, many variables were not quantified and analyzed. The study, however, did provide a sound data collection technique that was modified for the Virginia study.

Data for the traffic and safety field studies were collected by a five-man crew utilizing photographic and manual techniques. Two observers were located in a vehicle approximately 1/4 mile ahead of the wide load (including pilot car); one observer rode in the cab with the driver of the load; and two observers were stationed in a vehicle located approximately 1/4 mile behind the wide load. The specific tasks of the team members are outlined below.

1. Lead driver

   (a) Team leader in charge of coordinating field data collection activities.

   (b) Operate lead car.

(c) Record opposing traffic volume on two-, three-, and four-lane undivided highways.

(d) Operate citizens band radio to notify rear vehicle operator of possible vehicle and load interactions.

2. Lead photographer

(a) Operate and perform maintenance on camera.

(b) Identify and maintain record of film used.

(c) Record the number of vehicles passing the load (traveling in the same direction as the load).

3. Observer in cab of wide load

(a) Complete wide load trip data form before departure.

(b) Record departure, arrival, and delay times, including the nature of causes for delays.

(c) Periodically record maximum speed of load and road and traffic conditions.

(d) Record incidences in which driver uses brakes to decelerate and note cause for deceleration (excluding deceleration for stop signs, traffic signals, and other traffic control devices).

(e) Record number of times wide load passes other traffic.

4. Rear driver

(a) Operate rear vehicle.

(b) Operate citizens band radio to communicate with lead vehicle.

(c) Update trip log.

(d) Record number of same direction vehicles interacting with load.

(e) Observe queue size, impedance, and passing times.

5. Rear photographer

   (a) Operate and perform maintenance on camera.

   (b) Identify and maintain record of film used.

   (c) Record queue size, impedance, and passing times.

Data collection was a coordinated effort between the Research Council, the Permit Office, the manufactured housing industry, and the data collection team. Prior to the collection of data on August 16, a 7-week schedule of activities was developed. Throughout the study, the schedule was constantly revised due to a variety of factors including the weather, shortage of drivers, last-minute changes in delivery schedules, permits lost or delayed in the mail, and vehicle breakdowns. These contingencies made daily communications necessary to assure the data collection team would have a test load available for study.

The activities during a typical data collection trip are described below.

1. The team arrived at the plant at 8:30 a.m. to prepare for departure at 9:00 a.m. The team leader contacted the traffic manager to identify the test load and driver.

2. As shown in Figure 7, the vehicle operators and the observer who rode in the cab of the wide load obtained the load dimensions and other pertinent data. During this period, the photographers prepared their cameras for filming. Prior to departure, the team leader read a checklist to assure the team was ready for data collection. Finally, the driver was contacted and details of the study route were discussed. Although it was obvious that the crew was recording the movement of the load, the driver was instructed to operate his vehicle as he would under normal circumstances.

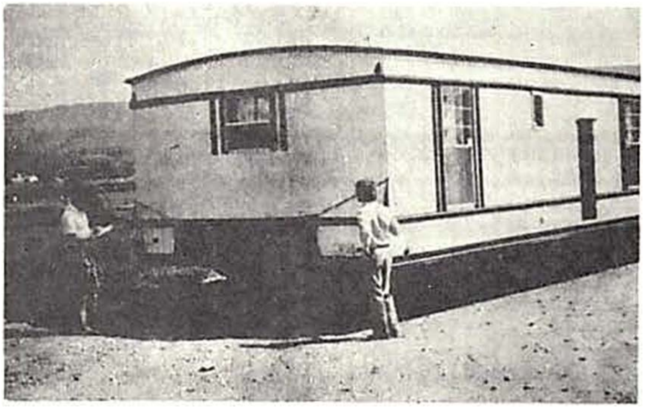

Figure 7. Data collection team recording load dimensions prior to departure.

3. Immediately prior to departure, the team leader checked with the crew to assure all data collection forms were in order for the trip. A complete assembly of the forms for a typical trip is given in Appendix C.

4. The team was also informed of the number of homogeneous roadway sections that would be encountered during the movement. The number of homogeneous sections was dependent on the nature of the route selected for study. For example, if movement consisted of travel exclusively on an interstate highway, only one homogeneous section was used. If the trip consisted of travel along a two-lane, four-lane divided, and interstate route, then three homogeneous sections were used. The purpose of segregating data collection by homogeneous sections was to evaluate the effects of wide load movement on various highway systems.

5. Once the trip began, the data collection effort was routine. In addition to performing their tasks as previously outlined, the team members were urged to record any unusual characteristic of the load, driver, or trip condition. The observers were requested to record all violations of the safety regulations committed by either the wide load driver or the pilot vehicle operators. At no time was the observer permitted to deny movement of a housing unit, regardless of any permit infraction.

6. During the trip the photographers filmed vehicle interactions in the vicinity of the wide load. The cameras were also activated when the housing units encroached on the adjacent traffic lanes, during travel through construction zones, and under other circumstances when the unit was outside the limits of the right-hand traffic lane and shoulder.

7. At the end of the trip, all data collection forms and exposed film were collected and filed for future use.

During the conceptual stages of the research, it was felt that the presence of the data collection vehicles and cameras would greatly influence the behavior of the wide load operator, the pilot vehicle operators, and the traveling public. During the test period several practice trips were made with the research vehicle at various intervals from the wide load. During these tests the citizens band radios were tuned to channel 19. By listening to the communications on the radio, the relative interest of the public in the research vehicles and cameras could be examined. Only a few persons with radios noticed the study team and relayed their findings to other motorists. Obviously the team and cameras did have some influence on passing vehicles, but it was felt the influence was minimal except on two-lane facilities. On these facilities, the rear research vehicle usually had to be maneuvered within 500 feet of the wide load assembly to maintain a view of the load. The presence of the research vehicle caused traffic approaching the rear pilot car to decelerate and form a queue behind the research vehicle. Thus, it was impossible to determine all rear end traffic conflicts that could normally be attributed to the wide load. It should be reiterated, however, that since the same bias was introduced for both 12- and 14-foot wide loads, the comparative methodology remains valid.

Another concern expressed in the developmental stage of the project was that the lead research vehicle might retard the normal speed of the wide load driver and influence the study results. Extensive practice sessions were held prior to actual data collection to determine if it were possible to maintain a headway that would not influence the wide load driver. The results of the experiments indicated that the lead driver could accurately judge the speed of the load through various roadway geometrics and continuously maintain a sufficient distance ahead of the load. The results of the data collected during the study also indicate that the lead car did not influence the speed of the wide load. For further details see the discussion on wide load speed in the ANALYSIS section of the report.

Equipment

The equipment used to conduct manual counts were stopwatches graduated to the nearest 0.1 second and mechanical counters. A 100-foot tape measure was used to measure the size of the wide load and towing unit.

The photographic data were recorded on color film with 16 mm cameras electrically powered by batteries. As shown in Figures 8 and 9, the cameras were secured on mounts especially designed for the study. The ease of operation of the cameras, including film changes that could be accomplished in less than 60 seconds, provided an excellent photographic record of the movement of the wide load. The purpose of filming the movement of the wide load from two directions was to maximize the number of observations and to provide better coverage of traffic occurrances. During the study, 294 rolls (1 roll = 100 feet) of film were taken.

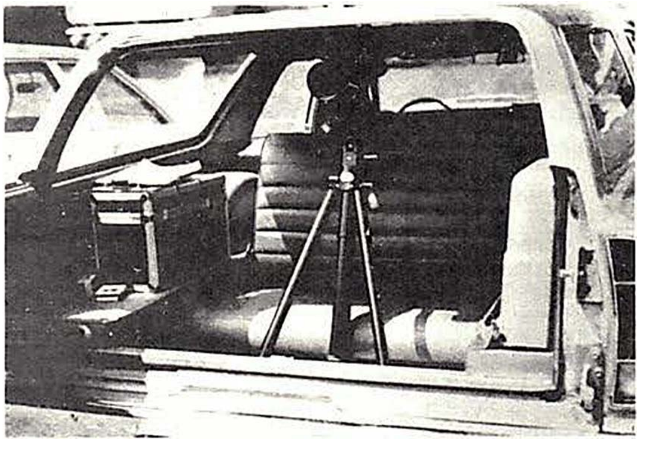

Figure 8. Camera in lead vehicle.

Figure 9. Camera in rear vehicle.

Figure 10. Communications between the data collection team were made with citizens band radio.

Data Reduction

In the interest of conserving time, several members of the data collection team were utilized in the data reduction process. The primary advantage of using the data collection team was that the team members were familiar with the variables being studied and required little training in reduction.

The film data were reduced with two LW Model 224-A photo-optical data analyzers having a variable speed advance and a stop action capability. The data reduction process was straightforward. Utilizing the experience gained by the team during data collection, a list of all observed and recorded traffic and safety variables was made. After each variable was identified, the data reduction technique needed for it was outlined. The variables were then subdivided into either manual or film reduction categories, and the necessary forms for data reduction were developed. A complete assembly of the data reduction forms is given in Appendix D.

Several procedures for reducing the film data were tested. The technique finally chosen was to assemble the eight-person data reduction team in one room and use two optical data analyzers to simultaneously project the view from the front and rear vehicles on the same screen. This procedure, shown in Figure 11, permitted a one-time showing of each trip. At the end of each trip, the data values were tabulated and the forms filed for analysis.

Figure 11. Film data reduction technique.

Traffic and Safety Variables

The identification and quantification of variables that describe the movement of wide housing units were perhaps the most difficult tasks given the researchers. Guidance in these tasks was provided in part by the experience of the Midwest Research Institute, and in part by experience gained in practice runs during the developmental phase of the project. Time constraints also dictated the manner in which some variables were identified and measured. The variables on which data were collected during the investigation are discussed below.

Traffic Volume Data

Traffic volume is usually defined as the number of vehicles that pass a given point during a specified period of time.(12) Since the wide load data were being recorded while the load was in transit, the traffic volume at a stationary point would not be especially useful in describing vehicle interactions with the load. For the purpose of this study, the term "volume" is defined as the number of vehicles that interacted with the load over a specified test section. With this definition, the following four specific volume categories were found to be associated with wide load movement.

1. The number of vehicles that were traveling in the same direction as the load and that passed the load were defined as "vehicle passing load — same direction volume".

2. The number of vehicles that were traveling in the same direction as the wide load and that either passed the load or formed a queue behind it were defined as "vehicle interaction — same direction volume".

3. The number of times the load passed other vehicles traveling in the same direction was defined as "load passing vehicle volume". This does not include incidences when the load passed parked vehicles on the shoulder This criterion for volume was applicable only when the vehicles and the load were in motion.

4. The number of vehicles that were traveling in the opposing direction and met the load were defined as "opposing traffic volume". These data were recorded on only two-, three- and four-lane undivided facilities. On highways separated with a physical barrier, the wide load did not appear to influence traffic in the opposing direction.

Speed Data

Speed is a term that describes the rate of movement of an object per unit of time. The speed of the load as well as the speed of vehicles in the traffic stream influence the type of vehicle interactions and the number of interactions. Thus vehicle and load speeds prior to interaction would be desirable variables to collect. The Midwest Research Institute investigators collected these data using a photographic technique.[9] This technique is time-consuming, and it was felt that the project time limitations were too restrictive to permit collection of individual vehicular interaction speeds.

For the purpose of this study, "speed" is defined as the average running speed of the wide load. The average speed was determined by timing the movement of the load over the specified test route. In addition to average running speeds, maximum spot speeds of the load were recorded from the speedometer by the observer riding in the cab of the wide load. Spot speeds at the end of load decelerations were also noted to determine the frequency with which wide load drivers changed speeds during transit and their reasons for doing so. These decelerations do not include incidences in which the driver stopped for traffic control devices. Although individual vehicle spot speeds were not measured directly, the traffic conflicts technique described below does provide a relative measure of the frequency and severity of speed changes undergone by vehicles as the result of interactions with wide loads.

Lateral Placement Data

For the purpose of this study, "lateral placement" is defined as the position of the right tire for vehicles traveling in the right lane (or the left tire for vehicles in the left lane) during the time they were adjacent to the wide load. Lateral placement data were measured for passing traffic and for the load. Lateral placement is usually measured in terms of distance from the centerline or edgeline and could have been obtained from the photographic data. However, the data reduction process is time-consuming and could not have been accomplished within the time constraints for the study. Instead of being based on actual distance relationships, "lateral placement" was defined in terms of the relative position of the vehicle or load tires. For example, the lateral placement of the tractor-trailer combination shown passing a mobile home in Figure 12 would be recorded as "edgeline", because its left rear wheels are located on the pavement edgeline. The lateral placement for the load would be recorded as "pavement", because the right rear tire is within the limits of the right lane.

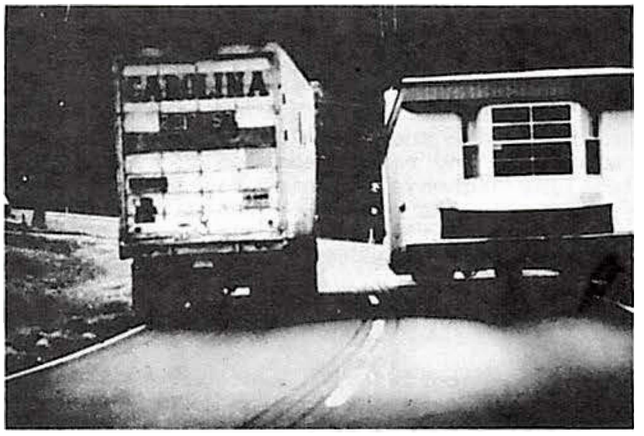

Figure 12. Lateral placement of vehicle and wide load.

The categories of lateral placement included: (1) pavement when the wheels of the vehicle or load were within the limits of the traffic lane, (2) edgeline — when the wheels of the vehicle or load were on the edgeline, (3) shoulder — when one wheel of the vehicle or load was entirely off the pavement, and (4) off — when both wheels of the vehicle or load were entirely off the pavement. These data were extracted from the films taken of wide load movement. The lateral placement is felt to be a measure of perceived driver discomfort and is therefore considered to be an important evaluation parameter.

Encroachment Data

One concern associated with wide load movement is that the load frequently encroaches on the adjacent traffic lane. From previous studies it was observed that although the 14-foot wide loads were two feet wider than the standard 12-foot traffic lane, the driver could position the load in most cases to overhang the shoulder.(9) There were, however, incidences where encroachment on the adjacent lane was necessary because of parked vehicles, pedestrians, narrow structures, etc. The frequency and type of encroachments relating to wide loads had not been quantified, but numerous discussions of encroachment were found in the literature.(9) The categories of encroachment included: (1) sharp curve, (2) vehicle on shoulder, (3) narrow structure, (4) pedestrian, (5) signing, and (6) other roadside obstructions. As the width of the load could significantly affect encroachment, the encroachment data were felt to be desirable evaluation factors. The encroachment data were extracted from the film records.

Queuing Data

One of the most noticeable effects of wide loads is the impedance they create for other traffic. Queue size and duration were measured to examine the effect of width of load on queuing. On the interstate and four-lane divided highways, little queuing was found and random samples of these data were recorded. On two-lane highways, queuing was frequent and it was possible to keep a continuous record of the data. The queue data were recorded manually by noting the time and queue size when vehicles entered or left the queue.

Passing Time Data

Passing times were recorded with a stopwatch and included occasions when vehicles passed the load and when the load passed other vehicles. "Passing times" were defined as the time required to pass the load (or the time required by the load to pass a vehicle), and were measured from the time the right wheel crossed the centerline at the beginning of the passing maneuver until the left wheel recrossed the centerline at the end of the maneuver.

Maneuverability Data

The maneuverability data collected during the movement of 12- and 14-foot wide housing units were primarily subjective. The data collection team noted any delays or problems the housing units experienced in urban areas, at intersections, in construction and maintenance areas, etc.

Regulation Violation Data

One reason that has been offered to explain why wide loads are not involved in many highway accidents is that elaborate safety precautions are employed during the transportation process.(11) The traffic and safety field studies provided an opportunity to examine industry's implementation of the regulations for 12- and 14-foot test units. The data collection team was familiar with the requirements of the regulations and noted incidences of noncompliance.

Traffic Conflicts Data

One of the primary concerns of allowing the movement of 14-foot wide loads is their effect on the safety of the traveling public. Although accident data seem to suggest that wide loads are seldom involved in reportable accidents, it has been suggested that wide loads may create causal factors that lead to accidents in which they are not directly involved.[9,11] To investigate the accident potential of wide loads, the traffic conflicts technique was employed.

The traffic conflicts technique was developed by Perkins to describe potential accident maneuvers at intersections.[13] According to Perkins, a traffic conflict is an evasive maneuver by a driver who either brakes, as indicated by a brake light signal, or changes lanes to avoid a collision. This method has been the subject of a number of research studies and is being used in several states to identify hazards and evaluate the effectiveness of improvements at spot locations.

Although the traffic conflicts technique has not been applied to examine the accident potential of a moving load, it appears to have valid application. To test this possibility, traffic conflicts observed during the movement of wide loads were filmed. During the reduction of the film data, conflicts were classified and a comparison was made between conflicts related to 12-foot units and those related to 14-foot units.

Safety Incidences Data

The data collection team was urged to record all problems and potentially hazardous conditions that occurred during the field studies. These records were summarized and are presented in the ANALYSIS section of this report.

Motorist Opinion Survey

Motorist interviews were conducted Monday through Thursday over a period of 3 weeks, at a different site each day. Three areas of the state — namely, the Martinsville-Roanoke area, the South Hill-South Boston area, and the Harrisonburg-Mt. Jackson area were sampled during succeeding weeks.

In the normal flow of traffic, meetings between manufactured housing units and other vehicles occur infrequently, because relatively few of the units travel Virginia's highways and their travel is restricted to low traffic volume hours. In order to obtain the reactions of motorists meeting a 14-foot wide load, the frequency of meetings had to be increased to provide a statistically meaningful amount of data over the time available for the study. For this purpose, the housing unit manufacturers made available a 14-foot unit and a 12-foot unit for the exclusive use of the study team for the time periods and geographical areas mentioned above. These units traveled designated routes, periodically passing the interview stations. With the help of the State Police, motorists interacting with the unit were selected from the stream of traffic and administered a standard questionnaire. They were asked if they had experienced a delay or encountered a safety hazard on the road that day, and to what they attributed the delay or hazardous situation. At the end of the interview they were asked if they had encountered a "wide load" and if they had any comments concerning it. This questionnaire was designed so that manufactured housing units were not directly mentioned and the interviews would not exceed two minutes in length. This questionnaire appears in Appendix E.

Site Selection

To provide safe interviewing conditions, survey sites were selected with certain criteria in mind. Each route had to be between 5 and 12 miles long due to the limits of the State Police radio equipment, and had to provide safe places to turn the wide units around at both ends. Also, at one end of the route there had to be an area with a good sight distance and other features making it appropriate as an interview site. District and resident engineers familiar with the roads in their areas were asked to submit a number of routes representing interstates, four-lane divided highways, and two- and three-lane roads which met the above criteria. These proposed routes were screened by the coordinators from the Research Council and the Traffic and Safety Division of the Virginia Department of Highways and Transportation, who selected 12 of them for the study. A list of these routes was circulated among members of the study steering committee for their comments before being finalized. The list, along with the travel schedules for the wide units, appears in Appendix E. The committee decided that if inclement weather or any other circumstance should prevent the movement of the wide loads on any given day, that day's route would be dropped from the schedule. There were 3 days of rain and 2 days on which other circumstances prevented survey operations.

Procedure

The survey party met with the wide load crew and State Police at the specified interview site at 9:15 a.m. each morning. (This meeting time was usually adjusted based on the length of time necessary to transport the wide load to the interview site, since movement of the 14-foot wide units was prohibited before 9 a.m.)

While traffic control devices were being set up, the wide load crew was familiarized with the route and the portable radio equipment was installed in the cab. The unit usually made one run over the first leg of the route to test the radio equipment, and interviewing was begun on the return leg. One of the members of the survey party rode in the cab and radioed a description of any vehicle interacting with the wide unit to another team member stationed in a state trooper's vehicle. The interacting vehicle was pulled from the stream of traffic and directed into the interview area. The interviewer approached the vehicle from the driver's side, as seen in Figure 13, and administered the questionnaire to the driver. Upon completion of the interview, the motorist was thanked for his cooperation and was allowed to leave the survey site. The interviewers were instructed to try to politely persuade those motorists disinclined to participate in the interview to do so. However, if the motorist reiterated his refusal, he was thanked and allowed to leave the site without further comment.

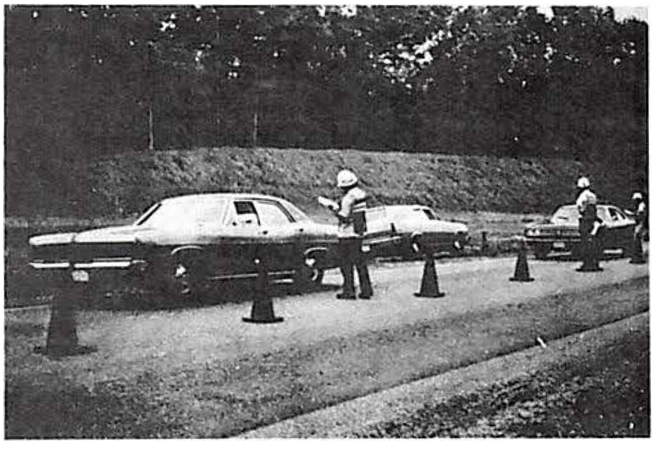

Figure 13. Motorist interview site.

At 12:00 noon, the wide load used during the morning was sent back to the plant and exchanged for the alternate unit; that is, if the 12-foot housing unit was run in the morning, the 14-foot unit was run in the afternoon, and vice versa.

Afternoon interviewing was begun as soon after 1:00 p.m. as possible, depending on the travel time for the wide load, and was terminated at 3:30 p.m. The only exception to this practice occurred in areas where the local Director of Pupil Transportation Safety felt that wide load travel would interfere with school bus traffic. At these sites, interviewing was suspended between 2:00 p.m. and 3:00 p.m., if so requested by the local officials.

Figure 14 shows the setup for interview sites on interstate and four-lane divided highways. On these roads, only two vehicle maneuvers were considered as constituting interaction with the wide load; viz., passing the wide unit going in the same direction (Vehicle 1) and following the wide load (Vehicle 2).

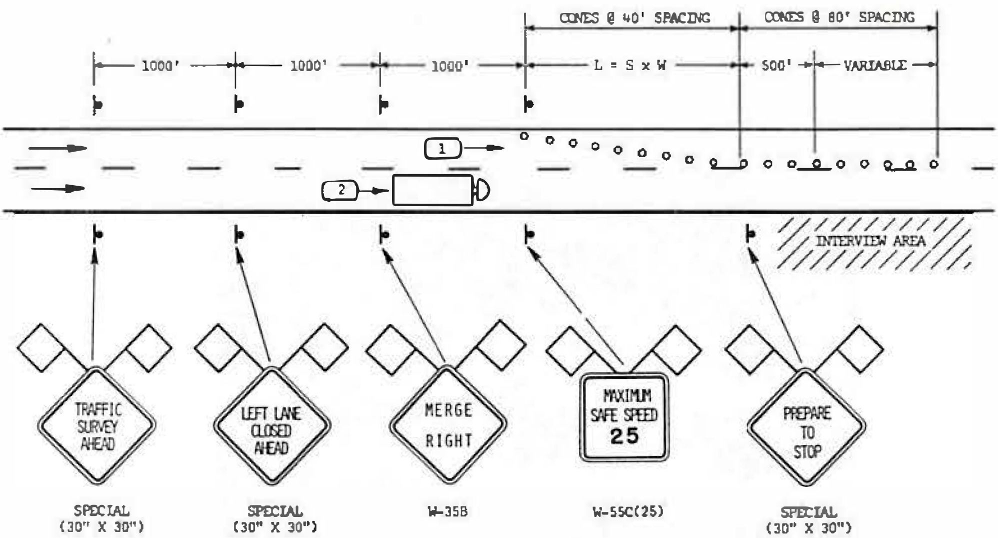

Figure 14. Interview setup and signing for interstate and four-lane divided highways.

Figure 15 shows the setup for sites used on two-lane roads. Three types of vehicle maneuvers were considered to be interactions with the wide load. As the wide unit approached the interview station (position A), vehicles passing the load going in the same direction (vehicle 1) and those following the load (vehicle 2) were sampled. As the load made the return leg of the route (position B), vehicles passing going in the opposite direction (vehicle 3) were stopped and their drivers interviewed.

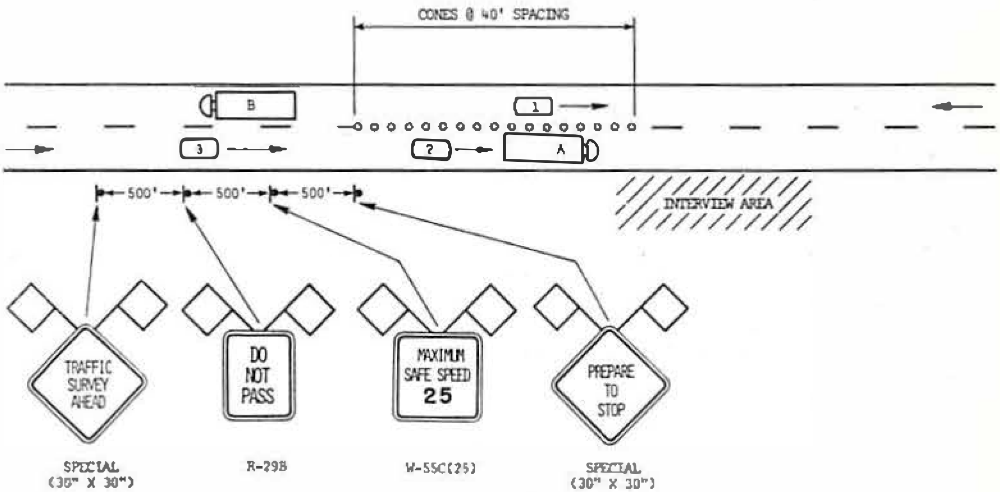

Figure 15. Interview setup and signing for two-lane roads.

Accident Analysis

As mentioned in the SCOPE of this report, a comprehensive statewide analysis of wide load accidents was not feasible because the existing traffic records system cannot be used to identify wide load accidents. In an attempt to provide some measure of the accident involvement of wide loads, a two-part analysis was attempted.

To gain one measure of wide load accident frequency, an attempt was made to select two sections of highway with similar traffic, geometric, and environmental characteristics, except that one section would be frequently used by wide loads and the other would not. This analysis was not conducted for the reasons outlined in the ANALYSIS section of this report.

The second part of the accident analysis consisted of a review of reported 14-foot wide load accidents. This phase was also eliminated as no 14-foot wide load accidents were reported during the test period.

Regulations

Permit regulations are imposed on the movement of oversize loads to protect the public from hazards and unnecessary inconvenience and to prevent damage to the highway system. During the development of test regulations for the 14-foot wide housing units in Virginia an attempt was made to develop regulations that were compatible with those in adjacent states. It was soon apparent that there is considerable variation in permit requirements from state to state. Upon further investigation it was learned that many safety precautions have been conceptually developed and little data are available to substantiate the efficacy of regulations promulgated to provide safe movement. In fact, at least one study has suggested that some regulations pose additional hazards for traffic.[9]

Based on available research reports, regulations of other states, and Virginia experience with 12-foot wide housing regulations, a set of regulations governing the movement of 14-foot test units was developed and is given in Appendix F. It was felt that a limited evaluation of these test regulations could be made during the field data collection phase of the project. Time constraints, however, limited the collection of data that could be used for such an evaluation.

It was also recognized that one possible outcome of the evaluation stipulated in House Joint Resolution No. 41 would be for Virginia to approve the movement of 14-foot units. Realizing that such approval was possible, it was felt that the decisions makers should have a knowledge of 14-foot regulations in other states to use as a guideline for amending the 14-foot test regulations in Virginia. With this in mind, copies of regulations in other states were obtained and summarized. A detailed discussion of the regulations is included in the ANALYSIS section of this report.

ANALYSIS

The analysis was based on information obtained from a survey of previous experience with 14-foot movement and data collected during the movement of 14-foot wide housing units on Virginia highways. The analyses of the data collected for the specific tasks of the evaluation are described below.

Literature Survey

A literature survey conducted by the Highway Research Information Service indicated that little information was available concerning the movement of 14-foot wide housing units. However, from the responses to the questionnaires sent to other states several studies were found. Brief summaries of these studies are given below.

1970 Nevada Study[14]

In October 1970 the Nevada Department of Highways conducted a 2-day evaluation of the movement of a 14-foot wide mobile home on 470 miles of highway. Videotapes and 16-mm black and white movies were taken during the test run. Although inclement weather (rain and snow) was encountered, there were no apparent problems during the test.

The study also included a summary of comments from six other western states concerning their experience with the movement of 14-foot wide housing units. The comments indicated that the states were inconsistent in the regulations imposed on 14-foot units. The regulations ranged from little control in one state to stringent controls in another.

Specific conclusions and recommendations were not given in the report, as the authors concluded that one controlled test provided insufficient information to permit the development of recommendations.

Comment: The Nevada study consisted only of observations of the test unit, and did not provide research data that could be used to determine whether or not 14-foot units should be allowed on highway systems.

1970 Utah Study[15]

During 1970 the Utah Department of Highways conducted several field tests of 12- and 14-foot wide sectional houses on its interstate system. The tests investigated the effects of 14-foot wide loads on traffic flow, speed, and safety. The test sample sizes were small, but for the 14-foot load the operating speeds, delays caused by queuing, and passing times of vehicles were approximately the same as those encountered with the 12-foot load. The loads were damaged by wind estimated to be blowing at 50 MPH. The authors felt the damage was unique to the study and could be prevented through regulation.

