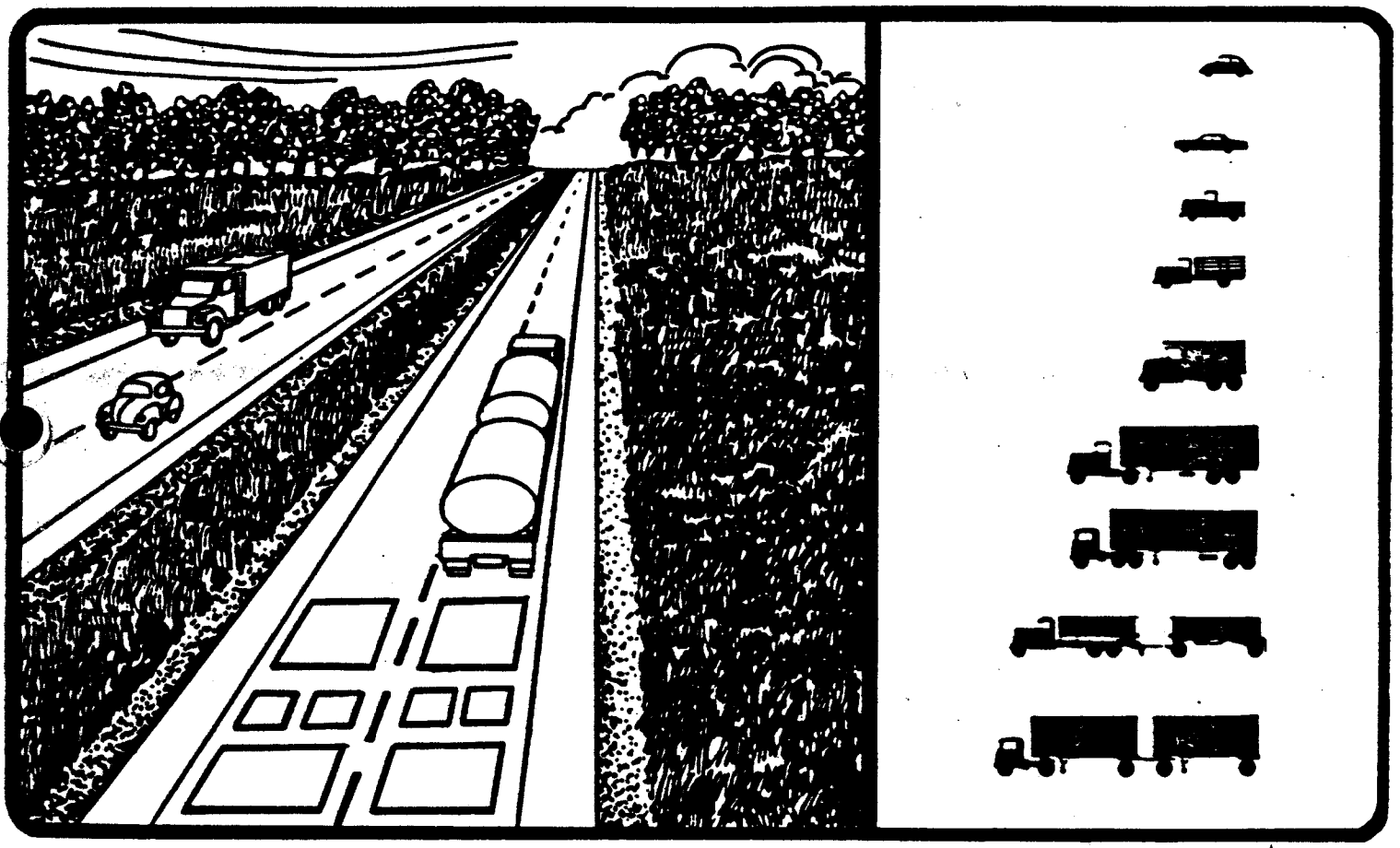


Kamhi



U.S. Department
of Transportation
Federal Highway
Administration

TRAFFIC MONITORING GUIDE



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TRAFFIC MONITORING GUIDE

**Procedures for the
collection and analysis of**

- **Traffic volume data**
- **Vehicle classification data**
- **Truck weight data**



**U.S. Department
of Transportation**

**Federal Highway
Administration**

**Office of Highway Planning
Highway Statistics Division**

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June 1985

**U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
OFFICE OF HIGHWAY PLANNING**

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Introduction

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CHAPTER 1

Overview of this Guide

The following discussion provides a synopsis of the material covered in the following sections.

In Section 2 of this Guide, the reader will find a discussion of the structure of traffic characteristics monitoring; how traffic counting, vehicle classification, and truck weighing relate to the overall monitoring effort; and how this effort is structured through the sample design.

In Section 3, traffic counting is discussed. This chapter focuses on the development of the statistical scheme. The sample is critical to both the reliability of information on traffic volumes and to the later development of samples for vehicle classification and vehicle weighing.

Section 4 covers vehicle classification. This section includes aspects of sample development pertinent to obtaining vehicle classification information along with a description of the FHWA vehicle categories.

Section 5 covers truck weighing and contains information on collection and summarizing data obtained at truck weigh sites. Also included are discussions of the various types of equipment available for weighing vehicles and the specification of the traffic characteristics sample design for obtaining truck weight information.

This Guide is intended to be a statement of good practice. It is not to be considered a Federal standard. Data collection agencies are encouraged to consider the methods presented here in their administration of a data collection program and to compare the cost-effectiveness of this methodology to procedures they presently use.

CHAPTER 2

Guide Objectives

Beginning with the statewide highway planning surveys of the 1930's, the collection of information on traffic volumes, vehicle types, and truck weights have formed a set of activities that are a significant portion of a highway planning program in terms of both cost and personnel. Manuals and guides have been issued describing data collection procedures for each type of activity. During most of the preceding period, each traffic data collection activity was approached as a unique endeavor. Decisions as to the degree to which each activity should be pursued i.e., number of monitoring sites, duration of monitoring, time or season of year for data collection, were generally determined by available funding, perceived need for the data and the size of previous data gathering efforts rather than by a statistical analysis of the monitoring needed.

The FHWA has a history of providing improved methodologies for monitoring the use of America's highways. In keeping with that history, this guide provides direction for improved traffic counting, vehicle classification, and truck weighing. Beyond simply providing ideas for updating these activities, this Guide also provides statistical procedures that allow the manager to determine how much monitoring is needed to achieve a desired precision level.

This Guide has two major objectives. First, to relate the intensity of the monitoring effort to the quality of the data gathered. This situation comes about through the development of a sample design procedure. Using the procedure, it is possible to assess the reliability of the gathered data. The second objective of this guide is to change our perception of traffic counting, vehicle classification, and truck weighing as being separate activities, to the recognition of these activities as part of a related set of traffic characteristic monitoring functions.

The concept of the relatedness of the vehicle count, class and weight data is a unifying element of this Guide. More than being an advocate of a unified approach for the gathering of traffic characteristic data, this Guide provides specific recommendations on the number, extent and duration of such monitoring. Further, the design of the data monitoring is set up in an interrelated and hierarchical fashion. Truck weighing sessions are selected as a subset of vehicle classification sessions. Vehicle classification sessions, in turn, are a subset of volume counting sessions. This "nesting" of sessions is expected to lead to economies of operation. For example, truck weighing locations will serve to gather a portion of the vehicle class and volume count data called for by the sample design. Similarly, vehicle classification sessions will provide needed volume count data.

CHAPTER 3

Data Uses

This Guide provides direction on the monitoring of traffic characteristics. Traffic characteristics are those data obtained through a coordinated program of traffic counting, vehicle classification, and truck weighing. This Guide provides direction for persons interested in conducting a statistically based monitoring of traffic characteristics. Information on traffic characteristics is used in all phases of highway transportation. Exhibit 1-3-1 shows examples of how the traffic characteristic data derived from traffic counting, vehicle classification, and truck weighing can be applied in highway engineering, economic studies, finance, legislation, planning, research, safety, statistics, and by the private sector. Exhibit 1-3-1 is not intended as a comprehensive listing of data uses but rather to portray the extensive utility of the data.

Exhibit 1-3-1
Examples of Studies Making Use of Traffic
Characteristic Data

Highway Management Phase	Traffic Counting	Vehicle Classification	Truck Weighing
Engineering	Highway Geometry	Pavement Design	Structural Design
Engineering Economy	Benefit of Highway Improvements	Cost of Vehicle Operation.	Benefit of Truck Climbing Lane
Finance	Estimates of Road Revenue	Highway Cost Allocation	Weight Distance Taxes
Legislation	Selection of State Highway Routes	Speed Limits	Permit Policy for Oversize Vehicles
Planning	Location and Design Of Highway Systems	Forecasts of Travel by Vehicle Type	Resurfacing Forecasts
Research	Methods of Improving Highway Usage Efficiency	Traffic Simulation	Pavement and Structural Design
Safety	Design of Traffic Control Systems	Safety Conflicts Due to Vehicle Mix	Posting of Bridges for Load Limits
Statistics	Average Daily Traffic	Travel by Vehicle Type	Ton-miles of Travel
Private Sector	Location of Service Areas	Marketing Keyed to Particular Vehicle Types	Trends in Freight Movement

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An Integrated Sample Design for Traffic Monitoring

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2. Federal Highway Administration, "Highway Performance Monitoring System - Field Manual for the Continuing Analytical and Statistical Data Base," U.S. DOT, January 1984 and earlier versions.
3. Federal Highway Administration, "Highway Performance Monitoring System - Vehicle Classification Case Study", U.S. DOT, August 1982.
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CHAPTER 1

Introduction

This chapter outlines procedures for the development of a statistical sampling program for the estimation of traffic volume, annual vehicle miles of travel (AVMT), annual average daily traffic (AADT), vehicle classification, and truck weight with known levels of reliability. The procedures emphasize the use of statistical sampling tied to the Highway Performance Monitoring System (HPMS) sample and the complete integration of the estimation and data collection processes at every level to produce reliable, directly-linked estimates which minimize data collection and eliminate duplication. The proposed program does not ignore the reality of practical considerations and the procedures allow flexibility beyond the theoretical constraints. The integration of the sampling program favors the development of the samples in a sequential or top-down format, i.e., volume samples are taken from the existing HPMS sample, vehicle classification samples are taken from the volume samples, and truck weight samples are taken from the classification samples.

The philosophical approach to the program development follows the system analysis concepts of holism and parsimony.

Holism is a system analysis term expressing the idea that the whole is much more than the sum of the parts, that is, program integration is far superior to program separation. However, it also implies that deficiencies in any part of the system will affect the whole system.

Parsimony in a systems sense is defined as the belief that the simplest, most economical, valid solution is the best. Complex solutions, difficult to comprehend and apply, fall apart during implementation. The reduction in complexity resulting from a simple solution is many times worth the relatively small losses of efficiency or information.

The emphasis on the use of statistical sampling results in estimates with known reliability levels, which are directly estimable from the data. By using the HPMS sample, which is already available and well understood, the need to redesign and implement a new sampling design is eliminated. Furthermore, the tie-in to the HPMS results in directly coordinated programs to address State as well as Federal information needs while eliminating the redundancy of separate programs.

One of the major disadvantages of a sampling program is the fact that sampling produces estimates for an aggregation of elements rather than estimates for specific elements. In context, this translates to the production of system estimates rather than of specific points in the

system. Therefore, sampling leaves a gap which must be addressed in a separate manner. This aspect is discussed in Section 3. The use of sampling, on the other hand, allows very precise estimates of the reliability of estimates and of the relationship between reliability and number of samples or cost of the program.

Decisionmakers are then able to judge the cost of programs versus the reliability of the estimates provided. Since the relationship between reliability and sample size is exponential, the implications of very precise estimates can be directly translated to the costs of the needed programs. In cases where existing programs are pseudo-randomized (approximate or assume randomness) it becomes possible to approximate the reliability of estimates derived from those programs.

The development of a sampling program has clearly defined steps:

1. Definition of desired objectives.
2. Establishment of cost limits or precision requirements.
3. Definition of the universe to be sampled.
4. Definition of sampling element.
5. Determination of reporting stratification desired.
6. Estimation of sampling element variability.
7. Development of sample design.
8. Implementation of sample design.
9. Development of estimation procedures.

However, this task can, in reality, be enormously complex. The definition of desired objectives is usually difficult. Sample size estimation procedures are only applicable to a single data item, while most data collection programs must address a wide variety of needs and purposes. The need to provide estimates for subsets of the data (reporting strata) create constraints which may greatly reduce the overall efficiency of the sample. Sampling element definition can be subject to numerous constraints and require great skill. Finally, as previously mentioned, sampling is concerned with the whole rather than the parts. The development of a real-life probability sample design is an art as much as a science. Even though great efforts are expended to maintain the theoretical constraints, the point is usually reached where practical considerations outweigh theory.

The structure of the traffic monitoring sample design proposed in this Guide consists of three major elements as shown below:

Traffic Monitoring Sample Design

1. Continuous (ATR) element

2. HPMS (coverage) element
 - a. HPMS sample subelement
 - b. Traffic volume subelement
 - c. Vehicle classification subelement
 - d. Truck weight subelement
3. Special Needs Element

Each of these areas are discussed in detail in the following sections.

CHAPTER 2

The Highway Performance Monitoring System (HPMS)

A basic understanding of the HPMS sampling base must precede a generalized discussion of the procedures in this Guide. The HPMS universe consists of all public highways or roads within a State with the exception of roads functionally classified as local. The reporting strata for the HPMS include type of area (rural, small urban, and individual or collective urbanized areas) and functional class (in rural areas these are Interstate, Other Principal Arterial, Minor Arterial, Major Collector, and Minor Collector. In urban areas these are Interstate, Other Freeway or Expressway, Other Principal Arterial, Minor Arterial, and Collector). A third level of stratification based on volume was added as a statistical device to reduce sample size and insure the inclusion of higher volume sections in the sample. For a complete definition of the stratification levels refer to Appendix F of the HPMS Field Manual, January 1984 or later versions.

The HPMS sample design is a stratified simple random sample (for statistical definitions, refer to any of the sampling texts listed as references). The HPMS sample size estimation process was tied to AADT, although near 100 data items are collected. The decision for using AADT was partly based on the fact that AADT is perhaps the most variable data item in the HPMS. Therefore, the reliability of most other characteristics would be expected to exceed that of AADT.

The spatial sampling element in the HPMS could have been defined as a point or a section of road. The use of a point approach would have resulted in more samples (there are an infinite number of points in the universe, but a finite number of sections), and would have required a definition of what constitutes a point, which in the end would have required a conversion to short sections. The use of sections or links acts to reduce sample size, to increase the precision of estimates, and to allow the use of existing State highway inventories.

Traditionally, roads have been thought of in terms of sections and the use of this concept as the sampling element allows a simple translation to road construction and traffic engineering terminology. However, the use of road sections introduces additional constraints which include the assumption that traffic volume and other characteristics or data elements remain constant within the defined section. The fact that some characteristics other than volume may not meet the assumption outright, and that other characteristics may change drastically over time within the section, requires the subdivision of sample sections.

The HPMS sampling element was defined on the basis of road sections which include both directions of travel and all travel lanes within the section. Direction of travel further complicates the definition

because characteristics can change drastically depending on the direction of travel. The same problems exist in the case of multilane facilities where characteristics change by lane of travel. In the interest of simplicity, direction of travel and travel lane were excluded from the sample design with the consequential loss of information.

The AADT variability was estimated based on data from the 1976 National Highway Inventory and Performance Study (NHIPS). The sample was selected as a simple random sample within strata according to predetermined levels of precision presented in the HPMS Field Manual. The HPMS expansion factors are computed as the ratio of universe mileage to sample mileage within strata, thereby insuring that mileage estimates at design stratification categories match the reported universe mileage. This method of expansion deviates from standard theory and may introduce bias if the length of sample sections within strata differs greatly. The estimation procedures for the HPMS are mostly ratio estimation based on length of section which result in higher reliability estimates and reduce bias.

The HPMS sample has now been implemented in every State, the District of Columbia, and Puerto Rico; and it provides a statistically valid, reliable, and consistent data base for analysis within States, between States, and for any aggregation of States up to the national level. For information purposes, Exhibit 2-2-1 presents the 1982 HPMS sample sizes by State and type of area.

Since the HPMS sample provides the basic framework for the traffic monitoring sample, it would be very appropriate for a State to reanalyze its HPMS sample prior to developing the traffic monitoring samples to insure an adequate, up-to-date base. Procedures to reevaluate the HPMS sample are provided in Appendix G of the HPMS Field Manual.

Exhibit 2-2-1
NUMBER OF SAMPLE SECTIONS
1982 HPMS DATA

STATE	SAMPLE SIZE			
	TYPE OF AREA			
	RURAL	SMALL URBAN	URBANIZED	STATEWIDE
ALABAMA.....	806	549	713	2,068
ALASKA.....	268	78	83	429
ARIZONA.....	616	322	374	1,312
ARKANSAS.....	553	472	554	1,579
CALIFORNIA.....	884	455	1,191	2,530
COLORADO.....	946	423	1,020	2,389
CONNECTICUT.....	393	185	983	1,561
DELAWARE.....	158	57	149	364
DISTRICT OF COLUMBIA	0	0	219	219
FLORIDA.....	820	322	1,352	2,494
GEORGIA.....	873	426	637	1,936
HAWAII.....	277	161	323	761
IDAHO.....	988	268	208	1,464
ILLINOIS.....	550	534	1,860	2,944
INDIANA.....	677	467	1,229	2,373
IOWA.....	1,115	865	700	2,680
KANSAS.....	875	544	596	2,015
KENTUCKY.....	976	654	638	2,268
LOUISIANA.....	612	294	411	1,317
MAINE.....	852	343	640	1,835
MARYLAND.....	520	356	616	1,492
MASSACHUSETTS.....	538	182	1,431	2,151
MICHIGAN.....	933	469	1,492	2,894
MINNESOTA.....	816	540	817	2,173
MISSISSIPPI.....	746	493	296	1,535
MISSOURI.....	642	280	316	1,238
MONTANA.....	755	350	235	1,340
NEBRASKA.....	701	449	332	1,482
NEVADA.....	488	120	457	1,065
NEW HAMPSHIRE.....	514	146	267	927
NEW JERSEY.....	380	134	937	1,451
NEW MEXICO.....	561	303	240	1,104
NEW YORK.....	778	563	1,383	2,724
NORTH CAROLINA.....	690	575	1,024	2,289
NORTH DAKOTA.....	568	192	203	963
OHIO.....	948	695	1,349	2,992
OKLAHOMA.....	834	485	448	1,767
OREGON.....	832	480	596	1,908
PENNSYLVANIA.....	1,026	672	2,058	3,756
RHODE ISLAND.....	326	63	326	715

2-2-3

Exhibit 2-2-1 (Cont.)
 NUMBER OF SAMPLE SECTIONS
 1982 HPMS DATA-Continued

STATE	SAMPLE SIZE			
	TYPE OF AREA			
	RURAL	SMALL URBAN	URBANIZED	STATEWIDE
SOUTH CAROLINA.....	612	352	318	1,282
SOUTH DAKOTA.....	856	278	199	1,333
TENNESSEE.....	665	518	700	1,883
TEXAS.....	861	512	1,693	3,066
UTAH.....	615	209	385	1,209
VERMONT.....	474	219	81	774
VIRGINIA.....	715	300	953	1,968
WASHINGTON.....	861	385	1,465	2,711
WEST VIRGINIA.....	640	324	703	1,667
WISCONSIN.....	864	405	1,624	2,893
WYOMING.....	572	360	225	1,157
PUERTO RICO.....	403	277	336	1,016
Total.....	34,773	19,105	37,385	91,263

CHAPTER 3

Development of a Volume Estimation Sample Based on the HPMS

A statistically valid sample design could be developed independently of the HPMS, but the availability of the clearly defined and implemented HPMS sample design results in an enormous reduction of effort. This fact, combined with the gigantic analysis capability offered by the direct linkage of traffic estimates to the data items collected by the HPMS, makes it unrealistic to consider an alternative design.

The conversion, staging, or incorporation of the volume sample into the HPMS framework presents several difficulties. Temporal variation and equipment error were ignored in the HPMS design by examining only sampling error using AADT figures which were assumed to be exact numbers. If the assumption is correct, no adjustments are needed. However, this assumption must now be compared to the reality of the situation. AADT numbers are based on factored short counts subject to error, be it due to equipment or to estimation procedures. These errors must be considered in an overall reliability assessment which goes beyond sampling error.

Traffic volume estimation can be subdivided into two basic categories: annual vehicle miles of travel (AVMT) estimation, and annual average daily traffic (AADT) estimation. AVMT estimation presents a much simpler approach than AADT estimation because AVMT is basically a system measure while AADT is a point-specific measure.

Annual Vehicle Miles Traveled Estimation Based on the HPMS

The existing AVMT estimation procedure used to expand the HPMS sample involves multiplying each section's AADT, section length, and expansion factor and summing the product for all sample sections of interest to yield any desired aggregation level. Estimation of sampling reliability based on this procedure ignores the fact that the AADT values reported are not exact, and this may introduce significant error. The problem can be eliminated by using exact measurements (assuming no equipment bias or compensating for equipment bias) rather than AADT figures and introducing a temporal sampling component.

Given that the spatial sample is already defined by the HPMS, only the temporal aspects remain to be incorporated into the plan. Many possible definitions of the universe and sample elements can be considered to address temporal variation. The recommended definition is that of link-days, which combine the spatial (HPMS section or link) and temporal components.

Within each HPMS stratum, the number of link-days equals the number of sections in the universe times 365. For 48-hour periods, the universe of link-days equals the number of sections times 365 divided by 2. Definitions for other time periods would be similarly derived. The variability of link-day volume can be roughly estimated and sample size specifications derived. Theoretically, the resulting sample would require a fairly complex randomized schedule which may result in multiple counts for a section.

A simpler procedure is to arbitrarily assume that daily (24-hour) VMT is the characteristic of interest and to distribute the measurement of sections systematically throughout the year (equivalent to a systematic sample). This procedure would result in a single volume measurement for each section during the year, and the measurements would be equally distributed throughout the months or seasons of the year. The daily estimates resulting from this approach would be multiplied by 365 to convert to AVMT. Available data indicate that application of this process to the full Interstate HPMS sample would result in AVMT estimates of approximately + 2 percent precision with 95 percent confidence for Interstate statewide estimates. The same process taking one-third of the HPMS sample for the remaining functional classes (excluding Interstate) would result in statewide AVMT estimates with an approximate + 5 percent precision with 95 percent confidence. The actual reliability achieved by each State could be directly estimated after the program has been in operation a full year, and a new assessment of sample vs. precision made using the latest data. The proposed program would cover the full HPMS sample every three years through a rotating schedule.

Traditionally, traffic volume counts under the coverage program have been tied to short periods of time with 24 hours being the predominant period. The usage of a 24-hour period in the previous discussion was arbitrary. Longer periods (say 48 hours) can provide more accurate information but tie-up equipment twice as long and double the data collection. As will be discussed later, AADT requirements may necessitate the use of a 48-hour period of monitoring, but the point that 24-hour periods would be sufficient for AVMT estimation is clearly made. This Guide emphasizes the need to discuss alternatives and to provide minimum guidelines. States wishing to expand on the minimum procedures are encouraged to do so and the procedures can be easily modified to incorporate changes.

The procedures for AVMT estimation discussed in detail in Section 3 will recommend the development of an AADT estimate for each HPMS sample section. This section AADT estimate will consist of a short volume count (48 hours) adjusted as needed for seasonality, axle correction, day-of-week or growth. The summation of the section AADT estimates multiplied by the section lengths and the HPMS expansion factors will then provide the total AVMT estimate.

A basic assumption made in the development of these procedures is that automatic equipment can collect accurate 48-hour volumes. Equipment error introduces bias which is not affected by sample size. For example, if counters undercount by 10 percent, then system estimates will be 10 percent low whether 300 or 3,000 sections are sampled. Since we assume that equipment bias is normally distributed with a zero mean, then no adjustment is required. If on the other hand, the equipment consistently undercounts or overcounts, then an adjustment should be made. The magnitude of this adjustment could be estimated based on an experimental comparison between the equipment counters and manual counts or between different types of equipment.

Annual Average Daily Traffic (AADT) Estimation Based on the HPMS

The estimation of AADT based on short counts presents a very complex problem. Statistical approaches are designed to estimate system rather than section characteristics, yet AADT estimates may be desired for each individual section. The only statistical way to estimate AADT for each section is to actually take measurements on every section of road. While this would be an expensive process, States may desire this type of program for their day-to-day management and administrative responsibility for these roads.

Present procedures for estimation of AADT are based on the application of the appropriate adjustment factors to the actual short term counts. The temporal or seasonal factors are usually estimated based on small samples of continuous traffic recorders (ATR's). Day-of-week and axle correction factors should also be incorporated into this process as needed, although at the present time, they are ignored by many States. The existing procedures for allocating short counts to seasonal factor groups are vague and largely based on engineering judgment.

The central problem with the existing factorization procedure is that it ignores random day-to-day variability which in many cases is larger than the combined factors applied to the short count. The following example illustrates the situation:

Example 2-3-1

Let's assume that a 24-hour count was taken on Monday and a volume of 2,000 axles recorded. The AADT would be estimated by multiplying the count by a seasonal factor (say 1.06), a day-of-week factor (say 1.1), and an axle correction factor (say 0.45). This would result in an AADT estimate of 1,050. Now let's assume that a 24-hour count was taken on Tuesday and a volume of 2,400 axles recorded. By the same procedure, 2400 times a seasonal factor (1.06), a day-of-week factor (1.08), and an axle correction factor (0.45) results in an AADT estimate of 1,237. The difference of 20 percent in the initial volume measurements remains basically unchanged by the factors.

This example explains the reason why a statistical approach to estimate AADT requires several measurements at the specific point of interest. The factors account only for what they are intended to measure, i.e., seasonal, day-of-week, and axle correction variability; but they do not address random variation in volume at the specific points. Analysis of ATR data have shown the coefficient of variation of daily volume to be in the 10 to 15 percent range. This translates to a variation of + 20 to 30 percent within the 95 percent confidence band. With this knowledge, daily variations of 20 percent would be expected to be the rule rather than the exception.

One method of addressing the problem of random variation is to take several measurements at each point and take an average. After all, AADT stands for annual average daily traffic. However, such a procedure would be very costly. Many alternatives can be considered to account for or reduce random variation, such as measuring over longer periods such as 48 hours, 72 hours, 7 days, or taking several randomly selected 24-hour period counts each season or month. The cost implications of these alternatives must be explored as well as the need for the higher accuracy achieved.

The proposed FHWA guidelines for the development of a traffic volume estimation program consist of three major parts or elements:

1. Continuous (ATR) element
2. HPMS (coverage) element and
3. Special Needs element.

The procedures proposed in this Guide revolve around using the previous volume monitoring counts needed for VMT estimation to provide a minimum, basic systemwide AADT coverage framework which could be expanded and supplemented by the individual States depending on their philosophical approach or needs. The VMT sample based on the HPMS provides a basic framework, randomly selected, consistent, and well distributed throughout the State. In some cases, one year's data would be sufficient to develop a rough, annual flow map. For others, 2 or 3 years may be needed. For some States, particularly heavily populated urbanized States, significantly more counting may be required which can be handled as part of the Special Needs element, justified and supported by the specific State needs. The Special Needs element is an integral part of the program.

The continuous (ATR) element (Chapter 2 of Section 3) discusses the procedures for establishing statistical (pseudo-randomized) interpretations of the reliability of seasonal factorization and groupings. The term pseudo-randomized means that randomization is assumed although the ATR locations were not randomly selected. Based on these procedures, the number of ATRs needed to achieve desired reliability levels will be determined and fixed. Seasonal factors and

estimation of precision levels require a reassessment of the ATR programs. The result is a clear evaluation of the number of seasonal groups needed by a State, of the composition of those groups, and of the number of locations needed to achieve desired levels of precision within these groups.

The HPMS element provides a minimum coverage framework of Statewide short counts for AVMT and AADT estimation. The guidelines on the HPMS (coverage) element recommend the use of 48-hour counts on the full sample of HPMS sections over a 3-year cycle. This proposal reduces the effect of the random variation, although it does not eliminate the problem. The procedures streamline the development of factors to compensate for seasonal (monthly) variation, day-of-week variation, axle correction, and growth factors.

Day-of-week factors will compensate for day-of-week travel differences identifiable from data collected by the continuous counters. Axle correction factors are used to compensate for equipment counting axles rather than vehicles, i.e., to account for vehicles with more than two axles. The direct tie-in to the vehicle classification element in Section 4 will provide estimates for axle correction. Growth factors are used to convert the 3-year cycle counts to annual estimates, i.e., sections not counted during the year are estimated by multiplying earlier counts by growth factors. All of these procedures will be discussed in detail in Section 3.

It is recognized that the proposed HPMS element of the traffic monitoring program cannot possibly address all data needs. The Special Needs element allows each State to devise traffic procedures or strategies to supplement the recommended framework to compensate for special requirements.

In addition to special data needs of the States, the administration of the I4R program by FHWA requires augmenting the basic travel data collection cycle for the Interstate System. Supplementing the three-year cycle of reporting of the Interstate System sample sections, the non-sampled portion of the Interstate universe is to have travel monitored by field observations on a cycle not exceeding six years. This special monitoring activity is described further in Appendix K of the HPMS Field Manual.

CHAPTER 4

Vehicle Classification Based on the HPMS Volume Sample

The proposed vehicle classification sample is selected as a subset of the volume estimation sample using simple random selection procedures within the defined strata. This approach eliminates duplication and directly ties the volume and vehicle classification estimation procedures. Duplication is eliminated because classification equipment also collects total volume. Therefore, the sections in the classification subsample are excluded from counting in the HPMS volume element. Direct linking of classification and volume eliminates the need for axle correction factors at the sampled section, and provides a direct procedure for the development of axle correction factors for the remaining sections in the volume sample. The standard vehicle classification categories are provided in Section 4. The estimation procedures will combine the classification estimates from the classification sample with the AVMT or AADT estimates from the volume sample to produce system AVMT or AADT estimates by classification categories. The HPMS sample and the volume sample are stratified by type of area, functional class, and volume group. The full HPMS stratification approach is inefficient for vehicle classification. It would result in an unnecessarily large sample because a positive number of samples would be needed in each strata. Also, most of the HPMS sample is concentrated in lower volume sections while the interest and priority of higher volume sections is paramount. Therefore, a procedure that insures an adequate presence or distribution of high volume sections in the classification sample was developed.

The proposed stratification for vehicle classification consists of type of area (rural and urban) and functional class (HPMS categories). As an option, States willing to apply larger samples than this Guide recommends may wish to apply the full HPMS area stratification (rural, small urban, and individual urbanized areas). The vehicle classification sample would be allocated to HPMS strata proportional to AVMT or DVMT. For example, if the rural Interstate system of a State carries 30 percent of the AVMT, then 30 percent of the classification sample will be allocated to that system. Other possible candidates for the sample distribution were examined including road mileage, truck AVMT, or truck volume. Total AVMT or DVMT provides the best result since it accounts for both mileage and travel, and can be easily estimated from the HPMS sample data. Truck AVMT was discarded because of its close relationship to total AVMT, and the present lack of reliable truck AVMT estimates for the desired stratification levels.

The estimation of vehicle classification variability needed to determine sample size versus precision is quite poor due to the present lack of data. A FHWA-sponsored research study (Reference 1) analyzed the available data and proposed procedures for estimating the required sample sizes in each stratum. The following stratification groups were defined:

1. Rural Interstate
2. Rural Other Principal Arterial
3. Rural Minor Arterial
4. Rural Collector
5. Urban Interstate
6. Urban Other Freeways and Expressways
7. Urban Other Principal Arterial
8. Urban Minor Arterial
9. Urban Collector

These categories represent reporting strata. When following a direct sampling approach, each category requires basically the same number of samples, and total sample size is approximated as the number of samples in a stratum times the number of strata. It is quite easy to see that sample size is directly proportional to the number of strata.

Therefore, the best way to minimize the sample is to reduce the number of reporting strata or not to specify target precision levels for reporting strata.

The recommended sample selection procedures (proportional to AVMT) will insure that some sample sections fall in every strata, but the subdomain reporting precision requirements will not be maintained. The procedures used to estimate sample size are based on standard statistical theory. Estimates of variability from the HPMS Vehicle Classification Case Study are used. Exhibit 2-4-1 presents an example (using Interstate Rural data) of the relationship between sample size and precision at the 95 percent confidence level. The graph shows that an accurate estimate of the percentage of standard automobiles in the system requires a small number of sites. However, the percentage of vehicles in truck categories require much larger samples.

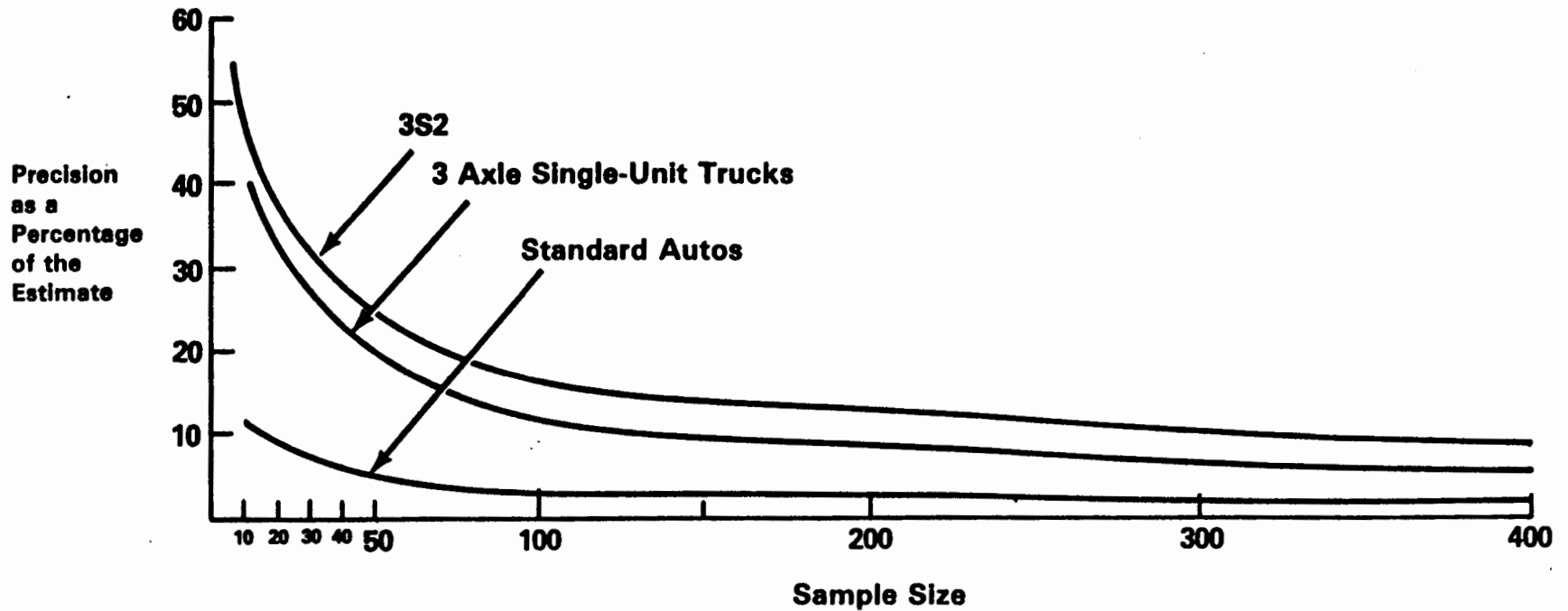
The equation used to estimate the sample size needed to achieve a specified reliability (precision) for a sample random sample is:

$$n = \frac{(Z_{d/2})^2 C^2}{D^2} \quad 2-4-1$$

- where
- n = sample size,
 - $Z_{d/2}$ = value of the two-sided normal distribution for d level of significance (value equals 1.96 for 95% confidence),
 - C = coefficient of variation, and
 - D = desired accuracy as a percentage of the estimate.

Exhibit 2-4-1
Rural Interstate Sample Size vs. Precision
(Vehicle Classification Percentages at the
95 % Confidence Level)

2-4-3



The coefficients of variation estimates used in Exhibit 2-4-1 were taken from page A.2, Reference 1 and are shown below.

<u>VEHICLE CATEGORY</u>	<u>VEHICLE PERCENTAGE</u>	<u>STANDARD DEVIATION (% OF ESTIMATE)</u>	<u>COEFFICIENT OF VARIATION (%)</u>
Standard Auto	41.5	7.4	18%
3-Axle Single	.6	.4	67%
3S2	14.8	12.6	85%

These data present generalized information and will not be applicable to each State. States that have vehicle classification data bases available are encouraged to develop their own specific estimates.

The following table examines the precision vs. sample size relationships:

<u>VEHICLE CATEGORY</u>	<u>SAMPLE SIZE</u>	<u>PRECISION ACHIEVED WITH 95% CONFIDENCE</u>
Standard Auto	10	11
	20	8
	30	6
	100	4
	300	2
3-Axle Single	10	42
	20	29
	30	24
	100	13
	300	8
3S2	10	53
	20	37
	30	30
	100	17
	300	10

Several interpretations can be made based on this table. First, statistical precision is tied only to the variability of the characteristic under consideration. Basically, 10 samples would be expected to approximate a 10 percent of the estimate precision for standard autos, but 53 percent for 3S2's.

Second, in the table precision is presented as a percentage of the estimate. For example, the percentage of 3S2 vehicles in the Rural Interstate is 14.9 and the 95 percent confidence precision is 14.9 ± 1.5 or between 13.4 and 16.4 of the traffic stream. Third, the analysis examines only the Rural Interstate, which means that to achieve the 3S2 target precision would necessitate 300 measurements.

As was mentioned, the estimates of variability based on the generalized data can be expected to differ considerably from State to State. Small States with less variability may achieve the target precision with a much smaller sample. On the other hand, States with large roadway networks, heavy industry, or trucking concentrations may show more variability. To reduce the overall burden and because precise truck information is not needed on an annual basis, the sample has been spread out over a 3-year cycle.

Based on the analysis conducted, we estimate that 300 measurements taken over a 3-year cycle and distributed by functional class would result in statewide estimates of the percentage of 3S2's in the traffic stream with an approximate reliability of + or - 10 percent of the estimate with 95 percent confidence. Estimates for each of the vehicle classification categories will be possible, but estimates for rare vehicle categories (i.e., six-axle multitrailer trucks) will be much less reliable. Actual reliability estimates can be computed for any desired vehicle class category after the sample is in place. Adjustments (increases or decreases) to the sample to meet desired reliability levels can then be made based on a valid sample design and using the latest available data.

As a result of the foregoing discussion, this Guide recommends a minimum of 300 vehicle classification measurements over a 3-year cycle. This represents 100 measurements each year. Under the recommended program, the reliability of system percentages of 3S2 vehicles would be expected to approximate a precision of 95-17 on an annual basis and 95-10 after a 3-year cycle. A halving of the recommended program to 150 measurements would result in an annual target precision (3S2 percentages) of 95-24 and 3-year cycle precision of 95-14. Since the sample is subdivided by functional class VMT, functional class estimates would deteriorate enormously. Under the recommended program and assuming 20 percent VMT, the Interstate sample size would be 60 measurements resulting in target precisions of 95-20 for the 3-year cycle and 95-38 annually. The one-half reduction would result in target precisions of 95-30 for the 3-year cycle and 95-53 annually. The inferences that could be made from the core program for site specific concerns would be significantly reduced by the sparser sample. The linking of truck weight, vehicle classification, and volume estimates would be significantly affected since the magnitude of collective error would be larger. The size of the Special Needs part of the program may necessitate substantial increases.

In summary, the graph in Exhibit 2-4-1 presents a deceptively simple picture. Traffic monitoring is a very complex issue which requires adequate consideration of many interrelated concerns. Decisions on the appropriate level of effort vs. cost should not be based on simplistic assessments. The value of incorrect decisions made on the basis of incorrect information and the need for or planned use of the information collected merit adequate review.

Once selected, the classification sample would become a permanent panel or fixed sample, as in the case for the HPMS sample or the volume sample. This is intended to introduce stability and to allow the installation of permanent equipment at any desired sites. The rotating sample would be monitored completely every 3 years. Although proposed as a panel (fixed) sample, changes or modifications must be expected to occur for one reason or another. The recommended approach is to establish a fixed sample where modifications would be made only when sufficient justification exists to require such modification.

Because of the lack of specific State information (results are based on the HPMS Vehicle Classification Case Study data) and the cost of data collection, an implementation schedule in stages is recommended. A small number of measurements would be scheduled during one year and analysis of the data conducted prior to adding locations. The process would be continued until the specified reliability or the recommended sample is reached. This type of implementation would allow feedback to insure a State-specific answer to the precision vs. cost question. Small States with limited mileage and variability may be able to achieve the desired precision levels with sample sizes substantially below those in the recommended program.

The period of monitoring also requires trade-offs. Longer periods increase the accuracy of the data by reducing random variation, but increase data collection cost. A 48-hour period was selected as the recommended monitoring period. Analysis of the available data have shown that the number of vehicles for several vehicle types vary widely with daily coefficients of variation of about 100 percent (by comparison ATR total daily volume coefficients of variation are in the range of 10 to 15 percent). The use of a 48-hour period would help to stabilize this variation, would not extend beyond the capability of portable classification equipment, and would tie directly to the period recommended for the volume sample. Although a 48-hour period is the goal, shorter periods of 24 hours may have to be used until automatic classification equipment can bridge the gap from the present manual procedures.

The distribution of traffic by direction of travel and travel lane for multilane facilities also demands consideration. We recommend classification by travel lane, although, travel lane is ignored in our sample guidelines and is not a reporting specification. Direction of travel can be handled in a number of ways. We recommend monitoring both directions of travel and maintaining separate figures for each direction. Other possible alternatives include 24 hours in each direction or selecting the direction of monitoring by the flip of a fair coin. These alternatives present trade-offs. The objectives of the data collection should guide the decision.

As discussed previously for the volume sample, the process is designed to provide system estimates of a specified reliability. Direct section estimates are only provided for sections in the vehicle classification sample. For others, stratum inferences are made. As before, only guidelines are specified. States wishing to expand the recommended samples or to measure specific sections or points under the Special Needs element are encouraged to do so.

Temporal variation of vehicle classification is the last item to be discussed. Classification volume is affected by seasonal effects, although in some cases truck volume may not be as affected as passenger vehicle volume. The monitoring must be distributed throughout the year, otherwise seasonal adjustment procedures may be necessary. Alternatives include random selection of periods or a consistent systematic schedule throughout the year. We recommend the latter.

The estimation procedures vary depending on whether sections are in or out of the sample. Sections in the sample have direct (section specific) estimates. Sections not in the sample are estimated by assigning the stratum averages from their specific stratum. Stratum estimates of classification AVMT are simply derived by multiplying the stratum average classified category percentage by the total stratum AVMT from the volume sample. Aggregation of classification AVMT strata to any level can be accomplished by summation of classification AVMT over strata. Aggregated percentages of classification are computed by dividing the aggregated classification category AVMT by the total AVMT. Specific procedures, formulas, and examples are provided in Section 4.



CHAPTER 5

Truck Weight Sample Based on Vehicle Classification Sample

The proposed truck weight sample is selected as a subset of the vehicle classification sample. This eliminates duplication and directly ties the estimates on weight, classification, and volume. Since automatic vehicle weighing equipment classifies and counts, and the recommended period of measurement is the same (48 hours); sample sections in the weight sample do not require a separate classification or volume count. This combination further reduces the level of effort required by the recommended program.

The stratification categories will remain the same as those in the classification element. However, the reporting categories are simplified by collapsing categories to insure that sample sizes reduce to realistic numbers. As in the classification element, the distribution of the sample within the combined strata will remain proportional to AVMT. The minimum recommended reporting strata are:

1. Interstate
2. All other roads

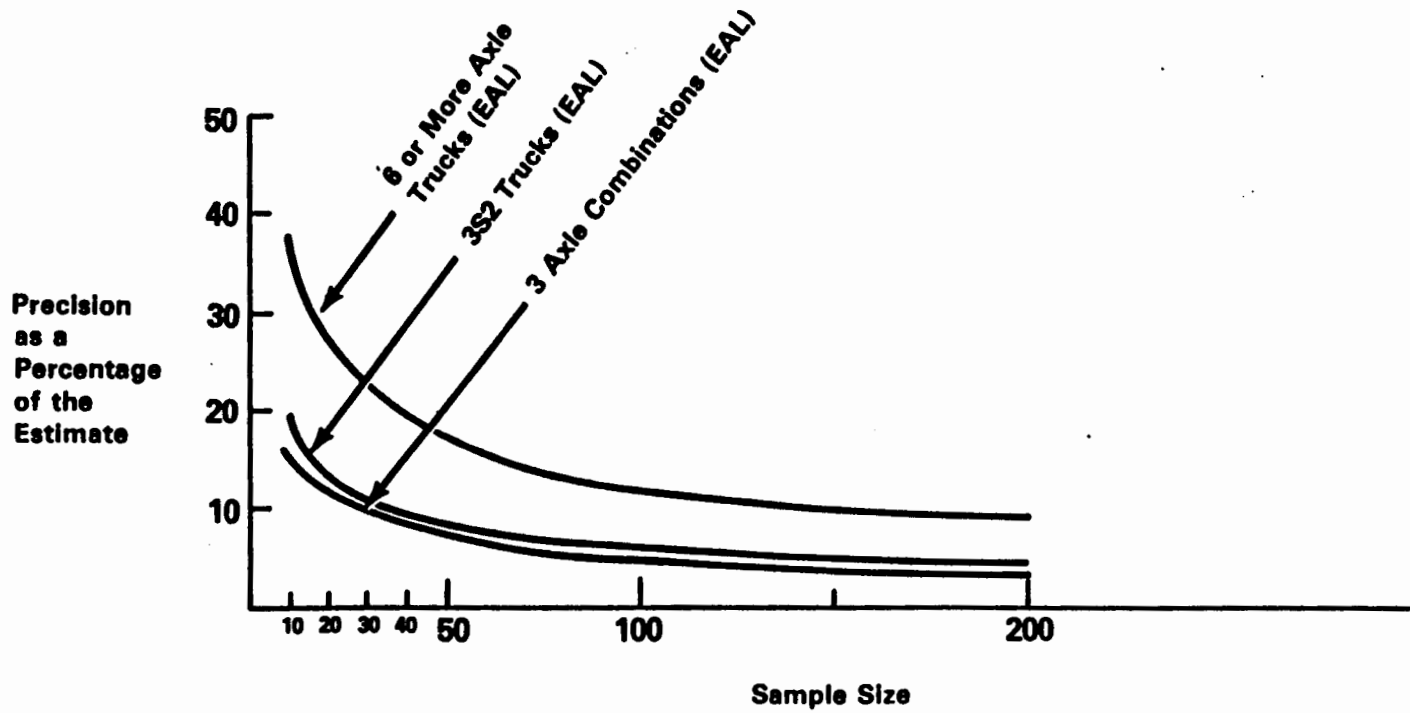
The estimation of sample size for the truck weight sample was based on the characteristic Equivalent Axle Loadings or Loads (EAL). The variability of EAL's was estimated from the HPMS Vehicle Classification and Truck Weight Case Studies. Since 3S2 (18-wheelers) carry a high proportion of the loadings, this vehicle type was selected as the one to guide the sample estimation process. It should be noted that the EAL variability of 3S2's is significantly less than for most other vehicle types, therefore, the decision also reduced the number of samples needed. Research work conducted for the FHWA (Reference 1) provided estimates of the EAL's and their variability by vehicle type and functional class of highway. Exhibit 2-5-1 illustrates the sample size and precision relationships at the 95 percent confidence level for the total Interstate system.

The procedure is the same as used in Chapter 4. Equation 2-4-1 is used to estimate the sample size and the following table presents the estimated EAL coefficients of variation:

EAL COEFFICIENTS OF VARIATION (% OF ESTIMATE)

<u>VEHICLE CATEGORY</u>	<u>URBAN (%)</u>	<u>RURAL (%)</u>	<u>AVERAGE (%)</u>
3-Axle Combination	26	24	25
3S2	35	25	30
6 or more axles	68	54	61

Exhibit 2-5-1
Interstate Sample Size vs. Precision
(Equivalent Axle Loads at the 95% Confidence Level)



2-5-2

The exhibit shows that a target precision of 3S2 EAL estimates on the Interstate system of + or - 10 percent of the estimate (95-10) necessitates 30 measurements. The remaining functional classes show more variability than the Interstate, and the combination of all other roads (excluding local) is necessary to bring the sample size to realistic levels.

A halving of the sample size to 15 would reduce total 3S2 Interstate estimates to 95-15, which is not a large reduction for the corresponding halving of the cost. However, lower subdivisions of the Interstate category would degrade much quicker. Assuming a one-half sample of 8 measurements (corresponding to a 50% break in VMT between urban and rural) on the Interstate Rural system, the target precision of 3S2 EAL would approximate 95-26 over a 3-year cycle and 95-45 for annual data. Regardless of precision figures, statistical samples this small are inadequate. Small samples are also more likely to miss changes occurring in the system and to greatly reflect the effects of atypical occurrences, equipment problems, or other biases. Development of the sample in stages and followed by analysis as described in Chapter 4 would serve to provide State-specific data to better guide the precision vs. cost decision process.

The analysis conducted shows that about 30 measurements (over a 3-year cycle) are needed to estimate equivalent axle loadings (EAL) on the Interstate system for 3S2 trucks (18-wheelers) with a precision of + 10 percent with 95 percent confidence. The 3-year cycle acts to further reduce the sample needed annually. If the reporting strata were Interstate Rural and Interstate Urban, and the same precision levels were desired in each; then a sample of 60 locations, 30 in the rural and 30 in the urban, would be needed.

Using the single Interstate reporting stratum would necessitate 30 measurements, and these would be distributed to urban and rural as well as to HPMS volume subgroups proportional to AVMT as estimated from the HPMS for the vehicle classification sample and considering existing installations (Section 4). In this manner, sufficient urban and rural measurements would be available to produce estimates for these subgroups, although, reliability levels for non-reporting subdomains would be much wider. This procedure will also allow future expansion or reduction of the program to other desired reliability levels.

The same sampling procedure would be applied to the second highway category "all other roads." However, since the variability of the data is much greater as is the mileage, a sample of 60 measurements (over a 3-year cycle) would be needed to estimate 3S2 truck EAL's with approximately + 10 to 20 percent precision with 95 percent confidence. As before, these samples would be distributed based on AVMT from the HPMS and selected by a simple random sample procedure.

The recommended program consists of 90 measurements over a 3-year cycle (30 per year) and results in statewide 3-year EAL estimates of 3S2 trucks with approximately + or - 10 percent precision with 95 percent confidence. Although, so far only EAL's have been discussed, it will also be possible to estimate the reliability of any estimate derived from the sample, including the number of overweight trucks or overweight AVMT in the system. The procedures for making such estimates will be discussed in Section 5. The proposal is, of course, presented as a minimum specification. Options to expand the system based on States' desires are encouraged and can be easily accommodated on a case by case basis.

The recommended period of monitoring is 48 hours. This is the established goal. The data analysis have shown so much variability, particularly for the less common vehicle categories, that anything less would make the reliability of estimates extremely questionable. All the temporal problems present and discussed in the volume estimation section are compounded in the vehicle classification and truck weight samples. The use of a 48-hour period, however, depends on the availability of automatic equipment. Shorter periods of 24 hours may be used in the interim.

The distribution of the sample to cover temporal aspects requires judgment. Obviously, a totally statistical procedure would specify a random sample. However, the fixing of sample size on 3S2 EAL variability has ignored the difference in size (mileage and travel) between the systems of different States. This is particularly a problem for the Interstate system. Since the differences between spatial (distribution over locations) and temporal (distribution at a point in time) variation have not been clearly identified, both must be incorporated into the sample. Here is where judgment must play a part. For example, a State with very limited Interstate mileage could propose to take the 30 weight-classification-volume measurements over a 3-year cycle or 10 per year, at a small number of locations. Rather than single 48-hour measurements during the 3-year cycle at 30 separate locations, multiple measurements would be taken at a small sample of locations. That is, due to the limited system mileage, the distribution of the sample of measurements would be made over time (temporal) rather than location (spatial). At the opposite extreme, very large States would be better served by establishing 30 separate locations of monitoring over a 3-year cycle. A combination of approaches between the two extremes should also be considered. As with previous parts of the program, once selected the sites would become permanent (fixed sample) until events produced sufficient justification to require change.

The previous discussion makes it clear that equipment portability is a critical need. Collecting five 48-hour periods of data at a single point is far less efficient statistically than collecting 48 hours at

five different points in the system. In terms of information gain, very little is accrued after data have been collected at a point for periods longer than 7 days (except for specific objectives that require it, such as seasonality, 30th highest hourly volume, etc.). If seasonal differences are present in vehicle classification and truck weight data, the rudimentary temporal distribution over the year would detect it. In States where truck weight seasonality is expected to be high, special strategies could be devised.

Finally, complete truck weight information is difficult to capture given the enormous cost constraints presented. Although the average weight of loaded trucks may not have changed much over time; the bimodal distribution of weights due to loaded and empty trucks combined with the changing vehicle fleets and the difficulties involved in truck weighing operations, make the assessment of actual loads supported by the system a somewhat arduous task. The spatial differences caused by concentration of certain kinds of vehicles on certain routes and the effect of measurement on truck travel behavior further complicate the situation. The program proposed in this Guide presents a sensible solution to the information needs faced by most agencies. It will not, however, provide an answer to every question that will be asked. Special studies or supplementary information will always be needed.

CHAPTER 6

Summary of Recommendations

The proposed traffic monitoring program described in this section integrates traffic volume, vehicle classification, and truck weight. The traffic volume part of the program consists of three major elements:

1. Continuous (ATR) element
2. HPMS (coverage) element
3. Special Needs element

The sampling guidelines which are the main topic of this section are applicable to the HPMS (coverage) element. The basic sampling framework for traffic volume, vehicle classification, and truck weight data is then expanded and supplemented by the Special Needs element.

The sample design incorporated into the HPMS element consists of four major samples:

1. HPMS sample
2. Traffic volume sample
3. Vehicle classification sample
4. Truck weight sample

The HPMS sample is already defined and implemented in each State. The volume sample corresponds to the HPMS sample at the completion of each 3-year cycle. The vehicle classification sample consists of a subsample of the volume sample. The truck weight sample consists of a subsample of the vehicle classification sample. A diagram of the sample structure is presented in Exhibit 2-6-1, and a brief description of the sample design is presented in Exhibit 2-6-2.

The traffic volume sample consists of 48-hour measurements systematically distributed throughout the year and the State, annually covering a randomly selected one-third of the HPMS sample sections. The vehicle classification sample consists of 300 48-hour measurements over a 3-year cycle. These measurements are systematically distributed throughout the year and the State, and are taken at randomly selected volume sample sections which have been distributed based on HPMS AVMT to provide a fully balanced sample. The recommended truck weight sample consists of 90 48-hour measurements over a 3-year cycle designed to place added emphasis on the Interstate system. The locations are randomly selected from the vehicle classification sample and are allocated to strata based on AVMT. The measurements are distributed systematically throughout the year and the State.

The guidelines are presented as minimum specifications which can be expanded and supplemented to any degree desired by the States. The Special Needs element allows each State flexibility to address additional concerns.

Exhibit 2-6-1

TRAFFIC MONITORING SAMPLE STRUCTURE

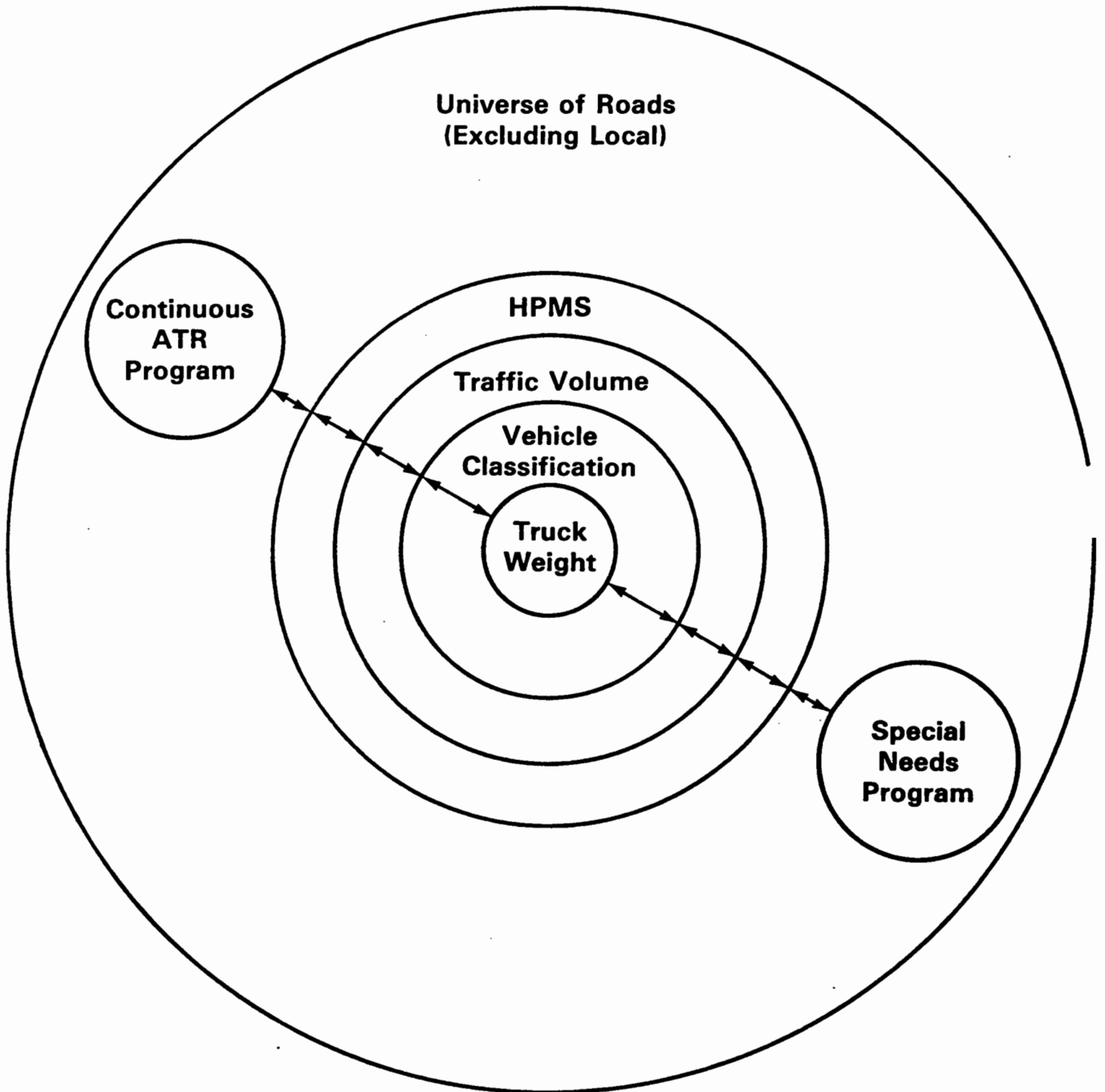


Exhibit 2-6-2

Recommended Traffic Monitoring Sample Design

<u>Program Element</u>	<u>Sample Subelement</u>	<u>Period</u>	<u>Number</u>	<u>Products</u>	<u>Design (Target) Precision</u>
1. Continuous	—	365 Days	40 to 60 (Average State)	Seasonality Growth Temporal Distribution	Annual Seasonal Factors <u>95-10</u>
2. HPMS	HPMS Sample	—	HPMS Sample	System Estimates By Functional Class	Stratum AADT (See HPMS Field Manual)
	Traffic Volume	48 Hours	Annual— 1/2 of HPMS Sample 3-Year Cycle -Full HPMS Sample	System AVMT By Functional Class AADT At Sample Points	Annual AVMT (<u>95-5</u>) (Excluding Local)
	Vehicle Classification	48 Hours	Annual - 100 3-Year Cycle - 300	Classified AVMT Axle Correction Factor Percentage Distribution of Vehicles	Statewide Percentage of 3S2's <u>95-10</u> (3-Year)
	Truck Weight	48 Hours	Annual-30 Measurements: 10 Interstate 20 Others 3-Year Cycle - 90 Measurements: 30 Interstate 60 Others	Weight + EAL by Classification Category	Interstate EAL for 3S2 <u>95-10</u> (3-Year) Other Roads EAL for 3S2 <u>95-20</u> (3-Year)
3. Special Needs (State Needs and Others)	—	—	At State Discretion	Site Specific Information Project Information I4R Truck Routes Pick-up/Auto Split Local Roads Any Others	—

Although the emphasis is on volume, the Special Needs element also concerns vehicle classification and truck weight. Great emphasis has been placed on the use of portable automatic equipment as the most effective and cost-efficient means of achieving statistical validity. The following sections provide more detailed discussions of the traffic volume, vehicle classification, and truck weight procedures.

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Traffic Volume Monitoring

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SECTION 3

Traffic Volume Monitoring

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CHAPTER 1

Introduction and General Summary

The measurement of traffic volumes is one of the most basic functions of highway planning and management. For many years, the traditional approach to the development of annual average daily traffic (AADT) has consisted of three different but complementary types of traffic counts: continuous, control, and coverage (Reference 1).

Continuous counts are taken 365 days a year on a small number of points. These counts provide the most useful information and, usually, imply the use of the most sophisticated permanent counting equipment available to the planning organizations. Because these counts are most consistent from State to State and are maintained at permanent locations, the FHWA summarizes the information on a monthly basis for the development of national travel trends. Continuous counts are the backbone of contemporary State traffic counting programs.

Control or seasonal counts are much more difficult to characterize because of the many alternatives in use by the State planning organizations. These counts are usually taken from 2 to 12 times a year, for periods of time ranging from 24 hours to two weeks. The main purpose of control counts is to provide a seasonal assignment linkage for factoring short counts to AADT.

Coverage counts are short duration counts, ranging from 6 hours to 7 days, distributed throughout the system to provide point-specific information. Coverage count programs vary considerably from State to State. Several States have implemented coverage programs as system tools with limited numbers of counts, lengthy count cycles, and efficient computerized analysis capability. Other States have emphasized complete and detailed coverage of the highway systems resulting in a very large number of counts taken on short cycles and stored in manual form. Obviously the diverse requirements and constraints faced by State planning organizations have translated into very divergent programs.

Previous sections of this report have presented general discussions of the need for a more rigorous statistical procedure, the tie in to the Highway Performance Monitoring System (HPMS), the emphasis on program integration, and the dependence on technological advances in monitoring equipment.

The program as presented in this section consists of 3 major elements:

1. A limited Continuous Count element,

2. A more extensive HPMS framework as the traffic volume sample, and
3. A very flexible Special Needs element.

The procedures are intended to combine system and point estimation in an efficient manner. The proposed program does not make use of control or seasonal count programs.

Chapter 2 presents the recommended approach for the restructuring of continuous ATR programs. The objectives of the recommended programs are to develop adequate and reliable seasonal factors based on a cost-efficient approach; to provide limited statistical rigor; to integrate the continuous program with the overall traffic monitoring program; to minimize modifications to existing continuous programs; to emphasize the development of a consistent approach for national analysis; to establish minimum precision levels for seasonal factors; and to make available a powerful, flexible, analytical tool through the use of computer technology.

Chapter 2 begins with a general introduction, followed by seven subsections. The following is a brief summary of the seven subsections:

o Seasonality Analysis of Existing Continuous ATR Data

The need to analyze available data to guide the development of the procedures is discussed. A cluster analysis procedure to gain insight into existing patterns of seasonality is described.

o Seasonality Procedures Based on Functional Class

One of the major recommendations of the Guide is the establishment of seasonal patterns based on functional class to allow a simple and direct identification and assignment of locations to pattern groups.

o Establishing the Seasonal Pattern Groups

The procedures for the establishment of seasonal pattern groups are presented. The methodology is guided by the analysis of each State's data and the knowledge of specific travel characteristics. The procedures are designed to be tailored for each State.

The minimum seasonal groups recommended are:

1. Interstate Rural
2. Other Rural
3. Interstate Urban
4. Other Urban
5. Recreational

Additional groups for regional or other particular concerns are optional. The determination of recreational patterns is based on substantial judgement and is treated as an exception.

o **Determining the Appropriate Number of Continuous ATR Locations**

Statistical procedures to tie precision to number of locations in each seasonal group are presented. In general, 5 to 8 locations per seasonal group are sufficient to achieve the desired target precision (+ or - 10 percent with 95 percent confidence) of average monthly seasonal factors.

o **Modifications to the Existing Continuous ATR Program**

A discussion of how to modify present programs to bring them in line with the recommended procedures is presented.

o **Computation of Monthly Factors**

The methodology for the development of the monthly factors for the appropriate seasonal groups is presented. The application of the factors to expand short counts and the assignment of location to groups are discussed.

o **Hardware and Software for Data Management and Analyses**

A brief discussion of computer technology and its application to traffic data is presented. The emphasis is on the development of fully computerized data processing and analytical tools.

Chapter 3 discusses the HPMS element of the Traffic Monitoring Program.

It begins with a general introduction followed by eleven subsections which completely describe the recommended approach.

The following summarizes the Chapter subsections:

o **Monitoring Period Specification**

A 48-hour period of monitoring is recommended to provide reliable estimates of AADT at the specific locations.

o **Monitoring Cycle Specification**

A 3-year cycle of monitoring is recommended as the most appropriate alternative for the HPMS core sample.

o Selection of the Core Interstate Sample

The procedures for defining and selecting the Interstate samples are described. The annual sample consists of a rotating one-third of the HPMS sample. Exhibit 3-3-1 lists the 1982 HPMS Interstate sample by State.

o Selection of the Core Sample for the Remaining HPMS Functional Classes

The procedures for defining and selecting the core non-Interstate sample are described. The annual sample consists of a rotating one-third of the HPMS sample. Exhibit 3-3-2 lists the 1982 HPMS non-Interstate sample by State.

o Spatial and Temporal Distribution of Core Counts

The distribution of counts over the system (spatial) and the year (temporal) are discussed. The spatial considerations are covered by the HPMS distribution. A temporal distribution over the complete year or the appropriate months of the year is recommended.

o AADT Estimation for HPMS Core Sample Sections

AADT is used as the basic starting point for the estimation process. The procedures for AADT estimation are presented.

o AVMT Estimation

The procedures for expanding the AADT estimates to system AVMT are presented.

o Computation of Growth Factors

Procedures for the development of growth factors are presented, including a discussion of several alternative methodologies.

o Estimation of Day-of-Week Factors

A discussion of procedures for the development of day-of-week factors is presented.

o Estimation of Axle Correction Factors

The recommended procedures for estimation of axle correction factors are presented. Estimates by functional class from the vehicle classification sample are used to adjust coverage counts taken by axle counting equipment.

o Data Collection and Processing Considerations

Several concerns including the use of hourly breakdowns, missed counts, imputation, computer processes, and the use of unique section identification numbers (HPMS) are mentioned.

The different topics discussed have a common basis, which results in similar procedural development. This makes the process easy to understand and very effective in terms of learning or training. Similarly, extension of the procedures to related travel data can be easily accomplished.

Chapter 4 discusses the Special Needs element of the program. The main focus is on defining additional needs beyond those addressed in earlier chapters. Since the focus of the earlier two elements is system information which can be addressed with a limited amount of coverage, the focus of this chapter is on point-specific information beyond the capabilities of the earlier parts of the program. Because of the great differences existing between States, the presentation is intended to allow maximum flexibility to address any issues of concern to the States. The chapter consists of an introduction followed by limited discussions of system needs beyond the continuous and HPMS core elements, of point-specific needs, of related programs, and of data processing considerations.

Appendix A presents an example of the continuous ATR procedures and a table of the student's T distribution.

CHAPTER 2

The Continuous Count Element

Background and Introduction

The continuous count programs are the most common and consistent traffic data collection programs existing in the States today. These programs have strong historical ties and have become the most basic planning data collection tools in most states. In terms of statistical rigor, most continuous programs lack a firm statistical base. Their design can best be characterized as evolutionary and incremental. These programs, however, have provided the data to guide the development of most of the highway programs in existence today. By providing a permanent, data-intensive method of operation, continuous Automated Traffic Recorders (ATR) have made available a large periodic data base with enormous utility potential to the trained analyst. Indeed one of the purposes of this Guide is to emphasize the need to establish a strong, integrated, and effective analysis capability through the use of analytical computer tools.

Because of the enormous expenditures made to implement existing continuous programs and their present utility in terms of the data base provided, the intent of this chapter is more towards modifying than redoing. By using as much as possible of the existing framework, cost-effectiveness is improved and modifications to existing programs minimized. On the other hand, utilizing existing locations causes statistical rigor to suffer because of the lack of a strict probability sampling approach.

The objectives of continuous ATR programs are many and varied. These objectives should translate directly to the number and location of the counters, the type of equipment used, the analysis procedures, etc. It is, then, of the utmost importance for each organization responsible for the implementation of the continuous ATR program to establish, document, and analyze the objectives of the program. Only by thoroughly defining the objectives and designing the program to meet those objectives will it be possible to develop an effective and cost-efficient program. It is also important to anticipate future requirements, if at all possible, and to build in flexibility to allow incorporation of future modifications.

One of the contentions of this Guide is that the development of seasonal factors to expand short-term counts to annual average daily traffic (AADT) is the most important objective of the continuous ATR program and the one that should guide the establishment of sample size. This assessment does not in any way imply that it is the only

objective, and sufficient flexibility is built-in to address other objectives as needed. Nevertheless, the first objective of the continuous program recommended in this Guide is then to provide a cost-effective approach for the development of seasonal factors. The second objective is to allow a direct tie-in or grounding of the continuous program to the integrated traffic monitoring program based on the HPMS, thereby providing a strong statistical framework and estimation linkage. The third objective, as mentioned earlier, is to minimize modifications to existing continuous ATR programs, thereby emphasizing incremental rather than revolutionary change. Since the second and third objectives are not independent or exhaustive, compromises must be made.

The development of the following procedures is itself the result of compromises between many competing factors. The major emphases are on: 1) the development of data driven procedures, that is, allowing information extracted from available data to guide the formation of the program; 2) the complete integration of related traffic programs; 3) the continuing dependence on technological advances in automated monitoring equipment; and 4) the development of programs that provide an effective and efficient analysis tool.

Seasonality Analysis of Existing Continuous ATR Data

The first step is to define, analyze, and document the present continuous ATR program. A clear understanding of the present program will increase the confidence placed on later decisions to modify the program. The review should explore the historical design, procedures, equipment, personnel, and uses of the information. In most cases, the traffic data is available in computerized form resulting in easy access for statistical data analyses. Many types of analyses are possible and encouraged depending on the desired objectives. One such method of extracting information from the data is presented here.

The cluster analysis carried out is intended to assess the degree of seasonal (monthly variation) existing in each State as detected from the existing ATR program, and to corroborate or examine the validity of the existing grouping procedures used by the States. The analysis consists of examining the monthly variation (attributed to seasonality) of traffic volume at the existing ATR locations, followed by an attempt to group these locations into clusters or patterns of variation. An understanding of the monthly variation of traffic at the different points (ATR's) within the State and of the similarities of this variation as shown by the pattern groupings will help to ascertain the assignment of the ATR locations according to the recommended procedures.

The analysis begins by computing the monthly average daily traffic (MADT) at each ATR location. The MADT's are then used as input to a computerized cluster analysis procedure (a variety of statistical packages are available to perform this work). The seasonal analysis is carried out on a monthly basis because other studies have shown that patterns based on weekly or daily variation reduce the veracity of the resulting seasonal factors (Reference 2). The results of the clustering program are then used to roughly identify seasonal patterns detectable from the existing data. If the planning organization responsible for the counting program has developed seasonal patterns based on manual or computer procedures, a direct comparison is now possible.

Application of these procedures to a number of State programs has produced very reasonable results. In most cases, the patterns of variation that stand out are those of rural, urban and recreational areas. However, there are exceptions where clear patterns have failed to emerge. Plotting the resulting groups on a map is sometimes helpful to discern the reasons for patterns which are obviously influenced by the ATR locations. The advantage of this type of analysis is that it provides early evidence of the existence or validity of established seasonal traffic patterns.

The cluster procedure is illustrated by an example using actual data in Appendix A. The example as presented in the appendix uses MADT's. An alternative, which will reduce the influence of volume differences between locations on cluster formation, is to use the monthly factors (ratio of AADT to MADT) as input to the procedure.

An understanding of the computer programs used or of statistical clustering procedures is helpful but not required to make an adequate interpretation of the program results. The major weakness of clustering procedures is the lack of theoretical guidelines for establishing the optimal number of groups. Therefore, a subjective assessment is needed to establish what is appropriate. However, the objective of this analysis is to identify patterns based on available ATR data rather than to provide an optimal solution. In the context of continuous ATR's, 3 to 6 groups are usually sufficient to identify the specific patterns. If a State uses a fixed number of groups in its existing seasonal grouping methodology, then it is appropriate to compare those groups with those resulting from the clustering procedure as described in this Guide (using the same number of groups in both procedures).

Seasonality Procedures Based on Functional Class

The earlier FHWA procedures(Reference 1) for establishing seasonal patterns were based on random variation, that is, locations showing similar patterns of variation are grouped into a pattern. The weakness of the approach is that no clear, definable characteristic exists to guide the development of these seasonal patterns.

The statistical approach recommended in this Guide defines seasonal patterns based on functional class or a combination of functional classes according to the actual variability as shown in the existing data. Exceptions to the rule do exist and provision is made to address regional differences or recreational patterns. The decision on the appropriate number of groups is based on the actual data analysis results and the analyst's knowledge of specific, relevant conditions.

The definition of these seasonal patterns based on functional class provides a consistent national framework for comparisons between States and, more important, provides a simple procedure for allocating coverage counts to the factor groups for estimation of annual average daily traffic (AADT).

The statistical procedure emphasizes the use of composite (mean) factors for each seasonal group rather than the subjective allocation of specific counts based on nearness to continuous ATR's. The use of mean factors allows the incorporation of statistical theory to tie factor precision levels to sample size (number of locations). The resulting factors are generalized system factors. Maintaining an awareness of the individual factors at each ATR location will allow a judicious determination of the effects of using system factors for point-specific concerns. In cases where the ATR sample provides insufficient information, special counts may be desirable.

Establishing the Seasonal Pattern Groups

The previously described clustering analysis can be used to extract traffic pattern information from ATR data. The following descriptive analysis presents a more direct approach to examine existing data from continuous ATR's or alternatively, from control or seasonal programs. The combined result of both analyses provides the information needed to establish the groups.

The descriptive analysis is carried out by sorting the ATR locations by functional class, computing the percent coefficient of variation of monthly average daily traffic (MADT) at each location, and interpreting the results. As before, the SAS package is used, but other statistical packages would be quite appropriate. An example of the descriptive analysis of the continuous ATR data is presented in Appendix A.

The interpretation of the descriptive analysis is fairly straightforward. The seasonality peaks can be identified by examining the MADT's. The typical pattern shows an increase of travel during the summer months with a peak during July or August. The actual variability is shown by the standard deviation (MSD) and the percent coefficient of variation (MCV). The percent coefficient of variation,

the ratio of the standard deviation to the mean times 100, is a standardized measure that allows direct comparison between locations. In general, the descriptive analysis accounts for the variation of monthly values during the year, but it does not necessarily account for variation patterns. This is to say that locations with completely different monthly patterns may show the same variability as measured by the standard deviation or the coefficient of variation. However, descriptive analysis combined with the clustering of volumes or factors, an examination of monthly factors at the ATR's, and the knowledge of State characteristics provide adequate information to establish the appropriate seasonal groups by functional class. It is important to realize that hardly any two points in a road system show the same pattern of variation. The aggregation of points (ATR location) into seasonal groups is solidified into a functional class assignment process, which will always remain tempered by judgement. Locations showing very distinct patterns are easily grouped, but many borderline cases exist where assignment is difficult. The saving point is that correct identification or assignment is much more important for the distinct pattern locations than for the borderline cases.

Typical seasonal (monthly variation) patterns for urban areas have a percent coefficient of variation under 10%, while those of rural areas range between 10 and 25%. Values higher than 25% are indicative of highly variable travel patterns, which we term recreational patterns but which may be due to other reasons. The existence of a recreational pattern should be verified by knowledge of the specific locations and the presence of a recreational travel generator. The typical patterns identifiable in most States are then urban, rural, and recreational. An examination of the descriptive and cluster analysis should be sufficient to identify the recreational locations and the general variation patterns as detected from the data. An example is provided in Appendix A.

Because of the importance assigned to the Interstate system, it is recommended that separate groups be maintained for the Interstate categories. The Interstate system because of its national emphasis will always be subject to higher data constraints. Programs, such as the I4R, which require the use of Interstate VMT as apportionment factors provide sufficient justification for the separation. The determination to separate the Interstate groups is, however, an administrative recommendation justified by the importance of the system, not because the data show that separate groups are needed. An exception to the specification of separate Interstate groups may apply for States with very limited mileage in either the Interstate rural or urban categories where the level of effort necessary to establish reliable groups factors would not be justifiable.

This Guide recommends the following groups as a minimum:

<u>RECOMMENDED GROUP</u>	<u>HPMS FUNCTIONAL CLASS</u>
INTERSTATE RURAL	1
OTHER RURAL	2, 6, 7, 8
INTERSTATE URBAN	11
OTHER URBAN	12, 14, 16, 17
RECREATIONAL	ANY

The first 4 groups are self-defining. The recreational group requires the use of subjective judgement and knowledge of the travel characteristics of the State. Usually, the recreational pattern is identifiable from an examination of the continuous ATR data. Sometimes the continuous data are insufficient and, if a control program exists, the data should also be analyzed. The minimum specification can be expanded, as desired by each State, to account for regional variation or other concerns. However, data support should be one of the prerequisites for establishing additional groups. Additional groups will require additional ATR locations and increase cost.

Determining the Appropriate Number of Continuous ATR Locations

Having analyzed the data, extracted the relevant interpretations, established the appropriate seasonal groups, and allocated the existing locations to those groups; the next step is to determine the number of locations needed to achieve the desired precision level of the composite group factors. To carry out the task, a grounding on statistical sampling procedures is needed. Since the continuous ATR locations in existing programs have not been randomly selected, assumptions must be made. The basic assumption made in the procedure is that the existing locations are equivalent to a simple random sample selection (pseudo-random assumption). Once this assumption is made, the normal distribution theory provides the appropriate methodology. The standard for estimating the confidence intervals for a simple random sample is:

$$B = \bar{X} \pm T_{1-d/2, n-1} \frac{S}{\sqrt{n}} \quad 3-2-1$$

Where

B = upper and lower boundaries of the confidence interval,

\bar{X} = mean factor,

T = value of Student's T distribution with 1-d/2 level of confidence and n-1 degrees of freedom,
 n = number of locations
 d = significance level, and
 S = standard deviation of the factors.

The precision interval is:

$$D = T_{1-d/2, n-1} \frac{S}{\sqrt{n}} \quad 3-2-2$$

Where

D = absolute precision interval,

S = standard deviation of the factors.

Since the coefficient of variation is the ratio of the standard deviation to the mean, the equation can be simplified to express the interval as a proportion or a percentage of the estimate. The equation becomes:

$$D = T_{1-d/2, n-1} \frac{C}{\sqrt{n}} \quad 3-2-3$$

Where D = precision interval as a proportion or percentage of the mean, and

C = coefficient of variation of the factors.

Note that a percentage is equal to a proportion times 100, i.e., 10 percent is equivalent to a proportion of .10.

Using this last formula it is now possible to estimate the sample size needed to achieve any desired precision intervals or confidence levels. Specifying the level of precision desired can be a very difficult undertaking. Very tight precision requires large sample sizes which translates to expensive programs. Very loose precision reduces the usefulness of the data for decisionmaking purposes. Traditionally, traffic estimates of this nature have been thought of as having a precision of + 10 percent. A precision of 10 percent can be established with a high confidence level or a low confidence level. The higher the confidence level desired the higher the sample size required. Further, the precision requirement could be applied individually to each seasonal group or to an aggregate statewide estimate based on more complex stratified random sampling procedures.

The reliability levels recommended in this Guide are 10 percent precision with 95 percent confidence, 95-10, for each individual seasonal group excluding recreational groups where no precision requirement is specified.

The procedure begins by examining the monthly average seasonal factors for each group using the existing ATR's, anchoring the design criteria (number of groups), using the formula to establish the number of points, and determining the modifications needed in the existing program. An example is presented in Appendix A. When applying this procedure, the number of locations needed is usually 5 to 8 per seasonal group, although cases where more locations are needed have surfaced. The only exception is the recreational group where a subjective assignment is recommended.

Distinct recreational patterns can not be defined simply on the basis of functional class or area boundaries. Recreational patterns are very obvious for some locations but non-existent for other, almost adjacent, locations. The boundaries of these recreational groups must be defined based on subjective knowledge. Due to the high variability of the factors, blind application of the statistical procedure presented would result in too many locations and not be cost-efficient. The existence of different patterns, summer vs. winter, further complicates the situation. Therefore, the recommendation is to use a strategic approach, that is, subjectively determine the routes or general areas where the pattern is clearly identifiable, establish a set of locations, and subjectively allocate factors to short counts based on the judgement and knowledge of the analyst. While this may appear to be a capitulation to ad hoc procedures, it is actually a realistic assessment that statistical procedures are not directly applicable in all cases. However, recreational areas or patterns are usually confined to limited areas of the State and, in terms of total VMT, are very small in most cases. The statistical approach will suffice for the large majority of cases.

The procedure for recreational areas is then to define the areas or routes based on available data (as shown by the analysis of continuous and control data) and knowledge of the highway systems and to subjectively determine which short counts will be factored by which continuous ATR (recreational) location. The remaining short counts would be assigned on the basis of the functional class groups as defined in this Guide. A maximum of six continuous ATR locations in the recreational group is recommended depending on the importance assigned by the planning agency to the monitoring of recreational travel and the different recreational patterns identified.

Modifications to the Existing Continuous ATR Program

Once the number of groups and locations per group are established, the existing program must be modified.

The first step is to distribute the existing locations according to the defined groups. In general from 5 to 8 locations are needed in each of the 5 groups, usually resulting in a total of 30 to 40 locations in the State. Exceptions to this rule of thumb are expected; but since the procedures are directly driven by the analysis of each State's data, the results will be justifiable and directly applicable to each State.

If the distribution of existing locations results in a surplus of locations for a group, then redundant locations are candidates for discontinuation. If the surplus is large, reduction should be planned in stages and after adequate analysis to insure that the cuts do not affect reliability in unexpected ways. For example if 12 locations are available and six are needed then the reduction may be carried out by discontinuing 2 locations annually over a period of 3 years. The sample size analysis would be recomputed each of the 3 years prior to the annual discontinuation to insure that the desired precision was maintained.

If the distribution of present locations results in a shortage of locations, additional locations should be selected and added to the group. Since the number of additional locations is expected to be small, the recommendation is to select and include them as soon as possible.

Because of the small number of locations under consideration, extensive criteria for discontinuation or selection of additional sites will not be presented. Several important considerations are:

1. Other uses of existing information or importance assigned to sites. -- As mentioned before, seasonality is not the only objective or use of continuous ATR data. Each state should insure that these other criteria are met before discontinuation. It should also be clear that additional locations increase the reliability of the data.
2. Existing locations -- Available locations from control or other programs may be candidates for upgrading to continuous status.
3. Location on or near HPMS sites. -- Because of the direct linkage to the randomly selected HPMS sample sections, these locations should be given priority.
4. Tie-in to the classification, speed, or weight programs as mentioned in other sections of this Guide. -- Coordination with other programs is essential.
5. Distribution over geographical areas of the state.
6. Distribution by functional class system.
7. Random selection to reduce bias. -- New location should be randomly selected, if possible, from HPMS sample sections.
8. Quality of ATR equipment of sites. -- Older or malfunctioning equipment should be given higher priority for discontinuation.

Computation of Monthly Factors

The procedures for the development and use of monthly factors to adjust short volume counts to produce AADT estimates follow directly from the structure of the program. The individual monthly factors for each ATR station are the ratio of the AADT to MADT.

Group monthly factors are derived for each of the seasonal groups (with the exception of recreational or other optional groups) as the average of the factors of all the locations within the group. In the development of data processing or storage specifications, provision should be made for producing a table of factors to be used in the computerized expansion of short counts.

The individual annual factors for the specific ATR locations are exact, that is, there is no sampling variability (assuming a 100 percent sample). The reliability also depends on bias such as equipment error or missing data due to equipment malfunction, etc. The precision of annual group factors has been estimated by using equation 3-2-3 with the procedure described earlier for estimating the number of locations per group.

The recommended statistical approach defines seasonality based on functional class or a combination of functional classes according to the variability shown in each state's continuous ATR data. For system estimation, the average monthly factors for each group are then used to expand all short counts within the established boundaries of the group. For example, if a short count is taken on the Interstate Rural system during the month of March, then the March factor from the Interstate Rural group is used in the expansion of the short count to AADT. The only exception is for clearly different patterns, such as recreational, which have been defined during the data analysis stage. In these cases, a subjective allocation based on knowledge of conditions must be made.

The individual factors are best for each continuous location, but the application of these individual factors to short counts subjectively based on knowledge of conditions ignores the myriad of unidentifiable dynamic characteristics (weather, random variation, growth, economic conditions, etc.) affecting the patterns. The use of statistical average factors will not produce exact results (there are no exact figures in traffic counting), but on the average will compensate and balance out the many sources of variation. The statistical approach is not without disadvantages. Knowledge of very different conditions may in some circumstances result in better estimates. Recreational areas are a case in point, but other exceptions are always possible.

The recommended procedure breaks down to the application of the average group monthly factors as the default value for generalized (system) AADT estimates for all functional class groups, with the exception of other identifiable patterns outside of the norm (recreational for example) where subjective knowledge would indicate the use of either the generalized group value or the specific value of an appropriate continuous ATR location.

The specific ATR factors for each location should also be computerized. When developing site-specific information, the default values can be compared with the specific factors of nearby ATR locations to provide a sensitivity type of analysis. If the information available is judged insufficient for the desired objective, then a special count can be scheduled.

To estimate AVMT the use of annual factors would be preferable because direct representation of the year in question is provided (assuming no problems with equipment, construction, etc.). On the other hand, random occurrences such as a cold winter or a rainy summer can substantially distort the annual factors at a specific ATR (the group factors are not usually affected because of the averaging procedure). In most cases, however, historical factors computed over a number of years provide a better indication of seasonality. The procedures previously described can be applied either on an annual basis or over a number of years. Each State should determine which procedures to apply depending on specific analysis of available data.

Hardware and Software for Data Management and Analysis

The management and analysis of continuous ATR data require the use of computers. The basic data management functions including input, editing, manipulation, and report generation could be performed using mainframes or microcomputers. Analysis functions could also be carried out on both types of computers, but the use of complex statistical analysis packages and extensive data bases may be beyond the capacity of existing microcomputers.

The advantages of larger machines are high speed, capacity, and package availability. The disadvantages of mainframes are the expense involved and the lack of user control. With the advent of very powerful mini and microcomputers with large memories, the cost-effectiveness of these machines has greatly increased. Because of the large expenditures on computer processing related to the management of the several interrelated databases of the proposed traffic monitoring program, it has become cost-efficient to explore the acquisition of dedicated microcomputers with the capability to handle the desired functions.

Software for data management and analysis for the micro machines is available from a number of sources. Careful assessment of the capabilities of both hardware and software is of the utmost importance before final acquisition. Software needs beyond the available packages can be developed through the use of language compilers, or through contracts with appropriate sources. In general, because of the costs, required skills, and problems in developing software; it is usually more efficient to find third-party software that can perform the desired functions.

Finally, the ability to communicate directly and transfer files between micro and mainframe would allow the transfer of existing mainframe files to the micro. It would also provide an escape route should the capabilities of the micro be exceeded by future requirements.

The development of the Traffic Monitoring Guide procedures are intended to spur the use of efficient computer capabilities emphasizing storage and analysis on a cost-effective basis. A fully computerized operation would allow early preparation of reports and reduce the existing information lag.

CHAPTER 3

The HPMS Traffic Volume Sample

Introduction

The major purpose of the HPMS element as defined in this chapter is to provide a limited core framework or structure of randomly selected HPMS sample sections throughout the state. This core is, first, a systems tool that will completely satisfy the needs for statewide information such as system vehicle miles of travel (VMT). Second, it will provide an adequate statistical base for the development of adjustment factors for coverage counts. Third, it will provide a well balanced, geographically distributed, and statistically sound framework for AADT estimation. Fourth, the framework serves as the base for the selection of the vehicle classification and truck weight samples.

A clear understanding of the HPMS sample approach must precede the application of the procedures in this chapter. The HPMS has a direct, statistical link between the sample and the universe of roads in each State. Through this link, estimation procedures tying any of the HPMS collected variables to volume estimates (later to vehicle classification, and truck weight information) can be developed. Because of this connection, it will be possible to make reliability statements for any estimates derived by following the appropriate estimation procedures. Maps showing the location of existing HPMS samples would be sufficient to realize the degree of coverage provided by the sample in each specific state. Maps will also help to pinpoint voids which may require filling by the Special Needs element in Chapter 4.

Monitoring Period Specification

This guide recommends a 48-hour monitoring period for volume, classification, and truck weight monitoring. The selection of a time period for monitoring requires many trade-offs. This selection is a complex decision affected by many other considerations such as cycle of monitoring, cost, specific State characteristics, volume differentials, equipment, specific location characteristics, growth, and data collection constraints. The recommendations made in this guide are based on research conducted for the FHWA (Reference 2), work done by FHWA staff, reviews of existing State programs, and the redefinition of specific objectives to produce an integrated program. Although manual counting procedures may be extensively used today, the recommendations in this Guide are designed for automatic monitoring equipment.

Information available to the FHWA have indicated that the most common monitoring periods for volume counting in use today are 24 hours followed by 48 hours. The recommendation of a 48-hour monitoring period is a compromise given various alternatives and designed to

maximize data validity subject to cost and equipment limitation constraints. As discussed in Chapter 3 of Section 2, the use of a 48-hour period is related to the reliability of AADT estimates. VMT system estimation is less influenced by the length of monitoring periods.

The research conducted (Reference 2) clearly showed that the magnitude of daily traffic variation is much larger than the long term growth trend of most locations. This assessment supports the emphasis on longer monitoring periods taken on longer cycles rather than shorter monitoring periods taken on shorter cycles.

Exhibit 3-3-1 taken from page IV-23 of Reference 2 compares cost versus precision for several alternatives ranging from 24 hour annual counts to 72 hours on a 5 year cycle. The implicit assumptions of this exhibit are discussed in the reference. The authors recommended a 48-hour, 3-year cycle as the most cost-effective alternative.

Costs also play an important part. The use of longer periods of time reduces the cost-effectiveness of the program by reducing the number of counts per machine. However, the objectives and validity of the counts should take precedence. There is a direct trade-off between the collection of a smaller number of more reliable counts versus a larger number of less reliable counts. This Guide emphasizes the former.

State characteristics such as organization of the program, emphasis areas, specific requirements, and staffing have a direct effect on the selection of an appropriate period of monitoring.

Volume differentials affect the reliability of the counts and the importance of decisions made based on the counts. Exhibit 3-3-2 taken from the 1970 FHWA Traffic Volume Counting Manual (Reference 1) compared the precision of three monitoring periods versus weekday traffic volumes. Information on how the graph was derived was not provided and the referenced document was developed in the late 1950's. The exhibit indicates that reliable precision can be obtained with 24 hour counts for sections with AADT's higher than 500. No information is provided on the effects of factorization or equipment error.

Location characteristics can greatly influence the length of monitoring period as well as the cycle, the equipment, and the data collection concerns. Analysis of ATR data has shown that volume variability differs based on rural or urban locations. Urban areas because of lower variability may be better served by shorter periods. Recreational areas because of much higher variability would benefit by longer counts. Analysis of ATR locations shows standard deviations of 24-hour monitoring periods in the 10 to 15 percent range, indicating that periods longer than 24 hours are needed if estimates with lower than 10 percent precision are desired. The analysis also shows that

Exhibit 3-3-1
RELATIVE COST AND ACCURACY OF COUNT DURATION
AND FREQUENCY

3-3-3

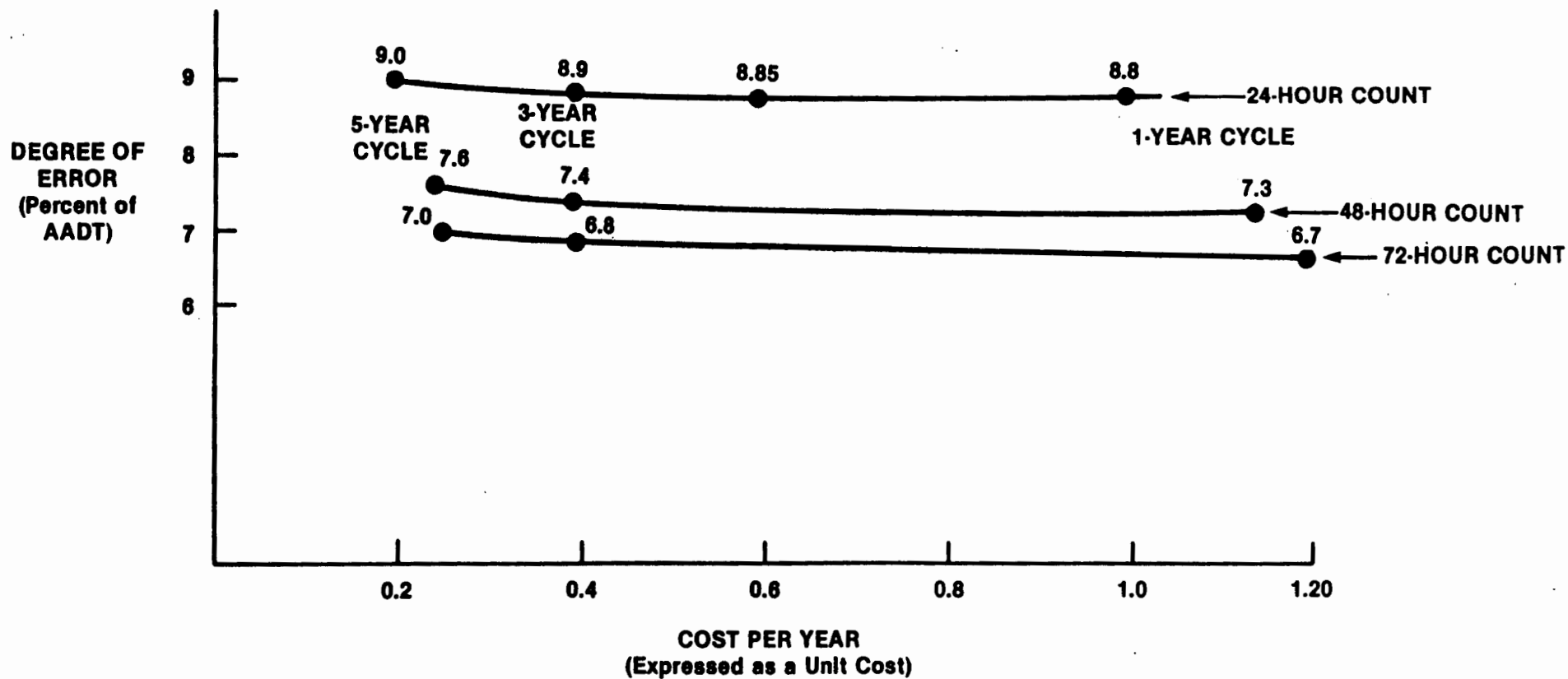
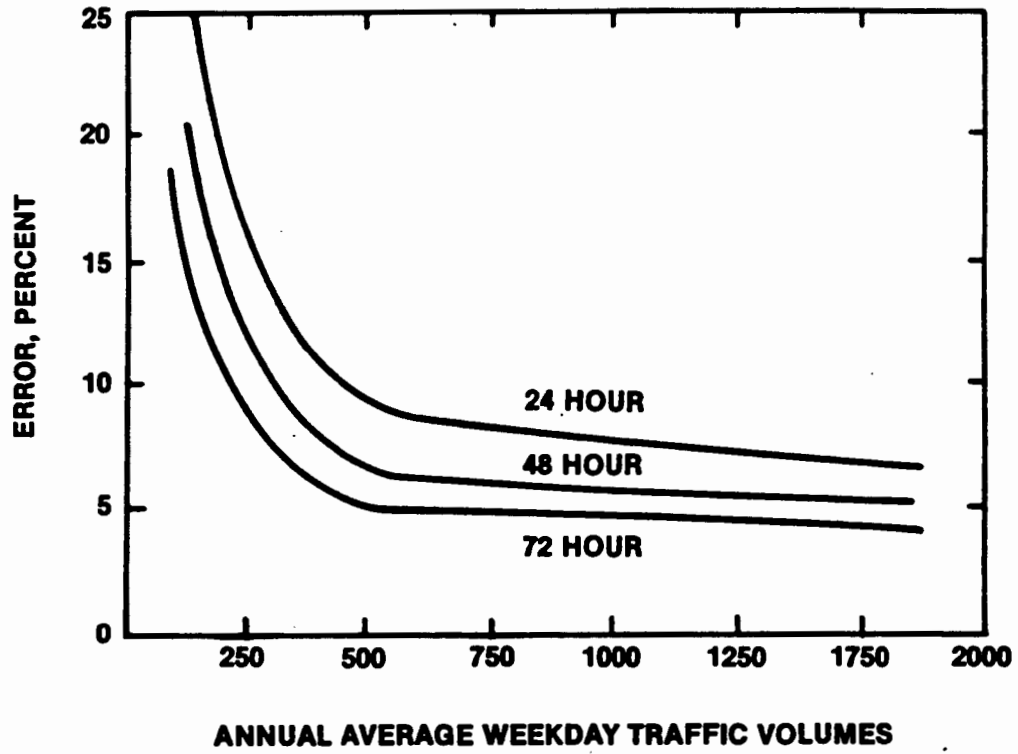


Exhibit 3-3-2



the gains produced by increasing the length of monitoring periods quickly diminish; the well-known economic principle of diminishing returns is applicable in this context.

Equipment also plays an important role. Obviously, equipment based on loops is not affected by the determination of monitoring period, but equipment based on pneumatic tubes is directly affected. The assessment made is that a 48-hour monitoring period approaches the maximum limit to the use of pneumatic tubes for collecting volume or classification information.

The coordination or integration of the complete program also introduces restrictions. Analysis of vehicle classification information from the HPMS Vehicle Classification Case study (Reference 6) showed the standard deviations of daily volume for most truck classification categories to be in the vicinity of 100 percent. Although the data on which the assessment is based is tenuous at best, it clearly indicates that the numbers of vehicles in a number of classification categories can halve or double from day to day. Given this variability, the collection of reliable classification information requires the use of monitoring periods of longer than 24-hour duration. Analysis of manual truck weight operations have brought out the issue of bias introduced through station bypassing, waiting out, or the shifting of the travel patterns of heavier trucks to periods when the monitoring has stopped. The need for longer monitoring periods to reduce these effects and produce valid estimates is apparent.

Since the framework established consists of a limited number of annual counts, the advantages of a 48-hour period are believed to surpass the disadvantages. The recommendation of a 48-hour period for volume, classification, and truck weight monitoring apply only to the HPMS framework or core element of the program. The Special Needs element, since it is guided by each State's own specific objectives, has no such requirement although the results presented here are directly applicable and worthy of consideration. It is clear that although the program's foundation is based on automation, situations will always arise where automation may not be possible. Exceptions to the arguments made in defense of the 48-hour monitoring period would not be difficult to find given the enormous differences in travel characteristics, highway systems, and methods of operation in the 50 states. There may be clear circumstances where the use of shorter or longer periods of monitoring may be more effective. It is important, however, to adequately explore, assess, and document alternative options to insure that all avenues have been considered and that the final decision is, indeed, responsive to the specific situation.

Finally the basic foundation of State programs and of the procedures recommended in this chapter is to collect reliable and unbiased information. Alternatives and constraints can be analyzed and

modifications made where applicable, however, it is important to maintain perspective to insure retaining the basic premise of reliable data.

Monitoring Cycle Specification

This guide recommends a 3-year cycle for traffic volume, vehicle classification and truck weight monitoring. The recommendation also presents trade-offs between a number of options and is intended to produce reliable information in a cost-effective manner.

As discussed earlier, the analytical work (Reference 2) indicated that, generally growth is less influential than daily variation. It was determined that on the average a 48-hour count taken every three years would be more cost-effective and reliable than an annual 24-hour count in estimating AADT. The reasoning being that the daily variability of volume is in the 10 to 15 percent range while annual growth would be in the range of 1 to 4 percent. On the average this is quite correct. However, traffic characteristics at specific locations can change quite rapidly by causes such as the opening of a new traffic generator such as a shopping center. Growth areas within States can easily surpass 2 percent annual growth rates.

Another concern pulling in the opposite direction is how far to extend the cycle. If a 3-year cycle is better than a one-year cycle, would a 5-year cycle surpass a 3-year cycle? Solely on a cost basis, a 10-year cycle is more cost-effective than a 5-year cycle. The law of diminishing returns also applies here. Three-year cycles produce, on the average, slightly less reliable information than annual cycles when using the same monitoring period length, but at substantial cost savings. Five year cycles would further reduce the cost at an additional reliability penalty. However, the growth area factor mentioned earlier works heavily against these gains. At 5-year cycles, a compounded 2 percent average growth rate approaches and confounds the daily volume variability of 10 to 15 percent.

The use of cycles can also be used to reduce the sample size needed annually to achieve the desired target precision of a sampling program. Tying the precision of estimates to longer cycles reduces the size of the annual program. For example, establishing the precision levels on a 3-year cycle on a rotating sample of HPMS sections results in one-third of the sample needed each year, thereby, reducing the annual effort by a factor of 3. The selection of a cycle could be combined with the length of the monitoring period to produce a two-dimension optimization problem. Evaluation of all possibilities considering the different characteristics, personnel, equipment, and cost constraints of different States is well beyond the scope of this Guide. The emphasis then becomes the selection of a consistent approach which will meet adequate reliability needs in a reasonable cost-effective manner. The decision made is to recommend the use of 48-hour counts on a 3-year cycle for traffic volume, vehicle classification and truck weight monitoring.

As before, there may be clear circumstances where the use of different cycles may be appropriate. In those cases, it is important to adequately consider the objectives and constraints, and to document in detail the reasoning process behind the decision.

Selection of the Core Interstate Sample

The Interstate System has top priority from a national or State perspective. On a national basis, it consists of 1 percent of the mileage, yet it carries an estimated 20 percent of the travel. The enormous investment and the magnitude of the programs to maintain that investment will always require a higher level of information. The HPMS sampling rate is far higher for the Interstate than for any other highway system. Similarly, the development of the Traffic Monitoring Guide places the Interstate System in a category second to none.

A brief description of the HPMS was provided in Chapter 2 of Section 2. The HPMS ratio of sample mileage to universe mileage for the Interstate varies by State from 11 to 100 percent with a national average of 50 percent. There are approximately 9,000 Interstate sample sections or a ratio of 1 sample per 4 miles of road. Although sample sections may represent up to several miles of road, it is quite apparent that for most States the large sample is sufficient to provide very adequate spatial coverage of the system. Given the controlled access and egress build into the system, a count between interchanges would provide 100 percent coverage of the spatial requirements. In many cases, the existing HPMS sample provides sufficient coverage to interpolate estimates of points located between samples. However, points where such interpretation would be judged inadequate would be monitored as a part of the Special Needs element. Because of the large HPMS Interstate sample framework, the need for special counts should be minimal.

In summary, the framework of spatial coverage provided by the HPMS sample for the Interstate system is sufficient to provide very reliable system estimates and most point-specific needs. Any remaining needs for information can be addressed through the Special Needs element described in the next chapter.

The HPMS sample is then the starting point for the selection of the volume core sample. The Interstate HPMS sample is substratified into urban, rural, and urbanized areas and by volume group within these areas. The HPMS Manual (Reference 8) provides a complete description of the stratification of the sample. The selection of the annual Interstate subsample of volume sections is carried out by randomly assigning 1/3 of the sections in each HPMS Interstate strata. The procedure is described in more detail in the next section.

Since the sample was selected as a simple random sample within strata, equation 3-2-3 can be used to estimate the reliability of system AADT estimates. VMT estimates require more work because the estimation procedures involve the use of section lengths. Simple random sample procedures could have been used, but more reliable procedures based on ratio estimation (using length of sample sections) are used instead. Sample section DVMT is computed by multiplying section AADT by section length. Stratum DVMT estimates are derived by summing section DVMT and multiplying by the HPMS stratum expansion factor. Annual Vehicle Miles of Travel (AVMT) equals DVMT times 365. Aggregate DVMT estimates are derived by summing the appropriate HPMS strata DVMT estimates. For example, to obtain estimates of Interstate Rural DVMT, sum the DVMT estimates for the volume group strata within the Interstate Rural system.

The HPMS sample sizes were defined in terms of AADT within strata (refer to the HPMS Manual, Reference 8, for a complete description). The HPMS procedures for AADT (described in the HPMS Manual) are better than using equation 3-2-3 because they account for the case of limited numbers of universe sections (the finite population correction). To estimate the precision of DVMT estimates, a more complex procedure is needed to account for the variation in AADT and also for the variation in section length. The equation to estimate the sampling variability of aggregate DVMT estimates is given on page 164 of Reference 5. Studies conducted by the FHWA have shown the precision of statewide estimates of Interstate DVMT to approximate plus or minus 2 to 3 percent with 95 percent confidence. These results, however, consider only sampling variability and ignore other sources of error.

The number of HPMS sample sections in the Interstate system in 1982 are shown in Exhibit 3-3-3. The recommended procedure covers the HPMS sample over a 3-year cycle, therefore 1/3 of the sample is to be counted annually. This, however, does not translate to an actual count at every HPMS sample. Judgement is necessary when determining the exact number of counts. Subdivided sample sections in the HPMS sense (see discussion of item 29 on page IV-18 of reference 8) may not need separate counts. Adjacent sample sections, without separation by interchanges or access/egress points, do not need separate counts. HPMS sample sections on or adjacent to continuous ATR locations or other related monitoring (speed, vehicle classification, truck weight, etc.) do not need separate counts. Considerations of this nature will, obviously, be more pronounced for States having higher sampling rates.

The development of an annual Interstate traffic counting plan requires an examination of the locations of the HPMS sample and those of related programs. A determination would then be made as to whether a separate count is needed. Several locations will be judged to have the available information without taking a separate count. However, the majority of the HPMS Interstate sample locations will need a separate count.

Exhibit 3-3-3
NUMBER OF INTERSTATE SAMPLE SECTIONS
1982 HPMS DATA

STATE	SAMPLE SIZE			
	TYPE OF AREA			
	RURAL	SMALL URBAN	URBANIZED	STATEWIDE
ALABAMA	65	11	47	123
ALASKA	121	8	26	155
ARIZONA	106	20	39	165
ARKANSAS	38	16	55	109
CALIFORNIA	153	32	142	327
COLORADO	163	7	69	239
CONNECTICUT	32	7	120	159
DELAWARE	4	0	16	20
DISTRICT OF COLUMBIA	0	0	13	13
FLORIDA	112	9	134	255
GEORGIA	113	31	52	196
HAWAII	5	12	32	49
IDAHO	115	27	20	162
ILLINOIS	83	20	130	233
INDIANA	82	13	68	163
IOWA	214	55	119	388
KANSAS	74	21	93	188
KENTUCKY	125	21	63	209
LOUISIANA	75	6	69	150
MAINE	71	12	48	131
MARYLAND	32	12	57	101
MASSACHUSETTS	58	7	209	274
MICHIGAN	161	17	138	316
MINNESOTA	61	5	65	131
MISSISSIPPI	62	17	35	114
MISSOURI	72	10	42	124
MONTANA	147	20	21	188
NEBRASKA	31	4	29	64
NEVADA	85	6	61	152
NEW HAMPSHIRE	32	13	13	58
NEW JERSEY	29	0	76	105
NEW MEXICO	102	10	22	134
NEW YORK	85	20	180	285
NORTH CAROLINA	74	15	70	159
NORTH DAKOTA	79	8	21	108
OHIO	117	30	242	389
OKLAHOMA	93	21	48	162
OREGON	114	19	53	186
PENNSYLVANIA	143	21	184	348
RHODE ISLAND	16	0	27	43

Exhibit 3-3-3 (Cont.)
 NUMBER OF INTERSTATE SAMPLE SECTIONS
 1982 HPMS DATA-Continued

STATE	SAMPLE SIZE			
	TYPE OF AREA			
	RURAL	SMALL URBAN	URBANIZED	STATEWIDE
SOUTH CAROLINA.....	72	0	36	108
SOUTH DAKOTA.....	74	7	17	98
TENNESSEE.....	92	18	117	227
TEXAS.....	132	38	84	254
UTAH.....	108	14	59	181
VERMONT.....	73	10	7	90
VIRGINIA.....	90	13	125	228
WASHINGTON.....	87	11	96	194
WEST VIRGINIA.....	86	15	81	182
WISCONSIN.....	102	11	100	213
WYOMING.....	69	24	24	117
Total.....	4,329	744	3,694	8,767

It is apparent from Exhibit 3-3-3 that the size of the State, the Interstate mileage, or the degree of urbanization are reflected in the number of needed counts as, indeed, they should be. Therefore, smaller States or States with limited Interstate mileage require no special procedures.

States with low HPMS sample rates may need to take additional counts under the Special Needs program element to allow the preparation of detailed flow maps or to address point-specific concerns. This determination would be made based on the need for the additional information after the establishment of the desired objectives and an assessment that the HPMS Coverage counts were insufficient for the purpose.

Selection of the Core Sample for the Remaining HPMS Functional Classes

The level of coverage by functional class provided by the HPMS sample ranges, on a national average, from about 50 percent of total mileage for the Interstate System to 3 percent for rural major collectors. This indicates that for the lower systems the core structure or HPMS-based coverage framework may be very sparse. For overall system information this presents no problem at all. However, for point-specific needs the voids or gaps in the HPMS-based framework will be larger for the lower systems necessitating more extensive coverage or potential coverage in the Special Needs element.

The HPMS sample design specifications lower the precision requirements of AADT estimates for lower functional class systems (refer to Appendix F of the HPMS Manual, Reference 8). This, of course, translates to smaller sample sizes and lower sampling rates. Exhibit 2-2-1 has presented the complete 1982 HPMS sample and Exhibit 3-3-3 the Interstate sample sections.

Exhibit 3-3-4 presents the 1982 HPMS sample excluding the Interstate in each State. Procedures for estimating the precision of AADT estimates within HPMS strata are defined in the HPMS Manual. Procedures to estimate the precision of aggregate DVMT estimates from the HPMS have been alluded to earlier in this chapter. Analysis conducted by FHWA has shown the precision of statewide DVMT estimates (excluding local functional class) to be in the range of 1 to 5 percent with 95 percent confidence. The analysis assumed that AADT values reported for the HPMS sample sections were exact. Because of the assumptions made, it would be realistic to target the achievable precision towards the 5 percent range. Therefore, the spatial target precision levels in this Guide have been specified in terms of the HPMS statewide DVMT estimates as plus or minus 5 percent with 95 percent confidence. Computation of annual DVMT estimates using the complete HPMS sample by expanding the AADT figure from each HPMS sample would be expected to achieve the stated precision.

Exhibit 3-3-4
 NUMBER OF SAMPLE SECTIONS EXCLUDING INTERSTATE
 1982 IPMS DATA

STATE	SAMPLE SIZE			
	TYPE OF AREA			
	RURAL	SMALL URBAN	URBANIZED	STATEWIDE
ALABAMA	741	538	666	1,945
ALASKA	147	70	57	274
ARIZONA	510	302	335	1,147
ARKANSAS	515	456	499	1,470
CALIFORNIA	731	423	1,049	2,203
COLORADO	783	416	951	2,150
CONNECTICUT	361	178	863	1,402
DELAWARE	154	57	133	344
DISTRICT OF COLUMBIA	0	0	206	206
FLORIDA	708	313	1,218	2,239
GEORGIA	760	395	585	1,740
HAWAII	272	149	291	712
IDAHO	873	241	188	1,302
ILLINOIS	467	514	1,730	2,711
INDIANA	595	454	1,161	2,210
IOWA	901	810	581	2,292
KANSAS	801	523	503	1,827
KENTUCKY	851	633	575	2,059
LOUISIANA	537	288	342	1,167
MAINE	781	331	592	1,704
MARYLAND	488	344	559	1,391
MASSACHUSETTS	480	175	1,222	1,877
MICHIGAN	772	452	1,354	2,578
MINNESOTA	755	535	752	2,042
MISSISSIPPI	684	476	261	1,421
MISSOURI	570	270	274	1,114
MONTANA	608	330	214	1,152
NEBRASKA	670	445	303	1,418
NEVADA	403	114	396	913
NEW HAMPSHIRE	482	133	254	869
NEW JERSEY	351	134	861	1,346
NEW MEXICO	459	293	218	970
NEW YORK	693	543	1,203	2,439
NORTH CAROLINA	616	560	954	2,130
NORTH DAKOTA	489	184	182	855
OHIO	831	665	1,107	2,603
OKLAHOMA	741	464	400	1,605
OREGON	718	461	543	1,722
PENNSYLVANIA	883	651	1,874	3,408
RHODE ISLAND	310	63	299	672

3-3-12

Exhibit 3-3-4 (Cont.)
 NUMBER OF SAMPLE SECTIONS EXCLUDING INTERSTATE
 1982 HPMS DATA-Continued

STATE	SAMPLE SIZE			
	TYPE OF AREA			
	RURAL	SMALL URBAN	URBANIZED	STATEWIDE
SOUTH CAROLINA.....	540	352	282	1,174
SOUTH DAKOTA.....	582	271	182	1,035
TENNESSEE.....	573	500	583	1,656
TEXAS.....	729	474	1,609	2,812
UTAH.....	507	195	326	1,028
VERMONT.....	401	209	74	684
VIRGINIA.....	625	287	828	1,740
WASHINGTON.....	774	374	1,369	2,517
WEST VIRGINIA.....	554	309	622	1,485
WISCONSIN.....	762	394	1,524	2,680
WYOMING.....	503	336	201	1,040
PUERTO RICO.....	403	277	336	1,016
Total.....	30,444	18,361	33,691	82,496

The procedures used to develop the AADT estimates at each sample section consider a variety of factors. The research work (Reference 2) provided statistical procedures to incorporate or aggregate some of the known or tractable errors that affect AADT and consequently DVMT estimates. This study indicated the use of a 48-hour period tied to a 3-year cycle as the most realistic procedure considering all alternatives. The recommended procedure uses a 48-hour count taken on a 3-year cycle. This recommendation reduces the level of effort to 1/3 of the HPMS sample annually. The procedures can be carried out by the use of strict simple random sample procedures using a table of random numbers to divide the sample in each stratum into three random subsets. One of the three subsets would be counted annually on a rotating basis. Following the procedures insures the complete counting of the HPMS sample every three years. HPMS sample sections not counted during the year would be expanded by procedures described later in this chapter, and the annual DVMT or AVMT estimates would be based on the complete sample.

Tables of random numbers to be used in the random selection are available from a variety of sources as are computerized random number generators. Since the stratum sample sizes are not all divisible by 3, the 3 subsets need not be exactly equal. For example, a stratum with 8 sample sections may be subdivided as 3, 3, and 2. Other strata may have less than 3 sample sections, but the same procedures apply. For example, a stratum with 1 sample section could be subdivided alternatively as 1,0,0 or 0,1,0 or 0,0,1. A certain degree of reconciliation will be necessary after the subsetting to insure that the annual subsamples are approximately equal. Organizing the full sample as shown in the following table would help to make the determination:

HPMS SAMPLE

Area Type	Functional Class	Volume Group	Full Sample	Annual Subsets		
				1	2	3
Rural	Minor Arterial	1	125	42	42	41
Rural	Minor Arterial	2	73	24	24	25
Rural	Minor Arterial	3	15	5	5	5
Total			213	71	71	71

After the sample is subdivided, a determination as to the actual number of counts needed would be made. As before, several of the locations may be coordinated with other programs (ATR, vehicle classification, speed monitoring) and have actual counts available for use. The remaining sections would be scheduled for counting.

Spatial and Temporal Distribution of Core Counts

Theoretically, the selection and distribution of the sample must be conducted randomly to maintain statistical validity. Statistical validity requires random spatial (geographical) and temporal (calendar year) distribution. The HPMS sample by virtue of its extensive

stratification and random selection already provides a balanced spatial distribution. However, bias can be easily introduced by improper temporal selection or scheduling procedures. On the other hand, scheduling operations are very dependent on effective use of personnel and equipment. Compromises will be necessary to insure that all important considerations are adequately addressed.

Because of the emphasis on statistical validity, the recommendation is to provide an adequate distribution over the two dimensions (spatial and temporal) even if this implies a loss of scheduling efficiency. This applies only to core counts. By coordinating the core and special counts, it may be possible to minimize or reduce the scheduling problems. The manner of operation and organizational structure of different States may turn the scheduling question into a major problem for some States and no problem at all for others. Because of these constraints, latitude is given while emphasizing the recommendation. However, scheduling considerations should not completely dictate or dominate the procedures.

The procedures for distribution of counts are to subdivide the annual subsample by the HPMS stratification categories and as many months of the year as possible in a random manner. That is, the counts should not be concentrated in one area of the State during a certain time of the year. Although the seasonal factoring procedure based on continuous ATR's will provide monthly factors to adjust counts, events specific to an area of the State or time of the year could easily bias the estimates. Valid statistical inference procedures require an appropriate distribution.

A random procedure to incorporate both dimensions can be designed by assigning a unique sequential number to each of the annual sample sections up to 365 (the number of days in the year) and selecting a random number between 1 and 365 which would indicate the HPMS sample section and the day the 48-hour monitoring period would begin. If the annual sample is greater than 365 then the process would be continued with the next 365 sections or until the sample were exhausted. Many other similar procedures could be developed based on the specific circumstances. For example, in cases where counting must be restricted to several months of the year the applicable number of days would replace 365; or in cases where counting operations are organized by districts, the process could be applied independently to each district. Alternative procedures developed by highway agencies to satisfy specific requirements are encouraged.

Once the schedule or complete counting plan is developed, the recommendation is to maintain the same schedule for use in the next cycle three years in the future. Although minor modifications are expected for one reason or another, maintaining the schedule would provide stability and begin to provide time-series data at the specific sample sections.

AADT Estimation for HPMS Core Sample Sections

The development of AADT estimates from the structure described in this Guide is a straightforward procedure. The 48-hour count taken at the sample sections during the current year may require adjustment by monthly (seasonal), day-of-week, and axle correction factors. For sections not counted during the current year, growth factors are also required. A description of the procedures to develop the factors and/or the need to use them is presented later in this chapter.

The equation used to estimate AADT at the sample sections is:

$$AADT_{hi} = \frac{1}{2} Vol_{hi} \times M_h \times D_h \times A_h \times G_h \quad 3-3-1$$

where $AADT_{hi}$ = the annual average daily travel at location i of functional class h ,

Vol_{hi} = the 48-hour axle volume at location i of functional class h ,

M_h = the applicable monthly factor for functional class h ,

D_h = the applicable day-of week factor for functional class h (if needed),

A_h = the applicable axle-correction factor for functional class h (if needed), and

G_h = the applicable growth factor for functional class h (if needed).

NOTE: For equipment units that automatically divide by two to produce a "vehicle" count, the number of axles can be estimated by multiplying by 2 or by modifying the software to report axles.

For one reason or another (as discussed in the appropriate section), the application of some of the factors may be unnecessary. For example, automatic equipment which counts vehicles does not require axle correction. In these cases, the inappropriate factors would be assigned a value of one in the equation.

An approximate estimate of the relative variance coefficient as a percentage of the AADT is given by the following formula:

$$C = \sqrt{CV^2 + CM^2 + CD^2 + CA^2 + CG^2} \quad 3-3-2$$

where C = relative variance coefficient as a percentage of the AADT,

- CV = relative variance coefficient of the 48-hour volume,
 CM = relative variance coefficient of the monthly factor,
 CD = relative variance coefficient of the day-of-week factor,
 CA = relative variance coefficient of the axle correction factor, and
 CG = relative variance coefficient of the growth factor.

The relative variance coefficient is defined as the standard error divided by the estimate. As before, any unnecessary terms are set equal to zero in the equation.

Annual Vehicle Miles of Travel (AVMT) Estimation

The procedures for developing daily vehicle miles of travel (DVMT) use the standard HPMS procedures for sample expansion. The first step is to compute an AADT estimate for each HPMS sample section. Next, the section AADT is multiplied by the section length and by the stratum expansion factor. Finally, the expanded stratum DVMT estimate is the sum of the expanded section DVMT estimates of all the sample sections within the stratum. In the same manner, aggregate estimates at any level can be derived by the sum of the appropriate strata. Annual vehicle miles of Travel (AVMT) are computed by multiplying any resulting DVMT values by 365. Estimates of DVMT or AVMT for specific vehicle classes or categories are derived by multiplying the strata numbers by the appropriate percentages derived from the vehicle classification or weight sample subsets.

An estimate of the standard error of a stratum DVMT estimate is given by the following formula:

$$s_h = \sqrt{\frac{N_h(N_h - n_h)}{n_h(n_h - 1)} \left[\sum D_{hi}^2 + \left(\frac{\sum D_{hi}}{\sum l_{hi}} \right)^2 (\sum l_{hi}^2) - 2 \left(\frac{\sum D_{hi}}{\sum l_{hi}} \right) \sum D_{hi} l_{hi} \right]} \quad 3-3-3$$

where

- s_h = standard error of DVMT estimate in stratum h,
 N_h = number of universe sections in stratum h,
 n_h = number of sample sections in stratum h,
 D_{hi} = DVMT of section i in stratum h, and
 l_{hi} = length of section i in stratum h.

This formula is presented in page 155 of Reference 5. A complete discussion of ratio estimation procedures is included in the reference.

The errors introduced by the use of factors to develop AADT estimates have been ignored. The assumption made is that these errors are normally distributed and therefore cancel out. The reason for ignoring these errors is that VMT estimates could be derived independent of AADT, i.e., directly expanding the 48-hour short counts adjusted only for axle correction or measurement error. The procedures have been tied to AADT for consistency and to integrate the point-specific and system estimation aspects.

Estimates of the standard error of aggregate VMT estimates are derived by summing the squared standard errors of the appropriate strata and taking the square root of the total. Coefficients of variation and confidence intervals can be derived by standard statistical procedures.

Computation of Growth Factors

The development of growth factors again brings to the surface the difference between point and system estimation. Growth factors at a point can be best estimated based on the presence of a continuous ATR assuming the differences found from year to year can be attributed to growth. Since it is well known that many extraneous effects contribute to these differences, the assumption would be incorrect in many cases. It should be clear that even with continuous ATR's the point-specific growth factor may be questionable. System growth estimates can be developed from all the continuous ATR's and this averaging effect compensates for the extraneous effects. However, the number of continuous ATR counters is very limited and may be insufficient to develop accurate system figures. The selection of ATR locations becomes very important in this context since growth occurs in some areas and not in others.

Growth factors can also be developed from the coverage program if structured in the manner recommended in this guide. Since AADT estimates will be developed annually at each HPMS sample, the AADT ratios from year to year should provide point-specific growth ratios. If continuous ATR factors were considered questionable, point specific estimates based on coverage counts would be expected to be less reliable by orders of magnitude. Another approach would be to use the cycle repetition (every 3 years) to develop these factors. System growth estimates can be developed from the rotating 3 year coverage counts and, since the number of counts is large, the averaging effect would be expected to reduce the variability considerably. Since the three rotating panels are independent of each other and randomly selected, independent verification of the growth estimates would be available.

The point of this discussion is to emphasize that there is not a best procedure that would be applicable in all cases. Instead of concentrating on a specific procedure, a better approach is to use all the tools available to examine the question from several perspectives. Rather than develop a single estimate, the different programs should be used to provide a number of alternatives from which appropriate growth ranges can be derived.

The procedure recommended in this Guide is based on the coverage program because it is believed that the large spatial sample size in the coverage program is superior to the large temporal sample size in the continuous ATR program. However, both procedures will be presented because of the importance for adequate verification and the examination of alternatives.

The estimation of annual growth factors based on continuous ATR's requires a minimum of two continuous years of data. Estimates can be developed by specific location, aggregation of specific locations, seasonal factor groups, and aggregation of groups. Location estimates are simply the ratio of AADT for the latest year to AADT for the previous year. Aggregations require the averaging of all appropriate locations. The aggregation would be most appropriate by the established seasonal groups defined using the procedures in Chapter 2. Statewide estimates should be weighted by the VMT carried by each of the seasonal groups.

The procedures for the development of growth factors based on continuous ATR's are as follows:

Annual growth factor at a location:

$$G_n = AADT_t / AADT_{t-1} \quad 3-3-4$$

where G_n = growth factor at location n,

$AADT_t$ = Annual average daily traffic (AADT) for year t, and

$AADT_{t-1}$ = AADT for year t-1.

Annual growth factor for a seasonal group:

$$G_h = \Sigma G_n / n_h \quad 3-3-5$$

where G_h = growth factor for seasonal group h, and

G_n = growth factor of location n within group h, and

n_h = number of locations in seasonal group h.

Standard error of annual growth factor for a seasonal group:

$$s_h = \sqrt{\frac{1}{n_h} \sum (G_n - G_h)^2 / (n_h - 1)} \quad 3-3-6$$

where s_h = standard error

Annual statewide growth factor:

$$G = \sum V_h G_h / V \quad 3-3-7$$

where G = statewide growth factor

V_h = VMT or DVMT for the seasonal group h , and

V = statewide VMT or DVMT (excluding local functional class).

A rough estimate of the variability (standard error) of the statewide growth factor is obtained by adding the square of the standard errors of the seasonal groups used in the computation of the statewide growth factor and taking the square root of the total. More complex formulas which account for VMT error could be developed, but the many uncertainties and assumptions in the estimation process would hardly justify the additional effort.

The procedures for the estimation of growth factors based on the HPMS core framework are recommended in this Guide, as stated earlier, because of the belief that the large spatial sample size of the coverage program is superior to the temporal sample size of the limited continuous program. Several different procedures can be used to estimate growth rates and the procedure presented here is just one of many possible. The annual counts could be used directly, converted to AADT, or converted to system VMT through the HPMS procedures before proceeding to estimate growth rates. Because of the emphasis on point-specific estimation and to provide a firm starting base, the recommended procedure is to convert to AADT before developing the growth factors (growth factors are not needed for sections actually counted during the year). This will allow the development of point-specific, system, and statewide estimates starting from the one basic building block in traffic counting - AADT. The computation of growth factors will require the program to have been in operation for a full 3 year cycle. However, even with one year's data very rough estimates could be derived based on historical or earlier AADT estimates at the corresponding sample sections.

The first step of the procedure is then to compute the AADT at each of the sections counted during the current year. A direct point-specific growth estimate can be derived based on the ratio of present AADT to past AADT (3 years ago). Aggregations by HPMS strata or combination of strata could be developed as needed. The recommendation is to develop factors at the functional class level for use in the expansion of sections not counted during the current year to AADT. The reason for the recommended procedure is that extraneous effects will be averaged out resulting in a better estimate of system growth. In this context, it is relevant to mention that computation of point-specific growth estimates would indicate whether the point values differ significantly from the system value and whether the system value may be inappropriate

for point-specific concerns. Plotting the location information on a map would be invaluable in estimating pockets or patterns of growth and in the detection of errors.

The procedure for developing functional class growth factors is to estimate AADT for the current year sections, expand these estimates to functional class DVMT, divide the resulting estimate by the corresponding estimate from the previous 3-year cycle counts, and divide by three to average the growth over the 3 years. For the first and second years, the use of available AADT's for HPMS sample sections could be used to derive rough estimates (in these cases, the appropriate number of years would be used as the divisor).

The estimation procedures for section AADT and functional class DVMT have already been described. The equation for estimating functional class growth factors based on the 3-year cycle HPMS Coverage program is:

$$G_h = 1 + \frac{1}{3} \left(\text{DVMT}_h / \text{DVMT}_{h-3} - 1 \right) \quad 3-3-8$$

where

G_h = growth factor for functional class h,

DVMT_h = daily vehicle miles of travel (DVMT) for functional class h during current year, and

DVMT_{h-3} = DVMT for functional class h from previous 3-year cycle.

Since the complete sample consists of 3 rotating fixed panels, independent verification of growth factors will be provided each of the 3 years. If the differences between years is larger than twice the precision of the growth factors, then it may be necessary to smooth out the time-series by, perhaps, a moving average procedure. Growth factors from alternative procedures (continuous ATR's) would also help to confirm the validity of the values derived from the coverage procedures.

The precision of coverage growth factors can be estimated by the following equation:

$$C_h = \sqrt{CV_h^2 + CV_{h-3}^2} \quad 3-3-9$$

where

C_h = the relative variance coefficient of growth factor G_h expressed as a percentage of the factor,

CV_h = the relative variance coefficient of the DVMT in functional class h during the current year, and

CV_{h-3} = the relative variance coefficient of the DVMT in functional class h during the previous 3-year count cycle.

The relative variance coefficients would be estimated from standard procedures similar to those presented for the continuous ATR's.

The resulting system growth factors by functional class would be used to expand the remaining two-thirds of the HPMS sample not counted during the current year. The result would be that all HPMS sample sections would have a current AADT value (estimate).

Estimation of Day-of-Week Factors

The statistical procedures described in this Guide recommend the use of day-of-week factors only if such use is shown to be necessary. The use of these factors may serve to improve both AADT and VMT estimates depending on the manner by which the counting procedures are structured and implemented.

Statistical sampling procedures require that each unit in the universe have a positive chance of selection. Excluding weekends from the temporal sampling frame would act to bias the procedures in unmeasurable ways. This is the reason for recommending full inclusion of the 7 days of the week. On the other hand, it is known that in many cases the work-week days are more consistent than the weekend days for AADT estimation. Many State programs have preferred the use of work-week days. The cost of using personnel outside of normal working schedules has restricted the use of weekend counts in the past. The development of automatic equipment which can be placed and retrieved during normal working schedules may eliminate or reduce the restriction in future programs.

Data from the continuous ATR program would be used to develop the day-of-week factors. Because of the potential differences between functional classes, the analysis would be carried out using the established seasonal groups as described earlier in Chapter 2 of this section. If no significant or large differences are detected, then statewide aggregation would be appropriate. Since the use of monthly factors has already accounted for month to month variation, the development of day-of-week factors would be carried out for each month. It is very likely that monthly differences will be insignificant, in which case aggregation of several months or the use of the combined factors for the full year would be appropriate.

The factors can be computed on an individual basis (7 daily factors) or a combined weekday (Monday, Tuesday, Wednesday, and Thursday) versus weekend (Friday, Saturday, and Sunday) factor. This decision depends on the data analysis and the State's perspective. If the computation of daily factors results in very similar figures then the simpler combined approach would be preferable.

So far, the discussion has considered an extensive number of possible actions including the determination of individual or combined day-of-week factors, by seasonal group, and by month. It is highly unlikely that all of these effects will be judged significant; indeed, since the procedures recommend the use of 48-hour periods which dilute the daily differences, daily factors may not be needed at all. Another consideration is introduced by the fact that examining all the possibilities mentioned will dilute the available ATR data, thereby introducing small sample discrepancies. In the final analysis, the judgement of the analyst guided by the knowledge of State conditions and supported by the interpretations derived from the data must be the deciding factor. Adequate documentation should be maintained to support the decisions made and to allow future reexamination.

The daily factors for a single continuous ATR location by month and seasonal group are computed as the ratio of MADT to monthly average day-of-week volume. For example, the Monday factor in January is the January MADT divided by the average volume of the Mondays in January. The seasonal daily factor for a seasonal group would be the average of all the continuous locations within the seasonal factor group. For example, the Monday factors in January for the Interstate Rural seasonal group is the average of the Monday factors of the Interstate Rural continuous ATR locations in January. The standard error and relative variance coefficient are estimated using standard procedures assuming a simple random sample (the same procedures used in the seasonal factor discussion in Chapter 2 of this section).

Since the procedures recommend the use of 48-hour periods, the application of the factors would require the averaging of the appropriate daily factors. For example, a 48-hour period including Monday and Tuesday would require averaging the Monday and Tuesday factors. Alternatively, the factoring procedure could be carried out as the combination of two days and would result in factors for the 7 possible combinations of 2 contiguous days. Other complications could arise such as a 48-hour period including the last day of one month and the first day of the next month. All these considerations can be easily handled based on a commonsense analytical interpretation.

The procedures are, indeed, data driven and to be successful require the use of flexible, computerized, analytical tools; and the skill to use effectively the available tools.

Estimation of Axle Correction Factors

The application of axle correction factors is dependent on the type of equipment in use. Obviously, vehicle detectors do not require the adjustment. However, the preponderance of equipment dependent on pneumatic tube detectors in counting operations makes the development

of these factors a virtual necessity. To represent vehicles, counts taken by axle counting equipment require adjustment by axle correction factors. The magnitude of the problem will obviously depend on the traffic characteristics at the point or system. For the system purposes of this Guide, axle correction factors by functional class are considered sufficient. For point-specific concerns, the judgement of the analyst and knowledge of specific conditions are of primary importance. If the system factor is not considered appropriate, then a special count may be required. This condition is likely to surface for specific situations such as truck routes or truck traffic generators.

The structure of the Traffic Monitoring Guide provides a simple process for estimating these factors for the specific points in the classification sample and for the system in general. The adjustment factor at a point is simply the ratio of vehicles to axles as determined by a classification count. Since most classification equipment provides both a vehicle and axle count directly, very specific procedures are unnecessary. If the AADT is estimated based on axles and the axle correction factor is multiplicative (the recommended procedures), then the ratio of vehicles to axles (axle correction factor) must be positive and range between the values of 0.2 and 0.5. A functional class factor is derived as the average of the individual factors of all the classification locations within the specific functional class. Standard errors and relative variance coefficients are estimated based on standard procedures assuming a simple random sample (the same procedure used in Chapter 2 of this section).

The application of the factors is a straightforward procedure. Sample sections where classification counts are taken or where vehicle detecting equipment is used require no adjustment since the number of vehicles are known. Sample sections where axle counts are taken are assigned the factors on the basis of functional class and these are applied in the computation of section AADT.

Data Collection and Processing Considerations

Many concerns must be addressed when implementing a program of this magnitude. Only some of the most salient considerations are addressed here. So far, no mention has been made of actual detail of data to be collected. Obviously much depends on equipment capability and the objectives of the program. In general, hourly breakdowns are recommended for the truck weight and classification sample sections. This would allow examination of other concerns such as peak-hour volume and design-hour factors. Urban locations may be desired by 15 minute intervals. Rural volume locations not tied to classification or weight may need only daily volumes for the monitoring period. Although the Guide recommends the use of 48-hour period a break or subtotal for each

24-hour period is recommended for all locations. The daily (24-hour) break is very useful for analysis of daily variation and is required for the factoring procedures. Furthermore, it may be very desirable to structure the full HPMS coverage element on an hourly basis (equipment permitting). This would allow addressing other related concerns such as peak-hour periods or examination of traffic conditions during specific hours, and provide sufficient records to detect equipment malfunctions or to input missing periods due to equipment malfunction.

Missed counts due to equipment failures, bad weather, or other reasons should be made up during the year. Partial counts could be adjusted based on hourly imputation procedures or retaken. Abnormal situations such as major construction, etc., should be handled based on the judgement of the responsible official. The typical procedures in use by each State should be applied and documented.

Data processing procedures should be designed to allow efficient utilization of computerized data. All procedures for data editing, the calculation of AADT estimates, and the development of factors should be fully computerized. Documentation on the processes including tables of the factors used should be maintained for historical purposes and to allow future reviews. Computerized data management and analysis procedures should allow the use of both mainframes and microcomputers and provide a connection to other relevant data bases. Since the HPMS requires reporting of AADT information, the use of unique HPMS sample section identification numbers in the data base would allow a direct connection between all the related programs (HPMS, volume, classification, weight, and any other). These numbers would also allow a tie-in to future developments such as computerized mapping tools.

CHAPTER 4

The Special Needs Element

Introduction

The development of a sampling approach for volume estimation can be predicated on two related but different concepts: Vehicle Miles of Travel (VMT) and Annual Average Daily Traffic (AADT). VMT estimates are more relevant to the systems and usually referred to as system estimates. AADT refers to specific locations and is, therefore, termed point-estimation. The procedures for developing these estimates are dependent on multidimensional effects which include temporal variation, spatial variation, equipment error, and adjustment factors. The two major concerns in VMT estimation, excluding equipment, are the temporal and spatial dimensions. AADT estimation presents a somewhat different problem since spatial considerations become immaterial. AADT estimation is concerned with temporal variation at the specific point in question. The only way to obtain an exact AADT (ignoring equipment error) is to install a continuous ATR at the desired point and count 365 days a year. Lacking an ATR, a number of short counts distributed throughout the year and averaged would provide an estimate. Sampling theory could then be used to define the length of counts and the number needed to achieve a desired precision. If the temporal periods of measurement were strictly defined and randomly selected, the reliability of the AADT estimate could be directly estimated. The less costly and less reliable approach is to take a short count and use a variety of adjustment factors to develop the AADT estimate (less reliable because extraneous factors are imputed to the specific location). Since this latter approach is, by far, the most common today; it is clear that cost considerations take precedence over reliability. The reliability of AADT estimates does not appear to be an overriding concern judging from the majority of existing State programs. It is apparent that the major need is to quantify the traffic at specific points roughly rather than in a strictly accurate manner. The concerns are then to detect changes of a large nature presenting an order of magnitude problem rather than one of detecting minute differences. This definition, as presented, allows a simple tie-in of AADT to VMT since system VMT estimates do not require accuracy at the point level.

It should be clear from this discussion that it is AADT (point - specific) estimation that complicates traffic counting programs. VMT estimation, by itself, would require small samples of short duration randomly distributed over the geographical (spatial) system and the calendar (temporal). The adjustment factor approach would be unnecessary. In fact, for generalized VMT estimation, the continuous ATR or Special Needs elements would not be needed. The combination of

AADT and VMT requirements into a statistical program has been described in the previous two chapters, and it is accomplished by establishing a sample framework (HPMS core) and beefing up the procedures to insure reliable AADT estimation at the sample points. What remains to be done is to tie points not included in the HPMS core sample into the program to provide a general measure of AADT.

In the case of the Interstate system, the higher precision HPMS reliability requirements for VMT result in a large HPMS core sample which should easily address most needs for AADT or VMT. The lower functional classes, due to lower VMT reliability requirements and far greater system extent, have a smaller, sparse HPMS core sample framework. These non-Interstate samples are sufficient for VMT estimation and for AADT estimation at the sample locations. However, the wide dispersion of the non-Interstate sample leaves enormous gaps which can be filled to the degree desired by each State by the Special Needs element of the program.

Chapters 2 and 3 have described the Continuous ATR element needed to adjust short counts to AADT estimates; and the HPMS coverage sample framework to produce VMT estimates, AADT at the specific sample points, and the statistical tie to vehicle classification and truck weight. This chapter describes the Special Needs element of the program. This is the last element of the three-tiered volume counting program. The Special Needs element is designed to complement and complete the program by providing sufficient flexibility to address any additional needs.

There is no question that after the first two elements are in place additional traffic data needs remain. However, these remaining needs vary enormously from State to State. A comprehensive discussion of all needs is impossible. The needs and the circumstances requiring them are too diverse. The programs, philosophies, and constraints faced by each of the 50 States are too different for complete coverage in one report or to be dealt with specifically. Therefore, these needs are described in general terms. The philosophy of the Special Needs element is then to provide wide flexibility, to encompass the diversity of situations, and to allow each State to design its program in accordance with its self-defined needs and priorities. The Special Needs program can range from minimal, limited coverage to a full, 100 percent inventory of the system depending on the desires and needs of each State. In general, judging by the size of existing programs, needs, and data requirements; the Special Needs element is expected to become the largest of the 3 elements of the program in most States.

The discussion of the Special Needs program in this chapter concentrates only on volume considerations. Although the initial direction and immediate needs may be more concerned with volume aspects, other parts of the overall program also have special needs.

The Special Needs element should then be inclusive to incorporate needs in related programs such as vehicle classification, truck weight, speed monitoring, etc. The integration of these separate needs will require more emphasis on initial planning and coordination but will result in a more efficient and effective program.

Special needs can be generally subdivided into 2 major categories: system needs and point needs. System needs reflect those concerns that affect the overall highway system, while point needs refer to specific concerns needed for a decision at a single point in the system.

System Needs

Some of the most important needs of this nature are the development of volume flow maps on a periodic basis, the determination of volume group strata for the HPMS and the development of subunit VMT estimates.

Flow maps have been traditionally developed by most highway agencies to serve a variety of purposes. FHWA purposes that require flow map information include the HPMS, the National Bridge Inspection Program, and the National Railroad-Highway Crossing Program. Obviously, the first considerations are the level of detail desired by each State in terms of geography and highway system, and the tolerances desired in terms of accuracy of AADT. For the Interstate system, the HPMS core coverage should in many cases be sufficient to develop adequate and accurate flow maps. Plotting of the HPMS sample sections on maps will allow a decision as to how many additional counts are needed to satisfy the State's desires. In general, because of the controlled access on the Interstate, only changes in traffic volume of a large magnitude such as major interchanges not already covered require counting. Concerns at a much finer level of detail such as interchange or ramp volumes are beyond the capability of the defined procedures and would require special coverage. Concerns of this nature may be more applicable to point than to system estimation.

For systems other than the Interstate, the HPMS coverage structure is extremely limited and may be insufficient in many States for adequate flow maps even those of a general nature. Plots of the existing HPMS sample locations will allow a determination of the number of additional counts needed to satisfy the State's needs.

The manner and procedures for these additional counts are left to the individual State's discretion. The recommendations for the core program are not applicable here. Accurate and reliable procedures for the development of AADT estimates have been presented in Chapter 3. It is unlikely that the level of accuracy needed for flow maps would approach that presented for the HPMS core. Procedures that generally quantify the traffic volumes at specific points to a plus or minus 50 percent for low volume sections (under 5,000 AADT) and plus or minus 20

percent for high volume sections (greater than 5,000 AADT) can be easily derived with few constraints based on 24 hours or shorter monitoring periods and limited adjustment for seasonality. Adjustment procedures have been presented in Chapters 2 and 3 for expanding short counts to AADT. Those procedures should be considered, but less reliable procedures are applicable particularly if wide tolerance levels are all that is required.

The determination of volume group strata for the HPMS is of key importance in insuring that the HPMS sample remains attuned to changes in the highway systems. With the passage of time, the traffic volumes on the HPMS universe and sample sections change. These changes must be monitored and the sample updated on a periodic basis to insure that representativeness is indeed maintained over time. Since the changes in the system are not, in general, of a drastic nature and the HPMS by virtue of its statistical design provides a self-correcting mechanism for minor deviations; the tolerance of needed estimates is fairly wide. Minor departures from volume group strata specifications have little or no effect. Indeed, the HPMS would be in great trouble if the converse were true. Therefore, results from a wide tolerance, up-to-date flow map are quite adequate for the purpose of establishing and updating HPMS volume group strata, and no additional requirements beyond the development of rough flow maps are needed.

The development of subunit VMT estimates is a very important concern to a number of States; since apportionment of highway funds to lower jurisdictions such as counties, urban areas, or towns may be based on travel estimates. If only VMT estimates by subunit are desired, very simple procedures based on the existing framework can be developed. First of all, short monitoring periods are quite adequate for VMT estimation. Second, the HPMS provides a complete universe definition of the State's road systems with the exception of the local functional class which is excluded from the HPMS and would require separate development. For all functional classes except local, the HPMS sampling procedures as described in the HPMS Manual can be used to develop the necessary sample sizes for the desired reliability levels of subunit VMT estimates. All available samples, whether from the HPMS core or other special purposes would be used in the scheme. Any additional samples would be randomly selected from the remaining universe sections within the subunits. Adjustment procedures to convert short counts to AADT could be used before expansion to VMT or, alternatively, direct expansion (requiring a random spatial and temporal distribution of the count schedule) of the short counts to VMT requiring no adjustment could be carried out. It should be intuitively obvious that if high reliability estimates for a large number of subunits within a State are desired, the sample sizes will be enormous.

Point-Specific Needs

One of the most basic concerns for traffic information is the need for highway project information. This is perhaps the most important concern from the point of view of State management of highway programs. It is unlikely that available information from the continuous or HPMS coverage elements will be sufficient to address this need, however, available information should be exhausted before additional data is collected. The manner by which this need has been met in the past differs markedly by State. In some States the information provided by the planning department through its regular count program is judged adequate and no special counts are taken. In others, the planning information is disregarded no matter how current and a special count is made whenever requested. It is debatable which procedure is best. However, it is a waste of resources to disregard reliable information no matter how current. It should also be very clear that taking a special count by no means insures an accurate estimate at the point in question. The reliability of a special count, particularly a very short one, may be no better than plus or minus 50 percent. Yet, this may be quite sufficient to support the intended decision. Project counts depend on the importance of the project and of the decisions that will be made based on the count and should be justifiable on that basis. Many projects may be adequately supported based on existing information, while an important project in a major urban area may require taking hundreds of special volume and classification counts.

The recommended procedure is to examine the available information (maps) from the continuous, HPMS core, classification, and any other special need programs to determine whether sufficient information is available. Even if the specific location is not directly available, extrapolation from or interpolation between existing points may be sufficient to address the need and may be even more reliable than a special count. If in the judgment of the analyst, the available information is sufficient, then special counts should not be scheduled. The adjustment procedures previously described could be used to estimate AADT or other appropriate procedures substituted. Since the number of projects considered during an annual program is not very large, the described methodology would seem far more efficient than a blanket coverage of the complete State system which may still necessitate supplementary special counts and the maintenance of an enormous data base. The decision on what is required is, obviously, best made close to the source, thus complete flexibility is emphasized for this level of the Traffic Monitoring Program.

Other Related Programs

Other concerns can also be at least partially addressed by the defined structure. Studies of a special nature, urbanized area transportation studies, intersection studies, turning movements, traffic

signalization, etc., can make use of any available information. Otherwise, special counts can be taken justified by the importance assigned to the study. If all or most of the specific needs can be defined at an early stage, it may be possible to coordinate the data collection to address as many concerns as possible. It is, however, unlikely that one program will be able to address all needs. Some redundancy and duplication will always exist and may actually be beneficial.

Growth areas and other areas where traffic variability is large, such as recreational areas, should receive a high level of priority in the planning of a Special Needs program. This is a basic consideration because fixed samples (continuous ATR and HPMS core elements) tend to be impervious to changes that occur away from the sample points. This is particularly important for the continuous ATR element which consists of a very limited sample. Growth areas are identifiable based on knowledge of the highway systems and by monitoring available information on travel generators, construction projects, highway construction, highway maintenance, zoning laws, building permits, population growth, etc. Maintaining a higher level of attention in these areas should also serve to indicate when seasonal patterns or use of growth factors developed as a part of the general program require revision or modification. Obviously, a periodic review of the procedures will be needed to keep them up-to-date.

Future programs and studies can present a challenge to the organization of any program. The maintenance of a clearly defined yet limited structure (the continuous ATR and the HPMS coverage core) combined with a very flexible Special Needs program should provide adequate leeway for the use of existing information as well as the future implementation of any needed modifications.

Data Processing Considerations

The effectiveness of a data base depends on the ability to extract information quickly. This in turn depends on the computer systems where the data is stored and the skills of the analyst. The integrated traffic monitoring program requires an effective data base management function that permits easy access to the data base for information, update, and control purposes. Capacity and processing speeds must be carefully considered before a hardware determination is made. The emphasis of the Traffic Monitoring Guide is on the use of user-controlled micro or mini-computers, although larger machines may be necessary in some cases. The sizes of the continuous and HPMS core elements are well suited for small computer processing. However, the Special Needs element since it depends on State definition requires careful analysis.

Software must include a capable data base management package with report or quick inquiry functions. A distributed data base operation, where different purpose data bases are stored separately but can be easily linked through common identifiers, may allow independent operation of the different sub-programs without sacrificing overall program integration.

The intricacies of a fully computerized program must be explored early in the planning stage. The development of an integrated program is totally dependent on the efficiency of a computerized operation.

APPENDIX A

The computer printout tables included in this appendix were produced by the SAS (Statistical Analysis System) package. For a description of SAS procedures refer to the SAS User's Guides (References 3 and 4). The procedures used were run in batch mode with standard Job Control Language (JCL) through IBM's Time Sharing Option (TSO) at the Transportation Computer Center (TCC) of the U.S. Department of Transportation. Job submission through other methods, such as batch using cards or interactive processing, is quite feasible depending on the SAS installation specification of the computer facility used.

Other statistical packages can also be used to conduct the analysis on a variety of machines ranging from mainframes to microcomputers. Statistical software for microcomputers capable of conducting these types of analysis is beginning to appear. Although the capability and processing power of any such packages may require examination, the option would provide a very cost-effective alternative to organizations owning or having access to high level microcomputers.

The appendix contains four major application or example routines and a table of the student's T distribution which are described below:

1. Cluster Analysis Example - Pages 3-A-10 to 3-A-12.

Page 3-A-10 describes the ATR data used in the example. The first column presents the observation number (OBS). The second column presents the station number (STNUM). The next twelve columns present the monthly average daily traffic from January thru December (M1 to M12). The last column presents the functional class (FUNC).

Page 3-A-11 describes statistical information used to evaluate the cluster formation. An understanding of this page is helpful but not necessary to interpret the results of the clustering. A complete explanation of the statistical terminology is provided in the SAS Users Guide (Reference 4).

Page 3-A-12 presents a dendogram or graph of the cluster formation. An understanding of this graph is necessary to select the clusters. The columns represent the location numbers (STNUM). The rows represent the clusters ranging from 1 to 20. The first row (row 1) shows a single cluster consisting of all the locations indicated by the solid line (made of x's). The second

row shows the first cluster break (two clusters) indicated by the break (spaces) in the solid line. The first cluster consists of 14 locations, those with numbers between 600 and 1200. The second cluster consists of 6 locations identified as those between 900 and 2200. The third row shows 3 clusters composed of 6, 8, and 6 respectively (indicated by the breaks in the solid line). The process continues until row 20 where 20 clusters each with a single location are shown. The first four cluster breaks are indicated in the printout by vertical lines with the sequential number at each break.

The example consists of the three printouts presented and an interpretation of the results. The MADT's are used as input. To eliminate the effects of volume differences between ATR locations, the factors themselves (ratio of AADT to MADT) should be used instead. A rule-of-thumb for determining the appropriate number of clusters is to stop when the cubic clustering criterion (CCC) reaches a minimum. Another is to stop the cluster selection at the point beyond which the coefficient of determination (R squared) gains become insignificant. In this example, the CCC points to 3 clusters and the R squared to four.

It should be remembered that these are rule-of-thumb criteria and continuing the process is sometimes effective. Since the intent of the cluster analysis is to examine variation patterns and identify recreational (high variation) locations, the simplest approach is to examine the clusters until the known variation patterns in the State stand out. If a grouping procedure is currently used, a comparison of both procedures with the same number of groups should be carried out.

The following table presents the four cluster break:

<u>Cluster 1</u>		<u>Cluster 2</u>		<u>Cluster 3</u>		<u>Cluster 4</u>	
<u>ATR Number</u>	<u>Func Class</u>	<u>ATR Number</u>	<u>Func Class</u>	<u>ATR Number</u>	<u>Func Class</u>	<u>ATR Number</u>	<u>Func Class</u>
600,1800	1	200,500	6	900	1	2200	11
1500,2000	2	14000	7	2600,6000	11		
700	11	100,300	14	1900,8000	12		
1600	12	400,1300	16				
		1200					

The interpretation of the defined patterns requires knowledge of the location of the ATR's. Plotting the locations on a map is sometimes helpful in identifying or distinguishing the characteristics of the patterns.

In this example, the interpretation was unclear. The main result was a separation of the higher and lower functional classes. Interpretation at this stage is sometimes difficult and must be aided by the knowledge of State characteristics.

Clustering procedures are adequate to identify patterns but are usually insufficient for a complete determination of what groups are appropriate. Since theory does not provide an optimal solution, no clear answer to the question of what the appropriate number of groups is can be provided. The answer usually depends on actual differences between groups and on individual interpretation of results. Therefore, an alternative procedure becomes necessary.

2. Descriptive Analysis of ATR Data - Page 3-A-13

Page 3-A-13 presents the ATR data sorted by functional class and station number. The columns represent the observation number (OBS), the station number (STNUM), the monthly average daily traffic (MADT) from January to December (M1 to M12), the functional class (FUNC), the annual average daily traffic (AADT), the standard deviation of the MADT's (MSD), and the percent coefficient of variation of the MADT's (MCV). In the printout, check marks indicate the traffic peaks at each location.

In the example, the rural pattern (functional classes 1, 2, 6, and 7) is quite distinct from the urban pattern (functional classes 11, 12, 14, and 16) as shown by the MCV's. Several locations (1500, 2000, 200, 14000, and 700) can be examined for the presence of recreational patterns. Two of these locations (200 and 1400) may be discarded because of low AADT which reduces the importance of the differences. Knowledge of an important travel generator served by the ATR locations may reverse the decision. Location 700 exhibits more of a rural than urban or recreational pattern and is also discarded. Exceptions of this nature (see also location 400) are very often found due to the lack of precise definitional boundaries between categories of functional classification. Similarly, urban and rural areas are defined by boundary lines that inadequately reflect the actual character of continuous highways. The two locations remaining (1500 and 2000) do exhibit a summer recreational type of pattern with the July traffic peaks almost 3 times the January troughs. Verification of the location patterns would require a reason or explanation such as the presence of an established recreational traffic generator. In the determination of recreational area

patterns, the data provide only an indication. Knowledge of the presence of recreational travel generators is essential when establishing the recreational pattern.

The following table describes the three groups directly indentifiable from the data provided:

<u>SEASONAL GROUP</u>	<u>LOCATION NUMBER</u>	<u>FUNCTIONAL CLASS</u>
1. RURAL	600,900,1900, 200,500, 14000	1 6 7
2. URBAN	700,2200,2600,6000, 1600,1900,8000, 100,300,400,1300, 1200	11 12 14 16
3. RECREATIONAL	1500,2000	2

In this case, the data have not shown a need for regional breaks, although, the very limited number of points (20) may mask or impede the detection of all possible differences existing in the State. The point is that the existing data, in this case, do not support the need for regional breaks. Still, the decision to develop regional breaks rests ultimately on the analyst's knowledge, data support being one of the prerequisites.

Descriptive Analysis of Control Data - Pages 3-A-14 and 3-A-15.

Pages 3-A-14 and 3-A-15 present the control data sorted by functional class and station number. The format is the same as that of page 3-A-13. The check marks show the monthly traffic peaks at each location.

In the previous example, 20 ATR locations are basically insufficient to detect or quantify the complete seasonal pattern picture in the State. Therefore, an analysis of the control location data was undertaken.

The variability of these locations should be similar to that of the continuous locations and support the patterns shown there. However, since seasonal control data are collected for shorter periods of time, usually one or two weeks each month or quarter, additional variability is to be expected. The particular control program shown in this example consisted of 2-week counts taken monthly. Each control ATR had basically one-half the data of a continuous ATR.

As the check marks indicate, summer or early fall peaks remain the norm but several noticeable exceptions exist.

The first step in examining the control data printout is to identify recreational pattern locations, i.e., locations with a percent coefficient of variation larger than say 20 or 25 percent. The following locations show such a pattern:

<u>RECREATIONAL LOCATIONS</u>	<u>FUNCTIONAL CLASS</u>
70800	2
20500,70400,70500,71200,73800	6
18900,70600,72600	7
50000,71300	11
71000,71500	12
70900,71600	14

Some of the locations with high variability (20200,33600,12500, etc.) are not included due to questionable entries for one or two of the monthly entries and/or low AADT's. Several others are borderline (70100). Plotting the locations on a State map should clearly indicate the areas of the state where high seasonal variability (recreational patterns) exist. In this example, the numbering system makes it apparent that locations in the 70,000 range are in the pattern. Also, notice that recreational patterns transcend functional class (the locations are distributed over all functional systems). However, it is also apparent that some locations with 70,000 numbers do not reflect the pattern (see locations 70300, 73300, 75000), therefore, the assignment of points or locations to the recreational group is not automatic and can not be based completely on geographical definition.

Another important distinction is that the type of recreational pattern is not universal. Although most of the locations identified as recreational show a summer recreational pattern, location 20500 shows a distinct winter (recreational) pattern with traffic peaks during the winter months. It should be quite clear from this discussion why the need exists for the exercise of judgement in the assignment of factors to short counts when dealing with recreational patterns even in the geographical areas where the recreational patterns are concentrated. This is, however, the exception to the rule. It is also quite obvious from the data that the majority of locations fall within the variability ranges of their assigned groups by functional class.

The next topic of interest is whether sufficient differences exist by functional class to justify separate groups. Similar questions could also be posed regarding regional areas. The following table examines the variability of control locations within functional class excluding recreational locations already identified.

PERCENT COEFFICIENT OF VARIATION (MCV)

<u>FUNCTIONAL CLASS</u>	<u>MINIMUM VALUE</u>	<u>AVERAGE VALUE</u>	<u>MAXIMUM VALUE</u>	<u>NUMBER OF LOCATIONS</u>
2	7.6979	16.7622	27.7114	6
6	6.4447	15.3495	26.8586	14
7	8.1241	17.9500	34.3637	11
11	7.7349	10.8694	15.4683	8
12	4.3861	8.0987	18.2506	23
14	3.6853	9.7941	17.3832	37
16	4.9034	11.8040	20.7685	8

The differences between the functional classes (2, 6, and 7) within the rural group do not appear to justify deviating from the established groups. Minor differences will always exist when analyzing statistical data as shown by the averages for the three functional classes (2, 6, and 7) within rural areas, and borderline locations will create minor distortions. The important aspect is to distinguish the characteristics which identify the major differences in the variation. In this example, urban functional classes consistently show less variability than those in rural areas; but once this break is made, the differences become almost negligible.

Regional differences could be probed in a similar manner if regional categories are considered important by the analyst. It is also important not to overclassify because the total sample size (number of locations) is dependent on the number of groups established.

Once the recreational patterns are identified, either by specific areas or as individual locations, a subjective determination is made regarding the allocation of continuous counters to the recreational groups. The remaining locations are assigned to the appropriate groups solely on the basis of functional class definition and region, if regional breaks have been defined. Based on the analysis conducted, the continuous ATR locations have been allocated to the seasonal groups as shown in the following table:

<u>SEASONAL GROUP</u>	<u>LOCATION NUMBER</u>	<u>FUNCTIONAL CLASS</u>
1. INTERSTATE RURAL	600,900,1900	1
2. OTHER RURAL	200,500,14000	6
3. INTERSTATE URBAN	700,2200,2600,6000	7
4. OTHER URBAN	1600,1900,8000, 100,300,400,1300, 1200.	12 14 16
5. RECREATIONAL	1500,2000	2

4. Monthly Factor Analysis - Pages 3-A-16 to 3-A-18.

Page 3-A-16 shows the monthly factors for each ATR station. The factors are computed as the ratio of AADT to MADT. The table presents the number of observations (OBS), the factor group (Group), the station number, (STNUM), the individual monthly factors from January to December (F1 to F12), the functional class (FUNC), and the AADT. The check marks indicate the month where average traffic is closest to annual average traffic (factor is nearest to unity).

Pages 3-A-17 and 3-A-18 present statistical information on the monthly factors by seasonal group. The information includes the months of the year (F1 to F12), the group sample size (N), the average monthly factor (MEAN), the standard deviation of the monthly factor, the minimum value, the maximum value, the standard error of the mean, the sum of the values, the variance, and the percentage coefficient of variation (CV). The five seasonal groups are Interstate Rural (1), Other Rural (2), Interstate Urban (3), Other Urban (4), and Recreational (5).

The example builds on the previously described group assignments. The check marks in the printout (3-A-16) indicate the month whose average is closest to AADT. Several studies have indicated that a good estimate of AADT could be obtained from counts during a specific month of the year. While this is true in some cases, the check marks clearly indicate that caution should be exercised when following that procedure. An analysis of historical information would be necessary since individual locations vary significantly. What holds for one location may not hold for another. A determination as to whether the difference is due to random effects can only be determined based on a time-series analysis.

Pages 3-A-17 and 3-A-18 present the monthly group factors (F1 to F12) and statistical information about the factors. The seasonal groups are defined in the previous section. The average (MEAN) monthly factors provide the group factors for each month (F1 to F12). The following table presents a brief summary of the Interstate Rural group:

INTERSTATE RURAL GROUP

<u>MONTH</u>	<u>N</u>	<u>MEAN FACTOR</u>	<u>CV (%)</u>	<u>PRECISION (%)</u>
JAN	3	1.280	5.640	95 + or - 14
FEB	3	1.198	11.101	95 + or - 28
MAR	3	1.179	3.326	95 + or - 8
APR	3	1.100	5.993	95 + or - 15
MAY	3	.985	8.054	95 + or - 20
JUN	3	.924	8.234	95 + or - 20
JUL	3	.823	7.987	95 + or - 20
AUG	3	.811	8.381	95 + or - 20
SEP	3	.927	7.395	95 + or - 18
OCT	3	.934	10.060	95 + or - 25
NOV	3	1.020	5.877	95 + or - 15
DEC	3	<u>1.105</u>	<u>1.052</u>	95 + or - <u>3</u>
AVERAGE	-	1.000	6.925	95 + or - 17

The precision of the monthly factor is determined by the use of equation 3-2-3. Values of the T distribution are given on page 3-A-19. For the January factor the 95% two-sided precision is given by 4.303 (the T value) times 5.64 (CV) divided by the square root of 3 and equals 14.

As the last column shows, the precision varies for each monthly estimate. The design precision criteria could be tied to individual monthly factor estimates or to a general annual average encompassing all factors. The recommendation is to use the average of the twelve monthly values. Under these criteria, the average precision achieved by the use of the existing 3 locations is approximately 95-17.

To estimate the number of locations needed to reduce the precision to the desired 95-10, an iterative process using equation 3-2-3 is used. The process involves using the average coefficient of variation and substituting values of T and n in equation 3-2-3.

The following table presents estimates of precision for the Interstate Rural Group:

INTERSTATE RURAL

<u>n</u>	<u>T</u>	<u>CV</u>	<u>ESTIMATED PRECISION</u>
3	4.303	6.925	95 + - 17
4	3.182	6.925	95 + - 11
5	2.776	6.925	95 + - 9
6	2.571	6.925	95 + - 8
7	2.447	6.925	95 + - 7
8	2.365	6.925	95 + - 6

Under the assumptions made, 5 locations would be sufficient to achieve the target 95-10 criteria in the example. This same procedure would be applied to all the defined groups with the exception of recreational groups.

5. Table of Student's T Distribution

Page 3-A-19 presents a one-sided table of the T distribution. The arrow indicates the values to be used in estimating 95 percent two-sided confidence intervals as used in the sample size analysis. The values of n represent the degrees of freedom.

For example, the T value with 95 percent (2 sided) confidence and a sample size of 4 is 3.182:

$$T_{95,3} = 3.182$$

MONTHLY AVERAGE DAILY TRAFFIC
1983 CONTINUOUS ATR DATA

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OBS	STNUM	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	FUNC
1	600	15333	17594	16111	16131	17668	18311	20981	21450	20809	22114	17929	16867	1
2	900	32804	34095	36175	41362	47371	49410	50445	50131	42124	41530	44345	38398	1
3	1800	25424	26269	28001	30186	33693	37683	45575	46661	38521	36077	31847	30643	1
4	1500	16480	19060	20797	24846	28779	37099	48206	45510	37253	28074	20789	20824	2
5	2000	11372	11627	13529	15827	18847	22660	28528	19564	15411	13354	11978	14471	2
6	200	2820	2902	2953	3359	4054	4566	5990	5910	4398	4033	3450	3059	6
7	500	3785	3188	4206	3147	4671	4872	4572	4781	4835	4768	4445	3772	6
8	14000	1570	1778	1013	1070	2650	2668	2768	2742	2590	2545	2180	1975	7
9	700	13230	13076	14694	16721	18959	21338	24895	26296	22159	19101	17303	16024	11
10	2200	63980	66140	71135	75364	77337	77706	75087	77275	76569	76368	73924	68590	11
11	2600	43544	48011	45822	46704	47865	49329	51554	45851	47108	43581	46240	49501	11
12	6000	34276	33817	37513	40193	43226	45610	46000	46528	46499	42912	40973	39138	11
13	1600	20370	19204	21015	21657	22618	24109	24797	25618	25341	23777	22923	22024	12
14	1900	37879	37977	40989	41970	41753	45023	43756	45391	44822	46168	43325	41780	12
15	8000	49576	49554	54095	54992	56945	59423	57404	60159	57560	58489	56035	55045	12
16	100	8067	8259	8846	9165	10183	10155	9466	10026	9851	9745	9413	9374	14
17	300	6574	6497	7175	7624	7629	7936	7600	8670	7909	7686	7561	7418	14
18	400	4494	5390	5531	6061	7021	6157	7739	7728	7653	7995	6619	5528	14
19	1300	7244	7305	7848	8183	8589	8765	8570	8885	9039	8895	7724	8090	14
20	1200	5416	5379	6220	6574	6804	7265	6572	6709	7054	6803	6219	6070	16

3-A-10

MONTHLY AVERAGE DAILY TRAFFIC
1983 CONTINUOUS ATR DATA

10:11 MONDAY, APRIL 22, 1985 2

WARD'S MINIMUM VARIANCE HIERARCHICAL CLUSTER ANALYSIS

SIMPLE STATISTICS

	MEAN	STD DEV	SKEWNESS	KURTOSIS	BIMODALITY
M1	20211.90	17873.90	1.04	0.25	0.55
M2	20707.70	18227.33	1.05	0.38	0.54
M3	22187.40	19526.98	1.06	0.45	0.53
M4	23556.80	20485.73	1.01	0.44	0.51
M5	25335.10	21047.13	0.93	0.19	0.50
M6	27004.25	21805.06	0.73	-0.35	0.48
M7	28525.25	21969.50	0.46	-0.99	0.47
M8	28309.75	22120.02	0.57	-0.73	0.47
M9	26375.25	21153.65	0.75	-0.23	0.47
M10	25200.75	20805.54	0.92	0.18	0.49
M11	23761.10	20562.95	0.97	0.10	0.53
M12	22929.55	19645.49	0.91	-0.16	0.54

EIGENVALUES OF THE CORRELATION MATRIX

EIGENVALUE	DIFFERENCE	PROPORTION	CUMULATIVE
11.81062	11.65996	0.98422	0.98422
0.15067	0.13164	0.01256	0.99677
0.01903	0.00917	0.00159	0.99836
0.00986	0.00544	0.00082	0.99918
0.00442	0.00223	0.00037	0.99955
0.00219	0.00073	0.00018	0.99973
0.00145	0.00059	0.00012	0.99985
0.00086	0.00050	0.00007	0.99993
0.00037	0.00012	0.00003	0.99996
0.00024	0.00004	0.00002	0.99998
0.00021	0.00014	0.00002	0.99999
0.00007		0.00001	1.00000

ROOT-MEAN-SQUARE TOTAL-SAMPLE STANDARD DEVIATION = 1
 ROOT-MEAN-SQUARE DISTANCE BETWEEN OBSERVATIONS = 3.4641

NUMBER OF CLUSTERS	FREQUENCY OF NEW CLUSTER	RMS STD OF NEW CLUSTER	SEMI-PARTIAL R-SQUARED	R-SQUARED	APPROXIMATE EXPECTED R-SQUARED	CUBIC CLUSTERING CRITERION
10	3	0.133995	0.001425	0.995416	0.993611	1.4942
9	4	0.172967	0.002834	0.992582	0.991476	0.6271
8	2	0.239244	0.003013	0.989570	0.988688	0.2597
7	4	0.180559	0.003706	0.985864	0.984715	0.2515
6	8	0.121475	0.004185	0.981680	0.978614	0.5015
5	5	0.31787	0.016124	0.965555	0.968338	-0.2765
4	6	0.373453	0.028966	0.936590	0.948739	-0.7156
3	6	0.620936	0.080192	0.856398	0.904066	-1.4378
2	14	0.501091	0.129662	0.726736	0.767384	-0.6986
1	20	1	0.726736	0.000000	0.000000	0.0000

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MONTHLY AVERAGE DAILY TRAFFIC
1983 CONTINUOUS ATR DATA

NUMBER OF CLUSTERS	STNUM									
	1	2	3	4	5	6	7	8	9	10
1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1
17	1	1	1	1	1	1	1	1	1	1
18	1	1	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1

MONTHLY AVERAGE DAILY TRAFFIC
1983 CONTINUOUS-AIR DATA

8:32 THURSDAY, APRIL 18, 1985 1

ORS	STNUM	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	FUNC	AADT	MSD	MCV
1	600	15333	17594	16111	16131	17668	18311	20981	21460	20809	22114✓	17929	16867	1	18442.3	2319.1	12.5749
2	900	32804	34095	36175	41362	47371	49410	50445✓	50431	42124	41530	44345	38398	1	42374.2	6212.7	14.6616
3	1800	25424	26269	28001	30186	33693	37683	45575	46661✓	38521	36077	31847	30643	1	34215.0	6953.7	20.3236
4	1500	16480	19060	20797	24846	28779	37089	48206✓	45510	37253	28074	20789	20824	2	28976.4	10661.8	36.7949
5	2000	11372	11627	13529	15827	18847	22660	28528✓	19564	15411	13354	11978	14471	2	16430.7	5156.0	31.3804
6	200	2820	2902	2953	3359	4054	4566	5990✓	5910	4398	4033	3450	3059	6	3957.8	1102.2	27.8480
7	500	3785	3188	4206	3147	4671	4872✓	1572	4781	4835	4768	4445	3772	6	4253.5	631.7	14.8510
8	14000	1570	1778	1013	1070	2650	2668	2768✓	2742	2590	2545	2180	1975	7	2129.1	643.9	30.2427
9	700	13230	13076	14694	16721	18969	21338	24885	26296✓	22159	19101	17303	16024	11	18650.5	4325.7	23.1937
10	2200	63980	66140	71135	75364	77367	77706✓	75087	77275	76569	76368	73924	68590	11	73292.1	4716.5	6.4351
11	2600	43544	45043	45822	46704	47865	49329	51554✓	45851	47108	43581	46240	49501	11	46845.2	2406.9	5.1381
12	6000	34276	33817	37513	40193	43226	45610	46000	46528✓	46499	42912	40973	39138	11	41390.4	4541.9	10.9733
13	1600	20370	19204	21015	21657	22618	24109	24787	25618✓	25341	23777	22923	22024	12	22787.8	2023.3	8.8789
14	1900	37879	37977	40989	41970	41753	45023	43756	45391	44822	46168✓	43325	41780	12	42569.4	2717.3	6.3832
15	8000	49576	49554	54095	54982	56945	59423	57404	60159✓	57560	58489	56035	55045	12	55773.1	3414.8	6.1226
16	100	8067	8259	8846	9165	10183✓	10155	9466	10026	9851	9745	9413	9374	14	9379.2	696.6	7.4275
17	300	6574	6497	7175	7624	7629	7836	7600	8670✓	7909	7686	7561	7418	14	7523.3	585.9	7.7877
18	400	4494	5390	5531	6061	7021	6157	7739	7728	7653	7995✓	6619	5528	14	6493.0	1141.9	17.5863
19	1300	7244	7305	7848	8183	8589	8765	8570	8885	9039✓	8895	7724	8090	14	8261.4	624.9	7.5647
20	1200	5416	5379	6220	6574	6804	7265✓	6572	6709	7054	6803	6219	6070	16	6423.8	590.4	9.1916

3-A-13

AVERAGE DAILY TRAFFIC BY MONTH
1983 CONTROL DATA

10:19 MONDAY, APRIL 22, 1985 1

3-A-14

ORS	STNUM	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	FUNC	AADD	MSD	MCV
1	16400	5126	5487	5346	5798	6604	7026	7963	7760	7405	6713	6168	5420	2	6401.3	989.9	15.4675
2	19100	1929	1794	2184	2223	2558	2393	2517	2340	2758	2924	2494	2136	2	2354.2	325.5	13.8264
3	20200	6622	6696	7271	7599	8617	8276	9192	9236	9195	10349	4126	3425	2	7550.3	2092.3	27.7114
4	61700	12751	11508	13600	13781	14095	14683	14493	14998	15400	14921	14425	14664	2	14109.9	1086.2	7.6979
5	70700	18686	24156	20882	21009	22105	26970	29685	30787	26997	21940	19099	17000	2	23276.3	4448.6	19.1119
6	70800	19526	20352	23472	27771	33017	39604	48788	47121	37836	31284	27227	24341	2	31694.9	9844.8	31.0611
7	10100	4280	4430	4436	4971	6343	5903	6691	7579	6324	8132	5133	4728	6	5745.8	1288.8	22.4301
8	20500	9777	10611	4892	5529	7619	6751	4624	4557	7500	7800	6900	7500	6	7005.0	1920.4	27.4146
9	20900	21089	23832	23594	24654	25141	24103	22519	23816	25079	25571	25295	21106	6	23816.6	1534.9	6.4447
10	29200	2055	2801	2526	2978	3137	3082	2935	3273	4244	3211	2837	2850	6	2994.1	513.7	17.1571
11	29300	6556	7790	7743	8297	8673	8277	8094	8142	9131	9216	8990	7880	6	8232.4	735.2	8.7310
12	30100	1240	1266	1476	1544	1609	1561	1576	1580	1594	1751	1500	1437	6	1511.2	143.6	8.5052
13	30200	2787	2695	3178	3328	3770	3998	4210	4294	3893	4238	3437	3316	6	3595.3	553.7	15.4017
14	33600	4301	4718	4748	5286	6014	6231	8976	6272	9336	5388	5215	5211	6	5974.7	1604.7	26.8586
15	50900	5193	5032	5130	5325	5597	7251	7141	8070	8041	6043	6314	6340	6	6289.8	1107.4	17.6061
16	51000	7129	7200	7482	8437	9089	10234	9937	9897	9825	8964	8424	7100	6	8643.2	1193.6	13.8095
17	70400	8830	12207	9687	12352	13076	21505	23042	23000	21000	14410	13048	14000	6	15513.1	5168.1	33.3143
18	70500	6598	7950	9101	12344	12300	22822	28880	29621	22000	12521	12634	9000	6	15480.9	8152.1	52.6588
19	71200	9053	9932	9913	11744	12530	15000	18000	17291	16489	12213	11751	10516	6	12869.3	3075.6	23.8984
20	73800	3952	4400	4800	6915	7032	13700	21465	22000	17000	6469	6085	4195	6	9834.4	6826.5	62.4139
21	12500	482	463	585	596	792	708	1145	1135	922	1000	533	497	7	739.0	253.9	34.7637
22	13000	1193	1591	1562	1883	2090	2140	2660	2178	2153	2100	1900	1550	7	1916.7	391.0	20.3996
23	15500	2085	2581	2110	2252	2640	3416	3798	3472	3218	2524	2416	2280	7	2732.7	588.0	21.5157
24	18900	1284	1322	1129	1465	1881	1830	2755	3572	1885	1843	1692	1425	7	1840.3	691.4	37.5718
25	19000	1239	1378	1307	1600	1643	1736	1672	1961	1832	1436	1313	1324	7	1536.8	236.0	15.3559
26	20300	1246	1256	1429	1433	1706	1692	1831	1822	1627	1798	1512	1418	7	1564.2	210.7	13.4729
27	21100	4709	5004	5458	5190	5698	6574	6375	6434	6639	6683	5706	5375	7	5820.4	695.6	11.9518
28	30300	4838	5270	5194	5888	5395	5173	4551	5100	5026	5900	5800	5723	7	5321.5	432.3	8.1241
29	32100	2176	2295	2844	2918	3430	3424	4064	3769	3380	3528	2883	2730	7	3120.1	574.6	18.4165
30	70600	22683	21480	29167	30287	37920	35425	49371	48282	38144	34581	29423	26582	7	33612.1	8999.9	26.4783
31	72600	4815	5272	5021	6650	7500	9937	10939	11200	9600	6779	6242	5641	7	7466.3	2344.3	31.3979
32	31600	13727	15356	16393	17030	17566	17715	16387	17605	18219	18938	18179	17123	11	17019.8	1414.2	8.3093
33	39000	19597	19601	22353	23782	25586	27148	28374	29650	27593	27731	25457	22938	11	24984.2	3349.8	13.4078
34	50000	23085	24928	27019	31554	36138	47623	58910	53943	40625	32863	29613	26606	11	36075.6	11801.2	32.7124
35	51100	62814	59100	59498	49837	65166	67446	36000	70212	69700	71971	56452	52513	11	62700.8	7258.8	11.5769
36	60100	24487	24185	26855	29180	31690	33959	36405	39386	36441	35326	30200	29065	11	31281.6	4838.7	15.4687
37	65000	37198	36388	39910	40864	42318	43514	42299	45466	44800	46184	46304	42233	11	42290.7	3271.1	7.7349
38	69100	70933	68658	80090	82924	85482	90967	88044	92048	88418	87404	85027	83706	11	83641.8	7293.4	8.7198
39	71300	11476	11333	15359	16633	24360	24228	30000	30000	18267	19121	17401	15000	11	19431.5	6390.3	32.8861
40	28000	8106	8521	8452	8788	8994	9161	8469	8580	8546	8757	9004	7640	12	8601.5	427.5	4.9699
41	30600	16497	16439	16229	16127	18347	17985	18193	18231	18118	20257	16644	15120	12	17348.9	1404.7	8.0969
42	30700	26317	26405	28103	29462	30826	31343	28963	30040	30212	30993	30089	28559	12	29276.0	1672.4	5.7124
43	31000	8073	8324	8994	10615	10831	11199	10833	13455	12847	10800	10316	9500	12	10482.3	1623.0	15.4835
44	40100	33759	34220	34895	35398	34141	37803	35622	35047	38572	36110	34362	37384	12	35609.4	1564.6	4.3937
45	40500	39577	40000	40300	40431	42704	44431	45646	45902	44208	46903	42759	40221	12	42756.8	2627.3	6.1447
46	50200	21320	20547	21472	22473	23737	24556	22789	22711	24700	26200	22002	21933	12	22870.0	1640.6	7.1735
47	50400	40068	44644	44876	49254	51407	58856	55400	58800	53365	50469	49138	50940	12	50601.4	5610.6	11.1471
48	50500	26800	30400	30007	29952	31438	34796	29310	33572	33411	29813	28503	28329	12	30527.6	2375.4	7.7813
49	55000	25024	26523	27002	30164	31432	32955	30404	32493	32157	30538	27835	26981	12	29459.0	2667.3	9.0542
50	61300	29470	34118	35014	38463	38531	41779	32580	40658	37564	34619	30502	27000	12	35024.8	4578.5	13.0721
51	61400	54250	53795	58685	60070	62295	60519	57398	61525	59668	58229	58000	56231	12	58388.8	2666.8	4.5673
52	70100	42824	43100	52275	53970	60937	70345	71211	73889	59810	59325	57817	46770	12	57689.4	10528.6	18.2506
53	71000	6946	11240	10188	13063	13874	24774	28077	25686	21252	11344	9179	8000	12	15301.9	7520.6	49.1481
54	71500	27193	27057	29944	33546	38272	48579	55343	54299	45317	40054	36717	35430	12	39312.6	9747.0	24.7835
55	82000	41154	39471	43058	41848	44129	45235	45832	45462	43834	43857	42000	44000	12	43323.3	1900.2	4.7061

AVERAGE DAILY TRAFFIC BY MONTH
1983 CONTROL DATA

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ORS	S1NUM	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	FUNC	AADT	MSD	MCV	
56	82100	46058	43976	44075	49544	49086	51038	45557	46882	45516	46866	45576	51185	✓ 12	47113	3	2512.17	5.3322
57	82200	48000	48183	50145	51042	52106	50455	45811	50000	46000	53000	53000	47372	12	49592.8	2513.87	5.0690	
58	94100	19384	19293	22087	21139	20945	22703	27141	22519	25490	23984	25805	22177	12	22722.3	2478.87	10.9094	
59	94200	8098	8397	9517	9586	8947	9460	9338	9599	8923	9425	9738	8963	12	9165.9	511.47	5.5801	
60	94300	16219	16046	17858	✓ 17732	15928	16346	15024	15931	15778	15223	14635	15978	12	16058.2	956.34	5.9555	
61	94400	7695	8240	9493	9037	9108	10424	10576	10857	9539	10546	10191	11082	✓ 12	9757.3	1053.25	10.7945	
62	94500	24727	23829	26271	25936	27892	28500	✓ 27865	27590	24392	24907	28051	27249	12	26434.1	1638.54	6.1986	
63	10500	7103	7763	8127	9316	10096	11057	11396	✓ 9556	10021	7985	7578	8967	14	9080.4	1397.77	15.3913	
64	10700	12876	11461	13410	13465	14993	15536	17815	✓ 17628	15378	16156	13928	14072	14	14726.5	1898.09	12.8889	
65	10800	5783	5370	6474	6666	7534	7652	8179	8554	✓ 7551	7952	6906	6256	14	7081.4	993.20	14.0255	
66	10900	10005	9340	11917	9687	12330	11704	12739	13035	13304	✓ 13202	11766	11680	14	11725.8	1369.35	11.6781	
67	12600	2007	1845	2296	2377	2723	2668	3082	3228	✓ 2634	2854	2350	2004	14	2505.7	435.56	17.3832	
68	16200	10964	11471	12527	13095	13090	13196	12123	13901	✓ 13531	13859	12317	12855	14	12744.1	907.78	7.1232	
69	22900	8138	8734	8929	9972	10365	10783	✓ 9700	10082	10105	9540	9335	8564	14	9520.6	799.40	8.3966	
70	25700	9534	9998	10167	9907	12351	✓ 11313							14	10545.0	1069.83	10.1454	
71	27200	7191	7920	7822	8448	8995	9673	9662	10025	10041	✓ 9335	8870	7987	14	8830.8	951.95	10.7800	
72	28100	6375	7281	7087	8080	8630	8986	✓ 8802	8860	8546	8684	7800	7002	14	8011.1	881.63	11.0051	
73	30400	14217	15346	15163	16455	17252	17514	✓ 16183	16971	16853	16996	16689	15458	14	16258.1	1001.78	6.1618	
74	30500	4547	4483	5166	5348	5566	6027	✓ 5887	5762	5940	5834	5220	5480	14	5438.3	514.87	9.4674	
75	30800	8015	8383	8523	9108	9698	9744	10743	✓ 9500	9060	9724	7287	8400	14	9015.4	940.90	10.4365	
76	30900	12377	13495	13730	13487	14691	14673	14575	14619	14825	15115	✓ 14638	13019	14	14103.7	854.60	6.0594	
77	40200	19000	19000	19810	19773	20849	22506	✓ 20210	20677	21565	20193	21400	20626	14	20467.4	1036.65	5.0620	
78	40300	32700	34000	33300	33945	37269	26294	35687	34779	34000	✓ 37735	33435	34905	14	34004.1	2872.96	8.4489	
79	40600	13324	13103	12243	12283	15316	✓ 14177	14548	14815	14966	15292	13078	13451	14	13883.0	1112.49	8.0134	
80	40700	19300	19400	20167	19766	21212	21865	✓ 20339	20632	20768	19869	19890	20604	14	20317.7	748.76	3.6853	
81	40900	11700	11400	9300	10094	10604	14073	✓ 12336	11000	15420	11331	12600	13330	14	11932.3	1730.73	14.5046	
82	41000	11412	11922	12377	12475	12308	13320	12521	12409	12942	12393	12293	13522	✓ 14	12491.2	567.67	4.5446	
83	41100	5528	5528	5669	5634	6233	6405	✓ 5815	5869	6294	6079	5807	6065	14	5910.5	301.03	5.0931	
84	44000	9184	9400	9897	10021	10422	10982	✓ 10125	9698	10795	10161	9898	10147	14	10060.8	516.25	5.1313	
85	49100	11600	11300	12383	17573	14262	14784	✓ 14012	14300	14263	13943	13505	11283	14	13600.7	1783.52	13.1135	
86	50300	14000	12800	14792	11619	15734	16484	✓ 16483	16441	16795	✓ 16666	14499	15722	14	15169.6	1672.12	11.0229	
87	52600	4600	4600	4599	4764	6675	6811	✓ 5914	5294	5197	5444	4949	4671	14	5293.2	789.65	14.9184	
88	53400	8100	8100	9818	10484	9600	9200	11093	11146	11714	✓ 11650	10614	11253	14	10231.0	1270.73	12.4204	
89	60700	25177	24600	25000	28316	30046	35380	✓ 34094	32984	32437	27322	26199	26300	14	28987.9	3859.17	13.3130	
90	61500	9004	8936	9594	9567	10098	10713	9667	10957	✓ 10800	10800	9123	9863	14	9926.8	740.07	7.4553	
91	61600	6413	5745	6700	6631	6845	7191	✓ 6432	6386	7070	6694	6266	6800	14	6597.8	386.30	5.8550	
92	65200	14652	15566	16103	17117	17903	18747	✓ 16771	17936	17282	17892	17219	17500	14	17057.3	1140.87	6.6884	
93	66000	5100	4895	4876	6119	6974	7017	5412	6669	7357	✓ 7179	4792	6180	14	6047.5	989.99	16.3703	
94	70300	9409	10869	11245	11463	10701	11721	11683	12000	✓ 11900	11600	11200	11000	14	11232.6	704.49	6.2719	
95	70900	13174	15131	14530	17814	17793	24641	21415	22672	✓ 21689	16047	15215	13813	14	17827.8	3856.36	21.6311	
96	71600	9432	7937	9770	10078	11215	11755	12405	13893	✓ 12700	11550	5099	5552	14	10115.5	2754.67	27.2322	
97	73300	9900	9932	10143	10491	10601	10801	9647	10704	10805	✓ 11567	11047	9500	14	10428.2	614.15	5.8893	
98	75000	13125	12700	13268	13939	18000	18690	✓ 18187	17338	17130	14902	14366	14300	14	15495.4	2208.74	14.2541	
99	75000	13125	12700	13268	13939	18000	18690	✓ 18187	17338	17130	14902	14366	14300	14	15495.4	2208.74	14.2541	
100	36900	3540	3162	3962	4312	4904	5194	✓ 4982	5033	4968	4894	4241	4089	16	4440.1	658.17	14.8234	
101	39300	4560	4781	4800	4978	5455	5831	✓ 5085	5105	5433	5707	4973	3715	16	5035.3	565.87	11.2781	
102	44300	10277	9796	10348	10993	11762	✓ 11288	8884	10000	10600	10976	10484	10500	16	10492.3	746.06	7.1105	
103	47500	6600	6600	5375	6900	7937	8717	6902	6852	9110	9100	7716	9562	✓ 16	7614.3	1287.67	16.9114	
104	56000	1851	2138	2077	2506	2700	3595	3914	✓ 3530	3480	2371	2253	2168	16	2715.3	714.96	26.7312	
105	61900	5397	5442	5746	5950	6779	7605	9815	✓ 8435	6476	5926	5630	5884	16	6590.4	1368.73	20.7685	
106	69500	11330	11696	11824	11871	11264	13161	12700	12320	12945	12500	11779	14154	✓ 16	12295.3	845.09	6.8732	
107	82500	18740	19799	20088	20719	21337	21806	19685	21189	20701	22421	✓ 21000	20122	16	20633.9	1011.76	4.9034	

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MONTHLY FACTORS BY STATION
1983 CONTINUOUS ATR DATA

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OBS	GROUP	SIMM	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	FUNC	AADT
1	1	600	1.20279	1.04822	1.14470	1.14329	1.04383	1.00717	0.879002	0.85938	0.88627	0.83397	1.02863	1.09340	1	18442.3
2	1	900	1.29174	1.24283	1.17137	1.02447	0.89452	0.85760	0.840007	0.84024	1.00594	1.02033	0.95556	1.10355	1	42374.2
3	1	1800	1.34378	1.30249	1.22192	1.13347	1.01549	0.90797	0.750741	0.73327	0.88822	0.94839	1.07436	1.11657	1	34215.0
4	2	200	1.40349	1.36303	1.34028	1.17828	0.97628	0.86681	0.660740	0.66968	0.89992	0.98136	1.14720	1.29383	6	3957.8
5	2	500	1.12378	1.33422	1.01129	1.35160	0.91062	0.87305	0.930337	0.88967	0.87973	0.89209	0.95692	1.12765	6	4253.5
6	2	1400	1.35610	1.19746	2.10176	1.98980	0.80343	0.79801	0.769178	0.77647	0.82204	0.83657	0.97664	1.07802	7	2129.1
7	3	700	1.40971	1.42632	1.26826	1.11539	0.98321	0.87405	0.749166	0.70925	0.84167	0.87641	1.07788	1.16391	11	18650.5
8	3	2200	1.14555	1.10814	1.03032	0.97251	0.94733	0.94320	0.976096	0.94846	0.95720	0.95972	0.99145	1.06855	11	73292.1
9	3	2600	1.07581	1.04001	1.02233	1.00302	0.97869	0.94965	0.908662	1.02168	0.99442	1.07490	1.01309	0.94635	11	46845.2
10	3	6000	1.20758	1.22395	1.10336	1.02979	0.95754	0.90749	0.899792	0.88958	0.89014	0.96454	1.01019	1.05755	11	41390.4
11	4	100	1.16266	1.13563	1.06027	1.02337	0.92106	0.92360	0.990827	0.93548	0.95210	0.96246	0.99641	1.00055	14	9379.2
12	4	300	1.14439	1.15796	1.04854	0.98679	0.98614	0.94799	0.989901	0.86773	0.95123	0.97883	0.99501	1.01419	14	7523.3
13	4	400	1.44482	1.20464	1.17393	1.07128	0.92480	1.05457	0.838997	0.84019	0.84843	0.81213	0.98096	1.17457	14	6493.0
14	4	1200	1.18607	1.19423	1.03276	0.87714	0.84411	0.88421	0.977442	0.95748	0.91065	0.94425	1.03292	1.05828	16	6423.8
15	4	1300	1.14045	1.13093	1.05268	1.00958	0.96186	0.94255	0.963993	0.92982	0.91397	0.92877	1.06958	1.02119	14	8261.4
16	4	1600	1.11869	1.18661	1.08436	1.05221	1.00751	0.94520	0.918972	0.88952	0.89924	0.95839	0.99410	1.03468	12	22787.8
17	4	1900	1.12383	1.12093	1.03856	1.01428	1.01955	0.94550	0.972882	0.93784	0.94974	0.92205	0.98256	1.01889	12	42569.4
18	4	8000	1.12500	1.12550	1.03102	1.01420	0.97942	0.93858	0.971589	0.92709	0.96896	0.95357	0.99533	1.01323	12	55773.1
19	5	1500	1.75828	1.52027	1.39330	1.16624	1.00686	0.78106	0.601086	0.63670	0.77783	1.03214	1.39383	1.39149	2	28976.4
20	5	2000	1.44484	1.41315	1.21448	1.03814	0.87179	0.72510	0.575949	0.83984	1.06616	1.23039	1.37174	1.13542	2	16430.7

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MONTHLY FACTORS BY SEASONAL GROUP
1983 CONTINUOUS ATR DATA

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VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
----- GROUP #1 -----									
F1	3	1.28010015	0.07220120	1.20278702	1.34577565	0.04168538	3.84030046	0.00521301	5.640
F2	3	1.19784314	0.13286900	1.04821720	1.30248582	0.07676969	3.59352943	0.01768075	11.101
F3	3	1.17933038	0.03921936	1.14470445	1.22192065	0.02264331	3.53799114	0.00157816	3.326
F4	3	1.10040953	0.06594752	1.02447093	1.14328519	0.03807482	3.30122859	0.00434908	5.893
F5	3	0.98461225	0.07930047	0.89451704	1.04382688	0.04578415	2.95383675	0.00628856	8.054
F6	3	0.92424818	0.07610192	0.85760305	1.00717237	0.04393746	2.77274453	0.00579150	8.234
F7	3	0.82324981	0.06575208	0.75074054	0.87900164	0.03796198	2.46974944	0.00432334	7.987
F8	3	0.81096329	0.06796368	0.73326761	0.85938180	0.03923885	2.43288987	0.00461906	8.381
F9	3	0.92680760	0.06853658	0.88626716	1.00593882	0.03956961	2.78042279	0.00469726	7.395
F10	3	0.93422709	0.09398371	0.83396642	1.02032667	0.05426152	2.80268126	0.00883294	10.060
F11	3	1.01951459	0.05992179	0.95555681	1.07435551	0.03459586	3.05854377	0.00359062	5.877
F12	3	1.10450566	0.01161487	1.09339736	1.11656822	0.00670585	3.31351699	0.00013491	1.052
----- GROUP #2 -----									
F1	3	1.29445637	0.14969835	1.12377807	1.40348700	0.08642838	3.88336910	0.02240960	11.565
F2	3	1.29850377	0.08875010	1.19745969	1.36382954	0.05123989	3.89551132	0.00787658	6.835
F3	3	1.48444309	0.55934590	1.01129339	2.10176045	0.32293851	4.45332926	0.31286784	37.681
F4	3	1.50655983	0.42737524	1.17827727	1.98978751	0.24674521	4.51967948	0.18264959	28.368
F5	3	0.89677499	0.08725305	0.80342767	0.97627857	0.05037557	2.69032496	0.00761309	9.730
F6	3	0.81595423	0.04164054	0.79800725	0.87305008	0.02404118	2.53786270	0.00173393	4.922
F7	3	0.78675149	0.13565482	0.66074012	0.93033683	0.07832035	2.36025446	0.01840223	17.242
F8	3	0.77860751	0.11000720	0.66968415	0.88966743	0.06351269	2.33582253	0.01210158	14.129
F9	3	0.86722922	0.04041559	0.82203990	0.89991663	0.02333395	2.60168765	0.00163342	4.660
F10	3	0.90334340	0.07304624	0.83657498	0.98136210	0.04217327	2.71003020	0.00533575	8.086
F11	3	1.02691989	0.10462985	0.95691789	1.14719807	0.06040807	3.08075968	0.01094741	10.189
F12	3	1.16650013	0.11303106	1.07801688	1.29383241	0.06525851	3.49950040	0.01277602	9.690
----- GROUP #3 -----									
F1	4	1.20965860	0.14381846	1.07581221	1.40971277	0.07190923	4.83863439	0.02068375	11.889
F2	4	1.19960344	0.16914262	1.04000992	1.42631539	0.08457131	4.79841377	0.02860923	14.100
F3	4	1.10631862	0.11458321	1.02232916	1.26925956	0.05729160	4.42527446	0.01312931	10.357
F4	4	1.03017899	0.06144142	0.97250787	1.11539382	0.03072071	4.12071594	0.00377505	5.964
F5	4	0.96669206	0.01708406	0.94733004	0.98320945	0.00854203	3.86676824	0.00029187	1.767
F6	4	0.91859535	0.03501010	0.87405099	0.94964760	0.01750505	3.67438138	0.00122571	3.811
F7	4	0.88342895	0.09577395	0.74916650	0.97609551	0.04788697	3.53371579	0.00917265	10.841
F8	4	0.89224341	0.13342585	0.70925236	1.02168255	0.06671293	3.56897362	0.01780246	14.954
F9	4	0.92085660	0.06818479	0.84166704	0.99442062	0.03409239	3.68342638	0.00464917	7.404
F10	4	0.99389448	0.05445657	0.95972244	1.07489885	0.02722829	3.97557791	0.00296552	5.479
F11	4	1.02315090	0.03772294	0.99145181	1.07787667	0.01886147	4.09260359	0.00142302	3.687
F12	4	1.05909060	0.08905059	0.94634789	1.16391038	0.04452530	4.23636238	0.00793001	8.408

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MONTHLY FACTORS BY SEASONAL GROUP
1983 CONTINUOUS ATR DATA

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VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
----- GROUP=4 -----									
F1	8	1.18073835	0.10904215	1.11869170	1.44481531	0.03855222	9.44590677	0.01189019	9.235
F2	8	1.15705270	0.03372840	1.12092626	1.20463822	0.01192479	9.25642158	0.00113760	2.915
F3	8	1.06526340	0.04717477	1.03102104	1.17392877	0.01667880	8.52210716	0.00222546	4.428
F4	8	1.01860668	0.03111540	0.97714481	1.07127537	0.01100095	8.14885346	0.00096817	3.055
F5	8	0.96805617	0.03655877	0.92106125	1.01955349	0.01292548	7.74444936	0.00133654	3.777
F6	8	0.94777403	0.04804004	0.88420509	1.05457203	0.01698472	7.58219223	0.00230785	5.069
F7	8	0.95307536	0.05127815	0.83899729	0.99082682	0.01812956	7.62460287	0.00262945	5.380
F8	8	0.91064525	0.04042568	0.84019151	0.95748249	0.01429264	7.28516203	0.00163424	4.439
F9	8	0.92429084	0.03931034	0.84842545	0.96895558	0.01389831	7.39432676	0.00154530	4.253
F10	8	0.93255689	0.05197154	0.81213258	0.97882514	0.01837472	7.46045509	0.00270104	5.573
F11	8	1.00585793	0.03026427	0.98096389	1.06957751	0.01070003	8.04686341	0.00091593	3.009
F12	8	1.04194654	0.05628831	1.00055117	1.17456585	0.01990092	8.33557235	0.00316837	5.402
----- GROUP=5 -----									
F1	2	1.60155649	0.22163728	1.44483527	1.75827771	0.15672122	3.20311298	0.04912308	13.839
F2	2	1.46671063	0.07574962	1.41314756	1.52027370	0.05356307	2.93342126	0.00573800	5.165
F3	2	1.30388773	0.12644510	1.21447754	1.39329791	0.08941018	2.60777545	0.01598836	9.698
F4	2	1.10219114	0.09057977	1.03814157	1.16624071	0.06404957	2.20438228	0.00820469	8.218
F5	2	0.93932585	0.08550721	0.87179215	1.00685975	0.06753380	1.87865190	0.00912163	10.168
F6	2	0.75307608	0.03957035	0.72509562	0.78105654	0.02798046	1.50615216	0.00156581	5.254
F7	2	0.58852221	0.01778152	0.57594878	0.60109565	0.01257343	1.17704442	0.00031618	3.021
F8	2	0.73827314	0.14363990	0.63670439	0.83984189	0.10156875	1.47654627	0.02063242	19.456
F9	2	0.92189630	0.20388514	0.77782774	1.06616486	0.14416856	1.84399260	0.04156915	22.113
F10	2	1.13126855	0.14018298	1.03214421	1.23039289	0.09912434	2.26253711	0.01965127	12.392
F11	2	1.38278558	0.01562494	1.37173707	1.39383408	0.01104850	2.76557115	0.00024414	1.130
F12	2	1.26345583	0.18106863	1.13542027	1.39149139	0.12803556	2.52691165	0.03278621	14.331

3-A-18

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1	.325	1.000	3.078	6.314	12.706	31.821	63.657	636.619
2	.289	.816	1.886	2.920	4.303	6.965	9.925	31.598
3	.277	.765	1.638	2.353	3.182	4.541	5.841	12.941
4	.271	.741	1.533	2.132	2.776	3.747	4.604	8.610
5	.267	.727	1.476	2.015	2.571	3.365	4.032	6.859
6	.265	.718	1.440	1.943	2.447	3.143	3.707	5.959
7	.263	.711	1.415	1.895	2.365	2.998	3.499	5.405
8	.262	.706	1.397	1.860	2.306	2.896	3.355	5.041
9	.261	.703	1.383	1.833	2.262	2.821	3.250	4.781
10	.260	.700	1.372	1.812	2.228	2.764	3.169	4.587
11	.260	.697	1.363	1.796	2.201	2.718	3.106	4.437
12	.259	.695	1.356	1.782	2.179	2.681	3.055	4.318
13	.259	.694	1.350	1.771	2.160	2.650	3.012	4.221
14	.258	.692	1.345	1.761	2.145	2.624	2.977	4.140
15	.258	.691	1.341	1.753	2.131	2.602	2.947	4.073
16	.258	.690	1.337	1.746	2.120	2.583	2.921	4.015
17	.257	.689	1.333	1.740	2.110	2.567	2.898	3.965
18	.257	.688	1.330	1.734	2.101	2.552	2.878	3.922
19	.257	.688	1.328	1.729	2.093	2.539	2.861	3.883
20	.257	.687	1.325	1.725	2.086	2.528	2.845	3.850
21	.257	.686	1.323	1.721	2.080	2.518	2.831	3.819
22	.256	.686	1.321	1.717	2.074	2.508	2.819	3.792
23	.256	.685	1.319	1.714	2.069	2.500	2.807	3.767
24	.256	.685	1.318	1.711	2.064	2.492	2.797	3.745
25	.256	.684	1.316	1.708	2.060	2.485	2.787	3.725
26	.256	.684	1.315	1.706	2.056	2.479	2.779	3.707
27	.256	.684	1.314	1.703	2.052	2.473	2.771	3.690
28	.256	.683	1.313	1.701	2.048	2.467	2.763	3.674
29	.256	.683	1.311	1.699	2.045	2.462	2.756	3.659
30	.256	.683	1.310	1.697	2.042	2.457	2.750	3.646
40	.255	.681	1.303	1.684	2.021	2.423	2.704	3.551
60	.254	.679	1.296	1.671	2.000	2.390	2.660	3.460
120	.254	.677	1.289	1.658	1.980	2.356	2.617	3.373
∞	.253	.674	1.282	1.645	1.960	2.326	2.576	3.291



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SECTION 4

Vehicle Classification

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References

1. Wyman, John ; Braley, Gary A. and Stevens, Robert I., "Field Evaluation of FHWA Vehicle Classification Categories," Maine Department of Transportation, Final Report under contract DTFH-71-80-54-ME-03 for U.S. Department of Transportation, Federal Highway Administration; Office of Highway Planning, January 1985.
2. Davies, Peter and David R. Salter, "Reliability of Classified Traffic Count Data" in Transportation Research Record 905.