As a result of the field tests, the authors recommended that 14-foot wide loads be allowed to use the interstate system under safety precautions similar to those used in adjacent states.

Comment: The collection of data for 12- and 14-foot units provided a technique that could have been used to determine if statistically significant differences existed between these units. However, due to a small sample size and the need for comparative data in some cases, the data collected could not be tested for statistical significance. These data only served to indicate that there were no operational problems unique to 14-foot units on Utah's interstate highways.

1972 and 1973 California Studies[16,17]

In a 1972 California study, a 14-foot wide housing unit was driven over 1,000 miles of various types of state and local roads. As a result of operational problems and potential safety hazards encountered during the demonstration, California decided against permitting routine movements of 14-foot wide housing units on its highway systems. In July 1973, California reviewed the feasibility of moving factory-built housing units greater than 12 feet over their highways and again concluded not to routinely permit loads greater than 12 feet wide. As of January 1, 1976, California highway officials were not aware of any developments in either the housing industry or state legislature that would cause them to reevaluate their prohibition of 14-foot wide units.

Comment: The California study consisted of observations of problems encountered during the movement of the 14-foot test unit, but no attempts were made to collect or quantify traffic data, e.g. factors as lateral placement, queuing, and passing times, that could be used to describe the effects of the load on other traffic. Also the study did not include observations of the movement of 12-foot units or any other loads that could be used as a basis for a comparative evaluation. For these reasons, the observations reported in the study are of limited value in evaluating the movement of 14-foot housing units.

1972 Florida Study[18]

In August 1972, a study was conducted by the Florida Department of Transportation to determine if loads wider than 12 feet should be routinely permitted on the state's highways. In the Florida study, a tractor-trailer unit with a 12-foot,9-inch module used in hotel construction was driven over a variety of primary and secondary highways. The study resulted in the recommendation that Florida prohibit loads wider than 12 feet on its highways because of the wide load's potential for damaging structures, causing accidents, and reducing highway capacity.

Comment: The Florida study consisted of only one test run. As in the California study, traffic and safety variables were not quantified and no basis for comparing the results was provided. Furthermore, as the test unit was a tractor-trailer with a 12-foot,9-inch hotel module, the results of the study are not applicable to the movement of the 14-foot wide manufactured housing units used in the current study.

1972 Michigan Study[19]

From July 1971 through February 1972 the Michigan Department of Highways observed the effects of 14-foot wide mobile and modular movement on traffic at seven study areas in lower Michigan. The study concluded that "The hauling of 14-foot wide mobile and modular homes on Michigan's highways has an adverse effect on other traffic."[19]

The author of the study report stated that the 14-foot units disrupted the free flow of traffic, created hazardous conditions, and caused damage to the pavement and shoulder. Accident data and observations were cited as verification of the conditions reported.

Comment: The Michigan study provides only a limited amount of information concerning the movement of 14-foot housing units. The data reported consisted of observations and accidents for 14-foot units, but no comparative data for other loads were given.

1973 Midwest Research Institute Study[9]

One of the most comprehensive studies of wide housing units was conducted by the Midwest Research Institute in 1973 for the Federal Highway Administration. The project included photographic and visual observations of traffic in the vicinity of 12- and 14-foot wide housing units. Approximately 12,000 miles of wide load movement were studied during 63 trips in 20 states. In addition to collecting traffic data, study personnel interviewed approximately 3,000 motorists in an effort to determine public opinion concerning the transporting of wide housing units. The results of the study suggest that "the question is not a simple one and, unfortunately, the data obtained in this study do not clearly show that states should or should not allow 14-foot wide loads."[9] The researchers concluded that generally the data indicated that 14-foot loads caused more problems and greater impositions on other highway users than did 12-foot units, but felt the differences were not extreme. They recommended that the problems be minimized by imposing greater restrictions on 14-foot units than are imposed on 12-foot loads.

Comment: The Midwest study provided considerable information concerning the movement of 12- and 14-foot housing units; however, in some cases the sample size was insufficient to allow statistical comparisons. Other data, such as encroachment, maneuverability, regulation violations, and traffic conflicts, were not collected. As the study data were not conclusive, they do not provide the information needed for a decision on whether or not 14-foot units should be allowed on the highways.

Summary

Generally the literature provides few conclusive results concerning the movement of 14-foot wide housing units. The methodologies of the studies reported ranged from subjective observations to comparative evaluations of 12- and 14-foot units. In many cases, the sample size was limited and the data could not be subjected to tests for statistical significance. The study recommendations ranged from allowing 14-foot units to total prohibition. The data reported in the literature indicate a need for a comprehensive evaluation of the movement of oversize manufactured housing units.

Questionnaire for Other States

To ascertain the experience other jurisdictions had had with the movement of 14-foot wide loads on their highways, a questionnaire was sent to 49 states (other than Virginia) and to the District of Columbia. Completed questionnaires were returned by 49 of the 50 jurisdictions. A tabulation of the responses received is presented in Appendix G.

A number of observations can be made based on the data in Appendix G. First, the survey results confirmed that 43 of the 49 states permit the movement of 14-foot wide housing units on their highways while only 6 prohibit them. Over two-thirds of the states permit or deny the movement of 14-foot wide units on the basis of highway department policy, while one-fourth use state law to accomplish the same purpose. In over one-half of the states the decision to permit or deny 14-foot wide movements was made on the basis of departmental judgement, in most cases in connection with pressure from the housing industry. Only 3 states conducted a research study before making their decision, although 7 states acted after permitting trial periods.

Of the 43 states which permit 14-foot wide movements, only 5 permit them on a multi-use or blanket permit basis. Thus, 38 states (88.4%) permit these movements on a single trip basis. Only 2 states, Montana and South Dakota, permit housing units greater than 14-foot wide to be moved on a multi-use permit. Eleven states permit 14-foot wide loads other than housing units on a multi-use basis. In most cases this permission is for farm or construction equipment, although 4 states permit the movement of any 14-foot indivisible load on a blanket permit. Over 30% of the states which permit 14-foot housing units have denied the housing industry permission to routinely transport them. Most of the states emphasized the narrowness of their highways and their desire to control the route and time of travel as reasons for denying routine permission.

Data on the number of 14-foot wide movements in the states are not readily available in most instances. Though many of the answers to the question on the number of movements were estimates, most tended to fall between 5,000 and 10,000 movements annually. Virtually all of the states permit movement of the 14-foot wide loads through cities, though many restrict such movements during rush hours. Over one-third of the states had recently relaxed their regulations on the movement of 14-foot wide loads. In most cases the relaxation involved a change in the number of escort vehicles required, from two to one, or even none in some cases. Only 5 states had recently placed additional requirements on 14-foot wide movements. Again, the changes were generally in the number of escort vehicles required or the rules for operating them.

Only 3 states indicated that there had been a change in accident or accident potential resulting from the transportation of 14-foot wide housing units; only 4 states had compiled any figures on accident experience. Nearly 40% of the states had received public comment on the 14-foot wide loads, though most of these states indicated that the comments were not numerous. Most of the comments received were complaints of being run off the road, being delayed, or being annoyed by the nuisance of the wide loads.

Virtually all of the states which permit the movement of 14-foot wide housing units have regulations governing the movement. (A comparison of the regulations by state is given later in this report.) Only 16% of the states indicated any difficulties in enforcing their regulations. The violations most often cited as problems were traveling outside the route or time limit specified in the permit, and the lack of proper escort vehicles. Thirty percent of the states had experienced highway maintenance difficulties that they attributed to 14-foot wide movements. Most of these states complained of shoulder damage or deterioration as the main problem, although several indicated that signs and roadside delineators were often damaged.

Summary

In general, the survey results show that —

1. there is very little indication of a safety problem related to 14-foot wide loads, but little data on the subject are available;

2. most of the states attempt to maintain control over 14-foot wide movement by issuing single trip permits and by issuing safety regulations;

3. few complaints about the 14-foot wide movement are received from motorists; and

4. some maintenance problems are associated with these movements, but shoulder deterioration is apparently the only serious one.

The few states which commented about 14-foot wide loads in the questionnaire, indicated that the problems were not severe, though they attempted to control the movements as much as possible through safety regulations.

Visits to Adjacent States

Officials in the states of Kentucky, Maryland, Pennsylvania, Tennessee, and West Virginia were interviewed. The interviews were useful for disclosing the personal feelings of permit, safety, and enforcement personnel toward wide loads. They were of little use in gaining empirical evidence or other hard data on the safety problems actually encountered in moving wide loads — apparently because such information is simply inseparable from all other accident and safety data. In addition, it was impossible to measure the level of citizen inconvenience or dissatisfaction because no formal complaint mechanism has been established in these states.

The road network regulated at the state level appeared to be considerably less extensive than that in Virginia. The states tended to directly supervise movement and enforce regulations on only their primary roads. The roads of lower geometric design were under county or city jurisdiction. This situation contrasts with that in Virginia where nearly all primary and secondary roads outside of population centers of 3,500 are regulated and maintained at the state level. The percentage of state roads classified as primary also varied considerably. In Maryland, nearly all state roads were estimated to be 24-foot wide, while West Virginia officials stated that less than 4% of their road miles are in this category.

The states have differing philosophies on route selection and preclusion for wide loads. Each state makes efforts to restrict wide load travel to the highest class roads, even if circuitous routing is necessary. The real differences arise in secondary road travel. Kentucky adheres strictly to a policy that no 14-foot wide load can be moved more than 3 miles on a road not designated an approved primary route. Tennessee, on the other hand, puts the burden on the mover to verify the feasibility of the route he selects. If the mover verifies he can maneuver on the route, the move is permitted. Pennsylvania allows use of any route necessary during a move.

The personal opinions of the permit, safety, and compliance personnel were nearly unanimous. They did not feel a 14-foot vehicle can safely travel on a 12-foot lane. Since none of these states has documented the safety record of these loads, their feelings remain unsupported. The lack of factual information on wide load safety was found even in the so-called "study periods" that several of the states employed prior to allowing routine movement of the 14-foot loads. None of the five states documented their preliminary studies. In Pennsylvania, for instance, the study period consisted of 60 days during which 14-foot wide loads were permitted on a trial basis. No accidents occurred, and no other data were taken, so the loads were permitted. As mentioned, no follow-up studies on safety or compliance have been made in any of these states nor are any contemplated.

Of the five states visited, none had accident data involving a 14-foot wide load; probably not because 14-foot units have never been involved in an accident, but because data collection for these loads is impossible due to problems with the accident record systems. In Pennsylvania, for instance, of 34 categories of vehicles established to analyze accident frequencies, one category is "truck-towing house trailer." This category includes housing units of every description. Of 288,245 reported accidents in Pennsylvania in 1975, in 38 the "offending vehicle" was in this category, but no conclusions can be drawn regarding width alone as a causative factor.

The problem of identifying 14-foot wide loads surfaces when regulation compliance rates are examined. Kentucky, for instance, has an elaborate and complete listing of safety inspection results tabulated by month. In September, 1976, 84.5% of all trucks and large loads inspected had lighting defects and 22.7% had defects in emergency equipment. However, the number of these defects that were found on mobile homes cannot be ascertained. Kentucky officials hope to remedy this data problem by December 1976. The other states had compliance data that were inseparable and no effort was planned to remedy the situation. West Virginia officials estimated that their most common violation is the hauling of wide loads without any permit whatsoever.

It was generally agreed that speeding of wide loads was prevalent and was a problem practically limited to mobile and modular homes. The latter fact was explained by noting that construction-type wide loads such as bulldozers or reactor cores tend to be in excess of the legal weight limits and are transported at reduced speeds. The weights of mobile and modular homes, on the other hand, are within legal limits.

The states differ markedly in philosophies of enforcement. Three of the states rely exclusively on their regular state police, or comparable force, for roadside compliance inspections. It was generally agreed that among the tasks assigned the police, enforcing compliance of safety regulations for wide loads is far from being the most pressing. Two states, Kentucky and Maryland, have apparently deemed the subject of oversize and overweight vehicles to be so important that they have formed special enforcement units. Kentucky has a 60-man Division of Highway Enforcement; Maryland has an 81-man Truck Weight Enforcement Division of the State Police. Officers from both of these groups were interviewed, and they offered the opinion that specialization is essential to effective enforcement. They felt the regulations for oversize and overweight loads are complex and a proper inspection so involved that regular State Police officers tend to shy away from them. They also pointed to the economy of having an officer inspect and issue a summons — as opposed to the situation in Virginia wherein a specialist inspects and then requests that a police officer write the summons. These officers also stated that, despite the special forces, enforcement was difficult. Further, they offered the opinion that, based on vehicles they have observed, compliance with regulations is quite low in states without specialized enforcement personnel.

The states also vary considerably in the area of enforcement sanctions. In the 3 states without a special enforcement division of the state police if a wide load is found to be in violation of regulations, it is cited, then allowed to proceed. The size of the fine depends on the local judge. Also, if a wide load is found without a permit or proper escort vehicles, it is not allowed to continue until this situation is remedied. In Maryland and Kentucky, if regulations are violated or serious defects are noted, the permit is voided. The mover must correct the defect and apply for a new permit. This process can consume considerable time and may extend into periods when wide load travel is not permitted. Maryland does not rely on local judges, but rather assesses a fine of $105 for every violation.

There was general agreement that fines should be sizeable and inspections frequent to make unsafe practices uneconomical.

There is no doubt that escort vehicles are an expensive part of any move. If, for instance, they cost $100 per move per vehicle, it would be profitable to the mover to be fined $900 per violation if he is caught only 10% of the times he fails to provide an escort. This situation penalizes the honest mover. A mover who continuously violates regulations presents a special problem. Pennsylvania has concluded that refusing to issue new permits to a habitual violator is not feasible, because of the economic hardships that would accrue to the workers at a plant that might be forced to shut down.

If a vehicle is found to be off of the route approved for its move, other problems arise. The home may be already sold to a consumer on a forbidden route. West Virginia officials stated they often find wide loads already delivered to sites on unapproved roads.

Very few citizen complaints have been received by any of the states. Apparently citizens are stoic regarding the occasional inconvenience of a road closing to permit the passage of a wide load. None of the states have a formal mechanism for handling citizen complaints.

Several general recommendations and observations were offered by most of the personnel interviewed: (1) wide loads must travel only during off-peak traffic hours, (2) escorts are essential to provide warning to other vehicles, (3) uniformity among the states is desirable, and (4) regular enforcement is essential to ensure any level of compliance with regulations. Other recommendations include: (1) requirement of a flashing yellow light on the wide load to ensure visibility on lower class roads, and (2) specialization in the State Police to ensure proper compliance with safety regulations.

Several questions without answers surfaced. For example, Can needed housing be safely delivered to sites served by inadequate roads? Also, What should be done on road networks outside of state control, where apparently there is no regulation at all?

Summary

The state highway and transportation officials interviewed strenuously opposed the introduction of 14-foot housing units in their states. Most of the officials still feel they are unsafe, but do not have data to support their opinions.

The only contrary view was expressed by an enforcement officer in Maryland, who feels wide loads can be safely moved if regulations are strictly enforced and movements restricted to off-peak traffic hours.

Traffic and Safety Field Studies

As previously shown in Table 1, traffic and safety field data were recorded on 3,782 miles of Virginia highways. Details of the 192 highway sections used for data collection are given in the log in Appendix H. Because of rain, travel after 4 p.m., and mechanical breakdowns, data for 315 miles were eliminated before statistical comparisons were made.

Fourteen-foot wide test units were evaluated on 104 study sections with 8 modular and 10 mobile units. Twelve-foot units comprising 12 modular, 3 mobile, and 3 double-wide loads were used on 88 sections. The 12- and 14-foot test units were provided by four major Virginia housing unit manufacturers. Two of the firms produced 14-foot mobile homes, while the other two companies produced modular units. Actual 14-foot wide modular units were not constructed as the industry considered it too expensive to convert to 14-foot production for the few months the tests were scheduled. The 14-foot modular units used in the experiment were mock-ups composed of 12-foot units fully enclosed to give the appearance of 14-foot units. The 12- and 14-foot modular units are shown in Figure 16. Actual 14-foot mobile units were constructed by the industry and used for data collection.

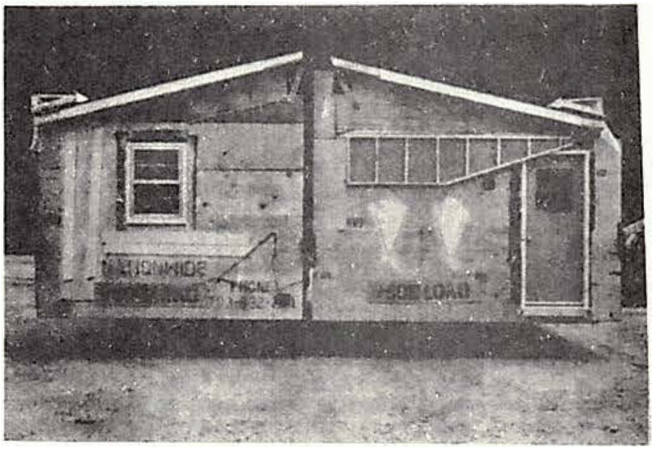

Figure 16. Twelve-foot modular unit on left and 14-foot mock-up on the right were used for data collection.

As previously stated, the primary objective of collecting field data for the 12- and 14-foot units was to identify the variables associated with wide load movement and determine if there were statistically significant differences in the variables between 12- and 14-foot units. To assure reliability in the results, three conditions were imposed for each variable identified. First, the samples had to be drawn from representative highway conditions in Virginia. To assure this condition, the test road sections were selected from typical interstate, primary, and secondary routes throughout the state. Secondly, the samples had to be drawn from the same population so that all traffic variables, i.e., volume, speed, etc., would be similar for both the 12- and 14-foot units. An attempt was made to achieve this condition by using both 12- and 14-foot units on the same test sections. Thirdly, the samples had to be large enough that the results could be statistically tested. To meet this criterion, sample sizes were computed according to the procedure outlined in the following section on Traffic Volume Data. All statistical differences were examined for practical significance.

As mentioned in the Literature Survey, few data have been collected that describe the characteristics of wide load movement. In fact, the manner in which the variables were identified and collected for this study is unique. Consequently, for most variables, there are no previous data that could be used to estimate sample size or to serve as a basis for comparing the results obtained in this study. Because there were no previous data, there was no documented mathematical basis for choosing a significance level for testing the differences in variables. For the purpose of this study, a 99% confidence level ($\alpha = 0.01$) was used unless otherwise noted. This high confidence level implies a reluctance to reject the null hypothesis unjustly, i.e., the differences in the characteristics of 12- and 14-foot units had to be great in order for rejection of the hypothesis that there were no differences. A consequence of this approach was that the probability of not rejecting the null hypothesis when it was really false was large, unless the deviation from the null hypothesis was great (commonly called a Type II error).[20] In other words, it was assumed that 12-foot housing units would continue to be used on Virginia highways and that 14-foot units should be permitted unless a substantial difference in traffic and safety characteristics were found. The only way any error in judgement (if in fact an error occurred) could be reduced would be to increase the sample size. Because of time constraints, it was not possible to extend data collection. To provide further reliability in the conclusions, the practical significance of each result was outlined.

Using the above procedure, analyses of all variables identified in the study were made and the results are given below.

Traffic Volume Data

As discussed in the METHODOLOGY section of this report, the term "traffic volume" is defined as the number of vehicles that interacted with the wide load over the specified test section. Because the purpose of collecting traffic and safety data for 12- and 14-foot housing units was to determine if there were significant differences in the characteristics of these units, it was desirable that the number of vehicle interactions be similar for a given highway section. For example, if the number of interactions for a 12-foot load on a given test section was 72, and the number of interactions for a 14-foot load on the same test section was 75, one might conclude that the numbers of vehicle interactions for the two loads were approximately the same. However, if the number of interactions for the 14-foot load was 225 instead of 75, one could suspect that traffic conditions for the two tests were different. Consequently, the finding of significant differences for some traffic variables could be erroneous if other parameters that affect the results were not considered. For example, if in the illustration given above (72 vehicle interactions for the 12-foot load and 225 for the 14-foot load) it was desirable to examine the effects of the two loads, it could be shown (see section on Queuing Data) that the 14-foot load would create greater delays to traffic. However, if all other factors, i.e., speeds, weather conditions, time of day, etc., were similar, the difference might be due to a significant increase in the volume of traffic on the test route and not to the size of the load. For the above example, as well as for many of the other variables that are affected by volume, it was necessary to determine if there were significant differences between the numbers of vehicle interactions for the 12- and 14-foot units for a given highway system.

As previously mentioned, four specific volume counts were manually recorded for each test run. For the purpose of examining volume relations only, the opposing and same direction interactions were considered. For the purpose of analysis, the same direction volume included all vehicles that were passed by the load plus vehicles that passed or were delayed by the load.

In most cases, several runs were made with 12- and 14-foot units over a given test section. However, every highway system studied consisted of a number of test sections. For example, as shown in Table 1, there were 12 trips for 12-foot loads and 16 trips for 14-foot loads on the interstate system. These trips were made on selected sections of I-64, I-81, I-85 and I-95.

The lengths of the test sections on each of these routes varied. Data on each trip were collected on I-64 for 30.83 miles, on I-81 for 55.58 miles, etc. To account for differences in trip length, vehicle interactions for each trip were divided by the length of the test section. The result is volume expressed in terms of vehicles per mile.

A summary of the vehicle interactions per mile for the 12- and 14-foot units is given in Table 2. For the five highway systems studied, there was a tendency for the mean number of vehicles per mile for the 14-foot units to be greater than that for the 12-foot units. To determine if the differences were statistically significant, the variability of the vehicles per mile for the 12- and 14-foot units was assumed to be unequal and the t test was applied.[20] As noted in Table 2, the differences were not significant at the 99% confidence level. This result was expected because the trips were made on weekdays within similar time intervals. It has been shown in other studies that variations in volume for a given highway are consistent and repetitive for similar time spans.[12] This finding supports the suggestion that 12- and 14-foot units were evaluated under similar volume conditions on the test routes. However, as the speed of the load also affects the number of vehicle interactions, it must be shown that the speeds of the 12- and 14-foot units were similar for the test sections (see Speed Data) before one can accept the conclusion that the loads were evaluated under similar traffic conditions.

The volumes shown in Table 2 indicate some interesting trends. Although it has been shown that there were no significant differences between the 12- and 14-foot units for each of the highway systems, the numbers of vehicle interactions for these units increased as the design standards of the highway system decreased. This may be due, in part, to the speed of the load; i.e., as the geometric conditions of the system became more severe, the speed decreased and created an increase in the number of vehicle interactions. (One exception is the four-lane undivided highways that were located in predominantly urban areas.) This finding may have a practical application. For example, the data suggest that safety and convenience to other traffic could be maximized if the movement of all wide loads were on routes having a minimum of vehicle interactions. For the five systems shown in Table 2, this would mean that wide loads would encounter fewer vehicle interactions on interstate, four-lane divided, and secondary facilities; thus travel on these facilities would be more favorable than travel on two-lane primary highways, which have a higher number of interactions. Before specific routes or highway systems can be chosen as favorable for wide load travel, factors other than volume must be taken into consideration. A preliminary review has indicated that it may be possible to determine the level of vehicle interaction, most favorable for wide load movement; however, due to time constraints this task could not be included in the scope of the study.

TABLE 2

COMPARISON OF VEHICLES PER MILE

SYSTEM	DIRECTION SAME	DIRECTION OPP.	12-FOOT LOAD NO. OF TESTS	12-FOOT LOAD MEAN ($\bar{X}_{12}$)	12-FOOT LOAD VARIANCE (s^2_{12})	14-FOOT LOAD NO. OF TESTS	14-FOOT LOAD MEAN ($\bar{X}_{14}$)	14-FOOT LOAD VARIANCE (s^2_{14})	t-VALUE	SIGNIFICANCE $\alpha = 0.01$
Interstate	X		10	1.18	0.71	15	1.52	0.67	-1.02	No, 21 d.f.
4-Lane Divided	X		22	1.58	1.52	26	2.14	1.85	-1.48	No, 48 d.f.
4-Lane Undivided	X		7	3.81	2.94	9	3.96	3.41	-0.16	No, 16 d.f.
2-Lane Primary	X		25	0.77	0.45	28	0.85	0.82	-0.36	No, 51 d.f.
			25	4.34	12.74	28	4.81	14.78	-0.47	No, 53 d.f.
Secondary	X		12	0.08	0.02	12	0.13	0.04	-0.86	No, 22 d.f.
			12	0.88	0.53	12	1.02	1.51	-0.34	No, 19 d.f.

As previously discussed, before confidence could be placed in the statistical results, an adequate sample size had to be obtained. In the usual sequence of events, this task was accomplished before the results were tested for statistical significance. For the traffic volume data, the discussion of sample size determination was deferred for the purpose of illustrating the procedure.

The purpose of predetermining the required sample size is to assure that the number of samples taken will give a statistically meaningful description of the mean of the population at a given confidence level. The sample size usually is controlled by either time or budget constraints; for this study, it was limited by time restrictions. In many studies population parameters such as the mean and variance can be determined from previous tests, and the sample size can be determined before the tests are made. However, for this experiment there were no previous data and the authors were concerned throughout the study that time constraints would limit the data collected to the extent that the amount of data available would not be sufficient for statistical tests. In an attempt to secure as much data as possible within the 8-week data collection period, two cameras and five observers were utilized. Thus, after the data were collected and summarized, the adequacy of the sample size was determined by the following procedure.

For the data collected, the size of the sample was known. A confidence level of 90% (α = 0.10) was chosen and the task was to determine the tolerance error. The procedure is illustrated in the following example taken from the 10 samples of 12-foot movement on the interstate system shown in Table 2.

The tolerance error, E, is obtained from the equation[20]

$$E \quad \frac{tv}{\sqrt{N}}$$

where E = tolerance error, in percent,

t = sample risk (for α = 0.10 with 9 degrees of freedom $t_{0.95}$ = 1.83),

v = variation coefficient, in percent =

$$\frac{100\ (\text{standard deviation of sample})}{\text{sample mean}}\text{, and}$$

N = sample size.

For the 12-foot load on the interstate system

$$E = \frac{1.83\ (100\ \frac{(0.843)}{1.18})}{10}$$

$$E = 41\%.$$

Therefore, it can be concluded with 90% confidence that for a sample of 10 test trips, the mean number of vehicles per mile for a 12-foot load on the interstate system can be expected to fall between 0.70 and 1.66 vehicles.

This procedure was used to compute the errors in the mean vehicles per mile for the data in Table 2 and the results are given in Table 3. As shown in Table 3, the results generally indicate that it would be desirable to collect larger samples. The effect of larger sample sizes in reducing the tolerance error is illustrated by comparing the data for 12- and 14-foot loads. As shown in Table 2, more sample runs were made with 14-foot units than were made with 12-foot units. Consequently, the errors for 14-foot loads are lower than the errors for 12-foot units. While the significance of the results for the traffic volume data should be interpreted in view of the tolerance errors shown in Table 3, the errors appear within the practical limits of sample sizes associated with the collection of data on traffic variables. One exception is the errors for the secondary system. Such large errors clearly indicate that the sample size is too small to allow statistical comparisons. It should be noted that the numbers of vehicle interactions on the secondary system were extremely small; in fact, on many secondary facilities there were none. Thus, a considerable increase in the sample size on these routes may not result in a meaningful reduction in the tolerance error.

In the analyses of the other traffic and safety variables that follow, sample size determinations were made according to the procedure outlined above. These determinations are not shown or discussed unless the sample sizes or tolerance errors were of a magnitude to warrant discussion.

TABLE 3

COMPUTED ERRORS IN MEAN VEHICLES PER MILE*

System		12-foot Load	14-foot Load
Interstate		41	24
4-Lane Divided		29	21
4-Lane Undivided		33	29
2-Lane Primary —	Same	30	34
	Opp.	28	26
Secondary —	Same	92	80
	Opp.	43	63

*The interpretation of this table is as follows for the 10 test runs on the interstate system with a 12-foot unit. For the 10 tests, the mean vehicles per mile value is 1.18 and the variance is 0.71 (see Table 2). For a confidence level of 90% (α= 0.10), the error in the estimate is 41%. Thus, it can be concluded with 90% confidence that for a sample of 10 tests, the mean can be expected to fall between 0.70 and 1.66 vehicles per mile.

Summary

1. Although sample sizes were small, no statistically significant differences could be found between the number of vehicles interacting with 12- and 14-foot loads on the highway systems studied.

2. The traffic volume data suggested that there were few vehicle-load interactions on interstate, four-lane divided, and secondary facilities; however, a higher number of interactions occurred on four-lane undivided and two-lane roads. The high number of interactions on four-lane undivided highways can be attributed to the urban location of test sections.

Speed Data

Because the average running speed could influence the type and number of vehicle interactions, it was necessary to examine the speeds of the 12- and 14-foot units. From the field tests, some of the factors that appeared to affect the speed of the load were (1) the driver, (2) the load, (3) the roadway geometry, and (4) the traffic volume.

The running speeds for the tests were summarized by type of highway system and the results are shown in Table 4. The computed tolerance errors for the speeds ranged from 4% to 17%, which indicates the sample sizes were adequate for statistical comparisons. For each highway system, there was no apparent difference in the mean speeds of the 12- and 14-foot units, and the t values shown in Table 4 also indicate there was no statistically significant difference. As expected, the mean speed of the units decreased as the geometric design of the highway system became more restrictive. The finding that there were no significant differences in the speeds of the test units, combined with the previous finding of no significant difference in the number of vehicle interactions, provides evidence that the12- and 14-foot units were evaluated under similar traffic conditions.