CHAPTER 1

Introduction

Vehicle classification is the observation of highway vehicles and the subsequent sorting of the resulting data into a fixed set of categories. As with any classification scheme, the one for highway vehicles attempts to provide structure to the reporting of the multitude of vehicles observed while providing a scheme of logical relationships between categories.

Vehicle classification data are of considerable use to agencies involved in almost any aspect of transportation planning and engineering. Some examples include the following:

- o pavement design;
- o scheduling resurfacing, reconditioning, and reconstructing of highways based on projected pavement life remaining;
- o predicting commodity flows and freight movements;
- o providing design input relative to current and predicted capacity of highways;
- o developing weight enforcement strategies;
- o accident record analysis;
- o environmental impact analysis; and
- o analysis of alternative highway regulatory and investment policies.

In short, vehicle classification data are extremely important as transportation agencies and State legislatures grapple with the need to determine and allocate the costs associated with maintaining the highway system and in selecting the improvements that will be programmed.

CHAPTER 2

Procedures for the Vehicle Classification Sample

The purpose of this chapter is to provide guidelines on practical procedures the States may use to develop the vehicle classification sample. Similar procedures are also applicable to the truck weight sample and can be used for that purpose.

The FHWA recognizes that States have a considerable investment in equipment, expertise, and historical data trends at fixed locations in each State. Data collected at these locations may historically include volume, speed, classification, and weight; States generally return to the same sites annually for the latter three items. Many of these sites have instrumented equipment in place. From a cost and an efficiency viewpoint, it would be wise wherever possible to incorporate these existing sites into an expanded sample of sites based upon the HPMS structure. This is because the financial investment in these sites is substantial and this incorporation would allow continuation of long-term trend series at these locations. This chapter provides guidelines on how to incorporate existing sites into the broader design, thus achieving the joint objectives of maintaining continuity and limiting additional capital cost investments as well as achieving the representativeness necessary for estimation of State-level totals.

An overview of the existing programs shows that States already have the HPMS sections identified. These HPMS sections have been selected to represent the highway network in each State. In addition to the HPMS sample, States will also have in place a varying number of automatic traffic recorders (ATR's), speed, weight, and classification sites at which they had been obtaining data historically. These sites may or may not conform to the HPMS samples; generally, some sites will conform exactly, others will be quite close to existing HPMS sites, and others will not match. The objective is to describe the procedures whereby these existing fixed sites can be augmented by an additional number of sites, such that the group when taken together is representative of the HPMS sites and of the State system as a whole.

The methodology is as follows:

1. Identify the distribution and number of desired sites by HPMS functional class and volume group.
2. Determine the distribution of existing sites by HPMS functional class and volume group.
3. Determine the distribution of additional needed sites by HPMS functional class and volume group.
4. Identify the specific locations of the additional needed sites.
5. Check the combined distribution of existing and additional sites against the overall distribution of HPMS samples to insure an adequate distribution of samples.

STAGE 1. Identify the Desired Distribution of Sites

As described in Section 2, this Guide recommends that the HPMS samples be used as the sampling frame from which the smaller groups of volume, classification, and weight sites should be drawn.

The distribution of sites should conform to the distribution of HPMS annual VMT by area type and functional class. The steps necessary to achieve this are as follows:

Step 1A: Summarize HPMS Statistics by Area, Functional Class, and Volume Group

The first step is to prepare basic summaries of expanded traffic, mileage, the number of HPMS samples, and existing fixed sites by area, functional class, and volume group. Exhibit 4-2-1 shows such a summary based on the 1982 HPMS submittal for a State.

Step 1B: Estimate the Total Sample Size Required

Procedures for estimating the total sample size are given in Chapter 4 of Section 2.

Based on the analysis shown, a sample size of 300 classification sites, to be sampled for 48 hours over a 3-year period, would be sufficient to achieve a 95-10 reliability for key parameters such as the proportion of 3S2's in the statewide population. Smaller sample sizes will, of course, have greater error. For purposes of the following example, we will assume a sample size of 300 spread over a 3-year period, or 100 annually.

Step 1C: Determine the Desired Distribution of the Sample by Area, Functional Class, and Volume Group

This step is a straightforward allocation of the total sample size to each of the cells of the HPMS area/functional class/volume group matrix. If additional samples are ultimately to be drawn within a volume group in simple random sample fashion, then this allocation must be made to each of the volume groups within each of the cells shown in Exhibit 4-2-1.

Exhibit 4-2-1

Example of distribution of HPMS samples, travel, mileage, and ATR's by area, functional class, and HPMS volume group.

RURAL FUNCTIONAL CLASS

<u>HPMS Volume Group</u>	<u>Data Type</u>	<u>INT</u>	<u>OPA</u>	<u>MA</u>	<u>Major Collectors</u>	<u>Minor Collectors</u>
1	A	48	173	93	82	135
	B	2,186	3,010	3,464	5,929	2,866
	C	338	1,076	2,350	4,924	6,884
	D	0	0	2	0	0
2	A	26	35	36	21	37
	B	6,423	3,470	4,749	3,793	4,507
	C	444	534	1,484	1,175	3,100
	D	4	2	5	2	0
3	A	4	7	19	11	4
	B	1,807	1,424	4,873	1,941	1,408
	C	70	128	719	282	611
	D	0	3	4	4	0
4	A	6	5	10	--	8
	B	722	827	1,564	--	1,404
	C	20	52	127	--	378
	D	2	1	3	--	0
5	A	1	14	1	--	1
	B	40	557	77	--	225
	C	1	23	3	--	31
	D	0	1	0	--	0
6	A	--	1	--	--	--
	B	--	94	--	--	--
	C	--	3	--	--	--
	D	--	0	--	--	--

LEGEND A - Number of HPMS Sections
 B - DVMT (Expanded) in Thousands
 C - Mileage (Expanded)
 D - Fixed Existing Sites

States that may decide to use a sample of their own design are advised to consult with FHWA Headquarters (HHP-44) in order to determine the effect of any alternative design on the procedures in this Guide.

Exhibit 4-2-2 presents an example of the simple random sample procedure to the full stratification of the HPMS. In the table, it is assumed that the Interstate Rural system carries 6 percent of the VMT according to the HPMS. Therefore, 6 percent of the proposed 300 sample sections corresponds to 18 samples or six per year. The sections are then distributed to the volume groups based on the percentage of VMT. To insure a positive chance of selection for every section in the HPMS sample, one section has been moved from group 2 to group 5. This type of minor adjustment will occur often. An alternative may be to combine groups 4 and 5.

Several advantages of the simple random procedures are:

1. It allocates equal probability of selection to sample sections within each strata. Combined with the distribution to strata proportional to VMT, this results in a self-weighting sample, i.e., an average can be derived directly by summing the sample characteristics and dividing by the sample size.
2. It provides a well-balanced sample insuring a full distribution on the basis of volume.
3. It insures that higher volume sections are included in the classification sample in proportion to their representation in the universe.

One disadvantage is the fact that minor adjustments will be needed because of the large number of strata in the HPMS sample.

The allocation of the sample proportional to VMT or DVMT was made to distribute the sample in proportion to travel not mileage. An additional advantage is that systems (strata) with a limited proportion of travel do not receive an inordinate number of samples. This type of application, while quite appropriate for statewide estimation, may not account fully for the perceived importance of portions of the statewide highway system. The case in point is the Interstate system. In the example presented, the Interstate Rural system carried 6 percent of HPMS VMT (excludes local functional class) resulting in an annual classification sample of 6 sections. Although the statewide sampling on all functional classifications will approximate the target reliability, the 6 samples attributable to the Rural Interstate strata are insufficient to provide very reliable estimates of VMT by vehicle classes for the Interstate rural strata. Even though, many of the fixed sites on the Interstate will be incorporated into the vehicle classification sample, thereby, providing the capability of monitoring classification in ATR fashion and much more reliably than with 48-hour short counts; the States may desire to specify individual target reliability levels on the Interstate strata. Two alternatives are

EXHIBIT 4-2-2

Example of Full Stratification Simple Random Sample Procedure for
the Interstate Rural System Described in Exhibit 4-2-1.

Volume Group	<u>STAGE 1</u>			<u>STAGE 2</u>				<u>STAGE 3</u>			<u>STAGE 4</u>	
	<u>DESIRED DISTRIBUTION</u>			<u>EXISTING SITES</u>				<u>REMAINING SITES</u>			<u>SAMPLING FRAME</u>	
	1	2	3	4	5	6	7	8	9	10	11	12
	<u>DMT (000)</u>	<u>Percent</u>	<u>Desired Sample Sections</u>	<u>HPMS Match</u>	<u>Close Match</u>	<u>No Match</u>	<u>Total</u>	<u>Usable Existing Sites</u>	<u>Additional Sites Needed</u>	<u>HPMS Samples</u>	<u>Existing Sites</u>	<u>Samples Available</u>
1	2,186	20	4	0	0	0	0	0	4	48	0	48
2	6,423	57	(10) 9*	2	1	1	4	3	6	26	3	23
3	1,807	16	3	0	0	0	0	0	3	4	0	4
4	722	6	1	0	1	1	2	1	0	6	1	5
5	40	1	0 (1)*	0	0	0	0	0	1	1	0	1
TOTAL	11,178	100%	18	2	2	2	6	4	14	85	4	81

* One section from Group 2 has been added to Group 5.

provided to address this situation: (1) increase the sample sizes in the affected strata (Interstate) to establish individual target reliabilities (resulting in an increase in the overall sample); or (2) arbitrarily assign a percentage of the sample to the Interstate. This second alternative is used in the truck weight sample (Section 5), without increasing the overall sample required. For example, assigning one-third of the classification sample to the Interstate would result in an annual sample of 33 sections in the Interstate and these would be distributed to urban and rural based on VMT.

Because of the importance of the Interstate system, either of these alternatives are recommended for States with extensive Interstate mileage, regardless of system travel.

STAGE 2: Determine the Distribution of Existing Sites

The purpose of this exercise is to maximize the opportunities for using existing sites as part of the recommended desired distribution. The reason for this focus is FHWA's recognition that the States have invested considerable funds and effort and have obtained considerable knowledge from these existing locations; to the maximum extent possible, therefore, this investment should not be lost. The methodology described below allows for the maximum integration of the existing sites into the revised sampling plan. Examples of the application are continued on Exhibit 4-2-2.

The procedures to allow the use of existing sites in the sampling approach may change the structure of the program. The use of fixed sites may allow the collection of classification data on a continuous basis. The structure of the proposed program is then changed from a sample of short (48-hour) classification counts to a combination of continuous (ATR) and short classification counts. This gain can result in much better estimates of seasonality of classification data and allow the future development of seasonal factors in a manner similar to that used in the volume counting program.

Step 2A: Locate the Existing Sites

The next step is to describe each of the existing sites by area, functional class, and HPMS volume group. These are locations which have installed equipment (ATR's) or locations at which speeds, classifications or weights have been taken historically. The distribution of these sites by area, functional class, and volume group should be developed. Exhibit 4-2-2, column 7, shows an example of such a distribution of the six fixed sites in our example. These six fixed sites were chosen for this example because they each contain physical equipment which can be modified for classification purposes and, thus, form the basic fixed investment which is possibly usable. In each State, of course, the analyst may wish to include ATR sites, weight, classification, and speed sites.

Step 2B: Assess Usefulness of each Site for Inclusion in the Sampling Distribution

In this step, the analyst determines the degree to which each site identified can possibly be used as a portion of the desired distribution. The basic criteria on which the assessment should be made is whether or not the site matches exactly, is close to, or does not match an existing HPMS sample. This determination requires knowledge of the location of the HPMS sample sections and of the fixed sites. In Exhibit 4-2-2, our example shows that the existing sites in column 7 are subdivided into those that "match HPMS sections" (column 4), are "close to HPMS sections" (column 5), or "do not match" (column 6).

Obviously, some judgment is necessary to determine whether a site is "close to" or "does not match" an HPMS section. Generally, if the existing site is so close to the section that either the total volume or the classification of traffic by type and weight is not judged to be substantially different between the site and the HPMS section close to it, then the site can be considered for practical purposes to be at the HPMS section. Only in the case where no match occurs would a site be considered for relocation. However, there may be many other reasons for retaining such sites as part of the Special Needs element.

The procedures recommended in Section 3 (volume) of this Guide which are used to streamline the seasonal factor program and the number of ATR's needed by seasonal group should also be addressed when considering the use of existing fixed sites.

The HPMS samples constitute, overall, about 5 percent of highway mileage, but this proportion can vary substantially for higher volume facilities for which the proportion may be as high as 50 percent. Thus, on higher facilities, many sites will in fact coincide with HPMS samples, while for lower facilities this match will be much smaller and most sites will not correspond to HPMS sections. One may, therefore, expect that additional investments will largely be necessary on the lower level facilities.

STAGE 3: Determine the Distribution of Additional Needed Sites

The purpose of this stage is to determine additional site investment costs necessary to bring the existing distribution of sites into line with the desired distribution. To achieve this the following steps are necessary. (The example is continued on Exhibit 4-2-2).

Step 3A: Determine the Distribution of Existing Usable Sites

The existing usable sites are defined as those which presently fall exactly on HPMS sections and those which have been determined to be sufficiently close to HPMS sections to be considered to fall on them.

In the example in Exhibit 4-2-2, this is column 8 or the sum of the sites in columns 4 and 5. The example shows that four of the six existing sites were deemed to be usable as a portion of the desired distribution.

Step 3B: Determine the Distribution of Additional Needed Sites

This distribution is obtained by subtraction of the existing usable sites from the desired distribution. In Exhibit 4-2-2, this is shown in column 9. The proposed program recommends only portable, short classification counts (48 hours). Therefore, a determination would have to be made, after the selection of the additional sites, regarding how many of the sites could be monitored with portable equipment versus installation of fixed equipment.

Application of the recommended procedure may, of course, leave a number of existing sites for which no match with the HPMS sample is achievable. A number of alternatives are possible on how to handle these remaining sites:

- (1) The sites may already be justified by another purpose, i.e., speed monitoring or truck weight enforcement site, in which case the locations would be retained.
- (2) The State may wish to maintain the location to continue historical trends at these locations and to augment the information obtained from the HPMS-based program.
- (3) The State may wish to eliminate these locations if no justification exists to maintain them.
- (4) The State may wish to relocate these locations over a period of time to conform with the desired distributions and improve the sampling and estimation processes.
- (5) The oversampling implied by these sites can be incorporated into the desired distribution by the use of weighting factors although the surplus sites will always lack a direct tie-in to the HPMS.
- (6) In the particularly sensitive case in which an existing heavily outfitted location does not fall on an HPMS site, an HPMS sample could be added at the location (this would be considered an exception applicable only to a very limited number of sites).

The decision on which, if any, of these "no match" sites to retain must be made on a case-by-case basis. Careful comparison of the characteristics of these sites with respect to such factors as need for data, ease of administration, stability of trends in the data, accuracy

of equipment, local concerns for a continuous effort, degree to which the site can be integrated into future plans, and prospects for upcoming construction which may destroy the location, etc., should all be considered for each location.

STAGE 4: Identify Specific Locations for Additional Needed Sites

This stage consists of the actual sampling effort necessary to identify the HPMS sections which will be added to the existing locations to form the desired distribution. The steps necessary are as follows:

Step 4A: Establish the Sampling Frame

The sampling frame consists of the HPMS samples minus any samples already used as existing fixed sites. An example is presented in Exhibit 4-2-2. In the exhibit, column 10 presents the number of samples in the HPMS sample. Column 11 presents the number of existing sites which are matched to HPMS sites. Column 12 presents the remaining samples available for further sampling.

Step 4B: Draw the Vehicle Classification Subsample

In this step, the sites needed for addition to the sample are selected from the available HPMS samples. The method used is simple random sampling from each HPMS strata.

Exhibit 4-2-3 presents an example using data from Exhibits 4-2-1 and 4-2-2. The exhibit presents the percentage VMT, the HPMS samples remaining after accounting for the fixed sites, the additional samples needed, and the final sample including the fixed sites. The selection is made by assigning a unique sequential number to each section within a single stratum and randomly (by a table of random numbers or computer-generated random numbers) selecting the desired sample.

For example, in volume group 1 of Exhibit 4-2-3, assign to each of the 48 available HPMS samples a unique number ranging from 1 to 48. Randomly select four unique numbers within the range of 1 to 48 (disregard duplicates). These would become the sample.

EXHIBIT 4-2-3

Example of Simple Random Sample Selection for the Interstate Rural System of One State

		1	2	3	4
<u>Functional Class</u>	<u>Volume Group</u>	<u>Percent VMT</u>	<u>HPMS Samples Available</u>	<u>Additional Samples Needed</u>	<u>Final Sample</u>
Interstate Rural	1	20	48	4	4
	2	57	23	6	9
	3	16	4	3	3
	4	6	5	0	1
	5	1	1	1	1
	Total	100	81	14	18

Step 4C: Evaluate the Feasibility of New Sites

Once the particular locations of new sites have been identified, they must be carefully assessed with respect to other features which include:

- (1) Location characteristics - site geometry, physical safety for crews and equipment, equipment installation constraints, etc.
- (2) Administrative concerns - difficulty in outfitting site, type of equipment to be used, availability of land, etc.
- (3) System concerns - proximity to other sites (geographically, functionally or otherwise), overall coverage patterns, etc.

It is possible that some of the new randomly selected sites will not meet the test of practicality. In this case, non-practical selections should be discarded and additional sites randomly selected by the same procedures previously described. However, these modifications should be undertaken with great care, since sites which may be satisfactory on all the practical factors may be unique in other respects and reduce the representativeness of the resulting distribution. In general, new sites selected initially for inclusion should not be discarded unless sufficient reasons exist for doing so. It is of the utmost importance to maintain the statistical validity and representativeness of the sample.

STAGE 5: Check to Insure Representativeness

Once the final samples have been identified, the final step is to review the total distribution to insure that the sample as a whole is, indeed, representative of the HPMS sample and HPMS universe. The check should proceed by comparing the percentage distribution of the final sample against the percent distribution of the HPMS sample and/or universe over several dimensions. These may include:

- (1) The DVMT or VMT by area, functional class, or volume group. Because of its design, the sample should match these characteristics.
- (2) Federal-Aid class.
- (3) Area type (urban, suburban, rural).
- (4) Pavement type.
- (5) Region of the State.

The distribution will not match exactly and due to the small sample and design constraints, differences should not be considered exceptional. Statistical tests to detect significant differences exist but these must be applied following the design constraints (stratification and selection procedure). In case major differences are detected, special procedures that modify the selection procedures can be considered. Additionally, as data is collected and begins to flow in, the data itself should be checked for reasonableness and representativeness against other parameters that may be available.

Summary

The purpose of this chapter has been to describe procedures whereby the sampling plan for the vehicle classification element can be developed with maximum efficiency. The chapter showed how the desired distribution of sites can be obtained by beginning with existing site distributions and adding additional sites necessary to achieve the desired layout. In this way, the necessary investments by the State in achieving the desired distribution will be kept to a minimum, and historical trends will be continued to the maximum extent possible.

CHAPTER 3

FHWA Vehicle Types

The vehicle types of interest to FHWA are described in Exhibit 4-3-1. The classification scheme is based largely on whether the vehicle is a passenger or non-passenger carrying vehicle. Non-passenger vehicles are further subdivided by number of axles and number of units including both power and trailer units.

EXHIBIT 4-3-1

FHWA VEHICLE CLASSIFICATIONS WITH DEFINITIONS

Type Name and Description

1. Motorcycles (Optional)--All two- or three-wheeled motorized vehicles. Typical vehicles in this category have saddle type seats and are steered by handle bars rather than a wheel. This category includes motorcycles, motor scooters, mopeds, motor-powered bicycles, and three-wheel motorcycles. This vehicle type may be reported at the option of the State.
2. Passenger Cars--All sedans, coupes, and station wagons manufactured primarily for the purpose of carrying passengers and including those passenger cars pulling recreational or other light trailers.
3. Other Two-Axle, Four-Tire Single Unit Vehicles--All two-axle, four-tire vehicles, other than passenger cars. Included in this classification are pickups, panels, vans and other vehicles such as campers, motor homes, ambulances, hearses, and carryalls. Other two-axle, four-tire single unit vehicles pulling recreational or other light trailers are included in this classification.
4. Buses--All vehicles manufactured as traditional passenger-carrying buses with two axles and six tires or three or more axles. This category includes only traditional buses (including school buses) functioning as passenger-carrying vehicles. All two-axle, four-tire minibuses should be classified as other two-axle, four-tire single unit vehicles. Modified buses should be considered to be a truck and be appropriately classified.

NOTE: In reporting information on trucks the following criteria should be used:

- a. Truck tractor units traveling without a trailer will be considered single unit trucks.
 - b. A truck tractor unit pulling other such units in a "saddle mount" configuration will be considered as one single unit truck and will be defined only by the axles on the pulling unit.
 - c. Vehicles shall be defined by the number of axles in contact with the roadway. Therefore, "floating" axles are counted only when in the down position.
 - d. The term "trailer" includes both semi- and full trailers.
5. Two-Axle, Six-Tire, Single Unit Trucks--All vehicles on a single frame including trucks, camping and recreation vehicles, motor homes, etc., having two axles and dual rear wheels.
 6. Three-Axle Single Unit Trucks--All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., having three axles.
 7. Four or More Axle Single Unit Trucks--All trucks on a single frame with four or more axles.
 8. Four or Less Axle Single Trailer Trucks--All vehicles with four or less axles consisting of two units, one of which is a tractor or straight truck power unit.
 9. Five-Axle Single Trailer Trucks--All five-axle vehicles consisting of two units, one of which is a tractor or straight truck power unit.
 10. Six or More Axle Single Trailer Trucks--All vehicles with six or more axles consisting of two units, one of which is a tractor or straight truck power unit.
 11. Five or Less Axle Multi-Trailer Trucks--All vehicles with five or less axles consisting of three or more units, one of which is a tractor or straight truck power unit.
 12. Six-Axle Multi-Trailer Trucks--All six-axle vehicles consisting of three or more units, one of which is a tractor or straight truck power unit.
 13. Seven or More Axle Multi-Trailer Trucks--All vehicles with seven or more axles consisting of three or more units, one of which is a tractor or straight truck power unit.

CHAPTER 4

Data Collection Equipment and Data Reporting

To obtain classification data many States use manual observation and recording techniques, while some States use automated vehicle classification devices as a method of overcoming the high cost of manual procedures and as a means to gather more comprehensive vehicle classification data. In order to support the number and duration of classification sessions called for in this Guide, automation should be given serious consideration.

Automatic vehicle classification is a rapidly improving technology. An FHWA sponsored evaluation of various automated vehicle classification systems was published in 1985. The evaluation found equipment to be 90 to 95 percent accurate. This compares well with manually obtained information which has been found to have a ten percent error on total vehicle flows with errors above 30 percent for certain specific vehicle types.

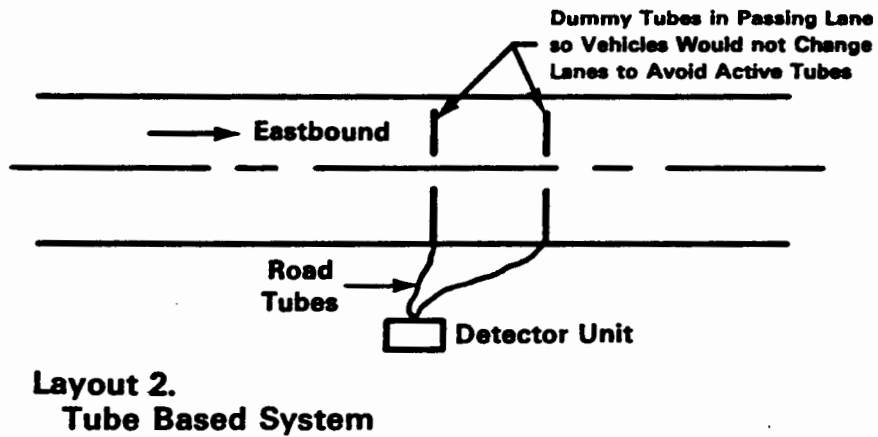
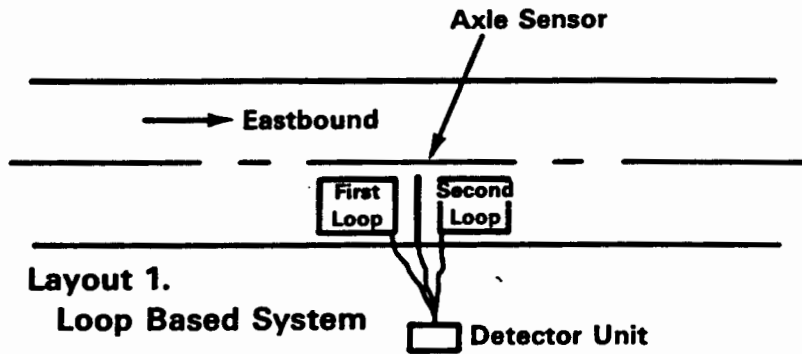
In general, each automated vehicle classification system has a common set of components:

1. the sensing device (sensor) which provides the system with the raw data of presence or passage of the vehicle to be classified;
2. the detector which receives the signals from the sensors, and amplifies and/or interprets them and passes them on to a recorder;
3. the recorder which performs the basic calculation of vehicle length, number of axles, or whatever data is being produced; and
4. the information processor which manipulates the basic data into the presentation format.

Typically, the last three components are not separable or interchangeable among systems from different manufacturers.

The typical installation of an automated vehicle classification system consists of sensing devices on the road connected to a roadside unit which contains the detector(s) and recording device. In some instances the roadside unit is self-contained (i.e., all data are recorded and/or displayed there), while in others it is only a temporary repository for the raw data which is transferred to another unit for ultimate processing, printing out, etc. Exhibit 4-4-1 shows two possible layouts for collecting classification data via automated equipment.

Exhibit 4-4-1
Typical Layouts for Vehicle
Sensing on a Multilane Facility



While the sensing devices used for data acquisition vary from manufacturer to manufacturer, current equipment generally records both axle count and vehicle speed. The method of calculating vehicle speed uses a pair of inductance loops or pneumatic tubes. If loops are used, the speed calculation involves dividing the distances from the leading edge of the first loop to the leading edge of the second loop by the time it takes the vehicle to travel the known distance. A similar calculation is made if tubes are used instead of loops. Since the tubes are narrow, they can also be used to simultaneously count the number of axles passing over them.

Loops systems alone are not able to distinguish individual axles and must be augmented by an axle sensing device. Such devices may be simple tubes or more elaborate devices such as capacitance pads whose resonant circuit frequency changes under pressure or magnetic sensors enclosed in a steel frame and permanently installed in the roadway.

Reporting

At the present time, site specific vehicle classification information is requested for submission to FHWA only for those vehicle classification operations carried on in conjunction with truck weight surveys. Section 5 discusses coding and editing of vehicle classification data for submission to FHWA.

The Highway Performance Monitoring System (HPMS) requires VMT data for the functional highway classes differentiated by various vehicle types. Application of the sampling scheme recommended in this manual would provide data compatible with the HPMS.

Finally, FHWA Headquarters (HHP-44) is interested in receiving single copies of all vehicle classification reports developed by the States whether or not they are based on the procedures recommended in this manual.

SECTION 5

Truck Weighing and Data Collection at Truck Weigh Sites

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CHAPTER 1

Introduction

Purpose of Truck Weight Data Collection

Information about the distribution and weight of the various vehicle types in the traffic stream is essential to the administration of the highway program at both the State and national levels. Decisions concerning such matters as pavement design criteria, equitable tax bases, and revenue projections require a knowledge of the volumes of traffic using highway facilities and the proportion of vehicles of each type. It is also fundamental to know the range and frequencies of the loads imposed upon the facilities and the dimensions of the vehicles.

Truck weight and vehicle classification count data are the bases for estimating frequencies of each type of truck and year-to-year changes in axle and gross weights and for comparison of the characteristics of actual usage with administrative policies. The results are used at the State and national levels in the consideration of transportation policy, allocation of highway costs and revenue, size and weight regulations, establishment of geometric design criteria related to the size and weight of vehicles, pavement design for the establishment of procedures and design criteria, and a variety of special administrative, planning, design and research studies. At the State level, truck weight data are used in calculating pavement loadings in 18-kip equivalents or another comparable procedure, and in bridge loading analysis in terms of both bending moment and shear. Planning, program budgeting, and administrative studies require axle and total weight distribution data which can be related to operational characteristics, taxation rates, incremental construction and maintenance cost responsibility, and enforcement effectiveness.

Objectives of the Truck Weighing Section of the Guide

This section of the Guide describes procedures that may be used in obtaining truck weight and vehicle classification count data at truck weigh sites. It has been developed to accomplish the following four objectives:

1. To provide guidance in the selection of truck weigh sites based on a statistically-based sampling scheme.
2. To provide information on current and emerging techniques for gathering truck weight data.

3. To document the instructions for coding, editing and submitting the truck weight and associated vehicle classification information to the Highway Statistics Division, FHWA.
4. To give examples of the types of useful analysis and summaries that can be produced from the truck weight and vehicle classification information.

The objectives are covered in subsequent chapters of this section as follows:

Chapter 2 presents the suggested sampling method for monitoring truck weights based on locating weigh sites on HPMS sample sections.

Chapter 3 describes the various types of equipment available for weighing trucks.

Chapter 4 gives some general guidelines for setting up and operating a truck weigh site.

Chapter 5 discusses the data items that the FHWA requests the States to collect at truck weigh sites.

Chapter 6 contains the instructions for coding the truck weight and associated vehicle classification data in the format required for submission to the FHWA.

Chapter 7 details the use of the FHWA-produced computer edit program which the States are encouraged to use in identifying and correcting coding errors in the truck weight and vehicle classification data.

Chapter 8 describes and gives examples of each of the FHWA W-Tables that are used to summarize the truck weight and vehicle classification data submitted to the FHWA by the States.

Chapter 9 contains examples of additional analysis and summary tables which are available to the States from the FHWA.

CHAPTER 2

Procedures for the Truck Weight Sample

Introduction

The development of an integrated sample framework based on the HPMS for monitoring truck weights to estimate pavement loads is the last link in the chain of the HPMS element of the recommended traffic monitoring program. The basic framework of the HPMS element is the HPMS sample followed by the volume sample, the vehicle classification sample, and the truck weight sample. This chapter describes the procedures to be used in selecting the truck weight monitoring sample, and discusses the implications of such an approach.

Statistical validity is a very desirable and well-understood quality, however, there is a price to be paid in achieving it. One of the results of the work undertaken to develop this Guide has been a much clearer assessment of the lack of reliable truck weight information on which to base policy decisions, whose effects may last for many years. Since the loads which the highway systems support are a major factor in the determination of pavement life, then it is important to develop reliable estimates of these loads. The sampling guidelines differ from earlier practices, procedures, and levels of effort. As was mentioned before, statistical validity and reliability sometimes carry a significant cost in terms of level of effort and investment. It is our belief that the results will translate into better, more informed decisions; more effective and efficient construction and maintenance programs; and, in the end, better highway service.

Recommended Traffic Monitoring Program

Section 2 describes the objectives and the development of the sample design for an integrated traffic monitoring program based on the HPMS. The program consists of the major elements:

1. Continuous Count element,
2. HPMS element, and
3. Special Needs element.

The HPMS element consists of four sample subsets:

1. HPMS sample,
2. Traffic Volume sample,
3. Vehicle Classification sample, and
4. Truck Weight sample.

The recommended development of the HPMS element framework should be conducted in the sequential order presented. To maintain consistency a complete plan comprising the four samples should be prepared prior to implementation of any of the specific parts of the program. However, the actual implementation need not follow any specific order, although the integrated estimation process requires all elements to be effective.

The HPMS sample requires limited effort since the sample is already defined and implemented. It is essential to reevaluate the HPMS sample to insure that the reliability requirements in the HPMS manual are being met, that all Census-designated urbanized areas are included, and that the sample is efficient to the satisfaction of the State. There is no substitute for an initial HPMS sample that is up-to-date. The traffic volume sample has also been clearly defined. On an annual basis, it constitutes a rotating one-third of the HPMS sample.

The vehicle classification sample presents a straightforward sampling scheme. It basically consists of 100 measurements annually.

The truck weight sample follows an approach very similar to the vehicle classification scheme. The information needed to develop the vehicle classification sample will also be needed to develop the truck weight sample. The truck weight sample consists of 90 measurements taken over a 3-year cycle with 1/3 of the sample concentrated on the Interstate system. A number of options are discussed to allow application to very different State systems.

The guidelines are presented as suggested minimums. The efforts required by parts of the program may be below those actually expended by existing programs. Large States may logically opt to expand on the minimum level of effort. The overall efforts required may also be beyond existing expenditures. Hopefully, the savings incurred in the reduction or streamlining of the excesses will compensate for the added cost of any increase.

The statistical process allows direct estimation of the reliabilities involved. Therefore, after the program has been fully implemented for 3 years, it will be possible to reevaluate the State's sampling plans using the data collected by each individual State. Options on cost versus reliability can then be more clearly assessed. Finally, it would be naive to assume that changes and alterations will not be made in the future. We live in a dynamic world and circumstances, which are unpredictable today or beyond our control, will conspire to force change tomorrow. Future changes can be dealt with on a case by case basis or as needed.

Selection of the Truck Weight Sample

The sample consists of 90 measurements taken over a 3-year cycle. This corresponds to about 30 per year. An arbitrary decision to allocate 1/3 of the 3-year sample to the Interstate system was made to insure higher precision estimates and focus the program on this system. The Interstate sample should result, after 3 years of data collection, in 3S2 truck (18 wheeler) EAL estimates with an approximate

precision of 10 percent with 95 percent confidence. In layman's terms this means that if 100 independent samples were taken, the estimates derived from 95 of the 100 samples will be ± 10 percent of the population value. These precision levels are based on a research study sponsored by the FHWA. The study makes it clear that the estimates are based on limited information.

The remaining 60 measurements are distributed over the remaining roads (with the exception of roads functionally classified as local which are excluded from the HPMS). The precision of 3S2 EAL estimates is expected to approach ± 10 to 20 percent with 95 percent confidence. The following table describes the truck weight sample:

<u>STRATA</u>	<u>Number of Measurements (3-year)</u>	<u>Annual Measurements</u>	<u>Expected Precision of 3S2 EAL System Estimates (3-year Cycle)</u>
Interstate	30	10	95-10
Other Roads	60	20	95-10 to 20

Only two reporting stratification levels are used:

1. Interstate
2. Other Roads (excluding local functional class)

This is done to reduce the sample size required. Other types of stratification are likely to result in increased sample sizes. Large States may opt to expand the stratification to increase reliability or provide more information. For example, separating the Interstate into rural and urban portions would require 60 measurements, 30 in the rural and 30 in the urban strata, to approximately achieve the precision levels in both strata. Approximate curves relating precision levels to sample size are presented in Section 2.

The distribution and selection of the sample section within strata could be carried out in a variety of ways. The most theoretically correct would be a procedure which accounts for the probability of selection of HPMS sections, the traffic volume sample sections, and the vehicle classification sample sections. The simplest would be a simple random sample of vehicle classification sample sections. The first procedure is enormously complex. The second procedure would not allow control over the selected sections. For example, since there are many more low volume sections in the road universe and HPMS sample, chances are that very few high volume sections would be included in the subsample. Also, the geometric characteristics of some sections may not allow weighing operations. The recommended procedure allocates the sample to type of area, functional class, and volume groups based on the proportion of AVMT those systems carry (HPMS AVMT) relative to other systems. The procedure will be explained by an application using actual 1982 HPMS data for one State. The results can be clearly applied to any State.

Given the need to have 10 Interstate truck weight samples in a year, the following example is presented to explain the procedure.

Example 5-2-1

**Interstate System
1982 HPMS DATA**

<u>Type of Area</u>	<u>HPMS Expanded Mileage</u>	<u>HPMS Expanded DVMT (Millions)</u>	<u>Unadjusted Truck Weight DVMT %</u>	<u>Sample</u>	<u>Adjusted Truck Weight Sample</u>
Rural	642	6.9	57.0	6	5
Small Urban	37	0.3	2.5	0	1
Urbanized	<u>143</u>	<u>4.9</u>	<u>40.5</u>	<u>4</u>	<u>4</u>
STATE TOTAL	822	12.1	100%	10	10

The unadjusted sample is derived by multiplying the area DVMT percentage times the total number of samples. In order to have at least one sample in each area, one sample is taken from the largest group, i.e., Rural, and used in the small urban.

For a State with this much Interstate mileage, the recommendation would be to select 30 different locations (3-year cycle), or ten different locations each year. Once selected, the locations would become fixed and sampled each 3-year cycle. Since the travel distribution is not expected to change much over 3 years, the DVMT distribution shown above could be used for 3 years. Alternatively, the computation could be carried out annually. Since 10 locations are needed annually, the area distribution would be five rural, one small urban, and four urbanized locations.

The volume group distribution would be made in the same manner on the basis of HPMS DVMT, as shown below for the Rural Interstate:

**Rural Interstate
1982 HPMS Data**

<u>Volume Group</u>	<u>HPMS Expanded DVMT (Millions)</u>	<u>DVMT Percentage</u>	<u>Annual Truck Weight Sample</u>
1	2.2	31.9	2
2	4.2	60.9	3
3	<u>0.5</u>	<u>7.2</u>	<u>0</u>
TOTAL	6.9	100%	5

Since the truck weight sample in this example is much too small for the extensive HPMS stratification and to insure that every vehicle classification sample has a positive selection probability, the sections in volume group 3 have been combined with those of volume group 2. Two of the sections could be selected from the first volume group and three from the second and third groups.

The sample procedure can be applied to the Interstate urban portion and to the remaining strata. Urbanized areas will present problems because of the large number of strata and exercising judgment will be required when applying the described procedure. It may be appropriate to group the urbanized areas when selecting the samples. Application of this process should result in a very balanced sample. The selection of the sample for a stratum should follow simple random sampling procedures using a table of random numbers. Existing fixed sites would be incorporated in the program by the same procedure used in the vehicle classification sample.

The following table continues the example. Assume there are three volume groups, from which 15 vehicle classification samples were selected, and for which we need to select five truck weight samples.

<u>Number of Classification Volume Group</u>	<u>Number of Weight Samples</u>	<u>Existing Fixed Samples</u>	<u>Remaining Selection Sites</u>	<u>Sites</u>
1	6	2	1	1
2	8	3	1	2
3	1	0	0	0

The fixed sites would be subtracted from the desired sample and any remaining samples randomly selected. The six vehicle classification sections would be assigned a unique sequential number 1 to 6. Using a table of random numbers, a unique number between 1 and 6 would be selected, and the selected vehicle classification sample section would become the truck weight sample section. The same procedure would be applied to volume groups 2 and 3 combined. In this case, the nine sections could be assigned unique numbers between 1 and 9, two random numbers would be selected and become the sample. The combination of volume groups ensures, as before, a positive probability of selection for each section.

As discussed extensively in the vehicle classification section, practical considerations also play a role. If the randomly selected sections are not amenable to weighing operations due to geometric requirements of automatic equipment, safety of crews, or other reasons; then another random location from the vehicle classification sample should be examined. If none of the sections in the vehicle classification sample are suitable for weight monitoring, then it will be necessary to randomly substitute sections in the vehicle classification sample, or alternatively to add additional sections to the vehicle classification sample to include vehicle class sample sections which

can be used for weighing operations. This is another reason for emphasizing that the integration of the procedures requires very close coordination, and that a problem in one part of the program may require changes in other parts of the program as well.

For States with very limited mileage, the 30 measurements could be taken at fewer than 30 locations. For example, one eastern State has 41 miles of Interstate, and it would be ridiculous to sample at 30 different points in the 3-year cycle. Alternatives would be to annually take two measurements scheduled at different times of the year at five different locations or five annual measurements at two different locations. Under the first alternative, the locations would be maintained during the 3-year cycle resulting in 30 measurements at five locations. Under the second alternative, different locations would be sampled each year of the 3-year cycle resulting in 30 measurements at six different locations. Data analysis would be carried out using the procedures in this Guide to determine if a smaller sample was statistically justified given the circumstances.

It should be clear from the discussion that judgment is needed at this level. The truck weight sample has been designed to provide maximum flexibility to insure adequate application given varied circumstances. It is appropriate, however, to caution that flexibility may well result in the introduction of bias and error. Care should be exercised when applying these procedures to insure that statistical objectives are maintained.

The recommended period of monitoring has been set at 48 hours to reduce the effects of random variation and for direct combination with the volume and classification samples. As discussed in Section 2, research has shown the coefficients of variation of EAL's of vehicles can be as high as 100 percent. Longer periods would reduce these effects, but further complicate other facets. The use of a 48-hour period was selected as the best compromise among all possible alternatives given present data. This recommendation implies the use of accurate automatic classification and weight monitoring equipment. Since such equipment may not be available, 24-hour periods may be substituted in the interim. However, the stated precision levels are unlikely to be achieved.

The emphasis on automatic equipment is unavoidable. Equipment that counts, classifies, and weighs at the same time is needed to avoid duplication and directly tie the resulting data. Such equipment is available today. The techniques and procedures to effectively develop the equipment and allow the development of this Guide's program await only a determined effort. Once the equipment to collect this data is available, the truck weight data collection sessions would eliminate the need for a separate vehicle classification session at the truck weight sample sections. In the same manner, sections in the vehicle classification sample eliminate the need for separate volume counts.

Estimation Procedures

The procedures described in this section are used to develop statistical estimates and the reliability of these estimates. In the truck weight sample sections where truck weight data are collected, the estimates are direct. For the remaining sample sections (HPMS, volume, or vehicle classification) or universe sections in general, statistical inferences based on stratum data are used to generate estimates involving weight information. This process is termed the statistical or "system" approach.

For the development of site-specific estimates three alternatives are presented:

- 1) the statistical "system" approach just described;
- 2) the collection of additional information under the Special Needs element; and
- 3) the application of judgment procedures based on expert knowledge or subjective inference based on other characteristics.

Alternatives 1 and 2 need no additional explanation. Alternative 3 represents the use of common sense and traditional traffic engineering procedures. The recommended sample will provide a very balanced sample, well-distributed over the areas, functional classes, and traffic volumes. Obviously, if correctly selected, a very representative sample should be available. Since the samples are HPMS sections, a wealth of information is available on the characteristics of those sections. Site-specific information or estimates could be derived by selecting sample sections with characteristics similar or equivalent to those of the section for which the point-specific inferences are desired. For example, if inferences on EAL's are desired for a four-lane Interstate section with high truck percentages and high volume in an urbanized area, the sample can be easily screened to find sample locations in close proximity to the desired location or with similar characteristics. Inferences would then be based on the results of the search.

For truck monitoring locations, the percentage of vehicles in any category (assuming a single 48-hour session) is simply the number of vehicles in that category divided by the total 48-hour volume for all vehicle types. The equation is:

$$P_{ijh} = \frac{V_{ijh}}{V_{jh}} \times 100$$

5-2-1

where

P_{ijh} = percent of vehicles in category i of location j in stratum h ,

i = one of the 13 vehicle classification categories,

j = location number

h = stratum number

V_{ijh} = number of vehicles in category i , and

V_{jh} = 48-hour volume for all vehicles types (total volume).

Notice that the sum of all the P_{ijh} 's must equal 100 percent.

The section AVMT is estimated by multiplying the section AADT by the section length (from the HPMS). The classification AVMT at each section is estimated by multiplying the total AVMT by the P_i 's. Since we are addressing vehicle classification, the procedure is the same used for sections in the vehicle classification sample.

Truck weight information is similarly derived. Assuming that axle weights have been collected; total axle load, average axle load, equivalent axle load, average truck weight, total truck weight, number of overloaded axles, number of overloaded trucks, weight overload, etc., could be directly computed for each vehicle classification category and any derived aggregation. The statewide AVMT estimates for any of the vehicle classification categories are derived by simply multiplying the percent estimate by the AVMT in each strata and then summing. Standard error estimates for any of these point estimates could be derived using cluster sampling procedures, since the 48-hour session constitutes a 48-hour cluster of vehicles randomly selected from a universe of 365/2 such periods; or, alternatively, by simple random sampling procedures assuming that the trucks constitute a simple random sample of the truck population at that point.

It should be obvious that this analysis has ignored seasonality. Due to the limited truck weight sample, seasonality of weight information is not considered. Limited procedures could be developed as part of the Special Needs element if desired by the States.

Example 5-2-2

Assume the following data were collected from a single 48-hour measurement on the Rural Interstate system:

48-hour volume : 48,000 vehicles
 Number of 3S2's (18 wheeler) : 4,800 vehicles
 Average weight of 3S2's : 55,000 pounds

The following estimates are derived:

$$\text{Percentage of 3S2's in 48-hour measurement} = \frac{4,800}{48,000} \times 100 = 10\%$$

Assuming a seasonal factor of 1.1 (seasonal and other factors are discussed in Section 3):

$$\text{Estimated AADT} = \frac{48,000}{2} \times \text{seasonal factor} = \frac{48,000}{2} \times 1.1 = 26,400.$$

$$\begin{aligned} \text{Estimated annual average daily number of 3S2's in traffic stream} \\ = 26,400 \times 10\% = 2,640 \end{aligned}$$

Notice that seasonality has introduced an additional effect. The average daily number of 3S2's measured from the sample was 2,400, but the annual average daily number of 3S2's estimated, after the AADT seasonality factor (an external factor) is included, becomes 2,640. When developing annual estimates involving number of vehicles it is important to consider the effects of any factor applied to the sample estimates.

$$\begin{aligned} \text{Estimated daily VMT} &= \text{AADT} \times \text{length of section (assume 1.0 miles)} \\ &= 26,400 \times 1 = 26,400 \end{aligned}$$

The estimated section AVMT for 3S2's

$$\begin{aligned} &= \text{DVMT} \times \text{percentage of 3S2 (P}_{ijh}) \times 365 \\ &= 26,400 \times 10\% \times 365 = 963,600 \end{aligned}$$

The section estimated annual gross ton-miles for 3S2's

$$\begin{aligned} &= \frac{\text{average 3S2 weight}}{2,000} \times \text{3S2 AVMT} \\ &= \frac{55,000}{2,000} \times 963,600 = 26,499,000 \end{aligned}$$

The estimated daily average 3S2 load on the sample section for the 48-hour measurement period (disregarding seasonality)

$$\begin{aligned} &= \text{average weight of 3S2's} \times \text{average number of 3S2's} \\ &= 55,000 \times \frac{4,800}{2} = 132,000,000 \end{aligned}$$

The estimated annual daily average 3S2 load on the sample section (after seasonality) = average weight of 3S2 x annual estimate of 3S2's

$$\begin{aligned} &= 55,000 \times 2,640 \\ &= 145,200,000 \end{aligned}$$

The question that cannot be answered based on a single sample estimate is whether volume (AADT) seasonal factors apply to 3S2's. This question will be partly answered later when aggregated estimates are derived, and this is one of the reasons why measurement sessions must be distributed throughout the year.

To develop estimates for stratum characteristics, inferences from the sample are made. In the truck weight sample, only two strata are defined. However, since the sample was allocated proportionally to the HPMS strata, estimates for lower strata can be derived by applying the procedures using only the points (sample sections) within the desired lower strata.

An estimate of average percentages of vehicles within strata for a vehicle classification category is derived by the equation:

$$P_{ih} = \frac{1}{n_h} \sum_{j=1}^{n_h} P_{ijh} \quad 5-2-2$$

where P_{ih} = average percentage of vehicles in vehicle classification category i and stratum h ,

P_{ijh} = the percentages of vehicles in vehicle classification i in location j of stratum h

i = index of vehicle classification category
($i = 1, \dots, 13$),

j = index of measurements with strata ($j = 1, \dots, n_h$),

h = index of strata, and

n_h = number of measurements within stratum h .

An estimate of the standard error is derived by the equation:

$$S_{ih} = \sqrt{\frac{1}{n_h (n_h - 1)} \sum_{j=1}^{n_h} (P_{ijh} - P_{ih})^2} \quad 5-2-3$$

where S_{ih} = the standard error of the percentage of vehicles in vehicle classification category i in stratum h .

The relative variance coefficient is defined as the ratio of the standard error to the mean:

$$C_{ih} = S_{ih}/P_{ih} \quad 5-2-4$$

A two-sided 95 percent confidence interval for the percentage of vehicles in vehicle classification category i in stratum h is given by:

$$P_{ih} \pm 1.96 S_{ih} \quad 5-2-5$$

and the two-sided precision interval in percentages is $1.96 C_{ih}$.

Stratum estimates for any desired truck weight characteristics are derived by the same procedure by substituting the desired characteristic into the equations. For example, to estimate average truck weight in vehicle classification category i , compute the average weight for that classification at each measurement location and begin the process in equation 5-2-2.

1/ NOTE: The relative variance coefficient is the ratio of the standard error to the estimate while the coefficient of variation is the ratio of the standard deviation to the estimate.

Example 5-2-3

An example using data from two Interstate Rural measurements at different locations will be used to illustrate the procedure. Assume that the following data were collected or derived from the actual measurements:

System	: Interstate Rural
48-hour volume at location 1	: 48,000
48-hour volume at location 2	: 20,000
Number of 3S2's at location 1 (48-hour)	: 4,800
Number of 3S2's at location 2 (48-hour)	: 5,000
Average weight of 3S2's at location 1 (48-hour)	: 55,000
Average weight of 3S2's at location 2 (48-hour)	: 50,000

Percentage of 3S2's at location 1 during 48-hour (P_1): 10%
(Example 5-2-2)

Percentage of 3S2's at location 2 during 48-hour (P_2): 25%

Estimated Interstate Rural percentage of 3S2's (equation 5-2-2)

$$P_{ih} = 1/2 (10 + 25) = 17.5\%$$

where $i = 3S2$ and $h = \text{Interstate Rural}$.

Estimated standard error of percentage of 3S2's in the Interstate Rural stratum (equation 5-2-3)

$$S_{ih} = \sqrt{\frac{1}{2(2-1)} \left((10-17.5)^2 + (25-17.5)^2 \right)} = 7.5\%$$

Estimated relative variance coefficient (equation 5-2-4)

$$C_{ih} = \frac{7.5}{17.5} = .43$$

A 95 percent confidence interval is given by (equation 5-2-5)

$$17.5 \pm 1.96 (7.5) = 17.5 \pm 14.7$$

The precision interval is 84 percent ($1.96 \times .43$) which shows the 95 percent confidence to be \pm 84 percent. The precision in short form is 95-84 based on these data. A simple interpretation of the results is that based on the information provided the true percentage is between 2.8 and 32.2 with 95 percent confidence. Obviously, the estimate is very poor as would be expected from such a limited sample.

Estimates of average weights by system are computed using the same procedure.

The estimated Interstate Rural average 3S2 weight is

$$1/2 (55,000 + 50,000) = 52,500.$$

Its standard error is

$$\sqrt{\frac{1}{2} (55,000 - 52,500)^2 + (50,000 - 52,500)^2} = 2,500$$

The relative variance coefficient is .05 ($2,500/52,500$).

A 95 percent confidence interval is given by $52,500 +$ or $- 1.96 \times 2,500$ and the precision interval is 10 percent ($1.96 \times .05$).

Therefore, the precision of the system average weight based on these data is 95-10. The interpretation is that based on the information provided the true average 3S2 Interstate weight is between 47,600 and 57,400 with 95 percent confidence. This is a simplification, since due to the small sample size ($n = 2$) the procedures would require modification and the value of the normal distribution (1.96) in the confidence interval calculation would have to be replaced by the student's distribution value. Even then, results based on very small samples are open to question. No implied judgment of the reliability of the sampling approach should be attempted based on any of these examples. We fully expect the recommended sample to achieve or approximate the sample design

criteria, although differences from State to State are anticipated. Once data are available on the recommended program from any State, then full assessment of the procedures for that State will be possible.

The above example is presented to show the computational procedure only. The procedure presented to estimate the average weight is the simplest and not the most efficient. Cluster procedures which consider the weight of every truck and take into account the volumes of trucks at each location would be more efficient but much more complex. These will not be discussed in this guide, but the sample design allows future use of improved estimation procedures.

Estimates of stratum AVMT for any of the estimates by vehicle classification categories are derived by multiplying the vehicle classification category estimate by the stratum AVMT. In the case of the Interstate system, the vehicle classification AVMT of vehicle category "i" is computed by multiplying the HPMS AVMT estimate for the Interstate times the average stratum classification (P_{ih}). A percent estimate of the two-sided precision interval of this estimate is given by 1.96 times the square root of the sum of the squared relative variance coefficients of stratum AVMT and average classification category. The equation is:

$$1.96 \sqrt{C_{AVMT}^2 + C_{ih}^2} \quad 5-2-6$$

where C_{AVMT} = relative variance coefficient of stratum AVMT estimate (from traffic volume chapter), and

C_{ih} = relative variance coefficient of classification category i in stratum h (equation 5-2-4).

The terms within the square root represent the relative variance coefficient of the combined estimate. As can be seen from this equation, the more terms involved in the estimation, the larger the reliability band.

Example 5-2-4

Based on the previous example, the estimated percentages of 3S2's on the Interstate Rural system is 17.5 percent with a relative variance coefficient of .43. For the purposes of this example, assume that the Interstate Rural DVMT estimated from the HPMS is 6.6 million with a relative variance coefficient of 0.10. The estimate of 3S2 DVMT on the Interstate Rural system is 1.16 million ($.175 \times 6.6$ million) and the relative variance coefficient of this estimate is .44 ($\sqrt{.43^2 + .1^2}$). The precision interval is 86 percent ($1.96 \times .44$) and in short form is expressed as 95-86. Based on these data, the Interstate Rural estimate of 3S2 AVMT is 423 million (1.16×365) with a 95 percent precision of + 86 percent. Obviously, this is an estimate of minimal value because of its lack of precision, but is just what would be expected based on a sample of two locations.

Aggregation of estimates by stratum up to statewide estimates is done by weighting the estimates by AVMT or DVMT. Therefore, an estimate of statewide percentage of vehicles in vehicle classification category i is given by:

$$P_i = \frac{1}{PAVMT} \sum_{h=1}^2 (PAVMT_h \times P_{ih}) \quad 5-2-7$$

where P_i = average statewide percent of vehicles in vehicle classification category i ,

$PAVMT_h$ = AVMT in stratum h for all vehicles

P_{ih} = average percentage of vehicles in vehicle classification category i in stratum h ,

$PAVMT$ = statewide AVMT,

i = index of vehicles classes (1,...,13), and

h = index of strata.

Example 5-2-5

Compute the average percentage of 3S2 vehicles in the Interstate stratum given the following data:

<u>System</u>	<u>DVMT (000,000)</u>	<u>Percentage of 3S2's</u>
Interstate Rural	6.6	17.5
Interstate Urban	2.0	7.3

The percentage is estimated using equation 5-2-7.

$$P_i = \frac{1}{8.6} (6.6 (17.5) + 2.0 (7.3)) = 15.1$$

Obviously, these are contrived examples. Given the obvious differences between the two systems, it would be more appropriate to maintain separate numbers for each system than to provide an average system number. Aggregation of estimates should be carried out only when it makes sense to do so or when it serves a desired objective.

Estimates of statewide AVMT for any weight or classification categories are aggregated by summing strata. Precision intervals are estimated by summing the squares of the coefficient of variation of the appropriate estimates and taking the square root. The process is the same as shown in equation 5-2-6, except that the appropriate estimates are used.

CHAPTER 3

Equipment for Weighing Trucks

Basically, there are two methods of weighing trucks. One involves stopping a vehicle and weighing it statically, and the other allows a vehicle to be weighed while in motion, or dynamically. There is a variety of equipment associated with each method of weighing. Several types of equipment and the advantages and disadvantages of each are discussed in this chapter.

Static Weighing Equipment

The three types of static weighing equipment most commonly used by the State highway agencies are permanent platform scales, semi-portable scales, and lightweight portable scales.

Permanent platform scales appear in a variety of sizes. While some States use large platforms, usually up to 50 feet in length, others still rely on a smaller platform about 10-15 feet long. The larger platforms are generally segmented into three independent scales, each capable of weighing a portion of the vehicle. For example, in weighing a tractor-semitrailer combination, the first segment would weigh the steering axle, the second segment would weigh the drive axles of the tractor, and the third segment would weigh the trailer axles. The smaller, single segment platform scales must rely on the repositioning of the vehicle in order to get the individual axle weights.

The portable and semi-portable static weighing equipment are scales that can be transported from one location to another in an automobile, a pickup truck, or a small trailer. The portable scale weighs from 40-100 pounds and is capable of weighing only one end of an axle. In order to weigh both ends of an axle, or all axles of a vehicle simultaneously, two or more portable scales must be used in combination. The semi-portable scale is somewhat larger and weighs as much as 500 pounds. It is capable of weighing both ends of an axle simultaneously when placed transversely on the weighing site, or one end of all axles of a group when placed longitudinally. Various combinations of this type of scale can be used to weigh virtually all types of vehicles.

There are several disadvantages associated with weighing trucks statically. The conventional weigh station is located at a fixed off-road location on a major highway and, therefore, occupies valuable real estate. The stopping of trucks causes trucker delays and motivates some truckers to bypass the station. It can also cause safety problems due to the queue of trucks on the highway. This generally results in trucks being allowed to pass the station until they can safely be stopped again.

The basic advantage of the static weighing system is the system's capability to acquire axle weights and spacings within tolerances acceptable to various weight and measure standards. It also allows sufficient time to determine the vehicle's characteristics such as the body type, whether or not the vehicle is loaded, and other related information that can only be ascertained by observation or driver interview.

Weigh-in-Motion (WIM) Equipment

WIM scales are dynamic weighing systems which determine weights while vehicles are in motion. It enables vehicles to be weighed with little or no interruption to their travel.

WIM scales have been designed to sense the weights of the axles passing over the instrument through the use of strain gauges or hydraulic or pneumatic pressure transducers. The readings are transmitted to a receiving unit where they are converted to actual weights.

The three main categories of WIM operation are:

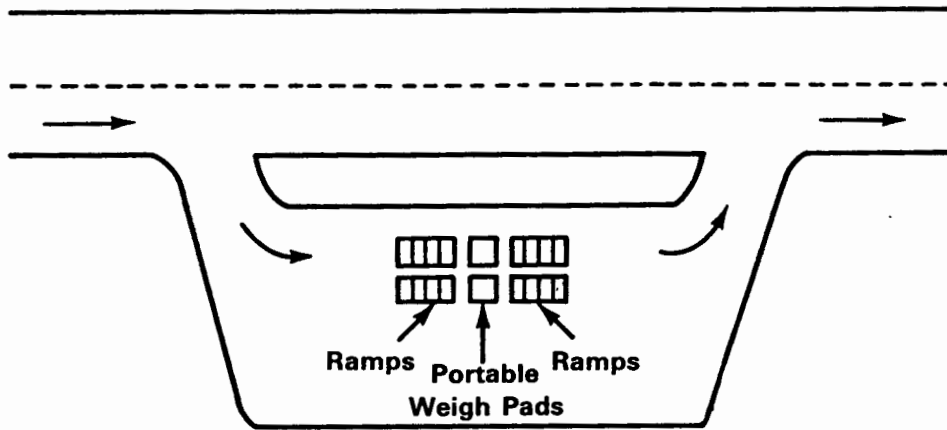
1. Low speed WIM - Vehicles are weighed at selected roadside areas at speeds of about 3-5 miles per hour on either portable WIM scales or where portable scales are placed in preconstructed pits.
2. Low to moderate speed WIM - Vehicles pass over WIM equipment located in the ramp as they enter a permanent weigh station site at speeds of up to 35 miles per hour.
3. High speed WIM - Vehicles are weighed at prevailing highway speeds by either: (a) specially-built load platforms placed in preconstructed frames embedded in the roadway, (b) portable load sensors attached directly to the pavement, or (c) strain transducers attached to bridge girders.

Examples of these three types of WIM equipment are shown on pages 5-3-3 and 5-3-4.

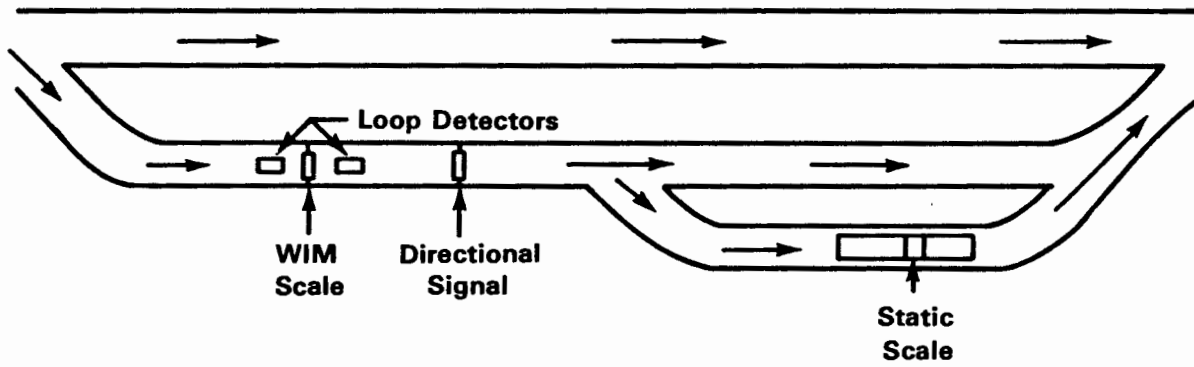
The advantages of using a WIM system are many. It offers a method (high-speed WIM) of recording and processing weight data automatically and without disruption to the truck driver. It has a degree of concealment which enhances data credibility since vehicles in violation, that might normally have deliberately bypassed a known weighing operation, are recorded at WIM sites. This could provide highway planners, researchers, and enforcement officials with more representative statistical data. Also, since WIM does not interrupt the traffic flow, it is capable of weighing high volumes of traffic, such as in urban areas where it is difficult to obtain weight data using static weighing equipment.

Exhibit 5-3-1

1. Low Speed WIM

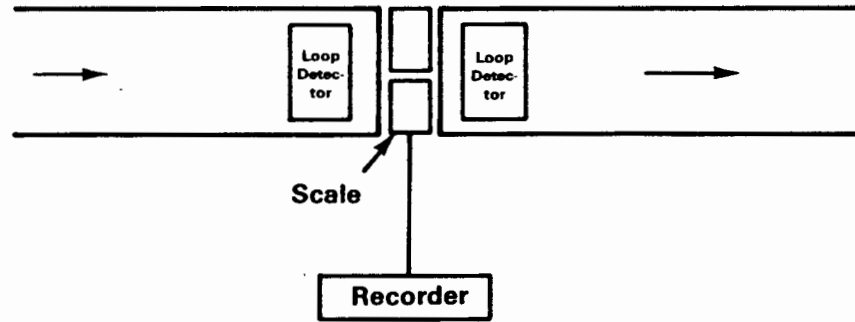


2. Low to Moderate Speed WIM (For Screening)

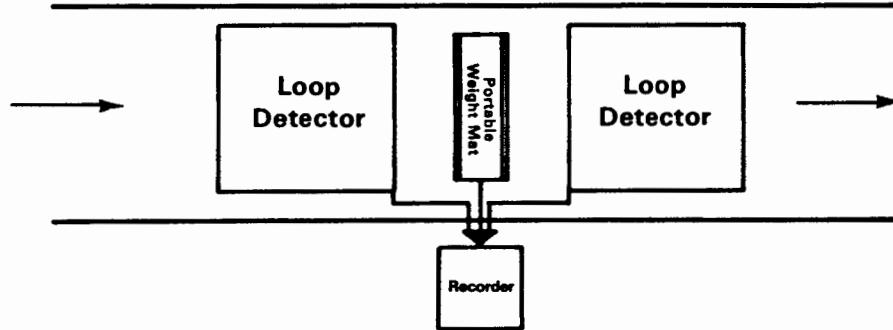


3. High Speed WIM

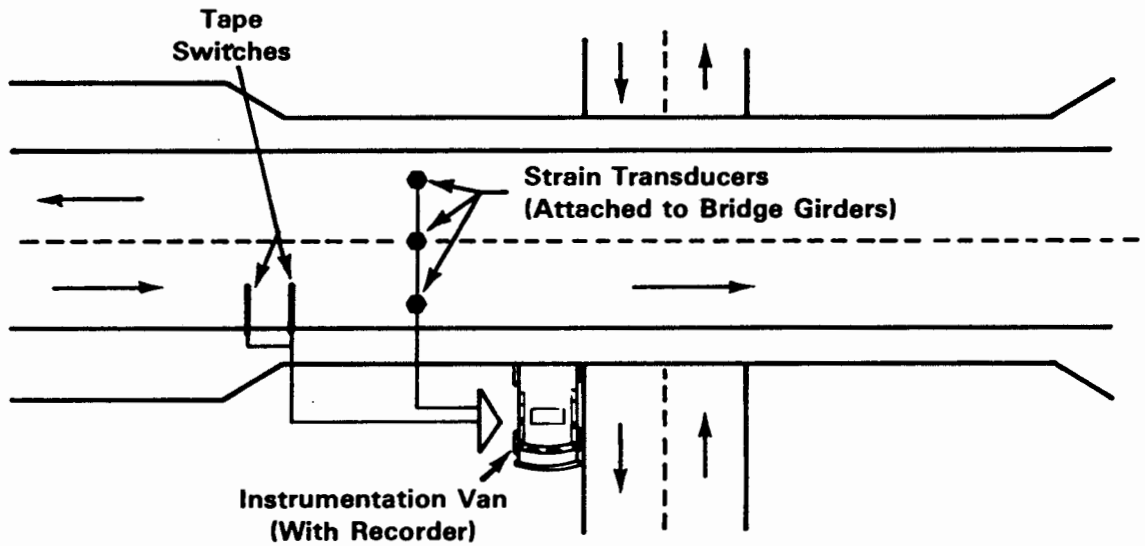
(a) In-Pavement Load Platforms



(b) On-Pavement Portable Load Sensor



(c) Bridge Used as a Weighing Platform



CHAPTER 4

Operating Weigh Stations

Introduction

Many factors must be considered before a truck weigh station can be put into operation. The safety aspect is a major consideration along with the need to ensure that the data collected is as accurate and reliable as possible. This chapter addresses some of the pertinent factors to consider and includes suggestions on how each factor can be handled. (For more specific guidelines on the proper use of scales at a weighing site, refer to the National Bureau of Standards Handbook 44, 1983, entitled, "Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices.")

The operation of each station is dependent on whether static or WIM scales are being used. Such activities as sampling trucks from the traffic stream, conducting driver interviews, and manually measuring axle spacings need only be considered in reference to the static weigh stations where each vehicle must be stopped to be weighed. Methods of signalization to ensure that trucks do not stop in the station but only reduce their speed through the station apply only to low and moderate speed WIM.

The one requirement that all off-highway weigh stations have in common is some form of roadside signing to direct truck drivers into the station. As a minimum, signs should instruct drivers concerning speed reduction, turn-off points and the presence of flagmen, if any. In addition to the standard signing for safety purposes, an indication that the weighing will be conducted for planning purposes would be appropriate so that all truck types can be sampled, and not just the heavier vehicles. (Guidance on the proper size, color, and placement of appropriate warning signs may be found in the "Manual on Uniform Traffic Control Devices for Streets and Highways," 1978.)

The remainder of the discussion on weigh station operation will distinguish the operation of a static weigh station from that at a WIM site.

Static Weighing Sites

A properly installed and adjusted platform scale is probably the most accurate and dependable method of obtaining static weights of trucks. However, in order to obtain the weights of the individual axles, the repositioning of the vehicle is required. Because research has shown that the total weight carried by the axle group is not evenly distributed among the individual axles of the group, it is important to obtain the weights of the individual axles of a tandem or tridem group. To accomplish this, the vehicle must be positioned so that only one axle of the group is on the scale at any one time. The brakes on the vehicle should be released before taking the weight reading.

Weighing trucks with portable wheel-weigher scales presents a number of problems that are not encountered in platform scale operations. There are a number of variations in the set-up of the portable scale operation that can affect the accuracy due to weight transfer. Ideally, the vehicle should be kept in a reasonably level plane. This can be accomplished through the use of recesses cut into the pavement so that the scales are at roadway level, or through the use of planks placed on the pavement surface to raise the vehicle to the height of the scale. It is especially critical to weigh axle groups with all axles of the group on the same plane. The reliability and usefulness of truck weight data depend on the care with which the vehicles are weighed. Available data have shown that for the greatest consistency, all wheels of the vehicle should be on the same horizontal plane with brakes released at the time of weighing. If the brakes must be set when weighing with portable scales, they should be released after the vehicle has stopped on the scales and then reset. To provide reliable data for all axles, the weight of each axle of a tandem or tridem group should be determined separately since available design and weight information indicate that a large proportion of these assemblies place an appreciably greater load on one axle of the tandem, and on two axles of the tridem.

The distance between axles for each vehicle weighed should be measured to permit accurate calculation of pavement and bridge loadings, as well as the bridge formula. Axle spacings should be measured with the vehicle components in a straight line.

Until the time that WIM equipment replaces static equipment at planning sites, a critical issue relating to the safety of operations at a static weighing site is the availability of storage area for trucks waiting to be weighed. For example, a station having an average time for weighing and measuring of 1 minute would have a theoretical capacity of 60 trucks per hour. If the number of trucks arriving at the station is greater than 60 per hour, some form of sampling technique will be required to avoid excessive storage requirements and delays to the vehicle operators. If sampling is necessary, care should be taken to ensure that all the types of trucks common to the site are represented in the sample.

Weigh-in-Motion (WIM) Sites

At sites where high speed WIM scales are utilized, proper setup of the scales and the safety of the setup crew are the primary considerations. The safety procedures prescribed for maintenance or other activities taking place on an active facility should be adhered to by the WIM field crew.

Ideally, a station using low or moderate speed WIM equipment should be designed to minimize the change of path and speed of vehicles as they are weighed in motion and proceed through the station area. Since the primary purpose of WIM is to weigh more vehicles safely while minimizing the vehicles' time in the station, the station's operation and design should not result in vehicles backing up onto the through lanes.

It has been noted that many drivers are not accustomed to WIM equipment and tend to stop on the scales, sometimes causing backups under high-volume conditions. The use of adequate traffic control devices can help to alleviate this problem. Advance guide signs at WIM sites are essential. Trucks should be instructed to slow to the indicated speed and to maintain at least a 100 foot interval between vehicles as they approach the scales. Flexible pylons or traffic cones may be used to guide the trucks over the WIM scales. Overhead directional signals, in conjunction with supplemental signing, should be positioned beyond the WIM scales so that the signals will direct the trucks back onto the highway. In some cases where a lane is closed to provide a buffer area for weighing on the shoulder, advance guide signs together with traffic control devices should be employed. Shoulder operations should be limited to low-volume routes.

CHAPTER 5

Truck Weight Data Collection for FHWA

Introduction

The data collected during truck weight surveys can be separated into three distinct groups--the identification data, the interview data, and the axle weight and spacing data. The identification data consist of those items that are necessary to identify a particular vehicle and the time and place that it was weighed. The interview data are the characteristics of the vehicle that can only be collected through a driver interview while a truck is stopped in a static weigh station. The axle weight and spacing data are collected and recorded for each individual vehicle.

The data items included in the FHWA data format can be grouped in the following manner:

A. Identification Data

1. State
2. Functional classification of the highway
3. Station number
4. Direction in which vehicle is traveling
5. Year of weighing
6. Month of weighing
7. Date of weighing
8. Hour of weighing
9. Type of vehicle weighed

B. Interview Data (Vehicle Characteristics)

1. Body type
2. Engine type (fuel type)
3. Registered weight
4. Basis of registration
5. Commodity carried
6. Load status

C. Axle Data

1. Individual axle weights
2. Spacings between each set of adjacent axles
3. Sum of all axle weights (total weight of vehicle)
4. Sum of all axle spacings (total wheelbase)

The detailed definitions and coding schemes for these data items are given in Chapter 6.

Because of the various types of truck weight data collection equipment currently available, it is necessary to be flexible in the data items

requested by FHWA. Since each weighing procedure has different data collection capabilities, each must be considered individually as to the data items that can feasibly be obtained. The following paragraphs give alternatives based on the weighing method employed.

Static Weighing

Based on the very nature of this method of weighing, it is possible for all the data (identification, interview and axle) to be obtained. However, from a survey conducted in all the State offices, it was concluded that the States needed freedom in determining which data items are justified in terms of the time and effort involved in collecting them. Since the identification and axle data are basic to truck weight surveys and are, by far, the most useful items, only the interview data remain to be scrutinized by each State as to their utility. The interview data are an optional part of the data requested for the FHWA truck weight survey and may be collected at the discretion of the State.

On the basis of the States' responses to the survey and FHWA review, the following interview data items seem to be of the greatest value at both the State and Federal levels:

1. Body type
2. Load status
3. Commodity carried

Weigh-in-Motion

The majority of the WIM equipment has the capability of acquiring all of the identification and axle data automatically. However, since the vehicles are not stopped, interview data cannot be collected. Therefore, at WIM sites, the interview items cannot be entered in the FHWA format. In their place, the State should code the default values as indicated in the coding scheme in Chapter 6.

Combination of Static Weighing and Weigh-in-Motion

States using a mix of WIM and static scales may collect the data at each site according to the instructions previously given based on the type of weighing procedure being employed at the site.

Enforcement Weighing

The States have the option to conduct their truck weight surveys at enforcement locations. Where WIM equipment is being operated at an enforcement site, the conversion from enforcement weighing only to collecting the data for this truck weight survey should be fairly simple and should not affect the station's operation. However, at a static weighing site the conversion to data collection will be more difficult due to the additional trained personnel required to obtain the axle spacing and, at the State's discretion, the interview data and to record all the data.

CHAPTER 6

Coding Instructions for the FHWA Truck Weight Survey

Introduction

This chapter contains detailed instructions for coding the field data in the requested FHWA format. The record formats and coding instructions have been developed to provide input to the battery of computer programs utilized by the Highway Statistics Division in summarizing the data submitted by the States.

The data requested are divided into three types: the station description data, the vehicle classification data, and the truck weight data. Each type of data has its own individualized record format. The coding instructions and record layouts are discussed separately for each type of data, except for the description of those data items which are common to all the record formats.

On the record format descriptions on pages 5-6-6, 5-6-13, 5-6-17, and 5-6-18, page references have been provided for each data item for easy reference to the appropriate coding schemes.

Data Items Common to all Record Formats

Certain data items are common to all three types of records. These items are located in the first 11 columns of every data record and are part of the identification information used to correlate the different types of records.

1. Record Identification (Column 1)

<u>Code</u>	<u>Record Type</u>
2	Station description record
4	Vehicle classification record
7	Truck weight record

2. FIPS State Codes (Columns 2-3)

<u>Name</u>	<u>Code</u>	<u>Name</u>	<u>Code</u>
Alabama	01	Montana	30
Alaska	02	Nebraska	31
Arizona	04	Nevada	32
Arkansas	05	New Hampshire	33
California	06	New Jersey	34
Colorado	08	New Mexico	35
Connecticut	09	New York	36
Delaware	10	North Carolina	37
District of Columbia	11	North Dakota	38
Florida	12	Ohio	39
Georgia	13	Oklahoma	40
Hawaii	15	Oregon	41
Idaho	16	Pennsylvania	42
Illinois	17	Rhode Island	44
Indiana	18	South Carolina	45
Iowa	19	South Dakota	46
Kansas	20	Tennessee	47
Kentucky	21	Texas	48
Louisiana	22	Utah	49
Maine	23	Vermont	50
Maryland	24	Virginia	51
Massachusetts	25	Washington	53
Michigan	26	West Virginia	54
Minnesota	27	Wisconsin	55
Mississippi	28	Wyoming	56
Missouri	29	Puerto Rico	72

3. Functional Classification
(Columns 4-5)

<u>Code</u>	<u>Functional Classification</u>
RURAL	
01	Principal Arterial - Interstate
02	Principal Arterial - Other
06	Minor Arterial
07	Major Collector
08	Minor Collector
09	Local System
URBAN	
11	Principal Arterial - Interstate
12	Principal Arterial - Other Freeways or Expressways
14	Principal Arterial - Other
16	Minor Arterial
17	Collector
19	Local System

4. Station Identification
(Columns 6-8)

This three-digit field should contain an alphanumeric designation for the station where the survey data are collected. Station identification field entries must be identical in all records for a station. Differences in characters, including spaces, blanks, hyphens, etc., prevent proper match. This applies to all three types of records which must be matched during various stages of the processing. Station identification numbers should be right justified, filled with leading zeros. Only the numbers 0 through 9 and the 26 letters of the alphabet should be used.

5. Direction of Travel
(Column 9)

<u>Code</u>	<u>Direction</u>
1	North
2	Northeast
3	East
4	Southeast
5	South
6	Southwest
7	West
8	Northwest
9	North-South (or Northeast-Southwest) combined
0	East-West (or Southeast-Northwest) combined

**6. Year of Current Data
(Columns 10-11)**

Code the last two digits of the year in which the data were collected.

Station Description Records

1. General Comments

The purpose of the station description records is to provide a means of locating the weighing sites on a standard highway map and to provide some general information about the site. The station description information should be submitted along with any submittal of the vehicle classification and truck weight data. This is necessary because the average annual daily traffic (AADT) figure must be current to ensure the valid comparison of the counts and weights to the average traffic stream at a site. Since the AADT will probably be the only data item that will require annual updating, the annual submittal process should require minimal additional effort.

2. Record Format

Enter data in the following manner:

- a. All records must contain a "2" in column 1.
- b. All data fields in columns 1-20 and 34-45 must contain the appropriate code for each data item and be filled with leading zeros.
- c. Columns 1-3 and 10-11 should be the same on every record.

Station Description Record

<u>Columns</u>	<u>No. of Columns</u>	<u>Description</u>	<u>Ref. Page</u>
1	1	Station description record code (2)	
2-3	2	State code	5-6-2
4-5	2	Functional classification	5-6-3
6-8	3	Station identification number	5-6-3
9	1	Direction of travel	5-6-3
10-11	2	Year of data	5-6-4
12	1	Posted route number category	5-6-7
13-17	5	Posted route number	5-6-7
18-20	3	County code	5-6-7
21-32	12	HPMS sample number	5-6-7
33	1	HPMS sample section subdivision number	5-6-7
34-35	2	Year station was established	5-6-8
36	1	Type of site	5-6-8
37	1	Type of weighing equipment	5-6-8
38	1	Method of vehicle classification counting	5-6-8
39	1	Coordination with enforcement activities	5-6-8
40-45	6	AADT most current figure	5-6-9
46-80	35	Location of station (distance and direction from nearest major intersecting route)	5-6-9

3. Coding Schemes (Columns 12-80)

- a. Posted Route Number Category
(Column 12)

<u>Code</u>	<u>Category</u>
1	Interstate
2	U.S.
3	State
4	County
0	Other

- d. Posted Route Number
(Columns 13-17)

Code the route number of the principal route on which the station is located. Right justify number and enter leading zeros if necessary. For example, to identify the route I-80, enter a "1" in column 12 and the number "00080" in columns 13-17.

If the station is located on a city street, zero-fill this field.

- c. County Code
(Columns 18-20)

Use the three-digit FIPS county code (see Federal Information Processing Standards Publication 6, "Counties of the States of the United States").

- d. HPMS Sample Number
(Columns 21-32)

If a station is located on an HPMS sample section, code the sample section identifier used for this section in the original HPMS submission or a unique number for a new sample section. This number may be route-milepoint or A-node, B-node, Segment, but will be considered as a unique number that may not change in the future. It will be assigned to all subdivided portions of the sample sections.

If the station is not on an HPMS sample section, leave this field blank.

- e. HPMS Sample Section Subdivision Number
(Column 33)

For those stations located on an HPMS sample section that is subdivided, enter the appropriate subdivision number from 0-9 as assigned to this portion of the section for the HPMS submission. For stations not on an HPMS sample section, leave this column blank.

- f. Year Station was Established
(Columns 34-35)

Code the last two digits of the year data was first collected at this location.

- g. Type of Site
(Column 36)

<u>Code</u>	<u>Site</u>
1	Station located on pavement (traveled lane)
2	Station located on shoulder
3	Safety rest area
4	Frontage road
5	Off-ramp
6	On-ramp
7	Other public land
8	Privately owned land
9	Turnoff for study station which removes traffic from through lanes (example: permanent scale site)
0	Other

- h. Type of Weighing Equipment Used for Study
(Column 37)

<u>Code</u>	<u>Equipment</u>
1	Portable static scales
2	Chassis-mounted, towed
3	Platform or pit
4	Weigh-in-Motion

- i. Method of Vehicle Classification Counting
(Column 38)

<u>Code</u>	<u>Method</u>
1	Manual
2	Automated

- j. Coordination with Enforcement Activities
(Column 39)

<u>Code</u>	
1	Planning and enforcement activities are conducted simultaneously at this site.
2	Planning and enforcement activities are conducted separately or only planning activities are conducted at this site.

k. AADT
(Columns 40-45)

Code the most current AADT for the roadway on which the station is located. Right justify figure in field and enter leading zeros if necessary.

l. Location of Station
(Columns 46-80)

For stations located on a numbered route, enter the distance and direction of the station from the nearest major intersecting route. Abbreviate wherever necessary while ensuring the information remains clear. For example, a location could be coded:

5 MILES WEST OF U.S. 283

or

5 MI. W. OF US 283

If the station is located on a city street, enter the city and street name.

Vehicle Classification Records

1. General Comments

Vehicle classification data collected at truck weigh sites are necessary to expand the truck weight information to the distribution of the various types of trucks in the traffic stream. The FHWA vehicle classification categories are discussed in Section 4 and the definitions are repeated here as a reference for the vehicle classification record format immediately following them.

Type Name and Description

1. Motorcycles (Optional)--All two- or three-wheeled motorized vehicles. Typical vehicles in this category have saddle-type seats and are steered by handle bars rather than a wheel. This category includes motorcycles, motor scooters, mopeds, motor-powered bicycles, and three-wheel motorcycles. This vehicle type may be reported at the option of the State.
2. Passenger Cars--All sedans, coupes, and station wagons manufactured primarily for the purpose of carrying passengers and including those passenger cars pulling recreational or other light trailers.
3. Other Two-Axle, Four-Tire Single Unit Vehicles--All two-axle, four-tire vehicles, other than passenger cars. Included in this classification are pickups, panels, vans and other vehicles such as campers, motor homes, ambulances, hearses, and carryalls. Other two-axle, four-tire single unit vehicles pulling recreational or other light trailers are included in this classification.
4. Buses--All vehicles manufactured as traditional passenger-carrying buses with two axles and six tires or three or more axles. This category includes only traditional buses (including school buses) functioning as passenger-carrying vehicles. All two-axle, four-tire minibuses should be classified as other two-axle, four-tire single unit vehicles. Modified buses should be considered to be a truck and be appropriately classified.

NOTE: In reporting information on trucks the following criteria should be used:

- a. Truck tractor units traveling without a trailer will be considered single unit trucks.
- b. A truck tractor unit pulling other such units in a "saddle mount" configuration will be considered as one single unit truck and will be defined only by the axles on the pulling unit.
- c. Vehicles shall be defined by the number of axles in contact with the roadway. Therefore, "floating" axles are counted only when in the down position.

- d. The term "trailer" includes both semi- and full trailers.
5. Two-Axle, Six-Tire, Single Unit Trucks--All vehicles on a single frame including trucks, camping and recreation vehicles, motor homes, etc., having two axles and dual rear wheels.
 6. Three-Axle Single Unit Trucks--All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., having three axles.
 7. Four or More Axle Single Unit Trucks--All trucks on a single frame with four or more axles.
 8. Four or Less Axle Single Trailer Trucks--All vehicles with four or less axles consisting of two units, one of which is a tractor or straight truck power unit.
 9. Five-Axle Single Trailer Trucks--All five-axle vehicles consisting of two units, one of which is a tractor or straight truck power unit.
 10. Six or More Axle Single Trailer Trucks--All vehicles with six or more axles consisting of two units, one of which is a tractor or straight truck power unit.
 11. Five or Less Axle Multi-Trailer Trucks--All vehicles with five or less axles consisting of three or more units, one of which is a tractor or straight truck power unit.
 12. Six-Axle Multi-Trailer Trucks--All six-axle vehicles consisting of three or more units, one of which is a tractor or straight truck power unit.
 13. Seven or More Axle Multi-Trailer Trucks--All vehicles with seven or more axles consisting of three or more units, one of which is a tractor or straight truck power unit.

2. Record Format

Enter data in the following manner:

- a. All records must contain a "4" in column 1.
- b. All data fields in columns 1-17 must contain an appropriate code for each data item and be filled with leading zeros.
- c. Columns 1-3 and 10-11 should be the same on every record.
- d. Each count field in columns 18-48 must contain a number or zeros.
- e. Passenger cars and single-unit trucks pulling light trailers should be entered in the field of the pulling unit.

Vehicle Classification Record

<u>Columns</u>	<u>No. of Columns</u>	<u>Description</u>	<u>Ref. Page</u>
1	1	Vehicle classification record code (4)	
2-3	2	State code	5-6-2
4-5	2	Functional classification	5-6-3
6-8	3	Station identification number	5-6-3
9	1	Direction of travel	5-6-3
10-11	2	Year of data	5-6-4
12-13	2	Month of data	5-6-14
14-15	2	Date of month	5-6-14
16-17	2	Hour of day	5-6-14
18-19	2	Number of motorcycles (optional)	5-6-14
20-23	4	Number of passenger cars or all 2-axle, 4-tire single unit vehicles	5-6-14
24-26	3	Number of other 2-axle, 4-tire single unit vehicles	5-6-14
27-28	2	Number of buses	5-6-14
29-31	3	Number of 2-axle, 6-tire single unit trucks	5-6-14
32-33	2	Number of 3-axle single unit trucks	5-6-14
34-35	2	Number of 4 or more axle single unit trucks	5-6-14
36-37	2	Number of 4 or less axle single trailer trucks	5-6-14
38-40	3	Number of 5-axle single trailer trucks	5-6-14
41-42	2	Number of 6 or more axle single trailer trucks	5-6-14
43-44	2	Number of 5 or less axle multi-trailer trucks	5-6-14
45-46	2	Number of 6-axle multi-trailer trucks	5-6-14
47-48	2	Number of 7 or more axle multi-trailer trucks	5-6-14
49	1	Motorcycle reporting indicator	5-6-14
50	1	Vehicle class combination indicator	5-6-15
51-80	32	Blank or optional State data	5-6-15

3. Coding Schemes
(Columns 12-80)

a. Month of Data
(Columns 12-13)

01 = January...12 = December

b. Date of Month
(Columns 14-15)

Code the day of the month. 01-31 are the valid codes.

c. Hour of Day
(Columns 16-17)

Code the beginning of the hour in which the count was taken, i.e.:

Midnight-1:00 a.m. = 00
1:00 a.m.-2:00 a.m. = 01

·
·
·

10:00 p.m.-11:00 p.m. = 22
11:00 p.m.-Midnight = 23

d. Vehicle Counts
(Columns 18-48)

Code the number of vehicles counted during the hour based on the vehicle type. Right justify the counts in the appropriate fields and zero-fill each field. If the vehicles in the two vehicle type categories "passenger cars" and "other two-axle single unit vehicles" are counted as one vehicle type, enter the combined count of the two categories in columns 20-23 and enter zeroes in columns 24-26.

e. Motorcycle Reporting Indicator
(Column 49)

Reporting motorcycle counts is optional. Indicate whether or not it was decided to count motorcycles.

Code

0 Motorcycles are not reported

1 Motorcycles are reported

f. Vehicle Class Combination Indicator
(Column 50)

Code

0 Passenger cars and 2-axle, 4-tire single unit trucks
are reported separately.

1 Passenger cars and 2-axle, 4-tire single unit trucks
are combined.

g. (Columns 51-80)

These columns may be used to enter any information the
State wishes to include on the vehicle classification
record. If no additional information is necessary, leave
these columns blank.

Truck Weight Records

1. General Comments

In Chapter 5 the three truck weight data groups (identification data, interview data and axle data) contained in the truck weight record format are discussed. The interview data items may be entered at the States' discretion. These items include body type, engine type, registered weight, basis of registration, commodity and load status.

Special coding problems which have arisen in the past are discussed on page 5-6-33.

2. Record Format

Enter data in the following manner:

- a. All records must contain a "7" in column 1.
- b. For vehicles having five or less axles, only the "face record" will be coded and column 80 will contain a zero.
- c. Vehicles having 6-13 axles will have the weights and spacings for the first 5 axles coded on the face record and the remaining weights and spacings coded on the continuation record. Column 80 will be a "1" on the face record and a "9" on the continuation record.
- d. Vehicles with more than 13 axles will have the weights and spacings for first 5 axles coded on the face record (Column 80 = 1), the weights and spacings for the 6th-13th axles coded on the first continuation record (Column 80 = 2), and the remaining weights and spacings coded on the last continuation record (Column 80 = 9).
- e. Columns 1-28 and 77-79 of the face and continuation records describing one vehicle must contain the same data.
- f. Columns 1-3 and 10-11 should be the same on every record.
- g. All data fields in columns 1-26 on all records and columns 29-32 and 36-41 on the face card must contain an appropriate code for each data item and be filled with leading zeros.
- h. All of the axle weight and spacing data fields must contain a number or zeros.

CONTINUATION RECORD*

<u>Columns</u>	<u>No. of Columns</u>	<u>Description</u>	<u>Ref. Page</u>
1-28	28	Same as columns 1-28 of the face record	
29-31	3	F-axle weight (hundreds of pounds)	5-6-32
32-34	3	G-axle weight " " "	5-6-32
35-37	3	H-axle weight " " "	5-6-32
38-40	3	I-axle weight " " "	5-6-32
41-43	3	J-axle weight " " "	5-6-32
44-46	3	K-axle weight " " "	5-6-32
47-49	3	L-axle weight " " "	5-6-32
50-52	3	M-axle weight " " "	5-6-32
53-55	3	(E-F) axle spacing (feet and tenths)	5-6-32
56-58	3	(F-G) axle spacing " " "	5-6-32
59-61	3	(G-H) axle spacing " " "	5-6-32
62-64	3	(H-I) axle spacing " " "	5-6-32
65-67	3	(I-J) axle spacing " " "	5-6-32
68-70	3	(J-K) axle spacing " " "	5-6-32
71-73	3	(K-L) axle spacing " " "	5-6-32
74-76	3	(L-M) axle spacing " " "	5-6-32
77-79	3	Record serial number (same as face record)	5-6-32
80	1	Continuation indicator (2 = first continuation record for a vehicle with more than 13 axles 9 = last continuation record)	5-6-32

*Used only for truck combinations having six or more axles and immediately follows the face record.

3. Coding Schemes
(Columns 12-80)

a. Month of Data
(Columns 12-13)

01 = January...12 = December

b. Date of Month
(Columns 14-15)

Code the day of the month. 01-31 are the valid codes.

c. Hour of Day
(Columns 16-17)

Code the beginning of the hour in which the truck was weighed, i.e.:

Midnight-1:00 a.m. = 00

1:00 a.m.-2:00 a.m. = 01

.

.

.

10:00 p.m.-11:00 p.m. = 22

11:00 p.m.-Midnight = 23

d. Vehicle Type
(Columns 18-23)

This six-digit code has been designed to allow maximum flexibility in identifying specific vehicle types and axle configurations. The next two pages contain the vehicle type coding chart that illustrates the six-digit coding scheme for this field. The passenger car and bus categories have been included for those States that are using WIM equipment and choose to weigh all vehicles.

When entering the vehicle type code, no columns should be left blank. Leading and trailing zeros should be entered to fill out the field as indicated on the chart.

Vehicle Type Coding Chart*

	<u>1st Character</u>	<u>2nd Character</u>	<u>3rd Character</u>	<u>4th Character</u>	<u>5th Character</u>	<u>6th Character</u>
Personal passenger vehicles	basic vehicle type = 0	9	0	Table A- light trailer modifier	0	0
Buses	basic vehicle type = 1	9	0	Table B- axle & tire modifier	0	0
Single-unit trucks or tractors	basic vehicle type = 2	Table C- total axles	0	Table A- light trailer modifier	0	0
Tractor + semitrailer	basic vehicle type = 3	total axles on power unit	Table D- total axles on first trailer	0	0	0
Truck + full trailer	basic vehicle type = 4	total axles on power unit	Table D- total axles on first trailer	0	0	0
Tractor + semitrailer + full trailer**	basic vehicle type = 5	total axles on power unit	Table D- total axles on first trailer	Table D- total axles on second trailer	0	0
Truck + full trailer + full trailer	basic vehicle type = 6	total axles on power unit	Table D- total axles on first trailer	Table D- total axles on second trailer	0	0
Tractor + semitrailer + 2 full trailers**	basic vehicle type = 7	total axles on power unit	Table D- total axles on first trailer	Table D- total axles on second trailer	Table D- total axles on third trailer	0
Truck + 3 full trailers	basic vehicle type = 8	total axles on power unit	Table D- total axles on first trailer	Table D- total axles on second trailer	Table D- total axles on third trailer	0

*See next page for table references.

**Semitrailers pulled by other semitrailers will be considered full trailers.

Table A - Light Trailer Modifier

- 0 No trailer
- 1 Camp trailer
- 2 Travel or mobile home
- 3 Cargo or livestock trailer
- 4 Boat trailer
- 5 Towed equipment
- 6 Towed auto
- 7 Towed truck
- 8 "Saddle mount" (Tractors or trailers with front axles on unit ahead)
- 9 Type trailer not determined

Table B - Axle and Tire Modifier

- 0 Axle arrangement not recorded
- 1 Two-axle, four-tire
- 2 Two-axle, six-tire
- 3 Three-axle
- 4 Four or more axles

Table C - Total Axles

- 0 Panel and pickup
- 1 Heavy two-axle, four-tire
- 2 Two-axle, six-tire
- 3 Three-axle
- 4 Four-axle
- 5 Five-axle
- 6 Six-axle
- 7 Seven-axle
- 8 Eight axles or more

Table D - Total Axles on Trailer

- 1 Single-axle trailer
- 2 Two-axle trailer
- 3 Three-axle trailer
- 4 Four-axle trailer
- 5 Five-axle trailer
- 6 Six-axle trailer
- 7 Two-axle trailer with axles in spread tandem configuration
- 8 Three-axle trailer including a spread tandem configuration
- 9 Four-axle trailer including a spread tandem configuration

VEHICLE TYPE CODING EXAMPLES:

<u>Vehicle</u>	<u>Code</u>
1. Car	090000
2. 3-axle bus	190300
3. 3-axle tractor without trailer (bobtail)	230000
4. 3-axle tractor + 2-axle semitrailer	332000
5. 2-axle tractor + 1-axle semitrailer + 2-axle full trailer	521200

e. Body Type
(Columns 24-25)

Recording the body type is optional. Enter "99" in this field when the body type is not determined.

Light truck

These bodies are found primarily on light trucks. Where other bodies, such as multistop delivery, are encountered on light trucks, the correct body type code should be used.

<u>Code</u>	<u>Body Type</u>
11	<u>Panel</u> --A fully enclosed body of limited capacity which includes driver's compartment.
12	<u>Pickup</u> --A small open box or express body.
13	<u>Light utility</u> --A body designed to carry readily accessible tools, equipment, and supplies in integrally constructed compartments, with or without other cargo spaces.
14	<u>Personnel and cargo</u> --A body with large integral enclosed passenger compartment and a separate open box or express body.
15	<u>Carryall or minibus</u> --An enclosed utility body with side windows and one or more removable seats designed for transporting either passengers, light cargo, or both. (Station wagons are considered to be passenger cars and are not included in this category).

General truck and semitrailer bodies

21	<u>Platform, flat, or stake</u> --A body having a floor without sides or roof, with or without readily removable stakes which may be tied together with chains, slats, or panels.
22	<u>Low-bed trailer</u> --A truck trailer with a platform body constructed to provide a low loading height and designed for the transportation of extremely heavy or bulky property.
23	<u>Rack</u> --A body with fixed slatted sides and headboard.
24	<u>Livestock rack</u> --A rack body with or without roof designed primarily for transportation of livestock.

- 25 Riggers or oil field--A platform body of heavy construction equipped with a rear end roller or bullnose adapted for loading by winch or crane mounted on the vehicle and designed primarily for rigging, construction, or work in oil fields.
- 26 Lumber--A platform body usually with transverse rollers designed primarily for the transportation of sawed lumber.
- 27 Log, or pipe--A body comprised of sill, bolsters, with or without headboard, with provision for uprights, and designed primarily for the transportation of logs, poles, pipes, or other loads which may be boomed. (Use body type codes 21 or 23 for trucks hauling pulpwood).
- 28 Canopy--An express body with fixed or removable uprights and roof which may be integral or separate from cab.
- 31 Express--An open box body with or without flareboards.
- 32 Open top box or van--A body with high closed sides and ends and a movable top, which usually is a tarpaulin cover.
- 33 Grain--A low-side open box primarily designed to transport dry fluid commodities in bulk.
- 34 Dump--A low-side open box designed primarily to transport dry fluid commodities in bulk, which can be tilted or otherwise manipulated to discharge its load by gravity.
- 35 Hopper--A body which is capable of discharging its load by gravity or mechanical power through means other than tilting, and usually loaded from the top.
- 41 Van--A fully enclosed body designed primarily for the transportation of packaged commodities.
- 42 Insulated van--A van body designed primarily for the transportation of commodities or the vending of food, beverages, or confections at controlled temperatures. It may be provided with equipment for refrigeration or heating.
- 43 Furniture or moving van--A van body designed primarily for transportation of furniture or household goods. Customarily, when truck-mounted, it includes an integral driver's compartment.

- 51 Tank--A body designed for bulk liquid commodities other than petroleum.
- 52 Petroleum tank--A tank body designed for transportation of petroleum products.
- 53 Bituminous material distributor--A tank body provided with means for distributing hot bituminous material under pressure, usually equipped with means for heating the material.
- 54 Bottler--A body designed primarily for the transportation of cased bottled beverages on open or closed shelves, A-frames, or pallets.
- 61 Multistop or standup delivery--A fully enclosed body with driver's compartment integral and designed for easy access.
- 62 Automobile transporter--A body designed primarily for the transportation of other vehicles.
- 63 Armored car (not military)--An enclosed cargo body with integral driver's compartment so constructed as to protect cargo and crew from overt attack.
- 64 Boat carrier--A body designed to transport two or more boats.
- 71 Concrete mixer or agitator--A body designed and equipped to mix or agitate concrete.
- 72 Wrecker--A body designed primarily for transportation of equipment for salvaging disabled vehicles and equipped with means for hoisting and towing such vehicles.
- 73 Utilities--A body designed primarily for the transportation of tools, equipment, and supplies for construction, maintenance, and repair purposes.
- 74 Garbage and refuse--A dump body designed primarily for the collection of garbage and refuse.
- 75 Container--A body designed to transport bundled, stacked, or palletized commodities or special containers, with special lifting, locking, or loading devices.

- 76 Equipment--Any truck-mounted or other self-propelled wheeled equipment designed for highway travel, such as truck-mounted cranes, well drills, compressors, etc.
- 77 Base chassis--A cargo type vehicle with no provision for carrying load. This code should be used also for the body type when one truck, without a body, is transporting a second without a body, where the front wheels of the second rest on the first.
- 78 Shop--A body constructed for use as a shop, laboratory, office, or for a similar purpose with tools, equipment, or supplies to be used, operated, or dispensed from inside the body. Insulated bodies designed for vending hot or cold foods, beverages, or confections should be coded 42, insulated van body.
- 79 Dwelling body--A body, other than a shop body, designed for use as an abode with bunk(s), including house body and camper body.
- 88 Truck-tractor without semitrailer or trailer--Any vehicle constructed primarily to pull a semitrailer, full trailer, pole trailer, house trailer, or equipment.
- 89 Empty log truck carrying pole trailer
- 91 Bus--A long body constructed with seats for transporting passengers.
- 99 Not determined

f. Engine Type
(Column 26)

This is an optional data item and may be collected and coded at the States' discretion. Enter a "9" if the engine type is not determined.

<u>Code</u>	<u>Engine</u>
1	Gasoline
2	Diesel
3	Propane
4	Turbine
8	Other
9	Not determined

g. (Columns 27-28)

This field may be left blank or it may be used to code any data the State may wish to include on the truck weight record.

h. Registered Weight
(Columns 29-31, Face Record Only)

This data item is optional. If a State chooses to collect this data, the basis of registration (Column 32) must also be coded.

If the weight is coded, it must be the appropriate weight for the basis of registration in the "home" State of the vehicle whether gross weight or empty weight. The sum of the registered weights for all units of the combination should be used. The weight should be expressed in thousands of pounds, right-justified in the field and filled with leading zeros.

If registered weight is not determined, this field should be filled with zeros.

i. Basis of Registration
(Column 32, Face Record Only)

This data item is needed only if the registered weight (Columns 29-31) is reported. Enter a "9" in the field if the basis of registration is not determined.

For States listed below, code as shown, for others code "1". Vehicles from Canada or Mexico, where parts of a combination are registered in different States having different bases of registration or other cases when the basis of registration is not determined, code "9".

Alaska	3
California	3
Colorado	3
D.C.	3
Hawaii	3
Maryland	5
Montana	2
Nevada	3
Ohio	3
Oregon	2
South Carolina	7
Wyoming	3

Legend

1	= Gross weight of combination
2	= Gross weight of units separately
3	= Empty weight of units separately
5	= Chassis weight
7	= Pay load
9	= Not determined

j. (Columns 33-35, Face Record Only)

This field may be left blank or it may be used to code any data the State may wish to include on the truck weight record.

k. **Commodity Code**
(Columns 36-40, Face Record Only)

Coding the commodity carried is optional. The following codes apply when no commodity is recorded:

	<u>Code</u>	
a.	Empty vehicle	00000
b.	Loaded, commodity not determined	46000
c.	Load status not determined	99999

The five-digit commodity code used for this study was developed by the Bureau of the Census for use in the Commodity Transportation Survey portion of the 1977 Census of Transportation. It is an adaptation of the Standard Industrial Classification. For the listing of the commodities and their associated five-digit codes, see Appendix C.

For the purposes of this study, the commodity code should indicate, at minimum, the major category into which the commodity falls. This requires the coding of at least the first two digits of the five-digit code. The commodity code should always be left-justified in this field and filled with trailing zeros if blanks occur. For example, the commodity code for apples could be either 01221 to identify the specific commodity or 01000 to identify the commodity as a farm product.

For those State that choose to classify the commodities by their major categories, the following alphabetical listing of these categories may be helpful. If it is not clear which category a commodity belongs in, the major category codes on this listing may be referenced in Appendix C to determine which commodities are in a specific category.

Major Categories of Commodities

APPAREL AND OTHER FINISHED TEXTILE PRODUCTS, INCLUDING KNIT	23	ELECTRICAL MACHINERY, EQUIPMENT OR SUPPLIES	36
Apparel Hats, millinery, and gloves Fur goods Miscellaneous apparel and accessories Miscellaneous fabricated textile products		Electrical generating, transmission, distribution, and industrial apparatus Household appliances Electric lighting and wiring equipment Radio, TV, and other communication equipment and related products Electronic components and accessories Other electrical machinery and equipment	
CHEMICALS OR ALLIED PRODUCTS	28	FABRICATED METAL PRODUCTS, EXCEPT ORDNANCE, MACHINERY OR TRANSPORTATION EQUIPMENT	34
Alkalies and chlorine Industrial gases Industrial organic chemicals Inorganic color pigments Fertilizers and agricultural chemicals Industrial inorganic chemicals Plastic materials Synthetic rubber Synthetic fibers Drugs and medicines Soap, glycerine, cleaning, polishing, and related products Surface active agents Toilet preparations and cosmetics Paints, varnishes, lacquers, enamels, and allied products Gum and wood chemicals Phosphatic fertilizers Adhesives and sealants Explosives Printing ink Chemical preparations, not elsewhere classified Carbon black		Metal cans Cutlery, hand tools, and hardware Heating equipment (except electric) and plumbers supplies Fabricated structural metal products, including doors Boiler shop and sheet metal products Prefabricated metal buildings and miscellaneous metal work Miscellaneous fabricated metal products Metal forgings and stampings, coating and engraving Fabricated wire products Shipping containers	
COAL	11	FARM PRODUCTS	01
Anthracite coal Bituminous coal or lignite		Field crops Fresh fruits or tree nuts Fresh vegetables Livestock or livestock products Dairy farm products, except pasteurized Poultry or poultry products Miscellaneous farm products	
CONTAINERS, SHIPPING, RETURNED EMPTY	42		
Shipping containers, returned empty Shipping devices, returned empty			
CRUDE PETROLEUM, -NATURAL GAS, AND NATURAL GASOLINE	13		
Crude petroleum or natural gas Natural gasoline			

FOOD AND KINDRED PRODUCTS			
Meat, poultry, and byproducts			
Dairy products			
Canned and preserved fruits, vegetables, and seafoods			
Frozen and fresh fish or other seafoods			
Frozen fruits, vegetables and prepared foods			
Mixed loads			
Grain mill products and animal feed products			
Bakery products, except frozen			
Sugar and related products			
Confectionery, chocolate, and chewing gum			
Beverages, flavoring, and related products			
Miscellaneous foods and kindred products			
FOREST PRODUCTS			
Barks or gums, crude			
Miscellaneous forest products			
FRESH FISH AND OTHER MARINE PRODUCTS			
Fresh fish and other marine products			
FURNITURES OR FIXTURES			
Household and office furniture			
Bedding products			
Public building, restaurant, and other furniture			
Partitions, shelving, lockers, and office and store fixtures - metal and wood			
Window shades and venetian blinds			
INSTRUMENTS, PHOTOGRAPHIC AND MEDICAL GOODS, WATCHES, AND CLOCKS			
Instruments			
Surgical, medical, dental, optical, and ophthalmic goods			
Photographic equipment and supplies			
Watches, clocks, and watchcases			
	20	LEATHERS OR LEATHER PRODUCTS	31
		Finished leather	
		Boot and shoe cut stock and findings	
		Footwear	
		Leather gloves and mittens	
		Luggage, handbags, and small leather goods	
		Leather goods, not elsewhere classified	
		LUMBER OR WOOD PRODUCTS, EXCEPT FURNITURE	24
		Lumber and timber basic products	
		Lumber and dimension stock	
		Millwork, plywood, and structural members	
		Wood buildings and mobile homes	
		Wood containers, pallets, and skids	
		Miscellaneous wood products	
		MACHINERY, EXCEPT ELECTRICAL	35
		Engines and turbines	
		Farm machines and tractors	
	08	Construction, mining, and oil-field machinery	
		Elevators, hoists, and materials handling machinery and equipment	
		Machine tools	
	09	Metalworking machinery	
		Special industry machinery	
		Pumps and compressors	
	25	General industrial machinery	
		Office and store machines and service industry machines	
		Miscellaneous service industry machines	
		Miscellaneous machinery and parts	
		METALLIC ORES	10
		Iron ores	
		Copper ores	
		Lead or zinc ores	
		Gold or silver ores	
		Bauxite or other aluminum ores	
	38	Manganese ores	
		Tungsten ores	
		Chromium ores	
		Miscellaneous metal ores	
		MISCELLANEOUS MIXED SHIPMENTS	46
		Loaded, commodity not determined	

MISCELLANEOUS PRODUCTS OF MANUFACTURING	39	PRINTED MATTER	27
Jewelry, silverware, and plated ware		Newspapers	
Musical instruments and parts		Periodicals	
Toys, sporting, and athletic goods		Books	
Pens, pencils, and other office and artists' supplies		Miscellaneous printed matter	
Miscellaneous manufactured products, including costume jewelry		Manifold business forms	
		Blankbooks, loose leaf binders, or devices	
		Products of service industries for the printing trades	
		Greeting cards, seals, labels or tags	
NONMETALLIC MINERALS, EXCEPT FUELS	14	PULP, PAPER, AND ALLIED PRODUCTS	26
Dimension, stone, quarry		Products of pulp mills	
Crushed or broken stone, including riprap		Paper and board mills	
Sand or gravel		Paper and board products	
Clay, ceramic or refractory minerals		Containers or boxes	
Chemical or fertilizer minerals		Building paper or building board	
Miscellaneous nonmetallic minerals, except fuels			
ORDNANCE AND ACCESSORIES	19	RUBBER OR MISCELLANEOUS PLASTICS PRODUCTS	30
Guns, howitzers, mortars, or related equipment, over 30 mm		Tires and inner tubes	
Ammunition, except for small arms, over 30 mm		Rubber and plastic footwear	
Full tracked combat vehicles or parts		Reclaimed rubber	
Sighting or fire control equipment		Fabricated rubber products, not elsewhere classified	
Small arms, 30 mm and under		Plastics products, not elsewhere classified	
Small arms ammunition, 30 mm and under			
Miscellaneous ordnance or accessories		STONE, CLAY, GLASS, OR CONCRETE PRODUCTS	32
		Glass and glass products	
PETROLEUM OR COAL PRODUCTS	29	Cement and structural clay products	
Petroleum refining products		Pottery and related products	
Paving and roofing materials		Concrete, gypsum, cut-stone, and plaster products	
Asphalt felts and coatings		Abrasives, asbestos, and miscellaneous nonmetallic products	
Lubricating oils and greases		Gaskets, packing, and sealing devices	
Petroleum and coal products, not elsewhere classified		Nonmetallic earths or minerals, ground	
		Mineral wool	
PRIMARY METAL PRODUCTS	33	Miscellaneous nonmetallic mineral products	
Steel mill products including coke and blast furnace products			
Ferroalloys		TEXTILE MILL PRODUCTS	22
Wire and wire products		Cotton broad woven fabrics	
Iron and steel castings		Manmade fiber broad woven fabrics	
Primary smelting of nonferrous ores, concentrates, or other primary materials		Wool broad woven fabrics	
Nonferrous metal basic shapes		Narrow fabrics	
Nonferrous wire drawing and insulating		Knitting mill products	
Nonferrous castings		Carpets, rugs, and other floor coverings	
Miscellaneous primary metal products		Yarn	
		Thread	
		Miscellaneous textile goods	

TOBACCO PRODUCTS	21
Cigarettes	
Cigars	
Chewing and smoking tobacco or snuff	
Stemmed or redried tobacco	
TRANSPORTATION EQUIPMENT	37
Motor vehicles, equipment, and parts	
Motor vehicle bodies and trailers	
Aircraft, missiles, space vehicles, and missile or space vehicle engines	
Boats and ships	
Railroad and other transportation equipment	
WASTE AND SCRAP MATERIALS	40
Ashes	
Waste and scrap, except ashes	

1. Load Status
(Column 41, Face Record Only)

<u>Code</u>	<u>Status</u>
0	Empty or not carrying a payload
1	Loaded with a payload, no overload permit
2	Equipment movement*
3	Loaded with a payload, overload permit
9	Not determined

*The code "2" is to be used for vehicles which are not empty but could not be considered as transporting a commodity. Examples are trucks with permanently or semipermanently mounted equipment such as compressors, cranes, generators, augers, well drilling rigs, etc., and utility trucks such as those used by gas, telephone and power companies, and by electrical, plumbing and heating contractors. If a "2" is coded, there must be a commodity code in Columns 36-40 indicating the type of equipment being transported. See page 5-6-33 under "Special Coding Problems" for the appropriate commodity codes.

m. Axle Weights and Spacings
(Columns 42-76, Face Record Only)
(Columns 29-76, Continuation Record)

The weights and spacings should be entered in the appropriate columns as indicated on the truck weight record format on pages 5-6-17 and 5-6-18. The weights will be expressed in hundreds of pounds and the spacings will be to the nearest tenth of a foot. Each figure must be right justified in its field with zeros entered where blanks occur. Any weight or spacing field that is unused should be zero-filled.

n. Record Serial Number
(Columns 77-79)

Serial numbering should start with "001" for the first truck weighed at each station. An entry of "000" is not a valid code. If the number of trucks exceeds "999," restart the serial number at "001."

A continuation record should always contain the same serial number as the face record it supplements.

o. Continuation Indicator
(Column 80)

<u>Code</u>	<u>Continuation Status</u>
0	This is the face record describing a vehicle with five or less axles.
1	This is the face record describing a vehicle with six or more axles.
2	This is the first of two continuation records describing a vehicle with more than 13 axles.
9	This is the last continuation record describing a vehicle with six or more axles.

. Special Coding Problems

a. Trucks Carrying Equipment

For trucks carrying permanently mounted equipment such as air compressors, cranes, welding units, and drilling rigs, code body type "76" in Columns 24-25. The appropriate commodity code from the 35 or 36 categories (pages 5-6-26 and 5-6-27) should be coded in Columns 36-40. For example, truck-mounted construction equipment would be coded "76" in Columns 24-25, "35000" in Columns 36-40, and "2" in Column 41.

b. Retractable Axles

Any axles that are retracted at the time a vehicle is weighed should not be considered when measuring the axle weights and spacings.

c. Fifth Wheel

Semitrailers being pulled by other semitrailers by way of a fifth wheel will be treated as full trailers.

d. Saddle-mounted Vehicles

If one or more vehicles are saddle-mounted on another vehicle, only the axles on the pulling vehicle should be weighed and the pulling vehicle should be classified as a single unit truck/tractor.

e. Determination of Load Status

Any vehicle carrying materials that are being moved or delivered should be considered loaded. However, in the case of a vehicle carrying shipping containers or pallets which were used in the delivery of other goods, the vehicle should be considered empty. Only if a vehicle is carrying these articles as a payload should it be coded as loaded.

Data Submittals to FHWA

When a State has completed one calendar year's truck weighing and vehicle classification operation, the data can be submitted to FHWA for analysis. The address is:

Federal Highway Administration
Highway Statistics Division, HHP-40
400 7th Street, SW
Washington, D.C. 20590

Attention: Truck Weight Survey

(The data must be in the record formats described in this chapter for further processing into the various summary tables.)

The information on the following page should be included with each data submittal.

Truck Weight Data Submittal To FHWA

1. State Name:

2. Year of Data:

3. Tape Characteristics (Check Appropriate Boxes)

Volume Name:

Tape Density: 3

4

Type of Labels: SL

NL

File Description:

Record Types in File

<u>File Number</u>	<u>Station Description</u>	<u>Vehicle Classification</u>	<u>Truck Weight</u>	<u>Record Length</u>	<u>Block Length</u>
1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

4. Special Requests

Specify Any Additional Summaries Desired. Indicate a Contact Person and Telephone Number in Case Further Clarification is Necessary.

CHAPTER 7

Editing of Truck Weight Data

Introduction

Prior to the submission of truck weight survey data to the Federal Highway Administration, the vehicle classification and truck weight records should be edited by the States using the computer edit program provided by FHWA. This chapter describes the edit program and identifies the data checks that can be made.

General Description

This truck weight edit program was written by Federal Highway Administration personnel and is usable by States able to execute American National Standard COBOL software on their computer.

The function of the program is to edit the vehicle classification and truck weight data according to the specifications indicated in Chapter 6. The program can edit records either in the number 4 record format or the number 7 record format, representing one year's data for any one State. It accepts card images on tape or disk, or punched data cards as input and produces a master file on tape or disk of the records passing all edit checks. Any records containing one or more errors are not written on the master file. All records input are listed and, in addition, error messages for records containing errors are listed preceding those records to which they apply.

The edit program requires only one parameter card. This card indicates the record code (4 or 7), the FIPS State code and the last two digits of the year of the data to be edited. The values on this card are compared to the same data items in the truck weight or vehicle classification records to ensure that the proper type of data for the proper State and year are being edited.

This software also includes an updating process which can be used to correct any errors identified in the initial edit of the data. It allows individual records to be deleted, new records to be added, and records containing errors to be replaced with corrected records.

The Edit Process

The edit program has the capability to perform the following important functions:

1. Ensures that the vehicle classification and truck weight data records are complete, in sequential order and free of coding errors.
2. Creates an edited data file which is ready for processing into the various analysis and summary tables.

3. Updates an existing file with additions, deletions, or corrections and creates a new or updated classification or weight file.

The edit checks performed on the data are indicated on the following pages. The checks are divided into those that apply to the vehicle classification data and those that apply to the truck weight data since the two files are processed individually.

1. Classification Record Valid Edit Values

<u>Columns</u>	<u>Field Description</u>	<u>Valid Values</u>
1	Record Type Code	must agree with Column 1 on parameter card (=4)
2-3	State Code	must agree with Columns 2-3 on parameter card
4-5	Functional Class.	01, 02, 06-09, 11, 12, 14, 16, 17, 19
6-8	Station ID Number	numeric or alpha (not blank)
9	Direction	0-9
10-11	Year	must agree with Columns 4-5 on parameter card
12-13	Month	01-12 and must be compatible with Columns 14-15
14-15	Date	01-31 and must be compatible with Columns 12-13
16-17	Hour	00-23
18-19	Vehicle count	numeric
20-23	Vehicle count	numeric
24-26	Vehicle count	numeric
27-28	Vehicle count	numeric
29-31	Vehicle count	numeric
32-33	Vehicle count	numeric
34-35	Vehicle count	numeric
36-37	Vehicle count	numeric
38-40	Vehicle count	numeric
41-42	Vehicle count	numeric
43-44	Vehicle count	numeric
45-46	Vehicle count	numeric
47-48	Vehicle count	numeric
49	Motorcycle Reporting Indicator	0-1 and must be compatible with Columns 18-19
50	Vehicle Class Combination Indicator	0-1 and must be compatible with Columns 24-26
51-80	Blank or optional data	(no edit check)

2. Weight Record Valid Edit Values

Face Record

<u>Columns</u>	<u>Field Description</u>	<u>Valid Values</u>
1	Record Type Code	must agree with Column 1 on parameter card (=7)
2-3	State Code	must agree with Columns 2-3 on parameter card
4-5	Functional Class.	01, 02, 06-09, 11, 12, 14, 16, 17, 19
6-8	Station ID Number	numeric or alpha (not blank)
9	Direction	0-9
10-11	Year	must agree with Columns 4-5 on parameter card
12-13	Month	01-12 and must be compatible with Columns 14-15
14-15	Date	01-31 and must be compatible with Columns 12-13
16-17	Hour	00-23
18-23	Vehicle Type Code	See Vehicle Code Checks (page 5-7-7)
24-25	Body Type	>10
26	Engine Type	1-4, 8, 9
27-28	(open)	(no edit check)
29-31	Registered Weight	numeric
32	Basis of Regis.	1, 2, 3, 5, 7, 9
33-35	(open)	(no edit check)
36-40	Commodity Code	See Commodity Code Checks (page 5-7-8)
41	Load Status Code	
42-45	Total Weight	must = sum of all axle weights
46-48	Axle Weight	numeric
49-51	Axle Weight	numeric
52-54	Axle Weight	numeric
55-57	Axle Weight	numeric

58-60	Axle Weight	numeric
61-63	Axle Spacing	zeros or (numeric and > 1.9 ft.)
64-66	Axle Spacing	zeros or (numeric and > 1.9 ft.)
67-69	Axle Spacing	zeros or (numeric and > 1.9 ft.)
70-72	Axle Spacing	zeros or (numeric and > 1.9 ft.)
73-76	Total Wheelbase	must = sum of all axle spacings
77-79	Record Serial No.	numeric and > zero
80	Continuation Code	= 0 and followed by another face record <u>or</u> = 1 and followed by a continuation record

Continuation Record

<u>Columns</u>	<u>Field Description</u>	<u>Valid Values</u>
1-28	Same as Face Record	Same as face record 1 preceding it
29-31	Axle Weight	numeric
32-34	Axle Weight	numeric
35-37	Axle Weight	numeric
38-40	Axle Weight	numeric
41-43	Axle Weight	numeric
44-46	Axle Weight	numeric
47-49	Axle Weight	numeric
50-52	Axle Weight	numeric
53-55	Axle Spacing	zeros or (numeric and > 1.9 ft.)
56-58	Axle Spacing	zeros or (numeric and > 1.9 ft.)
59-61	Axle Spacing	zeros or (numeric and > 1.9 ft.)
62-64	Axle Spacing	zeros or (numeric and > 1.9 ft.)
65-67	Axle Spacing	zeros or (numeric and > 1.9 ft.)
68-70	Axle Spacing	zeros or (numeric and > 1.9 ft.)
71-73	Axle Spacing	zeros or (numeric and > 1.9 ft.)
74-76	Axle Spacing	zeros or (numeric and > 1.9 ft.)
77-79	Record Serial No.	Same as face record 1 preceding it
80	Continuation Code	= 2 and followed by a continuation record <u>or</u> = 9 and followed by a face record

a. Vehicle Code Checks

For the purpose of this explanation, the following definitions will be used:

Digit 1 = 1st digit of the vehicle code
Digit 2 = 2nd digit of the vehicle code
Digit 3 = 3rd digit of the vehicle code
Digit 4 = 4th digit of the vehicle code
Digit 5 = 5th digit of the vehicle code
Digit 6 = 6th digit of the vehicle code

The vehicle code edit checks are:

- (1) must be numeric
- (2) Digit 1 = 0-8
- (3) Digit 1 = 0 \implies Digit 2 = 9
Digit 3 = 0
Digit 5 = 0
Digit 6 = 0
- (4) Digit 1 = 1 \implies Digit 2 = 9
Digit 3 = 0
Digit 4 = 0-4
Digit 5 = 0
Digit 6 = 0
- (5) Digit 1 = 2 \implies Digit 2 = 0-8
Digit 3 = 0
Digit 5 = 0
Digit 6 = 0
- (6) Digit 1 = 3 or 4 \implies Digit 2 = 2-9
Digit 3 = 1-9
Digit 4 = 0
Digit 5 = 0
Digit 6 = 0
- (7) Digit 1 = 5 or 6 \implies Digit 2 = 2-9
Digit 3 = 1-9
Digit 4 = 1-9
Digit 5 = 0
Digit 6 = 0
- (8) Digit 1 = 7 or 8 \implies Digit 2 = 2-9
Digit 3 = 1-9
Digit 4 = 1-9
Digit 5 = 1-9
Digit 6 = 0
- (9) The number of axles indicated in the vehicle code must equal the number of axle weights coded for that vehicle.

b. Commodity Code Checks

Cross checks between the commodity code and the load status are performed based on the valid commodity codes as follows:

<u>Commodity Code</u>	<u>Load Status</u>
(1) Columns 36-37 = 01, 08-11, 13, 14, 19-40, 42, 46	Column 41 = 1, 2, or 3
(2) Columns 36-40 = 00000	Column 41 = 0
(3) Columns 36-40 = 99999	Column 41 = 9

c. Axle Weights and Spacings

The number of axle weights coded for a vehicle must correspond to the number of axle spacings.

CHAPTER 8

Truck Weight Data Summaries (FHWA W-Tables)

Introduction

In order for the results of the truck weight surveys to be of value, summaries of the data must be made available in an appropriate form. The W-Tables were designed to provide a standard format for presenting the outcome of the vehicle weighing and classification efforts at truck weigh sites. These summary tables have been produced by FHWA for each submittal of a State's data and returned to the States for their use. This chapter provides a brief description of each of the W-Tables along with a sample of each as produced by the current software.

Table W-1

This table displays the characteristics of each weigh station based on the information contained in the station description records. The characteristics presently include a brief description of the location of the station along with various information on the adjoining roadway, the scale and its hours of operation, the attending personnel, the surrounding environment, and the prevailing weather conditions. A sample of the table is shown on page 5-8-3.

Table W-2

This table includes a summary of the number of vehicles counted and the number of vehicles weighed in each State by each functional classification of the highway, individual station location, and vehicle type. It also compares the figures for the current year to those for the year of the previous data submittal.

Several additional figures are provided in the table and are calculated in the following manner:

1. "Ratio" = $\frac{\text{Current year figure for this category}}{\text{Previous year figure for this category}}$
2. "Percent Distribution Total Vehicles" = $\frac{\text{"Number Counted" of a specific vehicle type}}{\text{"Total of All Vehicles"}} \times 100$
3. "Percent Distribution Trucks & Comb." = $\frac{\text{"Number Counted" of a specific truck type}}{\text{"Total Truck & Comb."}} \times 100$
4. "Percent Dist. of Number Weighed" = $\frac{\text{"Number Weighed" of a specific truck type}}{\text{"Total Truck & Comb."}} \times 100$
5. "Weighed as a Percent of Counted" = $\frac{\text{"Number Weighed" of a specific truck type}}{\text{"Number Counted" of a specific truck type}} \times 100$

TABLE W-2 FOR 1982-84

FUNC. CLASS OF ALL STATIONS

	NUMBER COUNTED			PERCENTAGE DISTRIBUTION						NUMBER WEIGHED		PERCENT DIST. OF NUMBER WEIGHED		WEIGHED AS A PERCENT OF COUNTED	
	1984	1982	RATIO	TOTAL VEHICLES 1984	1982	RATIO	TRUCKS & COMB. 1984	1982	RATIO	1984	1982	1984	1982	1984	1982
PASSENGER VEHICLES															
MOTORCYCLE SCOOTER	809	1173	0.69	0.38	0.58	0.66									
PASSENGER CARS															
SMALL IN STATE	12942	667	19.40	6.12	0.33	18.66									
SMALL OUT OF STATE	0	354	0.00	0.00	0.17	0.00									
SUBTOTAL SMALL	12942	1021	12.68	6.12	0.50	12.19									
STD-COMP IN STATE	82804	79664	1.04	39.15	39.17	1.00									
STD-COMP OUT STATE	27695	44063	0.63	13.10	21.66	0.60									
SUBTOTAL STD-COMP	110499	123727	0.89	52.25	60.83	0.86									
IN STATE ALL CARS	95746	80331	1.19	45.27	39.49	1.15									
OUT STATE ALL CARS	27695	44417	0.62	13.10	21.84	0.60									
SUBTOTAL PASS. CARS	123441	124748	0.99	58.37	61.33	0.95									
BUSES															
COMMERCIAL BUSES	339	428	0.79	0.16	0.21	0.76									
SCHOOL NON-REV BUS	135	172	0.78	0.06	0.08	0.75									
SUBTOTAL ALL BUSES	474	600	0.79	0.22	0.29	0.76									
TOTAL ALL PASS VEH	124724	126521	0.99	58.97	62.20	0.95									
SINGLE UNIT TRUCKS															
PANEL AND PICKUP	23112	20072	1.15	10.93	9.87	1.11	26.64	26.11	1.02	0	0	0.00	0.00	0.00	0.00
2-AXLE, 4 TIRE	119	568	0.21	0.06	0.28	0.20	0.14	0.74	0.19	0	1	0.00	0.02	0.00	0.18
2-AXLE, 6 TIRE	8047	7383	1.09	3.80	3.63	1.05	9.27	9.60	0.97	693	646	10.58	11.19	8.61	8.75
3-AXLE, OR MORE	974	1328	0.73	0.46	0.65	0.71	1.12	1.73	0.65	447	213	6.82	3.69	45.89	16.04
SUBTOTAL SINGLE-UNIT	32252	29351	1.10	15.25	14.43	1.06	37.17	38.18	0.97	1140	860	17.40	14.89	3.53	2.93
COMBINATIONS															
TRACTOR + SEMITRAILER															
2 AXLE TRCTR	4685	4463	1.05	2.22	2.19	1.01	5.40	5.80	0.93	456	538	6.96	9.32	9.73	12.05
3 AXLE TRCTR	48568	42686	1.14	22.96	20.99	1.09	55.98	55.52	1.01	4813	4375	73.46	75.76	9.91	10.25
4 AXLE TRCTR	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1	2	0.02	0.03	0.00	0.00
SUBTOTAL	53253	47149	1.13	25.18	23.18	1.09	61.38	61.32	1.00	5270	4915	80.43	85.11	9.90	10.42
TRUCK + FULL TRAILER															
2 AXLE TRCTR	26	100	0.26	0.01	0.05	0.25	0.03	0.13	0.23	1	0	0.02	0.00	3.85	0.00
3 AXLE TRCTR	0	285	0.00	0.00	0.14	0.00	0.00	0.37	0.00	1	0	0.02	0.00	0.00	0.00
SUBTOTAL	26	385	0.07	0.01	0.19	0.06	0.03	0.50	0.06	2	0	0.03	0.00	7.69	0.00
TRACTOR + SEMITRAILER + FULL TRAILER															
2 AXLE TRCTR	1133	0	0.00	0.54	0.00	0.00	1.31	0.00	0.00	122	0	1.86	0.00	10.77	0.00
3 AXLE TRCTR	99	0	0.00	0.05	0.00	0.00	0.11	0.00	0.00	18	0	0.27	0.00	18.18	0.00
SUBTOTAL	1232	0	0.00	0.58	0.00	0.00	1.42	0.00	0.00	140	0	2.14	0.00	11.36	0.00
TRUCK + FULL TRAILER + FULL TRAILER															
2 AXLE TRCTR	1	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00	0.00	0.00	0.00
SUBTOTAL	1	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00	0.00	0.00	0.00
TOTAL COMBINATIONS	54512	47534	1.15	25.78	23.37	1.10	62.83	61.82	1.02	5412	4915	82.60	85.11	9.93	10.34
TOTAL TRUCK & COMB.	86764	76885	1.13	41.03	37.80	1.09	100.00	100.00	1.00	6552	5775	100.00	100.00	7.55	7.51
TOTAL ALL VEHICLES	211488	203406	1.04	100.00	100.00	1.00									

5-8-5

NOTE: VEHICLES HAVING LOAD STATUS = 2 ARE NOT INCLUDED IN THE W2 TABLES.

Table W-3

This table provides information on the average weights of empty, loaded and all trucks and their average carried loads. This information is broken down by vehicle type, station location and functional classification and is provided for both the current year and the year of the previous data submittal.

The various figures in the table are calculated in the following manner:

1. "Aver Gross Wt. Lbs." = $\frac{\text{Total weight of all trucks weighed in this category}}{\text{Number of trucks weighed in this category}}$
2. "Percent Loaded" = $\frac{\text{Number of loaded trucks}}{\text{Total number of trucks}} \times 100$
3. "Estimated No. Loaded" = "Number Counted" x $\frac{\text{"Percent Loaded"}}{100}$
4. "Aver Load Wt. Lbs." = $\frac{\text{Total weight of loaded trucks in this category}}{\text{Number of loaded trucks in this category}}$
5. "Percent Empty" = $\frac{\text{Number of empty trucks}}{\text{Total number of trucks}} \times 100$
6. "Estimated No. Empty" = "Number Counted" x $\frac{\text{"Percent Empty"}}{100}$
7. "Aver Empty Wt. Lbs." = $\frac{\text{Total weight of empty trucks in this category}}{\text{Number of empty trucks in this category}}$
8. "Carried Load Wtd. Avg Lbs." = "Aver Load Wt. Lbs." - "Aver Empty Wt. Lbs."
9. "Ratio" = $\frac{\text{Current year figure for this category}}{\text{Previous year figure for this category}}$

TABLE W-3 FOR 1982-84
 NUMBER OF LOADED AND EMPTY VEHICLES, AVER. WEIGHT, AND AVER. LOADS BY VEHICLE TYPE

FUNC. CLASS 01
 ALL STATIONS

VEHICLE TYPE	YEAR OF SURVEY	TOTAL VEHICLES		LOADED VEHICLES			EMPTY VEHICLES			CARRIED LOAD WTD. AVG LBS
		NUMBER COUNTED	AVER GROSS WT. LBS.	PERCENT LOADED	ESTIMATED NO. LOADED	AVER LOAD WT. LBS.	PERCENT EMPTY	ESTIMATED NO. EMPTY	AVER EMPTY WT. LBS.	
SINGLE UNIT TRUCKS										
PANEL AND PICKUP	1984	23,112	0	0.00	0	0	0.00	0	0	0
	1982	20,072	0	0.00	0	0	0.00	0	0	0
	RATIO	1.151	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2-AXLE, 4 TIRE	1984	119	0	0.00	0	0	0.00	0	0	0
	1982	568	7,400	100.00	568	7,400	0.00	0	0	0
	RATIO	0.210	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2-AXLE, 6 TIRE	1984	8,047	14,775	61.04	4,812	15,918	38.96	3,135	12,984	2,933
	1982	7,383	14,786	66.25	4,891	15,860	33.75	2,492	12,678	3,181
	RATIO	1.090	0.999	0.921	1.004	1.004	1.154	1.258	1.024	0.922
3-AXLE, OR MORE	1984	974	45,840	71.14	693	52,986	28.86	281	28,225	24,760
	1982	1,328	30,261	47.89	636	37,895	52.11	692	23,245	14,649
	RATIO	0.733	1.515	1.485	1.090	1.398	0.554	0.406	1.214	1.690
COMBINATIONS										
TRACTOR + SEMITRAILER										
2 AXLE TRCTR	1984	4,685	33,088	68.64	3,216	36,005	31.36	1,469	26,704	9,300
	1982	4,463	33,949	70.26	3,136	36,684	29.74	1,327	27,488	9,196
	RATIO	1.050	0.975	0.977	1.026	0.981	1.054	1.107	0.972	1.011
3 AXLE TRCTR	1984	48,568	51,441	76.36	37,087	57,315	23.64	11,481	32,470	24,845
	1982	42,686	50,449	75.02	32,023	56,593	24.98	10,663	32,001	24,592
	RATIO	1.138	1.020	1.018	1.158	1.013	0.946	1.077	1.015	1.010
TRUCK + FULL TRAILER										
2 AXLE TRCTR	1984	26	61,500	100.00	26	61,500	0.00	0	0	0
	1982	100	0	0.00	0	0	0.00	0	0	0
	RATIO	0.260	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3 AXLE TRCTR	1984	0	51,800	0.00	0	0	0.00	0	0	0
	1982	285	0	0.00	0	0	0.00	0	0	0
	RATIO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRACTOR + SEMITRAILER + FULL TRAILER										
2 AXLE TRCTR	1984	1,133	58,448	97.54	1,105	59,174	2.46	28	29,633	29,541
	1982	0	0	0.00	0	0	0.00	0	0	0
	RATIO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3 AXLE TRCTR	1984	99	61,944	94.44	93	63,564	5.56	6	34,400	29,164
	1982	0	0	0.00	0	0	0.00	0	0	0
	RATIO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TRUCK + FULL TRAILER + FULL TRAILER										
2 AXLE TRCTR	1984	1	0	0.00	0	0	0.00	0	0	0
	1982	0	0	0.00	0	0	0.00	0	0	0
	RATIO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

5-8-7

NOTE: FOR VEHICLE TYPES THAT WERE COUNTED BUT NOT WEIGHED, THE NUMBER COUNTED IS GIVEN AND WEIGHT RELATED FIELDS ARE ZERO FILLED. VEHICLES HAVING LOAD STATUS = '2' ARE NOT INCLUDED IN THE W3 TABLES.

Table W-4

This table is most commonly used in pavement design since it contains information on truck axle loadings and their effect on flexible and rigid pavements based on 18-KIP equivalent axle loads. It also provides the number of single, tandem, and total axles weighed that fall into particular weight ranges and gives the resulting 18-KIP equivalent axle loads on the two types of pavement. All of the information is produced by truck type and can be shown for each station location and/or functional classification.

The 18-KIP axle equivalence factors used in the calculation of the 18-KIP equivalent axle loads are those recommended by the American Association of State Highway Transportation Officials. The 18-KIP values most commonly used in the W-4 table are associated with the following pavement conditions:

1. Rigid Pavement, $P = 2.5$, $D = 9$

This is concrete pavement with a serviceability value of 2.5 and a depth of 9 inches. (Serviceability values range from 0.0 to 5.0 with 0.0 representing the worst possible pavement condition and 5.0 representing the best possible pavement condition.)

2. Flexible Pavement, $P = 2.5$, $SN = 5$

This is asphalt pavement with a serviceability value of 2.5 and a structural number of 5. (The structural number is calculated from the depth and layer coefficient of the subbase, base and surface courses.)

The 18-KIP axle equivalence factors for pavement depths of 6 inches through 11 inches, a serviceability rating of 2.0, and structural numbers of 1 through 6 may be used in the table if desired.

An example of the Table W-4 is given on pages 5-8-11 through 5-8-20. The majority of the figures in the table are the numbers of axles weighed that fall into particular categories. The remaining figures are calculated from this information. The following definitions for determining these figures and examples of their derivation based on the example table are intended to help those using this table to better understand its contents.

1. "Probable No." = The product of the number of axles weighed in a specific weight range for a specific truck type and the ratio of total axles counted to total axles weighed for that truck type, summed for each truck type in the category.

e.g., (see page 5-8-13),

$$A_{10} = \frac{A_1 \times A_3}{A_2} + \frac{A_4 \times A_6}{A_5} + \frac{A_7 \times A_9}{A_8}$$

2. "18 K Eqv for All Trucks Weighed" = By truck type, the summation of 18-KIP equivalent axle loads calculated from the product of the number of axles in each weight range and the 18-KIP axle equivalence factor for that weight range.

e.g., (see pages 5-8-13 and 5-8-14),

$$B100 = (B1 \times C1) + (B2 \times C2) + (B3 \times C3) + \dots (B12 \times C12) + (B13 \times C13) + (D1 \times E1) + (D2 \times E2) + (D3 \times E3) + \dots (D15 \times E15) + (D16 \times E16)$$

and
$$F100 = (F1 \times C1) + (F2 \times C2) + (F3 \times C3) + \dots (F12 \times C12) + (F13 \times C13) + (G1 \times E1) + (G2 \times E2) + (G3 \times E3) + \dots (G15 \times E15) + (G16 \times E16)$$

3. "18 K Eqv per 1000 Trucks Weighed" = Average 18-KIP equivalent axle load per truck multiplied by 1,000.

e.g., (see pages 5-8-13 and 5-8-14),

$$H1 = \frac{H2}{H4} \times 1,000 \quad \text{or} \quad \frac{H2 \times H4 \times 1000}{H3}$$

NOTE: While H4 is nominally equal to the column heading, it is in fact calculated from the number of axles coded on the individual truck records.

4. "18 K Eqv for All Trucks Counted" = The ratio of the number of axles counted to the number of axles weighed multiplied by the 18-KIP equivalent axle load for all trucks weighed.

e.g., (see page 5-8-14),

$$J1 = \frac{J2}{H3} \times H2$$

5. "Percent Distribution of 18 K Eqv" = The 18-KIP equivalent axle load for all trucks counted in a particular truck type divided by the same figure under "Total All Trucks and Combinations Probable No." (on Part 5 of Table W-4).

e.g., (see pages 5-8-14 and 5-8-20),

$$K1 = (J1/K2) \times 100$$

6. "Total All Combinations Probable No." (Part 5 only) = The sum of the probable numbers from Parts 2-4 of this table.

e.g., (see pages 5-8-13, 5-8-15, 5-8-17, and 5-8-19),

$$L1 = \frac{L2}{\text{(Part 5)}} + \frac{L3}{\text{(Part 2)}} + \frac{L4}{\text{(Part 3)}} + \frac{L4}{\text{(Part 4)}}$$

7. "Total All Trucks and Combinations Probable No." (Part 5 only) = The sum of the probable numbers from Parts 1-4 of this table.

e.g., (see pages 5-8-11, 5-8-13, 5-8-15, 5-8-17, and 5-8-19),

$$M1 = M2 + L2 + L3 + L4 = M2 + L1$$

(Part 5) (Part 1) (Part 2) (Part 3) (Part 4)

8. "Percent Heavier Than Low Weight Interval" (Part 5 only) = 100 percent minus the percentage of the probable number of axles in a lower weight group.

e.g., (see page 5-8-19),

$$N1 = 100 - \frac{(N2 + N3 + N4 + N5) \times 100}{N6}$$

9. "Axles per 1,000 Trucks and Combinations" (Part 5 only) = The ratio of the probable number of trucks in a weight range to the probable number of total trucks counted, multiplied by 1,000.

e.g., (see pages 5-8-19 and 5-8-20),

$$P1 = (M1/P2) \times 1,000$$

10. "Ratio 1980/1979" = The ratio of the probable number of axles per 1,000 trucks for 1980 to the same figure for 1979.

e.g., (see page 5-8-19),

$$Q1 = Q2/Q3$$

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TABLE W-4

NUMBER OF AXLE LOADS OF VARIOUS MAGNITUDES OF LOADED AND EMPTY TRUCKS AND TRUCK COMBINATIONS OF EACH TYPE WEIGHED, THE PROBABLE NUMBER OF SUCH LOADS AND THE EIGHTEEN KIP AXLE EQUIVALENTS OF EACH GENERAL TYPE AND OF ALL TYPES COUNTED DURING 1984 COMPARED TO CORRESPONDING DATA FOR 1982

5-8-11

AXLE LOADS IN POUNDS AND EIGHTEEN KIP AXLE EQUIVALENCY ITEMS	18 KIP AXLE EQUIVALENCY FACTOR		SINGLE-UNIT TRUCKS									
	RIGID PAVEMENT	FLEXIBLE PAVEMENT	PANEL AND PICKUP (UNDER 1 TON)		2 AXLE 4 TIRE		2 AXLE 6 TIRE		3 AXLE OR MORE		SINGLE-UNIT TRUCKS PROBABLE NO.	
	P=2.5, D-9"	P=2.5, SN-5	1984	1982	1984	1982	1984	1982	1984	1982	1984	1982
	SINGLE AXLES											
UNDER 3,000	0.0002	0.0002	0	0	0	1	63	53	16	8	765	1211
3,000 - 6,999	0.0050	0.0050	0	0	0	1	647	621	131	50	7799 M2	7824
7,000 - 7,999	0.0260	0.0320	0	0	0	0	155	168	40	45	1887	2157
8,000 - 11,999	0.0820	0.0870	0	0	0	0	386	338	265	133	5060	4603
12,000 - 15,999	0.3410	0.3600	0	0	0	0	97	99	103	76	1351	1577
16,000 - 18,000	0.7830	0.7960	0	0	0	0	23	24	35	12	343	342
18,001 - 18,500	1.0650	1.0500	0	0	0	0	4	2	4	1	55	28
18,501 - 20,000	1.3360	1.3070	0	0	0	0	2	10	4	2	32	124
20,001 - 21,999	1.9260	1.8260	0	0	0	0	7	4	5	4	92	70
22,000 - 23,999	2.8180	2.5830	0	0	0	0	1	1	5	1	23	17
24,000 - 25,999	3.9760	3.5330	0	0	0	0	0	0	0	0	0	0
26,000 - 29,999	6.2890	5.3890	0	0	0	0	1	0	1	0	14	0
30,000 OR OVER	11.3950	9.4320	0	0	0	0	0	0	0	0	0	0
TOTAL SINGLE AXLES WEIGHED			0	0	0	2	1386	1320	609	332		
TOTAL SINGLE AXLES COUNTED			23112	20072	119	1136	16094	14766	1327	2051	17421	17953
			TANDEM AXLE GROUPS									
UNDER 6,000	0.0100	0.0100	0	0	0	0	0	0	6	4	13	25
6,000 - 11,999	0.0100	0.0100	0	0	0	0	0	0	115	65	251	402
12,000 - 17,999	0.0620	0.0440	0	0	0	0	0	0	146	57	318	352
18,000 - 23,999	0.2530	0.1480	0	0	0	0	0	0	150	23	327	142
24,000 - 29,999	0.7290	0.4260	0	0	0	0	0	0	109	22	238	136
30,000 - 32,000	1.3050	0.7530	0	0	0	0	0	0	58	2	126	12
32,001 - 32,500	1.5420	0.8850	0	0	0	0	0	0	9	2	20	12
32,501 - 33,999	1.7510	1.0020	0	0	0	0	0	0	36	4	78	25
34,000 - 35,999	2.1650	1.2300	0	0	0	0	0	0	29	5	63	31
36,000 - 37,999	2.7210	1.5330	0	0	0	0	0	0	11	4	24	25
38,000 - 39,999	3.3730	1.8850	0	0	0	0	0	0	6	2	13	12
40,000 - 41,999	4.1290	2.2890	0	0	0	0	0	0	0	1	0	6
42,000 - 43,999	4.9970	2.7490	0	0	0	0	0	0	0	0	0	0
44,000 - 45,999	5.9870	3.2690	0	0	0	0	0	0	1	0	2	0
46,000 - 49,999	7.7250	4.1700	0	0	0	0	0	0	0	0	0	0
50,000 OR OVER	10.1600	5.1000	0	0	0	0	0	0	2	0	4	0
TOTAL TANDEM AXLES WEIGHED			0	0	0	0	0	0	678	191		

TOTAL TANDEM AXLES COUNTED	23112	20072	119	0	0	0	1477	1180	1477	1180
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ALL AXLES

UNDER 3,000	0	0	0	1	63	53	63	50	870	1469
3,000 - 6,999	0	0	0	1	647	621	421	165	8430	8534
7,000 - 7,999	0	0	0	0	155	168	152	95	2131	2466
8,000 - 11,999	0	0	0	0	386	338	623	224	5840	5165
12,000 - 15,999	0	0	0	0	97	99	417	125	2035	1879
16,000 - 16,250	0	0	0	0	6	7	65	5	212	109
16,251 - 17,999	0	0	0	0	17	17	157	26	539	351
18,000 - 18,500	0	0	0	0	4	2	19	6	87	59
18,501 - 19,999	0	0	0	0	2	9	19	5	64	132
20,000 - 21,999	0	0	0	0	7	5	15	10	114	118
22,000 - 23,999	0	0	0	0	1	1	8	3	29	30
24,000 - 25,999	0	0	0	0	0	0	1	0	2	0
26,000 - 29,999	0	0	0	0	1	0	4	0	21	0
30,000 OR OVER	0	0	0	0	0	0	1	0	2	0

TOTAL AXLES WEIGHED	0	0	0	2	1386	1320	1965	714		
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TOTAL AXLES COUNTED	23112	20072	119	1136	16094	14766	4282	4410	20376	20312
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TOTAL VEHICLES COUNTED	23112	20072	119	568	8047	7383	974	1328	32252	29351
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18 KIP AXLE EQUIVALENTS

RIGID PAVEMENT, P-2.5, D-9"

18 K EQV FOR ALL TRUCKS WEIGHED	0.0	0.0	0.0	0.0	119.5	113.8	545.1	133.3	664.6	247.1
18 K EQV PER 1000 TRUCKS WEIGHED	0.0	0.0	0.0	5.2	172.5	172.4	1219.5	619.8	79.8	71.4
18 K EQV FOR ALL TRUCKS COUNTED	0.0	0.0	0.0	3.0	1388.0	1272.6	1187.8	823.1	2575.8	2098.7
PERCENT DISTRIBUTION OF 18 K EQV	0.01	0.0	0.0	0.01	2.18	2.65	1.86	1.71	4.05	4.37

FLEXIBLE PAVEMENT, P-2.5, SN=5

18 K EQV FOR ALL TRUCKS WEIGHED	0.0	0.0	0.0	0.0	122.6	117.7	368.1	105.3	490.7	223.0
18 K EQV PER 1000 TRUCKS WEIGHED	0.0	0.0	0.0	5.2	176.9	178.4	823.5	489.9	69.0	67.1
18 K EQV FOR ALL TRUCKS COUNTED	0.0	0.0	0.0	3.0	1423.9	1316.8	802.1	650.6	2226.0	1970.4
PERCENT DISTRIBUTION OF 18 K EQV	0.0	0.0	0.0	0.01	3.35	4.05	1.89	2.00	5.24	6.06

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TABLE W-4

5-8-13

AXLE LOADS IN POUNDS AND EIGHTEEN KIP AXLE EQUIVALENCY ITEMS	18 KIP AXLE EQUIVALENCY FACTOR		TRACTOR SEMI-TRAILER COMBINATIONS										
	RIGID PAVEMENT	FLEXIBLE PAVEMENT	H4 3 AXLE		4 AXLE		5 AXLE OR MORE		TRACTOR SEMI-TRAILER COMBINATIONS PROBABLE NO.				
	P-2.5, D-9"	P-2.5, SN-5	1984	1982	1984	1982	1984	1982	1984	1982			
SINGLE AXLES													
UNDER 3,000	B1	0.0002	0.0002	F1	1	0	4	C1	3	40	23	453	247
3,000 - 6,999	B2	0.0050	0.0050	F2	78	31	92	C2	112	912	503	10955	L2 6085
7,000 - 7,999	B3	0.0260	0.0320	F3	43	29	88	C3	128	376	347	5148	4663
8,000 - 11,999	*	0.0820	0.0870	*	131	133 A3	372	*	508 A6	3593	3746 A9	41434	41813 A10
12,000 - 15,999	*	0.3410	0.3600	*	31	47	126	*	133	639	523	8070	6603
16,000 - 18,000	*	0.7830	0.7960	*	8	3	20	*	26	137	111	1671	1313
18,001 - 18,500	*	1.0650	1.0600	*	2	1	5	*	5	18	8	264	126
18,501 - 20,000	*	1.3360	1.3070	*	2	0	2	*	3	17	16	213	179
20,001 - 21,999	*	1.9260	1.8260	*	1	0	6	*	5	9	15	163	184
22,000 - 23,999	*	2.8180	2.5830	*	0	0	3	*	0	3	5	61	49
24,000 - 25,999	*	3.9760	3.5330	*	0	0	0	*	1	1	1	10	18
26,000 - 29,999	B12	6.2890	5.3890	F12	0	0	0	C12	0	0	2	0	20
30,000 OR OVER	B13	11.3950	9.4320	F13	0	0	0	C13	0	1	1	10	10
TOTAL SINGLE AXLES WEIGHED					298	244 A2	718	924 A5	5746	5301 A8			
TOTAL SINGLE AXLES COUNTED					3084	2484 A1	7445	7085 A4	57923	51741 A7	68452	61310	
TANDEM AXLE GROUPS													
UNDER 6,000	D1	0.0100	0.0100	G1	0	1	3	E1	2	38	35	415	365
6,000 - 11,999	D2	0.0100	0.0100	G2	0	0	124	E2	146	1589	1567	17304	16415
12,000 - 17,999	D3	0.0620	0.0440	G3	0	1	136	E3	166	2040	1843	21974	19272
18,000 - 23,999	*	0.2530	0.1480	*	1	2	61	*	92	1900	1775	19796	18052
24,000 - 29,999	*	0.7290	0.4260	*	0	0	13	*	21	2087	2060	21173	20268
30,000 - 32,000	*	1.3050	0.7530	*	0	0	2	*	2	733	567	7410	5549
32,001 - 32,500	*	1.5420	0.8850	*	0	0	0	*	0	111	98	1119	957
32,501 - 33,999	*	1.7510	1.0020	*	0	0	3	*	1	297	196	3025	1921
34,000 - 35,999	*	2.1650	1.2300	*	0	0	1	*	2	216	141	2187	1391
36,000 - 37,999	*	2.7210	1.5330	*	0	0	2	*	1	91	41	938	408
38,000 - 39,999	*	3.3730	1.8850	*	0	0	0	*	0	41	9	413	88
40,000 - 41,999	*	4.1290	2.2890	*	0	0	0	*	0	15	8	151	78
42,000 - 43,999	*	4.9970	2.7490	*	0	0	0	*	0	17	3	171	29
44,000 - 45,999	*	5.9870	3.2690	*	0	0	0	*	0	4	2	40	20
46,000 - 49,999	D15	7.7250	4.1700	G15	0	0	0	E15	1	10	0	101	8
50,000 OR OVER	D16	10.1600	5.1000	G16	0	0	0	E16	0	8	1	81	10
TOTAL TANDEM AXLES WEIGHED					1	4	345	434	9197	8346			

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TOTAL TANDEM AXLES COUNTED 10 41 3577 3328 92711 81462 96298 84831

ALL AXLES

UNDER 3,000	1	1	18	15	257	212	2787	2191
3,000 - 6,999	78	33	442	501	5697	4990	62819	52884
7,000 - 7,999	43	30	172	226	1591	1481	18267	16494
8,000 - 11,999	133	136	564	819	8517	8366	93081	89323
12,000 - 15,999	31	48	163	176	5719	5459	59662	55122
16,000 - 16,250	0	1	4	7	409	314	4164	3129
16,251 - 17,999	8	2	19	24	1290	835	13284	8354
18,000 - 18,500	3	1	9	11	239	127	2533	1334
18,501 - 19,999	2	0	4	6	221	129	2290	1305
20,000 - 21,999	1	0	10	5	131	52	1435	546
22,000 - 23,999	0	0	3	0	38	15	414	146
24,000 - 25,999	0	0	0	1	14	4	141	47
26,000 - 29,999	0	0	0	0	8	7	81	68
30,000 OR OVER	0	0	0	1	9	2	91	28

TOTAL AXLES WEIGHED 300 H3 252 1408 1792 24140 21993

TOTAL AXLES COUNTED 3105 J2 2565 14600 13740 243344 214666 261049 230971

TOTAL VEHICLES COUNTED 1035 855 3650 3435 48568 42859 53253 47149

18 KIP AXLE EQUIVALENTS

RIGID PAVEMENT, P=2.5, D=9"

18 K EQV FOR ALL TRUCKS WEIGHED	37.1	H2	31.8	170.0	B100	203.7	5692.7	4517.5	5899.8	4753.0
18 K EQV PER 1000 TRUCKS WEIGHED	371.3	H1	379.0	482.9		454.7	1181.6	1028.8	1117.8	975.5
18 K EQV FOR ALL TRUCKS COUNTED	384.3	J1	324.0	1762.4		1561.8	57385.6	44093.4	59532.3	45979.2
PERCENT DISTRIBUTION OF 18 K EQV	0.60	K1	0.67	2.76		3.25	89.98	91.71	93.34	95.63

FLEXIBLE PAVEMENT, P=2.5, SN=5

18 K EQV FOR ALL TRUCKS WEIGHED	38.5		33.4	154.2	F100	181.3	3629.9	2948.5	3822.6	3163.2
18 K EQV PER 1000 TRUCKS WEIGHED	384.6		397.3	438.0		404.8	753.4	671.5	724.6	647.3
18 K EQV FOR ALL TRUCKS COUNTED	398.1		339.7	1598.6		1390.3	36591.4	28779.1	38588.1	30509.1
PERCENT DISTRIBUTION OF 18 K EQV	0.94		1.05	3.76		4.28	86.09	88.61	90.79	93.94

INTST RURAL
INCLUDES 12 STATIONS

PART 3 OF 5

TABLE W-4

AXLE LOADS IN POUNDS AND EIGHTEEN KIP AXLE EQUIVALENCY ITEMS	18 KIP AXLE EQUIVALENCY FACTOR		SEMI-TRAILER TRAILER				SEMI-TRAILER TRAILER COMBINATIONS PROBABLE NO.			
	RIGID PAVEMENT	FLEXIBLE PAVEMENT	5 AXLE		6 AXLE OR MORE		1984	1982		
	P=2.5, D=9''	P=2.5, SN=5	1984	1982	1984	1982	1984	1982		
			SINGLE AXLES							
UNDER 3,000	0.0002	0.0002	3	0	0	0	28	0		
3,000 - 6,999	0.0050	0.0050	71	0	12	0	728 L3	0		
7,000 - 7,999	0.0260	0.0320	19	0	6	0	209	0		
8,000 - 11,999	0.0820	0.0870	233	0	33	0	2354	0		
12,000 - 15,999	0.3410	0.3600	179	0	14	0	1749	0		
16,000 - 18,000	0.7830	0.7960	62	0	6	0	612	0		
18,001 - 18,500	1.0650	1.0600	8	0	1	0	80	0		
18,501 - 20,000	1.3360	1.3070	15	0	0	0	140	0		
20,001 - 21,999	1.9260	1.8260	3	0	0	0	28	0		
22,000 - 23,999	2.8180	2.5830	0	0	0	0	0	0		
24,000 - 25,999	3.9760	3.5330	0	0	0	0	0	0		
26,000 - 29,999	6.2890	5.3890	0	0	0	0	0	0		
30,000 OR OVER	11.3950	9.4320	0	0	0	0	0	0		
TOTAL SINGLE AXLES WEIGHED			593	0	72	0				
TOTAL SINGLE AXLES COUNTED			5553	0	375	0	5928	0		
			TANDEM AXLE GROUPS							
UNDER 6,000	0.0100	0.0100	0	0	0	0	0	0		
6,000 - 11,999	0.0100	0.0100	0	0	2	0	11	0		
12,000 - 17,999	0.0620	0.0440	2	0	6	0	49	0		
18,000 - 23,999	0.2530	0.1480	2	0	9	0	66	0		
24,000 - 29,999	0.7290	0.4260	2	0	2	0	29	0		
30,000 - 32,000	1.3050	0.7530	0	0	1	0	5	0		
32,001 - 32,500	1.5420	0.8850	0	0	0	0	0	0		
32,501 - 33,999	1.7510	1.0020	0	0	0	0	0	0		
34,000 - 35,999	2.1650	1.2300	0	0	1	0	5	0		
36,000 - 37,999	2.7210	1.5330	0	0	0	0	0	0		
38,000 - 39,999	3.3730	1.8850	0	0	0	0	0	0		
40,000 - 41,999	4.1290	2.2890	0	0	0	0	0	0		
42,000 - 43,999	4.9970	2.7490	0	0	0	0	0	0		
44,000 - 45,999	5.9870	3.2690	0	0	0	0	0	0		
46,000 - 49,999	7.7250	4.1700	0	0	0	0	0	0		
50,000 OR OVER	10.1600	5.1000	0	0	0	0	0	0		
TOTAL TANDEM AXLES WEIGHED			6	0	21	0				

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TOTAL TANDEM AXLES COUNTED	56	0	109	0	165	0
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ALL AXLES

UNDER 3,000	3	0	1	0	34	0
3,000 - 6,999	73	0	16	0	767	0
7,000 - 7,999	20	0	13	0	255	0
8,000 - 11,999	239	0	56	0	2530	0
12,000 - 15,999	182	0	18	0	1798	0
16,000 - 16,250	8	0	2	0	85	0
16,251 - 17,999	53	0	5	0	522	0
18,000 - 18,500	9	0	1	0	89	0
18,501 - 19,999	13	0	0	0	122	0
20,000 - 21,999	5	0	1	0	52	0
22,000 - 23,999	0	0	1	0	5	0
24,000 - 25,999	0	0	0	0	0	0
26,000 - 29,999	0	0	0	0	0	0
30,000 OR OVER	0	0	0	0	0	0

TOTAL AXLES WEIGHED	605	0	114	0		
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TOTAL AXLES COUNTED	5665	0	594	0	6259	0
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TOTAL VEHICLES COUNTED	1133	0	99	0	1232	0
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18 KIP AXLE EQUIVALENTS

RIGID PAVEMENT, P=2.5, D=9"

18 K EQV FOR ALL TRUCKS WEIGHED	166.0	0.0	21.1	0.0	187.1	0.0
18 K EQV PER 1000 TRUCKS WEIGHED	1371.6	0.0	1108.2	0.0	1349.2	0.0
18 K EQV FOR ALL TRUCKS COUNTED	1554.1	0.0	109.7	0.0	1663.8	0.0
PERCENT DISTRIBUTION OF 18 K EQV	2.44	0.0	0.17	0.0	2.61	0.0

FLEXIBLE PAVEMENT, P=2.5, SN=5

18 K EQV FOR ALL TRUCKS WEIGHED	169.8	0.0	18.4	0.0	188.2	0.0
18 K EQV PER 1000 TRUCKS WEIGHED	1403.5	0.0	971.1	0.0	1367.8	0.0
18 K EQV FOR ALL TRUCKS COUNTED	1590.2	0.0	96.1	0.0	1686.3	0.0
PERCENT DISTRIBUTION OF 18 K EQV	3.74	0.0	0.23	0.0	3.97	0.0

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INTST RURAL
INCLUDES 12 STATIONS

PART 5 OF 5

TABLE W-4

AXLE LOADS IN POUNDS AND EIGHTEEN KIP AXLE EQUIVALENCY ITEMS	18 KIP AXLE EQUIVALENCY FACTOR		TOTAL ALL COMBINATIONS PROBABLE NO.		TOTAL ALL TRUCKS AND COMBINATIONS PROBABLE NO.		PERCENT HEAVIER THAN LOW WEIGHT INTERVAL		AXLES PER 1000 TRUCKS AND COMBINATIONS		RATIO 1984 1982
	RIGID PAVEMENT	FLXIBLE PAVEMENT	1984	1982	1984	1982	1984	1982	1984	1982	
	P=2.5, D=9''	P=2.5, SN=5									
SINGLE AXLES											
UNDER 3,000	0.0002	0.0002	481	247	1246	1458	N2 100.00	100.00	14.36	18.96	0.757
3,000 - 6,999	0.0050	0.0050	11684	6085	19483	13909	N3 98.64	98.16	224.55	180.91	1.241
7,000 - 7,999	0.0260	0.0320	5357	4663	7244	6820	N4 77.42	80.61	83.49	88.70	0.941
8,000 - 11,999	0.0820	0.0870	43789	41813	48849	46416	N5 69.53	72.01	563.01	603.71	0.933
12,000 - 15,999	0.3410	0.3600	9820	6603	11171	8180	16.32	13.45	128.75	106.39	1.210
16,000 - 18,000	0.7830	0.7960	2283	1313	2626	1655	4.15	3.13	30.27	21.53	1.406
18,001 - 18,500	1.0650	1.0600	344	126	399	154	1.29	1.04	4.60	2.00	2.296
18,501 - 20,000	1.3360	1.3070	353	179	385	303	0.86	0.85	4.44	3.94	1.126
20,001 - 21,999	1.9260	1.8260	191	184	283	254	0.44	0.46	3.26	3.30	0.987
22,000 - 23,999	2.8180	2.5830	61	49	84	66	0.13	0.14	0.97	0.86	1.128
24,000 - 25,999	3.9760	3.5330	10	18	10	18	0.04	0.06	0.12	0.23	0.492
26,000 - 29,999	6.2890	5.3890	0	20	14	20	0.03	0.04	0.16	0.26	0.620
30,000 OR OVER	11.3950	9.4320	10	10	10	10	0.01	0.01	0.12	0.13	0.886
TOTAL SINGLE AXLES WEIGHED											
TOTAL SINGLE AXLES COUNTED			74383	61310	91804	79263	N6 100.00	100.00	0.0	0.0	0.0
TANDEM AXLE GROUPS											
UNDER 6,000	0.0100	0.0100	415	365	428	390	100.00	100.00	4.93	5.07	0.972
6,000 - 11,999	0.0100	0.0100	17315	16415	17566	16817	99.56	99.55	202.46	218.73	0.926
12,000 - 17,999	0.0620	0.0440	22023	19272	22341	19624	81.63	79.99	257.49	255.24	1.009
18,000 - 23,999	0.2530	0.1480	19863	18052	20190	18194	58.82	57.18	232.70	236.64	0.983
24,000 - 29,999	0.7290	0.4260	21203	20268	21441	20404	38.20	36.03	247.12	265.38	0.931
30,000 - 32,000	1.3050	0.7530	7415	5549	7541	5561	16.31	12.30	86.91	72.33	1.202
32,001 - 32,500	1.5420	0.8850	1119	957	1139	969	8.61	5.84	13.13	12.60	1.042
32,501 - 33,999	1.7510	1.0020	3025	1921	3103	1946	7.45	4.71	35.76	25.31	1.413
34,000 - 35,999	2.1650	1.2300	2192	1391	2255	1422	4.28	2.45	25.99	18.50	1.405
36,000 - 37,999	2.7210	1.5330	938	408	962	433	1.98	0.80	11.09	5.63	1.969
38,000 - 39,999	3.3730	1.8850	413	88	426	100	1.00	0.29	4.91	1.30	3.775
40,000 - 41,999	4.1290	2.2890	151	78	151	84	0.56	0.18	1.74	1.09	1.593
42,000 - 43,999	4.9970	2.7490	171	29	171	29	0.41	0.08	1.97	0.38	5.225
44,000 - 45,999	5.9870	3.2690	40	20	42	20	0.23	0.04	0.48	0.26	1.861
46,000 - 49,999	7.7250	4.1700	101	8	101	8	0.19	0.02	1.16	0.10	11.188
50,000 OR OVER	10.1600	5.1000	81	10	85	10	0.09	0.01	0.98	0.13	7.532
TOTAL TANDEM AXLES WEIGHED											

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TOTAL TANDEM AXLES COUNTED	96465	84831	97942	86011	100.00	100.00	0.0	0.0	0.0
ALL AXLES									
UNDER 3,000	2821	2191	3691	3660	100.00	100.00	42.54	47.60	0.894
3,000 - 6,999	63587	52884	72017	61418	98.72	98.54	830.03	798.83	1.039
7,000 - 7,999	18522	16494	20653	18960	73.68	74.10	238.04	246.60	0.965
8,000 - 11,999	95613	89323	101453	94488	66.51	66.56	1169.30	1228.95	0.951
12,000 - 15,999	61463	55122	63498	57001	31.24	28.95	731.85	741.38	0.987
16,000 - 16,250	4249	3129	4461	3238	9.17	6.27	51.42	42.11	1.221
16,251 - 17,999	13806	8354	14345	8705	7.62	4.98	165.33	113.22	1.460
18,000 - 18,500	2622	1334	2709	1393	2.63	1.52	31.22	18.12	1.723
18,501 - 19,999	2412	1305	2476	1437	1.69	0.96	28.54	18.69	1.527
20,000 - 21,999	1487	546	1601	664	0.83	0.39	18.45	8.64	2.137
22,000 - 23,999	419	146	448	176	0.27	0.13	5.16	2.29	2.256
24,000 - 25,999	141	47	143	47	0.12	0.06	1.65	0.61	2.696
26,000 - 29,999	81	68	102	68	0.07	0.04	1.18	0.88	1.329
30,000 OR OVER	91	28	93	28	0.03	0.01	1.07	0.36	2.943

TOTAL AXLES WEIGHED

TOTAL AXLES COUNTED	267314	230971	287690	251283	100.00	100.00	0.0	0.0	0.0
TOTAL VEHICLES COUNTED	54512	47534	86764	P2 76885	0.0	0.0	0.0	0.0	0.0

18 KIP AXLE EQUIVALENTS

RIGID PAVEMENT, P=2.5, D-9"				
18 K EQV FOR ALL TRUCKS WEIGHED	6088.9	4753.0	6753.5	5000.1
18 K EQV PER 1000 TRUCKS WEIGHED	1122.5	967.6	734.9	K2 625.5
18 K EQV FOR ALL TRUCKS COUNTED	61197.1	45979.2	63772.9	48077.9
PERCENT DISTRIBUTION OF 18 K EQV	95.95	95.63	100.00	100.00

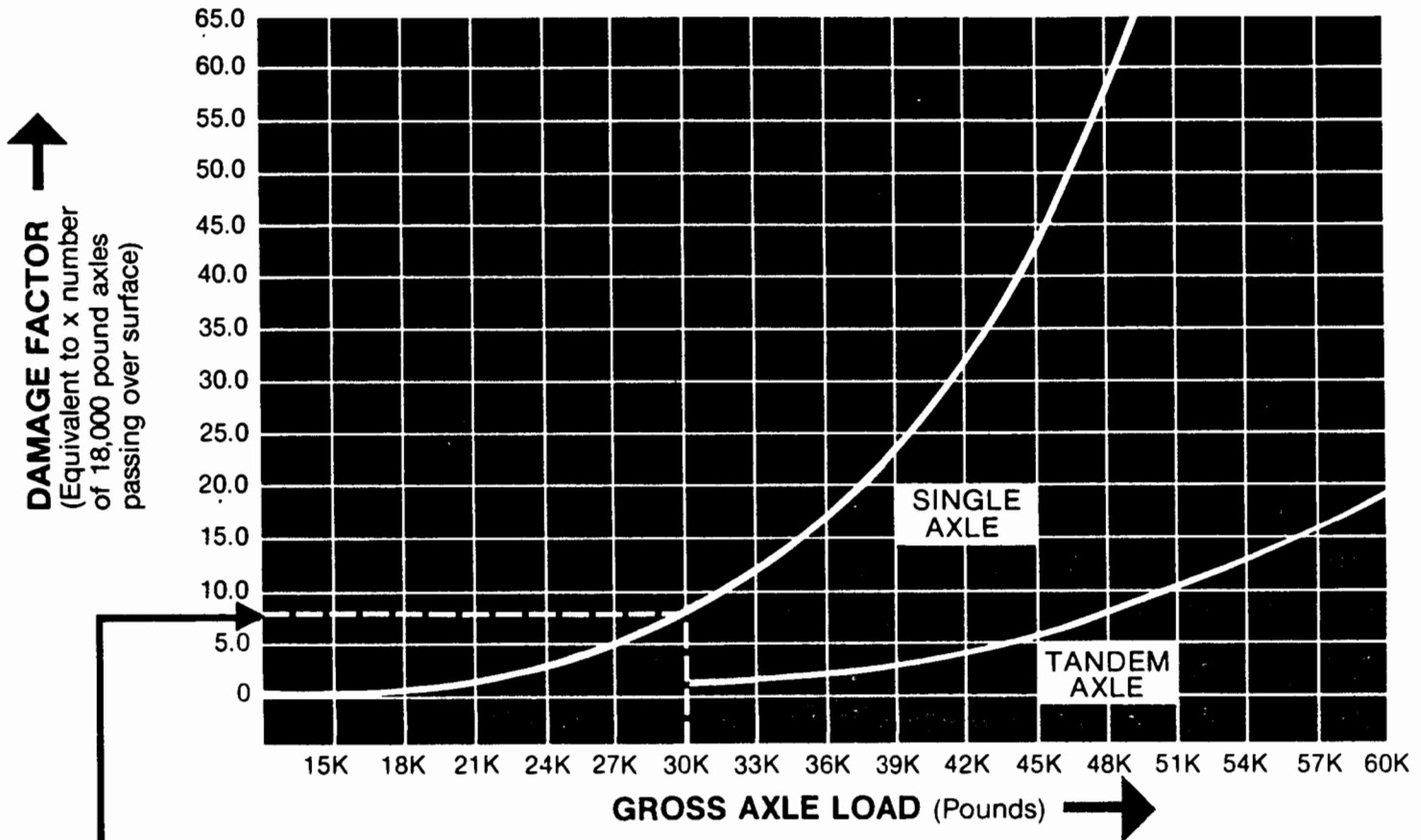
FLEXIBLE PAVEMENT, P-2.5, SN=5				
18 K EQV FOR ALL TRUCKS WEIGHED	4012.3	3163.2	4503.0	3386.2
18 K EQV PER 1000 TRUCKS WEIGHED	738.7	642.0	489.8	422.5
18 K EQV FOR ALL TRUCKS COUNTED	40275.2	30509.1	42501.2	32479.5
PERCENT DISTRIBUTION OF 18 K EQV	94.76	93.94	100.00	100.00

5-8-20

The two illustrations on pages 5-8-22 and 5-8-23 have been provided to show the relationship between the weight applied by the load on an axle and the effect on the pavement. Each axle load is equated to the number of 18,000 pound axles necessary to do the same damage to the road surface.

Road Damage vs Axle Load

5-8-22



***EXAMPLE**
 1 each 30,000 lb. single axle is equivalent to 8 each 18,000 lb. axles passing over surface

NOTES: 1. Residual Performance Value P=2.5
 2. Slab thickness for rigid pavement D=9"
 3. Reference—these curves derived from A.A.S.H.T.O. data

Road Damage

vs

Axle Load

ROAD DESIGN AND DAMAGE CRITERIA ARE BASED ON AXLE LOAD

Data from American Association State Highway Transportation Officials Studies (A.A.S.H.T.O.)
U.S. Government Data - Washington, D.C., U.S.A.

SINGLE AXLE

Gross weight on single axle

▶▶▶ Equivalent to

Number of axles passing over road surface at 18,000 lbs. each



Each axle equals 18,000 lbs.

18,000 LBS
WEIGHT



▶▶▶ Equivalent to

Each axle equals 18,000 lbs.



30,000 LBS
WEIGHT



▶▶▶ Equivalent to

Each axle equals 18,000 lbs.



*(See example on chart)

42,000 LBS
WEIGHT



▶▶▶ Equivalent to

Each axle equals 18,000 lbs.



TANDEM AXLE

Gross weight on tandem axle

▶▶▶ Equivalent to

Number of axles passing over road surface at 18,000 lbs. each



Each axle equals 18,000 lbs.

36,000 LBS
WEIGHT



▶▶▶ Equivalent to

Each axle equals 18,000 lbs.



42,000 LBS
WEIGHT



▶▶▶ Equivalent to

Each axle equals 18,000 lbs.



61,000 LBS
WEIGHT



▶▶▶ Equivalent to

Each axle equals 18,000 lbs.



Table W-5

This table shows the number of trucks weighed in various gross weight ranges and the probable number of trucks in each range in the traffic stream. These figures are produced by truck type and can be shown for each station or functional classification. An example of this table is shown on pages 5-8-25 through 5-8-29.

On Part 5 of this table the probable numbers and the remaining figures, which are all calculated from these numbers, are determined in the same manner as for Table W-4. For definitions and examples of how each is calculated, refer to the explanation of Table W-4.

INTST RURAL
INCLUDES 12 STATIONS

TABLE W-5

NUMBER OF LOADED AND EMPTY TRUCKS AND TRUCK COMBINATIONS OF EACH TYPE OF VARIOUS TOTAL WEIGHTS
DURING 1984 COMPARED TO CORRESPONDING DATA FOR 1982

SINGLE-UNIT TRUCKS

GROSS OPERATING WEIGHT IN POUNDS	PANEL AND PICKUP (UNDER 1 TON)		2 AXLE 4 TIRE		2 AXLE 6 TIRE		3 AXLE OR MORE		SINGLE UNIT TRUCKS PROBABLE NO.	
	1984	1982	1984	1982	1984	1982	1984	1982	1984	1982
UNDER 3,999	0	0	0	0	1	1	0	0	10	12
4,000 - 9,999	0	0	0	1	155	147	0	0	1800	2212
10,000 - 13,499	0	0	0	0	161	124	0	2	1870	1400
13,500 - 19,999	0	0	0	0	253	269	25	38	2992	3244
20,000 - 21,999	0	0	0	0	42	46	12	16	514	614
22,000 - 23,999	0	0	0	0	27	23	17	17	351	362
24,000 - 25,999	0	0	0	0	18	23	19	24	250	405
26,000 - 27,999	0	0	0	0	17	15	19	33	238	372
28,000 - 29,999	0	0	0	0	12	6	23	12	189	141
30,000 - 31,999	0	0	0	0	3	4	18	8	74	94
32,000 - 33,999	0	0	0	0	2	1	27	9	82	67
34,000 - 35,999	0	0	0	0	0	1	17	7	37	54
36,000 - 37,999	0	0	0	0	1	0	16	6	47	37
38,000 - 39,999	0	0	0	0	1	0	7	5	27	31
40,000 - 44,999	0	0	0	0	0	0	31	8	68	49
45,000 - 49,999	0	0	0	0	0	0	28	7	61	43
50,000 - 54,999	0	0	0	0	0	0	32	6	70	37
55,000 - 59,999	0	0	0	0	0	0	32	5	70	31
60,000 - 64,999	0	0	0	0	0	0	31	4	68	25
65,000 - 69,999	0	0	0	0	0	0	21	5	46	31
70,000 - 72,000	0	0	0	0	0	0	16	2	35	12
72,001 - 74,999	0	0	0	0	0	0	24	1	52	6
75,000 - 79,999	0	0	0	0	0	0	26	0	57	0
80,000 - 84,999	0	0	0	0	0	0	4	0	9	0
85,000 - 89,999	0	0	0	0	0	0	1	0	2	0
90,000 - 94,999	0	0	0	0	0	0	0	0	0	0
95,000 - 99,999	0	0	0	0	0	0	0	0	0	0
100,000 - 104,999	0	0	0	0	0	0	0	0	0	0
105,000 - 109,999	0	0	0	0	0	0	1	0	2	0
110,000 OR OVER	0	0	0	0	0	0	0	0	0	0
TOTAL VEHICLES WEIGHED	0	0	0	1	693	660	447	215		
TOTAL VEHICLES COUNTED	23112	20072	119	568	8047	7383	974	1328	9021	9279

5-8-25

INIST RURAL
INCLUDES 12 STATIONS

TABLE W-5

TRACTOR SEMI-TRAILER COMBINATIONS

GROSS OPERATING WEIGHT IN POUNDS	3 AXLE		4 AXLE		5 AXLE OR MORE		TRACTOR SEMI-TRAILER COMBINATIONS PROBABLE NO.	
	1984	1982	1984	1982	1984	1982	1984	1982
UNDER 3,999	0	0	0	0	0	0	0	0
4,000 - 9,999	0	0	0	0	0	0	0	0
10,000 - 13,499	0	0	0	1	0	0	0	7
13,500 - 19,999	14	7	3	5	5	3	225	137
20,000 - 21,999	10	4	9	7	12	11	317	202
22,000 - 23,999	15	5	18	26	50	34	846	582
24,000 - 25,999	7	7	26	35	81	73	1159	1052
26,000 - 27,999	20	11	27	43	144	173	1939	2131
28,000 - 29,999	8	13	33	34	236	256	2804	2892
30,000 - 31,999	4	12	35	39	261	244	3035	2803
32,000 - 33,999	5	8	36	34	204	207	2481	2362
34,000 - 35,999	2	5	30	41	175	156	2096	1888
36,000 - 37,999	6	7	27	31	157	119	1925	1471
38,000 - 39,999	2	0	20	35	164	137	1881	1605
40,000 - 44,999	7	5	42	58	424	358	4782	3990
45,000 - 49,999	0	0	21	36	389	350	4139	3692
50,000 - 54,999	0	0	13	15	369	382	3855	3844
55,000 - 59,999	0	0	10	5	429	388	4429	3825
60,000 - 64,999	0	0	1	1	459	472	4637	4615
65,000 - 69,999	0	0	1	1	481	470	4859	4596
70,000 - 72,000	0	0	0	1	219	181	2208	1775
72,001 - 74,999	0	0	0	0	219	204	2208	1991
75,000 - 79,999	0	0	0	0	243	134	2450	1308
80,000 - 84,999	0	0	0	0	57	25	575	244
85,000 - 89,999	0	0	0	0	25	12	252	117
90,000 - 94,999	0	0	0	0	4	1	40	10
95,000 - 99,999	0	0	0	0	7	0	71	0
100,000 - 104,999	0	0	0	0	2	1	20	10
105,000 - 109,999	0	0	0	0	0	0	0	0
110,000 OR OVFR	0	0	0	0	2	0	20	0
TOTAL VEHICLES WEIGHED	100	84	352	448	4818	4391		
TOTAL VEHICLES COUNTED	1035	855	3650	3435	48568	42859	53253	47149

5-8-26

INIST RURAL
INCLUDES 12 STATIONS

TABLE W-5

SEMI-TRAILER TRAILER

GROSS OPERATING WEIGHT IN POUNDS	5 AXLE		6 AXLE OR MORE		SEMI-TRAILER TRAILER COMBINATIONS PROBABLE NO.	
	1984	1982	1984	1982	1984	1982
UNDER 3,999	0	0	0	0	0	0
4,000 - 9,999	0	0	0	0	0	0
10,000 - 13,499	0	0	0	0	0	0
13,500 - 19,999	0	0	0	0	0	0
20,000 - 21,999	0	0	0	0	0	0
22,000 - 23,999	1	0	0	0	10	0
24,000 - 25,999	2	0	0	0	19	0
26,000 - 27,999	0	0	0	0	0	0
28,000 - 29,999	2	0	0	0	19	0
30,000 - 31,999	0	0	0	0	0	0
32,000 - 33,999	0	0	0	0	0	0
34,000 - 35,999	3	0	1	0	35	0
36,000 - 37,999	0	0	0	0	0	0
38,000 - 39,999	2	0	0	0	19	0
40,000 - 44,999	2	0	1	0	24	0
45,000 - 49,999	14	0	1	0	136	0
50,000 - 54,999	12	0	2	0	122	0
55,000 - 59,999	23	0	1	0	220	0
60,000 - 64,999	17	0	5	0	185	0
65,000 - 69,999	24	0	5	0	251	0
70,000 - 72,000	8	0	1	0	80	0
72,001 - 74,999	6	0	0	0	56	0
75,000 - 79,999	4	0	0	0	37	0
80,000 - 84,999	1	0	2	0	19	0
85,000 - 89,999	0	0	0	0	0	0
90,000 - 94,999	0	0	0	0	0	0
95,000 - 99,999	0	0	0	0	0	0
100,000 - 104,999	0	0	0	0	0	0
105,000 - 109,999	0	0	0	0	0	0
110,000 OR OVER	0	0	0	0	0	0
TOTAL VEHICLES WEIGHED	121	0	19	0		
TOTAL VEHICLES COUNTED	1133	0	99	0	1232	0

5-8-27

INISI RURAL
INCLUDES 12 STATIONS

TABLE W-5

TRUCK AND TRAILER

GROSS OPERATING WEIGHT IN POUNDS	3 AXLE		4 AXLE		5 AXLE OR MORE		TRUCK AND TRAILER COMBINATIONS PROBABLE NO.	
	1984	1982	1984	1982	1984	1982	1984	1982
	UNDER 3,999	0	0	0	0	0	0	0
4,000 - 9,999	0	0	0	0	0	0	0	0
10,000 - 13,499	0	0	0	0	0	0	0	0
13,500 - 19,999	0	0	0	0	0	0	0	0
20,000 - 21,999	0	0	0	0	0	0	0	0
22,000 - 23,999	0	0	0	0	0	0	0	0
24,000 - 25,999	0	0	0	0	0	0	0	0
26,000 - 27,999	0	0	0	0	0	0	0	0
28,000 - 29,999	0	0	0	0	0	0	0	0
30,000 - 31,999	0	0	0	0	0	0	0	0
32,000 - 33,999	0	0	0	0	0	0	0	0
34,000 - 35,999	0	0	0	0	0	0	0	0
36,000 - 37,999	0	0	0	0	0	0	0	0
38,000 - 39,999	0	0	0	0	0	0	0	0
40,000 - 44,999	0	0	0	0	0	0	0	0
45,000 - 49,999	0	0	0	0	0	0	0	0
50,000 - 54,999	0	0	0	0	1	0	0	0
55,000 - 59,999	0	0	0	0	0	0	0	0
60,000 - 64,999	0	0	0	0	1	0	1	0
65,000 - 69,999	0	0	0	0	0	0	0	0
70,000 - 72,000	0	0	0	0	0	0	0	0
72,001 - 74,999	0	0	0	0	0	0	0	0
75,000 - 79,999	0	0	0	0	0	0	0	0
80,000 - 84,999	0	0	0	0	0	0	0	0
85,000 - 89,999	0	0	0	0	0	0	0	0
90,000 - 94,999	0	0	0	0	0	0	0	0
95,000 - 99,999	0	0	0	0	0	0	0	0
100,000 - 104,999	0	0	0	0	0	0	0	0
105,000 - 109,999	0	0	0	0	0	0	0	0
110,000 OR OVER	0	0	0	0	0	0	0	0
TOTAL VEHICLES WEIGHED	0	0	0	0	2	0		
TOTAL VEHICLES COUNTED	0	0	26	87	1	298	1	0

5-8-28

INTST RURAL
INCLUDES 12 STATIONS

TABLE W-5

GROSS OPERATING WEIGHT IN POUNDS	TOTAL ALL COMBINATIONS PROBABLE NO.		TOTAL ALL TRUCKS AND COMBINATIONS PROBABLE NO.		PERCENT HEAVIER THAN LOW WEIGHT INTERVAL		VEHICLES PER 1000 TRUCKS AND COMBINATIONS		RATIO 1984 1982		
	1984	1982	1984	1982	1984	1982	1984	1982			
UNDER	3,999	0	0	0	10	12	100.00	100.00	0.2	0.2	0.740
4,000 -	9,999	0	0	1800	2212	99.98	99.98	28.3	39.2	0.723	
10,000 -	13,499	0	7	1870	1407	97.15	96.06	29.4	24.9	1.181	
13,500 -	19,999	225	137	3217	3381	94.21	93.57	50.7	59.9	0.845	
20,000 -	21,999	317	202	831	816	89.14	87.57	13.1	14.5	0.905	
22,000 -	23,999	856	582	1207	944	87.83	86.13	19.0	16.7	1.136	
24,000 -	25,999	1178	1052	1428	1457	85.93	84.45	22.5	25.8	0.871	
26,000 -	27,999	1939	2131	2177	2503	83.68	81.87	34.3	44.4	0.773	
28,000 -	29,999	2823	2892	3012	3033	80.25	77.44	47.4	53.7	0.882	
30,000 -	31,999	3035	2803	3109	2897	75.51	72.06	49.0	51.3	0.954	
32,000 -	33,999	2481	2362	2563	2429	70.62	66.93	40.4	43.0	0.938	
34,000 -	35,999	2131	1888	2168	1942	66.58	62.62	34.1	34.4	0.992	
36,000 -	37,999	1925	1471	1972	1508	63.17	59.18	31.1	26.7	1.162	
38,000 -	39,999	1900	1605	1927	1636	60.06	56.51	30.3	29.0	1.047	
40,000 -	44,999	4806	3990	4874	4039	57.03	53.61	76.7	71.6	1.072	
45,000 -	49,999	4275	3692	4336	3735	49.35	46.45	68.3	66.2	1.032	
50,000 -	54,999	3977	3844	4047	3881	42.52	39.83	63.7	68.8	0.927	
55,000 -	59,999	4649	3825	4719	3856	36.15	32.96	74.3	68.3	1.087	
60,000 -	64,999	4823	4615	4891	4640	28.72	26.12	77.0	82.2	0.937	
65,000 -	69,999	5110	4596	5156	4627	21.02	17.90	81.2	82.0	0.990	
70,000 -	72,000	2288	1775	2323	1787	12.90	9.70	36.6	31.7	1.155	
72,001 -	74,999	2264	1991	2316	1997	9.24	6.53	36.5	35.4	1.030	
75,000 -	79,999	2487	1308	2544	1308	5.60	2.99	40.1	23.2	1.728	
80,000 -	84,999	594	244	603	244	1.59	0.68	9.5	4.3	2.196	
85,000 -	89,999	252	117	254	117	0.64	0.24	4.0	2.1	1.929	
90,000 -	94,999	40	10	40	10	0.24	0.04	0.6	0.2	3.554	
95,000 -	99,999	71	0	71	0	0.18	0.02	1.1	0.0	0.0	
100,000 -	104,999	20	10	20	10	0.07	0.02	0.3	0.2	1.777	
105,000 -	109,999	0	0	2	0	0.03	0.0	0.0	0.0	0.0	
110,000 OR OVER		20	0	20	0	0.03	0.0	0.3	0.0	0.0	
TOTAL VEHICLES WEIGHED											
TOTAL VEHICLES COUNTED		54486	47149	63507	56428	100.00	100.00	0.0	0.0	0.0	

5-8-29

Table W-6

Table W-6 is actually a listing showing the characteristics of the trucks weighed during the time the truck weight survey was being conducted whose axle or gross weights exceeded Federal or State weight laws. This information is useful in formulating revised weight limits or modifying design standards on specific highway sections.

An example of this table is shown on pages 5-8-32 and 5-8-33. Each line of the listing, representing one vehicle, is split onto two pages. The vehicles are sorted by functional classification, vehicle type, the percent in excess of AASHTO weight limits and the percent in excess of the State weight limits.

Column 1 titled "Func Class" (Functional classification), column 2 titled "Vehicle Type," column 7 titled "Class Oper." (Class of Operation), column 8 titled "Commodity Carried," and column 9 titled "Body Type" contain the numeric codes indicated in the coding instructions in Chapter 6. The functional classification, vehicle type and class of operation codes and the station number (column 10) are used to identify the location and type of truck concerned. The commodity and body type codes indicate factors that may be contributing to the overload.

All of the axle loads (columns 12-18) and spacings (columns 19-24) and the gross weight (column 11) and total wheelbase (column 25) of each vehicle are shown to determine where an overweight occurs. The axles are identified by alphabetic codes as follows:

A	=	1st axle
B	=	2nd axle
C	=	3rd axle
D	=	4th axle
E	=	5th axle
F	=	6th axle
G	=	7th axle

e.g., the axle spacing under the column heading "D-E" (column 22) is the distance to the nearest tenth of a foot between the 4th and 5th axles.

The overweight conditions for which each vehicle is examined are:

1. Single Axle Overweight
2. Tandem Axle Overweight
3. Axle Configuration Overweight (In most cases according to the Bridge Formula)
4. Gross Weight Overweight

Under the column groupings "Percentage Over AASHTO Recommendations" (columns 26-34) and "Percentage Over State Recommendations" (columns 35-43), any excesses are identified for each individual axle, the most overweight axle grouping and the gross weight. The most overweight axle grouping is determined by checking every grouping of axles, including tandem axles, against the bridge formula or the State-specified weight limits by number of axles. The percent of excess for each identified overweight is indicated to the nearest tenth of a percent.

Column 3 titled "Maximum in Excess of AASHTO" shows the greatest percentage of excess of all the overweight conditions. For example, if a vehicle has a single axle that is 5 percent overweight, a tandem axle that is 10 percent overweight, and a gross weight that is 8 percent in excess, the tandem axle's 10 percent will be shown in this column. The same procedure is applied to determine the values for column 4 titled "Maximum in Excess of State."

The "Type of Excess" (columns 5 and 6) indicates which overweight condition had the highest percentage in excess. The alphabetic codes used for these conditions are:

1. SA = Single Axle
2. AG = Axle Group (Includes Tandem Axle)
3. GW = Gross Weight

For the preceding example, since the tandem axle was determined to be the greatest percentage in excess, the column under "AASHTO" would contain an "AG."