There were noticeable differences between drivers in observing the speed limits imposed on wide load units. For example, drivers for two of the companies who supplied test units consistently operated the units in a cautious manner and were careful never to exceed the 35 and 45 mph speed limits imposed on the loads. The drivers for two other companies did not exhibit this same characteristic; in fact, their average speeds were well above the speed limits. This observation is illustrated in Table 5 and in the speed distributions shown in Figure 17. This finding has some practical implications. Although a complete analysis could not be made for inclusion in this report due to time limitations, a preliminary review of the speed, volume, impedance, and conflict data suggests that the closer the wide load speed was to the mean speed of the traffic stream, the fewer were the observed vehicle interactions, delays, and conflicts. This observation was especially true for the interstate, four-lane divided, and two-lane facilities. While further analysis is warranted, the data suggest that there is a need to revise the maximum speed limits imposed on wide loads.

TABLE 4

COMPARISON OF AVERAGE RUNNING SPEEDS*

SYSTEM	12-FOOT LOAD			14-FOOT LOAD				
	No. of Tests	Mean($\bar{X}_{12}$)	Variance (s_{12}^2)	No. of Tests	Mean($\bar{X}_{14}$)	Variance (s_{14}^2)	t Value	Significance $\alpha = 0.01$
Interstate	10	51.8	27.25	15	52.5	17.55	-0.34	No, 18 d.f.
4-Lane Divided	20	41.2	63.84	26	38.2	66.73	1.22	No, 43 d.f.
4-Lane Undivided	6	32.5	43.10	9	32.7	38.24	-0.05	No, 12 d.f.
2-Lane Primary	24	34.0	57.94	27	33.9	38.21	-0.05	No, 46 d.f.
Secondary	12	26.4	15.24	12	26.0	26.18	0.49	No, 23 d.f.

* Speeds are in miles per hour.

TABLE 5

WIDE LOAD SPEED SUMMARY*

SYSTEM	12-FOOT LOAD No. of Tests	RANGE MIN.	RANGE MAX.	MEAN($\bar{X}_{12}$)	85th PERCENTILE SPEED	MAX. SPOT SPEED	14-FOOT LOAD No. OF TESTS	RANGE MIN.	RANGE MAX.	MEAN($\bar{X}_{14}$)	85th PERCENTILE SPEED	MAX. SPOT SPEED
Interstate	10	45	60	51.8	57	62	15	45	58	52.5	57	63
4-Lane Divided	20	24	55	41.2	51	61	26	24	51	38.2	49	62
4-Lane Undivided	6	25	42	32.5	42	50	9	27	43	32.7	43	50
2-Lane Primary	24	16	47	34.0	42	56	27	20	47	33.9	42	55
Secondary	12	20	34	26.9	30	40	12	17	35	26.0	30	34

* Speeds are in miles per hour.

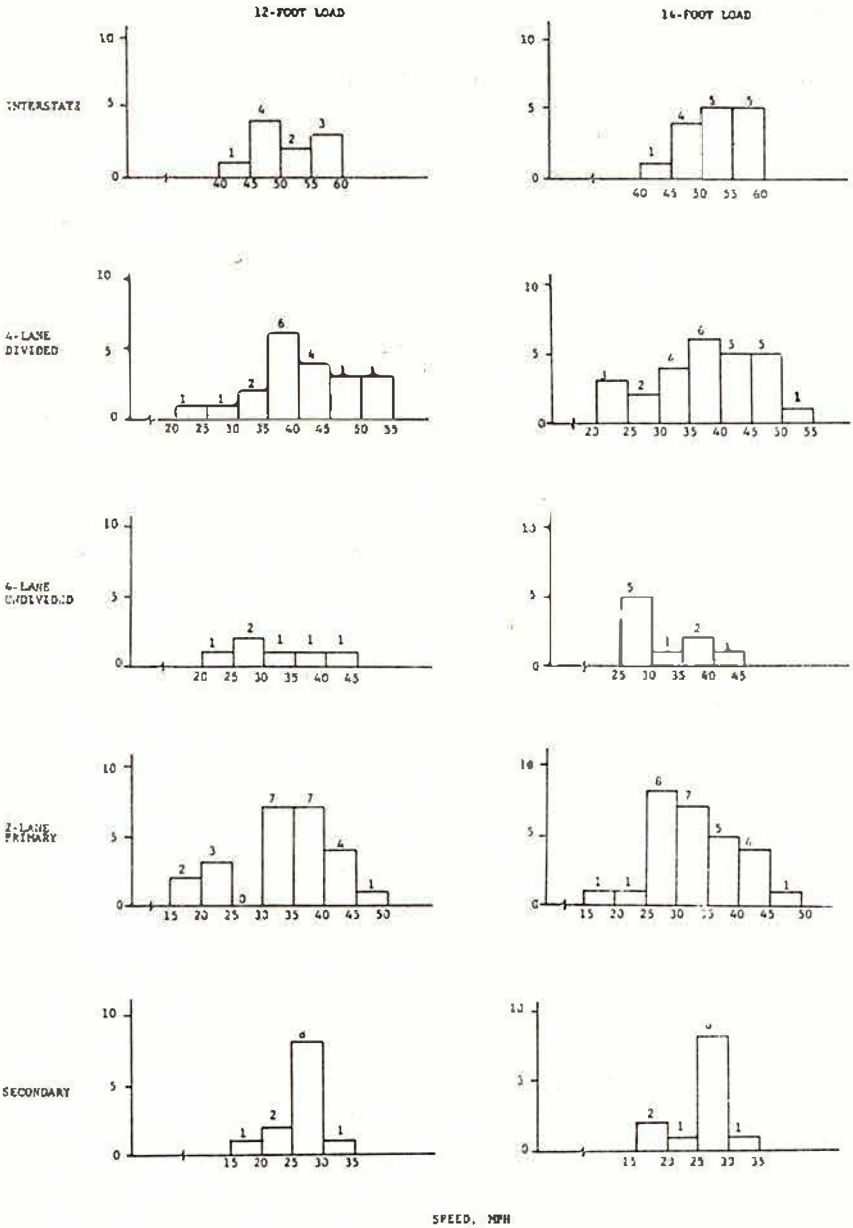

Figure 17. Wide load speed distributions.

Summary

1. There were no statistically significant differences between the mean running speeds of 12- and 14-foot units on the highway systems studied.

2. An analysis of the speed and volume data suggests that the 12- and 14-foot units were evaluated under similar traffic conditions.

3. The drivers of some firms strictly complied with the speed limits imposed on wide loads, while the drivers for other companies frequently exceeded the speed limits.

4. A preliminary analysis of speed, volume, impedance, and conflict data suggests that the safety and convenience of the motoring public could be enhanced if the wide load speed was close to the mean speed of the traffic stream.

Lateral Placement Data

As the width of vehicles using a highway system influences the position of other vehicles during a passing or meeting maneuver, it would be expected that 14-foot loads would induce greater lateral displacements than would 12-foot loads.(9) As previously mentioned, lateral placement was defined for vehicles passing and meeting the load and for the load in terms of four relative positions: (1) wheels on pavement, (2) one wheel on edgeline or edge of pavement, (3) one wheel on shoulder, and (4) all wheels off the pavement.

The lateral placements for vehicles passing and meeting the test units were summarized by type of highway system and the results are shown in Table 6. In some cases, the data in the cells were combined to produce a statistically meaningful sample size. The method used to analyze the lateral placement data was to compare the proportions of vehicles in the placement categories of 12-foot loads to those in the categories of 14-foot loads by means of the chi-square statistic. As shown in Table 6, there was a significant difference in vehicle lateral placement between 12- and 14-foot loads on every highway system, except for vehicles traveling in the same direction as the load on two-lane highways and vehicles meeting wide loads on the secondary facilities. As previously shown, vehicle interactions and wide load speeds were similar for 12- and 14-foot units on each highway system. Therefore the significant difference in lateral placements is probably attributable to the width of the load. It is important to examine the implications of the differences shown in Table 6. In order to examine which categories of placement were affected by the width of the loads, Table 7 was developed. The interpretation of Table 7 follows.

TABLE 6

VEHICLE LATERAL PLACEMENT SUMMARY

SYSTEM	DIRECTION		12-FOOT LOAD					14-FOOT LOAD					x^2	SIGNIFICANCE
	SAME	OPP.	PAVE.	EDGE-LINE	SHOULDER	OFF	OTHER	PAVE.	EDGE-LINE	SHOULDER	OFF	OTHER		$\alpha = 0.01$
Interstate	X		257	38	4	0	(1) 21	341	91	24	0	(2) 28	16.1	Yes, 3 d.f.
4-Lane Divided	X		383	53	6	0	(3) 8	451	121	46	1	(4) 28	40.9	Yes, 4 d.f.
4-Lane Undivided	X		64	3	0	0	(5) 30 (6) 24 (7) 15	34	5	0	0	(8) 29 (9) 53 (10) 7	23.2	Yes, 4 d.f.
2-Lane Primary	X		24	9	3	1	1 (11)	16	3	1	0	6(12)	8.1	No, 4 d.f.
		X	523	251	292	1(13)	1 (10)	544	447	421	4	0 (14)	33.5	Yes, 4 d.f.
Secondary		X	9	0	27	4	0	6	0	33	2	0	1.9	No, 2 d.f.

(1,2) Number of vehicles passing load in 3rd lane on 6-lane divided interstate highway.
(3,4) Number of vehicles passing load in 3rd lane on 6-lane divided highway.
(5,8) Number vehicles encroaching into opposite direction lane.
(6,9) Number vehicles using 3rd lane to pass load on 6-lane divided highway.
(7,10) Number of vehicles encroaching into center turn lane, while passing load
(11,12) Number of vehicles encroaching into opposing traffic lane (3-lane area) while passing load.
(13,14) Number of approaching vehicles encroaching across centerline.

TABLE 7

X^2 VALUES FOR VEHICLE LATERAL PLACEMENT

SYSTEM	DIRECTION: SAME	DIRECTION: OPPOSITE	VEHICLE LATERAL PLACEMENT: PAV.	EDGELINE	SHOULDER	OFF	OTHER		
Interstate	X		* 9.3	6.4	* 6.8	-	(1) 0.1		
4-Lane Divided	X		* 33.7	* 9.0	* 18.4	0.03	(2) 4.7		
4-Lane Undivided	X		* 11.0	0.2	-	-	(3) 0.001	(4)* 16.9	(5) 2.0
2-Lane Primary	X		0.03	1.1	0.04	0.02	4.2 (6)		
		X	27.2*	19.2*	1.6	0.3	0.02 (7)		
Secondary		X	0.4	-	1.2	0.2	-		

(1) Vehicles in 3rd lane on 6-lane divided highway.
(2) Vehicles in 3rd lane on 6-lane divided highway.
(3) Vehicles encroaching into opposite direction lane.
(4) Vehicles using 3rd lane on 6-lane divided highway.
(5) Vehicles encroaching into center turn lane.
(6) Vehicles encroaching into opposing traffic lane (3-lane area).
(7) Number of approaching vehicles encroaching across centerline.

* Significant Difference

On the interstate system, there was a tendency for 14-foot loads to produce greater vehicle displacements as proportionally fewer motorists remained on the pavement while passing a wide load. Consequently, more motorists used the edgeline and shoulder during the passing maneuver. The chi-square values in Table 7 show that significantly fewer motorists used the pavement when passing 14-foot loads. In addition, significantly more motorists used the shoulder during the passing maneuver. The results for the other systems can be interpreted in a similar manner. Generally, for all highway systems the 14-foot load induced a significant change in lateral placement. Fewer motorists used the pavement when meeting or passing a 14-foot unit and a greater number of motorists provided an additional margin of clearance by moving to the edgeline and shoulder area. This result was also obtained in the Midwest Research Institute study.[9]

One important relationship shown in Table 6 is the number of vehicles that passed the test units on four-lane undivided facilities and encroached into the opposing lane of traffic. For 12-foot units, 30 motorists encroached into the opposing lane and for 14-foot units, 29 motorists made a similar maneuver. The difference is not statistically significant. This maneuver is perhaps one of the most potentially hazardous conditions observed during the field test; a mistake in judgement by a motorist could result in a head-on collision.

Lateral placement data were also recorded for the test units and the results are shown in Tables 8 and 9. The significant shifts from the pavement to the shoulder observed for vehicle placement also were noted for the placement of the load; however, the shift for the load was more pronounced than that for passing vehicles.

The significant differences in lateral placement indicate that both motorists and wide load drivers reacted with greater driver discomfort with 14-foot units than they did with 12-foot units. This is an important finding, and further investigation is warranted to determine if other factors were operative.

During the field tests, it was noted that the following factors affect lateral placement.

1. pavement width
2. load axle width
3. road geometrics
4. width of passing vehicle
5. width of load
6. speeds of load and vehicles
7. obstacles on or near shoulder
8. traffic congestion
9. weather conditions, (e.g. wind)
10. lateral movement of escort vehicles

TABLE 8

LOAD LATERAL PLACEMENT SUMMARY

SYSTEM	DIRECTION SAME	DIRECTION OPP.	12-FOOT LOAD PAVE.	12-FOOT LOAD EDGE-LINE	12-FOOT LOAD SHOULDER	12-FOOT LOAD OTHER	14-FOOT LOAD PAVE.	14-FOOT LOAD EDGE-LINE	14-FOOT LOAD SHOULDER	14-FOOT LOAD OTHER	X^2	SIGNIFICANCE $\alpha = 0.01$
Interstate	X		112	120	72	0	11	34	434	0	369.3	Yes, 2 d.f.
4-Lane Divided	X		285	93	38	(1) 4	242	150	97	(2) 21	45.9	Yes, 3 d.f.
4-Lane Undivided	X		99	25	3	(3) 6	71	13	19	(4) 48	51.8	Yes, 3 d.f.
2-Lane Primary			26	9	8	0	4	6	7	0	6.8	No, 2 d.f.
			493	283	227	6(5) 13(6)	317	393	288	0 (7) 8(8)	70.4	Yes, 4 d.f.
Secondary		X	30	0	1	0	26	0	7	0	4.7	No, 1 d.f.

(1,2,3,4) Number of times load used 1½ lanes on 6-lane divided highway.
(5,7) Load encroaching into opposite direction lane because of narrow structures, pedestrians, etc.
(6,8) Load encroaching into opposite direction lanes in towns because of parked vehicles.

TABLE 9

X^2 VALUES FOR LOAD LATERAL PLACEMENT

SYSTEM	DIRECTION		LOAD LATERAL PLACEMENT			
	SAME	OPPOSITE	PAVEMENT	EDGELINE	SHOULDER	OTHER
Interstate	X		* 165.0	* 121.3	361.4	-
4-Lane Divided	X		* 38.2	5.9	* 17.6	(1)* 7.7
4-Lane Undivided	X		* 21.0	5.5	* 9.2	(2)* 32.4
2-Lane	X		5.2	0.7	2.2	
Primary		X	58.4*	29.0*	10.6*	4.1(3) 0.7 (4)
Secondary		X	3.2	-	3.2	-

(1) Load using 1½ lanes on 6-lane divided highway.
(2) Load using 1½ lanes on 6-lane divided highway.
(3) Load encroaching into opposite direction lane because of narrow structures, pedestrians, etc.
(4) Load encroaching into opposite direction lanes in towns because of parked vehicles.

* Significant Difference

Time constraints prevented a detailed investigation of each of these factors, however some of the parameters were analyzed.

Pavement Width

The effect of pavement width on lateral placement was investigated on two-lane primary facilities. To eliminate the effect of other factors, e.g., axle width, only 12-foot units were used in this analysis. Vehicle and load placement samples were taken for 10-, 11- and 12-foot pavements and the results are given in Table 10. Based on the data in Table 10, it can be concluded that decreases in pavement width cause motorists and the wide load driver to increase their use of the shoulder. This result implies increased hazards for motorists and the wide housing units. Increased use of the shoulder could also lead to increased maintenance expenditures as shown in Figure 18. Because of small sample sizes, it was not possible to examine the effects of lateral placement on 8- and 9-foot pavements. The overall result of this finding is that wide load travel should be minimized on roads with lanes less than 12-feet wide.

TABLE 10

EFFECT OF PAVEMENT WIDTH ON LATERAL PLACEMENT

Pavement Width, Ft.	Lateral Placement: Vehicle				12-foot Load			
	Pave.	Edge.	Shoulder	χ^2- Sign.	Pave.	Edge.	Shoulder	χ^2-Sign.
12	107	15	1	26.78	89	30	0	0.003
11	78	44	11	Yes, 2 d.f.	64	22	0	No,1 d.f.
11	78	44	11	14.57	64	22	0	17.88
10	17	8	12	Yes, 2 d.f.	12	4	4	Yes,2 d.f.
12	107	15	1	42.94	89	30	0	24.51
10	17	8	12	Yes, 2 d.f.	12	4	4	Yes,2 d.f.

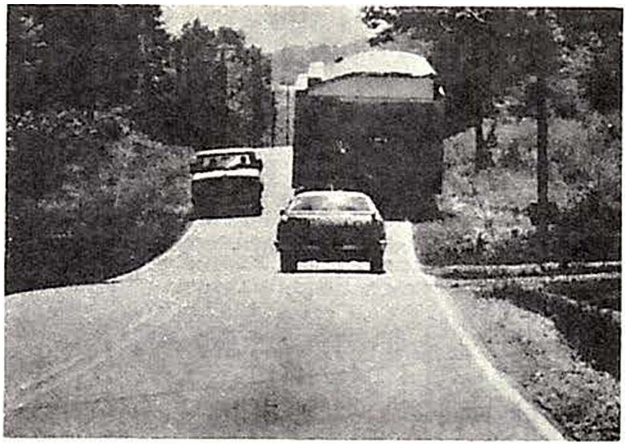

Figure 18. Wide loads on 10-foot lanes influence use of the shoulder.

Load Axle Width

During the study period, one firm produced 14-foot mobile units with an axle width of 9.7 feet. Most companies produced standard axle widths ranging from 7.4 feet to 8.5 feet. It was hypothesized by the study team that the extra wide axle was affecting the lateral placement of the load, which possibly could explain the differences in lateral placement between 12- and 14-foot loads. To test this hypothesis, the placement data for the interstate and four-lane divided facilities were summarized according to load size and axle width. This analysis was not possible on the other highway systems because the sample sizes were too small to afford comparison. As shown in Table 11, for the interstate system there was no significant difference in vehicle and load placement data for the 14-foot units with 7.9- and 9.7-foot axles. There was, however, a significant difference between the placement values for 12- and 14-foot units with the same axle width (7.9 feet). The importance of this result is that the width of the load and not the axle width created a significant difference in lateral placement between 12- and 14-foot loads.

TABLE 11

EFFECT OF AXLE WIDTH ON LATERAL PLACEMENT

		Lateral Placement							
		Vehicle				Load			
Load Width, ft.	Axle Width, ft.	Pav.	El.	Sh.	χ^2 Sign.	Pav.	El.	Sh.	^{2} Sign
					Interstate				
12	(7.9)	257	38	4	12.18	112	120	72	127.22
14	(7.9)	73	26	4	Yes,2 d.f	3	4	76	Yes, 2 d.f.
14	(7.9)	73	26	4	2.45	3	4	76	1.77
14	(9.7)	252	62	19	No,2 d.f.	7	29	335	No,2 d.f.
					4-Lane Divided				
12	(7.6)	303	47	11	17.31	206	86	44	9.20
14	(7.4)	233	64	28	Yes,2 d.f	137	95	25	No,2 d.f. (Yes at 97.5%)
14	(7.4)	233	64	28	8.16	137	95	25	68.26
14	(9.7)	46	25	12	No,2 d.f. (Yes at 97.5%)	9	27	35	Yes, 2 d.f.

On four-lane divided facilities there were significant differences in vehicle and load lateral placements when 12- and 14-foot units having axles of the same width were compared. However, there were also significant differences in the placement values for 14-foot units with axles of different widths (7.4-foot vs. 9.7-foot axle). The effect of the wide axle was to induce increased useage of the shoulder. This finding is contrary to that noted for the interstate system. The following is a possible explanation of this phenomenon. It appears that vehicle lateral placement is directly affected by the proximity of the wide load. Because the shoulders are not paved on four-lane divided facilities wide load drivers refrain from using the shoulder. A 14-foot unit with a short axle can be maneuvered within the pavement area but the load forces more motorists toward the shoulder than is the case for the 12-foot units. On a 14-foot unit with a wide axle, the load driver must use the shoulder to avoid encroaching on the adjacent lane. Although the wide axle 14-foot unit must move over to the shoulder further than is necessary for a 14-foot unit with a standard axle, motorists perceive the load as more unstable because the load is on the shoulder, and they move further to the shoulder to allow greater clearance.

The importance of this finding is that wide axle (in excess of 8.5 feet) housing units should not use any highway system not having paved shoulders.

Vehicle Width

The effect of vehicle width (vehicles other than the wide load) on lateral placement was investigated for the interstate and two-lane primary systems. To make this evaluation, only 12-foot units were used, and the pavement width and the axle width of the load were held constant. The results of the analysis are given below.

Interstate System

1. Trucks and tractor-trailers are displaced further toward the shoulder than are cars.

2. The load is displaced further toward the shoulder by a tractor-trailer than it is by a car.

3. There is no significant difference in lateral placement between cars and trucks as determined by the reactions of the wide load driver.

Two-Lane Primary System

1. On 12-foot lanes, trucks and tractor-trailers were displaced further toward the shoulder than were cars.

2. On 12-foot lanes there was no difference in the lateral placement of the load as influenced by the width of other vehicles.

3. On 11-foot lanes there was no apparent effect of vehicle width on lateral placement.

These results are of practical significance because they lead one to conclude that (1) on 12-foot lanes wide vehicles in the traffic stream are displaced more than are narrow vehicles, and (2) as the pavement width decreases, there is no effect of vehicle width on lateral placement.

Summary

1. Fourteen-foot wide units were found to produce significantly greater vehicle displacements than did 12-foot units. In meeting or passing other vehicles, a 14-foot unit used the shoulder more frequently than did a 12-foot unit.

2. On four-lane undivided highways, motorists passing 12- and 14-foot units crossed the double yellow line and encroached on the opposing traffic lane.

3. Wide housing units traveling on traffic lanes less than 12 feet wide used the shoulder when meeting other traffic. Also, other vehicles frequently used the shoulder when meeting wide loads on narrow roads.

4. On highways without paved shoulders, wide loads with axle widths in excess of 8.5 feet produced significantly greater vehicle displacements than did loads with axle widths less than 8.5 feet.

Encroachment Data

The reasons for recording encroachment data were to identify factors that cause wide loads to encroach into the adjacent lane, and to determine if there was a significant difference in the encroachment parameters for 12- and 14-foot units. Based on the field data, the factors that contribute to encroachment of wide loads are: (1) vehicle on shoulder, (2) narrow structure, (3) pedestrian, (4) signing, (5) construction and maintenance zones, (6) narrow pavement and shoulder, and (7) sharp curve. A summary of the encroachment data is given in Tables 12 and 13. The chi-square statistic was used to compare the proportions of encroachments in each category for 12- and 14-foot loads and the results are given in Table 14. Although there was a tendency for 14-foot units to encroach more frequently than 12-foot units, the difference was statistically significant for only the interstate and two-lane primary systems.

As shown in Table 15, the significance of each encroachment parameter was investigated. For the interstate system, the data indicate that the significant difference in distribution can be attributed to a higher frequency of encroachment of 14-foot units at narrow structures, e.g., at structures that were perceived by the driver to be narrow enough to cause him to encroach into the adjacent traffic lane. On two-lane primary highways the difference in distribution was more pronounced. As shown in Table 15, 14-foot units encroached significantly more at narrow structures, on narrow pavements with narrow shoulders, and on sharp curves. On the secondary system, encroachment was defined as continuous because the 12- and 14-foot units always encroached into the adjacent traffic lanes on those facilities. This phenomenon is shown in Figure 19. Although traffic volumes were sparse on the secondary system, motorists meeting a wide load often had to pull off the road until the unit passed.

The encroachment data indicate that, in general, wide loads frequently encroach on the adjacent traffic lane. On divided highways the encroachment of either the 12- or 14-foot units did not appear to affect traffic. However, on two-lane facilities the encroachment was more serious because it could result in a head-on collision. This possibility is shown in Figures 20 and 21.

TABLE 12

ENCROACHMENT SUMMARY FOR 12 FOOT UNITS

SYSTEM	VEHICLE ON SHOULDER	NARROW STRUCTURE	PEDESTRIAN	TEMPORARY SIGN	CONSTRUCTION & MAINTENANCE	NARROW PAVEMENT SHOULDER	SHARP CURVE
Interstate	19	3	5	0	7		0
4-Lane Divided	76	42	14	6	0	20	4
4-Lane Undivided	12	22	9	0	3	11	0
2-Lane Primary	40	52	9	0	0	22	12
Secondary		Continuous Encroachment					

TABLE 13

ENCROACHMENT SUMMARY FOR 14-FOOT UNITS

SYSTEM	VEHICLE ON SHOULDER	NARROW STRUCTURE	PEDESTRIAN	TEMPORARY SIGN	CONSTRUCTION & MAINTENANCE	NARROW PAVEMENT SHOULDER	SHARP CURVE
Interstate	48	26	5	0	6	0	0
4-Lane Divided	102	89	20	14	0	41	1
4-Lane Undivided	22	37	14	0	15	23	0
2-Lane Primary	78	80	16	6	0	102	73
Secondary		Continuous Encroachment					

TABLE 14

SIGNIFICANCE OF ENCROACHMENT

SYSTEM	X^2	SIGNIFICANCE $\alpha = 0.01$	
Interstate	13.4	Yes	4 d.f.
4-Lane Divided	8.8	No	5 d.f.
4-Lane Undivided	3.0	No	4 d.f.
2-Lane Primary	28.5	Yes	5 d.f.

TABLE 15

X^2 VALUES FOR ENCROACHMENT

SYSTEM	VEHICLE ON SHOULDER	NARROW STRUCTURE	PEDESTRIAN	TEMPORARY SIGN	CONSTRUCTION AND MAINTENANCE	NARROW PAVEMENT & SHOULDER	SHARP CURVE
Interstate	0.0003	5.4	1.3	-	3.0	0.2	-
4-Lane Divided	2.8	2.2	0.1	0.2	-	0.5	2.2
4-Lane Undivided	0.002	0.3	0.1	-	1.9	0.0002	-
2-Lane Primary	2.7	*11.9	0.5	1.1	-	*7.4	*8.5
Secondary	Continuous Encroachment						

* Significant Difference $\alpha = 0.01$.

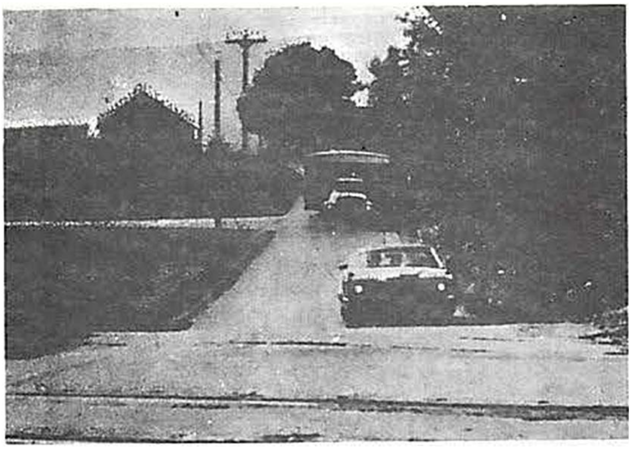

Figure 19. Twelve- and 14-foot housing units continuously encroached into the adjacent lane on secondary facilities.

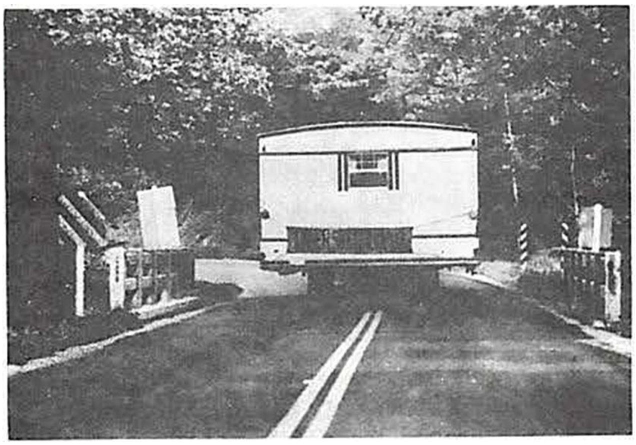

Figure 20. Wide loads frequently encroached into the opposing traffic lane on narrow two-lane highways.

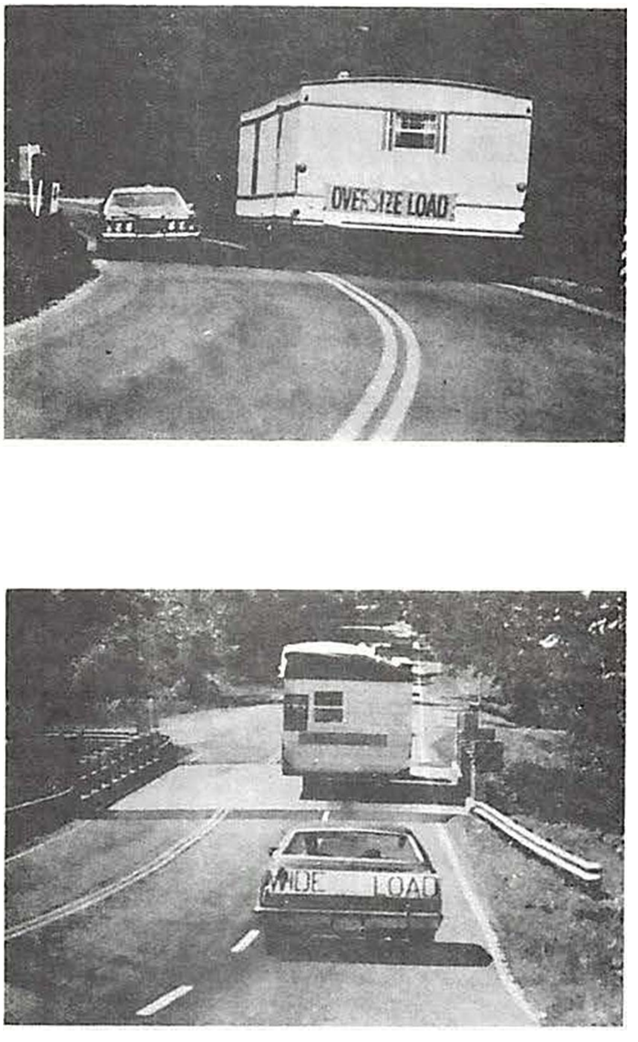

Figure 21. Encroachment at narrow structures.

Although the distributions of encroachment parameters were not significantly different for 12- and 14-foot loads, there was a greater number of encroachments with 14-foot units,especially at narrow structures. To test the significance of this observation, the encroachments at narrow structures for each trip were divided by the length of the test section. The t statistic was used to examine the difference in mean structure encroachments for 12- and 14-foot units. The t value was -2.53, which is not significant at the 99% confidence level. Therefore, the trend for 14-foot wide units to encroach at narrow structures is not significantly different from that of 12-foot units. One possible explanation of the greater number of encroachments by the 14-foot units was offered by the data collectors. As most of the wide load drivers had not transported a 14-foot unit before this experiment, it is possible that they perceived a problem with the new load and encroached more frequently than they do with a 12-foot unit.

Summary

1. There was a tendency for 14-foot units to encroach into the adjacent traffic lanes more frequently than did 12-foot units; however, the difference was significant for only the interstate and two-lane primary highways. On the interstate facilities the difference can be attributed to narrow structures. On two-lane primary highways encroachment was attributed to narrow structures, narrow pavement and shoulders, and sharp curves.

2. On narrow two-lane facilities 12- and 14-foot units continuously encroached into the adjacent lane.

3. The data suggest that 12- and 14-foot units frequently encroach on the opposing traffic lane on narrow two-lane facilities, which creates potentially hazardous conditions.

Queuing Data

As discussed in the literature, one of the objections to the movement of 14-foot wide units on highways is the inconvenience these units impose on other traffic.(7) For the purpose of this study, inconvenience was measured by the impedance times experienced by motorists who entered a queue created by a wide load. During the field tests, the team observed that among the factors affecting queuing are (1) speed of the load relative to the speed of traffic, (2) roadway design characteristics (e.g. four-lane divided vs. two-lane highways), (3) the number of times the wide load driver stopped to permit traffic to pass, and (4) the traffic volume.

The queue data were analyzed by dividing the total impedance time, which is the sum of the times vehicles were in queue due to wide loads,by the length of the test section. The purpose of this computation was to eliminate the effect of trip length on impedance time. The impedance data, expressed as seconds of impedance per mile, are shown in summary form in Table 16. As shown in Table 16, there were no statistically significant differences between the impedance times for 12- and 14-foot units. The impedance values for the interstate, four-lane divided, and secondary systems should be viewed with caution as the tolerance errors ranged from 52% to 198%, which indicates the sample sizes were small. These small sample sizes were a result of the queuing characteristics on these facilities. For example, on the interstate and four-lane divided facilities queuing was a rare event. Most motorists approached and passed the wide load without forming a queue. Because of low traffic volumes on the secondary facilities, queues were infrequent; however, once a motorist joined a queue on these facilities, he remained in it until the load pulled off or he turned off the roadway.

Queuing caused by wide loads occurred frequently on two-lane facilities. On these roadways there were few opportunities for motorists to pass the load. Although there was considerable inconvenience to motorists on two-lane primary routes, no significant difference was found between impedances caused by 12- and 14-foot loads.

It should be noted that queue data were not collected on four-lane undivided highways. These test sections were located in suburban areas where traffic flow was regulated by traffic signals. Due to the queuing effects of signals on traffic, it was not possible to separate the queues created by signals from those created by the wide loads.

TABLE 16

IMPEDANCE TIME SUMMARY*

SYSTEM	12-FOOT LOAD			14-FOOT LOAD				
	NO.	MEAN $(\bar{X})_{12}$	VARIANCE$(s^2)_{12}$	NO.	MEAN $(\bar{X})_{14}$	VARIANCE$(s^2)_{14}$	t VALUE	SIGNIFICANCE $\alpha = 0.01$
Interstate	8	10.6	77.15	11	8.6	67.67	0.50	No, 16 d.f.
4-Lane Divided	14	8.5	166.60	19	8.5	859.01	-1.84	No, 27 d.f.
4-Lane Undivided		NO	DATA	AVAILABLE				
2-Lane Primary	20	234.8	50101.21	24	207.6	42662.49	0.41	No, 41 d.f.
Secondary	3	42.2	2451.77	6	61.7	2980.22	-0.54	No, 7 d.f.

*Data expressed as seconds of impedance per mile.

The queue data were also examined to determine if there were significant differences in the distributions of vehicles by queue size, that is, to determine the numbers of 1, 2, 3, ... vehicle queues. These data are given in Table 17. The chi-square statistic indicates that there were no significant differences in queue size caused by 12- and 14-foot units. Table 17 also illustrates the queuing characteristics of the highway systems. On interstate, four-lane divided, and secondary roads, a queue size greater than 2 vehicles was rare. The average impedance time for a vehicle in a queue ranged from 73 seconds on the interstate system to 213 seconds on the secondary system. Conversely, on two-lane primary highways queues of 10 vehicles or more often occurred. The average impedance time for a vehicle in a queue was 420 seconds (7 minutes).

One of the factors that affects impedance time due to queuing on two-lane facilities is the number of times the wide load driver stops to let traffic pass. To illustrate this effect, 12- and 14-foot test units were driven over a 100-mile section of two-lane primary highway. Travel speeds for the 12- and 14-foot units were 34 mph and 29 mph, respectively. During the test, the driver of the 12-foot unit twice pulled over to let traffic pass, while the driver of the 14-foot unit yielded to traffic 12 times. The effects of these actions on the impedance time for vehicles in a queue are shown in Figure 22. The data clearly indicate that inconvenience to other traffic is minimized by having the wide load driver frequently yield to following traffic.

The effects of average load speed and traffic volume on queuing were also investigated for several selected test runs. A complete analysis of these data could not be included in this report because of time limitations, however, a preliminary review of the data suggests that increases in travel speed for the load lead to small incremental decreases in impedance times. An increase in traffic volume on a given test section produced a small increase in impedance time.

Summary

1. There were no statistically significant differences in the total impedance times (delay to traffic) or queue sizes created by 12- and 14-foot loads.

2. Queuing caused by wide loads occurred frequently on two-lane primary highways.

TABLE 17

QUEUE SIZE DISTRIBUTION*

SYSTEM	12-Foot Load										14-Foot Load										X^2	Significance $\alpha = 0.01$
	Queue Size																					
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10		
Interstate	40	11									55	8									1.60	No, 1 d.f.
4-Lane-Div.	37	4									44	11	3	2	1						6.19	No, 1 d.f.
4-Lane-Und.	DATA WERE NOT TAKEN																					
2-Lane Prim.	46	41	32	18	18	16	12	12	7	3	56	53	37	27	19	17	10	16	8	7	2.73	No, 9 d.f.
Secondary	4	1									8	1									0.21	No, 1 d.f.

*The interpretation of this table is as follows. For 12-foot loads on the interstate system, there were a total of 40 1-vehicle queues, 11 2-vehicle queues, etc.

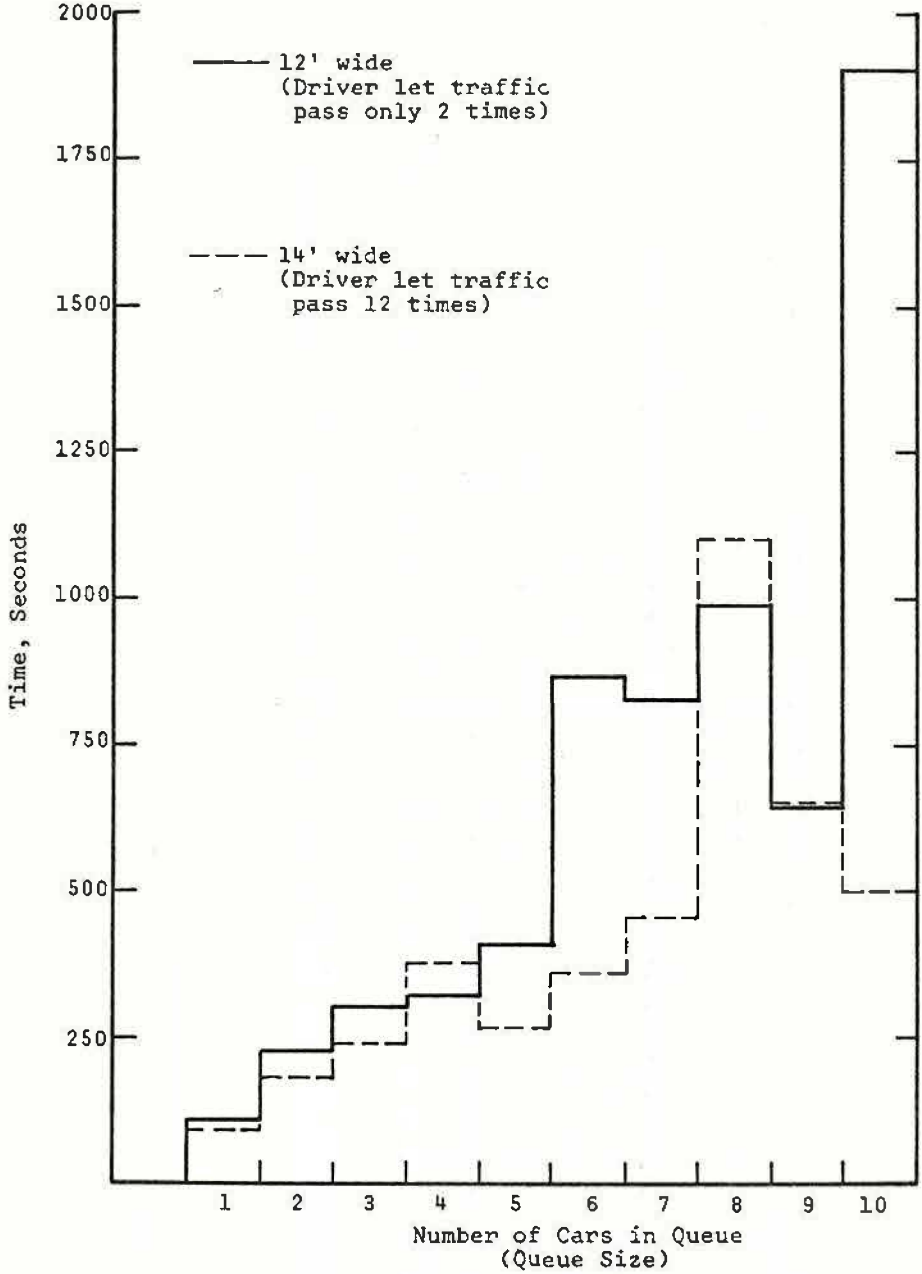

Figure 22. Effects of wide load drivers yielding to traffic on average vehicle impedance time.

Passing Time Data

The passing time data were taken when vehicles passed wide loads and when the loads passed other vehicles. The results of the analysis of vehicle passing times are shown in Table 18. Although there was a tendency for vehicles passing a 14-foot load on interstate and four-lane divided highways to use a longer passing time, the trend was not statistically significant. Motorists passing wide loads on two-lane facilities completed the passing maneuver in significantly less time than did motorists on either interstate or four-lane facilities. The reason for the difference is twofold. First, the average travel speed of the load on two-lane facilities was considerably lower than its speed on interstate and four-lane routes. This differential permitted vehicles to overtake the loads in less time on two-lane routes. Secondly, on two-lane facilities it was observed that motorists quickly responded to a passing opportunity because such opportunities did not occur frequently.

The times required by wide loads to pass slower moving vehicles were recorded and the results are given in Table 19. It should be noted that the loads passed other vehicles only on interstate and four-lane divided routes. For any given wide load, the number of vehicles passed per test section ranged from 2 to 7, depending upon the speed of the load. As noted in Table 19, there were no statistically significant differences between the load passing times for 12- and 14-foot units.

Summary

1. There were no significant differences between the times required for vehicles to pass the 12- and the 14-foot housing units.

2. There were no significant differences between the times required by the 12- and the 14-foot units to pass other vehicles.

TABLE 18

VEHICLE PASSING TIME SUMMARY
(Passing times expressed in seconds.)

System	12-foot Load			14-foot Load			t Value	Significance $\alpha = 0.01$
	No.	Mean ($\bar{X}_{12}$)	Variance(s_{12}^2)	No.	Mean ($\bar{X}_{14}$)	Variance(s_{14}^2)		
Interstate	33	30.42	209.55	41	39.63	359.56	-2.37	No, 74 d.f.
4-Lane Divided	34	22.29	84.52	23	31.82	245.53	-2.63	No, 33 d.f.
4-Lane Unidivided	2	38.50	—	0	—	—	—	—
2-Lane Pri.	29	12.71	19.44	17	11.94	10.87	.67	No, 44 d.f.
Secondary	None	—	—	None	—	—	—	—

TABLE 19

LOAD PASSING TIME SUMMARY
(Passing times expressed in seconds.)

System	12-foot Load			14-foot Load			t Value	Significance $\alpha = 0.01$
	No.	Mean ($\bar{X}_{12}$)	Variance(s^2_{12})	No.	Mean ($\bar{X}_{14}$)	Variance(s^2_{14})		
Interstate	21	27.62	89.97	20	29.68	142.61	-0.61	No, 38 d.f.
4-Lane Divided	19	20.05	24.22	8	18.56	6.82	1.02	No, 26 d.f.
4-Lane Undivided	2	19.50	Not meaningful	1	20.00	0		--
2-Lane Pri.	1	13.00	0	None	—	—	—	—
Secondary	None	—	—	None	—	—	—	—

Maneuverability Data

A subjective evaluation of the maneuverability characteristics of wide housing units was made by the data collection team. The 12- and 14-foot units were observed as they maneuvered at ramps, junctions, intersections, and along the highway.

The geometric design of the interstate system roads that provides wide pavement and shoulders and large radius curves enabled both the 12- and 14-foot units to maneuver without difficulty. This fact is illustrated in Figure 23. As shown in Figure 24, the units also exhibited no problems in maneuvering through maintenance and construction zones. The only problem associated with the travel of 14-foot units on the interstate system was in negotiating toll plazas. Figure 25 shows a 12-foot unit using a toll plaza on the Richmond-Petersburg Turnpike. These plazas were built to accommodate a maximum width of 12 feet. This design construction forced the 14-foot units to bypass I-95 and use Route 1 through Petersburg, Colonial Heights, and Richmond. To allow the collection of compatible data, the 12-foot units were also detoured along Route 1. No major differences were observed in the performances of the 12- and 14-foot units on Route 1, but these units were passed by motorists who crossed the double yellow line into the opposing direction traffic lane. The 14-foot units caused increased traffic hazards on Route 1 in the Petersburg, Colonial Heights, and Richmond areas. In one incident, traffic barriers had to be moved to permit the unit to pass through a maintenance zone.

As was observed on the interstate system, travel on four-lane divided highways presented no maneuverability problems for either the 12- or 14-foot units. No difficulty was encountered at intersections or along the highway, as is illustrated in Figures 26 and 27. Although similar observations were made for the units on four-lane undivided systems, their presence directly affected the actions of other vehicles. This effect is discussed later under Safety Incidences. The maneuverability of wide loads in high wind was not investigated as there was very little wind during the tests.

Maneuverability problems with wide loads were often noted on two-lane primary and secondary roads. These problems were encountered by the vehicles while turning at intersections, traveling on roads with narrow pavements and narrow shoulders, and crossing railroad tracks. Although the 12-foot units met with the same problems as did the 14-foot units, the degree of difficulty and the frequency of occurrence were greater for the 14-foot units. Specific examples of these problems are discussed below.

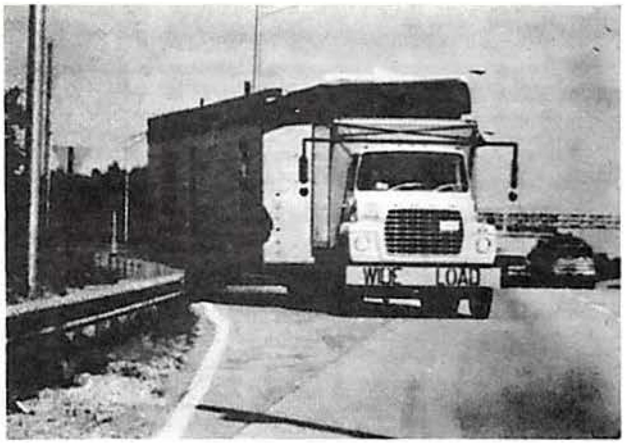

Figure 23. Twelve-foot wide modular housing unit entering interstate route.

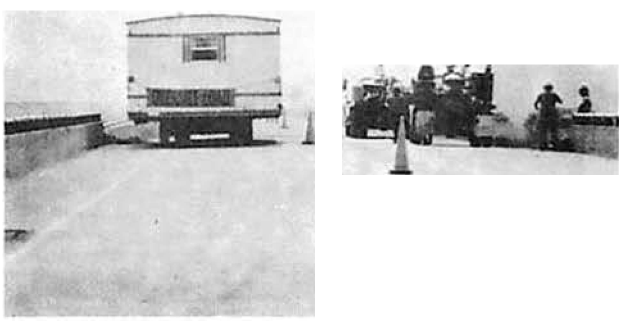

Figure 24. Fourteen-foot wide mobile housing unit exhibited little difficulty in maneuvering through maintenance and construction zones.

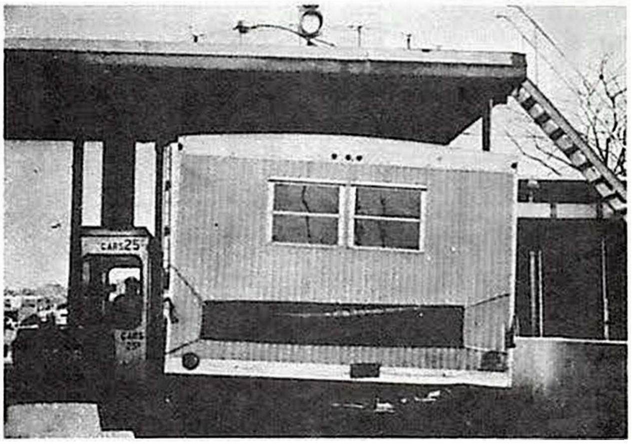

Figure 25. Twelve-foot mobile housing unit at Toll Plaza on Richmond-Petersburg Turnpike.

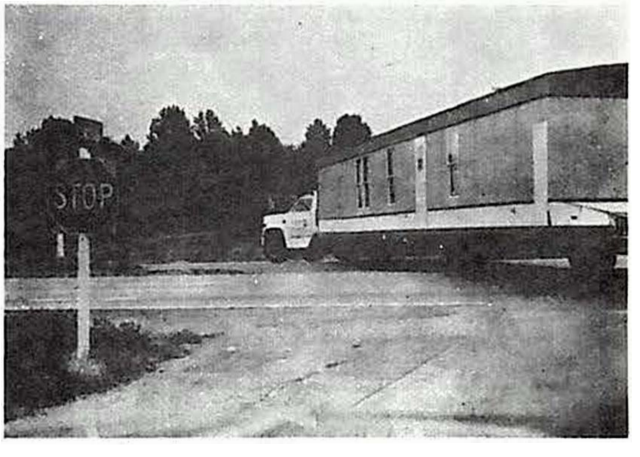

Figure 26. Fourteen-foot mobile housing unit turning onto four-lane divided highway.

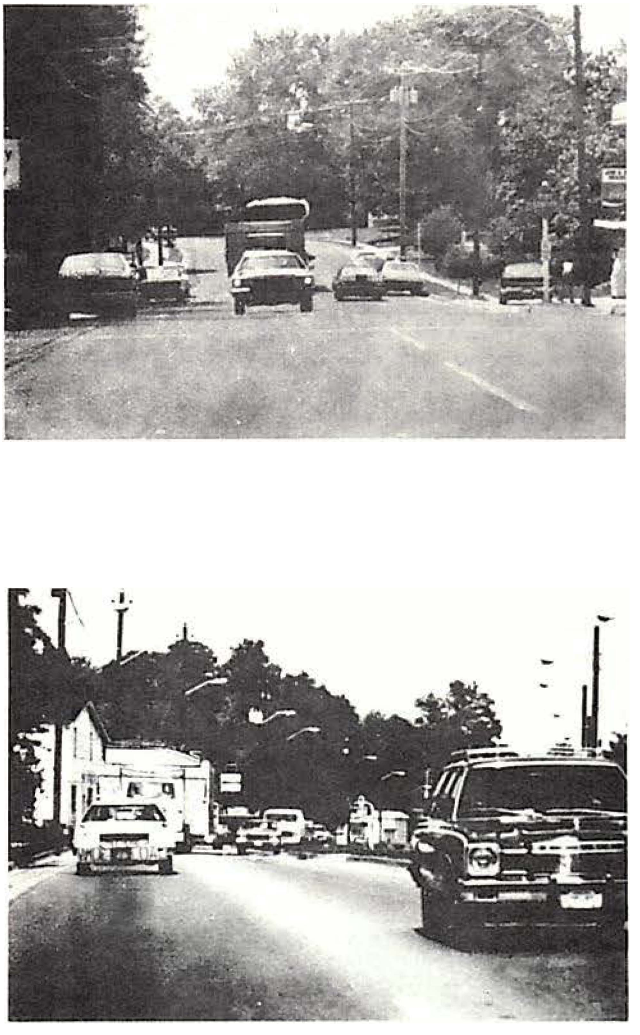

Figure 27. Fourteen-foot modular housing unit traveling through urban areas.

Intersection of Rte. 11 and Rte. 263

In turning left off Rte. 11 onto Rte. 263, a 14-foot load became stuck in a ditch. This intersection is shown in Figure 28. The problem in making the turn was caused by the stop sign in the center island on Rte. 263. Because of the width of the 14-foot unit, the driver had to use much of the shoulder to make the turn. The shoulder was lower than the pavement and, because of the low clearance on the underside of the 14-foot unit, the load dragged bottom and became stuck. By removing the stop sign and raising the hitch on the towing unit, the driver was able to free the load. This incident blocked the intersection for 25 minutes and traffic had to be directed around the load. Earlier that day a 12-foot unit had maneuvered through the intersection without a problem or delay.

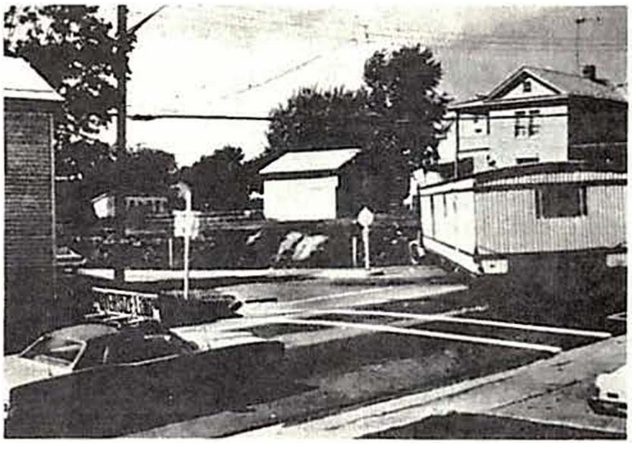

Figure 28. Fourteen-foot wide mobile home turning at the intersection of Rte. 11 and Rte. 263.

Intersection of Rte. 47 and Rte. 664

The 14-foot unit had difficulty in making a right turn from Rte. 47 onto Rte. 664. The problem was caused by the acute angle of the turn and the crown of the road, and was compounded by the low clearance of the 14-foot load. The load had to back up several times and use the front yard of an adjacent property in order to make the turn. The bottom of the load struck the road while making the turn and caused increased maneuvering difficulty. The next day a 12-foot unit made the same turn, and although it also struck the road, it had far less difficulty in completing the turn.

Railroad Tracks on Rte. 669 at Baskerville

The railroad tracks at Baskerville are on the crest of a short vertical curve. Because of the difficulty the driver of the 14-foot unit had experienced in negotiating the turn described above, he felt that the low load might get hung on the tracks. To avoid this possibility he stopped the load before crossing the tracks and raised the hitch on the towing unit. This gave the load an additional 2 inches of clearance; however, it still struck the rails when crossing the tracks. The next day, with the 12-foot wide load, the driver did not raise the hitch and also struck the rails.

Summary

1. Maneuverability problems were encountered by both the 12- and 14-foot wide loads.

2. The 14-foot units encountered more frequent and difficult maneuverability problems than did the 12-foot units.

3. The major cause of the increased problems for the 14-foot units was the low clearance of the unit.

Regulation Violation Data

During the course of the investigation the data collection team noted occasions when permit regulations were violated. It was the general consensus that most industries recognized the need to move wide loads in accordance with safety regulations. Several types of violations are discussed here because they reoccurred frequently.

As was mentioned previously, drivers for different companies exhibited noticeably different behavior toward obeying the speed limits imposed on wide load units. Of the 72 trips with a 12-foot load on which travel speeds were computed, 29 speed limit violations were observed. With the 14-foot load, 33 violations were observed in 89 trips. A statistical comparison of the distributions of speed violations using the chi-square test showed no difference between the violation rates for the 12- and 14-foot units. Although there were many violations of the speed restrictions, no problems were observed with those units traveling above the regulation speeds. A preliminary review of the data suggests that loads traveling slower than the mean speed of the traffic create more potential safety hazards than do those traveling with the flow of traffic, which indicates the need for further investigation of the speed restrictions placed on wide loads.

Another common violation of permit regulations related to the use of escort vehicles. On 20 of 104 trips with a 14-foot unit, the rear escort vehicle was absent or out of place for all or part of the trip. There were no such violations recorded for the 12-foot units. Although specific escort vehicle operations are not included in the permit manual, it was the general opinion of the observers that in many cases the performance of the escort vehicles was substandard. A wide variation in their operations was observed. Some of the escorts stayed in constant communication with the load, warning the driver of the load of oncoming traffic and obstructions, and working effectively to enhance safety during lane changes and turns made by the load. These escorts were in the minority as most of the escorts performed no function other than to display a warning sign. At the other extreme, the driver of an escort vehicle was observed to be so intent on protecting the load that often he would encroach into the opposing traffic lane and force vehicles off the road to ensure the safety of the load. It is felt that the major problems are caused by a lack of understanding and training regarding the proper use of escort vehicles. Similar observations made in the study by the Midwest Research Institute support the need for research in this area.[9]

Other violations included substandard or missing flags, failure to burn headlights, and improperly displayed signs. These violations were infrequent and were not unique to either the 12- or 14-foot units.

Summary

1. Although numerous violations of speed restrictions were observed, no significant differences were found between the numbers of violations for 12- and 14-foot units.

2. Load speeds above the regulation limits did not create any observed problems.

3. Substandard escort vehicle operations were commonplace during the study, especially on two-lane highways.

4. There is a need for a review and revision of permit regulations for wide loads; especially those pertaining to speed limits and escort vehicles.

Traffic Conflicts Data

The traffic conflicts technique developed by Perkins to measure accident potentials at intersections was modified to examine the accident potential of wide loads.(13) Based on preliminary tests, a definition that could be applied to all moving wide loads was developed. For the purpose of this study a traffic conflict is defined as an evasive measure, as evidenced by a brake light indication, taken by a driver operating a vehicle in the vicinity of a wide load. The definition also includes evasive maneuvers taken by a wide load driver operating in the vicinity of other traffic or narrow roadside obstructions (fixed objects). This definition does not include conflicts between the wide load and escort vehicles, as escorts were considered to be an integral component of the load.

The purpose of using traffic conflicts was twofold. First, the type and frequency of traffic conflicts associated with wide load movement could be determined. Second, the technique provides one measure that could be used to evaluate differences in accident potential (number and types of conflicts) between 12-foot and 14-foot loads.

On interstate and four-lane divided facilities, traffic interacting with a wide load is unidirectional, so the camera in the rear test car was used to record vehicle and load conflicts. On two-lane facilities the cameras in the rear and front research vehicles were utilized to record conflicts for both directions of travel.

During the study, 747 conflicts were observed for 12-foot housing units and 833 were noted for 14-foot units. For the analysis, these conflicts were defined for 13 specific occurrences. To simplify the discussion, the definitions of these conflicts are given in Figures 29 through 41.

Summaries of the conflict data are given in Tables 20 and 21, and a statistical comparison of these data is given in Table 22.

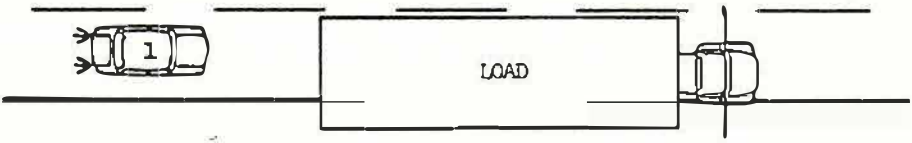

Figure 29. Direct rear end vehicle conflict. Vehicle No. 1 following the wide load must brake to avoid a collision with the load.