TABLE W. G. LISTING SHOWING TOTAL WEIGHT, AXLE LOADS, AND AXLE SPACING OF TRUCKS AND TRUCK COMBINATIONS WEIGHING IN EXCESS

PLANT CLASS	VEHICLE TYPE	MAXIMUM IN EXCESS OF		TYPE OF EXCESS		CLASS OPER.	COMMODITY CARRIED	BODY TYPE	STATION WT	TOTAL WT	AXLE LOADS IN 100 LBS							AXLE SPACINGS IN FEET						
		AASHO STATE	STATE	AASHO STATE	STATE						A	B	C	D	E	F	G	A-B	B-C	C-D	D-E	E-F	F-G	
1	221000	16.5	4.0	SA	SA	9	34000	21	402	339	106	233	0	0	0	0	0	16.1	0.0	0.0	0.0	0.0	0.0	0.0
1	221000	7.0	0.0	SA	A	9	29000	52	401	368	154	214	0	0	0	0	0	12.6	0.0	0.0	0.0	0.0	0.0	0.0
1	221000	3.0	0.0	SA	A	9	20000	42	401	268	62	206	0	0	0	0	0	15.2	0.0	0.0	0.0	0.0	0.0	0.0
1	221000	3.0	0.0	SA	A	9	20000	42	402	316	110	206	0	0	0	0	0	12.7	0.0	0.0	0.0	0.0	0.0	0.0
1	221000	3.0	0.0	SA	A	9	46000	51	406	275	69	206	0	0	0	0	0	14.6	0.0	0.0	0.0	0.0	0.0	0.0
1	221000	3.0	0.0	SA	A	9	34000	41	309	268	62	206	0	0	0	0	0	16.4	0.0	0.0	0.0	0.0	0.0	0.0
1	221000	3.0	0.0	SA	A	9	1000	41	303	328	122	206	0	0	0	0	0	18.6	0.0	0.0	0.0	0.0	0.0	0.0
1	222000	39.5	24.6	SA	SA	9	1000	41	301	397	118	279	0	0	0	0	0	17.2	0.0	0.0	0.0	0.0	0.0	0.0
1	222000	0.5	0.0	SA	A	9	20000	42	301	279	78	201	0	0	0	0	0	15.8	0.0	0.0	0.0	0.0	0.0	0.0
1	231000	35.0	32.4	SA	AG	9	1000	41	404	550	100	180	270	0	0	0	0	15.0	4.3	0.0	0.0	0.0	0.0	0.0
1	231000	10.3	10.3	AG	AG	9	33000	34	402	492	117	195	180	0	0	0	0	13.8	4.1	0.0	0.0	0.0	0.0	0.0
1	231000	9.4	9.4	AG	AG	9	32000	71	315	505	133	181	191	0	0	0	0	13.0	4.0	0.0	0.0	0.0	0.0	0.0
1	231000	7.6	4.6	AG	AG	9	32000	21	309	527	161	181	185	0	0	0	0	16.0	4.5	0.0	0.0	0.0	0.0	0.0
1	231000	3.5	0.6	AG	AG	9	40000	51	402	458	106	174	178	0	0	0	0	16.0	4.5	0.0	0.0	0.0	0.0	0.0
1	231000	2.9	2.9	AG	AG	9	32000	76	309	460	110	178	172	0	0	0	0	18.5	4.2	0.0	0.0	0.0	0.0	0.0
1	231000	2.5	0.0	SA	A	9	0	42	301	408	128	205	75	0	0	0	0	19.2	4.4	0.0	0.0	0.0	0.0	0.0
1	231000	1.0	0.0	SA	A	9	20000	32	309	436	144	202	90	0	0	0	0	16.9	4.1	0.0	0.0	0.0	0.0	0.0
1	241000	97.4	97.4	AG	AG	9	32000	34	312	1066	237	280	269	280	0	0	0	10.4	4.4	3.9	0.0	0.0	0.0	0.0
1	241000	45.8	45.8	AG	AG	9	11000	34	301	788	164	144	251	229	0	0	0	12.3	4.5	4.4	0.0	0.0	0.0	0.0
1	241000	42.9	42.9	AG	AG	9	29000	34	301	735	135	164	218	218	0	0	0	12.2	4.1	4.3	0.0	0.0	0.0	0.0
1	241000	40.8	40.8	AG	AG	9	41000	32	301	770	192	192	207	179	0	0	0	9.5	4.3	4.8	0.0	0.0	0.0	0.0
1	241000	39.5	39.5	AG	AG	9	14000	34	301	750	153	183	194	220	0	0	0	10.2	4.4	4.2	0.0	0.0	0.0	0.0
1	241000	38.3	38.3	AG	AG	9	32000	34	404	741	149	158	218	216	0	0	0	12.0	4.6	4.5	0.0	0.0	0.0	0.0
1	241000	28.5	28.5	AG	AG	9	32000	32	315	639	129	73	226	211	0	0	0	11.4	3.9	4.2	0.0	0.0	0.0	0.0
1	241000	22.8	22.8	AG	AG	9	11000	41	301	692	148	196	126	222	0	0	0	11.0	4.3	6.2	0.0	0.0	0.0	0.0
1	241000	22.2	22.2	AG	AG	9	11000	34	305	650	127	183	172	168	0	0	0	12.0	4.3	4.5	0.0	0.0	0.0	0.0
1	241000	18.2	18.2	AG	AG	9	32000	76	312	668	162	156	173	177	0	0	0	14.2	4.3	4.5	0.0	0.0	0.0	0.0
1	241000	15.9	15.9	AG	AG	9	32000	76	401	648	152	171	173	152	0	0	0	16.4	4.6	4.5	0.0	0.0	0.0	0.0
1	241000	14.8	14.8	AG	AG	9	11000	34	305	628	170	140	159	159	0	0	0	10.4	4.6	4.3	0.0	0.0	0.0	0.0
1	241000	12.6	12.6	AG	AG	9	40000	34	402	615	142	136	170	167	0	0	0	12.7	4.0	4.4	0.0	0.0	0.0	0.0
1	241000	11.7	11.7	AG	AG	9	14000	34	402	573	95	167	163	148	0	0	0	13.3	4.2	4.5	0.0	0.0	0.0	0.0
1	241000	11.7	11.7	AG	AG	9	24000	21	309	560	82	180	161	137	0	0	0	15.7	4.3	4.2	0.0	0.0	0.0	0.0
1	241000	10.6	10.6	AG	AG	9	32000	34	404	573	92	105	176	200	0	0	0	10.6	5.3	4.3	0.0	0.0	0.0	0.0
1	241000	9.2	9.2	AG	AG	9	40000	34	309	619	161	129	189	140	0	0	0	13.3	4.5	4.4	0.0	0.0	0.0	0.0
1	241000	9.0	0.0	SA	A	9	32000	34	301	554	153	172	11	218	0	0	0	13.6	4.6	4.6	0.0	0.0	0.0	0.0
1	241000	7.0	7.0	AG	AG	9	24000	34	402	566	108	129	206	123	0	0	0	12.7	4.3	4.4	0.0	0.0	0.0	0.0
1	241000	5.8	5.8	AG	AG	9	34000	34	401	587	134	144	144	165	0	0	0	14.4	4.4	4.2	0.0	0.0	0.0	0.0
1	241000	5.7	5.7	AG	AG	9	14000	34	406	592	168	121	162	141	0	0	0	11.9	4.5	4.3	0.0	0.0	0.0	0.0
1	241000	3.0	3.0	AG	AG	9	32000	21	315	559	118	118	166	157	0	0	0	11.4	4.3	4.9	0.0	0.0	0.0	0.0
1	241000	2.4	0.0	AG	A	9	0	34	303	435	87	87	87	174	0	0	0	9.9	3.4	4.0	0.0	0.0	0.0	0.0
1	241000	1.9	1.9	AG	AG	9	32000	21	402	568	140	123	146	159	0	0	0	15.5	4.1	4.1	0.0	0.0	0.0	0.0
1	242000	3.5	3.5	AG	AG	9	34000	34	402	496	53	146	174	123	0	0	0	12.0	4.4	4.6	0.0	0.0	0.0	0.0
1	251300	165.0	136.6	SA	SA	9	39000	41	402	861	64	530	108	47	112	0	0	14.1	4.1	4.4	30.7	0.0	0.0	0.0
1	251300	15.6	15.6	AG	AG	9	46000	41	312	820	99	168	160	171	222	0	0	12.2	4.0	28.2	4.3	0.0	0.0	0.0
1	251300	14.7	14.7	AG	AG	9	11000	41	404	760	80	175	175	165	165	0	0	11.0	4.2	17.6	4.0	0.0	0.0	0.0
1	251300	13.5	13.5	AG	AG	9	39000	41	402	647	102	66	93	195	191	0	0	10.7	4.4	25.8	4.2	0.0	0.0	0.0
1	251300	10.0	10.0	AG	AG	9	20000	41	312	798	106	156	162	199	175	0	0	11.8	4.0	23.8	4.2	0.0	0.0	0.0
1	251300	1.5	1.5	AG	AG	9	41000	41	306	751	74	163	156	176	182	0	0	11.4	4.5	23.6	9.1	0.0	0.0	0.0
1	252300	15.0	15.0	AG	AG	9	41000	41	312	691	65	149	86	177	214	0	0	9.7	4.0	32.3	4.0	0.0	0.0	0.0
1	252300	8.8	8.8	AG	AG	9	41000	41	312	690	99	119	102	173	197	0	0	9.5	4.0	30.9	4.2	0.0	0.0	0.0

5-8-32

COLUMN 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

1984

OF AASHTO RECOMMENDATIONS OR STATE LAW AT 28 STATIONS

WIFEI
BASE

PERCENTAGE OVER AASHTO RECOMMENDATIONS

PERCENTAGE OVER STATE RECOMMENDATIONS

	AXLES							GROSS WEIGHT	MAXIMUM AXLE GROUP		AXLES							GROSS WEIGHT	MAXIMUM AXLE GROUP	
	R	C	D	F	G				B	C	D	E	F	G						
16.1	16.5	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0		
12.6	7.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0		
15.2	3.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0		
12.7	3.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0		
14.6	3.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0		
16.4	3.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0		
18.6	3.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0		
17.2	39.5	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	24.6	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0		
15.8	0.5	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0		
19.3	0.0	35.0	0.0	0.0	0.0	0.0	9.3	B-C	32.4	0.0	20.5	0.0	0.0	0.0	0.0	9.3	B-C	32.4		
17.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-C	10.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-C	10.3		
17.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	B-C	9.4	0.0	0.0	0.0	0.0	0.0	0.0	3.5	B-C	9.4		
20.5	0.0	0.0	0.0	0.0	0.0	0.0	1.7	B-C	7.6	0.0	0.0	0.0	0.0	0.0	0.0	1.7	B-C	4.6		
20.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-C	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-C	0.6		
22.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-C	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-C	2.9		
23.6	2.5	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0		
21.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0		
18.7	40.0	34.5	40.0	0.0	0.0	0.0	33.3	B-D	97.4	25.0	20.1	25.0	0.0	0.0	0.0	33.3	B-D	97.4		
21.2	0.0	25.5	14.5	0.0	0.0	0.0	40.7	B-D	45.8	0.0	12.1	2.2	0.0	0.0	0.0	40.7	B-D	45.8		
20.6	0.0	9.0	9.0	0.0	0.0	0.0	31.3	B-D	42.9	0.0	0.0	0.0	0.0	0.0	0.0	31.3	B-D	42.9		
18.6	0.0	3.5	0.0	0.0	0.0	0.0	40.8	A-D	40.8	0.0	0.0	0.0	0.0	0.0	0.0	40.8	A-D	40.8		
18.8	0.0	0.0	10.0	0.0	0.0	0.0	37.1	B-D	39.5	0.0	0.0	0.0	0.0	0.0	0.0	37.1	B-D	39.5		
21.1	0.0	9.0	8.0	0.0	0.0	0.0	32.3	B-D	38.3	0.0	0.0	0.0	0.0	0.0	0.0	32.3	B-D	38.3		
19.5	0.0	13.0	5.5	0.0	0.0	0.0	15.6	C-D	28.5	0.0	0.9	0.0	0.0	0.0	0.0	15.6	C-D	28.5		
21.5	0.0	0.0	11.0	0.0	0.0	0.0	22.0	B-D	22.8	0.0	0.0	0.0	0.0	0.0	0.0	22.0	B-D	22.8		
20.8	0.0	0.0	0.0	0.0	0.0	0.0	16.1	B-D	22.2	0.0	0.0	0.0	0.0	0.0	0.0	16.1	B-D	22.2		
23.0	0.0	0.0	0.0	0.0	0.0	0.0	16.6	B-D	18.2	0.0	0.0	0.0	0.0	0.0	0.0	16.6	B-D	18.2		
25.5	0.0	0.0	0.0	0.0	0.0	0.0	9.3	B-D	15.9	0.0	0.0	0.0	0.0	0.0	0.0	9.3	B-D	15.9		
19.3	0.0	0.0	0.0	0.0	0.0	0.0	14.8	A-D	14.8	0.0	0.0	0.0	0.0	0.0	0.0	14.8	A-D	14.8		
21.1	0.0	0.0	0.0	0.0	0.0	0.0	9.8	B-D	12.6	0.0	0.0	0.0	0.0	0.0	0.0	9.8	B-D	12.6		
22.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	B-D	11.7	0.0	0.0	0.0	0.0	0.0	0.0	1.1	B-D	11.7		
24.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-D	11.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-D	11.7		
20.2	0.0	0.0	0.0	0.0	0.0	0.0	3.6	C-D	10.6	0.0	0.0	0.0	0.0	0.0	0.0	3.6	C-D	10.6		
22.2	0.0	0.0	0.0	0.0	0.0	0.0	9.2	A-D	9.2	0.0	0.0	0.0	0.0	0.0	0.0	9.2	A-D	9.2		
22.8	0.0	0.0	9.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0		
21.4	0.0	3.0	0.0	0.0	0.0	0.0	1.1	B-D	7.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	B-D	7.0		
23.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	B-D	5.8	0.0	0.0	0.0	0.0	0.0	0.0	2.4	B-D	5.8		
20.7	0.0	0.0	0.0	0.0	0.0	0.0	5.7	A-D	5.7	0.0	0.0	0.0	0.0	0.0	0.0	5.7	A-D	5.7		
20.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-D	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-D	3.0		
17.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-D	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0		
23.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-D	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-D	1.9		
21.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-D	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-D	3.5		
53.3	165.0	0.0	0.0	0.0	0.0	0.0	7.6	B-C	87.6	136.6	0.0	0.0	0.0	0.0	0.0	7.6	B-C	87.6		
48.7	0.0	0.0	0.0	11.0	0.0	0.0	2.5	D-E	15.6	0.0	0.0	0.0	0.0	0.0	0.0	2.5	D-E	15.6		
36.8	0.0	0.0	0.0	0.0	0.0	0.0	6.9	B-E	14.7	0.0	0.0	0.0	0.0	0.0	0.0	6.9	B-E	14.7		
45.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	D-E	13.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	D-E	13.5		
43.8	0.0	0.0	0.0	0.0	0.0	0.0	5.7	D-E	10.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	D-E	10.0		
48.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-E	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	B-E	1.5		
50.0	0.0	0.0	0.0	7.0	0.0	0.0	0.0	D-E	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	D-E	15.0		
48.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	D-E	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	D-E	8.8		

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Table W-7

The number and percent of overweight and legal weight vehicles are summarized in this table for each functional classification, vehicle type, and year of the data. Vehicles that violate Federal weight laws are distinguished from those that violate State weight laws and the number ("No") and percent ("Pt") of overweight vehicles ("All in Excess") and legal weight vehicles ("Not in Excess") are indicated for each. Also included are the accumulated numbers and percentages of vehicles exceeding the weight laws by specified percentages. An example of this table is shown on pages 5-8-35 through 5-8-37.

The columns under the title "Excess by Percent or More" are a frequency distribution of the maximum overweight percentages by vehicle taken from Table W-6. The five percentage categories are defined in the following manner:

1. "5" - Violations exceeding the legal limit by 5 percent or more
2. "10" - Violations exceeding the legal limit by 10 percent or more
3. "20" - Violations exceeding the legal limit by 20 percent or more
4. "30" - Violations exceeding the legal limit by 30 percent or more
5. "50" - Violations exceeding the legal limit by 50 percent or more

Therefore, the same vehicle could exist in several of the above categories. For example, a truck that exceeds a legal weight limit by 11 percent would be shown in both the first and second categories, while a truck that exceeds a legal weight limit by 50 percent would be shown in all of the categories. If a vehicle does not exceed the weight limit by at least 5 percent, it will not be shown in this distribution.

TABLE W-7 FUNCTIONAL CLASS: PRINCIPAL ARTERIAL, INTERSTATE, RURAL
NUMBER AND ACCUMULATIVE PERCENTAGE OF VEHICLES NOT IN EXCESS AND IN EXCESS BY SPECIFIED PERCENTAGES
OF LAW AND AASHTO RECOMMENDATIONS WEIGHED AT 12 STATIONS DURING 1982
AND AT 12 STATIONS DURING 1984

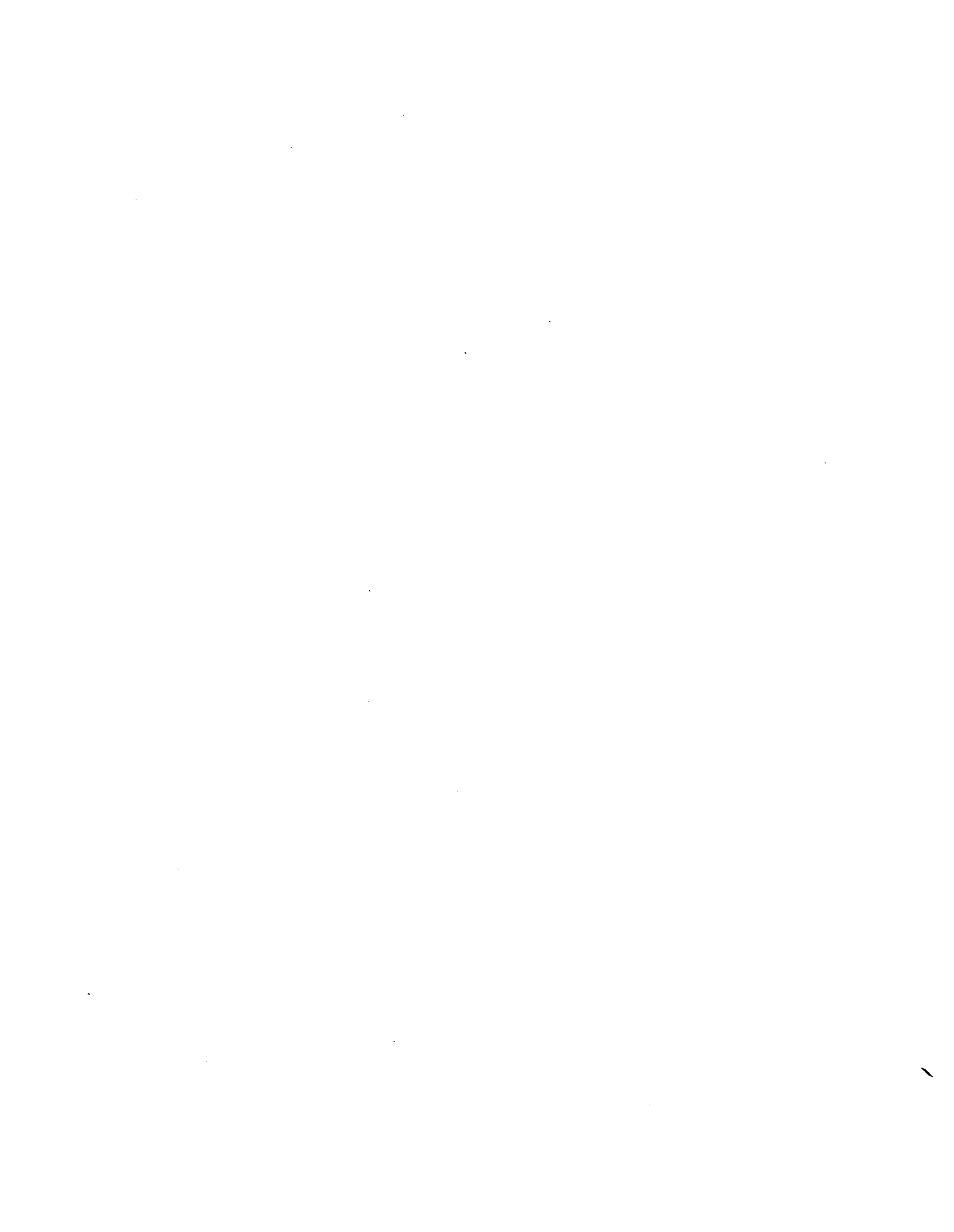
TYPE OF VEHICLE	NO OR PT	YR	WF	FIGHT	AASHTO RECOMMENDATIONS										LAW				
					ALL IN EXCESS	NOT IN EXCESS	EXCESS BY PERCENT OR MORE					ALL IN EXCESS	NOT IN EXCESS	EXCESS BY PERCENT OR MORE					
							5	10	20	30	50			5	10	20	30	50	
SINGLE-UNIT TRUCKS																			
PANEL AND PICKUP	NO	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	PT	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
2-AXLE, 4 TIRE	NO	84	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	PT	82	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
2-AXLE, 6 TIRE	NO	84	693	9	684	3	2	1	1	0	2	691	1	1	1	0	0		
	PT	82	659	4	655	1	1	0	0	0	0	659	0	0	0	0	0		
3-AXLE, OR MORE	NO	84	445	62	383	37	24	11	8	2	57	388	34	24	11	8	2		
	PT	82	212	23	189	15	13	9	2	0	21	191	14	12	8	2	0		
SURTOTL. SINGLE UNIT	NO	84	1138	71	1067	40	26	12	9	2	59	1079	35	25	12	8	2		
	PT	82	872	27	845	16	14	9	2	0	21	851	14	12	8	2	0		
COMBINATION																			
TRACTOR-SEMI TRAILER																			
2 AXLE TRCTR	NO	84	456	15	441	10	3	0	0	0	5	451	2	0	0	0	0		
	PT	82	532	9	523	4	2	2	1	1	5	527	3	1	1	1	1		
3 AXLE TRCTR	NO	84	4778	419	4359	251	138	51	23	7	388	4390	229	129	49	21	7		
	PT	82	4330	274	4056	133	54	15	7	3	243	4087	115	44	11	4	3		
4 AXLE TRCTR	NO	84	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0		
	PT	82	2	0	2	0	0	0	0	0	0	2	0	0	0	0	0		
5 AXLE TRCTR	NO	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	PT	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
6 AXLE TRCTR	NO	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	PT	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

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7 AXLE TRCTR	NO	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
PT	84	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8 AXLE TRCTR	NO	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
PT	84	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SUBTOTAL	NO	84	5235	474	4801	261	141	51	23	7	393	4842	231	129	49	21	7	
	82	4864	283	4581	137	56	17	8	4	248	4616	118	45	12	5	4		
PT	84	100.00	8.29	91.71	4.99	2.69	0.97	0.44	0.13	7.51	92.49	4.41	2.46	0.94	0.40	0.13		
	82	100.00	5.82	94.18	2.82	1.15	0.35	0.16	0.08	5.10	94.90	2.43	0.93	0.25	0.10	0.08		
TRUCK-FULL TRAILER																		
2 AXLE TRCTR	NO	84	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
PT	84	100.00	0.0	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.00	0.0	0.0	0.0	0.0	0.0	
	82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3 AXLE TRCTR	NO	84	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
PT	84	100.00	0.0	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.00	0.0	0.0	0.0	0.0	0.0	
	82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4 AXLE TRCTR	NO	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
PT	84	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5 AXLE TRCTR	NO	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
PT	84	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6 AXLE TRCTR	NO	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
PT	84	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7 AXLE TRCTR	NO	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
PT	84	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8 AXLE TRCTR	NO	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
PT	84	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SUBTOTAL	NO	84	2	0	2	0	0	0	0	0	0	2	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
PT	84	100.00	0.0	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.00	0.0	0.0	0.0	0.0	0.0	
	82	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TRACTOR, SEMI & 1 TRL																		
2 AXLE TRCTR	NO	84	122	4	118	2	0	0	0	0	0	122	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
PT	84	100.00	3.28	96.72	1.64	0.0	0.0	0.0	0.0	0.0	0.0	100.00	0.0	0.0	0.0	0.0	0.0	
	82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3 AXLE TRCTR	NO	84	17	2	15	1	1	0	0	0	2	15	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
PT	84	100.00	11.76	88.24	5.88	5.88	0.0	0.0	0.0	0.0	11.76	88.24	0.0	0.0	0.0	0.0	0.0	
	82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SUBTOTAL	NO	84	139	6	133	3	1	0	0	0	2	137	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
PT	84	100.00	4.32	95.68	2.16	0.72	0.0	0.0	0.0	0.0	1.44	98.56	0.0	0.0	0.0	0.0	0.0	
	82	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TRUCK & 2 TRAILERS																		

SUBTOTAL	NO	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TRACTOR, SEMI & 2 TRI.	PT	84	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	82	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SUBTOTAL	NO	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TRUCK & 3 TRAILERS	PT	84	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	82	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SUBTOTAL	NO	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTAL COMBINATIONS	PT	84	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	82	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TOTAL TRUCK & COMB.	NO	84	5376	110	4936	264	142	51	23	7	395	4981	231	129	49	21	7
	82	1864	283	4581	137	56	17	8	4	248	4616	118	45	12	5	4	
TOTAL ALL VEHICLES	PT	84	100.00	8.18	91.82	4.91	2.64	0.95	0.43	0.13	7.35	92.65	4.30	2.40	0.91	0.39	0.13
	82	100.00	5.40	94.60	2.67	1.22	0.45	0.17	0.08	5.10	94.90	2.43	0.93	0.25	0.10	0.08	
TOTAL TRUCK & COMB.	NO	84	6514	511	6003	304	168	63	32	9	454	6060	266	154	61	29	9
	82	5736	310	5426	153	70	26	10	4	269	5467	132	57	20	7	4	
TOTAL ALL VEHICLES	PT	84	100.00	7.84	92.16	4.67	2.58	0.97	0.49	0.14	6.97	93.03	4.08	2.36	0.94	0.45	0.14
	82	100.00	5.40	94.60	2.67	1.22	0.45	0.17	0.07	4.69	95.31	2.30	0.99	0.35	0.12	0.07	



CHAPTER 9

Other Analyses of Truck Weight Survey Data

Introduction

Although the W-Tables cover the most commonly utilized data relationships, there are other summaries that could be of value in analyzing data relationships or specific data items not referenced in the W-Tables. Several summaries have already been developed and are generally produced for each submittal of a State's data. These tables can be separated into two basic categories; those that provide more detailed analysis of the vehicle classification data and those that cover other data relationships in the truck weight data.

Other Vehicle Classification Data Analyses

Although Table W-2 provides vehicle classification counts by functional classification, station and vehicle type group, more detailed analysis might be needed such as the change in the counts by hour or the percent distribution of counts by vehicle type. The tables that currently show further analysis of the vehicle classification data are described here.

1. Annual Vehicle Count (See page 5-9-3)

This is a one-page statewide summary of the counts by functional classification and the vehicle type categories as indicated on the table.

2. Classification Count Summary (See pages 5-9-4 through 5-9-7)

This summary shows three separate figures for each functional classification and vehicle type code:

- a. The total count
- b. The average count per station within a functional classification
- c. The percent distribution of the vehicle types

Eight subtotal columns are shown between the vehicle types in the table and are defined as follows:

- a. SB-TOT #1 - The number of passenger cars
(After vehicle
type 062000)
- b. SB-TOT #2 - The number of motorcycles and buses
(After vehicle
type 180000)
- c. SB-TOT #3 - The number of cars, buses and motorcycles
(After SB-TOT #2)

- d. SB-TOT #4 - The number of single-unit trucks
 (After vehicle
 types 240000+)
- e. SB-TOT #5 - The number of tractor/trailer combinations
 (After vehicle
 type 532200)
- f. SB-TOT #6 - The number of truck/trailer combinations
 (After vehicle
 type 433000)
- g. SB-TOT #7 - The total number of combinations
 (After SB-TOT #6)
- h. SB-TOT #8 - The total number of trucks (with or
 (After SB-TOT #7) without trailers)

There are also two columns titled "OTHER" which include the following vehicles:

- a. OTHER #1 - All the tractor/trailer combinations that are
 (Before not specifically defined in the previous
 SB-TOT #5) vehicle type codes.
- b. OTHER #2 - All the truck/trailer combinations that are not
 (Before specifically defined in the previous vehicle
 SB-TOT #6) type codes.

3. Hourly Classification Count Summary (See pages 5-9-8 through 5-9-9)

This summary is a more detailed version of the previously-described Classification Count Summary. Besides the counts and percent distribution by vehicle type and functional classification, it also provides the percentage distribution by hour for a specific vehicle type.

The example table shows the information for only one functional classification.

A N N U A L V E H I C L E C O U N T

1984

FUNC. CLASS	VEHICLE TYPE														TOTAL
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	
01	23112	119	8047	974	1035	3650	49800	0	26	1	123441	809	339	135	211488
02	16028	85	4022	489	719	1290	10251	0	25	0	76828	837	142	118	110834
06	4136	38	796	130	146	220	2405	0	5	0	18045	252	10	11	26194
07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	8587	30	1778	144	132	217	1371	0	0	0	50087	237	90	76	62749
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALL	51863	272	14643	1737	2032	5377	63827	0	56	1	268401	2135	581	340	411265

VEHICLE TYPES

- 01 PANEL + PICKUP 5-U
- 02 OTHER 4 TIRE S-U
- 03 2 AX 6 TIRE S-U
- 04 3 AX OR MORE S-U
- 05 TRACTOR-TLR 3 AX
- 06 TRACTOR-TLR 4 AX
- 07 TRACTOR-TLR 5 AX +
- 08 TRUCK-TLR 3 AX
- 09 TRUCK-TLR 4 AX
- 10 TRUCK-TLR 5 AX +
- 11 PASSENGER CAR
- 12 CYCLES
- 13 COMMERCIAL BUS
- 14 OTHER BUS

FUNCTIONAL CLASSIFICATION CODES

- | | |
|---|---|
| <p style="text-align: center;">RURAL</p> <ul style="list-style-type: none"> 01 PRINCIPAL ARTERIAL-INTERSTATE 02 PRINCIPAL ARTERIAL-OTHER 06 MINOR ARTERIAL 07 MAJOR COLLECTOR 08 MINOR COLLECTOR 09 LOCAL SYSTEMS | <p style="text-align: center;">URBAN</p> <ul style="list-style-type: none"> 11 PRINCIPAL ARTERIAL-INTERSTATE 12 PRIN. ART.-OTHER FRWYS. & EXPWYS. 14 PRINCIPAL ARTERIAL-OTHER 16 MINOR ARTERIAL 17 COLLECTOR 19 LOCAL SYSTEMS |
|---|---|

NOTE: SOURCE IS THE NUMBER-4CARDS FOR THE DATA YEAR 1984 AS OF 04/09/85

5-6-5

CLASSIFICATION COUNT SUMMARY FOR 1984

	VEHICLE TYPES									
	071000	061000	072000	062000	#1 SB-TOT	030000	150000	180000	#2 SB-TOT	#3 SB-TOT
01 PRIN. ART. -I/R	82,804	12,942	27,695	0	123,441	809	339	135	1,283	124,724
AVG. FOR 12 STATIONS	6,900	1,079	2,308	0	10,287	67	28	11	107	10,394
DISTRIBUTION BY %	39.15	6.12	13.10	0.00	58.37	0.38	0.16	0.06	0.61	58.97
02 PRIN. ART. -O/R	65,772	3,423	7,633	0	76,828	837	142	118	1,097	77,925
AVG. FOR 10 STATIONS	6,577	342	763	0	7,683	84	14	12	110	7,793
DISTRIBUTION BY %	59.34	3.09	6.89	0.00	69.32	0.76	0.13	0.11	0.99	70.31
06+07+08+09 ALL O/R	17,206	266	573	0	18,045	252	10	11	273	18,318
AVG. FOR 3 STATIONS	5,735	89	191	0	6,015	84	3	4	91	6,106
DISTRIBUTION BY %	65.69	1.02	2.19	0.00	68.89	0.96	0.04	0.04	1.04	69.93
11 PRIN. ART. -I/U	0	0	0	0	0	0	0	0	0	0
AVG. FOR 0 STATIONS	0	0	0	0	0	0	0	0	0	0
DISTRIBUTION BY %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12+14 PRIN. ART. -O/U	47,911	1,549	627	0	50,087	237	90	76	403	50,490
AVG. FOR 3 STATIONS	15,970	516	209	0	16,696	79	30	25	134	16,830
DISTRIBUTION BY %	76.35	2.47	1.00	0.00	79.82	0.38	0.14	0.12	0.64	80.46
16+17+19 ALL O/U	0	0	0	0	0	0	0	0	0	0
AVG. FOR 0 STATIONS	0	0	0	0	0	0	0	0	0	0
DISTRIBUTION BY %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ALL RURAL	165,782	16,631	35,901	0	218,314	1,898	491	264	2,653	220,967
AVG. FOR 25 STATIONS	6,631	665	1,436	0	8,733	76	20	11	106	8,839
DISTRIBUTION BY %	47.57	4.77	10.30	0.00	62.64	0.54	0.14	0.08	0.76	63.40
ALL URBAN	47,911	1,549	627	0	50,087	237	90	76	403	50,490
AVG. FOR 3 STATIONS	15,970	516	209	0	16,696	79	30	25	134	16,830
DISTRIBUTION BY %	76.35	2.47	1.00	0.00	79.82	0.38	0.14	0.12	0.64	80.46
ALL FUNCTIONAL CLASSES	213,693	18,180	36,528	0	268,401	2,135	581	340	3,056	271,457
AVG. FOR 28 STATIONS	7,632	649	1,305	0	9,586	76	21	12	109	9,695
DISTRIBUTION BY %	51.96	4.42	8.88	0.00	65.26	0.52	0.14	0.08	0.74	66.01

5-9-4

VEHICLE TYPES

	200000	210000	220000	230000	240000+	#4 SB-TOT	321000	322000	323000	331000
01 PRIN. ART. -I/R	23,112	119	8,047	709	265	32,252	1,035	3,650	0	0
AVG. FOR 12 STATIONS	1,926	10	671	59	22	2,688	86	304	0	0
DISTRIBUTION BY %	10.93	0.06	3.80	0.34	0.13	15.25	0.49	1.73	0.00	0.00
02 PRIN. ART. -O/R	16,028	85	4,022	350	139	20,624	719	1,290	0	0
AVG. FOR 10 STATIONS	1,603	9	402	35	14	2,062	72	129	0	0
DISTRIBUTION BY %	14.46	0.08	3.63	0.32	0.13	18.61	0.65	1.16	0.00	0.00
06+07+08+09 ALL O/R	4,136	38	796	113	17	5,100	146	220	0	0
AVG. FOR 3 STATIONS	1,379	13	265	38	6	1,700	49	73	0	0
DISTRIBUTION BY %	15.79	0.15	3.04	0.43	0.06	19.47	0.56	0.84	0.00	0.00
11 PRIN. ART. -I/U	0	0	0	0	0	0	0	0	0	0
AVG. FOR 0 STATIONS	0	0	0	0	0	0	0	0	0	0
DISTRIBUTION BY %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12+14 PRIN. ART. -O/U	8,587	30	1,778	113	31	10,539	132	217	0	0
AVG. FOR 3 STATIONS	2,862	10	593	38	10	3,513	44	72	0	0
DISTRIBUTION BY %	13.68	0.05	2.83	0.18	0.05	16.80	0.21	0.35	0.00	0.00
16+17+19 ALL O/U	0	0	0	0	0	0	0	0	0	0
AVG. FOR 0 STATIONS	0	0	0	0	0	0	0	0	0	0
DISTRIBUTION BY %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ALL RURAL	43,276	242	12,865	1,172	421	57,976	1,900	5,160	0	0
AVG. FOR 25 STATIONS	1,731	10	515	47	17	2,319	76	206	0	0
DISTRIBUTION BY %	12.42	0.07	3.69	0.34	0.12	16.64	0.55	1.48	0.00	0.00
ALL URBAN	8,587	30	1,778	113	31	10,539	132	217	0	0
AVG. FOR 3 STATIONS	2,862	10	593	38	10	3,513	44	72	0	0
DISTRIBUTION BY %	13.68	0.05	2.83	0.18	0.05	16.80	0.21	0.35	0.00	0.00
ALL FUNCTIONAL CLASSES	51,863	272	14,643	1,285	452	68,515	2,032	5,377	0	0
AVG. FOR 28 STATIONS	1,852	10	523	46	16	2,447	73	192	0	0
DISTRIBUTION BY %	12.61	0.07	3.56	0.31	0.11	16.66	0.49	1.31	0.00	0.00

VEHICLE TYPES

	332000	333000	521100	521200	522200	531200	532200	#1 OTHERS	#5 SB-TOT	421000
01 PRIN. ART. -I/R	48,156	412	0	1,133	0	93	6	0	54,485	0
AVG. FOR 12 STATIONS	4,013	34	0	94	0	8	1	0	4,540	0
DISTRIBUTION BY %	22.77	0.19	0.00	0.54	0.00	0.04	0.00	0.00	25.76	0.00
02 PRIN. ART. -O/R	10,008	173	0	64	0	6	0	0	12,260	0
AVG. FOR 10 STATIONS	1,001	17	0	6	0	1	0	0	1,226	0
DISTRIBUTION BY %	9.03	0.16	0.00	0.06	0.00	0.01	0.00	0.00	11.06	0.00
06+07+08+09 ALL O/R	2,310	26	0	68	0	1	0	0	2,771	0
AVG. FOR 3 STATIONS	770	9	0	23	0	0	0	0	924	0
DISTRIBUTION BY %	8.82	0.10	0.00	0.26	0.00	0.00	0.00	0.00	10.58	0.00
11 PRIN. ART. -I/U	0	0	0	0	0	0	0	0	0	0
AVG. FOR 0 STATIONS	0	0	0	0	0	0	0	0	0	0
DISTRIBUTION BY %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12+14 PRIN. ART. -O/U	1,317	23	0	31	0	0	0	0	1,720	0
AVG. FOR 3 STATIONS	439	8	0	10	0	0	0	0	573	0
DISTRIBUTION BY %	2.10	0.04	0.00	0.05	0.00	0.00	0.00	0.00	2.74	0.00
16+17+19 ALL O/U	0	0	0	0	0	0	0	0	0	0
AVG. FOR 0 STATIONS	0	0	0	0	0	0	0	0	0	0
DISTRIBUTION BY %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ALL RURAL	60,474	611	0	1,265	0	100	6	0	69,516	0
AVG. FOR 25 STATIONS	2,419	24	0	51	0	4	0	0	2,781	0
DISTRIBUTION BY %	17.35	0.18	0.00	0.36	0.00	0.03	0.00	0.00	19.95	0.00
ALL URBAN	1,317	23	0	31	0	0	0	0	1,720	0
AVG. FOR 3 STATIONS	439	8	0	10	0	0	0	0	573	0
DISTRIBUTION BY %	2.10	0.04	0.00	0.05	0.00	0.00	0.00	0.00	2.74	0.00
ALL FUNCTIONAL CLASSES	61,791	634	0	1,296	0	100	6	0	71,236	0
AVG. FOR 28 STATIONS	2,207	23	0	46	0	4	0	0	2,544	0
DISTRIBUTION BY %	15.02	0.15	0.00	0.32	0.00	0.02	0.00	0.00	17.32	0.00

9-6-5

VEHICLE TYPES

	422000	423000	431000	432000	433000	#2 OTHERS	#6 SB-TOT	#7 SB-TOT	#8 SB-TOT	GR-TOT
01 PRIN. ART. -I/R	26	0	0	0	0	1	27	54,512	86,764	211,488
AVG. FOR 12 STATIONS	2	0	0	0	0	0	2	4,543	7,230	17,624
DISTRIBUTION BY %	0.01	0.00	0.00	0.00	0.00	0.00	0.01	25.78	41.03	100.00
02 PRIN. ART. -O/R	25	0	0	0	0	0	25	12,285	32,909	110,834
AVG. FOR 10 STATIONS	3	0	0	0	0	0	3	1,229	3,291	11,083
DISTRIBUTION BY %	0.02	0.00	0.00	0.00	0.00	0.00	0.02	11.08	29.69	100.00
06+07+08+09 ALL O/R	5	0	0	0	0	0	5	2,776	7,876	26,194
AVG. FOR 3 STATIONS	2	0	0	0	0	0	2	925	2,625	8,731
DISTRIBUTION BY %	0.02	0.00	0.00	0.00	0.00	0.00	0.02	10.60	30.07	100.00
11 PRIN. ART. -I/U	0	0	0	0	0	0	0	0	0	0
AVG. FOR 0 STATIONS	0	0	0	0	0	0	0	0	0	0
DISTRIBUTION BY %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12+14 PRIN. ART. -O/U	0	0	0	0	0	0	0	1,720	12,259	62,749
AVG. FOR 3 STATIONS	0	0	0	0	0	0	0	573	4,086	20,916
DISTRIBUTION BY %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.74	19.54	100.00
16+17+19 ALL O/U	0	0	0	0	0	0	0	0	0	0
AVG. FOR 0 STATIONS	0	0	0	0	0	0	0	0	0	0
DISTRIBUTION BY %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ALL RURAL	56	0	0	0	0	1	57	69,573	127,549	348,516
AVG. FOR 25 STATIONS	2	0	0	0	0	0	2	2,783	5,102	13,941
DISTRIBUTION BY %	0.02	0.00	0.00	0.00	0.00	0.00	0.02	19.96	36.60	100.00
ALL URBAN	0	0	0	0	0	0	0	1,720	12,259	62,749
AVG. FOR 3 STATIONS	0	0	0	0	0	0	0	573	4,086	20,916
DISTRIBUTION BY %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.74	19.54	100.00
ALL FUNCTIONAL CLASSES	56	0	0	0	0	1	57	71,293	139,808	411,265
AVG. FOR 28 STATIONS	2	0	0	0	0	0	2	2,546	4,993	14,688
DISTRIBUTION BY %	0.01	0.00	0.00	0.00	0.00	0.00	0.01	17.34	33.99	100.00

5-9-7

HOURLY CLASSIFICATION COUNT SUMMARY FOR 1984

	071000	061000	072000	062000	VEHICLE TYPES		150000	180000	SB-TOT	SB-TOT	
					SB-TOT	030000					
O1 PRIN. ART. -I/R	82804	12942	27695	0	123441	809	339	135	1283	124724	
COUNT FOR 12 STATIONS											
DISTRIBUTION BY PCT.	39.15	6.12	13.10	.00	58.37	.38	.16	.06	.61	58.97	
PCT. OF TOTAL BY HOUR	00	2.33	.57	1.96	.00	2.07	2.72	2.65	2.22	2.65	2.07
	01	1.89	.93	2.46	.00	1.92	2.35	4.13	5.19	3.12	1.93
	02	1.89	.70	2.11	.00	1.81	2.72	2.95	1.48	2.65	1.82
	03	1.97	.70	2.63	.00	1.99	1.98	2.06	5.93	2.42	1.99
	04	2.40	1.10	2.61	.00	2.31	2.97	1.47	5.93	2.88	2.32
	05	2.74	2.11	2.74	.00	2.67	3.46	5.31	4.44	4.05	2.69
	06	4.28	2.70	3.08	.00	3.84	3.83	5.01	7.41	4.52	3.85
	07	5.67	3.88	3.37	.00	4.96	5.07	5.90	2.96	5.07	4.96
	08	5.34	3.48	4.28	.00	4.90	3.58	5.31	3.70	4.05	4.90
	09	5.92	6.22	5.88	.00	5.94	3.83	5.01	3.70	4.13	5.93
	10	5.54	6.77	7.65	.00	6.15	5.93	9.73	7.41	7.09	6.16
	11	6.28	8.43	8.28	.00	6.95	8.65	5.31	8.89	7.79	6.96
	12	6.07	7.49	7.94	.00	6.64	7.29	6.78	.00	6.39	6.64
	13	4.64	7.87	6.24	.00	5.34	5.44	4.42	5.19	5.14	5.34
	14	5.19	8.83	6.18	.00	5.79	6.55	3.24	2.22	5.22	5.79
	15	5.21	7.98	6.42	.00	5.78	6.67	2.65	7.41	5.69	5.78
	16	5.56	7.27	5.65	.00	5.76	3.09	3.54	3.70	3.27	5.73
	17	6.43	6.37	6.67	.00	6.47	8.78	7.96	7.41	8.42	6.49
	18	4.49	4.03	4.56	.00	4.46	3.21	3.83	1.48	3.20	4.44
	19	3.93	3.72	3.20	.00	3.74	5.19	2.95	3.70	4.44	3.75
	20	3.79	3.28	1.95	.00	3.32	1.36	1.77	1.48	1.48	3.30
	21	3.16	2.06	1.78	.00	2.74	1.85	4.13	3.70	2.65	2.74
	22	3.00	1.98	1.46	.00	2.55	2.47	1.77	.74	2.10	2.54
	23	2.29	1.51	.91	.00	1.90	.99	2.06	3.70	1.56	1.89

	200000	210000	220000	230000	VEHICLE TYPES		321000	322000	323000	331000	
					SB-TOT	240000					
O1 PRIN. ART. -I/R	23112	119	8047	709	265	32252	1035	3650	0	0	
COUNT FOR 12 STATIONS											
DISTRIBUTION BY PCT.	10.93	.06	3.80	.34	.13	15.25	.49	1.73	.00	.00	
PCT. OF TOTAL BY HOUR	00	1.68	.00	2.29	3.10	1.51	1.85	2.32	3.42	.00	.00
	01	1.66	.00	2.40	2.26	.75	1.84	1.93	3.73	.00	.00
	02	1.87	.84	1.98	1.69	.00	1.88	2.51	3.40	.00	.00
	03	2.45	.00	2.83	2.68	.00	2.52	2.71	3.37	.00	.00
	04	2.31	5.04	3.70	2.12	1.51	2.66	2.51	3.45	.00	.00
	05	3.19	1.68	3.63	2.26	.75	3.25	3.19	4.38	.00	.00
	06	5.64	3.36	4.51	3.53	2.64	5.28	7.25	5.62	.00	.00
	07	5.89	5.04	4.47	4.37	6.79	5.51	6.28	4.90	.00	.00
	08	5.21	5.04	5.88	3.81	4.15	5.34	4.93	5.70	.00	.00
	09	5.64	7.56	5.55	7.62	10.57	5.71	5.99	6.03	.00	.00
	10	5.68	5.88	5.80	5.64	9.81	5.74	5.80	4.55	.00	.00
	11	7.02	5.88	6.85	9.45	7.17	7.03	3.77	5.04	.00	.00
	12	7.13	3.36	6.87	9.17	5.66	7.08	4.25	5.10	.00	.00
	13	5.53	8.40	5.03	7.90	5.66	5.47	5.51	5.40	.00	.00
	14	5.65	6.72	5.57	6.49	16.23	5.74	4.44	5.29	.00	.00
	15	5.45	3.36	5.67	5.78	4.91	5.50	9.76	5.07	.00	.00
	16	5.67	2.52	6.06	4.94	7.92	5.76	6.09	3.92	.00	.00
	17	5.82	3.36	5.16	4.09	4.53	5.59	5.41	4.27	.00	.00
	18	4.14	5.04	3.49	3.67	3.77	3.97	3.77	3.51	.00	.00
	19	3.54	7.56	3.04	3.67	2.26	3.43	4.25	3.59	.00	.00
	20	2.80	14.29	2.55	1.27	1.13	2.73	3.19	2.93	.00	.00
	21	2.41	5.04	2.15	1.27	1.13	2.32	2.03	2.14	.00	.00
	22	2.06	.00	2.60	.99	.38	2.15	.87	2.96	.00	.00
	23	1.57	.00	1.91	2.26	.75	1.66	1.26	2.25	.00	.00

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HOURLY CLASSIFICATION COUNT SUMMARY FOR 1984

	VEHICLE TYPES									
	332000	333000	521100	521200	522200	531200	532200	OTHERS	SB-TOT	421000
O1 PRIN. ART. -I/R	48156	412	0	1133	0	93	6	0	54485	0
COUNT FOR 12 STATIONS										
DISTRIBUTION BY PCT.	22.77	.19	.00	.54	.00	.04	.00	.00	25.76	.00
PCT. OF TOTAL BY HOUR										
00	4.28	1.70	.00	3.44	.00	2.15	.00	.00	4.14	.00
01	4.28	4.61	.00	4.50	.00	3.23	.00	.00	4.20	.00
02	4.09	1.46	.00	3.35	.00	6.45	.00	.00	3.98	.00
03	3.77	3.64	.00	2.74	.00	2.15	.00	.00	3.70	.00
04	4.44	9.71	.00	4.68	.00	.00	.00	.00	4.37	.00
05	4.32	2.18	.00	4.06	.00	3.23	.00	.00	4.28	.00
06	4.56	3.15	.00	4.94	.00	3.23	.00	.00	4.68	.00
07	4.44	4.61	.00	5.21	.00	10.75	.00	.00	4.54	.00
08	4.27	4.85	.00	4.24	.00	7.53	33.33	.00	4.39	.00
09	4.42	4.37	.00	2.82	.00	1.08	.00	.00	4.52	.00
10	4.90	2.67	.00	6.00	.00	4.30	.00	.00	4.90	.00
11	5.45	6.07	.00	4.06	.00	8.60	.00	.00	5.37	.00
12	4.39	6.07	.00	6.53	.00	12.90	.00	.00	4.51	.00
13	3.66	4.37	.00	5.12	.00	2.15	.00	.00	3.85	.00
14	3.63	3.40	.00	4.15	.00	1.08	.00	.00	3.76	.00
15	3.90	2.18	.00	4.06	.00	.00	.00	.00	4.08	.00
16	3.90	3.40	.00	3.27	.00	6.45	.00	.00	3.93	.00
17	3.97	6.31	.00	3.71	.00	3.23	50.00	.00	4.03	.00
18	3.72	15.05	.00	2.47	.00	2.15	.00	.00	3.77	.00
19	4.29	4.13	.00	5.38	.00	11.83	.00	.00	4.27	.00
20	4.07	1.70	.00	3.88	.00	2.15	.00	.00	3.91	.00
21	4.01	1.70	.00	4.15	.00	1.08	.00	.00	3.82	.00
22	3.74	1.21	.00	4.77	.00	3.23	16.67	.00	3.63	.00
23	3.53	1.46	.00	2.47	.00	1.08	.00	.00	3.36	.00

	VEHICLE TYPES									
	422000	423000	431000	432000	433000	OTHERS	SB-TOT	SB-TOT	SB-TOT	GR-TOT
O1 PRIN. ART. -I/R	26	0	0	0	0	1	27	54512	86764	211488
COUNT FOR 12 STATIONS										
DISTRIBUTION BY PCT.	.01	.00	.00	.00	.00	.00	.01	25.78	41.03	100.00
PCT. OF TOTAL BY HOUR										
00	.00	.00	.00	.00	.00	.00	.00	4.14	3.29	2.57
01	.00	.00	.00	.00	.00	.00	.00	4.20	3.33	2.50
02	.00	.00	.00	.00	.00	.00	.00	3.98	3.20	2.38
03	.00	.00	.00	.00	.00	.00	.00	3.70	3.26	2.51
04	.00	.00	.00	.00	.00	.00	.00	4.37	3.74	2.90
05	11.54	.00	.00	.00	.00	100.00	14.81	4.29	3.90	3.19
06	11.54	.00	.00	.00	.00	.00	11.11	4.68	4.91	4.28
07	.00	.00	.00	.00	.00	.00	.00	4.53	4.90	4.94
08	3.85	.00	.00	.00	.00	.00	3.70	4.39	4.74	4.83
09	26.92	.00	.00	.00	.00	.00	25.93	4.53	4.97	5.53
10	3.85	.00	.00	.00	.00	.00	3.70	4.90	5.21	5.77
11	.00	.00	.00	.00	.00	.00	.00	5.37	5.99	6.56
12	.00	.00	.00	.00	.00	.00	.00	4.50	5.46	6.16
13	.00	.00	.00	.00	.00	.00	.00	3.85	4.45	4.97
14	3.85	.00	.00	.00	.00	.00	3.70	3.76	4.50	5.26
15	.00	.00	.00	.00	.00	.00	.00	4.07	4.60	5.29
16	3.85	.00	.00	.00	.00	.00	3.70	3.93	4.61	5.27
17	.00	.00	.00	.00	.00	.00	.00	4.03	4.61	5.72
18	.00	.00	.00	.00	.00	.00	.00	3.76	3.84	4.20
19	.00	.00	.00	.00	.00	.00	.00	4.27	3.96	3.84
20	.00	.00	.00	.00	.00	.00	.00	3.91	3.47	3.37
21	34.62	.00	.00	.00	.00	.00	33.33	3.84	3.27	2.96
22	.00	.00	.00	.00	.00	.00	.00	3.63	3.08	2.76
23	.00	.00	.00	.00	.00	.00	.00	3.36	2.73	2.24

5-9-9

Other Weight Data Analyses

There are many truck weight data relationships that could be useful beyond those covered in the W-Tables. The relationships between the weights by vehicle type and the various interview items, such as load status or commodity carried, could provide valuable information for a specific site or functional classification. Further analysis of individual axle weights and axle spacings could also be of interest.

Because of requests for additional analysis, several tables have been developed to display the information. Each of the tables represents one State's data submittal for 1 year. A representative portion of each table is provided here along with an explanation of its contents.

1. Violations by Vehicle Type and Commodity Group (See pages 5-9-13 through 5-9-19)

This is a listing of the number of vehicles weighed by the type of commodity carried, vehicle type and functional classification. It also indicates any violation of the weight laws by the type of violation. The violation types are defined as follows:

- a. SA = Single Axle
- b. AG = Axle Group (by Bridge Formula)
- c. GW = Gross Weight
- d. TA = Tandem Axle

The example listing shows the information for one functional classification.

2. Trucks Exceeding Legal Weight Limits by Vehicle Type at Various Tolerances (See pages 5-9-20 and 5-9-21)

This summary provides station by station information on the frequency of trucks exceeding the legal gross or axle weight limits for various vehicle types. The distribution of overweight trucks is shown in terms of the percentage of excess. For example, any truck that is overweight will appear under the proper vehicle type in the row titled "00." The "00" indicates that the vehicle is greater than 0 percent overweight. The remaining rows include those trucks that are greater than the indicated percentage overweight. Therefore, a truck that has a gross weight or axle weight that exceeds the legal limit by 10 percent will appear under the appropriate vehicle type in all the rows from "00" to "09."

The information for each station is printed on two separate pages; one showing the percent tolerances of 00 to 20, and the other showing the percent tolerances of 21 to 100. The example summary shows only the total for all the stations of one state.

Also shown on each table are the total number of trucks weighed at that station and the legal weight limits used to determine if a truck was overweight.

3. Percentages of Axle Weights, Tandem Weights, and Gross Weights Exceeding 50 Weight Categories (See page 5-9-22)

As indicated by the title, this table contains the percentage of single axle, tandem axle, and gross weights that exceed a particular weight for eight of the most common truck types. The weights range from 0 to 100,000 pounds in 2,000 pound intervals. Also shown are the total number of single axles, tandem groups, and trucks for each vehicle type. The table is normally four pages long with two vehicle types on each page.

4. Count of Loaded (or Unloaded) Axles by Weight Group and Vehicle Type (See pages 5-9-23 through 5-9-26)

This is a set of two tables with one showing the frequency of loaded axles by weight and the other showing the frequency of unloaded axles by weight. Counts are given for each individual axle of the most common vehicle types. The axle positions are indicated with the following alphabetic codes:

B	=	2nd axle
C	=	3rd axle
D	=	4th axle
E	=	5th axle
F	=	6th axle

The steering axle is not included in this table since it is relatively unaffected by the presence of a load.

The weights indicated in the row headings are in thousands of pounds and range from 0 to 30,000 pounds. One axle could appear in more than one row, e.g., a 20,000 pound axle would appear in all the rows from 0 to 20. All of the axles for a particular axle position will appear in the first row since all the weights will be greater than zero.

5. Weight Distribution Summary (See pages 5-9-27 and 5-9-28)

This summary determines the average gross weight and average axle weights for each vehicle type by each load status. The average weights are also given by specified weight intervals. In addition, within each interval, the number of vehicles in the sample from which the average weights are calculated, the percent of the vehicles of a particular type that are in that interval, and the percent distribution of the axle weights are shown. The example represents this information for one vehicle type.

6. Body Type Analysis (See page 5-9-29)

This is a listing of the various body types that exist for each vehicle type based on the load status. For each body type in a specific category, average gross and axle weights are shown along with the number of vehicles involved in the calculation of the average weights and the minimum and maximum gross weights of the trucks in this sample. The example shows the information for one vehicle type.

Each body type indicated in the body type coding instructions in Chapter 6 will appear individually in this table except those represented by the codes 14, 63, 79 and those greater than 88. These codes are grouped into a category called "All Other Types."

7. Average (or Minimum or Maximum) Axle Spacing by Vehicle Type (See pages 5-9-30 through 5-9-32).

This is a set of three tables of information on axle spacings by vehicle type. One table shows the average axle spacings for a specific sample of vehicles and the other two tables show the minimum or maximum axle spacings found in the same sample.

The spacings are provided to the tenth of a foot and are shown under the axles between which they were measured in the following manner:

A-B =	Distance between 1st and 2nd axle
B-C =	Distance between 2nd and 3rd axle
C-D =	Distance between 3rd and 4th axle
.	
.	
.	
K-L =	Distance between 11th and 12th axle
L-M =	Distance between 12th and 13th axle

Availability of Data and Technical Assistance from FHWA

Many types of analyses of vehicle classification and truck weight data have been discussed in Chapters 8 and 9, however, there may still be data relationships that were not covered in these tables or that were not displayed in enough detail for a particular State's use. Obviously, analysis of this data is not limited to these specific tables. Other analysis may be performed at the State level and, if necessary, technical assistance is available from the Highway Statistics Division (HSD), FHWA. Also, the HSD maintains a state master file of vehicle classification data and a state master file of truck weight data for every year from 1966 to present. Selected states for selected years may be drawn from the master files for the State's use at the State's request.

VIOLATIONS BY VEHICLE TYPE AND COMMODITY GROUP
1984

FUNCTIONAL CLASS 01 INTERSTATE RURAL

VEHICLE TYPE	# OF VEHICLES WEIGHED	NUMBER WEIGHED THAT WERE IN VIOLATION				PERCENT OF THOSE WEIGHED THAT WERE IN VIOLATION				AVERAGE PERCENT OF EXCESS OVER THE STATE LIMIT FOR THE INTERSTATE SYSTEMS			
		SA	AG	GW	TA	SA	AG	GW	TA	SA	AG	GW	TA
SINGLE UNIT (2AXLE-6TIRE)													
FARM PRODUCTS	22	1	0	0	0	4.5	0.0	0.0	0.0	24.6	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	2	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	75	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	16	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	3	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	7	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	32	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	43	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	493	1	0	0	0	0.2	0.0	0.0	0.0	4.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	693	2	0	0	0	0.3	0.0	0.0	0.0	14.3	0.0	0.0	0.0
SINGLE UNIT (3-AXLE)													
FARM PRODUCTS	5	0	1	0	0	0.0	20.0	0.0	0.0	0.0	32.4	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	17	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	2	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	2	0	1	0	0	0.0	50.0	0.0	0.0	0.0	10.3	0.0	0.0
MACHINERY	3	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	7	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	61	0	4	0	0	0.0	6.6	0.0	0.0	0.0	4.3	0.0	0.0
TOTAL ALL COMMODITIES	97	0	6	0	0	0.0	6.2	0.0	0.0	0.0	10.0	0.0	0.0
SINGLE UNIT (4AX OR MORE)													
FARM PRODUCTS	1	0	1	0	0	0.0	100.0	0.0	0.0	0.0	4.5	0.0	0.0
COAL/NON-METALLIC MINERALS	11	0	8	0	0	0.0	72.7	0.0	0.0	0.0	22.1	0.0	0.0
FOOD + KINDRED PRODUCTS	53	0	8	0	0	0.0	15.1	0.0	0.0	0.0	3.4	0.0	0.0
LUMBER + WOOD PRODUCTS	6	0	2	0	0	0.0	33.3	0.0	0.0	0.0	9.3	0.0	0.0
PETROLEUM OR COAL PRODUCTS	7	0	1	0	0	0.0	14.3	0.0	0.0	0.0	42.9	0.0	0.0
PRIMARY METAL PRODUCTS	16	0	5	0	0	0.0	31.3	0.0	0.0	0.0	4.0	0.0	0.0
MACHINERY	4	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	13	0	1	0	0	0.0	7.7	0.0	0.0	0.0	15.6	0.0	0.0
OTHER COMMODITIES	237	1	24	0	0	0.4	10.1	0.0	0.0	136.6	14.3	0.0	0.0
TOTAL ALL COMMODITIES	348	1	50	0	0	0.3	14.4	0.0	0.0	136.6	13.0	0.0	0.0
SINGLE UNIT (SUBTOTAL)													
FARM PRODUCTS	28	1	2	0	0	3.6	7.1	0.0	0.0	24.6	18.4	0.0	0.0
COAL/NON-METALLIC MINERALS	13	0	8	0	0	0.0	61.5	0.0	0.0	0.0	22.1	0.0	0.0
FOOD + KINDRED PRODUCTS	145	0	8	0	0	0.0	5.5	0.0	0.0	0.0	3.4	0.0	0.0
LUMBER + WOOD PRODUCTS	24	0	2	0	0	0.0	8.3	0.0	0.0	0.0	9.3	0.0	0.0
PETROLEUM OR COAL PRODUCTS	10	0	1	0	0	0.0	10.0	0.0	0.0	0.0	42.9	0.0	0.0
PRIMARY METAL PRODUCTS	25	0	6	0	0	0.0	24.0	0.0	0.0	0.0	5.0	0.0	0.0
MACHINERY	39	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	63	0	1	0	0	0.0	1.6	0.0	0.0	0.0	15.6	0.0	0.0
OTHER COMMODITIES	791	2	28	0	0	0.3	3.5	0.0	0.0	70.3	12.9	0.0	0.0
TOTAL ALL COMMODITIES	1,138	3	56	0	0	0.3	4.9	0.0	0.0	55.0	12.6	0.0	0.0

NOTE: FOR ALL VEHICLES HAVING MULTIPLE VIOLATIONS, ONLY THE VIOLATION WITH THE HIGHEST PERCENTAGE OF EXCESS WAS TABULATED. ALSO FROM THE DATA COLLECTED, IT WAS NOT POSSIBLE TO DETERMINE IF ANY OF THE VEHICLES IN EXCESS WERE OPERATING UNDER SPECIAL PERMIT.

5-9-13

VIOLATIONS BY VEHICLE TYPE AND COMMODITY GROUP
1984

FUNCTIONAL CLASS OF INTERSTATE RURAL

VEHICLE TYPE	# OF VEHICLES WEIGHED	NUMBER WEIGHED THAT WERE IN VIOLATION				PERCENT OF THOSE WEIGHED THAT WERE IN VIOLATION				AVERAGE PERCENT OF EXCESS OVER THE STATE LIMIT FOR THE INTERSTATE SYSTEMS			
		SA	AG	GW	TA	SA	AG	GW	TA	SA	AG	GW	TA
TRACTOR + 1 TRLR (321000)													
FARM PRODUCTS	2	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	6	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	2	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	8	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	81	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	100	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRACTOR + 1 TRLR (322000)													
FARM PRODUCTS	2	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	27	1	0	0	0	3.7	0.0	0.0	0.0	1.8	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	7	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	6	1	0	0	0	16.7	0.0	0.0	0.0	3.1	0.0	0.0	0.0
MACHINERY	15	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	47	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	240	1	2	0	0	0.4	0.8	0.0	0.0	3.6	8.1	0.0	0.0
TOTAL ALL COMMODITIES	346	3	2	0	0	0.9	0.6	0.0	0.0	2.8	8.1	0.0	0.0
TRACTOR + 1 TRLR (323000)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	8	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	10	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRACTOR + 1 TRLR (331000)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	4	0	1	0	0	0.0	25.0	0.0	0.0	0.0	10.7	0.0	0.0
TOTAL ALL COMMODITIES	6	0	1	0	0	0.0	16.7	0.0	0.0	0.0	10.7	0.0	0.0

5-9-14

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VIOLATIONS BY VEHICLE TYPE AND COMMODITY GROUP
1984

FUNCTIONAL CLASS 01 INTERSTATE RURAL

VEHICLE TYPE	# OF VEHICLES WEIGHED	NUMBER WEIGHED THAT WERE IN VIOLATION				PERCENT OF THOSE WEIGHED THAT WERE IN VIOLATION				AVERAGE PERCENT OF EXCESS OVER THE STATE LIMIT FOR THE INTERSTATE SYSTEMS			
		SA	AG	GW	TA	SA	AG	GW	TA	SA	AG	GW	TA

TRACTOR + 1 TRLR (332000)													
FARM PRODUCTS	110	0	10	0	0	0.0	9.1	0.0	0.0	0.0	9.4	0.0	0.0
COAL/NON-METALLIC MINERALS	49	0	19	0	0	0.0	38.8	0.0	0.0	0.0	6.1	0.0	0.0
FOOD + KINDRED PRODUCTS	564	4	59	0	0	0.7	10.5	0.0	0.0	9.0	10.0	0.0	0.0
LUMBER + WOOD PRODUCTS	120	1	8	0	1	0.8	6.7	0.0	0.8	52.7	14.5	0.0	2.2
PETROLEUM OR COAL PRODUCTS	47	0	8	0	0	0.0	17.0	0.0	0.0	0.0	6.1	0.0	0.0
PRIMARY METAL PRODUCTS	279	2	45	0	0	0.7	16.1	0.0	0.0	4.2	10.3	0.0	0.0
MACHINERY	184	0	13	0	0	0.0	7.1	0.0	0.0	0.0	9.3	0.0	0.0
MIXED FREIGHT (ALL KINDS)	353	0	24	0	0	0.0	6.8	0.0	0.0	0.0	6.1	0.0	0.0
OTHER COMMODITIES	3,018	4	176	0	1	0.1	5.8	0.0	0.0	122.7	10.5	0.0	2.8
TOTAL ALL COMMODITIES	4,724	11	362	0	2	0.2	7.7	0.0	0.0	53.4	9.8	0.0	2.5

TRACTOR + 1 TRLR (333000)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	5	0	1	0	0	0.0	20.0	0.0	0.0	0.0	3.8	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	1	0	1	0	0	0.0	100.0	0.0	0.0	0.0	3.5	0.0	0.0
PRIMARY METAL PRODUCTS	5	0	3	0	0	0.0	60.0	0.0	0.0	0.0	17.6	0.0	0.0
MACHINERY	7	0	3	0	0	0.0	42.9	0.0	0.0	0.0	22.9	0.0	0.0
MIXED FREIGHT (ALL KINDS)	4	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	25	0	4	0	0	0.0	16.0	0.0	0.0	0.0	15.3	0.0	0.0
TOTAL ALL COMMODITIES	48	0	12	0	0	0.0	25.0	0.0	0.0	0.0	15.8	0.0	0.0

TRACTOR + 1 TRLR (OTHERS)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRACTOR + 1 TRLR(SUBTOTAL)													
FARM PRODUCTS	114	0	10	0	0	0.0	8.8	0.0	0.0	0.0	9.4	0.0	0.0
COAL/NON-METALLIC MINERALS	55	0	20	0	0	0.0	36.4	0.0	0.0	0.0	6.0	0.0	0.0
FOOD + KINDRED PRODUCTS	597	5	59	0	0	0.8	9.9	0.0	0.0	7.5	10.0	0.0	0.0
LUMBER + WOOD PRODUCTS	130	1	8	0	1	0.8	6.2	0.0	0.8	52.7	14.5	0.0	2.2
PETROLEUM OR COAL PRODUCTS	49	0	9	0	0	0.0	18.4	0.0	0.0	0.0	5.8	0.0	0.0
PRIMARY METAL PRODUCTS	291	3	48	0	0	1.0	16.5	0.0	0.0	3.8	10.7	0.0	0.0
MACHINERY	210	0	16	0	0	0.0	7.6	0.0	0.0	0.0	11.9	0.0	0.0
MIXED FREIGHT (ALL KINDS)	413	0	24	0	0	0.0	5.8	0.0	0.0	0.0	6.1	0.0	0.0
OTHER COMMODITIES	3,376	5	183	0	1	0.1	5.4	0.0	0.0	98.9	10.6	0.0	2.8
TOTAL ALL COMMODITIES	5,235	14	377	0	2	0.3	7.2	0.0	0.0	42.6	10.0	0.0	2.5

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VIOLATIONS BY VEHICLE TYPE AND COMMODITY GROUP
1984

FUNCTIONAL CLASS 01 INTERSTATE RURAL

VEHICLE TYPE	# OF VEHICLES WEIGHED	NUMBER WEIGHED THAT WERE IN VIOLATION				PERCENT OF THOSE WEIGHED THAT WERE IN VIOLATION				AVERAGE PERCENT OF EXCESS OVER THE STATE LIMIT FOR THE INTERSTATE SYSTEMS			
		SA	AG	GW	TA	SA	AG	GW	TA	SA	AG	GW	TA

TRUCK + 1 TRM (421000)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRUCK + 1 TRLR (422000)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRUCK + 1 TRLR (423000)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRUCK + 1 TRLR (431000)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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VIOLATIONS BY VEHICLE TYPE AND COMMODITY GROUP
1984

FUNCTIONAL CLASS 01 INTERSTATE RURAL

VEHICLE TYPE	# OF VEHICLES WEIGHED	NUMBER WEIGHED THAT WERE IN VIOLATION				PERCENT OF THOSE WEIGHED THAT WERE IN VIOLATION				AVERAGE PERCENT OF EXCESS OVER THE STATE LIMIT FOR THE INTERSTATE SYSTEMS			
		SA	AG	GW	TA	SA	AG	GW	TA	SA	AG	GW	TA

TRUCK + 1 TRLR (432000)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRUCK + 1 TRLR (433000)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRUCK + 1 TRLR (OTHERS)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRUCK + 1 TRLR (SURTOTAL)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	2	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	2	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NOTE: FOR ALL VEHICLES HAVING MULTIPLE VIOLATIONS, ONLY THE VIOLATION WITH THE HIGHEST PERCENTAGE OF EXCESS WAS TABULATED. ALSO FROM THE DATA COLLECTED, IT WAS NOT POSSIBLE TO DETERMINE IF ANY OF THE VEHICLES IN EXCESS WERE OPERATING UNDER SPECIAL PERMIT.

VIOLATIONS BY VEHICLE TYPE AND COMMODITY GROUP
1984

FUNCTIONAL CLASS 01 INTERSTATE RURAL

VEHICLE TYPE	# OF VEHICLES WEIGHED	NUMBER WEIGHED THAT WERE IN VIOLATION				PERCENT OF THOSE WEIGHED THAT WERE IN VIOLATION				AVERAGE PERCENT OF EXCESS OVER THE STATE LIMIT FOR THE INTERSTATE SYSTEMS			
		SA	AG	GW	TA	SA	AG	GW	TA	SA	AG	GW	TA
TRACTOR + 2 IRLRS (521200)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	33	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	87	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	121	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRACTOR + 2 IRLRS (522200)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRACTOR + 2 IRLRS (531200)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	3	1	0	0	0	33.3	0.0	0.0	0.0	4.5	0.0	0.0	0.0
OTHER COMMODITIES	14	0	1	0	0	0.0	7.1	0.0	0.0	0.0	0.1	0.0	0.0
TOTAL ALL COMMODITIES	17	1	1	0	0	5.9	5.9	0.0	0.0	4.5	0.1	0.0	0.0
TRACTOR + 2 TRRS (OTHERS)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NOTE: FOR ALL VEHICLES HAVING MULTIPLE VIOLATIONS, ONLY THE VIOLATION WITH THE HIGHEST PERCENTAGE OF EXCESS WAS TABULATED. ALSO FROM THE DATA COLLECTED, IT WAS NOT POSSIBLE TO DETERMINE IF ANY OF THE VEHICLES IN EXCESS WERE OPERATING UNDER SPECIAL PERMIT.

VIOLATIONS BY VEHICLE TYPE AND COMMODITY GROUP
1984

FUNCTIONAL CLASS 01 INTERSTATE RURAL

VEHICLE TYPE	# OF VEHICLES WEIGHED	NUMBER WEIGHED THAT WERE IN VIOLATION				PERCENT OF THOSE WEIGHED THAT WERE IN VIOLATION				AVERAGE PERCENT OF EXCESS OVER THE STATE LIMIT FOR THE INTERSTATE SYSTEMS			
		SA	AG	GW	TA	SA	AG	GW	TA	SA	AG	GW	TA
TRACTOR +2 TRLR(SUBTOTAL)													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	36	1	0	0	0	2.8	0.0	0.0	0.0	4.5	0.0	0.0	0.0
OTHER COMMODITIES	102	0	1	0	0	0.0	1.0	0.0	0.0	0.0	0.1	0.0	0.0
TOTAL ALL COMMODITIES	139	1	1	0	0	0.7	0.7	0.0	0.0	4.5	0.1	0.0	0.0
OTHER COMBINATIONS													
FARM PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COAL/NON-METALLIC MINERALS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD + KINDRED PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LUMBER + WOOD PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM OR COAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRIMARY METAL PRODUCTS	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACHINERY	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIXED FREIGHT (ALL KINDS)	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMMODITIES	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL ALL COMBINATIONS													
FARM PRODUCTS	114	0	10	0	0	0.0	8.8	0.0	0.0	0.0	9.4	0.0	0.0
COAL/NON-METALLIC MINERALS	55	0	20	0	0	0.0	36.4	0.0	0.0	0.0	6.0	0.0	0.0
FOOD + KINDRED PRODUCTS	597	5	59	0	0	0.8	9.9	0.0	0.0	7.5	10.0	0.0	0.0
LUMBER + WOOD PRODUCTS	131	1	8	0	1	0.8	6.1	0.0	0.8	52.7	14.5	0.0	2.2
PETROLEUM OR COAL PRODUCTS	49	0	9	0	0	0.0	18.4	0.0	0.0	0.0	5.8	0.0	0.0
PRIMARY METAL PRODUCTS	293	3	48	0	0	1.0	16.4	0.0	0.0	3.8	10.7	0.0	0.0
MACHINERY	210	0	16	0	0	0.0	7.6	0.0	0.0	0.0	11.9	0.0	0.0
MIXED FREIGHT (ALL KINDS)	449	1	24	0	0	0.2	5.3	0.0	0.0	4.5	6.1	0.0	0.0
OTHER COMMODITIES	3,478	5	184	0	1	0.1	5.3	0.0	0.0	98.9	10.5	0.0	2.8
TOTAL ALL COMMODITIES	5,376	15	378	0	2	0.3	7.0	0.0	0.0	40.0	9.9	0.0	2.5
GRAND TOTAL ALL TYPES													
FARM PRODUCTS	142	1	12	0	0	0.7	8.5	0.0	0.0	24.6	10.9	0.0	0.0
COAL/NON-METALLIC MINERALS	68	0	28	0	0	0.0	41.2	0.0	0.0	0.0	10.6	0.0	0.0
FOOD + KINDRED PRODUCTS	742	5	67	0	0	0.7	9.0	0.0	0.0	7.5	9.2	0.0	0.0
LUMBER + WOOD PRODUCTS	155	1	10	0	1	0.6	6.5	0.0	0.6	52.7	13.5	0.0	2.2
PETROLEUM OR COAL PRODUCTS	59	0	10	0	0	0.0	16.9	0.0	0.0	0.0	9.5	0.0	0.0
PRIMARY METAL PRODUCTS	318	3	54	0	0	0.9	17.0	0.0	0.0	3.8	10.1	0.0	0.0
MACHINERY	249	0	16	0	0	0.0	6.4	0.0	0.0	0.0	11.9	0.0	0.0
MIXED FREIGHT (ALL KINDS)	512	1	25	0	0	0.2	4.9	0.0	0.0	4.5	6.5	0.0	0.0
OTHER COMMODITIES	4,269	7	212	0	1	0.2	5.0	0.0	0.0	90.7	10.8	0.0	2.8
TOTAL ALL COMMODITIES	6,514	18	434	0	2	0.3	6.7	0.0	0.0	42.5	10.3	0.0	2.5

NOTE: FOR ALL VEHICLES HAVING MULTIPLE VIOLATIONS, ONLY THE VIOLATION WITH THE HIGHEST PERCENTAGE OF EXCESS WAS TABULATED. ALSO FROM THE DATA COLLECTED, IT WAS NOT POSSIBLE TO DETERMINE IF ANY OF THE VEHICLES IN EXCESS WERE OPERATING UNDER SPECIAL PERMIT.

5-9-19

TRUCKS EXCEEDING LEGAL WEIGHT LIMITS BY VEHICLE TYPE AT VARIOUS TOLERANCES

STATION ALL

1984 DATA FROM
THE ANNUAL TRUCK WEIGHT STUDY

PCT. TOL.	TOTAL TRUCKS	SINGLE UNIT TRUCKS					TRACTOR-SEMI-TRAILER COMB.					TRUCK-FULL-TRAILER COMB.			
		2 AXLE 4 TIRF	2 AXLE 6 TIRF	THREE AXLES	4 AXLES OR >	SU WITH TRLR	THREE AXLES	FOUR AXLES	FIVE AXLES	6 AXLES OR >	THREE AXLES	FOUR AXLES	FIVE AXLES	6 AXLES OR >	
00	278	0	15	6	57	7	0	10	165	18	0	0	0	0	
01	247	0	12	5	55	6	0	9	145	15	0	0	0	0	
02	218	0	11	2	54	4	0	8	125	14	0	0	0	0	
03	196	0	9	2	50	2	0	7	112	14	0	0	0	0	
04	175	0	7	1	49	2	0	5	99	12	0	0	0	0	
05	157	0	6	1	49	1	0	4	85	11	0	0	0	0	
06	136	0	6	1	46	1	0	3	68	11	0	0	0	0	
07	123	0	6	1	46	1	0	3	56	10	0	0	0	0	
08	110	0	5	1	44	1	0	3	47	9	0	0	0	0	
09	104	0	4	1	44	1	0	3	42	9	0	0	0	0	
10	93	0	4	1	42	1	0	3	36	6	0	0	0	0	
11	82	0	4	1	41	1	0	2	28	5	0	0	0	0	
12	75	0	4	1	39	1	0	2	23	5	0	0	0	0	
13	71	0	4	1	37	1	0	2	21	5	0	0	0	0	
14	69	0	4	1	36	1	0	2	20	5	0	0	0	0	
15	66	0	4	1	35	1	0	1	19	5	0	0	0	0	
16	63	0	4	1	34	1	0	0	18	5	0	0	0	0	
17	62	0	4	1	34	1	0	0	17	5	0	0	0	0	
18	60	0	3	1	34	1	0	0	17	4	0	0	0	0	
19	56	0	3	1	31	1	0	0	16	4	0	0	0	0	
20	55	0	3	1	31	1	0	0	16	3	0	0	0	0	

5-9-20

TOTAL NUMBER OF TRUCKS SAMPLED: 11,794

LEGAL LIMITS USED: 2 AXLE SINGLE UNIT TRUCKS- 44,800 #
 3 AXLE OR MORE S-U TRUCKS- 58,400 #
 3 AXLE COMBINATION TRUCKS- 67,200 #
 4 AXLE COMBINATION TRUCKS- 73,300 #
 5 AXLE COMBINATION TRUCKS- 80,000 #
 OTHER COMBINATION TRUCKS- 80,000 #

INDIVIDUAL AXLE LIMIT- 22,400 #

TRUCKS EXCEEDING LEGAL WEIGHT LIMITS BY VEHICLE TYPE AT VARIOUS TOLERANCES

STATION ALL

1984 DATA FROM
THE ANNUAL TRUCK WEIGHT STUDY

PCT. TOL.	TOTAL TRUCKS	SINGLE UNIT TRUCKS					TRACTOR-SEMI-TRAILER COMB.					TRUCK-FULL-TRAILER COMB.			
		2 AXLE 4 TIRE	2 AXLE 6 TIRE	THREE AXLES	4 AXLES OR >	SU WITH TRLR	THREE AXLES	FOUR AXLES	FIVE AXLES	6 AXLES OR >	THREE AXLES	FOUR AXLES	FIVE AXLES	6 AXLES OR >	
21	47	0	2	0	29	1	0	0	12	3	0	0	0	0	
22	41	0	2	0	25	1	0	0	11	2	0	0	0	0	
23	38	0	2	0	23	1	0	0	11	1	0	0	0	0	
24	31	0	1	0	18	1	0	0	10	1	0	0	0	0	
25	28	0	0	0	16	1	0	0	10	1	0	0	0	0	
26	24	0	0	0	13	1	0	0	9	1	0	0	0	0	
27	23	0	0	0	12	1	0	0	9	1	0	0	0	0	
28	22	0	0	0	12	1	0	0	8	1	0	0	0	0	
29	17	0	0	0	8	1	0	0	8	0	0	0	0	0	
30	16	0	0	0	7	1	0	0	8	0	0	0	0	0	
35	12	0	0	0	4	1	0	0	7	0	0	0	0	0	
40	9	0	0	0	1	1	0	0	7	0	0	0	0	0	
45	8	0	0	0	1	1	0	0	6	0	0	0	0	0	
50	8	0	0	0	1	1	0	0	6	0	0	0	0	0	
55	7	0	0	0	1	1	0	0	5	0	0	0	0	0	
60	7	0	0	0	1	1	0	0	5	0	0	0	0	0	
65	6	0	0	0	1	1	0	0	4	0	0	0	0	0	
70	6	0	0	0	1	1	0	0	4	0	0	0	0	0	
75	5	0	0	0	1	1	0	0	3	0	0	0	0	0	
80	5	0	0	0	1	1	0	0	3	0	0	0	0	0	
100	4	0	0	0	0	1	0	0	3	0	0	0	0	0	

TOTAL NUMBER OF TRUCKS SAMPLED: 11,794

LEGAL LIMITS USED: 2 AXLE SINGLE UNIT TRUCKS- 44,800 #
 3 AXLE OR MORE S-U TRUCKS- 58,400 #
 3 AXLE COMBINATION TRUCKS- 67,200 #
 4 AXLE COMBINATION TRUCKS- 73,300 #
 5 AXLE COMBINATION TRUCKS- 80,000 #
 OTHER COMBINATION TRUCKS- 80,000 #

INDIVIDUAL AXLE LIMIT- 22,400 #

5-9-21

DATA YEAR: 1984

PERCENTAGE OF AXLE WEIGHTS, TANDEM WEIGHTS, AND GROSS WEIGHTS
EXCEEDING 50 WEIGHT CATEGORIES.

VEHICLE TYPE: 332000

VEHICLE TYPE: 337000

WEIGHT IN POUNDS	PERCENT OF AXLE WEIGHTS EXCEEDING	PERCENT OF TANDEM WEIGHTS EXCEEDING	PERCENT OF GROSS WEIGHTS EXCEEDING	PERCENT OF AXLE WEIGHTS EXCEEDING	PERCENT OF TANDEM WEIGHTS EXCEEDING	PERCENT OF GROSS WEIGHTS EXCEEDING
0	100.00	100.00	100.00			
2,000	99.70	100.00	100.00			
4,000	94.92	99.96	100.00			
6,000	80.90	99.44	100.00			
8,000	65.33	95.37	100.00			
10,000	46.38	87.42	100.00			
12,000	31.56	78.80	100.00			
14,000	20.87	70.16	100.00			
16,000	9.59	63.26	100.00			
18,000	2.79	56.68	99.97			
20,000	0.79	50.39	99.92			
22,000	0.24	44.25	99.59			
24,000	0.09	38.36	98.44			
26,000	0.05	32.18	96.57			
28,000	0.03	24.86	92.82			
30,000	0.03	16.99	86.92			
32,000	0.02	9.74	80.91			
34,000	0.02	4.66	76.06			
36,000	0.02	2.22	72.05			
38,000	0.02	1.04	68.56			
40,000	0.02	0.52	65.16			
42,000	0.02	0.35	62.03			
44,000	0.02	0.20	58.86			
46,000	0.02	0.11	55.42			
48,000	0.01	0.07	52.36			
50,000	0.01	0.05	49.61			
52,000	0.01	0.05	46.72			
54,000	0.01	0.04	43.96			
56,000	0.01	0.03	40.95			
58,000	0.01	0.03	37.90			
60,000	0.01	0.03	34.82			
62,000	0.01	0.03	31.84			
64,000	0.01	0.03	28.08			
66,000	0.01	0.02	24.61			
68,000	0.00	0.02	20.68			
70,000	0.00	0.02	16.23			
72,000	0.00	0.02	12.13			
74,000	0.00	0.02	8.54			
76,000	0.00	0.02	5.33			
78,000	0.00	0.02	3.33			
80,000	0.00	0.02	1.82			
82,000	0.00	0.02	1.19			
84,000	0.00	0.02	0.80			
86,000	0.00	0.02	0.42			
88,000	0.00	0.02	0.22			
90,000	0.00	0.02	0.15			
92,000	0.00	0.02	0.12			
94,000	0.00	0.02	0.11			
96,000	0.00	0.01	0.09			
98,000	0.00	0.01	0.04			
100,000	0.00	0.01	0.04			

TOTAL NUMBER IN SAMPLE:

36,900 SINGLE AXLES

14,760 TANDEM GROUPS

7,380 TRUCKS

0 SINGLE AXLES

0 TANDEM GROUPS

0 TRUCKS

5-9-22

1984 COUNT OF LOADED AXLES BY WEIGHT GROUP AND VEHICLE TYPE

AXLES - OR - (IN K)	VEHICLE TYPES AND AXLE POSITIONS																	
	220000	230000			240000			321000		322000			323000			331000		
	R	R	C	R	C	D	B	C	B	C	D	R	C	D	E	B	C	D
0	0	0	0	0	0	0	123	123	552	552	552	30	30	30	30	14	14	14
1	0	0	0	0	0	0	123	123	552	551	552	30	30	30	30	14	14	14
2	0	0	0	0	0	0	123	123	552	550	551	30	30	30	30	14	14	14
3	0	0	0	0	0	0	123	123	551	545	542	27	30	30	30	14	14	14
4	0	0	0	0	0	0	122	123	549	516	513	27	30	30	30	14	14	13
5	0	0	0	0	0	0	121	111	541	470	460	27	29	30	30	12	12	13
6	0	0	0	0	0	0	119	103	528	397	379	27	29	28	29	11	10	13
7	0	0	0	0	0	0	115	86	506	311	296	27	28	27	26	9	8	11
8	0	0	0	0	0	0	99	72	483	231	232	27	25	27	26	6	8	10
9	0	0	0	0	0	0	86	55	440	163	168	27	21	24	24	4	6	6
10	0	0	0	0	0	0	74	42	400	109	112	27	19	20	21	3	5	5
11	0	0	0	0	0	0	58	32	339	72	77	27	18	17	16	2	2	5
12	0	0	0	0	0	0	45	22	289	46	52	25	15	9	12	0	2	2
13	0	0	0	0	0	0	38	14	245	35	32	23	14	6	11	0	2	1
14	0	0	0	0	0	0	26	9	194	19	22	19	10	4	6	0	1	0
15	0	0	0	0	0	0	22	8	142	15	18	17	5	2	5	0	1	0
16	0	0	0	0	0	0	14	5	93	10	9	16	4	1	2	0	1	0
17	0	0	0	0	0	0	11	3	72	8	9	15	2	0	1	0	1	0
18	0	0	0	0	0	0	7	3	50	5	6	12	2	0	0	0	1	0
19	0	0	0	0	0	0	5	1	35	2	5	10	0	0	0	0	1	0
20	0	0	0	0	0	0	3	0	28	0	3	8	0	0	0	0	1	0
21	0	0	0	0	0	0	2	0	17	0	2	3	0	0	0	0	1	0
22	0	0	0	0	0	0	0	0	12	0	0	3	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	8	0	0	3	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	2	0	0	3	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	123	123	552	552	552	30	30	30	30	14	14	14

5-9-23

AXLES
OR
(IN K)

332000

333000

521200

432000

	B	C	D	F	R	C	D	E	F	B	C	D	E	B	C	D	E
0	5.297	5.297	5.297	5.297	60	60	60	60	60	132	132	132	132	2	2	2	2
1	5.293	5.296	5.296	5.297	60	59	59	60	60	132	132	132	132	2	2	2	2
2	5.288	5.294	5.291	5.293	60	59	59	60	60	132	132	132	131	2	2	2	2
3	5.279	5.284	5.267	5.263	60	59	59	60	60	131	132	131	131	2	2	2	2
4	5.247	5.257	5.188	5.189	60	59	58	60	60	130	130	130	131	2	2	2	2
5	5.162	5.178	5.005	5.003	60	58	58	59	59	129	126	126	123	2	2	2	2
6	5.054	5.041	4.783	4.809	59	57	56	54	57	126	122	120	119	2	2	2	2
7	4.802	4.822	4.463	4.456	57	57	49	51	55	124	119	116	111	2	2	2	2
8	4.510	4.548	4.176	4.144	54	54	44	49	51	119	118	112	107	2	2	2	2
9	4.101	4.149	3.833	3.790	52	51	41	48	46	117	115	100	96	2	2	1	2
10	3.673	3.768	3.453	3.419	51	48	35	42	44	114	106	89	82	2	2	1	2
11	3.220	3.385	3.017	3.063	45	45	29	35	38	106	96	68	70	2	2	1	1
12	2.805	2.987	2.661	2.692	37	43	22	29	33	96	83	55	61	2	2	1	1
13	2.388	2.596	2.296	2.330	35	36	18	23	28	88	77	43	47	2	2	1	1
14	1.877	2.078	1.868	1.926	30	29	13	19	21	77	70	33	29	1	2	0	0
15	1.386	1.520	1.367	1.418	22	20	11	15	15	63	53	22	16	1	1	0	0
16	826	949	900	951	17	15	8	10	9	40	41	14	7	1	1	0	0
17	425	482	533	597	8	10	7	5	7	29	25	8	5	1	1	0	0
18	206	231	285	330	3	5	4	3	5	16	13	3	1	1	1	0	0
19	94	108	161	173	2	1	2	2	4	10	8	1	0	1	1	0	0
20	54	60	92	99	0	0	0	2	3	4	4	0	0	1	0	0	0
21	30	27	59	52	0	0	0	1	2	2	2	0	0	0	0	0	0
22	13	11	32	32	0	0	0	0	2	0	0	0	0	0	0	0	0
23	12	8	14	22	0	0	0	0	2	0	0	0	0	0	0	0	0
24	8	4	8	14	0	0	0	0	1	0	0	0	0	0	0	0	0
25	5	3	5	9	0	0	0	0	0	0	0	0	0	0	0	0	0
26	4	3	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0
27	4	2	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0
28	4	2	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0
29	3	2	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0
30	3	2	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	5.297	5.297	5.297	5.297	60	60	60	60	60	132	132	132	132	2	2	2	2

5-9-24

1984 COUNT OF UNLOADED AXLES BY WEIGHT GROUP AND VEHICLE TYPE

AXLES > OR = (IN K)	VEHICLE TYPES AND AXLE POSITIONS																		
	220000			230000			240000			321000		322000			323000			331000	
	B	R	C	B	C	D	B	C	B	C	D	B	C	D	E	B	C	D	
0	0	0	0	0	0	0	72	72	230	230	230	15	15	15	15	5	5	5	
1	0	0	0	0	0	0	72	72	230	229	230	15	11	15	15	5	4	5	
2	0	0	0	0	0	0	72	72	230	227	229	15	11	15	13	5	4	5	
3	0	0	0	0	0	0	71	71	229	219	219	15	8	13	13	5	4	5	
4	0	0	0	0	0	0	71	67	228	190	183	15	6	8	9	5	3	5	
5	0	0	0	0	0	0	70	58	222	124	116	14	5	5	6	5	3	5	
6	0	0	0	0	0	0	66	45	207	71	62	14	3	2	3	3	2	5	
7	0	0	0	0	0	0	56	32	186	42	32	14	2	1	3	2	2	5	
8	0	0	0	0	0	0	37	21	146	29	19	11	2	0	2	2	1	4	
9	0	0	0	0	0	0	24	11	94	16	14	5	2	0	1	1	1	2	
10	0	0	0	0	0	0	13	2	50	9	6	2	0	0	0	0	0	1	
11	0	0	0	0	0	0	3	0	30	4	6	1	0	0	0	0	0	1	
12	0	0	0	0	0	0	1	0	15	2	5	1	0	0	0	0	0	1	
13	0	0	0	0	0	0	1	0	9	2	4	1	0	0	0	0	0	1	
14	0	0	0	0	0	0	1	0	3	0	3	1	0	0	0	0	0	0	
15	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	
16	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	
17	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	
18	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
19	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTAL	0	0	0	0	0	0	72	72	230	230	230	15	15	15	15	5	5	5	

5-9-25

AXLES OR - (IN K)	332000				333000					521200				432000			
	B	C	D	F	R	C	D	E	F	B	C	D	E	B	C	D	E
0	2,083	2,083	2,083	2,083	27	27	27	27	27	4	4	4	4	0	0	0	0
1	2,056	2,074	2,080	2,079	27	27	21	25	27	4	4	4	4	0	0	0	0
2	2,053	2,070	2,065	2,067	27	27	21	25	27	4	4	4	4	0	0	0	0
3	2,035	2,049	1,936	1,990	27	27	19	22	26	4	4	3	4	0	0	0	0
4	1,970	1,994	1,483	1,582	27	27	11	14	21	4	4	3	4	0	0	0	0
5	1,798	1,793	844	862	25	25	8	11	11	4	2	3	4	0	0	0	0
6	1,378	1,248	458	478	20	22	5	7	8	2	0	0	1	0	0	0	0
7	758	655	297	269	10	9	3	5	3	1	0	0	0	0	0	0	0
8	448	365	200	185	4	3	3	2	2	0	0	0	0	0	0	0	0
9	266	212	132	118	1	1	1	2	1	0	0	0	0	0	0	0	0
10	161	147	91	86	1	1	1	1	0	0	0	0	0	0	0	0	0
11	79	81	67	67	1	1	0	0	0	0	0	0	0	0	0	0	0
12	62	61	53	50	1	1	0	0	0	0	0	0	0	0	0	0	0
13	46	51	40	34	1	0	0	0	0	0	0	0	0	0	0	0	0
14	34	39	33	24	0	0	0	0	0	0	0	0	0	0	0	0	0
15	26	27	27	20	0	0	0	0	0	0	0	0	0	0	0	0	0
16	19	17	16	8	0	0	0	0	0	0	0	0	0	0	0	0	0
17	16	12	14	6	0	0	0	0	0	0	0	0	0	0	0	0	0
18	6	8	11	3	0	0	0	0	0	0	0	0	0	0	0	0	0
19	2	5	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0
20	1	3	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2,083	2,083	2,083	2,083	27	27	27	27	27	4	4	4	4	0	0	0	0

5-9-26

VEHICLE TYPE 332000

VEHICLES WITH PERMITTED OVERLOAD

VEHICLE TYPE 332000

GROSS WEIGHT GROUP	AVERAGE GROSS WEIGHT	VEHICLES IN SAMPLE	% OF TOTAL SAMPLE	AVERAGE AXLE WEIGHTS (IN 100#)							AVERAGE AXLE WT AS % OF AVERAGE GROSS WT							
				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
40K - 45K	44,500	1	50.0	59	113	119	87	67										
70K - 75K	71,000	1	50.0	91	141	143	192	143										
ALL WGT'S	57,750	2	100.0	75	127	131	140	105										

VEHICLE TYPE 332000

TOTAL FOR ALL VEHICLES

VEHICLE TYPE 332000

GROSS WEIGHT GROUP	AVERAGE GROSS WEIGHT	VEHICLES IN SAMPLE	% OF TOTAL SAMPLE	AVERAGE AXLE WEIGHTS (IN 100#)							AVERAGE AXLE WT AS % OF AVERAGE GROSS WT							
				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
16K - 18K	17,850	2		31	45	36	31	37										
18K - 20K	19,375	4	.1	61	41	38	29	25										
20K - 25K	23,282	158	2.1	61	50	48	37	37										
25K - 30K	27,963	770	10.4	81	58	56	41	43										
30K - 35K	32,258	978	13.3	89	69	66	49	50										
35K - 40K	37,429	643	8.7	91	80	78	63	63										
40K - 45K	42,486	604	8.2	89	89	90	78	78										
45K - 50K	47,386	551	7.5	92	98	100	92	92										
50K - 55K	52,388	515	7.0	94	109	113	104	103										
55K - 60K	57,429	571	7.7	95	120	125	117	117										
60K - 65K	62,613	632	8.6	97	131	134	132	132										
65K - 70K	67,586	726	9.8	101	142	146	143	145										
70K - 75K	72,275	700	9.5	104	152	155	155	156										
75K - 80K	77,006	389	5.3	109	163	165	166	167										
80K - 85K	82,249	93	1.3	113	168	172	183	187										
85K - 90K	86,761	33	.4	111	184	171	196	206										
90K - 95K	92,225	4	.1	96	181	175	241	230										
95K - 100K	96,400	4	.1	108	189	210	223	235										
100K - 105K	101,700	1		108	280	269	209	151										
120K OR >	200,800	2		54	442	648	726	139										
ALL WGT'S	50,601	7,380	100.0	93	106	108	99	100										

5-9-28

1984 DATA

BODY TYPE ANALYSIS
 VEHICLE TYPE: 332000

BODY TYPE	NUMBER OF VEHICLES	AVERAGE GROSS WEIGHT	MINIMUM GROSS WEIGHT	MAXIMUM GROSS WEIGHT	AVERAGE WEIGHT OF INDIVIDUAL AXLES (WEIGHT IN HUNDREDS OF POUNDS)									
					A	B	C	D	E	F	G	H	I	J
EMPTY VEHICLES														
PLATFORM	365	307	178	770	87	66	63	45	47					
LOW-BED TRAILER	36	329	230	450	86	70	72	52	49					
RACK	2	291	286	295	90	60	58	44	41					
LIVESTOCK RACK	1	348	348	348	116	71	71	49	41					
LOG / PIPE	5	288	258	315	81	61	55	44	47					
CANOPY	12	327	263	383	96	70	65	49	46					
OPEN TOP BOX / VAN	227	328	207	790	87	71	65	53	53					
DUMP	50	338	250	716	90	71	68	53	56					
HOPPER	55	323	222	703	88	71	68	49	47					
VAN	813	327	197	770	88	68	65	52	53					
INSULATED VAN	164	358	223	785	89	76	75	60	58					
FURNITURE / MOVING VAN	9	369	289	465	96	76	67	64	65					
TANK	200	319	213	728	87	67	65	49	50					
PETROLEUM TANK	94	306	203	726	84	65	63	49	45					
AUTOMOBILE TRANSPORTER	48	390	237	680	102	42	102	69	74					
EQUIPMENT	2	331	291	371	89	84	48	65	46					
TOTAL - ALL BODY TYPES	2083	326	178	790	88	68	67	52	52					
LOADED VEHICLES														
PLATFORM	760	605	211	1017	95	127	128	128	127					
LOW-BED TRAILER	68	604	291	967	97	128	129	124	127					
RACK	11	592	462	726	91	114	144	124	120					
LIVESTOCK RACK	8	674	374	768	115	131	126	146	155					
LOG / PIPE	10	536	234	795	93	104	114	107	118					
CANOPY	22	642	367	840	99	135	133	142	133					
OPEN TOP BOX / VAN	365	609	250	947	94	126	127	130	133					
DUMP	57	693	361	827	96	141	143	155	158					
HOPPER	32	652	304	812	100	134	136	139	143					
VAN	2856	548	179	2051	95	116	117	110	110					
INSULATED VAN	574	594	240	904	97	126	130	120	120					
FURNITURE / MOVING VAN	21	495	340	730	91	92	103	102	107					
TANK	257	644	206	962	96	140	140	133	136					
PETROLEUM TANK	132	675	223	965	95	145	147	141	146					
AUTOMOBILE TRANSPORTER	121	564	284	846	103	99	141	111	110					
EQUIPMENT	1	643	643	643	98	98	174	131	142					
TOTAL - ALL BODY TYPES	5295	577	179	2051	96	121	124	118	118					
VEHICLES CARRYING PERMITTED OVERLOAD														
PLATFORM	1	710	710	710	91	141	143	192	143					
INSULATED VAN	1	445	445	445	59	113	119	87	67					
TOTAL - ALL BODY TYPES	2	578	445	710	75	127	131	140	105					

5-9-29

AVERAGE AXLE SPACING BY VEHICLE TYPE

TYPE OF VEHICLE	NUMBER IN SAMPLE	1984											AVERAGE TOTAL WHEEL BASE	
		AVERAGE AXLE SPACING IN FEET												
		A-B	B-C	C-D	D-E	E-F	F-G	G-H	H-I	I-J	J-K	K-L	L-M	
220000	2286	14.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.8
230000	252	15.4	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0
240000	187	12.8	4.4	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.6
321000	195	11.6	26.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.3
322000	782	11.6	28.2	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.3
323000	45	12.8	22.1	4.7	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.1
331000	19	10.9	4.2	22.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.0
332000	7380	11.6	4.4	28.3	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.7
333000	87	12.8	4.4	22.4	4.8	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.2
342000	2	9.9	4.3	4.3	29.6	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.1
423000	1	11.6	14.9	14.3	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.3
432000	2	17.7	4.0	20.8	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.6
433000	1	17.7	4.5	18.8	9.1	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.7
521200	136	10.9	20.0	9.7	20.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	61.5
522200	1	10.0	4.3	19.4	19.4	12.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	65.8
531200	18	9.9	4.2	19.5	8.7	21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	63.6

MINIMUM AXLE SPACING BY VEHICLE TYPE

1984

TYPE OF VEHICLE	NUMBER IN SAMPLE	MINIMUM AXLE SPACING IN FEET											
		A-B	B-C	C-D	D-E	E-F	F-G	G-H	H-I	I-J	J-K	K-L	L-M
220000	2286	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
230000	252	10.1	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
240000	187	8.1	3.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
321000	195	8.6	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
322000	782	7.5	3.9	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
323000	45	11.4	4.3	3.5	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
331000	19	9.6	3.2	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
332000	7380	2.7	2.0	2.3	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
333000	87	7.5	3.2	12.4	2.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
342000	2	9.0	4.2	4.2	28.5	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
423000	1	11.6	14.9	14.3	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
432000	2	10.6	3.9	10.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
433000	1	17.7	4.5	18.8	9.1	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
521200	136	9.0	3.4	2.5	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
522200	1	10.0	4.3	19.4	19.4	12.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
531200	18	9.2	3.1	18.5	2.1	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MAXIMUM AXLE SPACING BY VEHICLE TYPE

1984

TYPE OF VEHICLE	NUMBER IN SAMPLE	MAXIMUM AXLE SPACING IN FEET											
		A-B	B-C	C-D	D-E	E-F	F-G	G-H	H-I	I-J	J-K	K-L	L-M
220000	2286	41.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
230000	252	21.4	24.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
240000	187	18.9	11.1	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
321000	195	18.2	41.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
322000	782	19.0	74.1	84.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
323000	45	15.4	32.8	26.0	14.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
331000	19	15.6	4.5	37.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
332000	7380	96.7	82.5	58.8	44.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
333000	87	19.2	8.4	44.2	10.6	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
342000	2	10.8	4.3	4.4	30.6	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
423000	1	11.6	14.9	14.3	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
432000	2	24.7	4.1	31.6	14.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
433000	1	17.7	4.5	18.8	9.1	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
521200	136	15.3	30.1	59.5	38.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
522200	1	10.0	4.3	19.4	19.4	12.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
531200	18	11.0	4.5	24.3	11.4	24.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

APPENDIX A
Glossary of Terms

AXLE: A shaft on which or with which two or more wheels on a vehicle revolve.

AXLE GROUP: Two or more consecutive axles considered together in determining their combined load effect on a bridge or pavement structure.

AXLE LOAD: The weight carried by one axle of a vehicle.

AXLE SPACING: The distance between two consecutive axles of a truck or combination, usually measured from the point of ground contact of one tire to the same point on the other tire or from a point on an axle hub to the same point on the other axle hub.

AXLE WEIGHT: See SINGLE AXLE WEIGHT or TANDEM AXLE WEIGHT.

BOBTAIL: A tractor on the road without a semitrailer.

BRIDGE FORMULA: Refer to APPENDIX B

COMBINATION: A truck or tractor coupled to one or more trailers (including semitrailers).