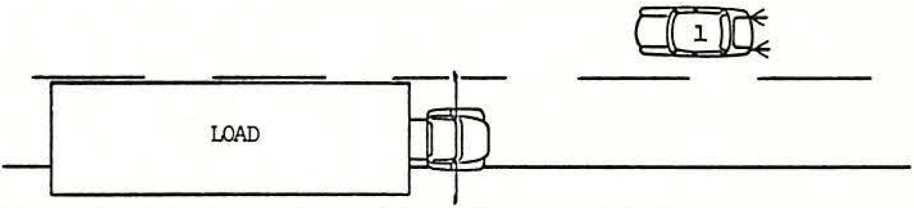

Figure 30. Direct opposing vehicle conflict. Vehicle No. 1 approaching the wide load brakes to avoid a collision with the load or adjacent roadside obstacle.

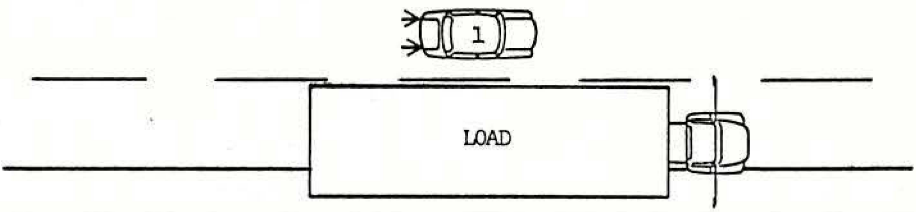

Figure 31. Direct passing vehicle conflict. Vehicle No. 1 passing the wide load brakes to avoid a collision with the load, approaching traffic, or roadside obstacle.

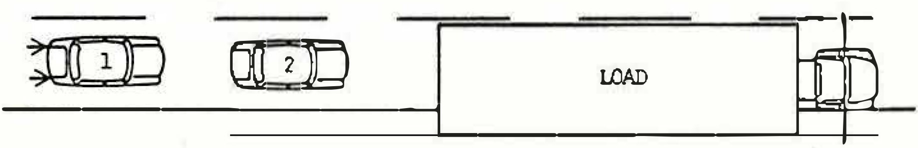

Figure 32. Indirect non-previous rear end vehicle conflict. Vehicle No. 1 must brake to avoid a collision with vehicle No. 2, who is following a wide load.

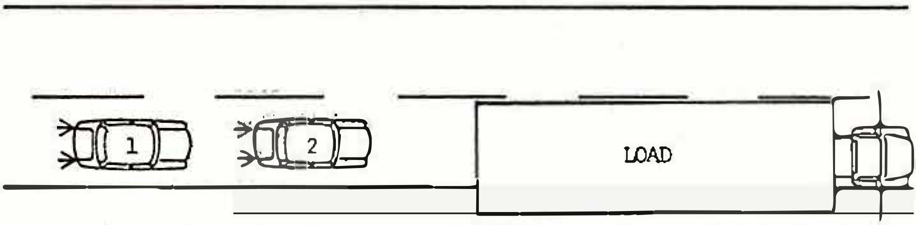

Figure 33. Indirect previous rear end vehicle conflict. Vehicle No. 1 brakes in response to vehicle No. 2, who brakes to avoid a collision with the wide load.

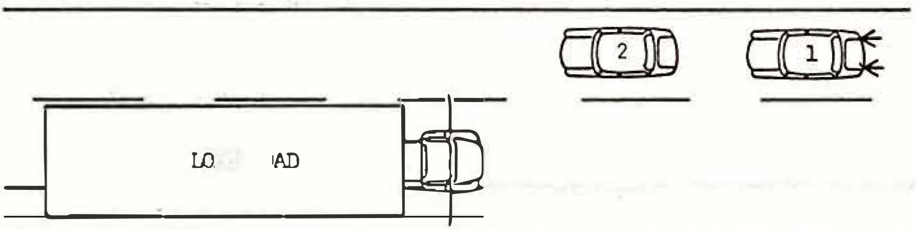

Figure 34. Indirect non-previous opposing vehicle conflict. Vehicle No. 1 brakes to avoid a collision with vehicle No. 2, which is approaching a wide load.

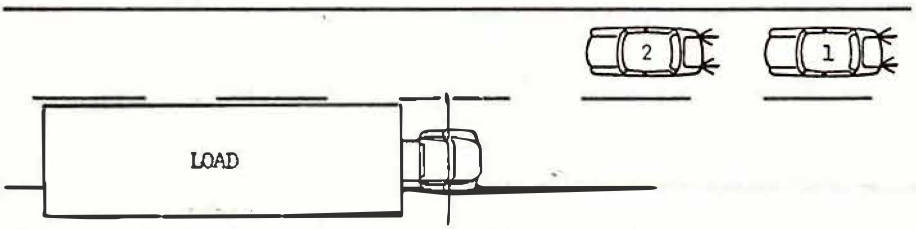

Figure 35. Indirect previous opposing vehicle conflict. Vehicle No. 1 brakes in response to vehicle No. 2, who brakes to avoid a collision with the wide load or roadside obstacle.

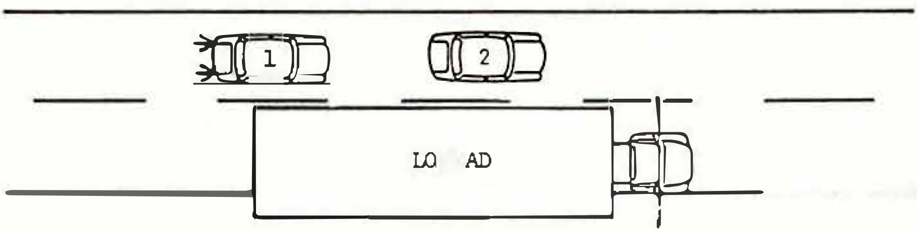

Figure 36. Indirect non-previous passing vehicle conflict. Vehicle No. 1 brakes to avoid a collision with vehicle No. 2, who is passing a wide load.

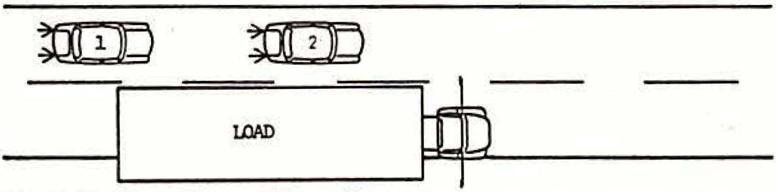

Figure 37. Indirect previous passing vehicle conflict. Vehicle No. 1 brakes in response to vehicle No. 2, who brakes to avoid a collision with the wide load, opposing traffic, or a roadside obstacle.

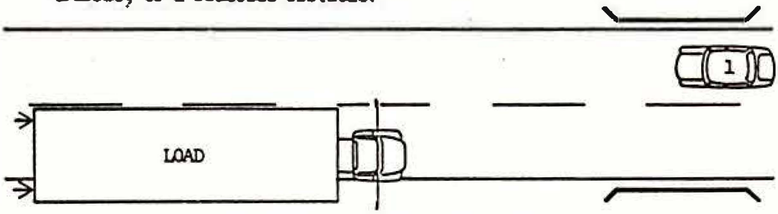

Figure 38. Opposing traffic and narrow structure load conflict. Load brakes to avoid a collision with a narrow strucutre and vehicle No. 1.

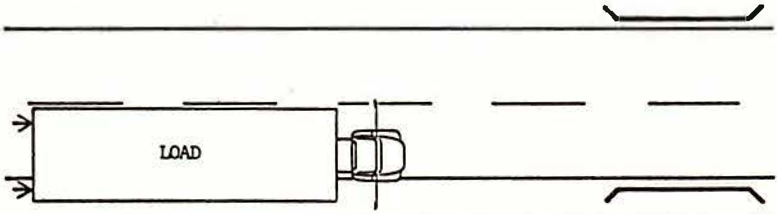

Figure 39. Narrow structure load conflict. Load brakes to avoid a collision with a narrow structure.

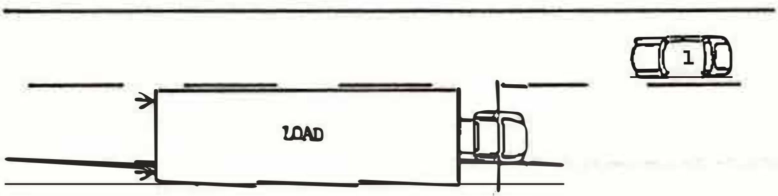

Figure 40. Opposing traffic load conflict. Load brakes to avoid a collision with vehicle No. 1 in the opposing traffic lane.

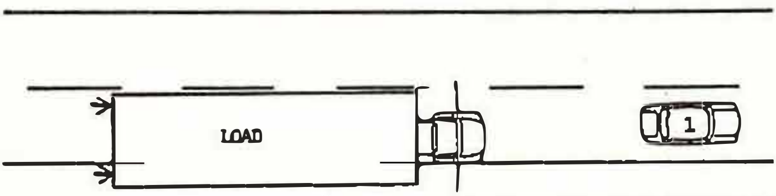

Figure 41. Read end load conflict. Load brakes to avoid a collision with vehicle No. 1 traveling in the same direction.

TABLE 20

VEHICLE CONFLICT SUMMARY 12-FOOT LOAD

SYSTEM	VEHICLE CONFLICTS: DIRECT			INDIRECT						Other	LOAD CONFLICTS				Other
	Rear End	Opp.	Pass.	Rear End		Opp.		Pass.			OT	NS	OT	E	
	Non-Prev.			NP	P	NP	P	NP	P		NS				
Interstate	2	0	4	0	0	0	0	1	0	0	0	0	0	0	0
4-Lane Divided	20	0	58	1	0	0	0	7	8	0	0	0	0	2	2
4-Lane Undivided	5	3	13	1	0	0	0	2	3	0	0	0	0	3	1
2-Lane Pri.	71	309	2	8	2	57	116	0	0	0	1	1	4	1	2
Secondary	0	28	0	0	0	0	0	0	0	1	0	0	8	0	0

TABLE 21

VEHICLE CONFLICT SUMMARY 14-FOOT LOAD

SYSTEM	VEHICLE CONFLICTS: DIRECT			INDIRECT						Other	LOAD CONFLICTS				Other
	Rear End	Opp.	Pass.	Rear End		Opp.		Pass.			OT	NS	OT	RE	
	Non-Prev.			N	P	NP	P	NP			NS				
Interstate	6	0	10	1	0	0	0	4	3	0	0	0	0	0	1
4-Lane Divided	24	0	109	6	3	1	4	21	16	0	0	1	0	0	0
4-Lane Undivided	4	0	19	1	0	1	0	3	5	0	0	0	0	0	1
2-Lane Pri.	44	297	5	7	1	49	145	0	0	0	1	3	4	0	4
Secondary	0	24	0	0	0	0	4	0	0	1	0	0	0	0	0

TABLE 22

SIGNIFICANCE OF CONFLICT DATA

SYSTEM	X^2	Significance = 0.01
Interstate	1.27	No, 2 d.f.
4-Lane Divided	10.98	No, 3 d.f.
4-Lane Undivided	3.04	No, 3 d.f.
2-Lane Pri.	12.15	No, 5 d.f.
Secondary	10.15	Yes, 2d.f.

The conflict data in Tables 20 and 21 reveal some interesting relationships among the types of highway systems and the numbers of conflicts. For example, the interstate system had the least number of conflicts for both 12- and 14-foot loads. The greatest number of conflicts occurred on two-lane primary facilities. The major types of conflicts on these roads were direct and indirect opposing vehicle conflicts. It is interesting to note that the most frequent type of conflict on four-lane divided routes was the direct passing vehicle conflict. This observation can be explained by the fact that the most common vehicle-load interaction on four-lane divided highways is the passing maneuver.

After combining some cells to obtain samples of sufficient size, the chi-square statistic was used to test for differences in the distributions of conflicts between 12- and 14-foot loads. As noted in Table 22, the only distribution that was significantly different was that for the secondary system. The sample size for the secondary system was small and the results do not seem to be realistic.

To examine the effects of various section lengths on conflicts, the number of observed conflicts for each test run was divided by the length of the test section. The result is the number of conflicts per mile, which was defined as the conflict index. In addition, to examine the effects of volume on conflicts, the conflict index was divided by the number of vehicle interactions. This result was defined as the conflict rate. The conflict indices and rates for each highway system were summarized and the results of t tests for these measures are given in Tables 23 and 24. As noted in the tables, no significant differences were found.

Summary

1. Use of the traffic conflicts technique to evaluate the accident potential of wide loads indicated that there were no significant differences between traffic conflicts observed during the movement of the 12- and the 14-foot loads.

2. The traffic conflicts data indicated that the greatest number of conflicts occurred on two-lane primary facilities

TABLE 23

CONFLICT INDICES

SYSTEM	12 FOOT LOAD			14 FOOT LOAD			t Value	Significance $\alpha = 0.01$
	No.	Mean ($\bar{X}_{12}$)	Variance (s^2_{12})	No.	Mean ($\bar{X}_{14}$)	Variance (s^2_{14})		
Interstate	10	0.14	0.05	14	0.45	0.21	-2.14	No, 22 d.f.
4-Lane Divided	23	1.79	3.35	25	3.04	5.67	-2.04	No, 46 d.f.
4-Lane Undivided	7	3.84	9.83	9	2.00	2.22	1.43	No, 9 d.f.
2-Lane Pri.	27	11.38	133.85	26	11.35	157.33	0.01	No, 52 d.f.
Secondary	12	6.74	28.64	12	6.87	68.97	-0.05	No, 20 d.f.

TABLE 24

CONFLICT RATE

SYSTEM	12 FOOT LOAD			14 FOOT LOAD				Significance
	No.	Mean ($\bar{X}_{12}$)	Variance (s^2_{12})	No.	Mean ($\bar{X}_{14}$)	Variance (s^2_{14})	t Value	$\alpha = 0.01$
Interstate	10	0.33	0.31	14	0.68	0.72	-1.21	No, 24 d.f.
4-Lane Divided	23	4.64	25.85	25	7.53	64.06	-1.51	No, 43 d.f.
4-Lane Undivided	7	1.57	2.03	9	0.71	0.17	1.56	No. 7 d.f.
2-Lane Pri.	27	57.56	18116.08	26	23.25	780.05	1.30	No. 28 d.f.
Secondary	12	297.46	86951.86	12	179.02	43485.60	1.14	No, 21 d.f.

Safety Incidences Data

During the traffic and safety field studies, observations of potentially hazardous conditions were recorded. The safety incidences recorded were not peculiar to 12- or 14-foot units, but rather to mobile and modular housing units in general.

One of the most serious incidences, in the opinion of the observers, was the towing of a 12-foot unit without brakes on the trailer. No problems were encountered, but this movement was felt to create a serious safety hazard. Another unit was towed with the load improperly aligned on the trailer, which caused the load to sway and pull unevenly. In several cases plastics and papers used for protection against the weather were not fastened to the unit securely, and pieces flew off into the path of oncoming traffic.

During the field studies two incidences were recorded in which wheels came off the unit. The first incidence occurred while a 12-foot unit was traveling on a two-lane primary road. The unit was headed west and one wheel on the right side came off the trailer and rolled off the road to the right. The driver pulled onto the shoulder of the road and as he did so, a second wheel fell off, causing the axle of the third and remaining wheel to be bent. This load was offset because of special heating ducts and the wheel failure was attributed to the uneven distribution of the weight.

The second incidence involving wheel failure also occurred on a section of two-lane primary road. The wheel came off the right side of the trailer, rolled behind the unit and into the opposing traffic lane, where it struck a car and caused minor damage. In this incident there was no apparent cause for the wheel failure. No injuries occurred.

During the study, it was observed that even a light rain can put enough water on the pavement so that the spray from the wide units significantly decreases the visibility of drivers in other vehicles. These conditions were observed in one instance. As the speed of the load increased, and the intensity of the rain increased, the problem became more acute. Dry weather conditions also were observed. During a trip on a two-lane primary the load occasionaly had to use the shoulder to permit oncoming vehicles to pass. The shoulder was extremely dry and the amount of dust thrown up tended to obscure the load from the view of any drivers behind it. This condition is shown in Figure 42.

Figure 42. Dust from 14-foot mobile unit on shoulder of road created visibility problems for motorists.

Wind can also be a problem; it was noted that even gusts of only 20 mph caused a wide load to sway enough to appear unstable.

Flat tires on the wide load units did not directly cause any safety incidences, but it was noted that flares and protective safety clothing were not used while repairs were being made.

A different type of safety hazard is created by the presence of wide load units on four-lane undivided highways. Although wide loads can maneuver on such roads without difficulty, they occasionally encroach into the adjacent lane. This encroachment does not prohibit vehicles from passing in the same direction, but motorists crossed the double yellow line and passed in the opposing traffic lane. Passing maneuvers of this type were observed to be hazardous, and in some instances evasive action by oncoming vehicles was required to avoid collisions.

Special attention should be given to those roads which because of geometrics are unsafe for any oversize load. During the field studies it was the practice of the data collection team to make a preliminary survey of those routes they were not familiar with before movement of the wide load over them. Several roads were dropped from the study because in the opinion of the observers they were unsafe for the movement of even the 12-foot units. One such road was Rte. 83 in the southwestern part of the state. This road had sharp curves, no shoulders, and nearly vertical embankments. The edge of the pavement was in poor condition and guardrails were sparse. This road is heavily traveled by both passenger vehicles and coal trucks. The lack of places to pull off the road would have meant that traffic would have had to be blocked for the entire section of road while the wide load was passing through. This action was not feasible so this road, as well as some other roads in that area, was dropped from the study.

Summary:

1. Several safety incidences, e.g., offset loads, unbalanced loads, and wheel failures, were observed during the tests.

2. Wide load travel during heavy rain is undesirable.

3. Some roads in the state cannot physically and safely accommodate 12- and 14-foot units.

Motorist Opinion Survey

In the motorist interview portion of this study, motorists' opinions on the movement of 12- and 14-foot wide housing units over the highway were obtained.

Before beginning the analysis of motorists' opinions, demographic and non-attitudinal items for the group of respondents encountering the 12-foot wide unit were compared to those for respondents encountering the 14-foot wide unit. This comparison was made to ensure that the two groups differed only with relation to the variable under study, viz., the width of the unit. There were no significant differences between the two groups in relation to the type of vehicles sampled, the maneuver the motorist was performing when interacting with the wide load, the frequency with which the motorist traveled on the roadway, and the sex and age of the respondents.

The overall question addressed in the analysis was, "Do motorists feel any differently about 14-foot wide manufactured housing units than they do about 12-foot units?" In the context of this study this means, "Do respondents more often perceive the 14-foot wide load as a source of delay or as a safety hazard than they do the 12-foot wide load?" The answer to these questions is essentially no. As seen in Table 25, 11% of the group encountering the 12-foot wide load felt they had been delayed during their travel. Of those persons delayed, 24% attributed the delay to the wide load (see Table 26). However, this figure constitutes only 2% of the total sample of persons encountering the 12-foot wide load. About 10% of those persons encountering a 14-foot wide load stated that they had been delayed, 35% of these attributing the delay to the wide load. This figure represents only 4% of the total sample of persons encountering the 14-foot wide load. About 2% of the total respondents in each group felt that this delay had caused them some amount of inconvenience (see Table 27). There were no significant differences between motorists' opinions of 12-foot and 14-foot wide manufactured housing units in relation to these delay oriented variables.

TABLE 25

"Have you encountered anything along the road today that caused you any delay?"

	12-Foot Unit	14-Foot Unit
Yes	36 (11%)	34 (10%)
No	301 (89%)	308 (90%)

X^2 = .10, d.f. = 1 Not Significant

TABLE 26

"What was it (type of delay)?"

	12-Foot Unit	14-Foot Unit
Manufactured Housing Unit	8 (24%)	12 (35%)
All Other	26 (76%)	22 (65%)

X^2 = 1.13

TABLE 27

"Did this delay cause you any amount of inconvenience?"

	12-Foot Unit	14-Foot Unit
Yes	6 (18%)	7 (26%)
No	27 (82%)	20 (74%)

X^2 = .52, d.f. = 1, Not Significant

In terms of safety, 10% of the respondents coming in contact with the 12-foot manufactured housing unit stated that they had encountered a safety hazard during their trip. About 14% of these respondents and only 1% of the total sample perceived the unit itself as the hazard (see Tables 28 and 29). Among persons coming in contact with the 14-foot wide unit, 8% felt that they had encountered a safety hazard, with 23% of these respondents (and 2% of the total sample) naming the unit as the dangerous element.

TABLE 28

"Have you encountered anything along the road today that you felt was a safety hazard?"

	12-Foot Unit	14-Foot Unit
Yes	35 (10%)	26 (8%)
No	301 (90%)	316 (92%)

X^2 = 1.64, d.f. = 1, Not Significant

TABLE 29

"What was it (type of safety hazard)?"

	12-Foot Unit	14-Foot Unit
Manufactured Housing Unit	5 (14%)	6 (23%)
All Other	30 (86%)	20 (77%)

X^2 = .78, d.f. = 1, Not Significant

Respondents were then asked what type of problem they had experienced in relation to the particular safety hazard. As seen in Table 30, among those persons naming the wide load as the hazard, width was the problem most often mentioned. Again, there were no significant differences in motorists' opinions of 12- and 14-foot wide loads, except in relation to the problem of visibility. Three of the respondents felt that the 12-foot wide unit posed a visibility problem, while no one felt that the 14-foot wide unit did ($Z = 2.22$, $p < .05$). However, this statistic involved such small numbers of respondents that it was not considered to represent a meaningful difference in the two groups. It was concluded that respondents were no more negative in their attitudes toward 14-foot wide manufactured housing units, in relation to their safety, than they were toward 12-foot wide units.

TABLE 30

"What kind of problems did this cause (multiple answers)?"

	12-Foot Unit	14-Foot Unit
Visibility	3 (60%)	0
Width	4 (80%)	4 (67%)
Delay	1 (20%)	1 (16%)
Other	1 (20%)	1 (16%)
Number of persons naming unit	5	6

As a check on the attentiveness of the drivers interviewed in the survey, respondents were asked if they had seen a wide load during their travel that day. As seen in Table 31, between 18% and 22% of the respondents who were known to have interacted with the manufactured housing unit by either passing or following it claimed not to have seen a wide load. While the 14-foot wide unit seems to be slightly more visible than the 12-foot (82% noticing vs. 78%), this difference is not significant. The key questions relating to the motorists' perception of delay and safety were then reanalyzed, excluding the answers of those persons who had not noticed the wide load. The results were similar to those for the sample as a whole, with no significant differences being found between the motorists' opinions of the 12- and 14-foot wide manufactured housing units.

TABLE 31

"Have you encountered a wide load on this road today?"

	12-Foot Unit	14-Foot Unit
Yes	261 (78%)	280 (82%)
No	75 (22%)	62 (18%)

X^2 = 1.85, d.f. = 1, Not Significant

Motorists who noticed the units were then asked if they had any comments concerning the particular wide loads they had seen (refer to Table 32). A majority of the persons in both groups made no comment. Of those drivers coming into contact with the 12-foot wide load, slightly over 6% made specific comments about characteristics of the load such as its width (3%), its handling characteristics (0.4%), and the delay it caused (3%). Another 8% made comments which did not fall into the above specific categories, but were essentially negative, such as, "it's dangerous" or "it makes me nervous." About 3% made general comments which were essentially positive, almost universally about the skill and courtesy of the driver, while 14% made remarks which were essentially neutral.

TABLE 32

"Have you any comment concerning the wide load?"

	12-Foot Unit	14-Foot Unit
No Comment	183 (69%)	180 (64%)
Comments		
Visibility	0	3 (1%)
Width	9 (3%)	27 (10%)
Delay	7 (3%)	2 (1%)
Handling Characteristics	1 (0.4%)	4 (1%)
Other Neutral	36 (14%)	37(13%)
Other Negative	20 (8%)	20 (7%)
Other Positive	7 (3%)	7 (3%)

X^2 = 8.57, d.f. = 5, Not Significant

Among persons encountering the 14-foot unit, 13% made specific comments concerning such characteristics as the unit's width (10%), its visibility (1%), its handling characteristics (1%) and the delay it caused (1%). Another 13% made comments which were essentially neutral, while 3% made positive comments and 7% made negative comments. There were no significant differences between motorists' comments concerning the 12- and 14-foot wide units.

The respondents' answers to the safety and delay related questions were then broken down by the type of roadway on which the respondent had met the wide load (interstate, four-lane divided, three-lane, two-lane). There were no significant differences in the motorists' perceptions of the 12- and 14-foot wide manufactured housing units when type of roadway was considered, which means that respondents meeting the wide loads on two-lane roads were no more likely to perceive a safety or delay difference in the two units than were respondents meeting units on the interstate. Similar results were found when the respondents' answers were broken down by the maneuver the driver had made when interacting with the wide load (passing in the same direction, passing in the opposite direction, or following the wide load) and by the location of the interview (Martinsville, South Hill/South Boston, Harrisonburg/Mount Jackson). There were no significant differences in motorists' opinions of the 12- and 14-foot manufactured housing units in relation to safety and delay when type of roadway, motorist maneuver, or location of interview were considered. There was, however, a difference in the relative noticeability of the 12- and 14-foot wide loads based on roadway type. Respondents meeting the 14-foot unit on a two-lane road were significantly more likely to notice the wide load than respondents meeting a 12-foot wide load on the same road. As shown in Table 33 this difference did not exist on interstate, four-lane or three-lane roads. Also the 14-foot units were more noticeable on two-lane roads. (x^2 = 8.37 on 3 d.f., $p < 0.05$). This difference did not exist among 12-foot units.

TABLE 33

WIDE LOAD NOTICEABILITY

System	12-Foot Unit	14-Foot Unit
Interstate		
Noticed	65 (80%)	84 (81%)
Did Not Notice	16 (20%)	20 (19%)
Four-Lane Divided		
Noticed	83 (76%)	76 (83%)
Did Not Notice	26 (24%)	16 (17%)
Three-Lane		
Noticed	47 (81%)	51 (74%)
Did Not Notice	11 (19%)	18 (26%)
Two-Lane		
Noticed	66 (75%)	67 (89%)
Did Not Notice	22 (25%)	8 (11%)

(x^2 = 5.54, $p < .05$, 1 d.f., significant)

Summary

In summary, there were no significant differences between the motorists' perceptions of 12- and 14-foot wide manufactured housing units as sources of delay or as safety hazards. Relatively few respondents specifically mentioned either of the units in relation to delay and safety problems. It can be concluded from these data that motorists' opinions of 14-foot wide manufactured housing units are not significantly different than their opinions of 12-foot wide units.

Accident Analysis

The analysis of the accident experience of wide loads was initially envisioned in two parts. First, because of the difficulty in identifying wide load accidents through Virginia's accident reporting system, total accident experience for two selected types of roadways, one that was frequently used by wide units and another which was not, would be compared. Second, accident histories of roadways frequently traveled by 14-foot wide manufactured housing units would be reviewed. Due to a lack of accessible accident data on these units, neither of these envisioned accident analyses could be conducted.

Regulations

Copies of the regulations governing the movement of 14-foot wide housing units were obtained from 41 of the 43 states which permit such movements and which responded to the questionnaire. While the sophistication and scope of these regulations varied significantly from state to state, some provisions appeared consistently in most of the regulations received. The data in Table 34 show the most often used restrictions by state.

Only 2 of the 41 states do not restrict the movements of 14-foot units on one or more days of the week. Most of the states (66%) prohibit the movements on Sunday and either half a day or all day on Saturday. Seven states prohibit them Saturday, Sunday and half a day or all day on Friday, and 5 states restrict them from Friday through Monday. Two of Virginia's border states, West Virginia and Pennsylvania, are among the 5 states which permit the movements only 3 days per week. Most states also prohibit movement on holidays, although the particular holidays involved vary from state to state. In addition, 20 states restrict travel for a period of time before and/or after a holiday when they feel vacation traffic will be heavy. Most of the 20 restrict movements for half a day before a holiday, but 4 states prohibit movements for a full day both before and after holidays. Most also provide that if the holiday falls on a Monday or a weekend, the restricted travel day will be the preceding Friday.

Virtually all of the states (95%) restrict movements by time of day also. Sixty-eight percent restrict the movements only at night (although about one-third of those also restrict movements during rush hours in cities). The time restrictions in the other 11 states vary somewhat but generally run from mid-afternoon (3 or 4 o'clock) until around 9 a.m. Twenty-nine of the states also restrict movements of the 14-foot wide units during periods of bad weather or high winds, although the criteria for determining when weather will preclude a movement vary by state. Generally the criteria emphasize the driver's ability to see and to control the 14-foot wide vehicle.

TABLE 34

SUMMARY OF 14-FOOT REGULATIONS IN OTHER STATES

	Days of Week Movement Is Restricted	Time of Day Movement Is Restricted (*Restricted During Rush Hours in Cities)	Are Movements Restricted The Day Before/Day of/Day After Holidays	Are There Restrictions For Bad Weather or High Winds	Maximum Length (Ft) Permitted Housing Unit/Total With Vehicle	Escort Cars Required In Front, Rear, or Both Divided/Undivided Highway	Red Flags Required	Vehicle Lights on Required	Wide Load Signs Required	Maximum Speed Limit, Divided/Undivided Hwy.	Distance Required Between Wide Loads	Radio Communications With Escorts Required	Amber Flashing Lights Required
Alaska	Sat. (pm), Sun.	Night	1/2/Yes/1/2	Yes	70/-	Both/Both	Yes	Yes	Yes	40/25	1 Mile	Yes	Yes
Arizona	Sat., Sun	Night	No/Yes/No	Yes	70/85	Rear/Both	Yes	Yes	Yes	45/45	1000'	Yes	Yes
Arkansas	Sat., Sun	Night*	No/Yes/No	No	-	-/Front	Yes	No	Yes	-		Yes	Yes
Colorado	Sat., Sun	3 pm - 1 am	No/Yes/No	Yes	-	-	No	No	Yes	-	-	No	No
Connecticut	Fri., Sat., Sun., Mon.	4 pm - 9 am	Yes/Yes/Yes	Yes	-	Both/Both	No	No	Yes	-	800'	Yes	Yes
Delaware	Fri. (pm), Sat., Sun.	4 pm - 9 am	1/2/Yes/No	No	-	-	No	Yes	Yes	45/45	-	No	Yes
Idaho	Fri., (pm), Sat., Sun.	Night*	1/2/Yes/No	Yes	-/85	Rear/Both	Yes	No	Yes	55/45	1000'	Yes	Yes
Illinois	Sat. (pm), Sun	Night*	No/No/No	Yes	-/85	Both/Both	No	No	No	45/45	-	No	Yes
Indiana	Sat., Sun	3:30 pm - 8:30 am	No/Yes/No	Yes	70/85	Rear/Front	No	Yes	Yes	55/45	1/2 Mile	Yes	Yes
Iowa	Sat., (pm), Sun.	Night	1/2/Yes/No	Yes	65/85	Front/Front	Yes	No	Yes	55/45	-	No	Yes
Kansas	Sat., Sun	Night	Yes/Yes/Yes	Yes	- /85	Both/Both	Yes	No	Yes	55/55	-	No	Yes
Kentucky	Sat. (pm) Sun.	3 pm - 9 am	1/2/Yes/No	Yes	70/85	Both/Both	Yes	Yes	No	45/35	-	No	Yes
Louisiana	Sat., Sun	-	No/Yes/No	No	-/95	Front/Front	No	No	Yes	-	-	No	No
Maine	Sat., Sun	Night	No/Yes/No	Yes	-	Rear/Front	Yes	No	Yes	-	-	Yes	Yes
Maryland	Sat., (pm), Sun.	-	No/Yes/No	No	-	Both/Both	No	No	Yes	-	-	No	Yes
Michigan	Sat., Sun.	Night	1/2/Yes/Yes	No	70/85	-	No	No	No	-	1000'	No	No
Minnesota	Fri.,(pm), Sat., Sun.	Night*	1/2/Yes/Yes	No	-/85	-	Yes	No	Yes	-	-	No	Yes
Mississippi	Fri., Sat., Sun.	2:30 pm - 9 am	No/Yes/No	Yes	-/85	Both/Both	Yes	Yes	Yes	45/45	-	Yes	Yes
Missouri	Sat., Sun	4 pm - 9 am	1/2/Yes/No	Yes	-/85	Rear/ Both	Yes	No	Yes	55/40	1000'	Yes	Yes
Montana	Sat. (pm), Sun.	Night	No/Yes/No	Yes	70/-	Both/Both	No	No	Yes	-	-	Yes	Yes
Nebraska	Sat., Sun.	Night	No/Yes/No	Yes	-/95	Rear /Front	Yes	No	Yes	-	-	No	Yes
Nevada	Sat., Sun	Night	No/Yes/No	Yes	-	Both/Both	Yes	Yes	Yes	60/40	1000'	Yes	Yes
New Hampshire	Fr., Sat., Sun., Mon.	Night	No/Yes/No	Yes	-/85	Rear /Both	No	Yes	Yes	50/40	-	No	Yes
New Jersey	Sat., Sun	Night	No/Yes/No	No	-/120	Rear/Front	Yes	Yes	Yes	-	-	No	No
New Mexico	Sat., Sun.	Night	1/2/Yes/No	Yes	80/95	Rear/Front	Yes	No	Yes	-	-	Yes	Yes
New York	Sat., Sun.	Night	Yes/Yes/Yes	Yes	-	Rear/Front	Yes	No	Yes	55/55	1/2 Mile	No	Yes
North Dakota	Sat., Sun.	Night	1/2/Yes/No	Yes	-	Rear/Front	Yes	No	Yes	-	-	No	No
Ohio	Sat., Sun.	3 pm - 9 am	1/2/Yes/No	Yes	-	Rear/Front	Yes	No	Yes	50/35	-	No	Yes
Oklahoma	Sat.,(pm), Sun.	Night*	1/2/Yes/No	No	-	Rear/Both	Yes	Yes	Yes	-	-	Yes	Yes
Oregon	Fri.,(pm), Sat., Sun.	Night*	1/2/Yes/No	Yes	-	Both/Both	Yes	No	Yes	65/35	1/2 Mile	Yes	Yes
Pennsylvania	Fri., Sat., Sun., Mon.	4 pm - 9 am	Yes/Yes/Yes	Yes	-	Rear/Both	Yes	Yes	Yes	-	500'	No	Yes
Rhode Island	Fr., Sat., Sun., Mon.	3:30 pm - 9 am	No/No/No	No	-	Both/Both	Yes	No	Yes	-	10 Miles	Yes	Yes
South Dakota	Sat.(pm), Sun.	Night	No/Yes/No	Yes	-	-	Yes	No	Yes	50/50	-	No	Yes
Tennessee	Sat., Sun	3:30 pm - 9 am	No/No/No	No	-	Rear/Both	Yes	No	Yes	-	-	Yes	Yes
Texas	-	Night	No/No/No	No	-/95	-	No	No	No	-	-	No	No
Utah	Sat., Sun.	Night*	1/2/Yes/No	Yes	-/85	Rear/Front	Yes	No	Yes	-	500'	Yes	Yes
Vermont	Fri.(pm) Sat., Sun.	Night*	No/Yes/No	Yes	-	Front/Front	Yes	No	Yes	50/35	-	No	Yes
Washington	Fri.(pm) Sat., Sun.	Night*	1/2/Yes/No	Yes	-/85	Rear/Both	Yes	No	Yes	65/40	1/2 Mile	Yes	Yes
West Virginia	Fr., Sat., Sun., Mon.	Night*	No/Yes/No	Yes	70/85	Rear/Both	Yes	Yes	Yes	65/40	-	Yes	Yes
Wisconsin	Sat., Sun	Night*	1/2/Yes/No	Yes	70/85	-	Yes	Yes	Yes	65/35	1000'	No	Yes
Wyoming	-	Night	No/Yes/No	Yes	-	Rear/Both	Yes	Yes	Yes	65/45	1000'	No	Yes

Twenty-three states set a maximum length restriction on 14-foot wide housing units. Most of the 23 (76%) set the maximum length of the housing unit at 70 feet or the length of the housing unit and towing vehicle combined at 85-feet; or they combine the two requirements. Most of the remaining states set the maximum length at 95 feet for the combination of towing vehicle and housing unit.

Thirty-four states require the use of pilot or escort vehicles for the movement of 14-foot wide loads, and several others require them at the discretion of the permit officer. Eleven of the 34 states requiring escorts require them in front and to the rear of the housing unit. However, several states have recently lowered their requirements; 10 no longer require the front escort on divided highways, and 9 others require neither the front escort on divided highways nor the rear escort on undivided highways. It is interesting also that 19 of the 41 states now require two-way radio communication between pilot cars and the wide load towing vehicle.

Several warning devices for marking the wide load are required in many states. Thirty-seven states require "Wide Load" signs either on the housing unit, the escort vehicles, or both. Thirty states require red warning flags on the unit or escort vehicles. Amber flashing lights are required by 35 states, and 14 states require that the headlights on all vehicles be on during movements.

Only 22 states specify that the 14-foot wide loads travel at speeds lower than the posted speed limits. In general the restriction is around 45 to 50 mph, though several states differentiate between speeds on divided and undivided highways. It is significant that many states seem more concerned with minimum speeds than with maximum speeds for wide loads, especially on divided highways where a slow moving load is often a dangerous nuisance, regardless of its size. Note that 16 states require that a minimum distance be maintained between wide loads, presumably to reduce the nuisance factor from slow moving wide loads. In general the distance required is 500 feet to 1,000 feet, although 6 states require half a mile or more.

Most of the states have some type of requirements for the size and capacity of the towing vehicle for 14-foot wide loads, although these vary so widely that no attempt was made to quantify them. Surprisingly, though, only 5 states have any regulations on the qualifications of the driver of the vehicle. Three states require experience with moving wide loads (from 1 to 2 years), while 2 states require a training period or police certification. Some states specify requirements for escort vehicle drivers as well, though most of the requirements are quite vague (shall be dependable, courteous, efficient, etc.)

Most states require that the mover carry insurance or post bond to cover any damage caused by 14-foot wide loads. However, 2 states have a provision for a bond to help enforce their regulations. In Mississippi, and in Missouri if he has a record of prior violations, the mover must post bond to serve as surety for adherence to the regulations. The bond is forfeited in case of a violation so that, in effect, it is a fine which is already in the hands of the police in case of a violation. Mississippi indicated that this provision has done much to encourage compliance with the regulations.

Summary

1. An analysis of state permit regulations indicated there is no uniformity in the regulations on the movement of 14-foot wide loads.

2. An analysis of state permit regulations indicated an absence of uniformity in the regulations used by the states for governing the movement of 14-foot wide loads.

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APPENDIX A

HOUSE JOINT RESOLUTION NO. 41

Relating to transportation of wide mobile homes and housing units.

Agreed to by the House of Delegates, February 20, 1976

Agreed to by the Senate, March 12, 1976

WHEREAS, the Commonwealth of Virginia is in dire need of adequate housing for its citizens; and

WHEREAS, forty-three states in the Union allow the transportation of fourteen foot wide mobile and modular housing units on their highways, and the Commonwealth of Virginia is subject to becoming totally surrounded and thereby isolated by these states; and

WHEREAS, mobile and modular housing units have been shown to be an efficient and cost-effective means of providing this needed housing; and

WHEREAS, there is an ever increasing demand for larger housing units; and

WHEREAS, the restriction of movement of fourteen foot wide mobile and modular units will have a severely adverse effect on the economy of the Commonwealth's interstate and intrastate commerce; now, therefore, be it

RESOLVED by the House of Delegates, the Senate concurring, That the Department of Highways and Transportation together with the Housing Study Commission, the Office of Housing, the Division of Highway Safety, the Department of State Police, representatives from the manufactured housing industry and the Division of Motor Vehicles be requested to evaluate the movement of fourteen foot wide mobile and modular housing units over the highways of the Commonwealth of Virginia. For the purpose of this evaluation, the mobile and modular housing industry is requested to furnish fourteen foot wide mobile and modular units, together with trucks and drivers, which shall be driven over routes of the highway system to be selected in cooperation with the industry. Also, the Department of Highways and Transportation will instigate and evaluate limited movement of fourteen foot wide units, as may be reasonably necessary for the purposes of such study, from Virginia plants to the nearest Interstate highways, along such Interstate routes only with the dual purpose of conducting such study and at the same time permitting the manufacturer of such test fourteen foot wide mobile and modular units to transport them by Interstate highway to other states for sale there. Evaluation should include movies taken of this movement, together with interviews from passing motorists. The results of the study and evaluation shall be summarized and reported by the Department of Highways and Transportation to the General Assembly by December one, nineteen hundred seventy-six. Any such movement of such units shall be conducted with such safety precautions and reasonable standards and procedures as the Department of Highways and Transportation may prescribe.

No tests or travel of the fourteen foot wide mobile and modular housing units shall be allowed on State Route 220 north of its intersection with Interstate 81.

No test or movement of fourteen foot wide mobile and modular units shall be conducted on Route 77 in Bland, Wythe and Carroll Counties until construction is fully completed on said highway.

DEPARTMENT OF HIGHWAYS & TRANSPORTATION
DOUGLAS B. FUGATE, COMMISSIONER

J. E. HARWOOD
DEPUTY COMMISSIONER AND
CHIEF ENGINEER

EO E. BUSSER, III
DIRECTOR OF PROGRAM MANAGEMENT

DR. FRANK L. HEREFORD, JR., PRESIDENT

SCHOOL OF ENGINEERING & APPLIED SCIENCE
JOHN E. GIBSON, DEAN

DR. LESTER A. HOEL, CHAIRMAN
DEPARTMENT OF CIVIL ENGINEERING

COMMONWEALTH of VIRGINIA

HIGHWAY & TRANSPORTATION RESEARCH COUNCIL

BOX 3817 UNIVERSITY STATION
CHARLOTTESVILLE, VIRGINIA 22903

IN REPLY PLEASE
REFER TO FILE NO. 2.69

JACK H. DILLARD, HEAD
VIRGINIA HIGHWAY & TRANSPORTATION RESEARCH COUNCIL

August 18, 1976

Dear

As a result of a resolution passed during the 1976 session of the Virginia General Assembly, the Virginia Highway and Transportation Research Council is conducting a study, in cooperation with the Virginia Housing Study Commission, Office of Housing, Highway Safety Division, Department of State Police, Division of Motor Vehicles, Department of Highways and Transportation, and representatives from the manufactured housing industry, to evaluate the effects of allowing 14-foot wide manufactured housing units on the state's highway system.

The study has been specifically designed to determine the operational and safety effects associated with the movement of these 14-foot wide loads. The research includes a literature review; empirical studies of traffic volume, conflicts, speed, queue size, and impedance; a motorist opinion survey; an accident analysis of 12-foot wide loads; and a movie outlining the results of the study. As we must submit the final report on the study to the Governor and General Assembly by December 1, 1976, our experience in terms of accidents and long-range problems or benefits will be limited. To increase the effectiveness of our report, we have developed the attached questionnaire to examine wide-load practices and experiences in other states.

I would appreciate your cooperation through completing the questionnaire and returning it not later than September 17. I would appreciate receiving comments from your permit engineer, traffic and safety engineer, maintenance engineer or other officials familiar with the movement of wide loads. Should your organization not be responsible for regulating the transportation of 14-foot wide manufactured housing units, I would appreciate your forwarding the questionnaire to the proper authority.

Thank you for your assistance.

Sincerely,

J. H. Dillard, Head
Virginia Highway and Transportation
Research Council

JHD/cc

Attachment

PART B - QUESTIONNAIRE FOR OTHER STATES

QUESTIONNAIRE

MOVEMENT OF 14-FOOT WIDE MANUFACTURED HOUSING UNITS ON STATE HIGHWAYS

1. State   Date ____________

2. Is the movement of 14-foot wide manufactured housing units (mobile and modular homes) permitted on your state's highways?

   Yes ________   No ________ If no, answer questions 3 and 4 only, then skip to end of questionnaire

3. Is the movement of 14-foot housing units (allowed) (denied) on the basis of:

   State law
   Legislative resolution
   Departmental or Commission Policy
   Other (Please specify)

4. Was the decision to (allow) (deny) the movement of 14-foot wide housing units based on:

   Legislative resolution
   Departmental judgement
   Successful experience in other states
   Successful trial period in your state
   Research study
   Pressure from housing industry
   Other (Please specify)

5. What type of permit governs the movement of 14-foot housing units?

   Single trip permit basis
   Multi-use or blanket permit basis
   No permit required
   Other (Please specify)

6. Are manufactured housing units wider than 14-foot allowed in your state on a multi-use or blanket permit basis?

   Yes   If yes, how wide?
   No

7. Are 14-foot wide loads other than housing units allowed on the highways on a multi-use or blanket permit basis?

   Yes   If yes, what types?
   No

8. Has your organization denied the housing industry or any housing manufacturer permission to routinely transport 14-foot housing units in your state? Why?

Yes Reason ______________________

No

9. What is the estimated number of 14-foot wide or wider housing units moved within or through your state annually?

100 or less

1,000

5,000

10,000

20,000

________ Over 20,000 (If possible, please specify number ______

10. Do major cities in your state allow the movement of 14-foot wide housing units?

Yes No

Sometimes (Please specify under what conditions)

11. Has your state recently relaxed or eliminated any rules or regulations previously imposed on the movement of 14-foot housing units?

Yes (Please specify)

No

12. Has your state recently placed additional regulations on the movement of these units?

Yes (Please specify)

No

13. Have any studies been conducted in your state concerning the travel of 14-foot wide units? (If yes, please furnish a copy of the report no matter how formal or informal.)

Yes

No

14. Are any studies on this subject being conducted in your state?

Yes Completion date

No

15. Are you aware of any change in accidents or accident potential resulting from the transportation of 14-foot wide housing units?

Yes — (Please specify problems and how you are dealing with them)
No

16. Have any figures concerning accident experience in relation to 14-foot units been compiled for your state?

Yes — (Please enclose a copy of the figures or specify)

No

17. Has your department received public comment due to the movement of 14-foot wide housing units?

Yes — (Please specify number of complaints and type of problem)

No

18. What rules and regulations currently apply to the movement of 14-foot wide housing units in your state? Please furnish a copy of these regulations.

19. Have you had any difficulty in enforcing these regulations? (If yes, please specify what types of problems you have encountered, how you have dealt with them, and what the outcome has been.)

Yes — Problems ______________________________

No

20. [For the Maintenance Engineer] Has your state experienced any difficulties in relation to highway maintenance resulting from the movement of 14-foot wide units? (If yes, please specify what types of problems you encountered and how you dealt with them.)

Yes

No

Additional comments or observations.

May we use the information which you have provided in our study.

Yes
No

Would you like a copy of the final report.

Yes
No

Your name ______________________
Title ______________________
Mailing address ______________________

Thank you for your cooperation and assistance. If you have any additional comments, or if you would like more information concerning the study, please contact:

Mr. Wayne S. Ferguson
Project Coordinator
Virginia Highway & Transportation Research Council
P. O. Box 3817 University Station
Charlottesville, Virginia 22903

Telephone (804) 977-0290

APPENDIX C

DATA COLLECTION FORMS

WIDE LOAD TRIP DATA

General

Trip No. Sample Day & Date 7-31-76

Permit No. XM5252861

Observers I.C. All, C.D. Car, N.E. Body

Route Sample Termini Hither to Yon

Type 14' wide load

Load

Mobile ______ Modular ✓

Manufacturer Newhouse & Wheeler, Inc.

Width 13'9" Height 12'9" Length 42'9" Weight 22,400 lb.

No. of Axles 4 Axle Width 7'4"

Towing Unit

Make & Model '73 Hustler Deluxe

Horsepower ______ Wheelbase 11'5" Length 15'9" Weight 2.5 Ton

No. of Forward Speeds 5 Mirror Width 14'5"

Length of hitch 5'2" Total length of assembly 63'-8"

Driver

Driver Name N.E. Trucker Age 46

State Licenses Va.

Yrs. in Oversize Load Transporting 2

Regulations

Load	Front Pilot Vehicle	Rear Pilot Vehicle
Signs ✓	Signs ✓	Signs ✓
Flags ✓	Flags ✓	Flags ✓
Lights ✓	Lights ✓	Lights ✓
Radio ✓	Radio ✓	Radio NONE

Escorts—None ______ Front ______ Rear ______ Both ✓

Weather - Conditions During Trip

Temp. 70° Condition Cloudy Wind 0-5 mph

Miscellaneous

______

______

C-1

OPPOSING DIRECTIONAL VOLUME COUNT

TRIP NO. Sample

ROUTE Sample

DATE 7-31-76

OBSERVER N.E. Body

LOCATION AND TIME			NO. OF VEHICLES PASSING
on Rt.O	From Baltic Ave.	To Park Place	130
	9:15 a.m.	10:15 p.m.	

DC-2

VOLUME OF VEHICLES PASSING LOAD

SAME DIRECTION

TRIP NO. Sample

ROUTE Sample

DATE 7-31-76

OBSERVER G. Whiz

LOCATION AND TIME		NO. OF VEHICLES PASSING
On Rt. O from OO	1:05	2
to Schlitz Church	1:15	

DC-3

MAXIMUM OBSERVED WIDE LOAD SPEEDS

TRIP NO. Sample

ROUTE Sample

DATE 7-31-76

OBSERVER Po Kettle

TIME	MAXIMUM SPEED	ROAD AND TRAFFIC CONDITIONS
1:25	36 mph	Flat - light traffic
1:45	38 mph	Downhill- light traffic

DC-4

JOURNEY AND RUNNING TIME

TRIP NO.	Sample	DEPARTURE	AM 12:14 PM
ROUTE	Sample	ARRIVAL	AM 1:09 PM
DATE	7-31-76	ODOMETER START	3108.7
OBSERVER	I. M. Able	ODOMETER STOP	3135.0
JOURNEY TIME	55 min.	RUNNING TIME	50 min. 35 sec.
JOURNEY SPEED	40 M.P.H.	RUNNING SPEED	45 M.P.H.

NATURE OF DELAY	TIME STOP	TIME START	DELAY
Stopped to check tires	12:27	12:29	2 min.
Stopped to let traffic by	12:37	—	45 sec.
"	12:48	—	40 sec.
"	12:59	—	40 sec.
"	1:05	—	20 sec.
TOTAL DELAY			4 min. 25 sec.

DC-5

NOTE: RECORD ODOMETER READING FOR A MAJOR DELAY.

WIDE LOAD SPEED CHANGES

TRIP NO. Sample

ROUTE Sample

DATE 7-31-76

OBSERVER B. Smart

TIME	SPEED AT END OF LOAD DECELERATION	DRIVER USE OF BRAKES	CAUSE
12:14	37	✓	Long downgrade
12:15	32	✓	Steep downgrade
12:16	32	✓	Downgrade to bridge
12:21	34	✓	Long winding downgrade
12:51	33	✓	Slight downgrade

DC-6

PASSING TIME - QUEUE SIZE

TRIP NO. *Sample* TERMINI *Rt. O, Hither to Yon*

ROUTE *Sample* TRIP TIME *1:05 - 2:15*

DATE *7-31-76* VEHICLE INTERACTION

OBSERVER *I. C. All* COUNT (SAME DIRECTION) *11*

TIME OF DAY	NO. & TYPE IN QUEUE	TIME IN QUEUE	RPC	PASSING TIMES LOAD	FPC	POS. IN QUEUE
1:06:30	1 PU			18 sec., PU		
1:07:30	0					
1:09:45	1 PU		✓	21 sec., PU		
1:11	0					
1:13:25	1 PU					
1:14:20	2 PU, 1 C			15 sec., C		2
1:15:45	2 PU, 2 C					
1:17	0	Load	pulled over			
1:21:15	1 C					
2:15	0	End of trip				

DC-7

TRIP LOG NOTES

TRIP NO. Sample

ROUTE Sample

DATE 7-31-76

OBSERVER T. Time

12:15 Load straddled centerline, man walking on shoulder

12:30 Straddled centerline for narrow railroad overpass

12:37 Load stopped to let traffic pass (4 cars, 1 truck)

12:48 " " " " (6 cars, 2 trucks)

DC-8

APPENDIX D

DATA REDUCTION FORMS

VOLUME

TRIP NO. Sample

ROUTE Sample

DATE 7-31-76

OBSERVER G. Whiz

OPPOSING DIRECTION	SAME DIRECTION		
	VEHICLES PASSING LOAD	LOAD PASSING VEHICLES	VEHICLE INTERACTIONS
143	12	1	13

DR-1

LATERAL PLACEMENT

Trip No. *Sample*

Route No. *Sample*

Date *7-31-76*

Observer *C. D. Cor*

Vehicle Description	Direction of Travel		Vehicle Placement					Load Placement				
	Opp.	Same	Pav.	EL	Sh.	Off	Other	Pav.	EL	Sh.	Other	Remarks
PU		/					*	In S. lane drag - straddle lane to opposing lane				
T	/		/									
C	/				/							
C	/			/								
PU	/			/					/			
C	/		/									
C	/		/					/				
C	/		/					/				
T	/		/					/				
TT	/				/			/				
C		/	/									
Data Summary												
Opposing												
Car	6		4	2	1			2	1			
Truck	2		2	0	0			1	0			
Trailer Truck	1		0	0	1			1	0			
TOTAL	9		6	2	2			4	1			
Same												
Car		2	1	0	0		*	0	●			
Truck		0	0	0	0			0	0			
Trailer Truck		0	0	0	0			0	0			
TOTAL		2	1	0	0		*	0	0			

ENCROACHMENTS

TRIP NO. Sample
ROUTE NO. Sample
DATE 7-31-76
OBSERVER C.D. Carr

SHARP CURVE	VEHICLE ON SHOULDER	NARROW STRUCTURE	PEDESTRIAN	SIGN	REMARKS
					NARROW SHOULDER
					"
					"
					"
					"
					"
	✓				
			✓		
			✓		
✓					
	✓				
		✓			
			✓		
1	2	1	3	0	6

DR-3

QUEUE LENGTH, DURATION AND IMPEDANCE

TRIP NO. Sample

ROUTE Sample

DATE 7-31-76

OBSERVER O.U. Clown

TIME	QUEUE SIZE	CAR		TRUCK		TT		TOTAL	
		NO.	TIME	NO.	TIME	NO.	TIME	#	SEC.
12:16 [30]	1	1	1'					1	60
12:20	1	1	1'15"					1	75
12:23 [20]	1	1	55"					1	55
12:24 [45]	3	3	1'25"					3	85
12:26	4	4	1'15"					4	75
12:31 [15]	1	1	1'					1	60
12:36 [25]	6	5	55"	1	55"			6	55
12:39 [15]	1	1	1'					1	60
12:42 [30]	2	2	3'15"					2	195

DR-4

PASSING TIMES

TRIP NO. Sample

ROUTE Sample

DATE 7-31-76

OBSERVER B.E. Sea

VEHICLES PASSING LOAD			LOAD PASSING VEHICLES		
CARS	TRUCKS	TRUCK TRAILERS	CARS	TRUCKS	TRUCK TRAILERS
20"	53"	31.5"	23.5"	21"	
17.5"	25"	43"			
67"		31"			
14"					
17"					
24"					
25"					

DR-5

MANEUVERABILITY

TRIP NO. Sample

ROUTE Sample

DATE 7-31-76

OBSERVER A.Q. Large

INTERSECTION:

CONSTRUCTION AREAS:

MAINTENANCE AREAS:

RAILROAD TRACKS:

OTHER:

Load dropped off pavement three times for no apparent reason - otherwise no problems

DR-6

REGULATIONS

TRIP NO. Sample

ROUTE Sample

DATE 7-31-76

OBSERVER O.A. Truck

PILOT VEHICLE

ONE OR BOTH ABSENT:

PERFORMANCE:

FRONT:

REAR: Did not follow lateral movement of the LOAD.

SIGNS:

LIGHTS:

OTHER

LOAD

FLAGS:

LIGHTS: Rear brake lights inoperative

SIGNS:

OTHER

DR-7

CONFLICTS

TRIP NO. Sample

ROUTE NO. Sample

DATE 7-31-76

OBSERVER I.C. All

VEHICLE											LOAD				
DIRECT				INDIRECT						OTHER	OT & NS	NS	OT	REAR END	OTHER
REAR END		OPPOSING	PASSING	REAR END		OPP.		PASSING							
NP	P			NP	P	NP	P	NP	P						
✓		✓	✓				✓								
✓		✓													
		✓					✓								
		✓				✓									
		✓													
		✓					✓						✓		
		✓													
							✓								
							✓								
							✓								
							✓								
												✓			
2		7	1			1	7					1	1		

DV-V

SAFETY INCIDENCES

TRIP NO. Sample

ROUTE: Sample

DATE: 7-31-76

OBSERVER: T. Doff

FLAT TIRE	LOSING WHEEL	WIND EFFECTS	OFFSET LOAD	TOWING UNIT LENGTH	OTHER
1:28 P.M., stopped					
to change flat					
tire, no safety protective clothing					
used, or flares.					

DR-9

APPENDIX E

MOTORIST OPINION SURVEY DATA

PART A - QUESTIONNAIRE

(A) Stimulus Vehicle: 12 foot .... 1 14 Foot 2

(B) Motorist's Vehicle:
- Motorcycle 1
- Passenger Car........2
- Car with trailer.....3
- Van/bus..............4
- Pickup...............5
- Straight truck 6
- Tractor-trailer......7

(C) Motorist's Maneuver:
- Passing, same direction........1
- Passing, opposite direction....2
- Vehicle in queue...............3
- Unknown........................4

MOTORIST SURVEY

READ: Good (Morning/Afternoon). We are conducting a brief traffic survey for the Highway Department. We would like to ask you a few questions about your use of Virginia's highways. Could you tell me:

(1) How often do you drive on this particular road? Would you say it was

- 5 or more times a week............1
- 2 to 4 times a week...............2
- Once a week.......................3
- Less than once a week.............4
- Refused...........................5

(2) Have you encountered anything along this road today that caused you any delay?

- Yes ....1 (if 2 or 3, skip to Question 5)
- No................................2
- Refused...........................3

(3) What was it?

- Accident..........................1
- Construction......................2
- Traffic congestion................3
- Other ....4 ____________________
- Slow moving vehicle (Probe: What type of vehicle was it?)
  - Motorcycle....................5
  - Passenger car.................6
  - Car with trailer..............7
  - Van/bus.......................8
  - Pickup........................9
  - Straight truck................10
  - Tractor-trailer (8 foot)......11
  - Mfg. housing unit (12-14 ft.).12
  - Do not know...................13
  - Other.........................14 ____________________

(4) Did this delay cause you any amount of inconvenience?

- Yes...............................1
- No................................2
- Refused...........................3

(5) Have you encountered anything along the road today that you felt was a safety hazard?

- Yes...............................1 (if 2 or 3, skip to Question 8)
- No................................2
- Refused...........................3

(6) What was it?