COMMODITY: The items or freight to be moved including items placed on or in a vehicle.

CONTINUATION RECORD: The 80-character truck weight data record that contains the axle weights and spacings for the 6th through the 13th axles of a vehicle with more than 5 axles.

DYNAMIC WEIGHT: The weight of a vehicle or an individual axle as measured while the vehicle is in motion.

EQUIVALENT AXLE LOAD (EAL): The damage per pass to a pavement caused by a specific axle load relative to the damage per pass of a standard 18,000 pound axle load moving on the same pavement.

FACE RECORD: The 80-character truck weight data record that contains the axle weights and spacings for up to the first five axles of every vehicle weighted.

FIFTH WHEEL: A coupling device located on a vehicle's rear frame used to connect the vehicle to a semitrailer. It can sometimes be moved forward or backward on the vehicle to obtain the desired distribution of weight between the trailer axles and the pulling vehicle.

FLEXIBLE PAVEMENT: Road construction of a bituminous material, generally asphalt, which has little tensile strength.

FULL TRAILER: A truck trailer with wheels on the front and rear (as opposed to a semitrailer in which the front rests on the rear of the tractor).

GROSS WEIGHT: The weight of a vehicle and/or vehicle combination together with the weight of its load.

KIP: A kilopound or 1,000 pounds.

OVERWEIGHT: Over the Federal or State legal restrictions for single axle weight, tandem axle weight or gross weight.

PAYLOAD: The cargo or freight that a truck or truck combination hauls.

PORTABLE SCALE: A scale of such size and weight as to be readily transportable from station to station.

RIGID PAVEMENT: Road construction of Portland cement concrete.

SADDLE MOUNT: A vehicle configuration using a tractor to transport other tractors or trailers by mounting the front axle of the vehicles to be transported on the rear of the tractor or the preceding mounted vehicle. Only the rear axle of the mounted vehicles are on the ground.

SEMITRAILER: A vehicle designed for carrying persons or property and drawn by another vehicle on which part of its weight and load rests.

SINGLE AXLE: An axle on a vehicle that is separated from any previous or succeeding axle by more than 96 inches.

SINGLE AXLE WEIGHT: The total weight transmitted to the road by a single axle.

SPREAD TANDEM: Two axles that are articulated from a common attachment but are considered as two single axles rather than one tandem axle because they are separated by more than 96 inches.

STATIC SCALE: A scale that requires that a vehicle be stopped to be weighed.

STEERING AXLE: The axle to which a vehicle's steering mechanism is affixed.

STRAIGHT TRUCK: A self-propelled vehicle designed and used for the transportation of property and not including tractors.

TANDEM AXLE: Two consecutive axles that are more than 40 inches but not more than 96 inches apart and are articulated from a common attachment.

TANDEM AXLE WEIGHT: The total weight transmitted to the road by a tandem axle.

TOWED VEHICLE: A vehicle drawn or towed by another vehicle supplying the motive power.

TRACTOR: A vehicle designed and used primarily as the power unit for drawing a semitrailer or trailer.

TRAILER: A vehicle without motive power designed to be drawn by another vehicle and so constructed that no part of its weight rests upon or is carried by the pulling unit.

TRUCK: A motor vehicle designed, used, or maintained primarily for the transportation of property.

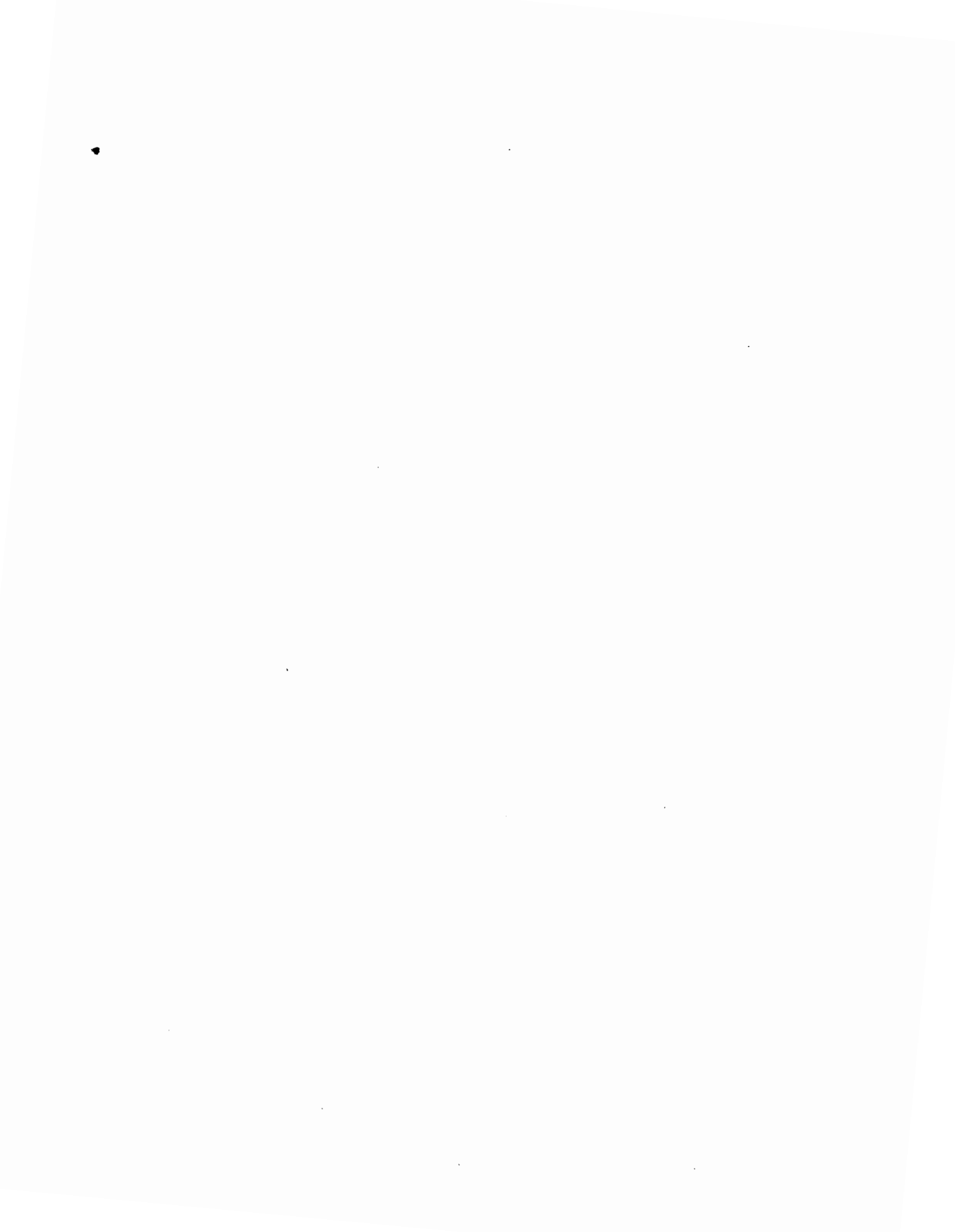
VEHICLE: Any conveyance of any type operated on a highway, whether self-propelled or drawn by another vehicle.

WEIGH-IN-MOTION SCALE: A scale that allows vehicle weights to be electronically recorded as the vehicle passes over the scale without stopping.

WEIGH STATION: A location equipped with weigh scales at which the axle weights and gross weights of vehicles are determined.

WEIGH VIOLATION: A single axle weight, axle group weight, or gross weight of a vehicle exceeding the maximum allowed weight for that vehicle.

WHEELBASE: The distance between the front and rear axles of a vehicle, or the center point of contact of the front and rear wheels with the ground.



APPENDIX B

Bridge Gross Weight Formula

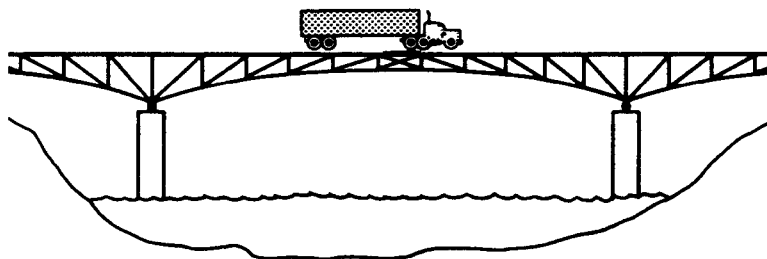
BRIDGE GROSS WEIGHT FORMULA



U.S. Department
of Transportation
Federal Highway
Administration

April 1984

$$W = 500 \left[\frac{LN}{N-1} + 12N + 36 \right]$$



Three questions are addressed by this pamphlet with regard to the Bridge Formula. *What is it? Why is it necessary? How is it used?*

WHAT IS IT?

The bridge gross weight formula provides a standard to control the spacing of truck axles on vehicles that use highway bridges.

W = the maximum weight in pounds that can be carried on a group of two or more axles to the nearest 500 pounds.

L = spacing in feet between the outer axles of any two or more consecutive axles.

N = number of axles being considered.

WHY IS THE FORMULA NECESSARY?

An individual set of bridge design computations cannot be completed for every type truck that may use the highways; to do this for every type truck would take years. Consequently, the Nation's bridge engineers have selected what is referenced as a design vehicle. This one vehicle is considered to be representative of *all vehicles* that will use a bridge during the 40 to 50-year life of the structure. A more common description would be to call the design truck an umbrella loading, as shown below:

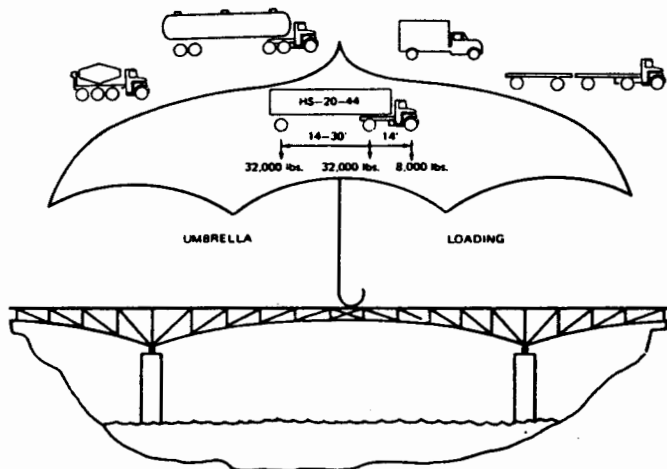


Figure 1

Assuming that the umbrella loading illustrated above creates the most severe situation as a bridge is

designed, bridge members are built strong enough to handle the umbrella loading and in effect the bridge is protected from being overstressed by any future truck that may use the structure.

The umbrella loading described in Figure 1, which is used for Interstate highway bridge design, was adopted in 1944 with specific axle weights and spacing as shown. For years enforcement officials have worked to check truck weights to keep the axle loads and gross loads within legal limits. With the passage of the Federal-aid Amendments of 1974, the States also had to become concerned with the spacing of axles when enforcing weight laws on the Interstate System.

The axle spacing is equally as important in design of the bridges as the axle weights. This is illustrated by what happens when a person tries to walk across ice that is hardly thick enough to support his/her weight; the person is likely to fall through. If that person stretched out prone on the same ice and scooted across, it is unlikely that he/she would break through. This is true because the load, or weight, is spread over a larger area in the latter situation. A similar comparison can be made between trucks crossing a bridge:

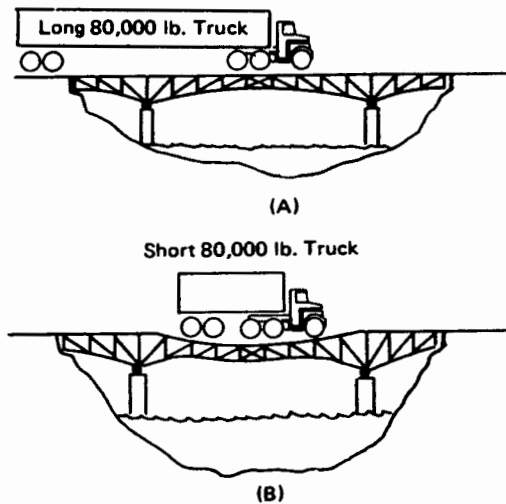


Figure 2

In view (A) of Figure 2, the stress on bridge members as the long truck rolls across is much less than that caused by the short truck in view (B), even though the trucks have the same total weight and individual axle weights. One can see that an extremely long truck would have its load spread out like the

person scooting across the ice. Whereas, the short truck is similar to a person standing up on ice with the total load placed in a limited area.

After the umbrella loading was adopted in 1944, many Interstate bridges were built during the late 1950s and 1960s. Simultaneously, bigger and heavier trucks were being placed into use than had been anticipated in 1944. It was not practical to consider rebuilding all bridges for the newer trucks that either had been or could be placed on the road. The logical and economical action not only was to control the gross and axle weights of trucks but also to control the spacing of the axles. The U.S. Congress concurred with this approach. In 1974, when the higher axle and gross weight limits were adopted for the Interstate System (20,000 pounds—single axle, 34,000 pounds—tandem axle, 80,000 pounds—gross), the Bridge Formula was written into Section 127 of the *United States Code*, Title 23. The Bridge Formula assures that allowable weight of heavy trucks is correlated with the spacing of axles to prevent overstressing of highway bridges; in other words, preventing an effect similar to a person standing erect on thin ice. The overstressing can occur even when the gross weight and each individual axle weight of a truck are within lawful limits.

HOW IS THE FORMULA USED?

Some definitions are needed before completing example applications of the Bridge Formula.

- **Gross Weight***—the weight of a vehicle and/or vehicle combination without load plus the weight of any load thereon. The Federal gross weight limit on the Interstate is 80,000 pounds.
- **Single Axle Weight ***—the total weight transmitted by all wheels whose centers may be included between two parallel transverse vertical planes 40 inches apart, extending across the full width of the vehicle. The Federal single axle weight limit on the Interstate is 20,000 pounds.
- **Tandem Axle Weight***—the total weight transmitted to the road by two or more consecutive axles whose centers may be included between parallel vertical planes spaced more than 40 inches and not more than 96 inches apart, extending across the full width of the vehicle. The Federal tandem axle weight limit on the Interstate is 34,000 pounds.

* AASHTO definitions: These weight limits may vary from State-to-State depending on local laws and limits in effect before the Federal limits were established in 1956.

A distinction is made at the 8-foot distance in Table B (pages 6-7) due to the tandem axle weight definition causing a considerable difference in the axle load, depending on whether the spacing of the axles is *8 feet and less* or *more than 8 feet*. The axle weight limit for any spacing greater than 8 feet (96 inches) shall be in accordance with the bridge formula. The tandem axle weight definition is not applicable when the axle spacing exceeds 96 inches. For example, *three axles* with an extreme spacing of 97 inches (more than 8 feet) can carry a load of 42,000 pounds as shown in Figure 3.

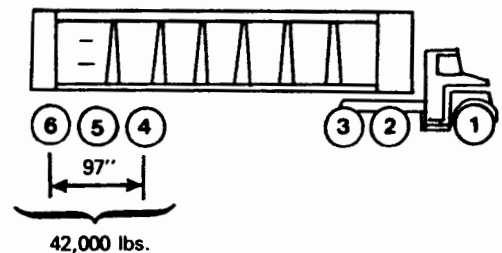


Figure 3

The Federal law states that any consecutive two or more axles may not exceed the weight as computed by the formula even though the single axles, tandem axles, and gross weights are within legal requirements.

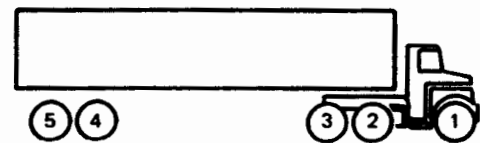


Figure 4

The most common vehicle (axle arrangement) checked for weight limit requirements is shown in Figure 4. While the Bridge Formula law applies to each combination of two or more axles, experience shows that axle combinations numbers 1 through 3, numbers 1 through 5, and numbers 2 through 5 are the critical combinations that must be checked. If these are found satisfactory, others will be satisfactory.

Permissible gross loads for vehicles in regular operation

Based on weight formula $W = 500 \left(\frac{LN}{N-1} + 12N + 36 \right)$ modified ¹

Tandem Axle Weight
(see pages 4 & 5)

Distance in feet between the extremes of any group of 2 or more consecutive axles	[Bridge table B] Maximum load in pounds carried on any group of 2 or more consecutive axles ²							
	2 axles	3 axles	4 axles	5 axles	6 axles	7 axles	8 axles	9 axles
4	34,000							
5	34,000							
6	34,000							
7	34,000							
8 and less	34,000	34,000						
More than 8	38,000	42,000						
9	39,000	42,500						
10	40,000	43,500						
11		44,000						
12		45,000	50,000					
13		45,500	50,500					
14		46,500	51,500					
15		47,000	52,000					
16		48,000	52,500	58,000				
17		48,500	53,500	58,500				
18		49,500	54,000	59,000				
19		50,000	54,500	60,000				
20	Example	51,000	55,500	60,500	66,000			
21	(see page 9)	51,500	56,000	61,000	66,500			
22		52,500	56,500	61,500	67,000			
23		53,000	57,500	62,500	68,000			
24		54,000	58,000	63,000	68,500	74,000		
25		54,500	58,500	63,500	69,000	74,500		
26		55,500	59,500	64,000	69,500	75,000		
27		56,000	60,000	65,000	70,000	75,500		
28		57,000	60,500	65,500	71,000	76,500	82,000	
29		57,500	61,500	66,000	71,500	77,000	82,500	
30		58,500	62,000	66,500	72,000	77,500	83,000	
31		59,000	62,500	67,500	72,500	78,000	83,500	
32		60,000	63,500	68,000	73,000	78,500	84,500	90,000
33			64,000	68,500	74,000	79,000	85,000	90,500
34			64,500	69,000	74,500	80,000	85,500	91,000
35			65,500	70,000	75,000	80,500	86,000	91,500
36			66,000	70,500	75,500	81,000	86,500	92,000
37	Exception		66,500	71,000	76,000	81,500	87,000	93,000
38	(see page 10)		67,500	71,500	77,000	82,000	87,500	93,500
39			68,000	72,500	77,500	82,500	88,500	94,000
40			68,500	73,000	78,000	83,500	89,000	94,500
41			69,500	73,500	78,500	84,000	89,500	95,000
42			70,000	74,000	79,000	84,500	90,000	95,500
43			70,500	75,000	80,000	85,000	90,500	96,000
44			71,500	75,500	80,500	85,500	91,000	96,500
45			72,000	76,000	81,000	86,000	91,500	97,500
46			72,500	76,500	81,500	87,000	92,500	98,000
47			73,500	77,500	82,000	87,500	93,000	98,500
48			74,000	78,000	83,000	88,000	93,500	99,000
49			74,500	78,500	83,500	88,500	94,000	99,500
50			75,500	79,000	84,000	89,000	94,500	100,000
51			76,000	80,000	84,500	89,500	95,000	100,500
52			76,500	80,500	85,000	90,500	95,500	101,000
53			77,500	81,000	86,000	91,000	96,500	102,000
54			78,000	81,500	86,500	91,500	97,000	102,500
55			78,500	82,500	87,000	92,000	97,500	103,000
56			79,500	83,000	87,500	92,500	98,000	103,500
57	Interstate Gross		80,000	83,500	88,000	93,000	98,500	104,000
58	Weight Limit			84,000	89,000	94,000	99,000	104,500
59	(see page 4)			85,000	89,500	94,500	99,500	105,000
60				85,500	90,000	95,000	100,500	105,500

¹ The permissible loads are computed to the nearest 500 pounds. The modification consists in limiting the maximum load on any single axle to 20,000 pounds.

² The following loaded vehicles must not operate over H15-44 bridges: 3-S2 (5 axles) with wheelbase less than 38 feet; 2-S1-2 (5 axle) with wheelbase less than 45 feet; 3-3 (6 axle) with wheelbase less than 45 feet; and 7-, 8-, and 9-axle vehicles regardless of wheelbase.

The vehicle with weights and axle dimensions as shown in Figure 5 will be used to illustrate a Bridge Formula check.

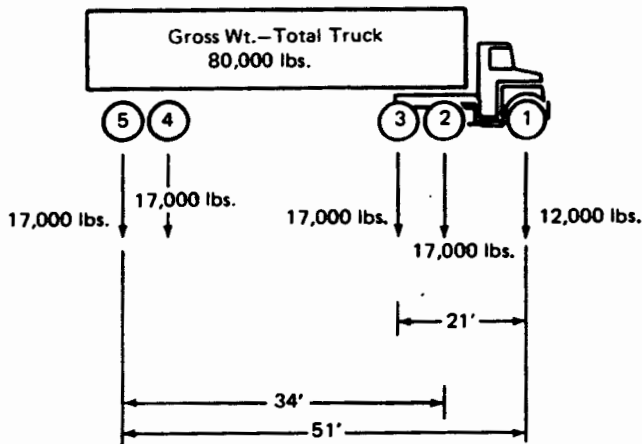


Figure 5

Before checking the axle 1 through 3 combination, a check should be made to see that single, tandem and gross weights are satisfied. The single axle Number 1 does not exceed 20,000 pounds, tandems 2-3 and 4-5 do not exceed 34,000 pounds, and the gross weight does not exceed 80,000 pounds. Thus, these requirements are satisfied so the first Bridge Formula combination is checked as follows:

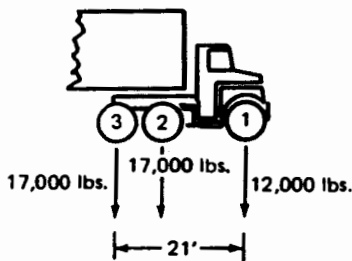


Figure 6

Check of 1 thru 3

W (actual weight) = 12,000 + 17,000 + 17,000 = 46,000 pounds (Figure 6).

N = 3 axles.

L = 21 feet.

$$W_{\text{maximum}} = 500 \left(\frac{LN}{N-1} + 12N + 36 \right)$$

$$= 500 \left[\frac{(21 \times 3)}{(3-1)} + (12 \times 3) + 36 \right] = 51,500\#.$$

W maximum = 51,500# which is more than the actual weight of 46,000# so the Bridge Formula requirement is satisfied.

Example—Bridge Table B

This same number (51,500#) could have been obtained from Bridge Table B as shown by reading down the left side to L = 21 and across to the right where N = 3.

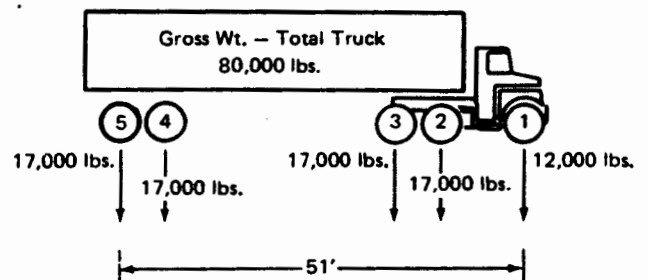


Figure 7

Now check axles 1 thru 5

W (actual) = 12,000 + 17,000 + 17,000 + 17,000 + 17,000 = 80,000# (Figure 7).

W maximum, from Table B for L of 51 feet and N of 5 = 80,000#.

Therefore, this axle spacing is satisfactory.

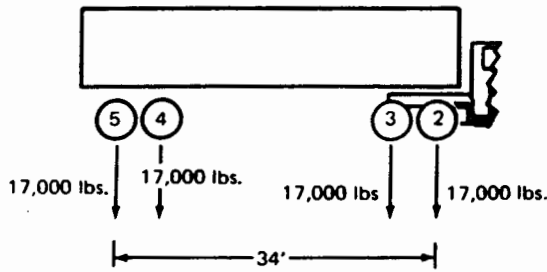


Figure 8

Now check axles 2 thru 5

$$W \text{ (actual)} = 17,000 + 17,000 + 17,000 + 17,000 = 68,000\# \text{ (Figure 8).}$$

W maximum, from Table B for "L" of 34 feet and "N" of 4 = 64,500#.

This is a "TILT" or violation in that the actual weight exceeds the maximum allowed weight for the given axle spacing. To correct the situation, some load must be removed from the truck or the axle spacing (34-foot dimension) increased.

Exception to Formula and Table B

There is one exception to use of the formula or Table B—two consecutive sets of tandem axles may carry a gross load of 34,000 pounds each providing the overall distance between the first and last axles of such consecutive sets of tandem axles is 36 feet or more. For example, a 5 axle truck tractor semi-trailer may be used to haul a full 34,000 pounds on the tandem of the tractor (axles 2 and 3) and the tandem of the trailer (axles 4 and 5) provided there is a spacing of 36 feet or more between axles 2 and 5. A spacing of 36 feet or more for axles 2 through 5 is satisfactory for an actual W of 68,000 pounds even though the formula or Table B computes W maximum to be 66,000 to 67,500 pounds for spacings of 36 to 38 feet. This special exception is stated in the Federal law.

Bridge Formula Application to Single Unit Trucks

The same procedure described above can be used to check any axle combinations but as a general rule several axles spaced closely together will usually give the most critical situation.

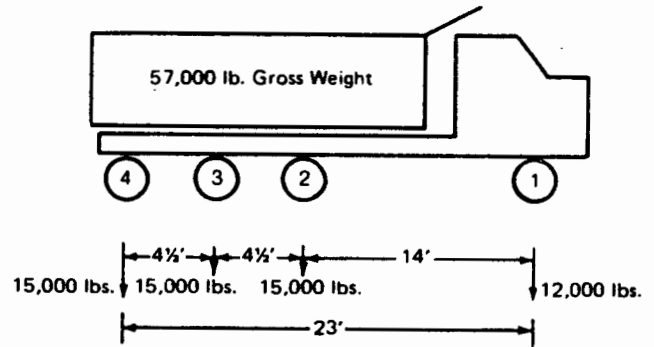


Figure 9

The truck in Figure 9 satisfies single axle restrictions (12,000# is less than 20,000#), tandem axle restrictions (30,000# is less than 34,000#) and gross limits (57,000# is less than 80,000#). With these restrictions satisfied a check will be made for Bridge Formula requirements, axles 1 through 4.

$$W \text{ (actual)} = 12,000 + 15,000 + 15,000 + 15,000 = 57,000\#.$$

W maximum for "N" of 4 and "L" of 23 feet = 57,500 from Table "B".

Since axles 1 thru 4 are satisfactory, check axles 2 thru 4:

$$W \text{ (actual)} = 15,000 + 15,000 + 15,000 = 45,000\#.$$

W maximum for "N" of 3 and "L" of 9 feet = 42,500# (From Table B).

This a TILT or a violation. The load would have to be reduced, axles added, or spacing changed to meet requirements.

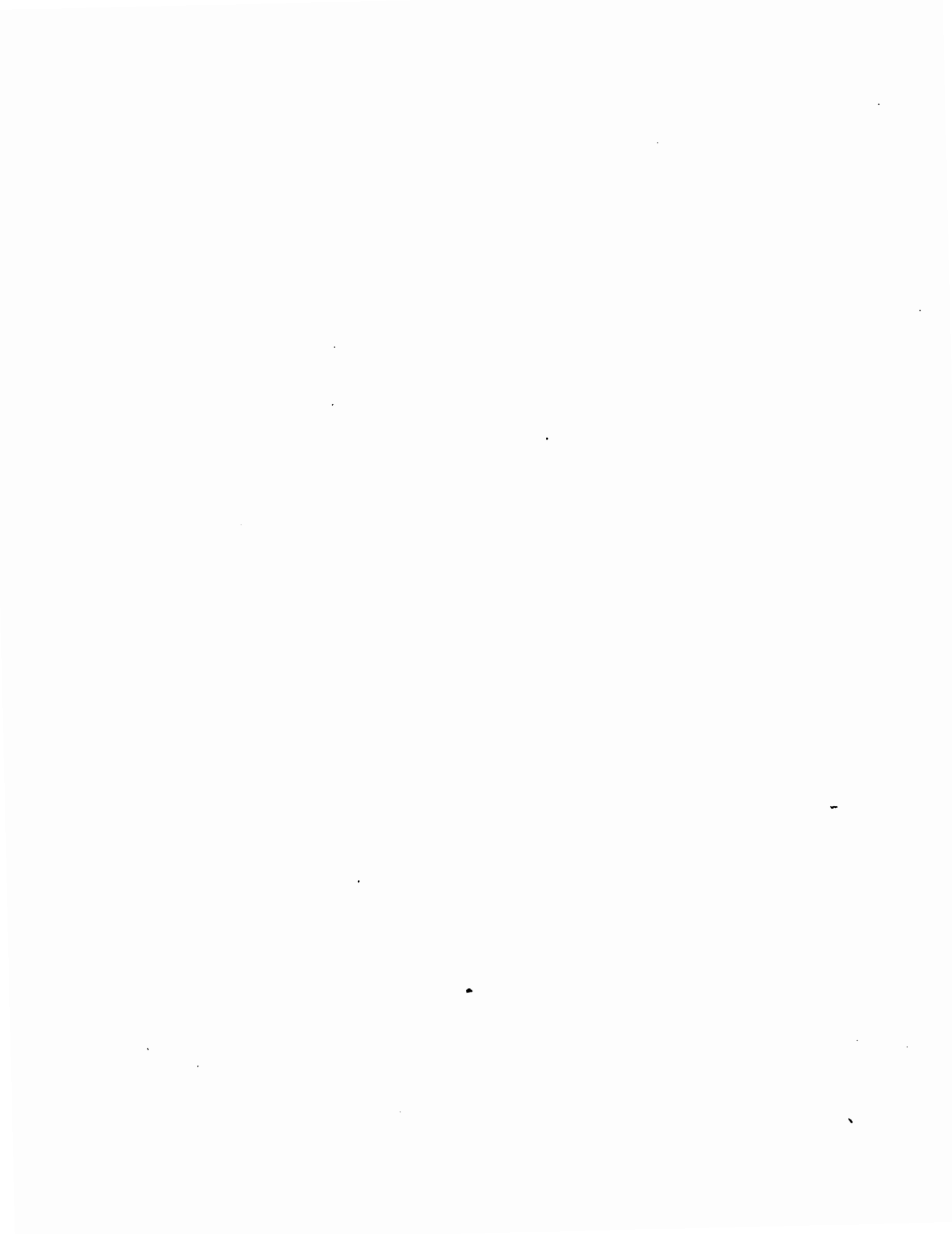
CAUTION

This pamphlet has attempted to explain the purpose of the bridge formula and Federal requirements applicable to the Interstate System, but procedures to determine the related weight limits and axle spacing requirements for specific vehicles may vary from State to State.

APPENDIX C

Commodity Coding Instructions

**(Taken from the "Instructions
for Completing the Commodity
Transportation Survey 1977 Census
of Transportation," U.S. Department
of Commerce, Bureau of the Census)**



COMMODITY CODING INSTRUCTIONS

Commodity Classification Reference List

The codes and commodity descriptions appearing in this booklet are based on the "Commodity Classification for Transportation Statistics" (CCTS), which was established by the Office of Management and Budget primarily for use in the Census of Transportation. The CCTS conforms to the first five digits of the "Standard Transportation Commodity Code" issued by the Association of American Railroads.

How to Use this Reference List

Commodity codes can be readily located by reference to the index beginning on page 6. The list is presented in two parts. Section A consists of products manufactured or processed. Section B includes non-manufactured commodities, ordnance, and scrap. Most establishments will find use for selected "waste and scrap materials" codes and some will have occasional use for other codes in Sections A and B, even though the establishment is "not in the business" of producing or shipping those items.

To enable us to classify entries, it is important to enter BOTH the commodity code (col. f) taken from this list, and the detailed commodity description (col. g). Commodity descriptions should be as specific as possible. For example, an entry "household washing machines" can be coded, but "household appliances" is too broad for classification.

INDEX FOR
Section A – MANUFACTURED COMMODITIES

FOOD AND KINDRED PRODUCTS	Page	PULP, PAPER, AND ALLIED PRODUCTS	Page
Meat, poultry, and byproducts	5-C-7	Products of pulp mills	5-C-12
Dairy products	5-C-7	Paper and board mills	5-C-12
Canned and preserved fruits, vegetables, and seafoods	5-C-7	Paper and board products	5-C-13
Frozen and fresh fish or other seafoods	5-C-7	Containers or boxes	5-C-13
Frozen fruits, vegetables, and prepared foods	5-C-7	Building paper or building board	5-C-13
Mixed loads	5-C-8	PRINTED MATTER	
Grain mill products and animal feed products	5-C-8	Newspapers	5-C-13
Bakery products, except frozen	5-C-8	Periodicals	5-C-13
Sugar and related products	5-C-8	Books	5-C-13
Confectionery, chocolate, and chewing gum	5-C-8	Miscellaneous printed matter	5-C-13
Beverages, flavoring, and related products	5-C-8	Manifold business forms	5-C-13
Miscellaneous foods and kindred products	5-C-8	Blankbooks, loose leaf binders, or devices	5-C-13
		Products of service industries for the printing trades	5-C-13
TOBACCO PRODUCTS		Greeting cards, seals, labels, or tags	5-C-13
Cigarettes	5-C-9	CHEMICALS OR ALLIED PRODUCTS	
Cigars	5-C-9	Alkalies and chlorine	5-C-13
Chewing and smoking tobacco or snuff	5-C-9	Industrial gases	5-C-14
Stemmed or redried tobacco	5-C-9	Industrial organic chemicals	5-C-14
		Inorganic color pigments	5-C-14
TEXTILE MILL PRODUCTS		Fertilizers and agricultural chemicals	5-C-14
Cotton broad woven fabrics	5-C-9	Industrial inorganic chemicals	5-C-14
Manmade fiber broad woven fabrics	5-C-9	Plastics materials	5-C-14
Wool broad woven fabrics	5-C-9	Synthetic rubber	5-C-14
Narrow fabrics	5-C-9	Synthetic fibers	5-C-14
Knitting mill products	5-C-9	Drugs and medicines	5-C-14
Carpets, rugs, and other floor coverings	5-C-9	Soap, glycerine, cleaning, polishing, and related products	5-C-15
Yarn	5-C-9	Surface active agents	5-C-15
Thread	5-C-9	Toilet preparations and cosmetics	5-C-15
Miscellaneous textile goods	5-C-9	Paints, varnishes, lacquers, enamels, and allied products	5-C-15
		Gum and wood chemicals	5-C-15
APPAREL AND OTHER FINISHED TEXTILE PRODUCTS, INCLUDING KNIT		Phosphatic fertilizers	5-C-15
Apparel	5-C-10	Adhesives and sealants	5-C-15
Hats, millinery, and gloves	5-C-10	Explosives	5-C-15
Fur goods	5-C-10	Printing ink	5-C-15
Miscellaneous apparel and accessories	5-C-10	Chemical preparations, not elsewhere classified	5-C-15
Miscellaneous fabricated textile products	5-C-10	Carbon black	5-C-15
		PETROLEUM OR COAL PRODUCTS	
LUMBER OR WOOD PRODUCTS, EXCEPT FURNITURE		Petroleum refining products	5-C-15
Lumber and timber basic products	5-C-11	Paving and roofing materials	5-C-16
Lumber and dimension stock	5-C-11	Asphalt felts and coatings	5-C-16
Millwork, plywood, and structural members	5-C-11	Lubricating oils and greases	5-C-16
Wood buildings and mobile homes	5-C-11	Petroleum and coal products, not elsewhere classified	5-C-16
Wood containers, pallets, and skids	5-C-11	RUBBER OR MISCELLANEOUS PLASTICS PRODUCTS	
Miscellaneous wood products	5-C-11	Tires and inner tubes	5-C-16
		Rubber and plastic footwear	5-C-16
FURNITURE OR FIXTURES		Reclaimed rubber	5-C-16
Household and office furniture	5-C-12	Fabricated rubber products, not elsewhere classified	5-C-16
Bedding products	5-C-12	Plastics products, not elsewhere classified	5-C-16
Public building, restaurant, and other furniture	5-C-12		
Partitions, shelving, lockers, and office and store fixtures – metal and wood	5-C-12		
Window shades and venetian blinds	5-C-12		

**INDEX FOR
Section A – MANUFACTURED COMMODITIES – Continued**

LEATHER OR LEATHER PRODUCTS	Page
Finished leather	5-C-17
Boot and shoe cut stock and findings	5-C-17
Footwear	5-C-17
Leather gloves and mittens	5-C-17
Luggage, handbags, and small leather goods	5-C-17
Leather goods, not elsewhere classified	5-C-17

STONE, CLAY, GLASS, OR CONCRETE PRODUCTS	
Glass and glass products	5-C-17
Cement and structural clay products	5-C-17
Pottery and related products	5-C-17
Concrete, gypsum, cut-stone, and plaster products	5-C-18
Abrasives, asbestos, and miscellaneous nonmetallic products	5-C-18
Gaskets, packing, and sealing devices	5-C-18
Nonmetallic earths or minerals, ground	5-C-18
Mineral wool	5-C-18
Miscellaneous nonmetallic mineral products	5-C-18

PRIMARY METAL PRODUCTS	
Steel mill products including coke and blast furnace products	5-C-18
Ferroalloys	5-C-19
Wire and wire products	5-C-19
Iron and steel castings	5-C-19
Primary smelting of nonferrous ores, concentrates, or other primary materials	5-C-19
Nonferrous metal basic shapes	5-C-19
Nonferrous wire drawing and insulating	5-C-20
Nonferrous castings	5-C-20
Miscellaneous primary metal products	5-C-20

FABRICATED METAL PRODUCTS, EXCEPT ORDNANCE, MACHINERY, OR TRANSPORTATION EQUIPMENT	
Metal cans	5-C-20
Cutlery, hand tools, and hardware	5-C-20
Heating equipment (except electric) and plumbers supplies	5-C-20
Fabricated structural metal products, including doors	5-C-21
Boiler shop and sheet metal products	5-C-21
Prefabricated metal buildings and miscellaneous metal work	5-C-21
Miscellaneous fabricated metal products	5-C-21
Metal forgings and stampings, coating and engraving	5-C-22
Fabricated wire products	5-C-22
Shipping containers	5-C-22

MACHINERY, EXCEPT ELECTRICAL	Page
Engines and turbines	5-C-22
Farm machines and tractors	5-C-22
Construction, mining, and oil-field machinery	5-C-22
Elevators, hoists, and materials handling machinery and equipment	5-C-23
Machine tools	5-C-23
Metalworking machinery	5-C-23
Special industry machinery	5-C-23
Pumps and compressors	5-C-23
General industrial machinery	5-C-23
Office and store machines and service industry machines	5-C-23
Miscellaneous service industry machines	5-C-24
Miscellaneous machinery and parts	5-C-24

ELECTRICAL MACHINERY, EQUIPMENT OR SUPPLIES	
Electrical generating, transmission, distribution, and industrial apparatus	5-C-24
Household appliances	5-C-25
Electric lighting and wiring equipment	5-C-25
Radio, TV, and other communication equipment and related products	5-C-25
Electronic components and accessories	5-C-25
Other electrical machinery and equipment	5-C-25

TRANSPORTATION EQUIPMENT	
Motor vehicles, equipment, and parts	5-C-26
Motor vehicle bodies and trailers	5-C-26
Aircraft, missiles, space vehicles, and missile or space vehicle engines	5-C-26
Boats and ships	5-C-26
Railroad and other transportation equipment	5-C-26

INSTRUMENTS, PHOTOGRAPHIC AND MEDICAL GOODS, WATCHES, AND CLOCKS	
Instruments	5-C-26
Surgical, medical, dental, optical, and ophthalmic goods	5-C-27
Photographic equipment and supplies	5-C-27
Watches, clocks, and watchcases	5-C-27

MISCELLANEOUS PRODUCTS OF MANUFACTURING	
Jewelry, silverware, and plated ware	5-C-27
Musical instruments and parts	5-C-27
Toys, sporting, and athletic goods	5-C-27
Pens, pencils, and other office and artists' supplies	5-C-27
Miscellaneous manufactured products, including costume jewelry	5-C-27

INDEX FOR
Section B – NONMANUFACTURED COMMODITIES, ORDNANCE, AND SCRAP

FARM PRODUCTS	Page	CRUDE PETROLEUM, NATURAL GAS, AND	Page
Field crops	5-C-28	NATURAL GASOLINE	
Fresh fruits or tree nuts	5-C-28	Crude petroleum or natural gas	5-C-30
Fresh vegetables	5-C-29	Natural gasoline	5-C-30
Livestock or livestock products	5-C-29	NONMETALLIC MINERALS, EXCEPT FUELS	
Dairy farm products, except pasteurized	5-C-29	Dimension, stone, quarry	5-C-30
Poultry or poultry products	5-C-29	Crushed or broken stone, including riprap	5-C-31
Miscellaneous farm products	5-C-29	Sand or gravel	5-C-31
FOREST PRODUCTS		Clay, ceramic or refractory minerals	5-C-31
Barks or gums	5-C-30	Chemical or fertilizer minerals	5-C-31
Miscellaneous forest products	5-C-30	Miscellaneous nonmetallic minerals, except fuels	5-C-31
FRESH FISH AND OTHER MARINE PRODUCTS		ORDNANCE AND ACCESSORIES	
Fresh fish and other marine products	5-C-30	Guns, howitzers, mortars, or related equipment, over 30 mm	5-C-31
METALLIC ORES		Ammunition, except for small arms, over 30 mm	5-C-31
Iron ores	5-C-30	Full tracked combat vehicles or parts	5-C-31
Copper ores	5-C-30	Sighting or fire control equipment	5-C-31
Lead or zinc ores	5-C-30	Small arms, 30 mm and under	5-C-31
Gold or silver ores	5-C-30	Small arms ammunition, 30 mm and under	5-C-31
Bauxite or other aluminum ores	5-C-30	Miscellaneous ordnance or accessories	5-C-31
Manganese ores	5-C-30	WASTE AND SCRAP MATERIALS	
Tungsten ores	5-C-30	Ashes	5-C-32
Chromium ores	5-C-30	Waste and scrap, except ashes	5-C-32
Miscellaneous metal ores	5-C-30	CONTAINERS, SHIPPING, RETURNED EMPTY	
COAL		Shipping containers, returned empty	5-C-32
Anthracite coal	5-C-30	Shipping devices, returned empty	5-C-32
Bituminous coal or lignite	5-C-30	MISCELLANEOUS MIXED SHIPMENTS	
		Loaded, commodity not determined	5-C-32

Section A - MANUFACTURED COMMODITIES

FOOD AND KINDRED PRODUCTS

MEAT, POULTRY, AND BYPRODUCTS

- 20111 Carcasses (whole or parts), fresh or chilled
- 20119 Meat, fresh or chilled, not elsewhere classified, except fresh sausage (see 20133)
- 20121 Carcasses (whole or part), fresh-frozen
- 20129 Meat, fresh-frozen, not elsewhere classified
- 20131 Lard
- 20132 Meats or sausage: cooked, cured, or dried including preserved, salted, or smoked
- 20133 Sausage, fresh
- 20134 Canned meat
- 20139 Meat products, not elsewhere classified
- 20141 Hides, pelts, skins, not tanned, cattle (including goats, horse, mule, sheep, swine)
- 20143 Grease or inedible tallow
- 20144 Animal refuse: tankage, meat meal, dried blood, or related animal byproducts
- 20149 Animal byproducts, inedible, not elsewhere classified
- 20151 Dressed poultry or small game, fresh or chilled
- 20158 Poultry or small game byproducts, fresh or chilled
- 20161 Dressed poultry or small game, fresh-frozen
- 20168 Poultry or small game byproducts, fresh-frozen
- 20171 Canned poultry or small game

DAIRY PRODUCTS

- 20172 Eggs: canned, dried, frozen, liquid, or otherwise processed
- 20211 Creamery butter
- 20231 Dry milk products
- 20233 Evaporated or condensed milk products
- 20234 Ice cream mix or ice milk mix
- 20241 Ice cream or related frozen desserts
- 20251 Cheese
- 20252 Cottage Cheese
- 20258 Casein products
- 20259 Special dairy products, not elsewhere classified
- 20261 Bulk fluid milk, including skim milk or cream in bulk
- 20262 Packaged (glass or paper) fluid milk, including skim milk or cream
- 20264 Buttermilk, chocolate milk, or other flavored milk drinks

FOOD AND KINDRED PRODUCTS - Continued

CANNED AND PRESERVED FRUITS, VEGETABLES, AND SEAFOODS

- 20311 Canned fish or other seafood, including soups
- 20314 Smoked, salted, pickled, or dried fish
- 20321 Canned baby foods
- 20322 Canned soups, except canned seafood soups (see 20311), frozen soups (see 20381), or frozen seafood soups (see 20361)
- 20323 Canned bean specialties
- 20329 Canned specialties, not elsewhere classified
- 20331 Canned fruits
- 20332 Canned vegetables
- 20333 Canned hominy or mushrooms
- 20334 Canned fruit juices, except cider (see 20996)
- 20335 Canned vegetable juices
- 20336 Catsup or other tomato sauces
- 20338 Jams, jellies, or preserves
- 20339 Canned fruits or vegetables, not elsewhere classified, including fruit or vegetable byproducts
- 20341 Dehydrated or dried fruits
- 20342 Dehydrated or dried vegetables, or soups, including soup mix, except field dried ripe vegetable food seeds (see 01341-01349)
- 20343 Dehydrated or dried potatoes or potato products, except potato chips (see 20992)
- 20352 Pickles or other pickled products
- 20354 Salad dressings, including mayonnaise or sandwich spreads
- 20359 Sauces or seasonings, not elsewhere classified, except spices (see 20997), and catsup or tomato sauces (see 20336)

FROZEN AND FRESH FISH OR OTHER SEAFOODS

- 20361 Frozen processed (packaged) fish or other seafoods
- 20362 Fresh processed (packaged) fish or other seafoods

FROZEN FRUITS, VEGETABLES, AND PREPARED FOODS

- 20371 Frozen fruits
- 20372 Frozen juices or ades
- 20373 Frozen vegetables
- 20379 Frozen fruits, fruit juices, vegetables in mixed loads without separate weights
- 20381 Frozen prepared foods or soups, except seafoods (see 20361)
- 20389 Frozen specialties, not elsewhere classified

Section A - MANUFACTURED COMMODITIES - Continued

FOOD AND KINDRED PRODUCTS - Continued

MIXED LOADS

20391 Mixed loads of canned or preserved fruits, vegetables, or sea foods without separate weights

GRAIN MILL PRODUCTS AND ANIMAL FEED PRODUCTS

20411 Wheat flour, except blended or prepared (see 20451-20452)
 20412 Wheat bran, middlings, or shorts
 20413 Corn meal or corn flour, except animal or poultry feed (see 20421-20423)
 20414 Rye flour or meal
 20415 Buckwheat flour or meal
 20416 Oatmeal or oat flour
 20418 Grain mill byproducts
 20419 Flour or other grain mill products, not elsewhere classified
 20421 Prepared feed: animal, fish, or poultry, except canned (see 20423) or chopped, ground or pulverized hay, straw, or related products (see 01991-01992)
 20423 Canned feeds; animal, fish, or poultry
 20431 Cooked cereals: flaked, shredded, popped, puffed, rolled, granulated, roasted
 20432 Cereals, uncooked
 20441 Rice, cleaned
 20442 Rice flour, bran, or meal
 20443 Brewers rice
 20449 Milled rice or byproducts, not elsewhere classified
 20451 Prepared flour (phosphated, self-rising)
 20452 Prepared flour mixes (pancake, biscuit, cake, pie crusts, etc.)
 20461 Corn syrup
 20462 Corn starch
 20463 Corn sugar
 20464 Dextrine (corn, tapioca, or other)
 20465 Corn oil
 20466 Starch (potato, wheat, rice, etc.) except corn (see 20462)
 20467 Wet process corn byproducts
 20469 Wet process corn milling products, not elsewhere classified

BAKERY PRODUCTS (EXCLUDING FROZEN)

20511 Bread or other bakery products
 20521 Biscuits, crackers, or pretzels
 20529 Dry bakery products, not elsewhere classified

FOOD AND KINDRED PRODUCTS - Continued

SUGAR AND RELATED PRODUCTS

20611 Raw cane or beet sugar
 20616 Sugar molasses
 20617 Blackstrap molasses
 20618 Bagasse
 20619 Sugar mill products, not elsewhere classified
 20621 Sugar, granulated or powdered
 20622 Sugar, liquid or syrup
 20625 Sugar refining byproducts
 20626 Molasses beet pulp
 20629 Sugar, refined, cane or beet, in mixed loads without separate weights

CONFECTIONERY, CHOCOLATE, AND CHEWING GUM

20711 Candy or candy bars, bulk or packaged
 20712 Nuts, blanched, coated, cooked or roasted, including salted
 20713 Chocolate or cocoa products, or byproducts, including syrups
 20714 Chewing gum
 20719 Confectionery or related products, not elsewhere classified

BEVERAGES, FLAVORING, AND RELATED PRODUCTS

20821 Beer, in bottles, cans, barrels, or kegs, including ale, porter, stout, or other fermented malt liquor
 20823 Malt extract or brewers' spent grains
 20831 Malt
 20832 Malt flour or sprouts
 20839 Malt products or byproducts, not elsewhere classified
 20841 Wines, brandy, or brandy spirits
 20851 Distilled, rectified, or blended liquors
 20859 Byproducts of liquor distilling
 20861 Soft drinks, bottled, canned, or in bulk
 20871 Miscellaneous flavoring extracts or syrups, except chocolate syrups (see 20713)

MISCELLANEOUS FOODS AND KINDRED PRODUCTS

20911 Cottonseed oil, crude or refined, except edible cooking oils (see 20961)
 20914 Cottonseed cake, meal, or byproducts, except fatty acids (see 28994)
 20915 Cotton linters
 20921 Soybean oil, crude or refined, except edible cooking oils (see 20961)
 20923 Soybean cake, meal, flour, grits, etc.

Section A - MANUFACTURED COMMODITIES - Continued

FOOD AND KINDRED PRODUCTS - Continued

MISCELLANEOUS FOODS AND KINDRED PRODUCTS - Con.

- 20931 Linseed oil, crude or refined, except edible cooking oils (see 20961)
- 20933 Nut or vegetable oils
- 20939 Nut or vegetable oil seed cake, meal, not elsewhere classified
- 20941 Marine oil mill products
- 20942 Marine oil mill byproducts (meal, scrap or tankage)
- 20951 Roasted coffee, including instant coffee
- 20961 Shortening, cooking, or salad oils, except corn oil (see 20465)
- 20962 Margarine
- 20971 Ice, natural or manufactured
- 20981 Macaroni, spaghetti, vermicelli, or noodles, dry, except canned (see 20329)
- 20991 Desserts (ready to mix)
- 20992 Chips (potato, corn, etc.)
- 20993 Sweetening syrups or molasses
- 20994 Baking powder or yeast
- 20995 Shipments identified only as "Groceries" (mixed shipments of food and kindred products without separate weights)
- 20996 Vinegar or cider
- 20997 Spices
- 20998 Tea, including instant tea
- 20999 Food preparations or byproducts, not elsewhere classified

TOBACCO PRODUCTS

- 21111 Cigarettes
- 21211 Cigars
- 21311 Chewing tobacco
- 21312 Smoking tobacco
- 21313 Snuff
- 21411 Tobacco, stemmed or redried
- 21419 Tobacco byproducts, leaf

TEXTILE MILL PRODUCTS

COTTON BROAD WOVEN FABRICS

- 22111 Cotton duck or allied fabrics
- 22112 Cotton sheetings, unfinished (grey goods)
- 22113 Cotton, or chiefly cotton blankets
- 22119 Cotton broad woven fabrics or specialties not elsewhere classified, except carpets, mats, or rugs (see 22711 or 22721), or tire cord or fabrics (see 22961)

TEXTILE MILL PRODUCTS - Continued

MANMADE FIBER BROAD WOVEN FABRICS

- 22211 Manmade fiber, broad woven fabrics, including glass fiber, except blankets (see 22213), carpets, mats, or rugs (see 22711 or 22721), or tire cord or fabrics (see 22961)
- 22213 Manmade fiber blankets
- 22221 Silk broad woven fabrics, except carpets, mats, or rugs (see 22711 or 22721), or tire cord or fabrics (see 22961)

WOOL BROAD WOVEN FABRICS

- 22311 Wool broad woven fabrics, except blankets (see 22313), or carpets, mats, or rugs (see 22711 or 22721)
- 22313 Wool, or chiefly wool, blankets

NARROW FABRICS

- 22411 Narrow fabrics, cotton, silk, or wool including glass or other manmade fibres

KNITTING MILL PRODUCTS

- 22511 Knit fabrics

CARPETS, RUGS, AND OTHER FLOOR COVERINGS

- 22711 Woven carpets, mats, or rugs, textile yard
- 22721 Tufted carpets or rugs, textile fibre, including mats
- 22799 Carpets, mats, or rugs, not elsewhere classified, all materials except cork (see 24941), rubber (see 30614), or hard surface floor coverings (see 39921)

YARN

- 22811 Cotton yarn
- 22813 Wool thread or yarn
- 22819 Yarn, not elsewhere classified (including manmade fiber and silk yarn), except hemp, jute, linen, or ramie (see 22999)

THREAD

- 22841 Thread, except hemp, jute, linen, ramie (see 22999) or wool (see 22813)

MISC. TEXTILE GOODS

- 22911 Felt goods, except woven felts (see 22311), or hats (see 23511 or 23521)
- 22921 Lace goods, including dyed or finished, except embroideries (see 23951)

Section A - MANUFACTURED COMMODITIES - Continued

TEXTILE MILL PRODUCTS - Continued

MISCELLANEOUS TEXTILE GOODS - Continued

- 22931 Paddings or upholstery fillings, except foam or sponge rubber (see 30613), expanded plastics (see 30716), or wood excelsior pads or wrappers (see 24294)
- 22941 Textile waste, garnetted or processed
- 22951 Artificial leather and oilcloth
- 22961 Tire cord or fabrics, including fuel cell, industrial belting, or for similar uses
- 22971 Wool or mohair, scoured or carbonized
- 22972 Tops, all fibers, processed, including combed or converted
- 22973 Textile fibers prepared for spinning, including combed or converted (laps, noils, mubs, slubs, sliver, or roving)
- 22974 Wool or mohair grease
- 22981 Cordage or twine
- 22991 Bonded fiber fabrics, except felts woven (see 22311) or unwoven (see 22911)
- 22992 Jute goods, except bags (see 23931)
- 22994 Packing or wiping cloths or rags (processed textile wastes)
- 22995 Vegetable fibers, except cotton (see 20915 or 22999)
- 22999 Textile goods, not elsewhere classified

APPAREL AND OTHER FINISHED TEXTILE PRODUCTS, INCLUDING KNIT

APPAREL

- 23111 Men's, youths', and boys' clothing, including uniforms, except raincoats, (see 23851) and leather or sheep lined clothing (see 23861)
- 23311 Women's, misses', children's, or infants' clothing

HATS, MILLINERY, AND GLOVES

- 23511 Millinery, except fur (see 23711) or braids or trimmings (see 23961)
- 23521 Hats or caps, also hat bodies
- 23811 Dress gloves, mittens, or linings, except all leather (see 31511), plastic (see 30719), or fur linings (see 23711)
- 23812 Work gloves or mittens, except all leather (see 31511), asbestos (see 32929), plastic (see 30719), or rubber (see 30619)

FUR GOODS

- 23711 Fur goods, except sheep lined clothing (see 23861)

APPAREL AND OTHER FINISHED TEXTILE PRODUCTS, INCLUDING KNIT - Continued

MISCELLANEOUS APPAREL AND ACCESSORIES

- 23841 Robes or dressing gowns, except children's or infants' (see 23311)
- 23851 Raincoats or other waterproof outer garments, except oiled fabric (see 23111), or vulcanized rubber (see 30619)
- 23861 Leather or sheep lined clothing, except leather gloves or mittens (see 31511), or fur garments (see 23711)
- 23871 Apparel belts
- 23891 Apparel, not elsewhere classified

MISCELLANEOUS FABRICATED TEXTILE PRODUCTS

- 23911 Window curtains, except lace (see 22921)
- 23912 Draperies or tapestries
- 23921 Bedspreads or bed sets, except embroidered (see 23951), or lace (see 22921)
- 23922 Sheets or pillow cases, except embroidered (see 23951)
- 23923 Towels or wash cloths, except embroidered (see 23951)
- 23924 Tablecloths, napkins, or related textile articles, except lace (see 22921), or embroidered (see 23951)
- 23925 Pillows
- 23926 Mops or dusters
- 23927 Slip covers, except embroidered (see 23951)
- 23928 Comforters or quilts, except embroidered (see 23951)
- 23929 Textile housefurnishings, not elsewhere classified, except embroidered (see 23951), or lace (see 22921)
- 23931 Textile bags, except garment or laundry (see 23929 or 26431)
- 23941 Tents
- 23942 Awnings or shades
- 23943 Tarpaulins
- 23944 Sails
- 23949 Canvas products, not elsewhere classified, except bags (see 23931)
- 23951 Textile products, pleated, quilted or embroidered
- 23961 Textile apparel findings, automotive trimmings, or related products
- 23991 Automobile seat covers
- 23993 Sleeping bags
- 23994 Parachutes
- 23999 Fabricated textile products, not elsewhere classified

Section A - MANUFACTURED COMMODITIES - Continued

LUMBER OR WOOD PRODUCTS, EXCEPT FURNITURE

LUMBER AND TIMBER BASIC PRODUCTS

- 24111 Sawlogs
- 24112 Hewn railroad or mine ties
- 24113 Short logs or wood bolts
- 24114 Pulpwood logs
- 24115 Pulpwood or other wood chips
- 24116 Wood posts, poles, or piling
- 24117 Fuelwood, hogfuel, or cordwood
- 24118 Wood mine props or mine timbers
- 24119 Primary forest products or wood raw materials, not elsewhere classified

LUMBER AND DIMENSION STOCK

- 24211 Lumber, rough or dressed; softwood cut stock or flooring
- 24212 Sawed ties (railroad, mine, etc.)
- 24214 Hardwood dimension stock, furniture parts or vehicle stock
- 24215 Flooring, hardwood
- 24219 Lumber or dimension stock, not elsewhere classified
- 24291 Shingles
- 24292 Cooperage stock
- 24293 Shavings or sawdust
- 24294 Excelsior, baled or bulk
- 24299 Sawmill or planing mill products, not elsewhere classified, except box springs or boxes (see 24416), millwork (see 24311 - 24319), plywood or veneer (see 24321), or textile machinery wood shapes or turnings (see 35522)

MILLWORK, PLYWOOD, AND STRUCTURAL MEMBERS

- 24311 Window units, wood
- 24312 Window sash, wood, including combination screen and storm sash, except window screens, wood framed
- 24313 Window or door frames or jambs, wood
- 24314 Doors or shutters, wood, or door units
- 24316 Wood mouldings
- 24319 Millwork products, not elsewhere classified, including cabinet work to be built-in
- 24321 Plywood, veneer, or built-up wood, except plywood or veneer containers (see 24411 - 24414), wood particle board (see 24996), hardboard (see 24993)
- 24341 Kitchen cabinets, wood

LUMBER OR WOOD PRODUCTS, EXCEPT FURNITURE - Con.

WOOD BUILDINGS AND MOBILE HOMES

- 24332 Prefabricated buildings, wood
- 24333 Ready-cut wood buildings, and panels or sections for prefabricated buildings
- 24391 Prefabricated structural members or wood laminates

WOOD CONTAINERS, PALLETS, AND SKIDS

- 24411 Boxes, cases, crates, or carriers, except animal or poultry
- 24412 Carriers or coops, animal or poultry, also crates
- 24413 Fruit or vegetable baskets or hampers, wooden
- 24414 Baskets or hampers, except fruit or vegetable (see 24413), toy (see 39411), bait or fish (see 39491), or ambulance or undertaker (see 39941)
- 24415 Cooperage
- 24416 Box shooks
- 24419 Wooden containers or container accessories, not elsewhere classified
- 24992 Pallets, skids, or platforms, wood except used, returned empty (see 42112)

MISCELLANEOUS WOOD PRODUCTS

- 24911 Wooden piling, posts, timbers, props, etc., creosoted or oil treated
- 24912 Wooden ties (railroad, mine, etc.), creosoted or oil treated
- 24919 Wood products, creosoted or treated with other preservatives, not elsewhere classified
- 24921 Rattan, bamboo, or willow ware, except furniture (see 25--), baskets, or hampers (see 24413-4)
- 24931 Lasts or related products, all materials
- 24941 Cork products
- 24951 Hand tool handles
- 24961 Scaffolding equipment
- 24962 Ladders or ladder parts
- 24971 Wooden ware
- 24972 Wooden novelties or flatware
- 24981 Poles, rods, or stakes, wood, finished
- 24982 Billboards or sign frames, or related articles, wood
- 24983 Bath tub seats, toilet seats, laundry tub covers, radiator covers or guards, sink drain boards, or related articles, wood
- 24985 Bottle stoppers, ice cream sticks, paint paddles, or pencil slats, wood

Section A - MANUFACTURED COMMODITIES - Continued

LUMBER OR WOOD PRODUCTS, EXCEPT FURNITURE - Con.

MISCELLANEOUS WOOD PRODUCTS - Continued

- 24987 Quilting frames or curtain stretchers, wood
- 24988 Ironing boards or tables, wood
- 24993 Hardboard
- 24994 Masts, spars, oars, or related boat accessories, wood
- 24995 Pipe, conduit, or fittings, wooden
- 24996 Wood particle board
- 24997 Fencing or gates, wood
- 24998 Reels or spools, wood, except textile machinery spools (see 35522)
- 24999 Wood products, not elsewhere classified, except containers (see 24411 - 24414 or 24419)

FURNITURE OR FIXTURES

HOUSEHOLD AND OFFICE FURNITURE

- 25111 Chairs, rockers, benches, or stools, household or office, except concrete (see 32719), stone (see 32819), or terra cotta (see 32699)
- 25121 Tables or desks, household or office, except concrete (see 32719), stone (see 32819), or terra cotta (see 32699)
- 25131 Sofas, couches, settees, davenports, or love seats, household or office
- 25141 Buffets, servers, china or corner closets, household
- 25161 Dressers, vanities, chests of drawers, and beds, household or office, except hospital beds (see 25991)
- 25171 Radio, phonograph, or television cabinets
- 25173 Filing cabinets or cases
- 25174 Kitchen cabinets, except wood (see 24341)
- 25179 Cabinets or cases, not elsewhere classified, except china cabinets (see 25141), or display cases (see 25411 - 25421), or kitchen cabinets (see 24341 or 25174)
- 25181 Infants' or children's furniture
- 25199 Household or office furniture, not elsewhere classified, except concrete (see 32719), stone (see 32819), or terra cotta (see 32699)

BEDDING PRODUCTS

- 25151 Mattresses, bed or box springs, assembled springs or spring cushions, except auto seats or backs (see 25312), or padding or upholstery fillings (see 22931)
- 25153 Studio couches, convertible sofas, sofa beds, or chair beds

FURNITURE OR FIXTURES - Continued

PUBLIC BUILDING, RESTAURANT, AND OTHER FURNITURE

- 25311 School furniture, except stone (see 32819), concrete (see 32719), or terra cotta (see 32699)
- 25312 Seats for public conveyances: automobiles, trucks, aircraft, school buses, or railroad cars
- 25314 Seats, auditorium, bleacher, circus, theatre or stadium
- 25991 Hospital beds
- 25999 Furniture or fixtures, not elsewhere classified, including restaurant furniture, except table arm chairs (see 25311), dental, hospital, operating room, or opticians' furniture (see 38412), hospital beds (see 25991), concrete furniture (see 32719), stone furniture (see 32819), or terra cotta furniture (see 32699)
- 25319 Public building furniture, not elsewhere classified, except concrete (see 32719), stone (see 32819), or terra cotta (see 32699)

PARTITIONS, SHELVING, LOCKERS, AND OFFICE AND STORE FIXTURES - METAL AND WOOD

- 25411 Wood partitions, shelving, lockers, office or store fixtures, except refrigerated cabinets, cases, or lockers (see 35853)
- 25421 Metal partitions, shelving, lockers, office or store fixtures, except refrigerated cabinets, cases, or lockers (see 35853), or safes or vaults (see 34921)

WINDOW SHADES AND VENETIAN BLINDS

- 25911 Venetian blinds, awnings or shades, including curtain rods or accessories, except canvas (see 23942)

PULP, PAPER, AND ALLIED PRODUCTS

PRODUCTS OF PULP MILLS

- 26111 Pulp
- 26112 Pulp mill byproducts

PAPER AND BOARD MILLS

- 26211 Newsprint
- 26212 Groundwood paper, uncoated
- 26213 Printing paper, coated or uncoated, including groundwood papers, coated; groundwood paper containing less than 60% groundwood, coated or uncoated; or writing paper
- 26214 Wrapping paper, wrappers, or coarse papers

Section A - MANUFACTURED COMMODITIES—Continued

PULP, PAPER, AND ALLIED PRODUCTS - Continued

PAPER AND BOARD MILLS - Continued

- 26217 Special industrial paper, including paper car liners
- 26218 Sanitary tissue stock
- 26219 Paper, not elsewhere classified, except building paper (see 26611 - 26619)
- 26311 Paperboard, pulpboard, or fiberboard, except insulating building board (see 26611 - 26619)

PAPER AND BOARD PRODUCTS

- 26421 Envelopes, except stationery (see 26491)
- 26431 Paper bags
- 26441 Wallpaper
- 26451 Office supplies
- 26452 Coated paperboard
- 26453 Closures for bottles, jars, cans (caps, covers, tops, etc.)
- 26459 Die-cut paper or paperboard products, or cardboard, not elsewhere classified
- 26461 Bituminous fiber pipe, sewer or drainage; and conduit, including fittings
- 26462 Egg cartons, cases, or related articles
- 26469 Pressed or molded pulp goods, not elsewhere classified
- 26471 Sanitary tissues or health products
- 26472 Sanitary napkins or tampons, paper or cotton
- 26491 Stationery, tablets, envelopes, or related products
- 26492 Wrapping products (gift wrap, etc.)
- 26495 Business machine supplies
- 26497 Packing cushions, covers, liners, or related articles
- 26499 Converted paper products or paperboard products, not elsewhere classified

CONTAINERS OR BOXES

- 26511 Paperboard boxes, fiberboard, or pulpboard boxes or containers, except butter, frozen food, ice cream or margarine boxes or containers (see 26542 - 26549)
- 26514 Baskets, hampers, or till boxes - paperboard or fiberboard
- 26515 Pallets, skids, or platforms, paperboard
- 26542 Bottles or cartons, and other liquid-tight food containers

PULP, PAPER AND ALLIED PRODUCTS - Continued

CONTAINERS OR BOXES - Continued

- 26543 Cans, pails, tubs, cups, covers, or straws: paperboard, fiberboard, or pulpboard
- 26545 Paper plates, dishes, spoons, forks, etc.
- 26549 Sanitary food containers, not elsewhere classified
- 26551 Fiber cans, tubes, or drums, or similar products, except sanitary food containers (see 26542 - 26549)

BUILDING PAPER OR BUILDING BOARD

- 26611 Insulating board
- 26612 Construction paper
- 26613 Wallboard, except hardboard (see 24993)
- 26614 Insulating materials, except insulating board (see 26611)
- 26615 Construction panels, partitions, siding, or forms
- 26619 Building paper or building board, not elsewhere classified

PRINTED MATTER

- 27111 Newspapers
- 27211 Periodicals
- 27311 Books
- 27411 Catalogues, directories, business service publication, or advertising materials
- 27415 Cards or tickets, except greeting cards (see 27711)
- 27417 Seals, labels, tags, or wrappers, except government stamped (see 27419) or greeting (see 27711)
- 27419 Printed matter, not elsewhere classified, including blueprints, building plans, or commercial designs
- 27611 Manifold business forms
- 27711 Greeting cards, seals, labels, or tags
- 27811 Blankbooks, pads, or tablets
- 27812 Loose leaf binders or devices
- 27911 Service industries for the printing trades, including electrotpe, engravers, lithographic, or stereotype plates, shells, blocks, or bars

CHEMICALS OR ALLIED PRODUCTS

ALKALIES AND CHLORINE

- 28122 Sodium alkalies
- 28124 Potassium alkalies
- 28128 Chlorine
- 28129 Alkalies, not elsewhere classified

Section A - MANUFACTURED COMMODITIES—Continued

CHEMICALS OR ALLIED PRODUCTS - Continued

INDUSTRIAL GASES

- 28132 Acetylene
- 28133 Carbon dioxide
- 28134 Elemental gases
- 28139 Industrial gases, not elsewhere classified, compressed, liquefied, or solid, except chemical warfare gases (see 28188), ammonia or ammonia compounds (see 28191 or 28198), chlorine (see 28128) fluorine (see 28199)

INDUSTRIAL ORGANIC CHEMICALS

- 28141 Crude products from coal tar, petroleum, or natural gas, except asphalt, tar, or pitches (see 29116)
- 28151 Cyclic intermediates derived from benzene, toluene, naphthalene, anthracene, pyridine, carbazole, or other cyclic chemical products
- 28156 Organic dyes
- 28158 Organic pigments (lakes or toners)
- 28182 Miscellaneous acyclic organic chemical products, except organic dyes (see 28156)
- 28183 Miscellaneous cyclic chemical products
- 28184 Alcohols
- 28185 Glycols or glycerine
- 28186 Organic acids or salts, except acid dyes (see 28151 - 28158), or fatty acids (see 28994)
- 28188 Chemical warfare gases
- 28189 Industrial organic chemicals, not elsewhere classified, except grain alcohol for beverage purposes (see 20851 - 20859) paints or allied products (see 28511 - 28519), plastics materials plasticizers, or synthetic fibers, resins or rubber (see 28211 - 28213), or specialty cleaning or sanitation preparations (see 28422 - 28423)

INORGANIC COLOR PIGMENTS

- 28161 Titanium pigments
- 28162 Lead pigments
- 28163 Zinc pigments
- 28169 Inorganic pigments, not elsewhere classified, except blacks (see 28996), or organic color pigments (see 28158)

CHEMICALS OR ALLIED PRODUCTS - Continued

FERTILIZERS AND AGRICULTURAL CHEMICALS

- 28191 Ammonia or ammonia compounds, except anhydrous ammonia (see 28198)
- 28192 Nitric acid
- 28198 Anhydrous ammonia

INDUSTRIAL INORGANIC CHEMICALS

- 28193 Sulphuric acid
- 28194 Industrial inorganic acids, except nitric (see 28192) or sulphuric (see 28193)
- 28195 Cobalt, copper, iron, nickel, or zinc compounds
- 28196 Aluminum compounds
- 28197 Radioactive or nuclear chemicals
- 28199 Industrial inorganic chemicals not elsewhere classified, except mining, milling or otherwise preparing natural boron, sodium or potassium compounds (see 14713) or household bleaches (see 28422)
- 28121 Inorganic bleaching compounds, except chlorine (see 28128)
- 28123 Sodium compounds, except sodium alkalies (see 28122)
- 28125 Potassium compounds, except potassium alkalies (see 28124)
- 28126 Barium, calcium, magnesium, or strontium compounds, except bleaches (see 28121 or 28422)

PLASTICS MATERIALS

- 28211 Plastics materials, synthetic resins, or nonvulcanizable elastomers, except fabricated plastic products (see 30711 - 30719)

SYNTHETIC RUBBER

- 28212 Synthetic rubbers (vulcanizable elastomers), except fabricated rubber products (see 30613 - 30619)

SYNTHETIC FIBERS

- 28213 Synthetic fibers, except glass (see 32293)

DRUGS AND MEDICINES

- 28311 Drugs for human use
- 28312 Drugs for veterinary use

Section A - MANUFACTURED COMMODITIES—Continued

CHEMICALS OR ALLIED PRODUCTS - Continued

SOAP, GLYCERINE, CLEANING, POLISHING, AND RELATED PRODUCTS

- 28411 Synthetic organic detergents, except synthetic glycerin (see 28185)
- 28419 Soap or other detergents, except shampoos or shaving products (see 28441) specialty cleaners (see 28422 - 28423) or synthetic organic detergents (see 28411)
- 28422 Specialty cleaning or sanitation preparations, household bleaches, except pesticidal preparations (see 28799)
- 28423 Waxes or polishing preparations or related products

SURFACE ACTIVE AGENTS

- 28431 Surface active agents, finishing agents, sulfonated oils or assistants

TOILET PREPARATIONS AND COSMETICS

- 28441 Perfumes, cosmetics, or other toilet preparations, except essential oils (see 28999), or synthetic flavoring or perfume materials (see 28189)

PAINTS, VARNISHES, LACQUERS, ENAMELS, AND ALLIED PRODUCTS

- 28511 Paints, varnishes, lacquers, shellacs and enamels
- 28512 Paint oil, thinners, solvents, or paint drying ingredients and related products
- 28513 Putty
- 28519 Paints, varnishes, lacquers, shellacs, enamels, or allied products, not elsewhere classified, including mixed shipments except calking compounds (see 28911). For bone, carbon, or lamp blacks see 28996; inorganic color pigments (see 28161 - 28169); organic color pigments (see 28151 - 28158); plastic materials, (see 28211 - 28213) or printers' ink (see 28931)

GUM AND WOOD CHEMICALS

- 28612 Gum or wood chemicals, except synthetic dyes (see 28151 - 28158), or synthetic organic chemicals or tanning materials (see 28182 - 28189)

PHOSPHATIC FERTILIZERS

- 28712 Superphosphate
- 28713 Ammoniating or nitrogen fertilizer solutions

CHEMICALS OR ALLIED PRODUCTS - Continued

PHOSPHATIC FERTILIZERS - Continued

- 28714 Miscellaneous fertilizer compounds
- 28719 Fertilizers, not elsewhere classified, except manufactured urea (see 28182), or milling, mining, or otherwise preparing natural boron, sodium, or potassium compounds (see 14713)
- 28799 Agricultural chemicals, not elsewhere classified, including fungicides, herbicides or plant hormones, household or industrial pesticidal preparations or agricultural disinfectants, insecticides or pesticides except pest control chemicals, not formulated (see 281--) or agricultural lime products (see 14211 or 32959)

ADHESIVES AND SEALANTS

- 28911 Adhesives, cements, glues or sizes, calking compounds, or sealants, except asbestos cements (see 32921 - 32929)

EXPLOSIVES

- 28921 Explosives, except ammunition (see 1929 - 1961) or fireworks and pyrotechnics (see 28993)

PRINTING INK

- 28931 Printing ink

CHEMICAL PREPARATIONS, NOT ELSEWHERE CLASSIFIED

- 28991 Salt, common
- 28993 Fireworks or pyrotechnics
- 28994 Fatty acids
- 28995 Water treated compounds
- 28999 Chemical products, not elsewhere classified, except sealants (see 28911)

CARBON BLACK

- 28996 Blacks

PETROLEUM OR COAL PRODUCTS

PETROLEUM REFINING PRODUCTS

- 29111 Gasoline, jet fuels, or other high volatile petroleum fuels, except natural gas or gasoline (see 13121 or 13211)
- 29112 Kerosene, except jet fuels (see 29111)
- 29113 Distillate fuel oil

Section A - MANUFACTURED COMMODITIES—Continued

PETROLEUM OR COAL PRODUCTS - Continued

PETROLEUM REFINING PRODUCTS - Continued

- 29114 Petroleum lubricating or similar oils, compounds or derivatives
- 29115 Petroleum lubricating greases
- 29116 Asphalt, tar, or pitches from petroleum, coke oven, coal tar, or natural gas
- 29117 Petroleum residual fuel oils including other low volatile petroleum fuels
- 29119 Products of petroleum refining, not elsewhere classified, except liquefied petroleum gases (see 29121) or petroleum coke (see 29913)
- 29121 Liquefied petroleum or coal gases

PAVING AND ROOFING MATERIALS

- 29511 Asphalt paving mixtures or blocks, including creosoted wood, tar or composition of asphalt or tar with other materials

ASPHALT FELTS AND COATINGS

- 29521 Asphalt or tar saturated felts, boards, or roofing
- 29522 Asphalt or tar coatings, cements, or pitches, except linoleum or tile cement (see 28911)
- 29523 Asphalt shingles, siding, or sheathing
- 29529 Asphalt felts or coatings, not elsewhere classified, except paint (see 28511 - 28519), linoleum or tile cement (see 28911) roofing (see 29522)

LUBRICATING OILS AND GREASES

- 29912 Lubricants or similar compounds, except petroleum refining (see 29114 or 29115)

PETROLEUM AND COAL PRODUCTS, NOT ELSEWHERE CLASSIFIED

- 29911 Coke or coal briquettes, anthracite culm (fuel brick) including bituminous slack, charcoal, peat or sawdust
- 29913 Petroleum coke, except briquettes (see 29911)
- 29914 Coke produced from coal, except briquettes (see 29911)
- 29919 Petroleum or coal products, not elsewhere classified, except dyes, dye (cyclic) intermediates (see 28151 - 28158) or petroleum refinery products (see 29111 - 29119)

RUBBER OR MISCELLANEOUS PLASTICS PRODUCTS

TIRES AND INNER TUBES

- 30111 Pneumatic tires
- 30114 Inner tubes
- 30115 Thread rubber, tire sundries, or repair materials
- 30119 Tires or related products, not elsewhere classified

RUBBER AND PLASTIC FOOTWEAR

- 30211 Rubber footwear (including rubber, rubber soled fabric, including canvas with rubber soled or plastic with rubber or leather with vulcanized soles)
- 30212 Plastic footwear (including fabric with plastic soles)

RECLAIMED RUBBER

- 30311 Reclaimed rubber
- 30411 Rubber or plastic belts or belting
- 30412 Rubber or plastic hose

FABRICATED RUBBER PRODUCTS, NOT ELSEWHERE CLASSIFIED

- 30613 Sponge or foam rubber goods
- 30614 Rubber floor or wall coverings
- 30618 Fabricated rubber products, not elsewhere classified, except elastic webbing (see 22411), elastic webbing products or rubberized fabric garments (see 23...), synthetic rubbers (see 28212), rubber cement (see 28911), rubber packing (see 32932), rubber belting (see 30411), or rubber hose (see 30412)

PLASTICS PRODUCTS, NOT ELSEWHERE CLASSIFIED

- 30711 Plastic dinnerware or housewares
- 30712 Plastic pipes, tubing, or fittings
- 30713 Industrial (molded) plastic products
- 30714 Unsupported vinyl or polyethylene film or sheeting
- 30715 Unsupported plastic floor or wall coverings
- 30716 Expanded or foamed plastics
- 30717 Plastic laminated sheets, rods, or tubes
- 30718 Plastic packaging and shipping containers (baskets, bottles, boxes, cans, drums, cups, tumblers, jars, tubs, tubes, caps, closures, inserts, or liners for containers)

Section A - MANUFACTURED COMMODITIES—Continued

RUBBER OR MISCELLANEOUS PLASTICS PRODUCTS - Con.

PLASTICS PRODUCTS, NOT ELSEWHERE CLASSIFIED - Con.

30719 Miscellaneous fabricated plastic products, not elsewhere classified, except artificial leather (see 22951), plastic materials (see 28211), plastic footwear (see 30212), plastic belting (see 30411), or plastic hose (see 30412)

LEATHER OR LEATHER PRODUCTS

FINISHED LEATHER

31111 Leather, tanned or finished
31211 Industrial leather belting

BOOT AND SHOE CUT STOCK AND FINDINGS

31311 Boot or shoe cut stock, all materials, including boot or shoe findings

FOOTWEAR

31411 Footwear - Leather or other material except rubber (see 30211), plastic (see 30212), or house slippers (see 31421)
31421 House slippers, leather or other materials

LEATHER GLOVES AND MITTENS

31511 Dress or work gloves or mittens, all leather except cloth and leather combined - (see 23811 - 23812) athletic or sporting (see 39499)

LUGGAGE, HANDBAGS, AND SMALL LEATHER GOODS

31611 Luggage, handbags, leather or other materials, or other personal leather goods, except hat boxes, paper or paperboard (see 26511) or precious metal (see 39111)

LEATHER GOODS, NOT ELSEWHERE CLASSIFIED

31999 Leather goods, not elsewhere classified

STONE, CLAY, GLASS OR CONCRETE PRODUCTS

GLASS AND GLASS PRODUCTS

32111 Sheet (window) glass
32112 Plate glass
32113 Laminated glass, including safety glass
32119 Flat glass, not elsewhere classified
32211 Glass containers and glass caps or covers, except glass bottles (see 32212)
32212 Glass bottles
32219 Glass containers, not elsewhere classified

STONE, CLAY, GLASS OR CONCRETE PRODUCTS - Con.

GLASS AND GLASS PRODUCTS - Continued

32291 Table, kitchen, art, or novelty glassware
32292 Lighting glassware, except complete electric light bulbs (see 36411)
32293 Glass fiber
32294 Glass mirrors
32295 Glass bricks, blocks, or related products, including skylights
32296 Electronic glassware, except complete electronic tubes (see 36711)
32299 Glass or glassware, blown or pressed, not elsewhere classified, except flat glass (see 32111 - 32119), glass containers (see 32211 - 32219), glass wool insulation products (mineral wool) (see 32961) or optical lenses (see 38311)

CEMENT AND STRUCTURAL CLAY PRODUCTS

32411 Hydraulic cement: portland, natural, including masonry
32412 Ready-mix cement or concrete, dry
32511 Brick or blocks, clay or shale, except refractory (see 32551 - 32552), glass (see 32295), or sandlime (see 32999)
32512 Glazed brick or block
32531 Ceramic wall or floor tile
32551 Clay refractories
32552 Nonclay refractories, except dead-burned magnesia or magnesite (see 32953)
32591 Clay culverts, conduit, pipe, or fittings
32592 Clay drain tile
32593 Clay terra cotta (architectural)
32594 Clay roofing tile
32595 Clay tile beams, channels, girders, double trees, or joists (reinforced)
32599 Structural clay products, not elsewhere classified

POTTERY AND RELATED PRODUCTS

32611 Vitreous china plumbing fixtures, including vitreous china or earthenware bathroom accessories or fittings
32621 Vitreous china kitchen or table articles, including fine earthenware (semivitreous or whiteware)
32641 Porcelain, steatite, or other ceramic electrical supplies
32699 Pottery products, not elsewhere classified

Section A - MANUFACTURED COMMODITIES - Continued

STONE, CLAY, GLASS OR CONCRETE PRODUCTS - Con.

CONCRETE, GYPSUM, CUT-STONE, AND PLASTER PRODUCTS

- 32711 Concrete brick or blocks
- 32713 Concrete posts, poles, piling
- 32714 Concrete conduit, culverts or drains, or pipe or tile
- 32715 Concrete structural shapes, reinforced
- 32719 Concrete products, not elsewhere classified
- 32731 Ready-mixed concrete, wet
- 32741 Lime or lime plaster
- 32751 Gypsum lath
- 32752 Gypsum plaster
- 32753 Gypsum building materials except lath (see 32751), wallboard (see 32754), or plaster (see 32752)
- 32754 Gypsum wallboard
- 32759 Gypsum products, except building materials (see 32751 - 32753)
- 32811 Cut granite or granite products
- 32812 Cut limestone or limestone products
- 32813 Cut marble or marble products
- 32814 Cut slate, soapstone, or talc, or related products
- 32819 Cut stone or stone products, not elsewhere classified

ABRASIVES, ASBESTOS, AND MISCELLANEOUS NONMETALLIC PRODUCTS

- 32911 Nonmetallic artificial (synthetic) abrasives - sized grains, powders, or flour
- 32912 Nonmetallic bonded abrasive products or nonmetallic coated abrasives or diamond abrasives
- 32914 Metal abrasives, including metal scouring pads, soap impregnated
- 32919 Abrasive products, not elsewhere classified
- 32921 Asbestos friction material
- 32922 Asbestos cement products
- 32923 Asphalt or vinyl asbestos floor tile, except linoleum, asphalted felt base or other hard surface floor coverings (see 39921), or cork tile (see 24941)
- 32924 Asbestos insulation
- 32929 Asbestos products, not elsewhere classified, except asbestos paper (see 26612), gaskets or packing (see 32931 - 32932)

STONE, CLAY, GLASS OR CONCRETE PRODUCTS - Con.

GASKETS, PACKING, AND SEALING DEVICES

- 32931 Gaskets, all types
- 32932 Packing, all types

NONMETALLIC EARTHS OR MINERALS, GROUND

- 32951 Vermiculite, exfoliated, loose
- 32952 Lightweight aggregates, ground, including treated in any other manner or clays or slags, except ground or otherwise treated at mine site (see 14911 - 14919) or diatomaceous or infusorial earth (see 14918)
- 32953 Magnesia or magnesite, calcined, dead-burned or ground
- 32954 Pyrophyllite, ground or otherwise treated, including steatite (soapstone) or talc
- 32955 Feldspar, ground or otherwise treated
- 32956 Crushed or ground uncalcined gypsum (including gypsite or anhydrite)
- 32957 Mica, ground or otherwise treated
- 32958 Natural graphite (black lead), ground, refined, pulverized, or blended
- 32959 Nonmetallic minerals or earths, ground or otherwise treated

MINERAL WOOL

- 32961 Mineral wool, except asbestos insulation products (see 32924), or textile glass fibers (see 32293)

MISCELLANEOUS NONMETALLIC MINERAL PRODUCTS

- 32996 Nonmetallic mineral insulating materials, except asbestos (see 32924), gypsum (see 32753), mineral wool (see 32961), or paper (see 26614)
- 32999 Nonmetallic mineral products, not elsewhere classified, including papier-mâché art goods, statuary goods, urns, or vases

PRIMARY METAL PRODUCTS

STEEL MILL PRODUCTS INCLUDING COKE AND BLAST FURNACE PRODUCTS

- 33111 Pig iron
- 33112 Furnace slag, except ground or otherwise treated (see 32952)
- 33115 Metalizing plant products
- 33119 Coke oven or blast furnace products, not elsewhere classified, except asphalt, pitches or tars (see 29116), crude tar products, or chemicals (see 28---), metallic ores (see 10---), or oils (see 29114 or 29912)

Section A - MANUFACTURED COMMODITIES - Continued

PRIMARY METAL PRODUCTS - Continued

STEEL MILL PRODUCTS INCLUDING COKE AND BLAST FURNACE PRODUCTS - Continued

- 33121 Steel ingot or semi-finished shapes
- 33122 Iron or steel plates
- 33123 Iron or steel sheet or strip, except tin mill products (see 33127)
- 33124 Iron or steel bars, bar shapes, or rods
- 33126 Iron or steel pipe, tubes, or fittings
- 33127 Tin mill products
- 33128 Railway track material (rails, rail guards, tie plates, or related materials)
- 33129 Primary iron or steel products, not elsewhere classified

FERROALLOYS

- 33131 Ferromanganese
- 33132 Ferrochrome
- 33133 Ferrosilicon
- 33139 Ferroalloys, not elsewhere classified

WIRE AND WIRE PRODUCTS

- 33151 Noninsulated ferrous wire rope, cable, or strand nonferrous wire (see 33571 - 33574)
- 33152 Steel nails, staples, tacks, or brads, spikes, except railway (see 33128)
- 33155 Steel wire, except miscellaneous fabricated wire products (see 34812 - 34819)

IRON AND STEEL CASTINGS

- 33211 Iron or steel cast pipe or fittings
- 33219 Iron or steel castings, not elsewhere classified

PRIMARY SMELTING OF NONFERROUS ORES, CONCENTRATES, OR OTHER PRIMARY MATERIALS

- 33311 Primary copper or copper base alloy pig, slab, or ingots, etc., including copper base alloy
- 33312 Copper matte, speiss, flue dust, residue, etc.
- 33321 Lead pig, slab, ingots, bullion and lead base alloy, except solder babbitt or type metal (see 33567)
- 33322 Lead matte, speiss, flue dust, dross, etc.
- 33331 Primary zinc or zinc base alloy smelter products, spelter, pig, slab, or ingots
- 33332 Zinc dross, residues, ashes, etc.
- 33341 Primary aluminum or aluminum base alloy pig, slab, ingot, billets, blooms, etc.

PRIMARY METAL PRODUCTS - Continued

PRIMARY SMELTING OF NONFERROUS ORES, CONCENTRATES, OR OTHER PRIMARY MATERIALS - Continued

- 33342 Aluminum residues, etc.
- 33391 Magnesium or magnesium base alloy pig, slab, ingot, etc.
- 33392 Manganese or manganese base alloy pig, slab, ingot, etc.
- 33393 Molybdenum or molybdenum base alloy pig, slab, ingot, etc.
- 33394 Nickel or nickel base alloy pig, slab, ingot, etc.
- 33395 Tin or tin base alloy pig, slab, ingot, etc., except solder, babbitt, or type metal (see 33567)
- 33396 Titanium or titanium base alloy pig, slab, ingot, etc.
- 33398 Miscellaneous nonferrous or nonferrous base alloy metal residues, including solder, babbitt, or type metal residues
- 33399 Primary nonferrous or nonferrous base alloy metal slab, pig, ingot, etc., not elsewhere classified

NONFERROUS METAL BASIC SHAPES

- 33511 Copper, brass, bronze, or other copper base alloy rods or bars
- 33512 Copper, brass, bronze, or other copper base alloy plate, sheet, or strip
- 33513 Copper, brass, bronze, or other copper base alloy pipe or tube
- 33519 Copper, brass, bronze, or other copper base alloy shapes, not elsewhere classified
- 33521 Aluminum or aluminum base alloy plate or sheet
- 33523 Aluminum or aluminum base alloy rods or bars
- 33524 Aluminum or aluminum base alloy pipe or tube
- 33529 Aluminum or aluminum base alloy basic shapes, not elsewhere classified, except foil or foil stock (see 34992)
- 33561 Magnesium or magnesium base alloy basic shapes
- 33562 Lead or lead base alloy basic shapes, except solder, babbitt, or type metal (see 33567)
- 33563 Nickel or nickel base alloy basic shapes
- 33564 Zinc or zinc base alloy basic shapes
- 33565 Titanium basic shapes
- 33566 Welding rods, bars, or wire

Section A - MANUFACTURED COMMODITIES—Continued

PRIMARY METAL PRODUCTS - Continued

NONFERROUS METAL BASIC SHAPES - Continued

- 33567 Solder, babbitt, or type metal shapes
- 33569 Nonferrous metal basic shapes, not elsewhere classified, except residues included in primary industries (see 33398)

NONFERROUS WIRE DRAWING AND INSULATING

- 33571 Aluminum or aluminum base alloy wire, strand, or cable, bare
- 33572 Copper or copper base alloy wire, strand, or cable, bare
- 33573 Nonferrous metal or nonferrous base alloy wire, bare, except aluminum or copper (see 33571 - 33572)
- 33574 Wire or cable, insulated, all types, including enameled or covered

NONFERROUS CASTINGS

- 33612 Aluminum or aluminum base alloy castings
- 33621 Brass, bronze, copper, or other copper base alloy castings
- 33691 Magnesium or magnesium base alloy castings
- 33692 Zinc or zinc base alloy castings
- 33693 Lead or lead zinc alloy castings, including babbitt or white metal
- 33699 Nonferrous metal castings, not elsewhere classified

MISCELLANEOUS PRIMARY METAL PRODUCTS

- 33911 Iron or steel forgings
- 33921 Nonferrous metal forgings
- 33991 Metal powder, flakes, or paste
- 33992 Nonferrous metal nails, brads, spikes, or staples
- 33999 Primary metal products, not elsewhere classified

FABRICATED METAL PRODUCTS, EXCEPT ORDNANCE, MACHINERY, OR TRANSPORTATION EQUIPMENT

METAL CANS

- 34111 Metal cans (including mixed shipments of cans, tops, and bottoms)

CUTLERY, HAND TOOLS, AND HARDWARE

- 34211 Table or kitchen cutlery or related cutting appliances, other than electrical
- 34213 Scissors or shears, other than electrical
- 34215 Razor blades or razors, other than electrical

FABRICATED METAL PRODUCTS, EXCEPT ORDNANCE, MACHINERY, OR TRANSPORTATION EQUIPMENT - Con.

CUTLERY, HAND TOOLS, AND HARDWARE - Continued

- 34219 Cutlery, not elsewhere classified, other than electrical
- 34231 Mechanics' hand service tools, including light forged hammers
- 34232 Edge tools
- 34233 Files, rasps, or file accessories
- 34234 Shovels, spades, scoops, or scrapers
- 34235 Heavy forged tools (sledges, picks, mattocks, mauls, tampers, or bars)
- 34236 Agricultural hand tools or parts, including forks, hoes, huskers, rakes, rollers, weeders, etc., except edged tools (see 34232) wheeled transportation equipment (see 3799)
- 34239 Hand tools, not elsewhere classified, except hand saws or saw blades (see 34251) or machine tools, (see 35412 or 35421)
- 34251 Hand saws, saw blades, or saw accessories
- 34281 Door or window hardware
- 34282 Fireplace equipment (dampers, irons, fire screens, etc.)
- 34283 Hinges, hasps, or butts, except cabinet (see 34284)
- 34284 Cabinet hardware, including cabinet hinges or locks
- 34285 Hooks, clamps, clips, fasteners, shelf hardware, or hangers, except door or window hangers (see 34281)
- 34289 Builders hardware, not elsewhere classified
- 34291 Transportation equipment hardware
- 34292 Furniture hardware, including hardware for office or household furniture
- 34293 Vacuum or insulated bottles, jugs, or chests
- 34294 Hose fittings, couplings, nozzles, or hose reels
- 34299 Hardware, not elsewhere classified

HEATING EQUIPMENT (EXCLUDE ELECTRIC) AND PLUMBERS' SUPPLIES

- 34311 Cast iron sanitary ware, including enameled
- 34312 Metal sanitary ware, including enameled, except cast iron
- 34321 Plumbing fixture fittings or trim, including bath, shower, sink or lavatory fittings, lavatory legs, strainers, etc. (brass goods)
- 34331 Oil burners, residential or industrial

Section A - MANUFACTURED COMMODITIES—Continued

FABRICATED METAL PRODUCTS, EXCEPT ORDNANCE, MACHINERY, OR TRANSPORTATION EQUIPMENT - Con.

HEATING EQUIPMENT (EXCLUDE ELECTRIC) AND PLUMBERS' SUPPLIES - Continued

- 34332 Warm air furnaces, except floor or wall (see 34339)
- 34333 Cast iron heating boilers, radiators, or convectors
- 34334 Domestic heating stoves, except electric
- 34335 Steel heating boilers
- 34336 Parts for nonelectric heating equipment
- 34339 Heating equipment, except electric, not elsewhere classified

FABRICATED STRUCTURAL METAL PRODUCTS, INCLUDING DOORS

- 34411 Fabricated structural metal products, iron or steel
- 34412 Fabricated structural metal products, except iron or steel (see 34411)
- 34421 Metal doors or door frames, except screen or storm doors (see 34425)
- 34422 Metal window sash or frames, except storm sash or screen and storm sash (see 34425)
- 34423 Metal molding or trim or store fronts except motor vehicle body trim (see 34613)
- 34425 Metal window or door screens including screen or storm doors, storm windows, combination screen and storm door or windows or metal weather strip

BOILER SHOP AND SHEET METAL PRODUCTS

- 34431 Heat exchangers or steam condensers
- 34432 Fabricated steel plate for pipe including penstocks, tunnel linings, etc.
- 34433 Steel power boilers, parts, or attachments
- 34434 Gas cylinders (pressure tanks)
- 34435 Metal tanks, except pressure tanks (see 34434)
- 34439 Fabricated plate products, not elsewhere classified
- 34441 Sheet metal roofing, ceiling, or siding
- 34442 Sheet metal culverts, flumes, irrigation pipe, or similar products
- 34443 Sheet metal cornices, skylights, or roof ventilators
- 34444 Sheet metal stove, furnace, or chimney pipe, elbows, ducts, or fittings
- 34445 Sheet metal roof drainage equipment
- 34446 Sheet metal bins, vats, or tubs, including metal covered

FABRICATED METAL PRODUCTS, EXCEPT ORDNANCE, MACHINERY, OR TRANSPORTATION EQUIPMENT - Con.

BOILER SHOP AND SHEET METAL PRODUCTS - Continued

- 34447 Sheet metal awnings or canopies
- 34449 Sheet metal products, not elsewhere classified
- 34461 Ornamental metal work (trellises, lattice work, porch or lamp posts, window guards, etc.)
- 34464 Stairs, staircases, balconies, fire escapes, or railings (including portable gangways, platforms, or stairways)
- 34469 Architectural metal work, not elsewhere classified

PREFABRICATED METAL BUILDINGS AND MISCELLANEOUS METAL WORK

- 34492 Prefabricated or portable metal buildings or parts
- 34499 Metal construction materials, not elsewhere classified

MISCELLANEOUS FABRICATED METAL PRODUCTS

- 34521 Bolts, except toggle or expansion bolts (see 34529), nuts, screws, rivets, or washers
- 34462 Scaffolding or ladders, or related articles
- 34529 Industrial fasteners, not elsewhere classified (dowels, cotter pins, toggle or expansion bolts, etc.)
- 34921 Metal safes or vaults
- 34931 Steel springs, except wire springs (see 34812)
- 34941 Metal valves for piping, plumbing, or heating systems
- 34942 Metal fittings or unions for piping systems
- 34943 Metal pipe coils
- 34944 Fabricated metal pipe or pipe fittings
- 34991 Collapsible metal tubes (toothpaste, cosmetic, etc.)
- 34992 Metal leaf or foil, or products therefrom except foil sanitary food containers (see 34996)
- 34993 Furniture parts, metal
- 34994 Coating of metals or metal products includes anodizing, coloring electro plating, engraving, plating or polishing, etc., except galvanizing (see 33-...)
- 34996 Foil sanitary food containers
- 34999 Fabricated metal products, not elsewhere classified

Section A - MANUFACTURED COMMODITIES - Continued

FABRICATED METAL PRODUCTS, EXCEPT ORDNANCE, MACHINERY, OR TRANSPORTATION EQUIPMENT - Con.

METAL FORGINGS AND STAMPINGS, COATING AND ENGRAVING

- 34611 Vitreous enameled metal products (cooking or kitchen utensils, refrigerator parts, washing machine parts, etc.)
- 34612 Stamped or spun hospital utensils, cooking or kitchen household utensils
- 34613 Automobile stampings
- 34614 Metal closures (caps, covers, tops, or bottoms)
- 34615 Metal boxes, baskets, buckets, pails, or crates except shipping (see 34912 - 34919) or (34997)
- 34616 Dispensers, holders, or containers for tissues, towels, napkins, etc.
- 34619 Metal stampings, not elsewhere classified

FABRICATED WIRE PRODUCTS

- 34812 Wire springs
- 34813 Wire fencing, fence posts, gates, or fittings
- 34814 Wire cloth or other woven wire products
- 34815 Wire chain
- 34816 Barbed or twisted wire
- 34817 Welded wire fabric or mesh
- 34819 Fabricated wire products, not elsewhere classified

SHIPPING CONTAINERS

- 34912 Steel shipping barrels, cans, drums, kegs, pails, etc.
- 34913 Metal reels
- 34919 Metal shipping barrels, cans, drums, kegs, and pails, etc., not elsewhere classified
- 34997 Metal shipping containers, except barrels, cans, drums, kegs, pails, or reels (see 34912 - 34919)

MACHINERY, EXCEPT ELECTRICAL

ENGINES AND TURBINES

- 35112 Steam engines, turbines, turbine generator sets, or parts
- 35195 Outboard motors or parts
- 35199 Internal combustion engines, not elsewhere classified, except aircraft missile, or space vehicle (see 37221 - 37222), or motor vehicle (see 37144)

MACHINERY, EXCEPT ELECTRICAL - Continued

FARM MACHINES AND TRACTORS

- 35222 Wheel tractors, parts or attachments, except garden or lawn equipment (see 35241), or contractors off-highway tractors (see 35311)
- 35223 Planting, seeding, or fertilizing machinery or parts
- 35224 Plows, listers, harrows, rollers, pulverizers, stalk cutters, or parts
- 35225 Harvesting or haying machinery or parts
- 35227 Machines for preparing crops for market or for use
- 35228 Barn, barnyard, or poultry equipment
- 35229 Farm machinery or equipment, not elsewhere classified
- 35241 Garden and lawn equipment, including snow blowers, and garden and lawn tractors.