Poor highway design or maintenance 1
Poor signing 2
Dangerous drivers..3 (Probe)
Other..4
Dangerous vehicle (Probe: What type of vehicle was it?)
   Motorcycle..5
   Passenger car...6
   Car with trailer......................................7
   Van/bus...8
   Pickup..9
   Straight truck..10
   Tractor-trailer (8 foot)..............................11
   Mfg. housing unit (12-14 ft.).........................12 (If any other answ. besides manufactured housing units, skip to Question 8.)
   Do not know...13
   Other...14

(7) What kind of problems did this cause (more than one answer possible)?

Visibility (hard to see around)..........................1
Width (could not pass, run off road).....................2
Delay (slow moving)......................................3
Other..4 ________________

(8) Have you encountered a wide load on this road today?

Yes..1 (If 2 or 3, skip to end of questionnaire)
No...2
Refused..3

(NOTE to Highway Transportation and Research Council staff:
No direct reference, by interviewer, to any type of wide load during this question.)

(9) Have you any comment concerning the wide load?

(INTERVIEWER: DO NOT READ RESPONSES)

Visibility (hard to see around)..........................1
Width (could not pass, run off road).....................2
Delay (slow moving)......................................3
Handling characteristics (sway)..........................4
No comment...5
Other..6 ________________

Thank you very much for helping us in this traffic safety survey. Have a good day.

OBSERVE AND RECORD: (D) SEX
Male...............................1
Female.............................2

(E) AGE
Young adult (16 to 30)............1
Middle adult (31 to 60)...........2
Older adult (61 and over).........3

DATE ________________ TIME ________________

14-FOOT WIDE LOAD STUDY

SCHEDULE FOR DATA COLLECTION

Week of September 13-17

Date	Manufacturer	No. Units	Study	Origin	Routes	Destination	Begin Data Collection Time	Begin Data Collection Place	End Data Collection Time	End Data Collection Place
13	Nationwide	1 14'	Motorist Inter-view	Martins-ville	Rt. 220 between Ridge-way and Route 220B		9:30a.m	Rt. 220 "Old Scale House Site"	12 p.m.	Same
		1 12'					1 p.m.		3:30p.m	
14	Nationwide	1 12'	"	"	Rt. 57 between Rt.220 and 15 miles west of Chatham		9:30a.m	Just beyond Intersection of Rts. 57 & 220	12 p.m.	Same
		1 14'					1 p.m.		3:30p.m	
15	Continental	1 14'	"	Roanoke	Rt. 460 between Rt. 604 and Rt. 652		9:30a.m	Rt. 460 Just before Rt. 652	12 p.m.	Same
		1 12'					1 p.m.		3:30p.m.	
16	Continental	1 12'	"	"	Rt. 604 between Rts. 460 and 220		9:30a.m	Intersection of Rts. 604 & 460	12 pm	Same
		1 14'					1 p.m.		3:30 p.m.	

PART B DATA COLLECTION SCHEDULE

14-FOOT WIDE LOAD STUDY

SCHEDULE FOR DATA COLLECTION

Week of <u>September 20-24</u>

Date	Manufacturer	No. Units	Study	Origin	Routes	Destination	Begin Data Collection		End Data Collection	
							Time	Place	Time	Place
20	?	1 12'	Motorist Inter-view		I-85 at the Alberta rest area		9:30a.m.	I-85 at the Alberta rest area	12 p.m.	Same
		1 14'					1 p.m.		3:30 pm	
21	U.S. Co.	1 14'	"	South Hill	Rt. 58 between Rt. 694 and the junction of Rts. 58 and 46		9:30am	Rt. 58 just east of Brodnax	12 pm	Same
		1 12'					1 pm		3:30 pm	
22	?	1 14'	"		Rt. 501 between Volens and abandoned school location		9:30 am	Rt. 501 near Stevens Groc.	12 pm	Same
		1 12'	"				1 pm		3:30 pm	
23	Va. Home Mfgs.	1 12'	"	Boydton	Rt. 58 between Rt. 1 and Va. Home Mfg.		9:30 am	Route 58	12 pm	Same
		1 14'					1 pm		3:30 pm	

14-FOOT WIDE LOAD STUDY

SCHEDULE FOR DATA COLLECTION

Week of September 27-30

Date	Manufacturer	No. Units	Study	Origin	Routes	Destination	Begin Data Collection		End Data Collection	
							Time	Place	Time	Place
27	Concord Homes	1 12'	Motorist Inter-view	Mt. Jackson	Rt. 33 between Rts. 276 and 602		9:30 am	Rt. 33 at the Rt. 640 service road	12 pm	Same
		1 14'					1 p.m.		3:30 pm	
28	Concord Homes	1 14'	"	"	I-81 at the New Market rest area		9:30 am	I-81 at the New Market Rest area	12 pm	Same
		1 12'					1 pm		3:30 pm	
29	Concord Homes	1 12'	"	"	Rt. 11 between Mauzy and the intersection of I-81 and Rt. 11		9:30 am	Rt. 11 near the Mauzy exit	12 pm	Same
		1 14'					1 pm		3:30 pm	
30	Concord Homes	1 14'	"	"	Rt. 211 between Rt. 615 and Luray		9:30 am	Rt. 211 near Rt. 615	12 pm	Same
		1 12'					1 pm		3:30 pm	

POLICY FOR TRANSPORTING MOBILE AND MODULAR HOUSING UNITS WITH WIDTHS IN EXCESS OF 12 FEET BUT NOT MORE THAN 14 FEET

In addition to the policies outlined in the Virginia Hauling Permit Manual for transporting oversize loads, the following restrictions are required when transporting mobile and modular housing units in excess of 12 feet but not more than 14 feet on the highways of Virginia.

The purpose of these regulations is to permit an evaluation of the movement of wide housing units as outlined in House Joint Resolution No. 41. For the purpose of research, the regulations will be effective from July 15, 1976, to December 1, 1976.

A. Permits and Fees

1. During the study period, permits will be issued on a single trip basis. All permits must be processed through the Permit Engineer in the Central Office at least two weeks prior to the movement of the wide load.

2. A $6.00 fee will be charged for each permit ($5.00 for the Virginia Highway and Transportation permit and $1.00 for the Division of Motor Vehicles permit).

B. Approved Routes

1. Each trip will be approved on an individual basis.

2. Permits will be issued to allow the transportation of 14-foot wide housing units from Virginia manufacturing plants to destinations out of state.

3. Transportation of 14-foot wide housing units from one state over the highways of Virginia to another state will not be permitted during the research period.

4. Route selection will be determined by an engineering study and coordinated with the State Police.

C. Restrictions

1. Moves will be permitted only on Monday, Tuesday, Wednesday, and Thursday between the hours of 9:00 a.m. and 4:00 p.m.,

unless otherwise noted on the permit.

2. No moves will be permitted the day before a holiday, the holiday, or the day following the holiday.

3. No moves will be permitted during adverse road conditions, inclement weather or during excessive wind conditions.

4. Travel on multi-lane highways will be on the right-hand lane with overhang on the shoulder.

5. Pilot car required in rear unless otherwise specified. Front pilot cars are required on all routes other than divided highways. All pilot vehicles and the wide load driver will be in communication with two-way radios.

6. Red flags a minimum of 18-inches square shall be displayed on all four corners of the load.

7. All lights shall be required to be burning during the move, including those on the pilot vehicles.

8. Wide load signs shall be placed on each pilot vehicle and the wide load as outlined on page 35 of the HAULING PERMIT MANUAL.

9. Wide load movements shall not travel in convoy or closer than 2,000 feet.

10. Maximum speed on divided highways will be 45 MPH and a maximum speed of 35 MPH will be permitted on all routes unless specified otherwise.

11. Towing vehicles shall have a minimum of two tons manufacturer's rating with dual tires and 4-speed transmission.

12. The maximum length of the housing unit, including the coupling and towing vehicle, shall not exceed 85 feet. The minimum length of the towing vehicle shall be 15 feet.

13. The driver of the towing vehicle will inconvenience other traffic as little as possible by using every opportunity to allow following traffic to pass.

14. All necessary safety precautions shall be employed. Caution should be exercised under conditions of crossing narrow structures, overtaking vehicles or pedestrians along the roadway's edge, or during vehicle breakdowns.

15. Drivers towing 14-foot wide housing units must have a minimum of 1 year experience in movement of overdimensional loads.

16. Unless otherwise specified above, additional restrictions will be as currently enforced on 12-foot wide units or as specified within permit provisions.

17. Whenever warrants exist, the Permit Engineer may impose additional restrictions on the movement of the load.

D. Damage Responsibility

All transporters shall have insurance according to Virginia statute and be responsible for any damage to roadways, structures, or the traveling public.

APPE 'DIX G

RESULTS OF QUESTIONNAIRE FOR OTHER STATES

QUESTIONNAIRE

MOVEMENT OF 14-FOOT WIDE MANUFACTURED HOUSING UNITS O STATE HIGHWAYS

1. State Total Tabulation Date ____________

2. Is the movement of 14-foot wide manufactured housing units (mobile and modular homes) permitted on your state's highways?

Yes 43(87.8%) No 6(12.2%) If no, answer questions 3 and 4 only, then skip to end of questionnaire

3.* Is the movement of 14-foot housing units (allowed) (denied) on the basis of:

12(24.5%) State law
1(2.0%) Legislative resolution
33(67.3%) Departmental or Commission Policy
7(14.3%) Other (Please specify)
2(4.1%) NO Answer

4.* Was the decision to (allow) (deny) the movement of 14-foot wide housing units based on:

3(6.1%) Legislative resolution
27(55.1%) Departmental judgement
3(6.1%) Successful experience in other states
7(14.3%) Successful trial period in your state
2(4.1%) Research study
24(49.0%) Pressure from housing industry
8(16.3%) Other (Please specify)
2(4.1%) No Answer

5.* What type of permit governs the movement of 14-foot housing units?

43(100%) Single trip permit basis
5(11.6%) Multi-use or blanket permit basis
0 No permit required
4 (9.3%) Other (Please specify)

6. Are manufactur d housing uni s wider than 14-foot allowed in your state on a multi-u e or blanket permit basis?

2(4.7%) Yes If yes, how wide? ________
41(95.3%) No

7. Are 14-foot wide loads other than housing units allow d on the highways on a multi-use or blanket permit basis?

11(25.6%) Yes If yes, what types?
32(74. %) No

*Percentages do not total 100% because some states gave more than one answer.

8. Has your organization denied the housing industry or any housing manufacturer permission to routinely transport 14-foot housing units in your state? Why?

13(30.2%) Yes Reason ______________________
29(67.4%) No
1(2.4%) No Answer

9. What is the estimated number of 14-foot wide or wider housing units moved within or through your state annually?

4(9.3%) 100 or less
6(14.0%) 1,000
10(23.3%) 5,000
13(30.2%) 10,000
4(9.3%) 20,000
________ Over 20,000 (If possible, please specify number ________
6(14.0%) No Answer

10. Do major cities in your state allow the movement of 14-foot wide housing units?

33(76.7%) Yes 2(4.7%) No
6(14.0%) Sometimes (Please specify under what conditions)
2(4.7%) No Answer

11. Has your state recently relaxed or eliminated any rules or regulations previously imposed on the movement of 14-foot housing units?

15(34.9%) Yes (Please specify) ______________________

28(65.1%) No

12. Has your state recently placed additional regulations on the movement of these units?

5(11.6%) Yes (Please specify)

38(88.4%) No

13. Have any studies been conducted in your state concerning the travel of 14-foot wide units? (If yes, please furnish a copy of the report no matter how formal or informal.)

5(11.6%) Yes
37(86.0%) No
1(2.4%) No Answer

14. Are any studies on this subject being conducted in your state?

1(2.3%) Yes Completion date
41(95.3%) No
1(2.3%) No Answer

15. Are you aware of any change in accidents or accident potential resulting from the transportation of 14-foot wide housing units?

2(7.0%) Yes (Please specify problems and how you are dealing with them)
40(93.0%) No

16. Have any figures concerning accident experience in relation to 14-foot units been compiled for your state?

4(9.3%) Yes (Please enclose a copy of the figures or specify)

39(90.7%) No

17. Has your department received public comment due to the movement of 14-foot wide housing units?

17(39.5%) Yes (Please specify number of complaints and type of problem)

26(60.5%) No

18. What rules and regulations currently apply to the movement of 14-foot wide housing units in your state? Please furnish a copy of these regulations.

19. Have you had any difficulty in enforcing these regulations? (If yes, please specify what types of problems you have encountered, how you have dealt with them, and what the outcome has been.)

7(16.3%) Yes Problems ______________________

35(81.4%) No

1(2.3%) No Answer

20. [For the Maintenance Engineer] Has your state experienced any difficulties in relation to highway maintenance resulting from the movement of 14-foot wide units? (If yes, please specify what types of problems you encountered and how you dealt with them.)

13(30.2%) Yes ______________________

27(62.8%) No

3(7.0%) No Answer

APPENDIX H

TRAFFIC AND SAFETY DATA COLLECTION LOG

Trip No.	Film Code	Date	Route	Termini From		Termini To	Facility Type	Lane Width	Terrain	Length Miles	Load Size	Load Type	Remarks
1	1-M1 1-T1	8-16	220 N.	Rt. 966, Martinsville M.P. 13.97 H.C.	-	N. of Collinsville M.P. 5.29 H.C.	4-Lane Undivided Urban	12	Rolling	8.68	14 x 40	Modular	
2	1-M1-M3 1-T1-T3	8-16	220 N.	N. of Collinsville M.P. 5.29 H.C.	-	SCL, Roanoke M.P. 12.87 R.C.	4-Lane Divided Rural	12 9' for 1.5 Miles	Rolling	41.42	14 x 40	Modular	
3	2-M3 2-T3	8-16	220 N.	Rt. 966, Martinsville M.P. 13.97 H.C.	-	N. of Collinsville M.P. 5.29 H.C.	4-Lane Undivided Urban	12	Rolling	8.68	12 x 30	Modular	
4	2-M4-M5 2-T3-T4	8-16	220 N.	N. of Collinsville M.P. 5.29 H.C.	-	SCL, Roanoke M.P. 12.87 R.C.	4-Lane Divided Rural	12 9' for 1.5 Miles	Rolling	41.42	12 x 30	Modular	
5	1-M1 1-T1	8-17	220 N.	Rt. 966, Martinsville M.P. 13.97 H.C.	-	N. of Collinsville M.P. 5.29 H.C.	4-Lane Undivided Urban	12	Rolling	8.68	14 x 40	Modular	
6	1-M1-M3 1-T1-T2	8-17	220 N.	N. of Collinsville M.P. 5.29 H.C.	-	SCL, Roanoke M.P. 12.87 R.C.	4-Lane Divided Rural	12 9' for 1.5 Miles	Rolling	41.42	14 x 40	Modular	
7	2-M4 2-T2	8-17	220 N.	Rt. 966, Martinsville M.P. 13.97 H.C.	-	N. of Collinsville M.P. 5.29 H.C.	4-Lane Undivided Urban	12	Rolling	8.68	12 x 42	Modular	
8	2-M4-M5 2-T2-T3	8-17	220 N.	N. of Collinsville M.P. 5.29 H.C.	-	SCL, Roanoke M.P. 12.87 R.C.	4-Lane Divided Rural	12 9' for 1.5 Miles	Rolling	41.42	12 x 42	Modular	
9	1-M1 1-T1	8-18	220 N.	Rt. 871, Boones Mill M.P. 2.20 F.C.	-	SCL, Roanoke M.P. 12.87 R.C.	4-Lane Divided Rural	12 9' for 1.5 Miles	Rolling	10.68	14 x 42	Modular	
10	1-M2 1-T1-T2	8-18	460 E.	ECL, Roanoke M.P. .88 R.C.	-	Rt. 622 M.P. 19.88 C.C.	4-Lane Divided Rural	12	Rolling	40.30	14 x 42	Modular	
11	1-M2-M3 1-T3-T4	8-18	501 S.	SCL, Lynchburg M.P. 8.66 C.C.	-	NCL, Brookneal M.P. 36.47 C.C.	3 & 2 Lane Rural	10 12' for 8 Miles	Rolling	27.81	14 x 42	Modular	
12	2-M3-M4 2-T4-T5	8-18	501 N.	NCL, Brookneal M.P. 36.47 C.C.	-	SCL, Lynchburg M.P. 8.66 C.C.	2 & 3 Lane Rural	10 12' for 8 Miles	Rolling	27.81	14 x 42	Modular	
13	2-M4-M6 2-T5-T7	8-18	460 W.	Rt. 622 M.P. 19.88 C.C.	-	ECL, Roanoke M.P. .88 R.C.	4-Lane Divided Rural	12	Rolling	40.30	14 x 42	Modular	
14	1-M1 1-T1	8-19	220 N.	Rt. 871, Boones Mill M.P. 2.20 F.C.	-	SCL, Roanoke M.P. 12.87 R.C.	4-Lane Divided Rural	12 9' for 1.5 Miles	Rolling	10.68	12 x 40	Modular	
15	1-M1 1-T1	8-19	460 E.	ECL, Roanoke M.P. .88 R.C.	-	Rt. 622 M.P. 19.88 C.C.	4-Lane Divided Rural	12	Rolling	40.30	12 x 40	Modular	
16	1-M1-M2 1-T1-T2	8-19	501 S.	SCL, Lynchburg M.P. 8.66 C.C.	-	NCL, Brookneal M.P. 36.47 C.C.	3 & 2 Lane Rural	10 12' for 8 Miles	Rolling	27.81	12 x 40	Modular	
17	2-M3 2-T2-T3	8-19	501 N.	NCL, Brookneal M.P. 36.47 C.C.	-	SCL, Lynchburg M.P. 8.66 C.C.	2 & 3 Lane Rural	10 12' for 8 Miles	Rolling	27.81	12 x 40	Modular	
18	2-M3 2-T3	8-19	460 W.	Rt. 622 M.P. 19.88	-	ECL, Roanoke M.P. .88 R.C.	4-Lane Divided Rural	12	Rolling	40.30	12 x 40	Modular	
19	1-H1-H2 1-T1	8-23	81 N.	Exit 68 M.P. 5.17 S.C.	-	W. Va. State Line M.P. 24.35 F.C.	4-Lane Divided Rural	12	Rolling	55.58	14 x 52	Mobile	State Police escorted load
20	2-H2 2-T2	8-23	81 N.	Exit 68 M.P. 5.17 S.C.	-	W. Va. State Line M.P. 24.35 F.C.	4-Lane Divided Rural	12	Rolling	55.58	12 x 57	Double-Wide	

Trip No.	File Code	Date	Route	From		To	Facility Type	Lane Width	Terrain	Length Miles	Size	Type	Remarks
21	1-H1 1-T1	8-24	81 N.	Exit 68 M.P. 5.17 S.C.	-	Rt. 37 M.P. 17.69 F.C.	4-Lane Divided Rural	12	Rolling	48.92 *	14 x 53	Mobile	
22	1-H1 1-T1	8-24	37 S.	I.81 M.P. 3.62 F.C.	-	Rt. 50 M.P. 0.00 F.C.	4-Lane Divided Rural	12	Rolling	3.62	14 x 53	Mobile	
23	1-H1 1-T1	8-24	50 W.	Rt. 37 M.P. 9.31 F.C.	-	West of Rt. 259 M.P. 20.68 F.C.	4-Lane Divided Rural	12	Rolling	11.37	14 x 53	Mobile	
24	1-H1 1-T1	8-24	81 N	Rt. 37 M.P. 3.62 F.C.	-	W.Va. Line M.P. 24.35 F.C.	4-Lane Divided Rural	12	Rolling	6.66	14 x 53	Mobile	
25	2-H1-H2 2-T2	8-24	81 N	Exit 68 M.P. 5.17 S.C.	-	Rt. 37 M.P. 17.69 F.C.	4-Lane Divided Rural	12	Rolling	48.92	12 x 57	Double-Wide	Includes travel after 4 p.m.
26	2-H2 2-T2	8-24	37 S.	I.81 M.P. 3.62 F.C.	-	Rt. 50 M.P. 0.00 F.C.	4-Lane Divided Rural	*12	Rolling	3.62	12 x 57	Double-Wide	Includes travel after 4 p.m.
27	2-H2 2-T2	8-24	50 W	Rt. 37 M.P. 9.31 F.C.	-	W. of Rt. 259 M.P. 20.76 F.C.	4-Lane Divided Rural	12	Rolling	11.45	12 x 57	Double-Wide	
28	1-H1 1-T1	8-25	81 N	Exit 68 M.P. 5.17 S.C.	-	Rt. 37 M.P. 17.69 F.C.	4-Lane Divided Rural	12	Rolling	48.92	14 x 52	Mobile	
29	1-H1 1-T1	8-25	37 S	I-81 M.P. 3.62 F.C.	-	Rt. 522 M.P. 1.63 F.C.	4-Lane Divided Rural	12	Rolling	1.99	14 x 52	Mobile	
30	1-H1 1-T1	8-25	522 N.	Rt. 37 M.P. 20.05 F.C.	-	End 4-Lane M.P. 10.09 F.C.	4-Lane Divided Rural	12	Rolling	9.14	14 x 52	Mobile	
31	1-H1 1-T1	8-25	522 N.	Begin 2-Lane M.P. 10.09 F.C.	-	W. Va. State Line M.P. 0.00 F.C.	2-Lane Rural	10	Rolling	10.09	14 x 52	Mobile	
32	1-H1 1-T1	8-26	81 N	Exit 68 M.P. 5.17 S.C.	-	W. Va. State Line M.P. 24.35 F. C.	4-Lane Divided Rural	12	Rolling	55.58	14 x 53	Mobile	
33	2-H1 2-T1	8-26	81 N	Exit 68 M.P. 5.17 S.C.	-	Exit 84 M.P. 23.85 F.C.	4-Lane Divided Rural	12	Rolling	55.18	12 x 56	Mobile	
34	1-H1 1-J1	8-30	58 E	Va. Homes Plant M.P. 22.07 M.C.	-	Rt. 1 M.P.12.61 M.C.	2-Lane Rural.	12	Rolling	9.46	14 x 56	Mobile	
35	1-H1 1-J1-J2	8-30	85 N	Rt. 1 M.P. 15.15 M.C.	-	Rt. 460 M.P. 21.52 D.C.	4-Lane Divided Rural	12	Flat	46.72	14 x 56	Mobile	
36	1-H1 1-J2	8-30	1 N	NCL Colonial Heights M.P. 17.11 C.C.	-	SCL Richmond M.P. 4.60 C.C.	4-Lane Undivided Suburban	10	Rolling	12.51	14 x 56	Mobile	
37	1-H1-H2 1-J2	8-30	1 N	SCL Richmond M.P. 4.60 C.C.	-	I. 95 M.P. 5.23 H.C.	4-Lane Divided Urban	12	Rolling	10.46	14 x 56	Mobile	
38	1-H2-H3 1-J2-J3	8-30	95 N	Rt. 1 M.P. 7.21 H.C.	-	Rt. 17 Bus. M.P. 1.20 Stafford	4-Lane Divided Rural	10	Rolling	52.75	14 x 56	Mobile	
39	1-H3 1-J4-J5	8-30	95 N	Rt. 17 Bus. M.P. 1.20 Stafford Co.	-	Rt. 1 Woodbridge M.P. 0.38 F.C.	4-Lane Divided Rural	12	Rolling	27.45	14 x 56	Mobile	
40	1-H3 1-J5-J6	8-30	1 N	I.95 M.P. 13.98 F.C.	-	I.495 M.P. 0.06 F.C.	4-Lane Undivided Suburban	10	Rolling	12.92	14 x 56	Mobile	

Trip No.	Film Code	Date	Route	Terminal		Facility Type	Lane Width	Terrain	Length Miles	Load		Remarks
				From	To					Size	Type	
41	1-H1 1-J1	8-31	58 E	Va. Homes Plant M.P. 22.07 H.C.	Rt. 1 M.P. 12.61 H.C.	2-Lane Rural	12	Rolling	9.46	14 x 68	Mobile	
42	1-H1-H2 1-J1	8-31	85 N	Rt. 1 M.P. 15.15 H.C.	Rt. 460 M.P. 21.52 D.C.	4-Lane Divided Rural	12	Flat	46.72	14 x 68	Mobile	
43	1-H2 1-J1-J2	8-31	1 N	NCL Colonial Heights M.P. 17.11 C.C.	SCL Richmond M.P. 4.60 C.C.	4-Lane Undivided Suburban	10	Rolling	12.51	14 x 68	Mobile	
44	1-H2 1-J2	8-31	1 N	SCL Richmond M.P. 4.60 C.C.	I.95 M.P. 5.23 H.C.	4-Lane Divided Urban	12	Rolling	10.46	14 x 68	Mobile	
45	1-H2-H3 1-J2-J3	8-31	95 N	Rt. 1 M.P. 7.21 H.C.	Rt. 17 Bus. M.P. 1.20 Stafford	4-Lane Divided Rural	12	Rolling	52.75	14 x 68	Mobile	
46	1-H3-H4 1-J3	8-31	95 N	Rt. 17 Bus. M.P. 1.20	Rt. 1 Woodbridge M.P. 0.38 F.C.	4-Lane Divided Rural	12	Rolling	27.45	14 x 68	Mobile	
47	1-H4 1-J4	8-31	1 N	1.95 M.P. 13.98 F.C.	I.495 M.P. 0.06 F.C.	4-Lane Undivided Suburban	10	Rolling	12.92	14 x 68	Mobile	
48	1-H1 1-J1	9-1	58 E	Va. Homes Plant M.P. 22.07 H.C.	Rt. 1 M.P. 12.61 H.C.	2-Lane Rural	12	Rolling	9.46	12 x 55	Modular	
49	1-H1-H2 1-J1-J2	9-1	85 N	Rt. 1 M.P. 15.15 H.C.	Rt. 460 M.P. 21.52 D.C.	4-Lane Divided Rural	12	Flat	46.72	12 x 55	Modular	
50	1-H1 1-J2	9-1	1 N	NCL Colonial Heights M.P. 17.11 C.C.	SCL Richmond M.P. 4.60 C.C.	4-Lane Undivided Suburban	10	Rolling	12.51	12 x 55	Modular	
51	1-H2-H3 1-J2-J3	9-1	1 N	SCL Richmond M.P. 4.60 C.C.	I.95 M.P. 5.23 C.C.	4-Lane Divided Urban	12	Rolling	10.46	12 x 55	Modular	
52	1-H3 1-J3-J4	9-1	95 N	Rt. 1 M.P. 7.21 H.C.	Rt. 17 Bus. M.P. 1.20 Stafford	4-Lane Divided Rural	12	Rolling	52.75	12 x 55	Modular	
53	1-H3-H4 1-J4	9-1	95 N	Rt. 17 Bus M.P. 1.20 Stafford Co.	Rt. 1 M.P. 0.38 F.C.	4-Lane Divided Rural	12	Helling	27.45	12 x 55	Modular	
54	1-H4 1-J4-J5	9-1	1 N	1.95 M.P. 13.98 F.C.	I.495 M.P. 0.06 F.C.	4-Lane Undivided Suburban	10	Rolling	12.92	12 x 55	Modular	
55	None 1-J1	9-2	58 E	Va. Homes Plant M.P. 22.07 H.C.	Rt. 1 M.P. 12.61 H.C.	2-Lane Rural	12	Rolling	9.46	12 Wide	Mobile	Trip canceled, heavy rain
56	None 1-J1-J2	9-2	85 N	Rt. 1 M.P. 15.15 H.C.	Rest Area M.P. 14.85 D.C.	4-Lane Divided Rural	12	Rolling	40.05	12 Wide	Mobile	Trip canceled, heavy rain
57	1-H1 1-J1	9-7	220 N	Rt. 871, Boones Mills M.P. 2.20 F.C.	SCL Roanoke M.P. 12.87 R.C.	4-Lane Divided Rural	12 9' for 1.5 Mile	Rolling	10.68	14 x 42	Modular	
58	1-H1 1-J1-J2	9-7	460 E	ECL Roanoke M.P. .88 R.C.	Bedford By-Pass M.P. 15.38 B.C.	4-Lane Divided Rural	12	Rolling	21.66	14 x 42	Modular	-
59	2-H2 2-J2	9-7	460 W.	Bedford By-Pass M.P. 15.38 B.C.	ECL Roanoke M.P. .882 R.C.	4-Lane Divided Rural	12	Rolling	21.66	14 x 42	Modular	
60	3-H3 3-J3	9-7	220 N.	Rt. 871, Boones Mill M.P. 2.20 F.C.	SCL Roanoke M.P. 12.87 R.C.	4-Lane Divided Rural	12 9' for 1.5 mile	Rolling	10.68	12 x 45	Modular	Includes travel after 4 P.M.