CONSTRUCTION, MINING, AND OIL-FIELD MACHINERY

- 35311 Contractors' off-highway wheel tractors or tracked tractors
- 35312 Railway maintenance machinery, equipment, or parts (locomotive cranes, rail layers, ballast spreaders, etc.)
- 35313 Parts or attachments for tracklaying or contractors' off-highway wheel or tracked tractors
- 35314 Power cranes, draglines, shovels, tractor-shovel-loaders, or parts
- 35316 Mixers, pavers, or related equipment
- 35318 Scrapers, graders, rollers, off-highway trucks, trailers, or wagons
- 35319 Construction machinery or equipment, not elsewhere classified
- 35321 Underground mining machinery, equipment, or parts
- 35322 Mining machinery, crushing, pulverizing, or screening plants or parts
- 35329 Mining machinery, equipment, or parts, not elsewhere classified, except oil field machinery, equipment, or parts (see 35331 - 35339)
- 35331 Oil or gas field drilling or production machinery, equipment or parts
- 35339 Oil or gas field machinery, not elsewhere classified, including oil or gas field tools

Section A - MANUFACTURED COMMODITIES - Continued

MACHINERY, EXCEPT ELECTRICAL - Continued

ELEVATORS, HOISTS, AND MATERIALS HANDLING
MACHINERY AND EQUIPMENT

- 35341 Elevators or moving stairways, equipment, or parts
- 35351 Conveyors, conveying equipment, or parts, except hoists (see 35361) or farm elevators (see 35229)
- 35361 Hoists
- 35362 Overhead traveling cranes or monorail systems
- 35371 Industrial trucks, tractors, trailers, stackers, or parts
- 35373 Industrial pallets or platforms, metal or skids, excluding wood and iron combined (see 24992)

MACHINE TOOLS

- 35412 Machine tools or parts, metal cutting types
- 35421 Machine tools or parts, metal forming types
- 35441 Special dies or tools, die sets, jigs, fixtures, industrial molds, or patterns
- 35451 Machine tool accessories, including measuring devices

METALWORKING MACHINERY

- 35481 Rolling mill machinery or equipment
- 35484 Automotive maintenance equipment, including automobile lifts or runways
- 35489 Metalworking machinery, not elsewhere classified, except machine tools (see 35412 or 35421)

SPECIAL INDUSTRY MACHINERY

- 35511 Dairy or milk products plant machinery or equipment
- 35512 Bakery machinery or equipment
- 35513 Meat or poultry packing plant machinery
- 35514 Fruit or vegetable canning or packing machinery
- 35515 Bottling machinery, except dairy (see 35511)
- 35516 Flour mill or grain mill machinery
- 35519 Food products machinery, not elsewhere classified
- 35522 Textile machinery, parts, or attachments
- 35531 Woodworking machinery
- 35541 Paper industries machinery, parts, or attachments

MACHINERY, EXCEPT ELECTRICAL - Continued

SPECIAL INDUSTRY MACHINERY - Continued

- 35552 Printing trades machinery or equipment, except printers' matrices or plates (see 27911)
- 35591 Chemical manufacturing industries machinery or equipment
- 35592 Foundry machinery or equipment, except metal furnaces (see 35671), or industrial molds or patterns (see 35441)
- 35594 Rubber or plastics working machinery or equipment, except industrial molds or patterns (see 35441)
- 35595 Petroleum refinery machinery or equipment
- 35596 Cotton ginning machinery or equipment
- 35597 Clay working machinery, including brick tile, or ceramic
- 35599 Special industry machinery, not elsewhere classified

PUMPS AND COMPRESSORS

- 35611 Industrial pumps, pumping equipment, or parts
- 35614 Air or gas compressors or parts, except refrigeration compressors or parts (see 35854)
- 35619 Industrial pumps, air or gas compressors, pumping equipment, or parts, not elsewhere classified

GENERAL INDUSTRIAL MACHINERY

- 35621 Ball or roller bearings, complete or parts, or mounted bearings
- 35641 Industrial fans or blowers
- 35642 Dust collection or air purification equipment, or air washers or filters
- 35661 Plain bearings
- 35669 Mechanical power transmission equipment, not elsewhere classified
- 35671 Industrial process furnaces or ovens
- 35691 Miscellaneous general industrial machinery or equipment, not elsewhere classified

OFFICE AND STORE MACHINES AND SERVICE INDUSTRY
MACHINES

- 35721 Typewriters or parts
- 35731 Electronic data processing machines or associated equipment, except typewriters or parts (see 35721)
- 35741 Calculating or accounting machines, or cash registers

Section A - MANUFACTURED COMMODITIES—Continued

MACHINERY, EXCEPT ELECTRICAL - Continued

OFFICE AND STORE MACHINES AND SERVICE INDUSTRY MACHINES - Continued

- 35761 Scales or balances, except laboratory (see 38113)
- 35791 Addressing, dictating, or duplicating machines
- 35799 Office machines, not elsewhere classified
- 35811 Automatic merchandising machines (coin operated only)
- 35821 Commercial laundry equipment or laundry presses
- 35822 Commercial dry cleaning equipment and clothes presses
- 35851 Heat transfer equipment
- 35853 Commercial refrigeration equipment
- 35854 Compressors or compressor units, all refrigerants
- 35855 Condensing units, all refrigerants
- 35856 Ice making machinery or equipment
- 35857 Air conditioning, cooling, or dehumidifying equipment
- 35859 Refrigerators or refrigeration machinery, not elsewhere classified

MISCELLANEOUS SERVICE INDUSTRY MACHINES

- 35891 Commercial cooking or food warming equipment
- 35892 Commercial or industrial vacuum cleaners, parts or attachments
- 35899 Service industries machines, not elsewhere classified (water softeners, water purifiers, carpet sweepers, dishwashing machines, floor scrubbing machines, etc.)

MISCELLANEOUS MACHINERY AND PARTS

- 35921 Carburetors, pistons, or piston rings
- 35922 Valves (intake or exhaust) for internal combustion engines
- 35993 Flexible metal hose or tubing, except flexible electric conduit (see 36442)
- 35994 Amusement or carnival machines or equipment, except coin operated (see 39992)
- 35999 Machinery or parts, not elsewhere classified, except electrical (see 36--) carburetors, pistons, rings or valves (see 35921 and 35922)

ELECTRICAL MACHINERY, EQUIPMENT OR SUPPLIES :

ELECTRICAL GENERATING, TRANSMISSION, DISTRIBUTION, AND INDUSTRIAL APPARATUS

- 36111 Watt-hour, ampere-hour, demand, or other electrical integrating meters or parts
- 36112 Test equipment for testing electrical, radio, or communication circuits, or motors
- 36113 Indicating, recording, or measuring instruments (electrical qualities or characteristics)
- 36121 Transformers or parts, or fluorescent ballasts
- 36123 Power regulators, boosters, or reactors
- 36129 Power, distribution, or specialty transformers, not elsewhere classified (radio or voice frequency chokes, coils, or transformers - see 36791, resistor welding transformers - see 36231)
- 36131 Switchgear or switchboard apparatus, including power switchgear assemblies, or other switching or interrupting devices
- 36132 Circuit breakers, fuses, or fuse equipment
- 36211 Motors
- 36212 Generators, except for land transportation (see 36213)
- 36213 Land transportation motors, generators, control equipment, or parts
- 36214 Prime mover generator sets, except steam or hydraulic turbine (see 35112)
- 36215 Motor generator sets, electric
- 36216 Parts or supplies for motors, generators, or motor generator sets, except land transportation (see 36213)
- 36219 Motors or generators, not elsewhere classified
- 36221 Industrial controls or parts
- 36231 Arc or resistance welding machines, components, or accessories, except electrodes (see 36232)
- 36232 Arc welding electrodes, except carbon electrodes (see 36241)
- 36241 Carbon or graphite products for electrical application, including carbon electrodes
- 36291 Capacitors for industrial use, except for electronic application (see 36791).
- 36292 Rectifying apparatus or parts
- 36299 Electrical industrial apparatus, not elsewhere classified

Section A - MANUFACTURED COMMODITIES—Continued

ELECTRICAL MACHINERY, EQUIPMENT OR SUPPLIES - Con.

HOUSEHOLD APPLIANCES

- 36311 Household ranges, ovens, surface cooking equipment, or parts, all types
- 36321 Household refrigerators, home or farm freezers, all types
- 36331 Household washing machines, dryers, washer-dryer combinations, or parts
- 36332 Other household laundry equipment, including ironing machines and equipment, wringers, or laundry equipment parts
- 36341 Electric fans, except attic fans or commercial or industrial exhaust or ventilating fans or blowers (see 35641)
- 36343 Small household type electric cooking or heating appliances, except water heaters (see 36392)
- 36346 Small household electrical appliances, attachments, or parts, except household fans (see 36341), and cooking or heating appliances (see 36343)
- 36347 Personal electric appliances, parts, or attachments (toothbrushes, portable hairdriers, manicure sets, razors, dry shavers, etc.)
- 36349 Electric housewares, not elsewhere classified (can openers, shoe shining machines, knife sharpeners, vaporizers, etc.)
- 36351 Household vacuum cleaners, parts, or attachments
- 36361 Sewing machines or parts, except cabinets or cases separately (see 25179)
- 36392 Household water heaters, all types
- 36393 Household dishwashing machines
- 36399 Household appliances, not elsewhere classified (floor waxing or polishing machines, garbage disposal units, etc.)

ELECTRIC LIGHTING AND WIRING EQUIPMENT

- 36411 Electric lamps (bulbs only), or sealed beam lamps
- 36421 Residential, commercial, institutional, or industrial type electric fixtures
- 36424 Vehicular lighting equipment, electrical
- 36425 Outdoor lighting equipment, all types (flood lighting or area lighting)
- 36429 Lighting fixtures or parts, not elsewhere classified (flashlights, lanterns, miners' lights, emergency warning lights, mercury or sodium vapor lighting equipment, or related equipment)

ELECTRICAL MACHINERY, EQUIPMENT OR SUPPLIES - Con.

ELECTRIC LIGHTING AND WIRING EQUIPMENT - Continued

- 36432 Convenience or power outlets or sockets
- 36433 Switches, except knife, time, solenoid, or automotive (see 36131)
- 36434 Lightning rods
- 36435 Overhead trolley line material, except poles, wire or cable, pole line hardware, or expansion shells or plugs for roof bolting in mines (see 36441)
- 36439 Current carrying wiring devices, not elsewhere classified
- 36441 Pole line or transmission hardware
- 36442 Electric conduit or conduit fittings, including flexible conduit
- 36449 Noncurrent carrying wiring devices, not elsewhere classified

RADIO, TV, AND OTHER COMMUNICATION EQUIPMENT AND RELATED PRODUCTS

- 36511 Household or automotive radios, radio phonograph combinations
- 36512 Household television receivers, including television combinations
- 36521 Phonograph records, record blanks, or prerecorded tapes
- 36611 Telephone switching or switchboard equipment
- 36612 Telephone or telegraph equipment, except switching or switchboard equipment (see 36611)
- 36621 Radio or television transmitting, signaling, or detection equipment or apparatus

ELECTRONIC COMPONENTS AND ACCESSORIES

- 36711 Electronic tubes, except X-ray tubes (see 36931)
- 36741 Solid state semi-conductor devices (diodes, thermistors, transistors, etc.)
- 36791 Miscellaneous electronic components or accessories

OTHER ELECTRICAL MACHINERY AND EQUIPMENT

- 36911 Storage batteries or plates
- 36921 Primary batteries (dry or wet)
- 36931 Radiographic X-ray, fluoroscopic X-ray, therapeutic X-ray, or other X-ray apparatus or X-ray tubes
- 36941 Electrical equipment for internal combustion engines
- 36999 Electrical machinery, equipment, supplies or lamp bulb components, not elsewhere classified, except glass blanks (see 32292)

Section A - MANUFACTURED COMMODITIES—Continued

TRANSPORTATION EQUIPMENT

MOTOR VEHICLES, EQUIPMENT, AND PARTS

- 37111 Motor passenger cars, assembled, including air cars
- 37112 Motor trucks or truck tractors, assembled
- 37113 Motor coaches, assembled (including trolley busses), or fire department vehicles, except chemical fire extinguishing equipment or parts (see 39991)
- 37114 Combat motor vehicles, except tracked (see 19311 - 19313)
- 37115 Motor passenger cars, knocked down or chassis
- 37116 Motor buses or trucks, truck tractors, motor coaches, or fire department vehicles, knocked down or chassis
- 37119 Motor vehicles, not elsewhere classified, including golf carts
- 37121 Passenger motor car bodies
- 37142 Motor vehicle accessories
- 37143 Motor vehicle gear frames
- 37144 Motor vehicle internal combustion engines or parts, except aircraft or missile engines or parts (see 37221 - 37222)
- 37145 Motor vehicle brakes or parts
- 37146 Motor vehicle steering gears or parts
- 37147 Motor vehicle body parts
- 37148 Motor vehicle wheels or parts
- 37149 Motor vehicle parts or accessories, not elsewhere classified, including mixed loads

MOTOR VEHICLE BODIES AND TRAILERS

- 37131 Motor truck bodies
- 37132 Motor bus bodies
- 37151 Truck trailers

AIRCRAFT, MISSILES, SPACE VEHICLES, AND MISSILE OR SPACE VEHICLE ENGINES

- 37211 Complete military aircraft
- 37213 Complete commercial transport type aircraft (passenger or cargo), including personal and utility types
- 37221 Aircraft engines or engine parts
- 37222 Missile engines or parts includes space vehicle engines or parts
- 37231 Aircraft propellers or parts
- 37299 Aircraft parts or auxiliary equipment, not elsewhere classified
- 37691 Guided missile parts, not elsewhere classified, including space vehicle and auxiliary equipment

TRANSPORTATION EQUIPMENT - Continued

BOATS AND SHIPS

- 37321 Inboard motor boats
- 37322 Outboard motor boats
- 37323 Nonpropelled ships (barges, dredges)
- 37324 Car floats, pontoon or portable bridges
- 37329 Ships, boats, parts, not elsewhere classified

RAILROAD AND OTHER TRANSPORTATION EQUIPMENT

- 37411 Locomotives or tenders
- 37413 Parts for locomotives, all types
- 37421 Passenger train cars
- 37422 Freight train cars
- 37423 Street cars or self-propelled railroad cars
- 37424 Maintenance or repair cars (weed burners, inspection, etc.)
- 37426 Railroad car wheels
- 37428 Railroad or street car parts or accessories, except wheels (see 37426)
- 37511 Motorcycles, motorscooters, or motorbikes, including bodies, chassis, or side cars
- 37512 Bicycles
- 37513 Parts or accessories for motorcycles, motorscooters, motorbikes, or bicycles
- 37911 Trailer coaches, housing type
- 37912 Travel trailers or campers
- 37992 Horsedrawn or similar vehicles, except sleighs or sleds (see 37995)
- 37993 Hand carts, wagons, wheelbarrows, or related articles or parts
- 37994 Horsedrawn or similar vehicle parts, except sleigh or sled (see 37995)
- 37995 Sleighs, sleds, or parts, horsedrawn
- 37999 Transportation equipment, parts, or accessories, not elsewhere classified, except industrial trucks, tractors, trailers, stackers, or parts (see 35371)

INSTRUMENTS, PHOTOGRAPHIC AND MEDICAL GOODS, WATCHES, AND CLOCKS

INSTRUMENTS

- 38111 Aircraft flight, nautical, or navigational instruments or automatic pilots
- 38112 Surveying or drafting instruments
- 38113 Laboratory or scientific instruments or laboratory furniture

Section A - MANUFACTURED COMMODITIES—Continued

INSTRUMENTS, PHOTOGRAPHIC AND MEDICAL GOODS, WATCHES, AND CLOCKS - Continued

INSTRUMENTS - Continued

- 38119 Engineering, instruments, not elsewhere classified
- 38212 Gas, water, or other liquid meters or recording devices
- 38213 Weather measuring instruments or gauges
- 38219 Mechanical measuring or controlling instruments, not elsewhere classified
- 38221 Automatic temperature controls

SURGICAL, MEDICAL, DENTAL, OPTICAL, AND OPHTHALMIC GOODS

- 38311 Optical instruments or lenses, range or height finders, for sight or fire control equipment, except military (see 19411)
- 38411 Surgical or medical instruments or apparatus
- 38412 Hospital, dental, opticians', or operating room furniture, except hospital beds (see 25991)
- 38421 Orthopedic, prosthetic, or surgical appliances or supplies
- 38431 Dental instruments, supplies, or equipment, except furniture (see 38412)
- 38511 Spectacles, eyeglasses, sunglasses, or related ophthalmic or opticians' goods

PHOTOGRAPHIC EQUIPMENT AND SUPPLIES

- 38612 Photographic developing, photocopy, microfilming, blueprinting, Van Dyke, or white printing equipment
- 38613 Photographic equipment for still motion pictures, including film magazines
- 38615 Photographic sensitized film, plates, paper, or cloth
- 38618 Prepared photographic chemicals
- 38619 Photographic equipment or supplies, not elsewhere classified

WATCHES, CLOCKS, AND WATCHCASES

- 38711 Watches, clocks, clockwork operated devices, or parts

MISCELLANEOUS PRODUCTS OF MANUFACTURING

JEWELRY, SILVERWARE, AND PLATED WARE

- 39111 Jewelry, precious metal; jewelers' findings, materials, or scrap, including lapidary work and cut or polished diamonds
- 39141 Silverware, plated ware, stainless steel ware, or flatware

MISCELLANEOUS PRODUCTS OF MANUFACTURING - Con.

MUSICAL INSTRUMENTS AND PARTS

- 39311 Pianos
- 39312 Organs
- 39313 Piano or organ parts
- 39319 Musical instruments, parts, or accessories, except pianos or organs (instrument benches - see 25111, or instrument cases - see 31611)

TOYS, SPORTING, AND ATHLETIC GOODS

- 39411 Games or toys, except dolls (see 39421), or children's vehicles (see 39431 - 39439)
- 39421 Dolls or stuffed toy animals
- 39431 Baby or doll carriages, strollers, or walkers
- 39439 Children's vehicles or parts, not elsewhere classified, except bicycles, motorcycles, or parts (see 37511 - 37513)
- 39491 Fishing tackle, equipment, or parts
- 39492 Billiard or pool tables or playing supplies, including balls
- 39493 Bowling alleys or bowling alley playing supplies, including balls
- 39494 Golf clubs, golf balls, golf equipment, or supplies
- 39496 Tennis, baseball, cricket, softball, football, basketball, badminton, or soccer equipment or supplies, including balls
- 39497 Playground or gymnasium equipment or parts
- 39499 Sporting or athletic goods or parts, not elsewhere classified

PENS, PENCILS, AND OTHER OFFICE AND ARTISTS' SUPPLIES

- 39511 Pens or parts
- 39521 Pencils or crayons
- 39522 Artists' materials
- 39531 Marking devices
- 39551 Carbon or stencil paper, or inked ribbons

MISCELLANEOUS MANUFACTURED PRODUCTS

- 39611 Costume jewelry or novelties, except precious metal (see 39111)
- 39621 Feathers, plumes, and artificial, decorative, or preserved flowers or fruits, except glass (see 32299), or decorative greens or live Christmas trees (see 08611 - 08613)

Section A - MANUFACTURED COMMODITIES - Continued

MISCELLANEOUS PRODUCTS OF MANUFACTURING - Con. <u>MISCELLANEOUS MANUFACTURED PRODUCTS - Continued</u>	MISCELLANEOUS PRODUCTS OF MANUFACTURING - Con. <u>MISCELLANEOUS MANUFACTURED PRODUCTS - Continued</u>
39631 Buttons or parts, except precious or semiprecious metals or precious or semiprecious stones 39641 Zippers or slide fasteners 39642 Needles, pins, fasteners or similar notions, except slide fasteners (see 39641) 39911 Brooms or brushes 39921 Asphalted - felt base floor coverings, including linoleum or wall coverings, except vinyl asbestos (see 32923), cork (see 24941), or rubber (see 30614) 39931 Luminous tubing or bulb signs 39932 Nonelectric advertising signs, advertising displays or novelties 39934 Nonelectric road or traffic signs 39941 Morticians' goods	39961 Matches 39971 Furs, dressed or dyed 39991 Chemical fire extinguishing equipment or parts 39992 Coin operated amusement or service machines 39993 Beauty or barber shop furniture or equipment 39994 Hair work, switches, toupees, wigs, etc. 39995 Tobacco pipes or cigarette holders, accessories, or parts 39996 Christmas tree or holiday decorations, except Christmas tree bulbs or sets (see 36999) 39999 Miscellaneous manufactured products, not elsewhere classified

Section B - NONMANUFACTURED COMMODITIES, ORDNANCE, AND SCRAP

FARM PRODUCTS	FARM PRODUCTS - Continued
01121 Raw cotton in bales 01129 Raw cotton, not elsewhere classified 01131 Barley 01132 Corn, except popcorn (see 01152) or sweet corn (see 01393) 01133 Oats 01134 Rice, rough 01135 Rye 01136 Sorghum grains 01137 Wheat, except buckwheat (see 01139) 01139 Grain, not elsewhere classified, including grain screenings, unground 01141 Cottonseeds 01142 Flaxseeds (linseeds) 01143 Raw peanuts, edible, not salted 01144 Soybeans (soya beans) 01149 Oil seeds, oil nuts, and oil kernels, not elsewhere classified (edible tree nuts - see 01298 or 20712) 01151 Lawn grass seed 01152 Popcorn, not popped 01159 Field seeds, except oil seeds, not elsewhere classified (oil seeds - see 01141 - 00149) 01191 Hay, fodder, or roughage, except chopped, ground, or pulverized (see 01991 - 01992)	01192 Hops 01193 Leaf tobacco 01194 Potatoes, sweet 01195 Potatoes, other than sweet 01196 Straw, except chopped, ground, or pulverized (see 01991). 01197 Sugar beets 01198 Sugar cane 01199 Field crops, not elsewhere classified 01211 Grapefruit 01212 Lemons 01214 Oranges 01215 Tangerines 01219 Citrus fruits, not elsewhere classified 01221 Apples 01222 Apricots 01223 Cherries 01224 Grapes 01225 Nectarines 01226 Peaches 01227 Pears 01228 Plums or prunes, except marmalade plums (see 01239) 01229 Deciduous fruits, not elsewhere classified

**Section B - NONMANUFACTURED COMMODITIES,
ORDNANCE, AND SCRAP—Continued**

FARM PRODUCTS - Continued	FARM PRODUCTS - Continued
01231 Avocados	01396 Peppers, fresh or green
01232 Bananas	01397 Pumpkins, squash, or cymplings, fresh or green
01233 Pineapples	01398 Cantaloupes, muskmelons, or melons, except watermelons (see 01392)
01239 Tropical fruits, not elsewhere classified, except citrus (see 01211 - 01219)	01399 Fresh vegetables, not elsewhere classified
01291 Cane or bush berries	01411 Cattle (bulls, cows, heifers, oxen, or steers), except calves
01292 Cranberries	01412 Calves
01293 Strawberries	01413 Swine (barrows, boars, hogs, pigs, or sows)
01294 Cocoa beans	01414 Sheep (ewes, lambs, rams, or wethers)
01295 Coffee, green	01415 Goats or kids
01298 Nuts, edible, in the shell, except peanuts (see 01143)	01419 Livestock, not elsewhere classified, except horses or mules (see 01921)
01299 Fresh fruits or tree nuts, not elsewhere classified	01421 Dairy farm products (fresh milk, cream, etc.), except pasteurized (see 20261 - 20264)
01311 Fresh beets, with or without tops, except sugar beets (see 01197)	01431 Wool, except scoured (see 22971)
01312 Fresh carrots, with or without tops	01432 Mohair (angora goat hair), except scoured (see 22971)
01313 Fresh green onions, with tops	01439 Animal fibers, not elsewhere classified, including silk fibers
01315 Fresh radishes, with or without tops	01511 Live chickens, except baby chicks
01317 Fresh turnips, with or without tops	01512 Live turkeys, except poults
01318 Onions, dry, without tops	01513 Live baby chicks, poults, etc.
01319 Bulbs, roots, or tubers, with or without tops, not elsewhere classified, except potatoes (see 01194 - 01195)	01519 Live poultry, not elsewhere classified
01331 Broccoli, fresh or green	01521 Eggs, market
01332 Brussels sprouts, fresh or green	01522 Hatching eggs, chicken
01333 Cabbage, fresh or green	01523 Hatching eggs, turkey
01334 Celery, fresh or green	01529 Poultry eggs, not elsewhere classified
01335 Lettuce or romaine, fresh or green	01911 Cut flowers
01336 Spinach, kale, chards, or collards, fresh	01912 Nursery stock (flower plants, bulbs, or tubers; shrubs; vines; fruit or shade trees, etc.)
01337 Cauliflower, fresh or green	01915 Herbs (seeds, leaves, roots, etc.)
01339 Leafy fresh vegetables, not elsewhere classified	01916 Mushrooms, fresh
01341 Beans, dried ripe	01917 Vegetable or berry plants
01342 Peas or split peas, dried	01918 Flower or vegetable seeds
01343 Lentils, lupines, or cowpeas, dried	01919 Horticultural specialties, not elsewhere classified
01349 Dry ripe vegetable seeds used as food not elsewhere classified, except artificially dried (see 20342 - 20343)	01921 Horses, ponies, mules, asses, or burros, live
01391 Beans (green, string, lima, wax) or peas, green or fresh	01923 Hides, skins, or pelts, not tanned, except cattle, pig, goat, sheep, mule, horse (see 20141), or marine animal (see 09132)
01392 Watermelons, fresh	01928 Animal or poultry manure
01393 Sweet corn, in the husk	
01394 Tomatoes, fresh or green	
01395 Cucumbers, fresh or green, or not further processed than pickled in brine	

**Section B - NONMANUFACTURED COMMODITIES,
ORDNANCE, AND SCRAP—Continued**

FARM PRODUCTS - Continued

- 01929 Animal specialties, not elsewhere classified
- 01991 Chopped, ground, or pulverized straw, hay, or related agricultural products, except alfalfa
- 01992 Chopped, ground, or pulverized alfalfa
- 01999 Farm products, not elsewhere classified

FOREST PRODUCTS

- 08422 Barks or gums, crude, except latex or allied gums (crude rubber)
- 08423 Latex or allied gums (crude natural rubber)
- 08611 Christmas trees
- 08612 Decorative evergreens, mistletoe, holly
- 08613 Ferns
- 08619 Forest products, not elsewhere classified, including inedible tree seeds, except oil seeds (see 01141 - 01149)

FRESH FISH AND OTHER MARINE PRODUCTS

- 09121 Finfish
- 09122 Shellfish
- 09123 Whale products
- 09131 Shells: oyster, crab, clam, etc.
- 09132 Marine animal skins, untanned, except whale skins (see 09123)
- 09139 Miscellaneous marine products, not elsewhere classified
- 09891 Tropical fish hatcheries or farms

METALLIC ORES

- 10111 Iron direct-shipping ores, crude
- 10112 Iron beneficiating-grade ores, crude
- 10113 Iron concentrates and agglomerates
- 10211 Copper ores, crude
- 10212 Copper concentrates or precipitates
- 10311 Lead ores, crude
- 10312 Lead concentrates
- 10321 Zinc ores, crude
- 10322 Zinc concentrates
- 10331 Lead and zinc ores combined, crude
- 10332 Lead and zinc concentrates combined
- 10411 Gold ore or tailings, crude
- 10412 Gold concentrates, precipitates, or gold mill bullion
- 10421 Silver ore or tailings, crude

METALLIC ORES - Continued

- 10422 Silver concentrates or silver mill bullion
- 10511 Bauxite ores, crude
- 10513 Bauxite ores, calcined or activated
- 10514 Aluminum ores, except bauxite
- 10611 Manganese direct-shipping ores, crude
- 10612 Manganese beneficiating-grade ores, crude
- 10613 Manganese concentrates and agglomerates
- 10711 Tungsten ores, crude
- 10712 Tungsten concentrates
- 10811 Chromium ores, crude
- 10812 Chromium concentrates
- 10923 Radioactive ores (uranium, radium, etc.)
- 10929 Metal ores, not elsewhere classified

COAL

- 11111 Raw anthracite
- 11112 Cleaned or prepared anthracite (crushed, screened, or sized), except ground or pulverized for other than fuel or steam purposes (see 29919)
- 11119 Anthracite coal wastes
- 11211 Raw bituminous coal
- 11212 Cleaned or prepared bituminous coal (crushed, screened, or sized), except ground or pulverized for other than fuel or steam purposes (see 29919)
- 11219 Bituminous coal wastes
- 11221 Lignite, raw or prepared (crushed, screened, or sized), except ground or pulverized for other than fuel or steam purposes (see 29919)

**CRUDE PETROLEUM, NATURAL GAS,
AND NATURAL GASOLINE**

- 13111 Petroleum, crude
- 13121 Gas, natural
- 13211 Gasoline, natural, except liquefied petroleum gases (see 29121)

NONMETALLIC MINERALS, EXCEPT FUELS

- 14111 Dimension stone, quarry, except dressed, polished, shaped or otherwise finished (see 32811 - 32819)
- 14211 Agricultural limestone, broken or crushed, except ground or otherwise treated (see 32959)
- 14212 Fluxing stone, including fluxing limestone, broken or crushed

**Section B - NONMANUFACTURED COMMODITIES,
ORDNANCE, AND SCRAP—Continued**

NONMETALLIC MINERALS, EXCEPT FUELS - Con.

- 14213 Dolomite, raw, broken or crushed
- 14219 Crushed or broken stone, including riprap, not elsewhere classified
- 14411 Sand (aggregate or ballast)
- 14412 Gravel (aggregate or ballast)
- 14413 Industrial sand, crude, including ground or pulverized, except otherwise treated (see 32952)
- 14511 Bentonite, crude, except ground or otherwise treated (see 32952)
- 14512 Fireclay, crude, except ground or otherwise treated (see 32952)
- 14513 Fullers' earth, crude, except ground or otherwise treated (see 32952)
- 14514 Kaoline or ball clay, crude, except ground or otherwise treated (see 32952)
- 14515 Feldspar, crude, except ground or otherwise treated (see 32955)
- 14516 Magnesite or brucite, crude, except ground or otherwise treated (see 32953 or 32959)
- 14519 Clay, ceramic or refractory minerals, not elsewhere classified, crude, except ground or otherwise treated (see 32951 - 32959)
- 14711 Barite, crude, except ground or otherwise treated (see 32959)
- 14712 Fluorspar, crude, except ground or otherwise treated (see 32959)
- 14713 Potash, soda, or borate, crude, except ground or otherwise treated (see 32959 or 28121 - 28129)
- 14714 Apatite or phosphate rock, clay or sand, crude, except ground or otherwise treated (see 28194 or 28712 - 28719)
- 14715 Rock salt, crushed, lump or screened, except sodium chloride (see 28991)
- 14716 Sulphur, crude, liquid, molten or solid, except ground or otherwise treated (see 32959)
- 14719 Chemical or fertilizer minerals, not elsewhere classified, except ground or otherwise treated (see 28712 - 28719 or 32951 - 32959)
- 14911 Gypsum or anhydrite, crude, except crushed or ground (see 32956)
- 14912 Mica, crude, except ground or otherwise treated (see 32957)
- 14913 Native asphalt or bitumens
- 14914 Pumice or pumicite, crude, except ground or otherwise treated (see 32959)
- 14915 Talc, soapstone, or pyrophyllite, crude, except ground or otherwise treated (see 32954)

NONMETALLIC MINERALS, EXCEPT FUELS - Con.

- 14916 Natural abrasives, flour or sized grains, including powders, except sand or industrial diamonds (see 32912 or 14411 - 14413)
- 14917 Peat, natural, except ground or otherwise treated (see 32959)
- 14918 Diatomaceous or infusorial earths, crude, including ground or otherwise treated, except fuller's earth (see 14513 or 32952)
- 14919 Nonmetallic minerals, not elsewhere classified, including soil, loam topsoil, earth, fill dirt, etc., except fuels or ground or otherwise treated (see 32951 - 32959)
- 14921 Water, raw, for construction or irrigation purposes
- 14922 Water, drinking, except carbonated or mineral (see 20861)

ORDNANCE AND ACCESSORIES

- 19111 Guns, howitzers, mortars, or related equipment, over 30 mm.
- 19251 Guided missiles, completely assembled
- 19291 Artillery ammunition or related parts
- 19293 Military bombs, mines, or parts
- 19299 Ammunition or related parts, not elsewhere classified (including torpedos, chemical warfare projectiles, depth charges, grenades, or rockets other than guided missiles)
- 19311 Military tanks and parts, except tank engines (see 35199)
- 19312 Military self-propelled combat weapons or parts
- 19313 Full tracked combat vehicles or parts, except tanks or self-propelled weapons (see 37114)
- 19411 Military sighting and fire control equipment, except optical lenses or prisms (see 38311)
- 19511 Machine guns, 30 mm. or under
- 19512 Small arms, 30 mm. or under, except machine guns
- 19611 Small arms ammunition, 30 mm. or under except blasting or detonating caps or safety fuses (see 28921), or fireworks (see 28993)
- 19911 Miscellaneous ordnance, accessories, or parts

**Section B - NONMANUFACTURED COMMODITIES,
ORDNANCE, AND SCRAP—Continued**

WASTE AND SCRAP MATERIALS

40112 Ashes
40211 Iron or steel scrap, wastes, or tailings
40212 Brass, bronze, copper, or other copper base alloy scrap, wastes, or tailings
40213 Lead, zinc, or lead and zinc alloy scrap, wastes, or tailings
40214 Aluminum or aluminum base alloy scrap, wastes or tailings
40219 Nonferrous metal or nonferrous metal alloy waste, scrap, or tailings, not elsewhere classified
40221 Textile waste, scrap, or sweepings
40231 Wood scrap or waste
40241 Paper waste or scrap
40251 Chemical or petroleum waste, including spent

WASTE AND SCRAP MATERIALS - Continued

40261 Rubber or plastic scrap or waste
40271 Stone, clay, or glass waste or scrap
40281 Leather waste or scrap
40291 Waste or scrap, not elsewhere classified

CONTAINERS, SHIPPING, RETURNED EMPTY

42111 Shipping containers, returned empty, barrels, bottles, bags, boxes, crates, cores, drums, kegs, reels, tubes or carriers, not elsewhere classified
42112 Shipping devices, returned empty, blocking, bolsters, cradles, pallets, racks, skids, etc.

MISCELLANEOUS MIXED SHIPMENTS

46000 Loaded, commodity not determined



U.S. Department
of Transportation

**Federal Highway
Administration**

Order

Subject

HIGHWAY PERFORMANCE MONITORING
SYSTEM (HPMS) FIELD MANUAL

Classification Code

M 5600.1A

Date

December 1, 1987

- Par. 1. Purpose
2. Cancellation
3. Authority
4. Responsibility
5. Comments

1. PURPOSE. To transmit the new HPMS Field Manual (OMB No. 2125-0028) for use beginning with the collection of calendar year (CY) 1988 data to be reported on June 15, 1989.
2. CANCELLATION. FHWA Order M 5600.1, Highway Performance Monitoring System (HPMS) Field Manual, dated January 1984, updated February 1987, is cancelled, effective June 30, 1988, (see paragraph 5a).
3. AUTHORITY. The reports and procedures outlined in the HPMS Field Manual are authorized under 23 U.S.C. 307 which authorizes the Secretary to engage in research on all phases of highway construction modernization, development, design, maintenance, safety, financing, and traffic conditions. In addition, 23 CFR 1.5 provides the Federal Highway Administrator with authority to request such information that is deemed necessary to administer the Federal-aid highway program. Estimates of the future highway needs of the Nation are mandated by the Congress on a biennial basis (23 U.S.C. 307 (e)). Additionally, HPMS data serve as the information source for the "Highway Safety Performance" report prepared by the FHWA pursuant to Section 207 of the Surface Transportation Assistance Act of 1982 (P. L. 97-424).
4. RESPONSIBILITY. While cities, counties, municipalities, and metropolitan planning organizations are participating in the HPMS in some instances, the State highway agencies are responsible for the overall collection and reporting of quality, timely HPMS data. The FHWA regional and division personnel will continue to be responsible for HPMS coordination and data quality reviews.

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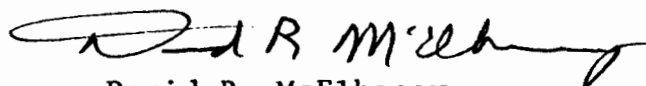
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OPI.

HPM-20

5. COMMENTS

- a. Although this Manual will supersede the current January 1984 manual, as updated, the current manual must be kept and used for the preparation of the June 15, 1988, submittal of CY 1987 data.
- b. The new HPMS Field Manual reflects the elimination of a few data items, coding revisions to a few data elements, the addition of several new pavement-related data items, and a revised data submittal tape format. These revisions go into effect beginning with the reporting of CY 1988 data on June 15, 1989, except as noted in paragraph 5c.
- c. With the reporting of CY 1989 data beginning on June 15, 1990, pavement roughness data shall be reported for all rural arterial and urban Interstate and other freeways and expressways sample sections.
- d. Chapter VI, "Highway Performance Monitoring System Software Package," and related appendices (M--Edit Specifications for HPMS Data; N--Battery of Summary Tables from the HPMS Submittal Software; O--Card Formats to Add New HPMS Sections; P--Update Data Item Numbers for HPMS Submittal Software; and Q--HPMS Submittal Software Subprogram Operation) will be transmitted when the revised software is completed (4th quarter of fiscal year 1988).
- e. Attention is directed to Appendix K of the HPMS Field Manual and the need for the States to undertake statistically based travel monitoring procedures as outlined in the "Travel Monitoring Guide."



David R. McElhaney
Director, Office of Highway
Information Management

Attachment



U.S. Department
of Transportation
**Federal Highway
Administration**

Order

Subject
HIGHWAY PERFORMANCE MONITORING
SYSTEM (HPMS) FIELD MANUAL UPDATES

Classification Code Date
M 5600.1A, Chg. 1 July 15, 1988

PURPOSE. To transmit new and revised portions of the HPMS Field Manual (OMB No. 2125-0028) dated December 1, 1987, for use beginning with 1988 data to be reported in June 1989.

- a. State highway agencies are responsible for collecting and reporting quality and timely HPMS data. The FHWA regional and division personnel will continue to be responsible for HPMS coordination and data quality reviews.
- b. Revised pages are being issued to make provisions for the addition of Chapter VI and several Appendices, and to correct minor errors in the text. Also, revised codes and definitions are being issued for data item 18, Designated Truck Route/Parkway.
- c. Chapter VI and Appendices M, N, O, P, Q and R are new additions to the December 1, 1987 HPMS Field Manual that document the HPMS Submittal Software Package.
- d. Appendix S contains the definitions of the Climate Zone codes.
- e. Appendix K has been revised and now contains expanded traffic monitoring documentation and program implementation directions. Immediate attention should be focused on this material.

David R. McElhane
Director, Office of Highway
Information Management

Attachment

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HPM-20

FILING INSTRUCTIONS

Page Changes

<u>Remove</u>	<u>Pages</u>	<u>Insert</u>	<u>Pages</u>
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		Chapter III	7
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May 17, 1990

HPMS Field Manual - December, 1987 Version

P12: 03

Expansion of Contents and Changes to Date

This Manual, as updated, is to be used for reporting the 1988 HPMS data in June, 1989, and thereafter. The format of the records was changed (in 1988) to accommodate new data items and to eliminate gaps in the records where some old data items were no longer being reported. There were several other changes as well. Previous versions of the HPMS Field Manual should be retained if the record format and contents of old (pre 1988) HPMS datasets will be used for other purposes, or simply for information.

This replacement Manual was distributed in December, 1987, as the date on each page indicates. Note that some pages in Chapter II do not follow the front to back pattern of the rest of the Manual (a printing error). Starting on page II-4, the pattern is backwards -- page II-4 and all even pages in the rest of Chapter II are on the front (right hand side). Only odd pages should be in this position. This will affect updates made to these pages. The updates are correctly oriented (front to back), and there may not be a one for one replacement where Chapter II is concerned. Please be careful when updating this Chapter (i.e., retain those pages that are not actually provided in the changes).

Change # 1 is dated July 15, 1988. It was actually distributed in early August, 1988. The change added a Chapter (VI) and several Appendices having to do with the HPMS Submittal Software. A few other pages were also changed where problems were found.

Change # 2 was dated April 14, 1989. It added a Chapter (VIII) that was then deleted in Change # 3. The subject area was the Highway System of National Significance (HSNS) and functional classification of principal arterials. It also contained the March, 1989 version of the "Highway Functional Classification: Concepts, Criteria and Procedures" manual, which should have been retained for future use.

Change # 3 is dated April 20, 1990. It was not distributed until about May 15, 1990 due to a printing backlog. It made numerous changes to the Manual incorporating "Bulletin" hand changes that were distributed during 1989, word changes, expanded explanation for some data items, added verbage that discouraged sampling urbanized ares on a collective basis, explained a method for reporting "optional" Latitude & Longitude coordinates on HPMS sections, etc. As noted above, this update also deleted (and therefore supercedes) the entire contents of Change # 2, as well as all Bulletins issued to date.



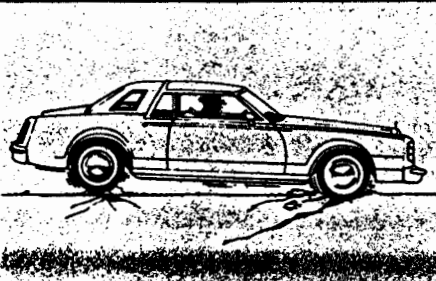
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Highway Performance Monitoring System Field Manual

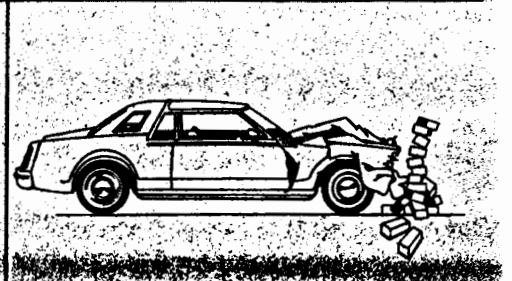
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Office of Highway
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December 1987



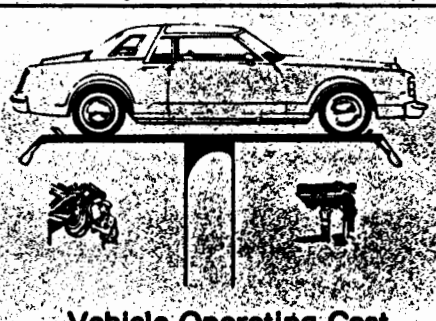
System Condition



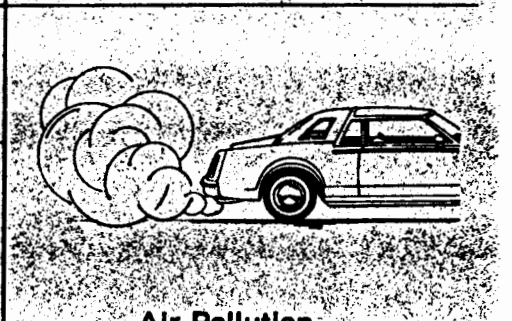
Safety



System Usage



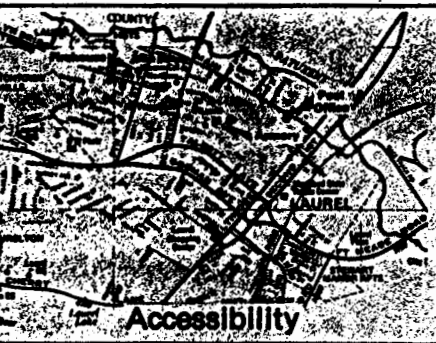
Vehicle Operating Cost



Air Pollution



Comfort and Convenience



Accessibility

HIGHWAY PERFORMANCE MONITORING SYSTEM

FIELD MANUAL

**FOR THE CONTINUING ANALYTICAL
AND STATISTICAL DATABASE**

**U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION**

DECEMBER 1987

**OMB NO. 2125-0028
(EXPIRES SEPTEMBER 30, 1990)**

PREFACE

In recent years, there has been a growing recognition of the need to assess the highway systems periodically with respect to extent and physical condition; the safety, efficiency, and economy of the systems in serving the movement of goods and people; and the impacts of existing national programs and policies. In addition, there is a need to assess the potential impacts of proposed programs, policies, and alternatives. The Highway Performance Monitoring System (HPMS) has been implemented to meet these needs. The HPMS is a program management tool considered to be prerequisite to sound Federal Highway Administration (FHWA) and State highway programs through the annual monitoring of highway performance. Through prudent analyses and application, it should ensure the efficient use of dwindling financial resources and provide invaluable information to decisionmakers. It will also serve as an information base to evaluate the effectiveness, over time, of various pavement rehabilitation strategies.

Estimates indicate that approximately 60 percent of today's, as well as the future's, highway investment dollars in the U.S. will be consumed by constructing, reconstructing, and preserving pavements. Our Nation's economic well being is highly dependent upon the availability of safe, efficient, and economical highway transportation. The condition of pavements, without any doubt, is a key variable in terms of the economy of transportation services that are provided. Poor pavements increase vehicle operating costs which result in increased cost of goods and services to the entire population. Since pavements play such an important role, we must continue to increase our knowledge of its condition and performance.

In the early 1980's, the overall mission of highway agencies began to change from that of constructing new highways to that of preserving existing highways, with particular emphasis being placed on pavement performance and the investigation and promotion of sound, economical, efficient means of preserving and extending the economic life of pavements. To do so, comprehensive information is needed regarding the condition, performance and the loadings placed on pavements. Many State highway agencies have developed and implemented Pavement Management Systems (PMS) to serve this need. Much of the pavement related data collected via HPMS should be available from State PMS's.

This Manual reflects the FHWA efforts to reduce total data reporting, to eliminate duplication, and to coordinate all fhwa data reporting requirements. The objectives of the HPMS are as follows;

1. To provide current data necessary to meet legislative requirements and agency needs in a timely fashion;
2. To provide current statistics on the mileage, extent and usage of the various systems;
3. To improve our knowledge of the condition and performance of pavements;
4. To evaluate highway programs by monitoring changes in highway characteristics and performance based on detailed, section specific data obtained on a sample basis;
5. To minimize the State reporting burden, the need for special data requests, and the need for special national studies; and
6. To be compatible with other data systems to permit meaningful comparisons.

The HPMS data system will provide indispensable information to highway administrators, legislative bodies, and others. The HPMS also consists of models and other analytical tools that will provide measures of resources, program accomplishments, trends, and will serve highway planning, programming, budgeting, forecasting, and fiscal management.

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CHAPTER I

INTRODUCTION

BACKGROUND

In a cooperative effort to develop the HPMS integrated data base, various organizations within the FHWA Headquarters have merged independent data collection efforts into a single data reporting system. Under this system, data for each calendar year is to be reported by June 15 of the following year.

With few exceptions, the data to be reported under the HPMS have been previously included in other data reporting systems. The merging of the previously separate data collection efforts will reduce the States' overall data collection effort while enhancing the usefulness of available data on a continuing basis. Inherent in the HPMS is the capability of reporting universe and sample inventory data and areawide data. The term "universe" is used throughout this Manual when referring to limited data reported for all mileage for a given highway system. These data are in contrast to "sample" data which are reported for a small portion of the highway mileage and contain more extensive information regarding physical characteristics, condition, and operation of sampled sections of highway. The sample data serve as a base for evaluating changes in data element values over time, thereby providing a basis for the analysis of the performance of the Nation's highways. The sampled sections form "fixed" panels of highway sections which are monitored from year to year. The panels of sections were established using a statistically designed sampling plan based on the random selection of road sections within predetermined annual average traffic (AADT) volume groups (strata) for each functional highway system in the rural, small urban, and urbanized areas of a State. Control totals for mileage, travel, accidents, and local functional system data are provided via areawide forms. The areawide mileage and travel data are to be consistent with the mileage and travel data developed from the universe and sample records.

PURPOSE AND SCOPE

The purpose of this Manual is to provide guidelines for reporting HPMS data and to establish updating procedures for the annual submission. This Manual outlines procedures for reporting three major types of data. They are:

1. Universe Mileage Data -- This includes a complete inventory of mileage classified by system, jurisdiction, and selected operational characteristics. These data will be reported for all mileage. Although grouped mileage reporting is acceptable for non-Interstate, non-sampled mileage, the States may provide section-by-section data if they so desire.
2. Sample Data -- This includes specific inventory, condition and operational data obtained for the sample panels of highway sections. These data will be expanded to represent the universe of highway mileage, permitting evaluation of the performance of the various highway systems.

Capital improvement data are also part of the sample section data requirements. This consists of all improvements completed on the sample panels of sections.

3. Areawide Data -- This information will be reported annually for rural, total small urban and individual urbanized areas. These data will be used in conjunction with universe and sample data, and therefore, it is important that it be kept current. Areawide data consists of totals for mileage, travel, accidents (rural and urban only), local system data, land area, population, and travel activity by vehicle type.

Data on capital expenditures by State and geographic area will be obtained through a financial reporting system. These are reported on the PR-534 form, "Capital Outlay and Maintenance Expenditures." The instructions for preparing this form are included in "A Guide for Reporting Highway Statistics."

This Manual outlines procedures for the preparation of the various types of HPMS data, including forms, contains instructions for building and editing the data set, and includes a timetable for coordinating and updating the various aspects/components of the HPMS.

It is important to note that each State is expected to make an annual submittal of the areawide forms and the data tape in accordance with the procedures outlined in this Manual.

ROLES OF PARTICIPANTS

The HPMS is a joint effort of the Federal, State, and local governments. The HPMS organization, guidance, and analyses are the responsibility of the FHWA. Data reporting for the HPMS will be accomplished by the State highway agencies (SHA) in cooperation with local governmental units, metropolitan planning organizations (MPO), and other organizations.

All SHA's, including the District of Columbia and Puerto Rico, are responsible for the development of those mechanisms necessary for reporting the data prescribed under the guidelines of this Manual and for the editing and timely annual submittal of the data set in the prescribed form. The SHA's are also responsible for maintaining the maximum practicable participation in the HPMS by city, county, and other local governments, including the MPO's.

Direct participation by the MPO's, in cooperation with the SHA's is especially important and necessary. This includes utilizing both technical staffs and existing committees of the MPO's to provide overall guidance. It will be the SHA's responsibility to ensure that all work performed by the local governments and MPO's conforms to the guidelines provided in this Manual and that the data are submitted to the SHA in advance of the due dates to allow sufficient time to incorporate it in the statewide submission to the FHWA.

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4. Year -- The last two digits of the calendar year for which the data apply.
5. State Code -- The Federal Information Processing Standard (FIPS) Code given in Appendix A.
6. Rural-Urban Code:
 - 1 -- Rural
 - 2 -- Small Urban (population of 5,000 to under 50,000)
 - 3 -- Urbanized (population of 50,000 and over)
 - 4 -- Total Urban (for accident and vehicle classification data, only)

For the HPMS, small urban and urbanized areas are defined as Federal-aid urban areas or portions thereof within the State boundary. In either case, a Federal-aid urban area must be a census place with a population of 5,000 to 49,999 (small urban area) or a designated urbanized area with a population of 50,000 or more. Federal-aid urban boundaries are established by responsible State and local officials and shall, at a minimum, encompass the entire urban place designated by the U.S. Bureau of the Census. (See Title 23, U.S.C., Section 101.)

7. Urbanized Area Code -- The 3-digit codes for designated urbanized areas are furnished in Appendix B.
8. Land Area (Net) -- The U. S. Bureau of the Census definition of land area will be used: Land area includes dry land and land temporarily or partially covered by water, such as marshland, swamps and river flood plains; systems, sloughs, estuaries and canals less than one-eighth of a statute mile in width; and lakes, reservoirs and ponds less than 40 acres in area. (For Alaska, one-half mile and 640 acres are substituted for these values.) The net land area should reflect the Federal-aid urban area boundaries.
9. Population -- Current population including annual updates to the latest official Census estimates adjusted to current Federal-aid urban area boundaries.
10. Number of Small Urban Areas -- This number will change over time as a result of Census actions and expansion of urban area boundaries.
11. Functional Systems -- The functional systems required by Title 23 U.S.C. have been chosen as the most logical, stable base for the HPMS. The regulations for developing such systems are included in Volume 4, Chapter 6, Section 7 of the "Federal-Aid Highway Program Manual", Federal-aid Highway System, (FHPM 4-6-7). They are as follows:

II-3

Rural	Code
Principal Arterial-Interstate.....	01
Other Principal Arterial.....	02
Minor Arterial.....	06
Major Collector.....	07
Minor Collector.....	08
Local.....	09
Urbanized and Small Urban Areas	Code
Principal Arterial-Interstate.....	11
Principal Arterial-Other Freeways and Expressways...	12
Other Principal Arterial.....	14
Minor Arterial.....	16
Collector.....	17
Local.....	19

12. Priority for Assigning Accidents to Systems:

- Federal-aid Interstate/Arterial
- Federal-aid Other Primary/Arterial
- Federal-aid Urban/Arterial
- Non-Federal-aid/Arterial
- Federal-aid Urban/Collector
- Federal-aid Secondary/Collector
- Non-Federal-aid/Collector
- Non-Federal-aid/Local

13. Percent Functional System DVMT -- This is reported on the Motor Vehicle Accident Summary (Figure II-2, Columns 8-10). Enter the percent of the travel for a particular functional system that is carried by a specified Federal-aid system. Report percents in whole numbers, right-justified with leading zero(es) in the three digit field. For example, the percentage would be coded 050 if the Federal-aid Urban system carried 5,000 of the 10,000 DVMT reported for urban collectors. The spreadsheet option for reporting areawide data allows for reporting this percentage to the nearest one-hundredth of a percent.

MILEAGE AND DAILY TRAVEL SUMMARY

Mileage, DVMT, population, net land area, number of small urban areas, and public Federal-aid ferryboat mileage are reported on the summary form shown as Figure II-1--Parts I and II. Part 1 of the form provides for statewide summaries of data by functional system for rural and small urban areas and also statewide totals of these data for all areas. Summaries for individual urbanized areas are to be reported on Part 2 of the form. States with many individual urbanized areas will need additional Part 2 forms. Data must be reported for individual urbanized areas regardless of the option chosen by the State for sampling urbanized areas. Note that a total line is provided for summing all urbanized area values.

Mileage Data

Road mileage data reported on the form(s) must agree with existing "open-to-traffic" public road mileage submitted on the tape file, and that reported as the certified public road mileage. Mileage by functional system will be reported for rural, small urban, and individual urbanized areas. If applicable, States are to report ferryboat mileage by Federal-aid system.

Travel Estimates

Estimates of DVMT by functional system are to be prepared for rural, small urban and individual urbanized areas of the State on an annual basis. These data will be reported on the mileage and travel summary forms. These DVMT estimates are important to the analyses of vehicle operating costs, traveltime, fuel consumption, emissions, people movement, freight movement, maintenance practices, urban transportation programs, and revenue projections. Selected Federal legislative programs include DVMT as references or as apportionment factors. In addition, DVMT estimates reported by the States are an integral part of certain legislative requirements, are included in reports to Congress, and are being used in day-to-day program and policy evaluation activities, monitoring trends, and responding to continuing inquiries and requests of the Administration, the Congress, and the public.

Development of HPMS estimates of highway travel by functional system are to be derived using count-based traffic data that are in concert with the "Traffic Monitoring Guide" (TMG). The explicit goal of HPMS is to derive areawide DVMT estimates based on count-based traffic volume data furnished for the arterial and collector sample sections. The HPMS panels of sections have been statistically designed for a high level of measurable accuracy, especially for the determination of travel. Recommended procedures for the annual updating of sample and Interstate universe section AADT's and for obtaining DVMT are described in Appendix K, with further references to the TMG. Briefly, the procedures entail traffic counting on one-third of the sample sections and one-sixth of the non-sample Interstate universe sections each year, and the application of correction factors, such as axle, weekday/weekend and seasonal, to pneumatic tube counts. Growth factors are applied to those sample and Interstate sections that are not counted in the current year. Note: all Interstate sample and universe sections must be updated each year either by direct count adjusted to AADT, or by factoring based on other known information. The Interstate data are used for the annual apportionment of I-4R funds. The entire HPMS sample is referred to in the TMG as the core sample; the vehicle classification sample is a statistical subset of that core sample -- the truck weight sample is a subset of the vehicle classification subset (see the TMG for procedures and good practice recommendations).

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DVMT estimates will be developed separately for rural, small urban and individual urbanized areas for each functional system. Emphasis must be placed on the development of local functional system DVMT to assure that it is reasonable and consistent. The sum of the individual urbanized area travel estimates for a State choosing to group urbanized areas, must be consistent with the overall travel estimate produced from the expanded sample for the areas grouped into a collective urbanized area. (See Appendix K for more details concerning traffic counting and travel estimating procedures.)

Population and Land Area

Periodic review and updating of the population and net land area data are necessary. Since population and land area estimates are for the most part based on Census estimates, updates of population should, at a minimum, be tied to changes in Census estimates. However, between Census periods, Federal-aid urban boundaries may be changed. States should submit annually revised estimates when they find significant changes have occurred in either population or land area for any rural or urban area of a State, for any given reason.

MOTOR VEHICLE ACCIDENT SUMMARY

Motor vehicle accident data shall be reported for rural and urban areas by functional and Federal-aid systems. This information will provide accident totals from which rates will be derived to establish the performance of the functional systems. These data will also be the basis of the annual report to the Congress required by Section 207 of the Surface Transportation Assistance Act of 1982. The form used for reporting accident data is displayed in Figure II-2.

States use a variety of procedures for collecting and processing accident data. Therefore, SHA's should develop appropriate cooperative arrangements with responsible State and local agencies to obtain the necessary accident data. Data for accidents on public roadways under Federal jurisdiction within the State should be obtained from the appropriate agencies. Detailed accident related definitions are contained in the "Manual on Classification of Motor Vehicle Traffic Accidents," American National Standards Institute (ANSI) D16.1-1976, as amended. In general, a traffic accident is an accident which occurs within the right-of-way of a public road or highway. All motor vehicle accidents involving injuries, both fatal and non-fatal, that occur within the rights-of-way of these public roadways are to be reported.

II-7

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II-8

Fatal accident statistics reported to FHWA shall conform to the 30-day rule, i.e., a fatality resulting from an accident and occurring within 30 days of the accident is counted. This definition applies only to statistics used by the U.S. Department of Transportation agencies and should not be taken to imply that States should be required or urged to stop collecting and using, for their own purposes, information about fatalities that occur more than 30 days after an accident. The National Highway Traffic Safety Administration's Fatal Accident Reporting System (FARS) statistics are based on the 30-day definition and are available to the States. If the State uses some other fatality counting definition, appropriate adjustments shall be made to the data.

Accidents are assigned to systems based on the "Manual on Classification of Motor Vehicle Traffic Accidents", ANSI D16.1-1983, as amended, using the hierarchy of the Federal-aid systems within the functional systems listed above. Accidents that occur at intersections should be assigned to the functional system that the involved vehicle(s) were using or, if more than one system was being used by vehicles involved in the accident, to the higher functional system. This rule applies to all intersections, including those within interchanges. An accident on an interchange ramp should be assigned to the higher functional system served by the ramp. Accidents on a frontage road must be assigned to the functional designation of the frontage road.

Coding instructions for the State's accident data follow. All entries are to be right justified, and complete reporting is essential.

Percent Functional System DVMT -- This figure (columns 8-10) is to be reported for all appropriate lines. This percentage is calculated as the ratio of the travel carried by Federal-aid mileage within the functional system to the total functional system travel.

The total percentage for each functional system category (including travel on Federal-aid and non-Federal-aid systems) should be 100 percent. This is true even though only the percent for Federal-aid systems is reported. For example, under the category Rural Principal Arterial, Other, only the percentage for Federal-aid Primary is to be reported. However, the percentage for that cell plus the percentage for non-Federal-aid should total 100 percent.

The percentage is entered as a whole percent on the form. The spreadsheet option for reporting areawide data will accommodate percent figures of less than a whole, but must include the decimal (i.e., 50.6 may be entered).

Fatal Accidents -- Enter the number of motor vehicle accidents involving one or more fatalities, including pedestrians.

Non-Fatal Injury Accidents -- Enter the number of motor vehicle accidents resulting in non-fatal injuries to one or more persons, including pedestrians.

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The percentage is entered as a whole percent on the form. The spreadsheet option for reporting areawide data will accommodate percent figures of less than a whole, but must include the decimal (i.e., 50.6 may be entered).

Fatal Accidents -- Enter the number of motor vehicle accidents involving one or more fatalities, including pedestrians.

Non-Fatal Injury Accidents -- Enter the number of motor vehicle accidents resulting in non-fatal injuries to one or more persons, including pedestrians.

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Fatalities -- Enter the number of persons fatally injured in motor vehicle accidents. The fatalities to be included are those (1) which result from accidents that occurred during the relevant calendar year and (2) in which the fatally injured died within 30 days of the accident. Included are fatally injured pedestrians which are also reported separately.

Non-Fatally Injured Persons -- Enter the number of persons who are non-fatally injured in motor vehicle accidents. Included are non-fatally injured pedestrians who are also reported separately.

Pedestrian Fatalities -- Enter the number of pedestrians fatally injured in motor vehicle accidents. The number of pedestrians included here is also included in fatalities.

Non-Fatally Injured Pedestrians -- Enter the number of pedestrians non-fatally injured in motor vehicle accidents. The number of pedestrians included here is also included in non-fatally injured persons.

LOCAL FUNCTIONAL SYSTEM MILEAGE SUMMARY

The Local Functional System Mileage Summary form (see Figure II-3) requires the reporting of public local functional system mileage stratified by surface type and annual average daily traffic (AADT) group for the rural, small urban, and total urbanized areas of the State. These data will be used to describe in general terms the AADT and pavement type characteristics of the local functional system and will be published annually in "Highway Statistics." Comparison of the annual submittals will be made to establish trends in AADT growth and paving. It is assumed that a very small portion of the mileage on the local functional system will experience significant traffic growth, thereby, reducing the effort required to update this information.

The mileages reported on the Local Functional System Mileage Summary form must be consistent with those reported in the Mileage and Daily Travel Summary form as well as that contained on the data submittal tape. Road mileages in Figure II-3 are to be stratified by three surface/pavement types (paved, gravel/soil, and unimproved) as well as by the appropriate AADT group.

Paved -- bituminous, concrete, brick, block, and other special surfaces (codes 51 and above).

Gravel/Soil -- graded roads with a soil, gravel, or stone surface (code 40).

Unimproved -- unimproved or natural earth roads (codes 20 & 30).

Since this summary is stratified by several general characteristics of the local functional system, the State should complete the summary using its best judgement. A "best" estimate is satisfactory but should be made in such a fashion that it can be repeated consistently on an annual basis.

Rural Local Roads

Procedures for stratifying rural mileage will depend on the degree of detail available in existing maps and local road inventories. In some cases, stratification by AADT and surface type may be available directly from road inventory data. County series general highway maps or United States Geological Survey (USGS) maps may also be examined to determine location and extent of development in an area to assist in estimating current AADT's where local roads are not included in the State or county traffic counting program.

Small Urban and Urbanized Areas' Local Roads and Streets

For small urban areas, it is recommended that the proportion of mileage in each stratification be determined from an analysis of a sample of the urban areas. An initial analysis of three areas is recommended. The area of consideration may then be enlarged if a reasonable degree of consistency is not apparent in the proportion of mileage in the various AADT and pavement type strata.

It is recommended that the required mileage stratification in the small urban areas be determined by dividing the areas into subareas with different types of development. Local land use planning maps, zoning maps, or any other readily available information can be used in accomplishing the stratifications. The local functional system mileage distribution for each surface and AADT strata can be determined for each subarea. The distribution for the subareas can then be averaged and applied to the total local functional system mileage to determine the required values for each strata.

A similar procedure is recommended for urbanized areas. Once estimates representative of all small urban and all urbanized areas are developed, they can be added to determine the total urban estimate.

Percent of Travel by Vehicle Type and Functional System

The percent of travel made by various vehicle types over the various functional systems of highway are to be reported as areawide data on the "Travel Activity by Vehicle Type and Functional System" form provided as Figure II-4, Part 1. The vehicle types to be reported are listed and defined in Table II-1. Travel is reported for each vehicle type relative to the total DVMT for a functional system for each area type such that the values for each functional system sum to 100 percent. Note that a level of accuracy to the nearest one-tenth of a percent of the travel is used. If a vehicle type has reported travel less than one tenth of a percent, report this on a separate sheet, with appropriate vehicle type identification and attach it to the form. The spreadsheet option for reporting areawide data provides for reporting values to hundredths or thousandths of a percent (the decimal must be included).

Reporting of motorcycle travel is optional. States that can report such travel data should do so.

FHWA believes that automation is the only method that will allow the number and duration of vehicle classification sessions needed to provide statistically reliable information. Various States have begun automated collection of data for the 13 vehicle types that are defined in Table II-1 and in the "Traffic Monitoring Guide" (TMG), and have found the information to be reliable for their own and Federal reporting purposes. Other States using equipment that they believe cannot differentiate autos from other 2-axle 4-tire vehicles may report these two vehicle types as an aggregate figure. Of course, if a State that uses automated equipment normally augments its data with automobile-specific information, that data should be provided. It is particularly important that States making manual classification counts continue to provide automobile information distinct from other two-axle, four-tire vehicles. In coding combined data for a functional system, the values should be entered in the passenger car column and the "other two-axle, four-tire" column should be kept blank. An entry of a zero in either column is interpreted to mean that such vehicle types were monitored but not found in the traffic stream.

The vehicle activity information is to be reported for rural areas, and total urban areas. The TMG includes procedures for the development of a vehicle classification sample which is a subset of the HPMS sample sections. The procedures are flexible, allow incorporation of existing automated sites, and are deemed sufficient to meet the areawide and sample section reporting needs of the HPMS.

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If the TMG has been fully implemented, estimates of percent travel for all vehicle type/functional system cells on the form are computed as the average of all the classification sample locations within that cell. For example, the percentage of buses on the rural Interstate System is simply the average of the percents of buses of all vehicle classification measurements in the sample taken on the rural Interstate System. If the sample consisted of 10 sections and the percent buses measured at each section were 0.9, 0.5, 1.1, 0.8, 0.3, 0.4, 0.2, 1.3, 0.5, and 0.3 (total = 6.3), then the average of 0.6 would be the estimated percentage of buses in the rural Interstate cell of the areawide form. If the TMG has not been fully implemented, the cell values will be based on the the State's internal procedures.

In addition, States are encouraged to submit to HPM-30 the site specific information upon which the areawide form is based, as it becomes available. The format for reporting such site specific classification data can be found in Chapter 6 of Section 5 of the TMG. The TMG section describes the reporting of station description and vehicle classification information. While submittal of the information as machine readable media is preferred, printed reports may also be furnished.

It should be noted that the TMG vehicle classification procedures also enable direct coding of the sample section data for Item 57, Percent Commercial Vehicles. Since the classification counts are made on a subset of the HPMS samples, however, other estimation methods will be needed on those samples that are not in close proximity to the classification counts.

Upon review of the classification data that has been submitted in the past, it became apparent that the treatment of trucks with trailers, and the time of day/day of week for which vehicle classification data is reported varies from State to State. These inconsistencies could cause inaccurate use of the data as well as results based on the data. In view of the rising importance of truck traffic estimates, it is imperative that the classification data be more precise, particularly concerning the information noted above. For these reasons, an additional form, provided as Figure II-4, Part 2, must be submitted as part of the Travel Activity by Vehicle Type and Functional System form. Each State is to indicate how various truck trailer counts are reported, and provide the time of day/day of week that the State normally collects the information. If classification is accomplished differently on different systems or in different areas (such as rural, urban), a copy of this form should be provided for each system/area, appropriately annotated.

Note: In reporting information on trucks, the following criteria should be used:

- a. Truck tractor units traveling without a trailer will be considered single-unit trucks.
- b. Truck tractor units pulling other such units in a "piggyback" (or "saddle-mount") configuration will be considered as one single-unit truck and will be defined only by the axles on the pulling unit.
- c. Vehicles shall be defined by the number of axles in contact with the roadway. Therefore, "floating" axles are counted only when in the down position.
- d. The term "trailer" includes both semi- and full-trailers.

Table II-1. Vehicle Types

<u>Type Code</u>	<u>Type Name and Description</u>
1	<u>Motorcycles (Optional)</u> -- All two- or three-wheeled motorized vehicles. Typical vehicles in this category have saddle type seats and are steered by handle bars rather than a wheel. This category includes motorcycles, motor scooters, mopeds, motor-powered bicycles, and three-wheel motorcycles. This vehicle type may be reported at the option of the State.
2	<u>Passenger Cars</u> -- All sedans, coupes, and station wagons manufactured primarily for the purpose of carrying passengers and including those passenger cars pulling recreational or other light trailers.
3	<u>Other Two-Axle, Four-Tire, Single-Unit Vehicles</u> -- All two-axle, four-tire vehicles, other than passenger cars. Included in this classification are pickups, panels, vans and other vehicles such as campers, motor homes, hearses, El Caminos, Rancheros, ambulances, carryalls, and four-wheel drive vehicles. Other two-axle, four-tire, single-unit vehicles pulling recreational or other light trailers are included in the classification.
4	<u>Buses</u> -- All vehicles manufactured as traditional passenger-carrying buses with two-axles, six-tires and three or more axles. This category includes only traditional buses functioning as passenger-carrying vehicles. All two-axle, four-tire minibuses should be classified as other two-axle, four-tire, single-unit vehicles. Modified buses should be considered as trucks and be appropriately classified.

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Table II-1. Vehicle Types (Cont.)

<u>Type Code</u>	<u>Type Name and Description</u>
5	<u>Two-Axle, Six-Tire, Single-Unit Trucks</u> -- All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., having two axles and dual rear wheels.
6	<u>Three-Axle, Single-Unit Trucks</u> -- All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., having three axles.
7	<u>Four or More Axle, Single-Unit Trucks</u> -- All trucks on a single frame with four or more axles.
8	<u>Four or Less Axle, Single-Trailer Trucks</u> -- All vehicles with four or less axles consisting of two units, one of which is a tractor or straight truck power-unit.
9	<u>Five-Axle, Single-Trailer Trucks</u> -- All five-axle vehicles consisting of two units, one of which is a tractor or straight truck power-unit.
10	<u>Six-or More Axle, Single-Trailer Trucks</u> -- All vehicles with six or more axles consisting of two units, one of which is a tractor or straight truck power-unit.
11	<u>Five-or Less Axle, Multi-Trailer Trucks</u> -- All vehicles with five or less axles consisting of three or more units, one of which is a tractor or straight truck power-unit.
12	<u>Six-Axle, Multi-Trailer Trucks</u> -- All six-axle vehicles consisting of three or more units, one of which is a tractor or straight truck power-unit.
13	<u>Seven-or More Axle, Multi-Trailer Trucks</u> -- All vehicles with seven or more axles consisting of three or more units, one of which is a tractor or straight truck power-unit.

FIGURE II-4

**TRAVEL ACTIVITY BY VEHICLE TYPE AND FUNCTIONAL SYSTEM
PART 2**

STATE: _____

DATA YEAR: _____

IS VEHICLE CLASSIFICATION DATA REPORTED ON PART 1 REPRESENTATIVE OF ALL HOURS OF THE DAY, DAYS OF THE WEEK, AND SEASONS OF THE YEAR?

YES NO

IF NO, PLEASE ANSWER THE FOLLOWING:

1. VEHICLE CLASSIFICATION DATA ON PART 1 ARE REPRESENTATIVE OF DATA NORMALLY COLLECTED DURING THE HOURS OF:

___AM/PM TO ___AM/PM

2. VEHICLE CLASSIFICATION DATA ON PART 1 ARE REPRESENTATIVE OF DATA NORMALLY COLLECTED ON THE FOLLOWING DAYS DURING THE FOLLOWING MONTHS (CHECK THOSE THAT ARE APPROPRIATE):

___ SUNDAY	___ THURSDAY	___ JANUARY	___ MAY	___ SEPTEMBER
___ MONDAY	___ FRIDAY	___ FEBRUARY	___ JUNE	___ OCTOBER
___ TUESDAY	___ SATURDAY	___ MARCH	___ JULY	___ NOVEMBER
___ WEDNESDAY		___ APRIL	___ AUGUST	___ DECEMBER

VEHICLE TYPE	REPORTED UNDER WHICH VEHICLE CATEGORY ON PART 1
2-AXLE, 4-TIRE TRUCKS WITHOUT A TRAILER	
2-AXLE, 4-TIRE TRUCKS WITH A TRAILER	
2-AXLE, 6-TIRE PICKUP TRUCKS WITHOUT A TRAILER	
2-AXLE, 6-TIRE PICKUP TRUCKS WITH A TRAILER	
OTHER SINGLE-UNIT TRUCKS WITH SEMI-TRAILERS	
OTHER SINGLE-UNIT TRUCKS WITH FULL-TRAILERS	

COMMENTS

CHAPTER III

UNIVERSE AND SAMPLE DATA REQUIREMENTS

The HPMS requires the annual reporting of universe data (comprehensive statewide public road mileage, and Federal-aid system mileage not yet built or open to traffic) classified by specific categories, and selected roadway physical operational and usage characteristics for sample sections. The annual data submittal must include all required items, including those that remain unchanged. Sample sections are to be updated according to the established schedule for each data element (see Chapter V). The type of capital improvement is also to be reported for arterial and collector sample sections in the year of completion. This Chapter outlines the requirements for universe and sample data.

Preliminary to discussing the makeup of the data tape records, the following definitions apply throughout this Manual:

Public Road -- "A public road means any road under the jurisdiction of and maintained by a public authority and open-to-public travel."
(23 U.S.C. 402(c)).

"The term 'maintenance' means the preservation of the entire highway, including surface, shoulders, roadsides, structures, and such traffic-control devices as are necessary for its safe and efficient utilization." (23 U.S.C. 101)

To be open to public travel, a road must be available, except during scheduled periods, extreme weather or other emergency conditions, and open to the general public for use by 4-wheel, standard passenger cars without restrictive gates, prohibitive signs, or regulation other than restrictions based on size, weight, or class of registration. Toll plazas of public toll facilities are not considered restrictive gates. (FHPM, 4, 5, 3)

Primitive roads (surface type A) do not meet the criteria for "public roads" since they are defined as routes "on which there is no public maintenance" and are "usable by 4-wheel drive vehicles and publicly traveled by small numbers of vehicles."

A public authority is defined as a Federal, State, county, township, municipal, or other local government or instrumentality thereof, with authority to finance, build, operate, or maintain highway facilities, either as toll or toll free. (FHPM 4, 5, 3)

III-2

Universe Data -- Data representing all public road mileage and Federal-aid system mileage not yet built or open to traffic. The universe data defines the extent of roadway mileage by system and jurisdiction. These can be reported in either of the following ways:

Section Data -- A continuous length of roadway that is homogeneous with respect to the physical, operational, administrative, and jurisdictional characteristics being reported, or

Grouped Data -- Universe data for a group of highway sections, not necessarily contiguous, with mileage aggregated with respect to the homogeneous administrative, physical, and jurisdictional characteristics being reported. Interstate System and sampled mileage data cannot be reported in grouped data form.

Sample sections -- Randomly selected sections from the universe of arterial and collector sections for which additional physical and operational data elements in addition to the universe data are reported. The sections are homogeneous as to geometrics, cross section, AADT and condition, and the termini are fixed as to location over time. The arterial and collector samples (in section form consisting of both universe and sample data) provide basic physical inventory and operational data for specific sections of highway from which the performance of the Nation's highways will be evaluated. A discussion of the HPMS sample selection design for the arterial and collector systems is presented in Appendix H.

UNIVERSE DATA

Records will be submitted on computer tape for all public road mileage for all systems plus Federal-aid system mileage not yet built or open to traffic. Universe data are required to be reported on a section-by-section basis for the rural and urban Interstate Systems and the sample sections. It is recognized that most States maintain data by individual section, especially for the higher functional systems, and that most States will report their data in this form. With the exception of sample sections and the Interstate System sections (includes basic Interstate System mileage (Section 103, title 23 U.S.C), Interstate System additions, section 139(a), 139(b), and 139(c), and Toll mileage), States may group remaining highway sections, such as collector and local functional system mileage. It should be noted, however, that the aggregation of data into grouped records for reporting to the FHWA could have adverse implications regarding future potential analytical use of the data set by the SHA's. Hence, deliberate grouping of data, when not necessary, could have an adverse effect on the future analytical options of the SHA.

III-3

The same record format will be used for both section-by-section and grouped data reporting; however, grouped sections, identified by a countywide (or equivalent) unique group number, are not tied to a particular location.

The general categories of universe data, reported for all records (universe and sample sections), are shown below. Data items contained in each category are described in detail in Chapter IV. The universe data categories are:

Identification -- Contains State, county, and rural/small urban/urbanized codes and a unique identification or location reference.

Optionally, the latitude and longitude coordinates for the beginning and ending points of universe and sample sections are provided.

System -- Provides for coding of functional system and Federal-aid system.

Jurisdiction -- Provides for coding of State or local highway system and special funding category.

Operation -- Includes type of facility, truck prohibition, and toll.

Other -- Contains length of highway section and fields for the coding of AADT and the number of through lanes.

SAMPLE SECTION DATA

In addition to the universe data items reported for all records, arterial and collector sample section records will contain additional condition, usage, inventory and operational data.

Sample sections selected in the initial implementation of the HPMS, plus any additional sections added as a result of change, constitute the panels of sampled sections for five functional systems in the rural, small urban, and urbanized areas of a State. The functional systems represented are: Rural areas -- Interstate, other principal arterial, minor arterial, major collector, and minor collector; small urban and urbanized areas -- Interstate, other freeways and expressways, other principal arterial, minor arterial, and collector.

When the HPMS was initially implemented, individual urbanized areas were required to be sampled. This requirement then became optional, along with the collective method. However, in view of possible future events concerning increased emphasis on urban areas, the States are now highly encouraged to sample urbanized areas, individually. At a minimum, the State shall sample the aggregate of the urbanized areas. However, at the State's option, it may continue to sample individual urbanized areas or it may sample some individual urbanized areas and group the remaining urbanized areas. For those States electing to group all or a portion of the urbanized areas, a procedure for drawing a new sample from the existing sample is contained in Appendix H.

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Sample section data reported in addition to the universe data are described below by category. The data items within each category are discussed in detail in Chapter IV.

Identification -- Contains unique identification for the sample section portion of the record.

Computational Elements -- Provides data items used to expand sample information to universe values.

Pavement Attributes -- Contains data items used to evaluate the physical characteristics of pavement, pavement performance, and the need for pavement overlays.

Improvements -- Describes the improvement type for the year of the improvement completion.

Geometrics/Configuration -- Describes the physical attributes used to evaluate the capacity and operating characteristics of the facility.

Traffic/Capacity -- Provides operational data items used to calculate the capacity of a section and the need for improvements.

Environment -- Contains items that marginally affect the operation of a facility but are important to its structural integrity.

Supplemental Data -- Provides linkage to existing structure and railroad crossing information systems.

Interstate System Sample Requirements

The Interstate System consists of four (4) separate sample mileage types, each with its own unique category mileage base to which it is expandable. The categories are as follows:

1. Interstate (other than categories 2-4 noted below)
2. Interstate Toll
3. Interstate with Secretarial Agreement
4. Interstate Section 139(a) additions

If only category "1" Interstate mileage exists within a State, then the Interstate System will continue to be sampled as a single unit (this will be the case in over half the States). However, an additional Interstate System sample unit is necessary for each of categories 2-4 if mileage exists for the respective category(s) -- the procedures outlined in Appendix H must be followed when this occurs.

Because of the importance of the Interstate System, its homogeneity and other factors, several States have sampled and reported via HPMS, 100 percent of the Interstate System mileage. If any other State has the desire and/or need to sample its entire Interstate and report it via HPMS, this is acceptable and we need only to be informed.

Capital Improvement Data

Improvement type data are essential to the evaluation of the relative effectiveness of existing highway programs. The following must be reported for each sample section having an improvement completed during the data year, and is carried unchanged, until another improvement is completed on the section in another year. The improvement types are shown in hierarchial order which should be followed in assigning the improvement type.

Type of Improvement -- Improvement types are as follows:

<u>Code</u>	<u>Description</u>	<u>Code</u>	<u>Description</u>
10	New Route	40	Major Widening
20	Relocation	50	Minor Widening
31	Reconstruction to Freeway	60	Restoration and Rehabilitation
32	Reconstruction with More Lanes	71	Resurfacing with Shoulder Improvements & Concrete Pavement
33	Reconstruction to Wider Lanes	72	Resurfacing with Shoulder Improvements & Bituminous Pavement
34	Pavement Reconstruction with Alignment Improvements	77	Resurfacing with Concrete Pavement
35	Pavement Reconstruction	78	Resurfacing with Bituminous Pavement

The type of improvement is determined by the nature of the construction rather than the source of funding. For example, bituminous resurfacing financed with Interstate-4R funds is to be coded as resurfacing (code 78) and the reconstruction of a 2-lane, urban collector facility with wider lanes financed with State and local funds should be coded "33". Only one type of improvement can be reported for a particular section in a given year. The year of improvement completion is also coded and retained in the record.

The "New Route" (code 10) improvement type can only be used when a new sample is randomly selected (because of volume group sample deficiency) on a newly constructed and completed roadway that was opened to traffic during the reporting year. The "Relocation" improvement type (code 20) can only be used if the existing section is replaced by a section on new alignment and the original section is abandoned. It should be noted that in cases where a relocation improvement has been made and the existing section remains in service as a collector or higher functional system, the original sample section should continue to be monitored. If the existing facility is reclassified as local, the sample is eliminated entirely. As an indirect consequence of this relocation improvement (if it meets the above conditions), a number of the data items on the original section will change. Since codes 10 & 20 will rarely be used, the majority of capital improvements will receive codes 31 through 78.

Section Data Changes Resulting from Capital Improvements -- If improvements are completed on a part or parts of a sample section during a specific year, thereby causing changes in a section, each dissimilar segment of the original section is treated as a separate and distinct record from that point on. Instructions explaining this situation are presented in Chapter IV, along with coding instructions for sample subdivisions and capital improvements.

When improvements are made, changes in data items as a result of the improvement are to be reported by updating the sample section's inventory record for the year the improvement was completed. States are encouraged to establish a system to document improvements as they are completed to avoid a peak workload. (See Chapter V.)

Note that the type of improvement, as well as the year of improvement, have become a part of the permanent (fixed portion) record for a sample section, and remain as part of the record until another surface improvement is completed on the section.

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Interstate 4R Apportionment

The current I4R apportionment formula under Sec. 104(b)(5)(B), Title 23, for resurfacing, restoring, rehabilitating, and reconstructing the Interstate System utilizes lane miles and vehicle miles travelled on Interstate routes that are completed and open to traffic. HPMS serves as the source for these data; several of the universe data items must be scrutinized to ascertain eligibility status. The pertinent eligibility items are as follows:

Item #	<u>Description</u>	<u>Codes</u>	<u>Meaning</u>
9	Functional System	01,11	Interstate
11	Federal-aid System	1	Interstate
12	Federal-aid System Status	1	Open to Traffic
16	Special Systems	41	Interstate 139(c) (Alaska & Puerto Rico)
19	Toll	1	Non-toll
	Toll	3	Interstate Toll under Secretarial Agreement
	Toll	4	Interstate non-toll under Secretarial Agreement
20	Length	\	If a section meets the I4R requirements based on the above data items, the items listed to the left are used for calculating the apportionment factors
21	AADT	>	
22	Number of Through Lanes	/	

It is important to note that only the Interstate through lanes and only the vehicular traffic on these Interstate through lanes are to be reported in HPMS for use in I4R apportionment. Specifically excluded from I4R apportionment are the lane miles and travel on toll facilities without Secretarial Agreements, ramps, frontage roads and collector/distributor segments that are part of interchanges.

Data for the following roadways are input to the I4R apportionment formula:

- Open to traffic Interstate on:
 - Interstate (free)
 - Interstate 139(c)
 - Interstate Toll/non-toll facilities under Secretarial Agreement

Data for the following roadways are excluded from the I4R apportionment formula:

- Non-Interstate
 - Interstate 139(a)
 - Interstate 139(b)
 - Interstate Toll facilities not under Secretarial Agreement
 - Not open to traffic Interstate

CHAPTER IV

RECORD FORMAT AND CODING INSTRUCTIONS

This Chapter contains the record format and detailed coding instructions for the universe and sample section data. There are four types of records that can be reported:

1. Universe Interstate Sections -- These will contain Items 1-23. The record length is 163 positions. Where an Interstate section is also a sample section, refer to (4), below for coding instructions.
2. Universe Sections excluding Interstate -- These will contain Items 1-23, where applicable, with non-applicable items zero-filled. The record length is 163 positions. When a section is also a sample, refer to (4) below for appropriate instructions.
3. Universe Grouped Records -- These will contain Items 1-23, where applicable, with non-applicable items zero-filled. The record length is 163 positions. Interstate and sample sections cannot be grouped.
4. Arterial and Collector Sample Sections -- These will contain Items 1-78. Items 1-76, where non-applicable, will be zero-filled and Items 77-78 will be coded if applicable. The record length for Items 1-76 is 427 positions. Items 77-78 will add additional length to the record, depending on whether the items are coded.

There are instances where a sample road section will have independent alignments with regard to the geometrics of such data items as curvature, grade, etc. Conflicting differences in dimension due to independent alignment are resolved by reporting average mileage in the case of section length and the lesser measurement or worse condition applicable to the data item(s) under consideration. The above rule for reporting the lesser or worse condition also applies to sections with common alignment but where staged construction resulted in substantial differences in roadway dimensions or operational conditions.

All numeric data items are to be zero-filled where codes are not applicable or are not required. Leading zeroes must be provided for numeric data items where the entered value or code does not already fill the allocated field length. Alphanumeric fields may include blanks and do not have to be zero-filled. There is one exception to this rule -- the route numbers (Item 14) for Interstate must be right-justified, zero-filled, and contain no alpha characters. (However, see Item 14 for additional route coding information.) Route numbers for other systems may follow the alphanumeric coding scheme. Appendix R provides a concise summary of the numeric and alphanumeric data items.

IV-2

RECORD FORMAT SUMMARY

Under the columns headed "Required Universe Items", an "X" indicates that the item is required for the type of section being reported. The following abbreviations are used:

- Int Report these items for all Interstate sections (including Interstate sample sections).
- Sam Report these items for all arterial and collector sample sections (including Interstate sample sections).
- All Report these items for all other sections/records.
- Pos This column indicates the position of the item in the tape record as reported to FHWA.
- Len This column indicates the length of the field used for the data item.

Under the columns headed "Required Sample Items", an "X" indicates that the item is required for the Functional System being reported. The following abbreviations are used:

Int	Interstate	Rural and Urban
OFE	Other Freeways and Expressways	Urban
OPA	Other Principal Arterial	Rural and Urban
MA	Minor Arterial	Rural and Urban
MaC	Major Collector	Rural
MiC	Minor Collector	Rural
Col	Collector	Urban

A few data items require additional discussion regarding the type of section for which the data item is applicable. For instance, Percent Passing Sight Distance (Item 54) is required for rural paved, 2-lane facilities. The summary table can only indicate that this item is required for rural. Each data item description must be consulted for complete details.

CHAPTER IV

RECORD FORMAT AND CODING INSTRUCTIONS

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3. Universe Grouped Records -- These will contain Items 1-23, where applicable, with non-applicable items zero-filled. The record length is 163 positions. Interstate and sample sections cannot be grouped.
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There are instances where a sample road section will have independent alignments with regard to the geometrics of such data items as curvature, grade, etc. Conflicting differences in dimension due to independent alignment are resolved by reporting average mileage in the case of section length and the lesser measurement or worse condition applicable to the data item(s) under consideration. The above rule for reporting the lesser or worse condition also applies to sections with common alignment but where staged construction resulted in substantial differences in roadway dimensions or operational conditions.

RECORD FORMAT SUMMARY

Under the columns headed "Required Universe Items", an "X" indicates that the item is required for the type of section being reported. The following abbreviations are used:

- Int Report these items for all Interstate sections (including Interstate sample sections).
- Sam Report these items for all arterial and collector sample sections (including Interstate sample sections).
- All Report these items for all other sections/records.
- Pos This column indicates the position of the item in the tape record as reported to FHWA.
- Len This column indicates the length of the field used for the data item.

Under the columns headed "Required Sample Items", an "X" indicates that the item is required for the Functional System being reported. The following abbreviations are used:

Int	Interstate	Rural and Urban
OFE	Other Freeways and Expressways	Urban
OPA	Other Principal Arterial	Rural and Urban
MA	Minor Arterial	Rural and Urban
MaC	Major Collector	Rural
MiC	Minor Collector	Rural
Col	Collector	Urban

A few data items require additional discussion regarding the type of section for which the data item is applicable. For instance, Percent Passing Sight Distance (Item 54) is required for rural paved, 2-lane facilities. The summary table can only indicate that this item is required for rural. Each data item description must be consulted for complete details.

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Universe Data

Item No.	Pos	Len	Required Universe Items			Data Item
			Int	Sam	All	
<u>Identification</u>						
1	1-100	100				State Control Field
2	101-102	2	X	X	X	Year
3	103-104	2	X	X	X	State code
4	105-107	3	X	X	X	County code
5	108	1	X	X	X	Rural/Urban Designation
6	109-113	5	X	X	X	Urbanized Area Code
7	114	1	X	X	X	Type of Section/Grouped Data
8	115-126	12	X	X	X	Section/Grouped Data Identification
<u>System</u>						
9	127-128	2	X	X	X	Functional System
10	129	1	X	X	X	Generated Functional System Code
11	130	1	X	X	X	Federal-aid System
12	131	1	X	X	X	Federal-aid System Status
13	132	1	X			Route Signing
14	133-137	5	X			Route Number
<u>Jurisdiction</u>						
15	138-139	2	X	X	X	Governmental Level of Control
16	140-141	2	X	X	X	Special Systems
<u>Operation</u>						
17	142	1	X	X	X	Type of Facility
18	143	1	X	X	X	Designated Truck Route/Parkway
19	144	1	X	X	X	Toll
<u>Other</u>						
20	145-150	6	X	X	X	Section/Group Length
21	151-156	6	X	X		AADT
22	157-158	2	X	X		Number of Through Lanes
23	159-163	5	X	X	X	Record Continuation Code

IV-4

Sample Data

Item	<u>Required Sample Items</u>													Data Item
	<u>Rural</u>						<u>Urban</u>							
No.	Pos	Len	Int	OPA	MA	MaC	MiC	Int	OFE	OPA	MA	Col		
														<u>Identification</u>
24	164-175	12	X	X	X	X	X	X	X	X	X	X	X	Sample Number
25	176	1	X	X	X	X	X	X	X	X	X	X	X	Sample Subdivision
														<u>Computational</u>
26	177-178	2	X	X	X	X	X	X	X	X	X	X	X	AADT Volume Group Identifier
27	179-184	6	X	X	X	X	X	X	X	X	X	X	X	Expansion Factor
														<u>Pavement</u>
28	185-186	2	X	X	X	X	X	X	X	X	X	X	X	Surface/Pavement Type
29	187-188	2	X	X				X	X	X				Concrete Joint Spacing
30	189	1	X	X				X	X	X				Load Transfer Devices
31	190	1	X	X	X	X	X	X	X	X	X	X	X	Pavement Section SN or D
32	191-192	2	X	X				X	X	X				Type of Base
33	193	1	X	X				X	X	X				Type of Subgrade
34	194	1	X	X				X	X	X				Subsurface Drainage
35	195	1	X	X				X	X	X				Measured Roughness
36	196-198	3	X	X	X			X	X					Reserved - Federal
37	199-210	12												PSR
38	211-212	2	X	X	X	X	X	X	X	X	X	X	X	Overlay or Pavement Thickness
39	213-215	3	X	X	X	X	X	X	X	X	X	X	X	
														<u>Improvements</u>
40	216-219	4	X	X	X	X	X	X	X	X	X	X	X	Year of Surface Improvement
41	220-221	2	X	X	X	X	X	X	X	X	X	X	X	Type of Improvement
														<u>Geometrics</u>
42	222	1	X	X	X	X	X	X	X	X	X	X	X	Access Control
43	223-224	2	X	X	X	X	X	X	X	X	X	X	X	Lane Width
44	225	1	X	X	X	X	X	X	X	X	X	X	X	Shoulder Type
45	226-229	4	X	X	X	X	X	X	X	X	X	X	X	Shoulder Width
46	230	1	X	X	X	X	X	X	X	X	X	X	X	Median Type
47	231-232	2	X	X	X	X	X	X	X	X	X	X	X	Median Width
48	233-235	3	X	X	X	X	X	X	X	X	X	X	X	ROW Width
49	236	1	X	X	X	X	X	X	X	X	X	X	X	Widening Feasibility

IV-5

Sample Data (Cont.)

Item No.	Pos	Len	<----- Required Sample Items ----->													Data Item
			<----- Rural ----->					<----- Urban ----->								
			Int	OPA	MA	MaC	MIc	Int	OFE	OPA	MA	CoI				
<u>Geometrics, Cont.</u>																
50	237	1				X	X								Horz. Align. Adeq.	
51	238-328	91	X	X	X	X	X	X	X	X	X				Curves by Class	
52	329	1				X	X								Vert. Align. Adeq.	
53	330-371	42	X	X	X	X	X	X	X	X	X				Grades by Class	
54	372-374	3	X	X	X	X	X	X	X	X	X				% Passing Sight Distance	
<u>Traffic/Capacity</u>																
55	375-376	2	X	X	X	X	X	X	X	X	X	X	X	X	Speed Limit	
56	377-378	2				X	X								Wtd. Des. Speed (calculated)	
57	379-382	4	X	X	X	X	X	X	X	X	X	X	X	X	Percent Commercial Vehicles	
58	383-384	2	X	X	X	X	X	X	X	X	X	X	X	X	K-Factor	
59	385-387	3	X	X	X	X	X	X	X	X	X	X	X	X	Dir. Factor	
60	388-392	5						X	X	X	X	X	X	X	Peak Capacity	
61	393-395	3	X	X	X	X	X	X	X	X	X	X	X	X	V/SF Ratio (calculated)	
62	396-397	2						X	X	X	X	X	X	X	Turning Lanes	
63	398	1						X	X	X	X	X	X	X	Signalization	
64	399-400	2						X	X	X	X	X	X	X	% Green Time	
65	401	1						X	X	X	X	X	X	X	Peak Parking	
66	402-407	6	X	X	X	X	X	X	X	X	X	X	X	X	Future AADT	
67	408-409	2	X	X	X	X	X	X	X	X	X	X	X	X	Future AADT Year	
<u>Environment</u>																
68	410-411	2	X	X	X	X	X	X	X	X	X	X	X	X	Climate Zone *	
69	412	1	X	X	X	X	X	X	X	X	X	X	X	X	Drainage Adeq.	
70	413	1	X	X	X	X	X	X							Type of Terrain	
71	414	1	X	X	X	X	X	X							Type of Development	
72	415	1						X	X	X	X	X	X	X	Urban Location	
73	416-417	2	X	X	X	X	X	X	X	X	X	X	X	X	# Grade Sep. Interchanges	
74	418-423	6	X	X	X	X	X	X	X	X	X	X	X	X	# At-Grade Intersections	
75	424-425	2	X	X	X	X	X	X	X	X	X	X	X	X	# Structures	
76	426-427	2	X	X	X	X	X	X	X	X	X	X	X	X	# At-Grade RR Crossings	
<u>Supplemental Data</u>																
77	--varies--		X	X	X	X	X	X	X	X	X	X	X	X	Structure ID's	
78	--varies--		X	X	X	X	X	X	X	X	X	X	X	X	At-Grade RR Crossing ID's	

* Initial entry of Item 68, Climate Zone will be accomplished by software.

UNIVERSE MILEAGE CODING INSTRUCTIONS

Identification

Item 1 -- State Control Field (Length = 100)

This portion of the record is for the use of the State. However, in view of the increased utility and emphasis on graphic capabilities and Geographic Information Systems (GIS), at both the State and Federal levels, the States are requested, on an optional basis, to supply the beginning and ending latitude and longitude coordinates for each universe and sample section. The primary interest is in the arterial systems at the Federal level, however, the States may provide coordinates for other systems, if they are available. Since there is no room in the current record to accommodate these data, we are requesting that the optional data be placed in the State Control Field until the HPMS record format is changed for other reasons. At that time, space will be provided elsewhere in the data record. The following field positions are to be used:

Beginning Point Latitude; positions 70-76; length = 7
Beginning Point Longitude; positions 77-83; length = 7
Ending Point Latitude; positions 84-90; length = 7
Ending Point Longitude; positions 91-97; length = 7

The data fields are to be right-justified, zero-filled and contain positive degrees, with an implied decimal point, four places in from the rightmost position. For example, a point at Latitude 35 deg., 33 min., 22 sec. = 35.556111 deg., and would be coded as "0355561". Similarly, a point at Longitude 121 deg., 5 min., 52 sec. = 121.097777 deg., and would be coded as "1210978".

If the State groups data (Item 7 = 3), zero fill these fields for the grouped section records, as well as for those records that are not reported (this need be done only if the State is reporting for some systems and not for others).

Should a State have coordinates, but cannot use this reporting method, other means for providing these data will be accepted at this time. This may include a separate file of coordinates tied to the HPMS route milepoint, or some other means of identification, such as a copy of the front of the HPMS records (county, ID, etc.). Thorough documentation of these files including record and field format will also be required. Please contact FHWA Headquarters (HPM-20) for more information exchange, if the State will provide these data in an external file.

Coordinate reporting for some systems will likely be standardized for HPMS in the future.

IV-7

Item 2 -- Year (Length = 2)

Enter the last two digits of the calendar year for which the data apply. For example, the 1989 data reported in 1990 would be coded "89".

Item 3 -- State Code (Length = 2)

The Federal Information Processing Standards (FIPS) codes, listed in Appendix A, are used. (See Federal Information Processing Standards Publication 5, "States of the United States".)

Item 4 -- County Code (Length = 3)

Use the 3-digit FIPS county code (see Federal Information Processing Standards Publication 6, "Counties of the States of the United States"). If a State elects to use some other coding scheme, supply a copy of the code relationship to the county FIPS codes to FHWA Headquarters (HPM-20).

Item 5 -- Rural/Urban Designation (Length = 1)

Federal-aid urban area boundaries apply. (See Chapter II under General Coding Instructions for definitions of urban areas.)