Trip No.	Film Code	Date	Route	Termini From	Termini To	Facility Type	Lane Width	Terrain	Length Miles	Load Size	Load Type	Remarks
61	3-H3 3-J3-J4	9-7	460 E	ECL Roanoke M.P. .88 R.C.	Bedford By-Pass M.P. 15.38 B.C.	4-Lane Divided Rural	12	Rolling	21.66	12 x 45	Modular	Inc. travel after 4pm
62	4-H3 4-J4	9-7	460 W	Bedford By-Pass M.P. 15.38 B.C.	ECL Roanoke M.P. .88 R.C.	4-Lane Divided Rural	12	Rolling	21.46	12 x 45	Modular	Inc. travel after 4pm
63	1-H1-H2 1-J1	9-8	58 W	Rt. 220 M.P. 12.87 H.C.	Rt. 8, Stuart M.P. 18.10 P.C.	2-Lane Rural	11	Rolling	29.01	12 x 41	Modular	
64	1-H2 1-J1-J2	9-8	8 N	Rt. 58, Stuart M.P. 9.25 P.C.	Rt. 40, Woolwine M.P. 23.00 P.C.	2-Lane Rural	10	Rolling	13.75	12 x 41	Modular	
65	1-H2 1-J2	9-8	40 E	Rt. 8, Woolwine M.P. 9.85 P.C.	Rt. 704 M.P. 4.00 P.C.	2-Lane Rural	8	Rolling	5.85	12 x 41	Modular	
66	1-H2 1-J2	9-8	704	Rt. 40, Charity	Rt. 57, Fairy Stone	2-Lane Rural	9	Rolling	7.01	12 x 41	Modular	
67	1-H2 1-J2	9-8	57 E	Rt. 704 M.P. 3.29 P.C.	Rt. 687 M.P. 30.92 H.C.	2-Lane Rural	11	Rolling	4.34	12 x 41	Modular	
68	1-H2 1-J2	9-8	687	Rt. 57 M.P. 0.00 H.C.	Rt. 609 M.P. 6.71 H.C.	2-Lane Rural	10	Rolling	6.71	12 x 41	Modular	
69	1-H2 1-J2	9-8	609	Rt. 687 M.P. 0.00 H.C.	Rt. 683 M.P. 1.42 H.C.	2-Lane Unmarked Rural	9	Rolling	2.57	12 x 41	Modular	
70	1-H2 1-J3	9-8	683	Rt. 609	Rt. 687	2-Lane Rural	8	Rolling	4.35	12 x 41	Modular	
71	1-H2 1-J3	9-8	687	Rt. 683 M.P. 11.31 H.C.	Rt. 58 M.P. 12.68 H.C.	2-Lane Rural	9½	Rolling	1.37	12 x 41	Modular	
72	1-H2 1-J3	9-8	58 E	Rt. 687 M.P. 17.80 H.C.	Rt. 220 M.P. 13.00 H.C.	2-Lane Rural	11	Rolling	4.80	12 x 41	Modular	
73	1-H1-H2 1-J1	9-9	58 W	Rt. 220 M.P. 12.87 H.C.	Rt. 8, Stuart M.P. 18.10 P.C.	2-Lane Rural	11	Rolling	29.01	14 x 41	Modular	
74	1-H2 1-J2	9-9	8 N	Rt. 58, Stuart M.P. 9.25 P.C.	Rt. 40 Woolwine M.P.23.00 P.C.	2-Lane Rural	10	Rolling	13.75	14 x 41	Modular	
75	1-H2 1-J2	9-9	40 E	Rt. 8, Woolwine M.P. 9.85 P.C.	Rt. 704 M.P. 4.00 P.C.	2-Lane Rural	8	Rolling	5.85	14 x 41	Modular	
76	1-H2-H3 1-J2	9-9	704	Rt. 40, Charity	Rt. 57, Fairy Stone	2-Lane Rural	9	Rolling	7.01	14 x 41	Modular	
77	1-H3 1-J2	9-9	57 E	Rt. 704	Rt. 687	2-Lane Rural	11	Rolling	4.34	14 x 41	Modular	
78	1-H3 1-J2-J3	9-9	687	Rt. 57 M.P. 0.00 H.C.	Rt. 609 M.P. 6.71 H.C.	2-Lane Rural	10	Rolling	6.71	14 x 41	Modular	
79	1-H3 1-J3	9-9	609	Rt. 687 M.P. 0.00 H.C.	Rt. 683 M.P. 1.42 H.C.	2-Lane Rural	9	Rolling	2.57	14 x 41	Modular	
80	1-H3 1-J3	9-9	683	Rt. 609	Rt. 687	2-Lane Rural	8	Rolling	4.35	14 x 41	Modular	

Trip No.	File Code	Date	Route	Termini From		Termini To	Facility Type	Lane Width	Terrain	Length Miles	Load Size	Load Type	Remarks
81	1-H3 1-J3	9-9	687	Rt. 683 M.P. 11.31 H.C.	-	Rt. 58 M.P. 12.68 H.C.	2-Lane Rural	9½	Rolling	1.37	14 x 41	Modular	
82	1-H3 1-J3	9-9	58 W	Rt. 687 M.P. 17.83 H.C.	-	Rt. 220 M.P. 13.00 H.C.	2-Lane Rural	11	Rolling	4.80	14 x 41	Modular	
83	1-H1 1-J1	9-13	58 W	Va. Homes Plant M.P. 22.07 H.C.	-	Clarksville M.P. 33.54 M.C.	2-Lane Rural	12	Rolling	11.47	14 x 66	Mobile	
84	1-H1-H2 1-J1	9-13	58 W	Clarksville, Begin 4Ln.- M.P. 33.54 H.C.		ECL Danville M.P. 9.87 P.C.	4-Lane Divided Rural	11	Rolling	49.01	14 x 66	-Mobile	
85	1-H2-H3-H4 1-J1-J2	9-13	29 N	NCL Danville M.P. 9.12 P.C.	-	SCL Lynchburg M.P. 20.32 C.C.	4-Lane Divided Rural	12	Rolling	56.96	14 x 66	Mobile	
86	1-H4 1-J2	9-13	29 N	SCL Lynchburg M.P. 20.32 C.C.	-	Rt. 130 M.P. 4.26 A.C.	4-Lane Divided Suburban	12	Rolling	10.41	14 x 66	Mobile	
87	1-H4 1-J2-J3	9-13	29 N	Rt. 130 M.P. 4.26 AmC.	-	Woods Hill M.P. 15.87 N.C.	4-Lane Divided Rural	12	Rolling	33.28	14 x 66	Mobile	
88	1-H5 1-J2-J3	9-13	29 N	Begin 4-Lane M.P. 0.09 Al.C.	-	I.64 M.P. 16.48 Al.C.	4-Lane Divided Rural	12	Rolling	16.39	14 x 66	Mobile	
89	1-H5-H6 1-J3	9-13	I-64 W	Rt. 29 M.P. 17.06 A.C.	-	I.81 M.P. 16.37 A .C	4-Lane Divided Rural	12	Rolling	30.83	14 x 66	Mobile	
90	1-H1 1-J1	9-14	58 W	Va. Homes Plant M.P. 22.07 M.C.	-	Clarksville M.P. 33.54 M.C.	2-Lane Rural	12	Rolling	6.00	12 x 49	Modular	Trip canc. wheel fail.
91	2-H1 2-J1-J2	9-14	58 W	Va. Homes Plant M.P. 22.07 M.C.	-	Clarksville M.P. 33.54 M.C.	2-Lane Rural	12	Rolling	11.47	12 x 49	Modular	
92	2-H1-H2 2-J2-J3	9-14	58 W	Clarksville, Beg. 4Ln. M.P. 33.54 M.C.	-	ECL Danville M.P. 9.87 P.C.	4-Lane Divided Rural	11	Rolling	49.01	12 x 49	Modular	
93	2-H3-H4 2-J3-J4	9-14	29 N	NCL Danville M.P. 9.12 P.C.	-	SCL Lynchburg M.P. 20.32 C.C.	4-Lane Divided Rural	12	Rolling	56.96	12 x 49	Modular	
94	2-H4 2-J5	9-14	29 N	SCL Lynchburg M.P. 20.32 C.C.	-	Rt. 130 M.P. 4.26 A.L.	4-Lane Divided Suburban	12	Rolling	10.41	12 x 49	Modular	
95	2-H4 2-J5	9-14	29 N	Rt. 130 M.P. 4.26 Am. C.	-	Woods Hill M.P. 15.87 N.C.	4-Lane Divided Rural	12	Rolling	33.28	12 x 49	Modular	
96	2-H5 2-J6	9-14	29 N	Begin 4-Lane M.P. 0.09 Al. C.	-	I.64 M.P. 16.48 Al. C.	4-Lane Divided Rural	12	Rolling	16.39	12 x 49	Modular	
97	2-H5-H6 1-J6-J7	9-14	I-64 W	Rt. 29 M.P. 17.06 Al. C.	-	I.81 M.P. 16.37 Av. C.	4-Lane Divided Rural	12	Rolling	30.83	12 x 49	Modular	
98	1-H1 1-J1	9-16	58 W	Va. Homes Plant M.P. 22.07 M.C.	-	Clarksville M.P. 33.54 M.C.	2-Lane Rural	12	Rolling	11.47	12 x 49	Modular	
99	1-H1-H2 1-J1-J2	9-16	58 W	Clarksville, Begin 4-Ln- M.P. 33.54 M.C.		ECL Danville M.P. 9.87 P.C.	4-Lane Divided Rural	11	Rolling	49.01	12 x 49	Modular	
100	1-H2-H3 1-J2-J3	9-16	29 N	NCL Danville M.P. 9.12 P.C.	-	SCL Lynchburg M.P. 20.32 C.C.	4-Lane Divided Rural	12	Rolling	56.96	12 x 49	Modular	

Trip No.	Film Code	Date	Route	Termini From		Termini To	Facility Type	Lane Width	Terrain	Length Miles	Load Size	Load Type	Remarks
101	1-H3 1-J3-J4	9-16	29 N	SCL Lynchburg M.P. 20.32 C.C.	-	Rt. 130 M.P. 4.26 A.C.	4-Lane Divided Suburban	12	Rolling	10.41	12 x 49	Modular	
102	1-H3-H4 1-J4	9-16	29 N	Rt. 130 M.P. 4.26 A.C.	-	Woods Mill M.P. 15.87 N.C.	4-Lane Divided Rural	12	Rolling	33.28	12 x 49	Modular	
103	1-H4 1-J4-J5	9-16	29 N	Begin 4-Lane M.P. 0.09 A.C.	-	1.64 M.P. 16.48 A.C.	4-Lane Divided Rural	12	Rolling	16.39	12 x 49	Modular	
104	1-H4-H5 1-J5	9-16	1.64 W	Rt. 29 M.P. 17.06 A.C.	-	1.81 M.P. 16.37 A.C.	4-Lane Divided Rural	12	Rolling	30.83	12 x 49	Modular	
105	1-H1 1-J1	9-20	220 N	Rt. 9.66 Martinsville M.P. 13.97 H.C.	-	N of Collinsville M.P. 5.29 H.C.	4-Lane Undivided Urban	12	Rolling	8.68	12 x 40	Modular	
106	1-H1-H2-H3 1-J1-J2-J3	9-20	220 N	N. of Collinsville M.P. 5.29 H.C.	-	SCL Roanoke M.P. 12.87 R.C.	4-Lane Divided Rural	12 9' for 1.5 Mile	Rolling	41.42	12 x 40	Modular	
107	1-H3-H4 1-J4-J5	9-20	460 E	ECL Roanoke M.P. .88 R.C.	-	Rt. 622 M.P. 19.88 C.C.	4-Lane Divided Rural	12	Rolling	40.30	12 x 40	Modular	
108	1-H4-H5-H6 1-J5-J6-J7	9-20	460 W	Rt. 622 M.P. 19.88 C.C.	-	ECL Roanoke M.P. .88 R.C.	4-Lane Divided Rural	12	Rolling	40.30	12 x 40	Modular	
109	1-H1 1-J1	9-21	220 N	Rt. 966, Martinsville M.P. 13.97 H.C.	-	N of Collinsville M.P. 5.29 H.C.	4-Lane Undivided Urban	12	Rolling	8.68	14 x 43	Modular	
110	1-H1-H2 1-J1-J2-J3-J4	9-21	220 N	No. of Collinsville M.P. 5 29 H.C.	-	SCL Roanoke M.P. 12.87 R.C.	4-Lane Divided Rural	12 9' for 1.5 Miles	Rolling	41.42	14 x 43	Modular	
111	1-H3-H4 1-J4-J5-J6	9-21	460 E	Int. Rt. 604 M.P. .28 R.C.	-	Rt. 622 M.P. 19.88 C.C.	4-Lane Divided Rural	12	Rolling	39.60	14 x 43	Modular	
112	1-H4-H5-H6 1-J6-J7-J8	9-21	501 S	SCL Lynchburg M.P. 8.66 C.C.	-	NCL Brookneal M.P. 36.47 C.C.	2 & 3 Lane Rural	10 12' for 8 Miles	Rolling	27.81	14 x 43	Modular	
113	1-H6-H7-H8 1-J8-J9-J10	9-21	501 N	NCL Brookneal M.P. 36.47 C.C.	-	SCL Lynchburg M.P. 8.66 C.C.	2 & 3 Lane Rural	10	Rolling	27.81	14 x 43	Modular	
114	1-H8-H9-H10 1-J10-J11-J12-J13	9-21	460 W	Rt. 622 M.P. 19.88 C.C.	-	Int. Rt. 604 M.P. .28 R.C.	4-Lane Divided Rural	12	Rolling	39.60	14 x 43	Modular	
115	1-H1 1-J1	9-22	58 W	Rt. 92 M.P. 22.78 M.C.	-	Clarksville M.P. 33.54 M.C.	2-Lane Rural	12	Rolling	30.76	14 x 66	Mobile	
116	1-H1-H2 1-J1-J2	9-22	58 W	Clarksville M.P. 33.54 M.C.	-	ECL Danville M.P. 9.87 P.C.	4-Lane Divided Rural	11	Rolling	49.01	14 x 66	Mobile	
117	1-H2-H3-H4 1-J2-J3-J4	9-22	29 N	NCL Danville M.P. 9.12 P.C.	-	SCL Lynchburg M.P. 20.32 C.C.	4-Lane Divided Rural	12	Rolling	56.96	14 x 66	Mobile	
118	1-H4 1-J4	9-22	29 N	SCL Lynchburg M.P. 20.32 C.C.	-	Rt. 130 M.P. 4.26 A.C.	4-Lane Divided Suburban	12	Rolling	10.41	14 x 66	Mobile	
119	1-H4-H5 1-J4-J5	9-22	29 N	Rt. 130 M.P. 4.26 A.C.	-	Woods Mill M.P. 15.87 N.C.	4-Lane Divided Rural	12	Rolling	33.28	14 x 66	Mobile	
120	1-H6 1-J5	9-22	29 N	Begin 4-Lane M.P. p.09 A.C.	-	1.64 M.P. 16.48 A.C.	4-Lane Divided Rural	12	Rolling	16.39	14 x 66	Mobile	

Trip No.	Film Code	Date	Route	Termini From	Termini To	Facility Type	Lane Width	Terrain	Length Miles	Load Size	Load Type	Remarks
121	1-H6-H7 1-J5-J6	9-22	164 W	Rt. 29 M.P. 17.06 A.C.	I 81 M.P. 16.37 A.C.	4-Lane Divided Rural	12	Rolling	30.83	14 x 66	Mobile	
122	1-H1 1-J1	9-23	11 N	Rt. 730, Concord Homes M.P. 29.57 S.C.	Rt. 263 M.P. 27.03 S.C.	2-Lane Rural	10	Rolling	2.54	12 x 57	Double-Wide	
123	1-H1-H2 1-J1	9-23	263	Rt. 11	Rt. 42	2-Lane Rural	10	Rolling	6.31	12 x 57	Double-Wide	
124	1-H2 1-J1-J2	9-23	42 S	Rt. 263	Rt. 767	2-Lane Rural	10	Rolling	5.82	12 x 57	Double-Wide	
125	1-H2 1-J2	9-23	767	Rt. 42	Rt. 616	2-Lane Rural	8	Rolling	3.50	12 x 57	Double-Wide	
126	1-H2-H3 1-J2-J3	9-23	616-617 728	Rt. 767	Rt. 260	2-Lane Rural	8	Rolling	4.53	12 x 57	Double-Wide	
127	1-H3 1-J3	9-23	260	Rt. 616-617-728	Rt. 11 New Market	2-Lane Suburban	20	Rolling	1.11	12 x 57	Double-Wide	
128	1-H3 1-J3	9-23	11 N	Rt. 260, New Market M.P. 33.92 S.C.	Rt. 730 M.P. 29.29 S.C.	3-Lane Rural	10	Rolling	4.63	12 x 57	Double-Wide	
129	2-H4 2-J4	9-23	11 N	Rt. 730, Concord Homes M.P. 29.57	Rt. 263 M.P. 27.03 S.C.	2-Lane Rural	10	Rolling	2.54	14 x 66	Mobile	
130	2-H5 2-J4-J5	9-23	263	Rt. 11	Rt. 42	2-Lane Rural	10	Rolling	6.31	14 x 66	Mobile	
131	2-H5-H6 2-J5	9-23	42 S	Rt. 263	Rt. 767	2-Lane Rural	10	Rolling	5.82	14 x 66	Mobile	
132	2-H6 2-J5-J6	9-23	767	Rt. 42	Rt. 616	2-Lane Rural	8	Rolling	3.50	14 x 66	Mobile	
133	2-H6-H7 2-J6-J7	9-23	616-617 728	Rt. 767	Rt. 260	2-Lane Rural	8	Rolling	4.53	14 x 66	Mobile	
134	2-H7 2-J7	9-23	260	Rt. 616-617 728	Rt. 11	2-Lane Suburban	20	Rolling	1.11	14 x 66	Mobile	
135	2-H7 2-J7	9-23	11 N	Rt. 260 New Market M.P. 33.92 S.C.	Rt. 730 M.P. 29.29 S.C.	3-Lane Rural	10	Rolling	4.63	14 x 66	Mobile	
136	1-H1 1-J1	9-27	58 E	Va. Homes Plant M.P. 22.07 H.C.	Rt. 1 M.P. 12.61 H.C.	2-Lane Rural	12	Rolling	9.46	14 x 61	Mobile	
137	1-H1-H2 1-J1-J2	9-27	I 85 N	Rt. 1 M.P. 15.15 H.C.	Rt. 460 M.P. 21.52 D. C.	4-Lane Divided Rural	12	Flat	46.72	14 x 61	Mobile	
138	1-H3 1-J2-J3	9-27	1 N	NCL Colonial Heights M.P. 17.11 C.C.	SCL Richmond M.P. 4.60 C.C.	4-Lane Undivided Suburban	10	Rolling	12.51	14 x 61	Mobile	
139	1-H3-H4 1-J3-J4	9-27	1 N	SCL Richmond M.P. 4.60 C.C.	I 95 M.P. 5.23 H.C.	4-Lane Divided Urban	12	Rolling	10.46	14 x 61	Mobile	
140	1-H4-H5 1-J4-J5-J6	9-27	I 95	Rt. 1 M.P. 7.21 H.C.	Rt. 17 Bus M.P. 1.20 S.C.	4-Lane Divided Rural	12	Rolling	52.75	14 x 61	Mobile	

141	1-H5-H6 1-J6-J7	9-27	I 95	Rt. 17 Bus M.P. 1.20 Stafford Co.	- Rt. 1 M.P. 0.38 F.C.	4-Lane Divided Rural	12		Rolling	27.45	14 x 61	Mobile	
142	1-H6 1-J7	9-27	1 N	I-95 M.P. 13.98 F.C.	- I-495 M.P. 0.06 F.C.	4-Lane Undivided Suburban	10		Rolling	12.92	14 x 61	Mobile	
143	1-H1 1-J1	9-28	58 E	Va. Homes Plant M.P. 22.07 H.C.	- Rt. 1 M.P. 12.61 H.C.	2-Lane Rural	12		Rolling	9.46	12 x 41	Mobile	
144	1-H1-H2 1-J1-J2	9-28	I-85 N	Rt. 1 M.P. 15.15 H.C.	- Rt. 460 M.P. 21.52 D.C.	4-Lane Divided Rural	12		Flat	46.72	12 x 41	Mobile	
145	1-H2-H3 1-J2-J3	9-28	1N	N.C.L. Colonial Heights M.P. 17.11 C.C.	- SCL Richmond M.P. 4.60 C.C.	4-Lane Undivided Suburban	10		Rolling	12.51	12 x 41	Mobile	
146	1-H3 1-J3-J4	9-28	1 N	SCL Richmond M.P. 4.60 C.C.	- I-95 M.P. 5.23 H.C.	4-Lane Divided Urban	12		Rolling	10.46	12 x 41	Mobile	
147	1-H3-H4 1-J4-J5	9-28	I-95 N	Rt. 1 M.P. 7.21 H.C.	- Rt. 606, Thornburg M.P. 1.58 S.C.	4-Lane Divided Rural	12		Rolling	44.76	12 x 41	Mobile	
148	1-H4-H5 1-J5-J6-J7	9-28	I-95 N	Rt. 17 Bus. M.P. 1.20 S.C.	- Rt. 1 M.P. 0.38 F.C.	4-Lane Divided Rural	12		Rolling	27.45	12 x 41	Mobile	
149	1-H5-H6 1-J7-J8	9-28	1 N	I-95 M.P. 13.98 F.C.	- I-495 M.P. 0.06 F.C.	4-Lane Undivided Suburban	10		Rolling	12.92	12 x 41	Mobile	
150													Trip omitted Run began Rt. 92
151	1-H1 1-J1	9-29	92	Rt. 58 M.P. 0.00 M.C.	- Rt. 660 M.P. 1.43 M.C.	2-Lane Rural	9		Rolling	1.43	14 x 66	Mobile	
152	1-H1 1-J1	9-29	660	Rt. 92	- Rt. 47	2-Lane Rural	8		Rolling	8.51	14 x 66	Mobile	
153	1-H1-H2 1-J1-J2	9-29	47	Rt. 660 M.P. 13.59	- Rt. 664 M.P. 18.85 H.C.	2-Lane Rural	10		Rolling	5.26	14 x 66	Mobile	
154	1-H2-H3 1-J2-J3	9-29	664-669	Rt. 47	- Rt. 615	2-Lane Rural	8		Rolling	11.28	14 x 66	Mobile	
155	1-H3 1-J3	9-29	615	Rt. 669	- Rt. 1	2-Lane Rural	8		Rolling	3.46	14 x 66	Mobile	
156	1-H3 1-J3	9-29	1	Rt. 615 M.P. 16.58 M.C.	- Rt. 711 M.P. 18.38 M.C.	2-Lane Rural	12		Rolling	1.80	14 x 66	Mobile	
157	1-H3 1-J3	9-29	711	Rt. 1	- Rt. 710	2-Lane Rural	8		Rolling	1.60	14 x 66	Mobile	
158	1-H3 1-J3-J4	9-29	710-616	Rt. 711	- Rt. 4	2-Lane Rural	8		Rolling	3.90	14 x 66	Mobile	
159	1-H3 1-J4	9-29	4	Rt. 710-616 M.P. 0.00 M.C.	- Rt. 58 M.P. 8.57 M.C.	2-Lane Rural	11		Rolling	8.57	14 x 66	Mobile	
160	1-H3 1-J4	9-29	58 W	Rt. 4 M.P. 16.77 M.C.	- Va. Homes Plant M.P. 22.07 M.C.	2-Lane Rural	12		Rolling	5.30	14 x 66	Mobile	

Trip No	Film Code	Date	Route	Termini From	Termini To	Facility Type	Lane Width	Terrain	Length Miles	Load Size	Load Type	Remarks
161												Trip omitted Run began Rt. 92
162	1-H1 1-J1	9-30	92	Rt. 58 M.P. 0.00 M.C.	- Rt. 660 M.P. 1.43 M.C.	2-Lane Rural	9	Rolling	1.43	12 x 66	Mobile	
163	1-H1 1-J1	9-30	660	Rt. 92	- Rt. 47	2-Lane Rural	8	Rolling	8.51	12 x 66	Mobile	
164	1-H1 1-J1-J2	9-30	47	Rt. 660 M.P. 13.59 M.C.	- Rt. 664 M.P. 18.85 M.C.	2-Lane Rural	10	Rolling	5.26	12 x 66	Mobile	
165	1-H1 1-J2-J3	9-30	664-669	Rt. 47	- Rt. 615	2-Lane Rural	8	Rolling	11.28	12 x 66	Mobile	
166	1-H2 1-J3	9-30	615	Rt. 669	- Rt. 1	2-Lane Rural	8	Rolling	3.46	12 x 66	Mobile	
167	1-H2 1-J3	9-30	1	Rt. 615 M.P. 16.58 M.C.	- Rt. 711 M.P. 18.38 M.C.	2-Lane Rural	12	Rolling	1.80	12 x 66	Mobile	
168	1-H2 1-J3	9-30	711	Rt. 1	- Rt. 710	2-Lane Rural	8	Rolling	1.60	12 x 66	Mobile	
169	1-H2 1-J3-J4	9-30	710-616	Rt. 711	- Rt. 4	2-Lane Rural	8	Rolling	3.90	12 x 66	Mobile	
170	1-H2 1-J4	9-30	4	Rt. 710-616 M.P. 0.00 M.C.	- Rt. 58 M.P. 8.57 M.C.	2-Lane Rural	11	Rolling	8.57	12 x 66	Mobile	
171	1-H2 1-J4	9-30	58 W	Rt. 4 M.P. 16.77 M.C.	- Va. Homes Plant M.P. 22.07 M.C.	2-Lane Rural	12	Rolling	5.30	12 x 66	Mobile	
172	1-H1 1-J1	10-4	19	Rt. 825	- SCL Lebanon Begin 2 Lane	4-Lane Divided Rural	12	Mnts.	16.60	12 x 40	Modular	
173	1-H1-H2-H3 1-J1-J2-J3-J4	10-4	19	SCL Lebanon Begin 2-Lane	- Rt. 460 Claypool Hill	2-Lane Rural	10 12' Lane 8.99 Mi.	Mnts.	24.76	12 x 40	Modular	
174	1-H4-H5-H6-H7 1-J4-J5-J6	10-4	19	Rt. 460 Claypool Hill	- SCL Lebanon End 2- Lane	2-Lane Rural	10 12' Lane 8.99 Mi.	Mnts.	24.76	12 x 40	Modular	
175	1-H6 1-J?-J5	10-4	19	SCL Lebanon End 2 -Lane	- Rt. 825	4-Lane Rural	12	Mnts.	16.60	12 x 40	Modular	
176	2-H7 2-J5-J4	10-4	19	Rt. 825	- SCL Lebanon Begin 2-Lane	4-Lane Divided Rural	12	Mnts.	16.60	12 x 40	Modular	
[illegible]	2-H7-H8-H9-H10 2-J9-J10-J11-J12	10-4	19	SCL Lebanon Begin 2-Lane	- 460 Claypool Hill	2-Lane Rural	10 12' Lane 8.99 Mi.	Mnts.	24.76	12 x 40	Modular	
178	2-H10-H11-H12 2-J12-J13-J14	10-4	19	460 Claypool Hill	- SCL Lebanon End 2-Lane	2-Lane Rural	10 12' Lane 8.99 Mi.	Mnts.	24.76	12 x 40	Modular	
179	2-H12 2-J14-J15	10-4	19	SCL Lebanon End 2-Lane	- Rt. 825	4-Lane Divided Rural	12	Mnts.	16.60	12 x 40	Modular	
[illegible]	1-H1 [illegible]	10-5	19	Rt. 825	- SCL Lebanon Begin 2-Lane	4-Lane Divided Rural	12	Mnts.	16.60	14 x 42	Modular	

Trip No.		Date	Route	Termini From		To	Facility Type	Lane Width	Terrain	Length Miles	Load Size	Load Type	Remarks
181	1-H1-H2-H3-H4 1-J2-J3-J4-J5	10-5	19	SCL Lebanon Begin 2-Lane	-	Rt. 460 Claypool Hill	2-Lane Rural	10 12' Lane 8.99 Mi.	Mnts.	24.76	14 x 42	Modular	
182	1-H4-H5-H6 1-J5-J6-J7	10-5	19	Rt. 460 Claypool Hill	-	SCL Lebanon End 2-Lane	2-Lane Rural	10 12' Lane 8.99 Mi.	Mnts.	24.76	14 x 42	Modular	
183	1-H6 1-J7-J8	10-5	19	SCL Lebanon End 2-Lane	-	Rt. 825	4-Lane Divided Rural	12	Mnts.	16.60	14 x 42	Modular	
184	2-H7 2-J8-J9	10-5	19	Rt. 825	-	SCL Lebanon Begin 2-Lane	4-Lane Divided Rural	12	Mnts.	16.60	14 x 42	Modular	
185	2-H7-H8-H9 2-J9-J10-J11-J12	10-5	19	SCL Lebanon Begin 2-Lane	-	Rt. 460 Claypool	2-Lane Rural	10 12' Lane 8.99 Mi.	Mnts.	24.76	14 x 42	Modular	
186	2-H9-H10-H11 2-J12-J13-J14	10-5	19	Rt. 460 Claypool Hill	-	SCL Lebanon End 2-Lane	2-Lane Rural	10 12' Lane 8.99 Mi.	Mnts.	24.76	14 x 42	Modular	
187	2-H11 2-J15	10-5	19	SCL Lebanon End 2-Lane	-	Rt. 825	4-Lane Divided Rural	12	Mnts.	16.60	14 x 42	Modular	
188	1-H1 1-J1	10-6	58-A	Hansonville	-	ECL St. Paul	4-Lane Divided Rural	12	Mnts.	14.59	14 x 42	Modular	
189	1-H1 1-J1	10-6	58-A	ECL St. Paul	-	Begin 4-Lane	2-Lane Rural	11	Mnts.	1.27	14 x 42	Modular	
190	1-H1 1-J1	10-6	58-A	Begin 4-Lane	-	East of Coeburn Begin of 2-Lane	4-Lane Divided Rural	12	Mnts.	8.40	14 x 42	Modular	
191	1-H1 1-J1-J2	10-6	58-A	E of Coeburn	-	WCL Coeburn	2-Lane Rural	11	Mnts.	1.60	14 x 42	Modular	
192	1-H1-H2 1-J2	10-6	58-A	WCL Coeburn	-	2 Lane E of Norton	4-Lane Divided Rural	11	Mnts.	6.32	14 x 42	Modular	
193	1-H2 1-J2-J3	10-6	58-A	End 4 Lane	-	Rt. 23	2-Lane Rural	11	Mnts.	3.45	14 x 42	Modular	
194	1-H2-H3 1-J3-J4-J5	10-6	23	Rt. 58-A	-	Big Stone Gap	2 & 3 Lane Rural	12	Mnts.	11.57	14 x 42	Modular	