Code Description

1	Rural
2	Small Urban (population 5,000 to 49,999)
3	Urbanized (population > 49,999)

IV-7A

Item 6 -- Urbanized Area Code (Length = 5)

This item must be coded when Item 5, Rural/Urban designation is coded "3" for urbanized. Otherwise, this field is not required.

The State may sample urbanized areas individually (which is highly encouraged) or it may group two-or-more urbanized areas into one-or-more collective groups (which is now discouraged). In order to identify how the State is sampling urbanized areas, this item must be coded in the format XXYYY where:

XX = 00 -- If urbanized area is being individually sampled.

XX = Sequential # from 11 -- If two-or-more areas are being grouped, one code should be used for each group. For example, if a State has consolidated all urbanized areas into one group, only "11" should be coded. If areas have been consolidated into two groups plus some individual areas, the first group of areas must be coded "11", the second group must be coded "12", and the individual areas must be coded "00".

YYY = The actual 3-digit urbanized area code, depending on which urbanized area the section mileage falls within. (See Appendix B.) The urbanized area code for the specific urbanized area is always coded regardless of the sampling option selected.

Both XX and YYY must be coded for all urbanized area universe and sample records.

Item 7 -- Type of Section/Grouped Data Identification (Length = 1)

Enter the code that indicates the type of section identification used.

Code Description

- | | |
|---|---|
| 1 | Route, Milepoint |
| 2 | A-Node, B-Node, Segment |
| 3 | Grouped Data -- a countywide unique number |
| 4 | Unique Number -- a countywide unique number |

See examples in Item 8.

Item 8 -- Section/Grouped Data Identification (Length = 12)

This field is used as a location identifier or for unique identification. It provides a State with flexibility for identifying sections in accordance with its needs independent of the unique identification maintained for HPMS sample sections (see Item 24, Sample Number). This item may change to suit the needs of the State. The Sample Number must never change. The appropriate ID is as follows:

1. For all Interstate, use route-milepoint identification compatible with that used for the Interstate Cost Estimates (ICE). Inventory milepoints for the "as built" Interstate should be used for this item and the ICE.
2. For non-Interstate arterial and collector sections, including samples, use either route-milepoint or A-node, B-node identification.
3. For non-Interstate, non-sample grouped data, use a countywide, unique, identification number.
4. For other sections, use an identification unique within each county.

Examples for each method follow:

1. Route, Milepoint (Item 7 = 1)

Inventory route number is coded in positions 115-120, right justified. Except for Interstate, the inventory route number is not necessarily the same as that posted along the roadway, but is a number used to uniquely identify a route within the State.

Milepoint is coded in positions 121-126, right justified, (xxx.xxx -- implied decimal point). The milepoint represents the distance in miles from a set reference point to the beginning of this highway segment. The reference point could be a State or county line or the point where the particular route originates. The milepoint is the position along a route where one of the values in the segment record changes. The milepoint numbering format should be such that the combination of county, inventory route number, and milepoint will define a unique location.

Example: Inventory Route 50 with milepoint 79.20

Pos.:	114	115	116	117	118	119	120	121	122	123	124	125	126
Code:	1	0	0	0	0	5	0	0	7	9	2	0	0

IV-9

Item 8 (Cont.)

2. A-Node, B-Node -- Segment (Item 7 - 2)

A-Node is coded in Positions 115-119, right justified
B-Node is coded in Positions 120-124, right justified
Segment is coded in Positions 125-126, right justified

The node numbers are unique within the State. They are usually located at major intersections, political boundaries, etc.

The segment number provides the position of the roadway segment being coded on the link between the same A-node and B-node pair. The segment is the position along the roadway where one of the data items changes. The number in this field should be low for the segment that begins at the A-node, and must increase for each segment progressing toward the B-node. While sequential numbers may be used, it is advantageous to leave gaps in the numbering to provide for expansion of the number of coded segments over time. For instance, if a section now contains only one segment, a "50" could be coded in this field to allow for changes over time on either end. The maximum number of segments between any A-node, B-node pair is 99.

Example: A-Node -- 572, B-Node -- 691, Segment -- 4

Pos.:	114	115	116	117	118	119	120	121	122	123	124	125	126
Code:	2	0	0	5	7	2	0	0	6	9	1	0	4

3. Grouped Data (Item 7 - 3)

Any countywide unique number with no more than 12 digits is coded, right justified.

Grouped data is an aggregation of roadway mileage, where at least the following data items are homogeneous across all mileage being combined: Items 1-12, and 15-19.

NOTE: Interstate and sample sections cannot be grouped. All other arterials, collectors and locals may be grouped.

Example: 98365

Pos.:	114	115	116	117	118	119	120	121	122	123	124	125	126
Code:	3	0	0	0	0	0	0	0	9	8	3	6	5

Item 8 (Cont.)

4. Unique Number (Item 7 - 4)

Any countywide unique number with no more than 12 digits is coded, right justified.

Example: 4321

```
|Pos.:|114|115|116|117|118|119|120|121|122|123|124|125|126| |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|Code:| 4| 0| 0| 0| 0| 0| 0| 0| 0| 0| 4| 3| 2| 1|
```

NOTE: Items 1-8 contain the identification portion of the section records.

System

Item 9 -- Functional System (Length - 2)

<u>Code</u>	<u>Description</u>
	Rural:
01	Principal Arterial -- Interstate
02	Principal Arterial -- Other
06	Minor Arterial
07	Major Collector
08	Minor Collector
09	Local
	Urban:
11	Principal Arterial -- Interstate
12	Principal Arterial -- Other Freeways and Expressways
14	Other Principal Arterial
16	Minor Arterial
17	Collector
19	Local

Codes 12 & 13 and 14 & 15 have been used in the past to identify non-connecting/connecting link portions of the urban Other Freeways and Expressways and Other Principal Arterial functional systems. Although codes 13 and 15 may still be used, if desired, codes 12 and 13 will be treated as code 12, and codes 14 and 15 will be treated as code 14.

Definitions of the highway functional systems can be found in "Highway Functional Classification, Concepts, Criteria and Procedures," FHWA, July 1974.

IV-11

Item 10 -- Generated Functional System Code (Length = 1)

This field consists of a code that is generated based on Item 9, Functional System, that is used as a software aid. It is encoded by the HPMS Submittal Software, SELCALC option, described in Chapter VI. If Item 9 is changed by non-HPMS software, the SELCALC option must be run to obtain the proper code in this field. This code is automatically updated when using the SELMODU option of the HPMS Submittal Software to update Item 9. The codes are as follows:

<u>Code</u>	<u>Description</u>	
	<u>Rural</u>	<u>Urban</u>
1	Interstate	Interstate
2	Other Principal Arterial	Other Freeways & Expressways
3	Minor Arterial	Other Principal Arterial
4	Major Collector	Minor Arterial
5	Minor Collector	Collector
6	Local	Local

Item 11 -- Federal-aid System (Length = 1)

<u>Code</u>	<u>Description</u>
1	Interstate
2	Federal-aid Primary (Other than Interstate)
3	Federal-aid Urban
4	Federal-aid Secondary (Rural Only)
8	Non-Federal-aid

Item 12 -- Federal-aid System Status (Length = 1)

<u>Code</u>	<u>Description</u>
1	Federal-aid System open-to-traffic
2	Federal-aid System not yet built or not-open-to-traffic
8	Non-Federal-aid open-to-traffic

A section is considered "open to traffic" when the geometric standards of the section are reasonably adequate for vehicle use and the roadway is open to present daily traffic.

ALL NON-FEDERAL-AID MILEAGE REPORTED SHOULD BE OPEN TO TRAFFIC.

IV-12

Item 13 -- Route Signing (Length = 1)

Only Interstate is required to be reported under this item. The reporting of routes other than Interstate is optional. These codes specify the manner in which the highway segment is or will be signed and do not necessarily bear any relationship to the Federal-aid System category. If not reporting this data item, this field should be coded "0". If roadway is unsigned, code this field "7".

<u>Code</u>	<u>Description</u>
0	Not reported
1	Interstate
2	U.S.
3	State
4	County
5	Township
6	Municipal
7	None of the above or not signed

When a route is signed with two-or-more identifiers (for example, Interstate Route 83 and U.S. Route 32), the code for the highest class of route should be used (Interstate in the above example). The hierarchy is in the order listed above. Signed Interstate business routes, unless they are built to Interstate standards and are part of the Interstate system, should be reported as non-Interstate routes.

Item 14 -- Route Number (Length = 5)

Enter the Interstate route number, right justified. This item is optional for non-Interstate routes. If two-or-more routes of the same class in the hierarchy (see Item 13) are signed along a roadway section, the lowest route number should be entered in this field. If Item 13 is coded "0", zero-fill this field.

Only the officially approved AASHTO Interstate route number should be coded, right-justified. Extra alphanumeric characters should not be entered -- zero-fill the remaining digits. Short Interstate route spurs should be identified with their own approved route number and not that of the main route.

Alaska, Hawaii and Puerto Rico may use alpha characters in the Interstate route number field as part of the official AASHTO route number. Other exceptions to the Interstate numeric rule include a major route that has a parallel or diverging branch with fully paired directional roadways and has an official route number containing a letter for relative direction (i.e., E for east). For example, route 35 in Minnesota splits with 35E going through St. Paul and 35W through Minneapolis.

IV-13

Jurisdiction

Item 15 -- Governmental Level of Control (Length - 2)

This data element is used to identify the level of government that has responsibility for the facility. In the case of toll authorities, this code is not dependent upon a toll being charged. Where more than one code could be used for a section, the lowest numerical code shall be reported (i.e., if county and town boundaries are the same and only one governing body exists, use code "02").

<u>Code</u>	<u>Description</u>
01	State Highway Agency
02	County Highway Agency
03	Town or Township Highway Agency
04	Municipal Highway Agency
11	State Park, Forest, or Reservation Agency
12	Local Park, Forest, or Reservation Agency
21	Other State Agencies
25	Other Local Agencies
26	Private
31	State Toll Authority
32	Local Toll Authority
60	Other Federal Agencies (not listed below)
62	Bureau of Indian Affairs
64	U.S. Forest Service
66	National Park Service
68	Bureau of Land Management
70	Military Reservation/Corps of Engineers

Item 16 -- Special Systems (Length = 2)

This field is used to code the special funding categories in which some existing and open-to-traffic highway segments fall (but not-open-to-traffic Federal-aid Systems should be included). These special systems are separate and distinct from those outlined in previously defined fields. Special systems may overlap previously defined systems. For example, the National Forest Highway System may include mileage under jurisdiction of a State or local government. However, if the mileage is part of the National Forest Highway System, it should be coded as such in this field. Where conflicts exist, the 40/41/42 codes have priority -- otherwise use the lower numbered code (i.e., use "15" where "15" and "20" are both applicable, but use "42" where both "20" and "42" are applicable).

<u>Code</u>	<u>Description</u>
01	Not on a Special System
02	National Forest Highway System <u>1/</u>
03	National Forest Development Roads and Trails
04	National Park Service Parkway <u>1/</u>
05	National Park Roads and Trails
06	Indian Reservation Roads and Bridges <u>1/</u>
10	Appalachian Development Highway <u>2/</u>
15	Appalachian Highway Access Road
20	Priority Primary Route (23 U.S.C. 147)
25	Great River Road (23 U.S.C. 148)
30	Defense Access Road (23 U.S.C. 210) <u>3/</u>
40	Addition to the Interstate System (23 U.S.C. 139 (a)) <u>4/</u>
41	Addition to the Interstate System (23 U.S.C. 139 (c))
42	Future addition to the Interstate System (23 U.S.C. 139 (b)) <u>5/</u>

- 1/ These definitions are intended to be consistent with 23 U.S.C. 101(a), Definitions and Declaration of Policy.
- 2/ This definition is intended to be consistent with 23 U.S.C. 143(f) (2) and 23 U.S.C. 101(a).
- 3/ Mileage constructed via Defense Access Road funds.
- 4/ Highway mileage designated as part of the Interstate System under the provisions of 23 U.S.C. 139(a) should be coded "40" for this data element and should be functionally classified as Interstate (Item 9 should be coded "01" or "11"). Item 11 should be coded "1".
- 5/ Highway mileage designated as a future part of the Interstate System under the provisions of 23 U.S.C. 139(b) should be coded "42" for this data element. This mileage is part of the Federal-aid Primary System (Item 11 should be coded "2") and should not be functionally classified as Interstate until the highway has been officially designated as part of the Interstate System.

IV-15

Operation

Item 17 -- Type of Facility (Length = 1)

<u>Code</u>	<u>Description</u>
1	One-Way
2	Two-Way

Definitions:

One-Way -- A one-way is a roadway with traffic moving in one direction only. When part of a one-way couplet, each roadway should be inventoried independently to obtain universe data.

Two-Way -- A road with two-way traffic during non-rush hours.

IV-15A

Item 18 -- Designated Truck Route/Parkway (Length = 1)

Designated truck routes (codes "1", "2") are those sections/routes that are available to truck tractor and 48-foot (or longer if grandfathered) semitrailer combinations, and to truck tractor and 28-foot twin trailer combinations that may be 102 inches wide with no overall length limitations.

The designated truck routes are (1) routes included in the National Truck Network designated under 23 Code of Federal Regulations (CFR) 658, Appendix A, and authorized by Sections 411 (length) and 416 (width) of the Surface Transportation Assistance Act of 1982, and (2) other roadways both on and off of the Federal-aid Systems, designated under State authority.

The following are not to be included as designated truck routes for the purposes of this data item (use code "4"):

- a. Routes (or portions thereof) that simply provide "access" for these large vehicles to terminals and for food, fuel, repair or rest services.
- b. Those routes designated only under State authority that restrict some of the trucks described above because of length or width limitations or because of time of day restrictions.

For purposes of this data element, a parkway (code "3") is a highway that has full or partial access control, is usually located within a park or a ribbon of park-like developments, and prohibits commercial vehicles. In this instance, buses are not considered commercial vehicles.

Code Description

- 1 Designated truck route under Federal authority in 23 CFR 658. This code would include all Interstate and those sections/routes designated only under Federal authority or under both Federal and State authority. It would not include the routes in those 15 States that have designated all, or almost all, of the non-Interstate Federal-aid Primary; use code "2" under this situation, if there are no limitations/restrictions 1/
- 2 Designated truck route only under State authority and fully available to both combinations of trucks described above 1/
- 3 Parkway -- not on a designated truck route
- 4 Not a Parkway -- not on a designated truck route

1/ Those States designating all, or almost all, of its non-Interstate Federal-aid Primary are: AR, CO, IN, KS, LA, MS, MT, NE, NV, OH, OK, SD, TX, WA AND WY. Code "2" shall be used for this mileage if it is fully available to the trucks described above.

Item 19 -- Toll (Length = 1)

<u>Code</u>	<u>Description</u>
1	Non-Toll
2	Toll
3	Interstate Toll segment under Secretarial Agreement (Section 105 of 1978 Federal-aid Highway Act)
4	Interstate Toll segment under Secretarial Agreement now free of tolls

If portions of a roadway can be traversed without the payment of a toll, but a toll is charged on other portions, the segment is considered to be toll. This applies even if a vehicle can enter and exit from the main through route without payment of a toll. If a toll is charged in only one direction, the "free" direction is also considered to be toll. The coding for this item should agree with any other data furnished to FHWA.

If a roadway was built with and is still maintained by toll funds, the roadway is considered toll.

Other Data

Item 20 -- Section/Group Length (xxx.xxx -- implied decimal) (Length = 6)

Mileage should be reported as measured along the centerline of the roadway. On independently aligned, divided highways, the reported mileage should be the average of the lengths of the directional roadways, measured along their centerlines. When a route terminates at an interchange, the length is measured as the average of the two directional, connecting roadway lengths to the first points of intersection or crossover/under with the other mainline route. Where a route length is reported from or to the intersection with another route, the point of measurement should be taken as the theoretical center of the intersection if the two routes were unseparated highways meeting at grade. Except in the case of the terminating route described above, ramps are considered part of the mainline routes and are not considered for HPMS length purposes.

For non-Interstate, non-sample type highways where records by category of mileage are grouped, the total mileage in the category is coded. Should it be necessary to code a number larger than 999.999, two or more records should be included so as to produce the required sum. Care should be taken to avoid splitting the mileage equally between records so that the possibility of mistaking these for duplicate records can be avoided -- the section identifications must be unique.

While provision has been made for coding to a maximum precision of 0.001 miles, records should reflect the precision normally utilized by the State, but at least to the nearest tenth. This not only provides maximum precision, but alleviates rounding, programming, and checking problems. The field should be coded with trailing and leading zeros, depending on the precision obtained, e.g., 56.2 miles would be coded "056200".

IV-17

Item 21 -- Annual Average Daily Traffic (AADT) (Required for all Interstate and sample sections; optional for remaining sections. 1/) (Length = 6)

Enter the section's AADT (total, both directions for two-way facilities and directional if part of a one-way couplet or just one-way) for the given year. Since many applications, including VMT estimates, will be based on sample section AADT's, the States are encouraged to concentrate on counts for sample sections of the highway system, and to provide "actual counts" adjusted to represent AADT rather than "estimates".

The reported AADT values are to be annually updated. Current traffic data taken from sites near/adjacent to continuous automatic traffic recorders (ATR's) are the preferred source in lieu of coverage counts. AADT values that are derived from pneumatic tube counts should include the application of seasonal, weekday/weekend, and growth factors (if not current year counts), as well as corrections for vehicles with more than 2-axles. Specific guidance for frequency and size of traffic data collection programs is contained in Appendix K with further references to the "Traffic Monitoring Guide."

Leading zeros must be coded. For example, an AADT of 25,300 vehicles per day is coded "025300". The field is zero filled when not used.

1/ If AADT information is accurate and available for all sections (except local functional system), the State may wish to enter all AADT data in order to use a software option that will calculate the volume group expansion factors for sample sections, automatically (no universe mileage cards are required). The software is described in Chapter VI under the SELEXP option.

Item 22 -- Number of Through Lanes (Required for all Interstate and sample sections) (Length = 2)

Enter the prevailing number of through lanes in both directions (excluding collector-distributor lanes, weaving lanes, frontage road lanes, parking and turning lanes, etc.) carrying through traffic in the off-peak period. Exclude truck climbing lanes unless the length and importance is sufficient to warrant inclusion. Other additional short-length lanes needed for toll booth operations, special emergency turnaround lanes, and deceleration lanes serving service stations and restaurants accessible under special circumstances in the roadway median, etc., should also be excluded.

Enter "00" for all non-applicable sections.

IV-18

Item 23 -- Record Continuation Code (Length = 5)

This field must be present in all records. It indicates what type of section record is being coded, consists of three elements, and is normally encoded by software. It consists of the following:

<u>Record Positions</u>	<u>Description</u>	<u>Code</u>
159-163	Indicates Universe Record, only	00000
159	Indicates Sample Record	1
160-161	Number of Structure ID's provided	xx
162-163	Number of Railroad Crossing ID's provided	yy

where "xx" and "yy" are counts of the ID's provided with leading zeroes coded. Enter "00" if none are reported.

Examples:

A sample section that has no ID's coded for either structures or railroad crossings	"10000"
A sample record with 4 railroad crossing ID's and no structure ID's	"10004"
A universe record	"00000"

NOTE: This is the end of the record for all non-sample sections.

SAMPLE SECTION CODING INSTRUCTIONS

Samples are obtained only from open-to-traffic, public road mileage under the jurisdiction of and maintained by a public authority.

Identification

Item 24 -- Sample Number (Length = 12)

Code the sample section identifier used for this section in the original HPMS submission or a unique number for a new sample section. This number may be route-milepoint or A-node, B-node, Segment, but, once coded, will be considered as a unique number that cannot change in the future. It will be assigned to all subdivided portions of the sample sections, as necessary.

IV-19

Item 25 -- Sample Subdivision (Length = 1)

This field will be used if it becomes necessary to subdivide a section due to operational or capital improvements on part of the section's length. Initially, this field is coded "0". If the section is subdivided over time, the code "0" is changed to 1, 2, 3, etc, depending upon the number of subdivisions (sections) created from the original section. Item 24, Sample Number, always remains the same.

Sample sections should be subdivided only when significant changes have occurred. Routine maintenance, short lengths of surfacing or sealing, or repair of several joints would not normally constitute a significant change. If more than nine subdivisions are proposed, it is suggested that the section be reviewed for recombination of contiguous subdivisions with similar characteristics. Recombining contiguous subdivisions that have become homogeneous should be done annually.

Computational Elements

Item 26 -- AADT Volume Group Identifier (Length = 2)

Enter the code representing the AADT volume group from which this sample section was selected. These codes are presented in Appendix F, Tables F-1 to F-3.

Item 27 -- Expansion Factor (Length = 6 -- xxx.xxx -- implied decimal)

Enter the factor to the nearest one-thousandth.

By definition, the expansion factor is the ratio of the total mileage in a volume group to the total sampled volume group mileage.

Expansion Factor = Total miles in the Volume Group / Sampled miles in the Volume Group

For small urban and rural areas, code the expansion factor for the volume group within the functional system to which the section belongs to the nearest thousandth. For urbanized areas, code the expansion factor for the volume group within the functional system and individual urbanized area or grouped urbanized areas to which the section belongs.

If, for any reason, the expansion factor for a given group exceeds 100.000, additional sections in the volume group must be selected for sampling until the expansion factor is reduced to a maximum of 100.000.

Item 27 (Cont.)

It should be stressed that the same expansion factor is used for all sample sections in the same volume group of a functional system (except for Interstate subcategories which are considered separately -- see Appendix H), and that it is normally calculated and encoded by software. A tabular summary of expansion factors by volume group within each functional system and geographic area will be prepared by the State and submitted along with the required data. HPMS Submittal Software (SELEXP option) will create the required table; this action is preferred by FHWA. However, if a State chooses to develop its own expansion factor table, the computer generated tables must still be executed to ensure that multiple expansion factors do not exist and that reported values are correct. The table would contain the following:

Table IV-1

Expansion Factor Computation

Area, System, and Volume Group	(A) Total Mileage of Sample Sections	(B) Total Mileage in Volume Group	(C) Expansion Factor Col B / Col A
-----+-----			
Rural, Interstate			
----- ----- -----			
Group 1			
Group 2			
Group 3			
etc.			
----- ----- -----			
Rural, Other Principal Arterial			
----- ----- -----			
Group 1			
Group 2			
Group 3			
etc.			
----- ----- -----			
Urban, etc.			
-----+-----			

IV-21

Pavement Attributes

Item 28 -- Surface/Pavement Type (Length = 2)

Enter the code that represents the type of surface on the section. These codes are consistent with the Financial Management Information System (FMIS).

Code Description

- 20 Unimproved Road -- A road using the natural surface and maintained to permit bare passability for motor vehicles, but not conforming to the requirements for a graded and drained road. The road may have been bladed and minor improvements may have been made locally. (Unpaved)
- 30 Graded and Drained -- A road of natural earth aligned and graded to permit reasonably convenient use by motor vehicles and with drainage systems (natural and artificial) sufficient to prevent serious impairment of the road by normal surface water. It is with or without dust palliative treatment or a continuous course of special borrow material to protect the new roadbed temporarily and to facilitate immediate traffic service. (Unpaved)
- 40 Soil, Gravel or Stone -- A road, the surface of which consists of mixed soil, stabilized soil, gravel or stone. Gravel or stone surfaces may also be stabilized. (Unpaved)
- 51 Bituminous Surface-Treated -- An earth road, a soil-surfaced road, or a gravel or stone road to which has been added by any process a bituminous surface course with or without a seal coat, the total compacted thickness of which is less than 1 inch. Seal coats include those known as chip seals, drag seals, plant-mix seals, and rock asphalt seals. (Low Type)
- 52 Mixed Bituminous -- A road, the surface course of which is 1 inch or greater and less than 7 inches in compacted thickness composed of gravel, stone, sand or similar material, and mixed with bituminous material under partial control as to grading and proportions. (Intermediate Type)
- 53 Bituminous Penetration -- A road, the surface course of which is 1 inch or greater and less than 7 inches in compacted thickness composed of gravel, stone, sand or similar material, bound with bituminous penetration material. (Intermediate Type)
- 61 High Flexible -- Mixed bituminous or bituminous penetration road on a flexible base with a combined (surface and base) thickness of 7 inches or more. Includes any bituminous concrete, sheet asphalt or rock asphalt having a high load-bearing capacity. (High Type Flexible)

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Item 28 (Cont.)

- 62 Composite; Flexible over Rigid -- Mixed bituminous or bituminous penetration road on a rigid pavement with a combined (surface and base) thickness of 7 inches or more. Includes any bituminous concrete, sheet asphalt or rock asphalt overlay that is greater than 1 inch of compacted bituminous material. Otherwise, use rigid pavement codes. (High Type Flexible)

NOTE: If applicable, codes 74, 75 and 76 have priority over other rigid surface type codes.

- 71 High Rigid; Plain Jointed -- Portland cement concrete pavement that is jointed but is without reinforcing. (High Type Rigid)
- 72 High Rigid; Reinforced Jointed -- Reinforced (with mesh or equivalent) portland cement concrete pavement that has been jointed. (High Type Rigid)
- 73 High Rigid; Continuously Reinforced -- Continuously reinforced portland cement concrete pavement. (High Type Rigid)
- 74 Rigid over Rigid; Bonded or Partially Bonded -- Portland Cement concrete pavement over a portland cement concrete pavement where the two separate layers have been bonded. (High Type Rigid)
- 75 Rigid over Rigid; Unbonded (i.e., bond breaker used) -- Portland cement concrete pavement over a portland cement concrete pavement where the two separate layers are unbonded. (High Type Rigid)
- 76 Rigid over Flexible -- Portland cement concrete pavements that have been placed over a bituminous (mixed or penetration) pavement. (High Type Rigid)
- 80 Brick, Block or Other Combination -- A road consisting of paving brick; stone, asphalt, wood and other block; steel or wood with or without a bituminous wearing surface less than 1 inch in compacted thickness. Includes roads with combination of wearing surfaces. (High Type Flexible)

Item 29 -- Concrete Joint Spacing (Length = 2)

This item is required for Interstate, Other Freeways and Expressways and Other Principal Arterials. Enter the joint spacing to the nearest foot. Code the leading zero where necessary. If there is no jointing or the surface type is not portland cement concrete, code "00". A weighted average is to be coded where the joint spacing is variable. Only the surface layer is to be considered. Construction joints (used primarily for continuously reinforced concrete pavements) are not to be considered. The intent of this item is to obtain a measure for all intentionally formed joints.

IV-23

Item 30 -- Load Transfer Devices (including dowel bars) (Length = 1)

Enter the code to indicate whether or not load transfer devices (including dowel bars) have been used in jointed portland cement concrete pavements. This item is required for Interstate, Other Freeways and Expressways and Other Principal Arterials. Only the surface layer is to be considered. Code "0" where this item is not applicable due to functional system or to surface type. Continuously reinforced Portland cement concrete surfaces would normally be jointless (except for construction joints) -- code "0" to indicate non-applicability.

Code Description

- 1 No load transfer devices have been used.
- 2 Load transfer devices have been used.

Item 31 -- Pavement Section (Length = 1)

Enter the appropriate code to indicate that the structural number (SN) for flexible pavements or the slab thickness (D) for rigid pavements is known or enter the code for the type of pavement section (heavy, medium, light) where SN or D are not reported. The SN or D, as appropriate, are required for Interstate, Other Freeways and Expressways and Other Principal Arterials. Where available, code SN or D for all functional systems. A roadway with at least 1 inch of compacted flexible overlay (disregarding short patches) is considered a flexible pavement for purposes of this code.

To assist in determining the type of pavement section for those sections where SN or D, as appropriate, are not required or are not available, Table IV-2 has been prepared showing typical pavement sections. This guide includes typical thicknesses of surface, base and subbase. Unpaved facilities are those designated as unimproved, graded and drained earth, gravel or stone (codes 20/30/40 in Item 28).

Code Description

- 0 Unpaved
- 1 "SN" known
- 2 "D" known
- 3 Heavy
- 4 Medium
- 5 Light

Item 31 (Cont.)

Table IV-2
Pavement Section Coding

Code	Type of Section	Flexible Pavement				Rigid Pavement
		"SN" Range	Surface Type & Min. Thick.	Base Type & Min. Thick.	Subbase Type & Min. Thick.	Range in Pavement Thickness "D"
3	Heavy	4.6-6.0	6" Asphaltic Concrete	12" Aggregate	13" Aggregate	> 9.0" (8" if continuously reinforced)
			4" Asphaltic Concrete	8" Asphaltic Concrete	8" Aggregate	
4	Medium	3.1-4.5	4" Asphaltic Concrete	8" Aggregate	8" Aggregate	7.1 - 9.0" (6" if continuously reinforced)
			3" Asphaltic Concrete	6" Asphaltic Concrete		
5	Light	1.0-3.0	Surface Treatment	4" Aggregate	4" Aggregate	6.0 - 7.0"
			2" Asphaltic Concrete	6" Aggregate		

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Item 32 -- Structural Number (SN) or Slab Thickness (D) (Length = 2)

This item is required for Interstate, Other Freeways and Expressways and Other Principal Arterials. Where available, code SN or D for all functional systems. Enter the SN value to the nearest tenth (x.x -- implied decimal) for those sections coded "1" in Item 31. Enter D (in inches) for those sections coded "2" in Item 31. Otherwise code "00".

Item 33 -- Type of Base (Length = 1)

This item is required for Interstate, Other Freeways and Expressways and Other Principal Arterials. Enter the code that describes the type of base. Use the highest numerical code where a mixture of materials have been used. Code "0" where this item is not applicable due to functional system requirements. The codes used for this item are consistent with the Financial Management Information System (FMIS) coding scheme. HPMS code "3" includes all stabilized FMIS codes of "3" to "7".

Code Description

- | | |
|---|---|
| 1 | Roadbed Soil. |
| 2 | Granular Material. |
| 3 | Stabilized earth or granular material with admixture (cement, lime, fly ash, asphalt, etc.) |
| 5 | Not applicable due to raised roadway (causeway, bridge deck, etc.) |
| 8 | Hot mix asphalt. |
| 9 | Lean concrete. |

Item 34 -- Type of Subgrade (Length = 1)

Enter the code that describes the type of material used for the subgrade on the section. This item is required for Interstate, Other Freeways and Expressways and Other Principal Arterials. Code "0" where this item is not applicable due to functional system requirements.

Code Description

- | | |
|---|--|
| 1 | Coarse graded material (gravel, sand, etc.) |
| 2 | Fine graded material (original earth, clay, etc.) |
| 5 | Not applicable due to raised roadway (causeway, bridge deck, etc.) |

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Item 35 -- Subsurface Drainage (Length = 1)

Enter the code that describes the subsurface drainage provided on the section for all Interstate, Other Freeways and Expressways and Other Principal Arterial sections. Code "0" where this item is not applicable due to functional system requirements. These codes are consistent with the Financial Information Management System (FMIS). The intent of this item is to obtain information about base drainage and edge drains, specifically. Ignore other types of drainage systems for HPMS purposes.

Code Description

- 1 Dense (undrainable) base without edge drains (i.e., no subsurface drainage).
- 2 Dense (undrainable) base with edge drains.
- 3 Drainable base without edge drains.
- 4 Drainable base with edge drains.
- 5 Not applicable due to raised roadway (causeway, bridge deck, etc.)

In the situation where edge drains no longer function, use "without edge drains" codes.

Item 36 -- Measured Pavement Roughness (Length = 3)

Zero-fill for unpaved roadways.

This item is required for all paved rural arterials and urban Interstate and other freeways and expressways. It is suggested for all other paved sample sections (see Table IV-3). Enter the actual calibrated roughness measurement to the nearest inch per mile. Provide leading zeroes for measurements less than "100". Enter "000" when not reported.

Appendix J contains requirements and references pertaining to equipment, calibration/correlation and data collection procedures. Note that calibration and data collection activities are to be conducted during stable pavement and weather conditions (no frost heave, freeze/thaw, wet conditions, etc.).

Table IV-3

Roughness Reporting Requirements

Functional System	Roughness
Rural:	
Interstate	Required
Other Principal Arterial	Required
Minor Arterial	Required
Major Collector	Suggested
Minor Collector	Suggested
Urban:	
Interstate	Required
Other Fwys and Exprswys	Required
Other Principal Arterial	Suggested
Minor Arterial	Suggested
Collector	Suggested

Item 37 -- Reserved for Federal Use (Length = 12)

This field shall be zero-filled when not using the HPMS Submittal Software to update and maintain the data. The HPMS software will zero-fill, otherwise.

Item 38 -- Pavement Condition (Length = 2 -- x.x -- implied decimal)

Enter the pavement condition, actual Present Serviceability Rating (PSR) or equivalent, to the nearest tenth, for all paved sections. For unpaved sections (defined in Item 31), code "00". The ratings are equivalent to those used in making a PSR, so recent PSR and Present Serviceability Index (PSI) ratings may be used where available. Also if current sufficiency ratings of pavement condition (but excluding geometrics) are available, a correlation between the sufficiency rating scale and the PSR scale or rating factors may be developed so that such existing ratings may be used.

If there are no recent PSR, PSI, or sufficiency ratings that can be adapted, the section should be rated from the following table. In view of the growing national concern regarding pavement deterioration, careful attention to realistic pavement condition ratings is strongly suggested. Estimates to the nearest tenth within the applicable range should be made, e.g. -- 2.3. This is most important for comparisons to prior years. Where different lanes have different pavement condition ratings, code the worst condition.

Item 38 (Cont.)

Table IV-4

Pavement Condition Rating

(Use full range of values)

PSR & Verbal Rating	Description
5.0	
Very Good	Only new (or nearly new) pavements are likely to be smooth enough and sufficiently free of cracks and patches to qualify for this category. All pavements constructed or resurfaced during the data year would normally be rated very good.
4.0	
Good	Pavements in this category, although not quite as smooth as those described above, give a first class ride and exhibit few, if any visible signs of surface deterioration. Flexible pavements may be beginning to show evidence of rutting and fine random cracks. Rigid pavements may be beginning to show evidence of slight surface deterioration, such as minor cracks and spalling.
3.0	
Fair	The riding qualities of pavements in this category are noticeably inferior to those of new pavements, and may be barely tolerable for high speed traffic. Surface defects of flexible pavements may include rutting, map cracking, and extensive patching. Rigid pavements in this group may have a few joint failures, faulting and cracking, and some pumping.
2.0	
Poor	Pavements that have deteriorated to such an extent that they affect the speed of free-flow traffic. Flexible pavement may have large potholes and deep cracks. Distress includes ravelling, cracking, rutting, and occurs over 50 percent or more of the surface. Rigid pavement distress includes joint spalling, faulting, patching, cracking, scaling, and may include pumping and faulting.
1.0	
Very Poor	Pavements that are in an extremely deteriorated condition. The facility is passable only at reduced speeds, and with considerable ride discomfort. Large potholes and deep cracks exist. Distress occurs over 75 percent or more of the surface.
0.0	

IV-29

Item 39 -- Overlay or Pavement Thickness (Length = 3 -- xx.x -- implied decimal)

Enter the overlay pavement thickness or the pavement thickness (for new pavements) to the nearest tenth (in inches) when an improvement has been completed on the section. This item is intended to be coded when resurfacing is accomplished as part of any improvement or when the pavement is completely reconstructed. It shall remain fixed (retained in the HPMS data record) until another resurfacing/reconstruction improvement is completed on the section. Code "000" initially.

All Type of Improvement codes (Item 41), with the possible exception of "40", "50" and "60" (Major or Minor Widening and Restoration and Rehabilitation), would cause a change to this item (or the initial coding of this item). When this item is changed (or initially coded), Item 40, Year of Surface Improvement, should also be changed.

The thickness reported here should include all newly laid pavement including replacement pavement material where milling has occurred.

Improvements

Item 40 -- Year of Surface Improvement (Length = 4)

Enter the year when a surface improvement (e.g., resurfacing or reconstruction, including new samples selected on newly constructed or improved roadway facilities) has been completed on the section; e.g., 1988 would be coded "1988". Do not remove this entry in subsequent data years (it shall be retained in the HPMS data record until another improvement affecting the surface is completed on the section). Initially, (for existing non-improved sections) this field should be coded "0000".

All Type of Improvement codes (Item 41), with the possible exception of "40", "50" and "60" (Major or Minor Widening and Restoration and Rehabilitation), would cause a change to this item (or the initial coding of this item). If this field is changed (or initially coded), check to see if Item 39, Overlay or Pavement Thickness, should also be changed.

Item 41 -- Type of Improvement (Length = 2)

This item is coded as defined below for all improvements completed during the reporting year. If completed improvements overlap, use the improvement type code with the highest priority (lowest numerical code). If no improvements were completed during the reporting year, the section shall retain the last improvement type coded. Do not include routine maintenance. Code "00", initially. The codes are consistent with the Financial Management Information System (FMIS), but contain an extra digit in some instances, and are somewhat more elaborate in other cases.

If only a portion of the section was improved and completed during the reporting year, the section should be split into two or more segments at the point(s) of change. Use one of the following codes:

Item 41 (Cont.)

Code

Improvement Type Definitions

- 10 NEW ROUTE -- The only time this code could possibly be used is when a new sample has been randomly chosen on a newly constructed roadway that was completed and opened to traffic in the data year being reported.
- 20 RELOCATION -- Construction of a facility on new location that replaces an existing route to the extent that the old route is abandoned. If the existing facility remains in use as a collector or higher functional system, do not code the improvement and retain the old facility as the sample with no improvement (unless the old facility was also improved). If the existing facility is abandoned, the sample should be placed (selected) on the new facility and coded with this improvement type; if the existing location becomes a local functional system facility, delete the sample.
- RECONSTRUCTION -- Construction on approximate alignment of an existing route where the pavement structure is substantially removed and replaced. Such reconstruction may include widening to provide additional through lanes, adding grade separations, and replacing other highway elements. Adjustment to existing horizontal and vertical alignment can be made. Code one of the following types of reconstruction (Codes 31 to 35). The last digit of each code corresponds to the FMIS codes.
- 31 RECONSTRUCTION TO FREEWAY -- Complete reconstruction to freeway design standards on substantially existing alignment. This improvement type always includes the addition of full control of access. It may include the addition of through lanes, dualizing, addition of interchanges or grade separations, or widening of through lanes, depending on what was required to bring the facility to freeway standards.
- 32 RECONSTRUCTION WITH MORE LANES -- Complete reconstruction on substantially the same alignment with the addition of through lanes to the existing section. Alignment, shoulder, and drainage deficiencies are corrected.
- 33 RECONSTRUCTION TO WIDER LANES -- Complete reconstruction on substantially the same alignment with through lanes at least one foot wider than the existing section. Alignment, shoulder, and drainage deficiencies are corrected.
- 34 PAVEMENT RECONSTRUCTION WITH ALIGNMENT IMPROVEMENTS -- Reconstruction of the highway section to correct a pavement deficiency. Specific horizontal or vertical alignment deficiencies are also corrected.
- 35 PAVEMENT RECONSTRUCTION -- Complete reconstruction on substantially the same alignment without widening the pavement structure. Drainage deficiencies and minor alignment deficiencies are corrected.

IV-31

Item 41 (Cont.)

<u>Code</u>	<u>Improvement Type Definitions</u>
40	MAJOR WIDENING -- The addition of through lanes or dualization of an existing facility where the existing pavement is salvaged. Also included, where necessary, is the resurfacing of existing pavement and other incidental improvements such as drainage and shoulder improvements.
50	MINOR WIDENING -- The addition of more width per through lane to the roadway of an existing facility without adding through lanes. The existing pavement is salvaged. In many cases, the improvement will include resurfacing the existing pavement and other incidental improvements such as shoulder and drainage improvements.
60	RESTORATION AND REHABILITATION -- Work required to return an existing pavement (including shoulders) to a condition of adequate structural support or to a condition adequate for placement of an additional stage of construction. There may be some upgrading of unsafe features or other incidental work in conjunction with restoration and rehabilitation. Typical improvements would include replacing spalled or malfunctioning joints; substantial pavement stabilization prior to resurfacing; grinding/grooving of rigid pavements; replacing deteriorated materials; reworking or strengthening bases or subbases, and adding underdrains. If this type of improvement is done in preparation for resurfacing, it should be reported separately only if the resurfacing is not completed in the year for which the data is reported. This HPMS code would include FMIS Type of Rehabilitation codes of "01" and "02" (subsealing, joint repair, diamond grinding, milling, inlays, etc.)
71	RESURFACING WITH SHOULDER IMPROVEMENTS AND PORTLAND CEMENT CONCRETE PAVEMENT RESTORATION -- Placement of additional portland cement concrete material over the existing roadway to improve serviceability or to provide additional strength. Shoulders are widened or reconstructed to provide additional strength. There may be some upgrading of unsafe features and other incidental work. This code should also be used when concrete restoration includes techniques such as sub-sealing, joint repair, diamond grinding, etc. Where surfacing is constructed by separate project as a final stage of construction, the type of improvement should be the same as that of the preceding stage ---relocation, reconstruction, minor widening, etc.
72	RESURFACING WITH SHOULDER IMPROVEMENTS AND BITUMINOUS PAVEMENT RESTORATION -- Placement of at least 1 inch of compacted bituminous material over the existing roadway to improve serviceability or to provide additional strength. Shoulders are widened or reconstructed to provide additional strength. There may be some upgrading of unsafe features and other incidental work. Where surfacing is constructed by separate project as a final stage of construction, the type of improvement should be the same as that of the preceding stage --- relocation, reconstruction, minor widening, etc.

IV-32A

GENERAL GUIDELINES for coding Number of Through Lanes (Item 22), Lane Width (Item 43), Shoulder Type (Item 44), Shoulder Width (Item 45) and Peak Parking (Item 65)

All of these data items need to be considered together in order to properly code them for HPMS. The normal descriptions are given under the respective data item. This section simply provides some additional guidelines where the coding of one item depends on one of the other items.

The number of through lanes and the lane width should be coded according to the striping, if present, or according to the usage if no striping or only centerline striping is present. The roadway beyond the ends of the sample section being inventoried may be considered when the number of lanes and the lane width, in particular, are being coded. For example, if the sample section is short and atypically wider than the rest of the contiguous roadway, code the typical roadway usage according to the rest of the roadway for these two data items.

Shoulder width (or lane width) cannot include parking lanes, bicycle lanes or bikeways. There is no shoulder (or shoulder width) under these circumstances. If there is parking on one side of a roadway and a shoulder or a curb on the other side, code both parking and shoulder type (and shoulder width), accordingly.

A shoulder cannot exist between a traffic lane and a parking lane that is completely within the roadway boundaries. Code no shoulder and zero (00) shoulder width under this circumstance. Code the lane width as it is actually being used.

As with all HPMS data items, code the lesser or worse condition where the two sides of the roadway differ.

It is recognized that the total roadway width may not be fully represented under a few of the coding schemes that would develop under these guidelines. Under these situations, the "lost" roadway area is considered to be for acceleration/deceleration, parking movement, driveway turning, weaving, etc., for which there are no data items in HPMS.

IV-33

Item 43 -- Lane Width (Length = 2)

Enter the prevailing traffic lane width (through lanes) to the nearest foot. Provide the leading zero for lane widths less than 10 feet. There are situations where the traffic lane and the shoulder have the same surface with no delineation to distinguish the lane from the shoulder. In such cases, use a reasonable width for each based on the actual width used by traffic. For example, a 32-foot total paved surface width with centerline striping only and no additional shoulder width, could be coded as 12-foot lanes with 4-foot shoulders. See the "GENERAL GUIDELINES", above, for further coding applications.

In some situations, striping is placed inside the edge of the pavement in order to keep traffic (particularly trucks) from raveling the edge. Ignore the striping and code the actual lane width under this situation. For example, a 2-lane roadway that contains a solid stripe one foot inside the edge of the roadway (to the left of the right shoulder), having a width from centerline to edge-striping of 11 feet, should be coded as 12 feet.

Item 44 -- Shoulder Type (Length = 1)

Enter the code for the predominant type of shoulder on the section. If left and right shoulder types differ on a multilane facility, the right shoulder type should be considered to be the predominant type. If the section has both shoulders and curbs (i.e., a shoulder bounded by a curb or a mountable curb and then a shoulder), code the shoulder. See the "GENERAL GUIDELINES" above Item 43, Lane Width, for further coding applications. These codes are consistent with the Financial Management Information System (FMIS).

Code Description

- 1 None -- No shoulders or curbs exist.
- 2 Surfaced with Bituminous Material -- A bituminous course over a granular or stabilized base.
- 3 Surfaced with Portland Cement Concrete (not tied) -- A portland cement concrete course over a granular or stabilized base.
- 4 Surfaced with Tied Portland Cement Concrete -- A portland cement concrete course over a granular or stabilized base that is part of the mainline pavement.
- 5 Stabilized -- A gravel or other granular material, with or without admixture, capable of supporting most loads even under wet conditions.
- 6 Combination -- A part of the shoulder width is surfaced and/or a part is stabilized, and/or a part is turf, etc. -- some combination of codes 2-5, 7.
- 7 Earth -- Natural earth with or without turf.
- 8 Curbed -- No shoulders exist; section is curbed.

Item 45 -- Shoulder Width (Length = 4)

- 45a -- Right Shoulder -- Enter the width to the nearest foot. Enter "00" if no right shoulder exists. (Length =2)
- 45b -- Left Shoulder -- On divided highways, enter the width of the left (median) shoulder to the nearest foot. Enter "00" where no left shoulder exists. (Length = 2)

Do not include parking or bicycle lanes. Use the predominant width where it is not constant. Particular attention should be paid to "combination" shoulders to ensure that the total width is being reported. See the "GENERAL GUIDELINES" above Item 43, Lane Width, for further coding applications.

Item 46 -- Median Type (Length = 1)

Enter one of the following codes:

<u>Code</u>	<u>Description</u>
1	Curbed
2	Positive Barrier
3	Unprotected
4	None

A positive barrier would normally consist of guard-rail or concrete, but could consist of a line of closely-spaced (large) trees or of thick, impenetrable shrubbery on most of the section. Turning lanes or bays are not considered medians unless a median exists on the major portion of the roadway, and the turning lanes/bays are cut into the median at intersections, entrances to commercial enterprises, etc.

Item 47 -- Median Width (Length = 2)

Enter the predominant median width (including shoulders, if any), measured between the inside edges of the through roadways, to the nearest foot. Enter "00" for undivided roadways. Enter "99" where the median width is 100 feet or greater. Ignore turning bays cut into the median.

Item 48 -- Existing Right-of-Way Width (Length = 3)

Enter the prevailing right-of-way width in feet for the section. Where data are unavailable, estimates are sufficient. In heavily built up areas such as the CBD where the only space between the curbs and buildings is the sidewalk area, enter the curb-to-curb width. Code "999" where the right-of-way is 1000 feet or greater. Provide leading zeroes, where necessary.

IV-35

Item 49 -- Is Widening Feasible? (Length = 1)

Enter the appropriate code to indicate the extent to which it is feasible to widen the existing road. Consider only the physical features along the roadway section, such as numerous large buildings, severe terrain, cemeteries and park land; do not consider restrictions because of current right-of-way width, State practices concerning widening, politics or projected traffic. Single-family residences, barns, private garages, etc. are considered expendable for purposes of this item. Office buildings, shopping centers and other large enterprises would not be considered expendable. The code is to represent the lanes that could be added in both directions, e.g. if a lane could be added for each direction of the roadway, then use code "4"; if only some widening could occur (a few feet, perhaps), use code "2".

Restriping to narrower lanes, such that an additional lane results in a multilane facility, does not constitute widening feasibility. When coding this item, medians and other areas already within (as well as outside) the right-of-way are considered to be available for widening.

<u>Code</u>	<u>Description</u>
1	No widening is feasible
2	Yes, partial lane
3	Yes, one lane
4	Yes, two lanes
5	Yes, three lanes or more

Items 50-53 -- Coding Guide for Horizontal and Vertical Alignment

Table IV-5

Highway Category	Item 50- Horizontal Alignment Adequacy	Item 51- Curves by Class	Item 52- Vertical Alignment Adequacy	Item 53- Grades by Class
Paved -- Rural				
Principal Arterial	Code "0"	Required	Code "0"	Required
Minor Arterial	Code "0"	Required	Code "0"	Required
Major Collector	Required	Not Req'd	Required	Not Req'd
Minor Collector	Required	Not Req'd	Required	Not Req'd
Paved -- Urban				
Principal Arterial	Code "0"	Required	Code "0"	Required
Minor Arterial	Not Req'd	Not Req'd	Not Req'd	Not Req'd
Collector	Not Req'd	Not Req'd	Not Req'd	Not Req'd

IV-36

Item 50 -- Horizontal Alignment Adequacy (Rural only) (Length = 1)

This item is required for paved rural collectors unless Item 51, Curves by Class, is present. (See Table IV-5, above.) Code "0" when Item 51 is reported (the HPMS calculation software will insert an appropriate value) or when this item is not required. If Item 51 is not reported for the required systems (rural arterials and urban principal arterials) this item should be appropriately coded. The following codes will be used:

<u>Code</u>	<u>Description</u>
1	All curves meet appropriate design standards for the type of roadway. Reduction of curvature would be unnecessary even if reconstruction were required to meet other deficiencies (i.e., capacity, vertical alignment, etc.).
2	Although some curves are below appropriate design standards for new construction, all curves can be safely and comfortably negotiated at the prevailing speed limit on the section. The speed limit was not established by the design speed of curves.
3	Infrequent curves with design speeds less than the prevailing speed limit on the section. Infrequent curves may have reduced speed limits for safety purposes.
4	Several curves uncomfortable and/or unsafe when traveled at the prevailing speed limit on the section, or the speed limit on the section is severely restricted due to the design speed of curves.

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Item 51 -- Curves by Class (Length = 91)

This item is required for paved rural arterials (Interstate, other principal arterial and minor arterial) and urban principal arterials (Interstate, other freeways and expressways and other principal arterial), but may be reported for other functional systems if the data are available. (See Table IV-5, above.) Zero-fill this item when it is not reported. When this item is not reported for the required systems, Item 50, Horizontal Alignment Adequacy should be coded. The following data will be reported:

	Curve Classes by Degree of Curvature	No. of Curves (right- justified)	Record Positions	Length of Curves in Class (implied decimal) (xx.xxx miles)	Record Positions
a.	0.0-0.4	--	238-239	-----	240-244
b.	0.5-1.4	--	245-246	-----	247-251
c.	1.5-2.4	--	252-253	-----	254-258
d.	2.5-3.4	--	259-260	-----	261-265
e.	3.5-4.4	--	266-267	-----	268-272
f.	4.5-5.4	--	273-274	-----	275-279
g.	5.5-6.9	--	280-281	-----	282-286
h.	7.0-8.4	--	287-288	-----	289-293
i.	8.5-10.9	--	294-295	-----	296-300
j.	11.0-13.9	--	301-302	-----	303-307
k.	14.0-19.4	--	308-309	-----	310-314
l.	19.5-27.9	--	315-316	-----	317-321
m.	28+	--	322-323	-----	324-328

The format is a 91-position field with 13 classes of curves reported (13 x 7). For each of the 13 curve classes, the numbers of curves (2 positions) and class length (5 positions, with implied decimal (xx.xxx mile)) are reported. The sum of the lengths of curves must equal the section length.

Item 52 -- Vertical Alignment Adequacy (Rural only) (Length = 1)

This item is required for paved rural collectors unless Item 53, Grades by Class, is present. (See Table IV-5, above.) Code "0" when Item 53 is reported (the HPMS calculation software will insert an appropriate value) or when this item is not required. If Item 53 is not reported for the required systems (rural arterials and urban principal arterials) this item should be appropriately coded. The following codes will be used:

<u>Code</u>	<u>Description</u>
1	All grades (rate and length) and vertical curves meet minimum design standards appropriate for the terrain. Reduction in rate or length of grade would be unnecessary even if reconstruction were required to meet other deficiencies (i.e., capacity, horizontal alignment, etc.).
2	Although some grades (rate and/or length) and vertical curves are below appropriate design standards for new construction, all grades and vertical curves provide sufficient sight distance for safe travel and do not substantially affect the speed of trucks.
3	Infrequent grades and vertical curves that impair sight distance and/or affect the speed of trucks (when truck climbing lanes are not provided).
4	Frequent grades and vertical curves that impair sight distance and/or severely affect the speed of trucks; truck climbing lanes are not provided.

IV-39

Item 53 -- Grades by Class (Length = 42)

This item is required for paved rural arterials (Interstate, other principal arterial and minor arterial) and urban principal arterials (Interstate, other freeways and expressways and other principal arterial), but may be reported for other functional systems if the data are available. (See Table IV-5, above.) Zero-fill this item when it is not reported. When this item is not reported for the required systems, Item 52, Vertical Alignment Adequacy should be coded. The following data will be reported:

	Grade Classes by Gradient (percent)	No. of Grades (Right- Justified)	Record Positions	Length of Grades in Class (implied decimal) (xx.xxx miles)	Record Positions
a.	0.0-0.4	--	330-331	-----	332-336
b.	0.5-2.4	--	337-338	-----	339-343
c.	2.5-4.4	--	344-345	-----	346-350
d.	4.5-6.4	--	351-352	-----	353-357
e.	6.5-8.4	--	358-359	-----	360-364
f.	8.5 +	--	365-366	-----	367-371

The format is a 42-position field with 6 classes of grades reported (6 x 7). For each of the 6 grade classes, the numbers of grades (2 positions) and the grade length (5 positions, with implied decimal (xx.xxx miles)) are reported. The sum of the lengths of grades must equal the section length.

Item 54 -- Percent of Length with Sight Distance of 1500 Feet (Rural, paved 2-lane facilities only) (Length = 3)

For all rural, paved two-lane facilities, excluding dense rural sections, enter the percent of the section length (estimated to the nearest 10 percent) which has an available passing sight distance (as measured from the driver's eye to the road surface) of at least 1500 feet. Striping should be used for this measurement where it delineates unsafe passing zones. Contiguous roadway on both ends of the section are to be considered in estimating this item, particularly where the section is very short (i.e., 1500 feet = .28 mile). Where there is a discernable directional difference, enter the more restrictive sight distance percentage. See Appendix C for optional estimating procedures. Code "000" for nonapplicable sections including dense rural.

Traffic/Capacity

Item 55 -- Speed Limit (Length = 2)

Enter the daytime speed limit (for automobiles) posted or legally mandated on the greater part of the section.

Item 56 -- Weighted Design Speed (Rural only) (Length = 2)

This item is required for all paved rural collectors with type of development -- rural (Item 71 = 1). Code "00" for all sections for which the weighted design speed is not supplied. Enter the weighted design speed, to the nearest 5 m.p.h., as determined by weighting the design speed of the individual horizontal curves and tangents in the section by the length of each. This item is calculated by the HPMS Submittal Software when Curves by Class (Item 51) are present. When Curves by Class are not provided for the required systems (rural arterials and urban principal arterials), this item must be appropriately coded. A recommended procedure for calculating weighted design speed is contained in Appendix D.

Item 57 -- Percent Commercial Vehicles (Peak and Off-Peak) (Length = 4)

Enter the percentage of commercial vehicles to the nearest whole percent. Commercial vehicles include classes 4 through 13 (buses through seven-or more axle, multi-trailer trucks) as identified in Chapter II and in the Traffic Monitoring Guide (TMG). These vehicle classes are discussed in Chapter 3 of the TMG, and exclude pickups, panels, etc.

Certain routes may exhibit significant differences in commercial vehicle percentages between peak and non-peak hour operation (i.e., recreational routes), and such differences can have a significant bearing on the calculation of capacity. In those cases where the State determines that such peak operations have a significant bearing on capacity calculations, separate peak usage values are to be reported even if they must be estimated. In those situations where such differences are known not to exist, the same percentage should be reported for both peak and non-peak.

The vehicle classification data reported for each sample section should be representative of the commercial vehicle activity over all days of the week and seasons of the year.

57a -- Peak Percent Commercial Vehicles (Length = 2)

57b -- Off-Peak Percent Commercial Vehicles (Length = 2)

Item 58 -- K-Factor (Length = 2)

Enter the K-factor -- the design hour volume (30th highest hour) -- as a percentage of the annual average daily traffic, to the nearest percent.

Item 59 -- Directional Factor (Length = 3)

Enter the percentage of the design hour volume (30th highest hour) flowing in the peak direction, to the nearest 5 percent. Code "100" for one-way facilities. Provide leading zeroes, where necessary.

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Item 60 -- Peak Capacity (Length = 5)

Urban Areas

Enter the present hourly capacity (in one direction) reflecting the peak-period situation, taking into consideration the peak-period parking regulations, signalization, local bus movements, etc. The procedures described in the 1985 "Highway Capacity Manual" (HCM) should be used for these calculations. For purposes of this data element, a service flow consistent with Level of Service "E" as defined in the 1985 HCM should be calculated.

Often, urban street capacity is governed by a critical intersection in the section under study. When this is the case, code the capacity for the critical intersection. Otherwise, code the capacity of a typical intersection. Where detailed information is not known, assumptions will necessarily have to be made regarding such items as percent right and left turns in order to calculate capacity by section.

Rural (Optional)

Enter the present hourly capacity (total of both directions for two-lane facilities and for one direction on multi-lane facilities). Capacity is the maximum service flow at Level of Service "E", as described in the 1985 HCM. The procedures described in the HCM should be used for this calculation; however, the rural capacity is normally calculated by the HPMS Submittal Software (see Chapter VI under the SELCALC option).

In built-up areas of small towns (population less than 5,000), it may be more reasonable to calculate capacity using the procedures described in the HCM for urban areas, but the capacity should still be reported as a total of both directions for two-lane facilities and for one direction on multi-lane facilities. It is requested that a capacity for dense rural sections be coded as it is very difficult to calculate a reasonable value based on the data reported.

This field should be zero filled when not reported.

The procedures used by the HPMS Submittal Software to calculate rural capacity are given in Appendix L.

Item 61 -- Volume/Service Flow Ratio (V/SF) (Length = 3 -- x.xx -- implied decimal)

This field is generated by the HPMS Submittal Software from data within the HPMS record. Appendix M contains the formulas.

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Item 62 -- Turning Lanes (Urban Data Item) (Length = 2)

Enter the code (one each for left and right) that best describes the peak-period turning lane situation for a typical intersection on the section. Where peak capacity (Item 60) has been entered for a particular (critical) intersection, code the turning lanes at that intersection; otherwise code for a typical intersection. Ignore turning lanes/bays that are not located at intersections (at commercial entrances, for instance). Code "0" for rural sections or when no intersections exist on the section.

LEFT Turning Lanes/Bays (Length = 1)

Code Description

- 1 Multiple left turning lanes/bays exist (includes a continuous left turning lane that becomes multiple left turn bays just prior to the intersection). Through movements are prohibited in these lanes.
- 2 A continuous left turning lane exists from intersection to intersection. Through movements are prohibited in this lane.
- 3 A single left turning bay exists.
- 4 No left turning lanes/bays exist (intersections do exist).
- 5 No left turns are permitted during the peak period.

RIGHT Turning Lanes/Bays (Length = 1)

Code Description

- 1 Multiple right turning lanes/bays exist (includes a continuous right turning lane that becomes multiple right turn bays just prior to the intersection). Through movements are prohibited in these lanes.
- 2 A continuous right turning lane exists from intersection to intersection. Through movements are prohibited in this lane.
- 3 A single right turning bay exists.
- 4 No right turning lanes/bays exist (intersections do exist).
- 5 No right turns are permitted during the peak period.

Examples:

- (1) A critical intersection with signals on a section contains 2 left turn lanes and a right turn bay; code "13".
- (2) No signal controlled intersections exist on a section with 3 intersections. One of the intersections has a turn bay for right turns; however, the capacity entered in Item 60 did not take the right turn bay into consideration. The code would be "44" for the section.

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Item 63 -- Prevailing Type of Signalization (Urban Data Item)
(Length = 1)

Enter the appropriate code that best describes the predominant signal system on the section. Code "0" for rural sections.

Code Description

- 1 Uncoordinated Fixed Time (includes pre-programmed changes for rush hour or other time periods)
- 2 Traffic Actuated
- 3 Progressive (coordinated signals)
- 4 No Signal System

Item 64 -- Typical Peak Percent Green Time (Urban Data Item)
(Length = 2)

Enter the typical percent green time in effect during peak hours at the signalized intersections for the route which is being inventoried. Enter "00" if no signalized intersections exist. Where signals are traffic actuated, code an estimated average green time during peak hours. Ignore green-arrow time for turning movements -- this item is intended to obtain through movement green time. Code "00" for rural sections.

Item 65 -- Peak Parking (Urban Data Item) (Length = 1)

Enter the appropriate code reflecting the type of peak-hour parking, if any, that exists on the section. If parking prohibitions are routinely ignored, use the "permitted" code(s) to reflect the actual situation rather than the regulations. The facility does not have to be formally signed or striped for parking to use the "permitted" code(s) (i.e., parking is simply available). If parking is actually beyond the shoulder (or beyond the pavement edge where no shoulder exists), use code "3" for no parking. Code "0" for rural sections. See the "GENERAL GUIDELINES" above Item 43, Lane Width, for further coding applications.

Code Description

- 1 Parking permitted one side
- 2 Parking permitted both sides
- 3 No parking allowed or none available

Item 66 -- Future AADT (Length = 6)

Enter the forecasted annual average daily traffic (AADT) (total both directions) for the appropriate year entered in Item 67, Year of Future AADT. This cannot be for less than 17 years nor for more than 22 years. The intent is to obtain a 20-year forecast, but it may be for some other period of time that is within the noted timespan. For example, the future AADT may be for any of the years 2006 to 2011 for the 1989 data year to be reported in 1990. This item may be updated anytime, but must be updated when the forecast falls below the 17-year limit.

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Item 67 -- Year of Future AADT (Length = 2)

Enter the last two digits of the year for which Item 66, Future AADT has been forecasted. This cannot be less than 17 years nor more than 22 years from the data year. For example, a 20-year forecast reported for the 1989 data year would be coded "09" (for the year, 2009).

Environment

Item 68 -- General Climate Zone (Length = 2)

This code is entered by the HPMS Submittal Software via the SELCALC option with the CZONE suboption from county/climate zone equivalency tables. It should be checked by the State and may be changed if found not to be representative of the area in question. Once corrected, there should be no further need for change except under extraordinary situations. Note that if the county code is changed using the SELMODU option, the climate zone will be updated, if necessary, by the HPMS Submittal Software. If county codes are updated via a State procedure, the climate zone should be updated via the SELCALC option. The definitions for the 9 possible climate zones are contained in Appendix S.

Item 69 -- Drainage Adequacy (Length = 1)

Enter the code for the drainage adequacy of the section. Adequacy is based on the height of the grade line, the design of the cross section, and the capability of the cross drains, both in condition and capacity, to maintain a well-drained surface on a stable subgrade.

Code Rating

- | | |
|---|--|
| 1 | Good -- Fully adequate drainage and cross section design. No evidence of flooding, erosion, ponding, or other water damage. |
| 2 | Fair -- Height of grade line, cross section, or culvert capacity somewhat below the standard for the type of roadway that would comply with standards if rebuilt. Drainage structures are structurally sound. Some added maintenance effort required due to drainage and sedimentation problems. |
| 3 | Poor -- Evidence of severe flooding, ponding, erosion, or other drainage problems. Drainage structures may be in poor condition. Considerable excess maintenance effort required due to drainage and sedimentation problems. |

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Item 70 -- Type of Terrain (Rural Data Item) (Length = 1)

Enter the code for the predominant terrain type through which the section passes. Code "0" for urban sections.

<u>Code</u>	<u>Terrain Type</u>
1	Flat Terrain -- That condition where highway sight distances, as governed by both horizontal and vertical restrictions, are generally long or could be made to be so without construction difficulty or major expenses.
2	Rolling Terrain -- That condition where the natural slopes consistently rise above and fall below the highway grade line and where occasional steep slopes offer some restriction to normal highway horizontal and vertical alignment.
3	Mountainous Terrain -- That condition where the longitudinal and transverse changes in the elevation of the ground with respect to the highway are abrupt and where the roadbed requires frequent benching or side hill excavation.

Item 71 -- Type of Development (Rural Data Item) (Length = 1)

Enter the code for the predominant type of development. Code "0" for urban sections.

<u>Code</u>	<u>Description</u>
1	Rural -- All areas outside of Federal-aid urban boundaries (places of 5,000 or more population), excluding those described as "dense".
2	Dense -- Those areas outside of Federal-aid urban boundaries which have urban characteristics (i.e., small towns) or areas in which major recreational facilities, such as parks, ski resorts, scenic overlooks, and rest areas, have significant impact on traffic operation of the adjacent facility.

Item 72 -- Urban Location (Urban Data Item) (Length = 1)

Enter the appropriate code that best reflects present land use in the area adjacent to the section. If an area appears to fit two of these categories, the code for the higher density of development should be used (lower numerical code). Code "0" for rural sections.

Code Description

- 1 Central Business District (CBD) -- That portion of a municipality in which the dominant land use is for intense business activity. The CBD is characterized by large numbers of pedestrians, commercial vehicle loadings of goods and people, a heavy demand for parking space, and high parking turnover.
- 2 Fringe -- That portion of a municipality immediately outside the CBD in which there is a wide range in type of business activity, generally including small businesses, light industry, warehousing, automobile service activities, and intermediate strip development, as well as some concentrated residential areas. Most of the traffic in this area involves trips that do not have an origin or destination within the area. This area is characterized by moderate pedestrian traffic and a lower parking turnover than is found in the CBD, but may include large parking areas serving that district.
- 3 Outlying Business District -- That portion of a municipality or an area within the influence of a municipality, normally separated by some distance from the CBD and its fringe area, and in which the principal land use is for business activity. This district has its own local traffic circulation superimposed on through movements to and from the CBD, a relatively high parking demand and turnover, and moderate pedestrian traffic. Compact off-street shopping developments entirely on one side of the street are not included in the scope of this definition.
- 4 Residential -- That portion of a municipality, or an area within the influence of a municipality, in which the dominant land use is residential development, but where small businesses may be included. This area is characterized by few pedestrians and a low parking turnover.
- 5 Rural in character.

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Item 73 -- Number of Grade-Separated Interchanges (Length = 2)

For all freeway and expressway facilities enter the number of grade-separated interchanges. If a section begins and ends with an interchange, only one of the interchanges is counted. The direction of inventory should always be consistent, statewide, (i.e., increasing milepoint or east to west or south to north, etc.) for all sections. Enter "00" if none exist or if the facility being sampled is not a freeway or an expressway.

An expressway is defined as a divided highway for through traffic with full or partial access control and including grade separations at all or most major intersections. A freeway is defined as an expressway with full control of access.

Item 74 -- Number of At-Grade Intersections with Public Roads
(Length = 6)

This data item pertains to the type of traffic controls on the route being inventoried and not those of the intersecting route. It consists of three elements. Only those controls facing (controlling) the route being inventoried are counted. If a section begins and ends with an intersection, only one of the intersections is counted. The direction of inventory should always be consistent, statewide, (i.e., increasing milepoint or east to west or south to north, etc.) for all sections. Controls at shopping centers, industrial parks and other large traffic generating enterprises, should be included.

74a -- Signals -- Enter the number of intersections with a signal controlling the route being inventoried. If none, enter "00". A signal that cycles through red, yellow, and green for all or a portion of the day shall be counted as a signalized intersection. (Length = 2)

74b -- Stop Signs -- Enter the number of intersections with a stop sign controlling the route being inventoried. A continuously-operating, flashing red signal shall be counted as a stop sign control. If none, code "00". (Length = 2)

74c -- Other or No Controls -- Enter the number of intersections where the route being inventoried is not controlled by either a signal or a stop sign -- or is controlled by other types of signing or has no controls. A continuously-operating, flashing yellow signal shall be considered as "other or no control". If none, code "00". (Length = 2)

Item 75 -- Number of Structures (Length = 2)

Enter the number of structures located within the section. Supply a leading zero where necessary. Include structures built over or under an obstruction such as water, highway, railway, pedestrian-way, depression, etc., and having a passageway for carrying traffic or other moving loads, and having a length measured along the centerline of the crossing of 20-or-more feet. Include structures that pass over the facility as well as those on the facility (except as noted below). Twin (side by side) structures are to be reported as two separate structures.

All highway grade-separated structures are to be reported only once, as part of the facility of highest functional system. If the higher type facility is not the sample, then the structure is not reported. If two sample sections intersect by means of a structure and both roadways are on the same functional system, report the structure data with the roadway on which the deck is located. Ramps or collector/distributor roadways are not considered part of a mainline sample for this item, and structures on these facilities are not reported unless the ramp or collector/distributor actually passes over or under the sample.

For any structure included in this field, the corresponding structure identification number will be recorded in Item 77. Code "00" if no structures exist. A maximum of "50" may be coded in this field. If more than that number of structures exist on the section, the section must be subdivided.

Item 76 -- Number of At-Grade Railroad Crossings (Length = 2)

Enter the number of at-grade railroad crossings on the section. Supply a leading zero where necessary. Multiple tracks should be reported as a single crossing. Exclude crossings on abandoned railroads. For any grade crossing in this field, the corresponding grade crossing identification number will be recorded in Item 78. Code "00" if no at-grade crossings exist.

A maximum of "15" may be coded in this field. If more than that number of railroad crossings exist on the section, the section must be subdivided.

Supplemental Data

NOTE: The following items constitute the variable portion of the sample record. The items are not reported if the data do not exist on the section.

Item 77 -- Structure Identification Numbers (Variable -- Length = 15 x Item 75)

For each structure reported in Item 75, the appropriate 15-digit unique structure identification number is coded from the "Bridge Inventory and Appraisal of the Nation's Bridges" (also referred to as the National Bridge Inventory or NBI). For example, if Item 75 = 03, this item will contain three structure ID fields, each 15-digits long for a total of 45-digits. A maximum of 50 structure ID's may be coded in this field. If there are more than 50 structures on this section, it must be split into two or more segments. If there are no structures on the section, this item is not coded.

The 15-digit structure ID's must be exactly the same as those in the NBI including embedded, leading or trailing blanks or zeroes.

Item 78 -- At-Grade Railroad Crossing Identification Numbers
(Variable -- Length = 7 x Item 76)

For each at-grade railroad crossing reported in Item 76, the appropriate 7-digit railroad grade crossing ID is coded from the "National Railroad Highway Crossing Inventory." For example, if Item 76 = 02, this item will contain two railroad crossing ID fields, each 7-digits long, for a total of 14-digits. A maximum of 15 railroad crossing ID's may be coded in this field. If more than 15 railroad crossings exist on this section, it must be split into two or more segments. If there are no railroad crossings on this section, this item is not coded.

CHAPTER V

UPDATE PROCEDURES FOR UNIVERSE AND SAMPLE DATA

The two previous chapters discussed the basic requirements for the HPMS data and contained guidelines, formats, and procedures for reporting data. These data are to be updated on a regularly scheduled basis. The continuous monitoring (updating) aspects of HPMS are the key to its success. It not only provides current mileage information but also provides a basis for evaluating highway performance. While absolute measures of performance, i.e., condition, congestion, etc., are significant and useful in some very important analyses, the changes and trends in the performance of highway systems over time provide extremely valuable information to highway planners, pavement specialists and administrators. Using this information to develop performance-investment relationships, planners can assess the effectiveness of various highway programs, improvement strategies and future investments.

The HPMS has been designed to permit updating to be accomplished with a minimum of effort. For the sample sections, special care is recommended to establish internal State highway agency mechanisms to report changes that have taken place as they occur (normally to a State data base from which HPMS is extracted). States are encouraged to set up these ongoing mechanisms so as to minimize periodic disruptions to other ongoing activities. By setting up a system for reporting and documenting changes as they occur, the data will not only be accurate and current, but States will also avoid periodic or sporadic workload requirements which are inefficient and disruptive.

It is essential that internal State coordination be established and maintained between the HPMS staff and that of the Pavement Management System (PMS). Such coordination should assure the efficient, dual use of the pavement data collected via the PMS. This is also true for other data collection efforts that are not contained within the same state office (traffic data, vehicle classification, improvements, etc.).

With a current nationwide data base containing mileage and performance information, the need for periodic national studies like those of the past will be greatly reduced or eliminated. The HPMS has been designed to obtain national standardized data that will serve a variety of purposes. With little additional effort, it can be used to assess the effectiveness of pavement rehabilitation strategies and as input to other future studies that may become necessary.

All data are submitted annually in the record format outlined in Chapter IV. Data items are updated annually as changes occur or on a 2-year or 4-year cycle as indicated below. Note that Interstate and sample section AADT is to be updated annually (see Appendix K). Where a 2- or 4-year update cycle period is indicated, updated data will be reported in the odd years for the even years, e.g., pavement condition data representative of 1988 should be reported in 1989. The following presents the types of updates that will be necessary. As can be expected, errors or needed improvement in quality of the data may become apparent as the data are used. These items should be examined and corrective action taken whenever necessary.

GENERAL UPDATING INSTRUCTIONS

The "Update Cycle" column in the listing below contains initials in some cases to indicate the following:

- N.C.P. "No Change Permitted" refers to an item that by its very nature cannot change except in extraordinary circumstances. (e.g., county code)
- C.A.N. "Change As Necessary" refers to items that may change as a result of administrative actions, changes in usage or operation, and capital improvements. (e.g., functional system)
- I.C. "Improvement Change" refers to those items that can only change as a result of a capital improvement. (e.g., shoulder width)

Universe Data

The updating of universe data is a straightforward process, with any change in system, jurisdiction, or operation reported for the year in which it occurs. Also any change in section identification or length should likewise be reported.

<u>Data Item</u>	<u>Update Cycle</u>
1. State Use	C.A.N.
2. Year	Code the calendar year for which data applies i.e., 1988 data submitted in 1989 is coded "88".
3. State Code	N.C.P.
4. County Code	N.C.P.
5. Rural/Urban (R/U) Designation	C.A.N. - Changes in small urban and urbanized area designations are expected as a result of the decennial Censuses or special Censuses. New or revised urban area boundaries may necessitate rural/urban (R/U) code revisions for some sections. Several other items will require updating as a result of a change to this item.

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<u>Data Item</u>	<u>Update Cycle</u>
<u>Identification (Cont.)</u>	
6. Urbanized Area Code	C.A.N. - When a rural or small urban section is redesignated as an urbanized section the appropriate urbanized area code from Appendix B is used. (Appendix B will be revised as necessary to reflect Census changes plus any changes caused by Federal-aid boundary revisions.) Care must be taken to indicate whether an urbanized area is part of a collective urbanized area. (See Chapter IV.)
7. Type of Section/Grouped Data ID	C.A.N.
8. Section/Grouped Data ID	C.A.N.
<u>System</u>	
9. Functional System	C.A.N.
10. Generated Functional System Code	C.A.N.
11. Federal-aid System	C.A.N.
12. Federal-aid System Status	C.A.N.
13. Route Signing	C.A.N.
14. Route Number	C.A.N.
<u>Jurisdiction</u>	
15. Governmental Level of Control	C.A.N.
16. Special Systems	C.A.N.
<u>Operation</u>	
17. Type of Facility	C.A.N.
18. Designated Truck Route/Parkway	C.A.N.
19. Toll	C.A.N.

<u>Data Item</u>	<u>Update Cycle</u>
	<u>Other</u>
20. Section/Group Length	C.A.N. - Changes in length may occur because of construction, section subdivision or due to events such as jurisdictional changes.
21. AADT	<u>AADT's on all Interstate sections and on all sample sections must be updated annually.</u> Appendix K contains a discussion concerning traffic counting recommendations and the annual updating of AADT estimates.
22. No. of Through Lanes	I.C.
23. Record Continuation Code	C.A.N.

Sample Section Data

The sections sampled and inventoried must be maintained. As part of the updating process, data elements reported for the sample sections must be accurate and current. Data elements that are traffic related or that indicate changes in physical condition must be verified on a periodic basis. AADT, pavement roughness and PSR are the most critical data elements in this regard. Other data, such as type and year of improvement, lane width, number of lanes, etc., will change only as a result of physical improvement to the section.

The remainder of this Chapter provides guidelines for keeping sample section data current, with detailed instructions and update schedules for the collection and submittal of the data. The instructions contained in this section are concerned with data item updates and not with changes in the panels of sample sections. The updated data is to be included in the annual data submission. Statistical procedures for verifying or revising the panels will be discussed in the following section of this chapter.

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<u>Data Item</u>	<u>Update Cycle</u>
<u>Identification</u>	
24. Sample Number	N.C.P. - This number is used for all subdivisions of the section, and <u>never changes</u> .
25. Sample Subdivision	C.A.N. - This item is provided for those cases where the original sample section is no longer uniform. For example, if part of a section is widened while the other is not, two segments numbered 1 and 2 will replace the original segment "0" with two updated section records submitted, both having the original (same) sample number. Consecutive numbers will be assigned without replacement as any additional sample subdivisions are established. For example, if segment 2 is later subdivided into two parts the segment numbers would be 1, 3 and 4.
<u>Computational Elements</u>	
26. AADT Volume Group Identifier	C.A.N. - As AADT for a section changes, it may fall outside of the limits of its present assigned volume group.
27. Expansion Factor	C.A.N. - As sample or total mileage within volume groups changes, the expansion factor must be recalculated. This is normally redone prior to every submittal.

<u>Data Item</u>	<u>Update Cycle</u>
<u>Pavement Attributes</u>	
28. Surface/Pavement Type	I.C.
29. Concrete Joint Spacing	I.C.
30. Load Transfer Devices	I.C.
31. Pavement Section	I.C.
32. SN or Slab Thickness	I.C.
33. Type of Base	I.C.
34. Type of Subgrade	I.C.
35. Subsurface Drainage	4 Year or I.C.
36. Roughness	I.C. or 2 Year
37. Reserved for Federal Use	-----
38. Pavement Condition (PSR)	I.C. or 2 Year
39. Overlay or Pavement Thickness	I.C.
<u>Improvements</u>	
40. Year of Surface Improvement	I.C.
41. Type of Improvement	I.C.
<u>Geometrics/Configuration</u>	
42. Access Control	I.C.
43. Lane Width	I.C.
44. Shoulder Type	I.C.
45. Shoulder Width	I.C.
46. Median Type	I.C.
47. Median Width	I.C.
48. ROW Width	I.C.
49. Widening Feasibility	C.A.N.

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<u>Data Item</u>	<u>Update Cycle</u>
<u>Geometrics/Configuration, Cont.</u>	
50. Horizontal Alignment Adequacy (Rural Only)	I.C.
51. Curves by Class	I.C.
52. Vertical Alignment Adequacy (Rural Only)	I.C.
53. Grades by Class	I.C.
54. Percent Passing Sight Distance (Rural Only)	I.C.
<u>Traffic/Capacity</u>	
55. Speed Limit	C.A.N.
56. Weighted Design Speed (Rural Only)	I.C.
57. Percent Commercial Vehicles (Peak and Off-peak)	2 Year
58. K-Factor	2 Year
59. Directional Factor	2 Year
60. Peak Capacity	C.A.N.
61. Volume/Service Flow (V/SF) Ratio	C.A.N.
62. Turning Lanes	I.C.
63. Prevailing Type Signalization (Urban Only)	C.A.N.
64. Typical Percent Green Time (Urban Only)	C.A.N.
65. Peak Parking (Urban Only)	C.A.N.
66. Future AADT	Revise target year such that the future AADT is in the range of not less than 17 years nor more than 22 years when compared to the current AADT.
67. Year of Future AADT	C.A.N.

<u>Data Item</u>	<u>Update Cycle</u>
<u>Environment</u>	
68. Climate Zone	N.C.P.
69. Drainage Adequacy	I.C. or 4 Year
70. Type of Terrain	N.C.P.
71. Type of Development	C.A.N.
72. Urban Location	C.A.N.
73. No. of Grade Separated Interchanges	I.C.
74. No. of At-Grade Intersections	I.C.
75. No. of Structures	I.C.
76. No. of At-Grade RR Crossings	I.C.
<u>Supplemental Data</u>	
77. Structure Identification Numbers	I.C.
78. At-Grade Railroad Crossing ID Numbers	I.C.

SAMPLE PANEL UPDATES

Each State must have panels of sample sections representing rural areas as a unit, small urban areas as a unit and urbanized areas in one of three possible ways:

1. Individually sampled as required in the initial HPMS implementation;
2. Grouped into one or more collective statewide panels similar to the rural and small urban panels (note that this method is no longer recommended); or
3. A combination of some individual urbanized areas and collective panel(s) for other areas. (Not recommended - see 2).

The option to group urbanized areas into one or more collective panels is discussed in Appendix H. States grouping urbanized areas for the first time should refer to Appendix H to establish the collective panel sample. Although the procedure is applicable to every State, only those States having a large number of urbanized areas will benefit significantly from it. It is recommended that the present individual area approach be maintained by any State where collective sampling will not significantly reduce the sample size.

The remainder of this chapter discusses the updating of rural, small urban, and previously established individual or collective urbanized area panels. Although the panels of sampled sections are to remain as fixed as possible, there are various changes, deletions, and additions in the size of the panels over time. The causes and corrective actions needed to maintain a valid sample are discussed below.

Types of Sample Updates

Census Designations

The decennial censuses of population are likely to cause changes in the panels of sample sections. As a result, the sampling bases of most States will change, in varying degrees, because the numbers of small urban areas (5,000 - 49,999 population), and individual urbanized areas (50,000 population and over), and the Federal-aid urban boundaries of existing urban areas may be altered. The addition of new areas and the expansion of current Federal-aid urban boundaries will require the functional reclassification of additional mileage within the new boundaries. This will likely require transfers of sample sections from one panel to another and the drawing of additional samples to satisfy urban area requirements. In addition, the loss of samples that move from rural to small urban or from rural or small urban to urbanized may cause a deficiency in the rural or small urban panels. However, since universe mileage also must be moved to accommodate these changes, the stability of the sample panel may remain in tact, but checks for this will still have to be made. The suggested procedures for adjusting to area sample assimilations, newly designated small urban and individual urbanized areas, and functional system revisions follow:

1. All universe mileage falling within new or expanded urban areas must be functionally classified in accordance with urban classification criteria. In the cases of small urban areas becoming an urbanized area and expansions of existing boundaries, a judgment will have to be made as to whether the new mileage will have to be reclassified or if all mileage within the area will need to be reclassified.
2. Functional system universe mileage within the new or expanded urban areas will be stratified into traffic volume groups consistent with those groups established for the latest HPMS sample.
3. Transfer rural sample sections taken over by small urban or urbanized areas into the appropriate functional systems and volume groups.
4. Transfer small urban sample sections taken over by urbanized areas into the appropriate functional systems and volume groups.
5. Establish the required sample sizes for the revised rural, small urban, and urbanized area panels, and draw additional samples where necessary. Procedures to draw additional samples are discussed below.

6. Although changes in census designation of small urban to rural and urbanized to small urban or to rural could possibly occur, such changes will be uncommon, and will not usually require sample base verification. Universe and sample sections affected by such changes should be assigned to the correct functional system and volume group in the new panel.

Functional Reclassification of Sections

Changes in the mileage of functional systems, other than those dictated by census changes, will result from:

1. Reclassification of mileage within panels as a result of functional system changes;
2. Areal reassignment of existing road sections to adjust for expanding urban boundaries between decennial censuses; and/or
3. New road construction which does not replace existing mileage.

In the case of areal reassignment, the adequacy of the gaining or losing sample base(s) should be checked. As for additional mileage resulting from functional reclassification or new road construction, a general "rule of thumb" may be applied; if the current universe mileage for a given functional system has increased from the base period mileage by 10 percent or more, additional randomly selected sections will probably have to be added to the functional system requirements. The base period is defined as the latest year of complete assessment of sample size requirements, by volume group, for a given functional system.

Volume Group Reassignments Within Functional System

Each volume group contained in a functional system is a separate sampling universe (see Appendix F). Normally, over the short term (less than 3 years) there should be only minor changes in sample section and universe mileage assignments to specific volume groups as a result of traffic increases (or decreases). Traffic increases can result from normal growth and/or capital improvements. Also, some volume group misassignments (inaccurate AADT) are inevitable and may be corrected when current and accurate AADT is assigned to the section.

If, for reasons other than census period readjustments, a specific volume group loses 5 to 10 percent of its sample sections to other volume groups, the volume group should be checked for sample adequacy using the formula and procedure outlined in Appendix G. Since universe sections/mileage will also have changed volume groups, the sample adequacy may remain stable, but it is prudent to make this check, anyway. The minimum requirement of 3 sample sections per volume group must be maintained, (or the State must sample/report all that exist where fewer than 3 are available). If volume group losses cause the sample adequacy to fall 5-10 percent below that required, new randomly selected sections are to be added to the affected volume groups to maintain the required precision level.

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Where a volume group loses samples due to volume group reassignments to the extent that it is no longer represented (no samples), or a new volume group turns up because of AADT change, new samples must be selected in those groups. Temporarily (for the current submittal), the universe mileage for the unsampled volume group(s) may be combined with an adjoining group in order to ensure that the expansion for the complete functional system mileage will be accurate. Note that DVMT expansion will be less accurate under this situation. It is imperative that the next HPMS submittal contain samples in these currently unsampled volume groups. |

Sample Size Review

The required sample size is a function of the variability of data (primarily AADT) within a volume group, the functional system/volume group precision level and the number of sections available for sampling in the volume group (the universe). The term "precision level" in this Manual is defined as the degree of confidence that the sampling error of a produced estimate will fall within a desired fixed range. Thus, for a precision level of 80-percent confidence with 10-percent allowable error (80-10), there is the probability that 80 times out of 100, the error of a data element estimate will be no greater or less than 10 percent of its true value. The prescribed precision levels for volume groups by functional system and geographic area are indicated in Appendix F, Tables F-1 to F-3.

A procedure (Appendix G) is provided for determining the required sample size. Note that there are three specific precision levels for the rural, small urban, and grouped urbanized areas and two precision levels for the individual urbanized areas. For individual urbanized areas, the design precision levels for individual volume strata are 80-10 or 70-15, depending upon the number of individual urbanized areas in a given State. Those States with less than three individual urbanized areas will use a precision level of 80-10 for all functional systems, while those with three or more will use the lower precision level of 70-15 for minor arterials and collectors and 80-10 for principal arterials.

If the total number of sections available for sampling is not known (i.e., the State groups some/all of its nonsampled universe mileage), an estimate of this total may be obtained by dividing the total volume group mileage by an estimate of the average section length in that stratum. Alternatively, the average length of the samples already existing in the volume group may be used.

The AADT coefficient of variation is an important part of the procedure (formula) to obtain the required number of samples for each stratum. Estimates of the AADT coefficients of variation for a particular State can be derived from its existing HPMS data using standard statistical computer packages. Alternatively, FHWA headquarters can supply the coefficients from any State tape submittal upon request. Further, a booklet entitled "Estimates of Sample Adequacy" can be generated from any State's HPMS tape submittal by FHWA Headquarters. The booklet contains the coefficients (generated both from the sample section AADT's and from the universe section AADT's, if they exist), the number of existing, unique sample sections, the required number of samples based on the generated coefficients, an estimate of the universe in the volume group, and other estimates and information useful for doing a sample size review. Advise FHWA Headquarters (HPM-20) if such a computer analysis (the booklet) is desired.

Another procedure to be used in the updating process is contained in Appendix I, Sample Size Requirements for Estimating Proportions. Figure I-1, "Functional System Sample Size Needed to Detect a 10 Percent Change in Proportions," provides a curve that can be used by a State to determine if its sample size meets the criteria set forth in the Appendix. Just as statewide precision level requirements are to be maintained for functional system volume group estimates of data element averages and aggregates, there is also a minimum sample size level needed to satisfy the statistical design requirements for estimating changes in the proportions of data item attributes (i.e., percentage of rough pavement) at the statewide functional system level. It is required that the design sample size at the statewide functional system level for all three geographic areas be such that the smallest detectable change in proportions is no greater than 10 percent, and preferably less, at the 80-percent confidence level. Normally, the sum of the volume group sample sizes for average and aggregates as determined by the formula in Appendix G exceeds the minimum functional system sample size requirements for the measurement of proportions, especially for rural and small urban areas. However, it is possible that the sample requirements for urbanized areas aggregated to statewide functional system levels may not satisfy the minimum criterion for proportions. This may also occur in any area (rural, small urban or urbanized) where the AADT coefficients of variation tend to be small.

The curve in Appendix I, Figure 1 is used to ensure minimum sample compliance in all areas. Sample size deficiencies, as determined from this curve for any functional system, are to be prorated among the volume groups within the functional system according to the initial sample sizes obtained from the Appendix G formula. Further discussion of proportions is contained in Appendix I.

The "Estimates of Sample Adequacy" booklet also contains a sample size estimation based on the Appendix I criteria. |

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Sample Selection for Updates

The selection of additional sample sections for a given volume group is straightforward for most updates. Basically, the number of existing sample sections is compared to the required number as determined on previous pages and additional sample sections are randomly drawn from the non-sampled universe sections to cover any shortfalls.

The only variation for this sample procedure occurs when new urbanized areas are designated. The State has the option of sampling these new urbanized areas as individual areas or grouping them with other new and/or current urbanized areas into a collective urbanized area panel. (Note, however, that the collective method is no longer recommended.) If a State chooses to sample new areas as individual areas or to group them as a collective new urbanized area, the selection process is as described above. Procedures for drawing a complete sample are discussed in Appendix H. In the case where new urbanized areas have been or are to be grouped with current urbanized areas, it is likely that the new urbanized area mileage will not be adequately represented by the rural and small urban samples that already exist in the new area or areas. For the new area mileage to be adequately represented, the number of samples in the new urbanized area in a given volume group should be proportional to the new area universe mileage in the given volume group. To achieve the required balance between current areas and new area mileage, any sample need required by the formula in Appendix G that exceeds the number of existing samples, must be randomly selected from the new area mileage (if new area mileage exists in the volume group), until the new area mileage is proportionally represented. Once proportionality is achieved, new samples will be drawn from the complete universe of the volume group for all areas in the collective group.

A simplified example will best illustrate the procedure. Let's assume that a collective urbanized area composed of seven urbanized areas exists in a State. Three new urbanized areas are defined as a result of the census, and a decision is made to incorporate them into the collective group. The procedure requires that every volume group stratum in every functional system be examined. However, for this hypothetical example only volume group two of the Interstate will be analyzed. The following table presents a summary of the Interstate part of the collective urbanized area for volume groups 1 through 6.

Example Interstate Sample Summary

	NUMBER OF SECTIONS OR MILEAGE IN VOLUME GROUPS					
	1	2	3	4	5	6
1 Existing Samples - Current 7 Areas	0	17	16	13	7	5
2 Existing Mileage	0	20	30	50	20	10
3 Existing Universe (Sections)	0	25	40	80	30	10
4 Additional Universe (Sections)	0	10	10	25	10	15
5 Additional Mileage	0	7	9	15	8	10
6 Required Sample (Sections)	0	23	17	14	8	7
7 Required minus Existing (Sections)	0	6	1	1	1	2
8 Existing Samples - New Areas	0	2	2	1	0	0
9 Samples to be Selected	0	4	0	0	1	2
10 Total Mileage	0	27	39	65	28	20

The first row lists the existing sample size in the existing collective urbanized area (7 individual areas), the second row lists the mileage, and the third the number of sections in the existing universe. The fourth and fifth rows list the additional number of sections and mileage from the three new urbanized areas. The sixth row lists the required overall sample size estimated from the formula in Appendix G for all 10 areas. The seventh row contains the number of additional samples needed to accommodate the formula results. The eighth row lists the rural and small urban samples already existing in the new areas, and the ninth row lists the number of sections which must be added to the sample. The last row lists the total mileage in the new collective urbanized area group consisting of all 10 areas.

To determine the number of samples to be selected from the added universe (the three new urbanized areas), compute the ratio of new mileage to total mileage ($7/27 = 26$ percent for volume group 2). It is determined that 26 percent of the mileage and 26 percent of the volume group 2 sample should be located in the "new" part of the collective urbanized area volume group mileage. Since only 9 percent ($2/23$) of the required number of samples exist in the new urbanized areas, all 4 of the additionally required samples should be selected from the three new urbanized areas. If any rural and small urban samples exist in the three new areas, they should be deducted from the samples to be selected as has been done in row nine. Two sections exist in the second volume group for the Interstate in the three new urbanized areas; therefore, only four new sample sections need to be selected. Since the selection of four new samples in the new areas will bring the sample into proper balance ($6/23 = 26$ percent), any samples required in the future should be randomly selected from all available volume group 2 sections from all 10 areas. If balance had not been achieved, preference should be given to the new areas (in subsequent new sampling) until balance is proper. See Appendix H, "Preparation for Sample Selection" for guidelines for establishing new sample sections.

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Expansion Factor

In the updating process, any change in sample mileage and/or the mileage from which samples are being taken (the universe) requires an updating of expansion factors relating to affected volume groups. Any of the following may require expansion factor updates:

1. Census Redesignations
2. Expansions of Federal-aid Boundaries and/or Census Boundaries
3. Functional System Redesignations
4. Sample section additions or losses in a volume group
5. Universe section additions or losses in a volume group
6. New Mileage

Normally, expansion factors are recalculated before every HPMS submittal tape to ensure that all volume group changes (both universe and sample), new sample sections, etc. have been accommodated. The calculation of expansion factors is discussed in Chapter IV and in Appendix H.

Summary of Causes for Updates and Corrective Procedures

The following overview of the causes for sample panel updates is in two parts: (1) point in time causes resulting directly or indirectly from Census releases; and, (2) causes generally occurring gradually over time during intercensus periods.

<u>Cause</u>	<u>Corrective Procedure</u>
<u>Census Period</u>	
1. New small urban areas (rural to small urban)	Adjust all rural sample section records within the new area to urban requirements. Verify statewide rural and small urban sample and universe bases and select additional samples as necessary.
2. New urbanized areas (small urban and/or rural to urbanized)	Adjust all rural and small urban sample section records within the new area to urbanized area requirements. Determine whether new areas are to be sampled individually or as a part of an existing or new collective area panel. Procedures for drawing new samples for individual or new collective area panels are discussed in Appendix H. Procedures for adding a new area or areas to an existing collective area panel are discussed above. Verify all sample and universe bases and select additional samples as necessary.

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- | | |
|--|---|
| 3. Expansion of the Federal-aid boundaries of small urban or urbanized areas (rural to small urban and rural and/or small urban to individual urbanized) | Adjust all affected rural sample section records to urban requirements. Verify all affected sample and universe bases and select additional samples as necessary. |
| 4. Functional system reclassification--any area | Reassign reclassified sections (universe and sample) to appropriate volume groups. Sample new sections as necessary to maintain required volume group precision levels. |
| 5. Losses in urban population | No action until area designation changes. |

Cause

Corrective Procedure

Intercensus Period

- | | |
|---|---|
| 1. New mileage by functional system | Verify sample and universe base if change in functional system mileage is 10 percent or more, and sample new sections, if necessary. |
| 2. Functional system reclassification--any area | Possible volume group reallocation of universe and/or sample sections, precision upgrading, and additional samples. |
| 3. Volume group reassignment of sample sections | Reassign sample sections but no further action is needed if changes are minor (see the section on volume group reassignments, above); if changes are major, verify volume group sample and universe bases for all affected volume groups and add samples, if necessary. |
| 4. Expansion Factor | Adjust expansion factor values for sample section records in the affected group. |

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Permanence of Sample Selections

Once a roadway section has been selected for a sample panel, its existence must be maintained regardless of changes in volume group assignment, functional system, geographic area or section segmentation. Sample sections transferred to other geographic areas become part of the sample base for those areas. It is recognized that in a few cases existing road sections are abandoned, but generally they are replaced by construction on new location, and the sample should then be placed on the new roadway. In cases where a roadway is truly abandoned with no relocation, i.e., not open to traffic, the section is dropped. Since only arterial and collector mileage is being sampled, sections reclassified as a part of the local functional system must also be dropped, even if it was reclassified as local because of the relocation.

Sample Panel Conformity

The changes in sample panels during the periods between Censuses are generally not expected to be frequent or extensive. It is suggested that the overall mileage for each functional system be verified whenever major functional reclassifications or urban boundary changes are made or at least every 3 years for conformity with sample size requirements (see the previously discussed subsection on functional reclassification, the "rule of thumb" criterion). However, it is necessary to maintain a minimum of 3 samples per volume group (where more than that number of sections actually exist), and to sample unsampled volume groups that appear because of AADT (volume group) change, on as close to a yearly basis as possible. Where time does not permit this to be accomplished before a June 15 submittal, additional samples should be drawn and readied for the next annual submittal (or prior to another submittal) in order to preserve the integrity of the sample panel. More information and other alternatives are contained in Appendix H. Such changes that occur would be included with other changes in the annual submittals.

Sample Panel Reduction

The previous discussions have all commented upon the need for additional samples. The intent is to ensure that the sample panel is kept in conformance with the precision levels and sample size that enables an adequate representation of the States' arterial and collector systems, and meets target reliabilities. Since the HPMS has been in existence for some time, these additions of samples and the movement of universe and sample sections from one volume group to another, etc., have caused oversampling in some volume groups in some States. A volume group is considered to be oversampled when the number of existing unique samples exceeds the number of required samples by more than 10 percent. For example, if 40 sample sections are required in a particular volume group based upon accurate AADT data, the volume group could be considered to be oversampled if it contains more than 44 samples. However, individual volume group reductions of less than 3 sample sections should not be considered.

To the extent that all sampling criteria would still be met, a sample reduction could take place in the oversampled volume groups, if the sample panel size has become a burden for a State. There are several steps that must be taken BEFORE any sample deletion/elimination actually takes place. These would include a comprehensive report of intended actions that would be submitted to FHWA Headquarters for evaluation, which would contain a plan and other information related to the required steps in the list below:

1. Random deletion of the samples within each volume group that is oversampled is a must in order to maintain a statistically sound sample panel. Some "special situation" deletions of particular sample sections can be discussed on a case by case basis.
2. The minimum of 3 samples per volume group must be maintained (where there are more than 3 sections available).
3. A few samples (around 10 percent normally) above the number required by the procedure contained in Appendix G should be retained (where they already exist) to allow for movement, over time, from one volume group to another, from one area type to another, etc. For instance, if 32 samples are required, 35 should be retained if more than that already exist.
4. Trends of sample/universe section movement from one volume group to another should be examined, so that volume groups that are continually losing or gaining samples may be treated appropriately (i.e., the sample retention discussed in step 3 could be increased or decreased depending on the trends).
5. A maximum expansion factor of 99.999 must be maintained. Again, to allow for movement of samples from one group or area to another, over time, the expansion factor should be kept to levels that will ensure that the maximum expansion factor will not be easily reached over a reasonable time period.
6. The sample size requirements for estimating proportions discussed under the "Sample Size Review" heading, above, must be maintained for each functional system (see Appendix I, also).
7. The AADT on the samples should be as up to date and accurate as possible, such that coefficients of variation derived from them are reliable. AADT coefficients of variation should be derived from the universe if all or most of the arterial/collector systems contain reasonably accurate AADT data. In addition, the universe section count by volume group must be as accurate as possible so that the results from the Appendix G formula (giving the required number of samples) are reasonably accurate.
8. Only one of a series of sample subdivisions is to be counted as an existing sample. However, if a sample has been subdivided because of AADT (volume group) change, functional system change or an area type change, one of the subdivided portions is to be counted in each of the respective categories.

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There are other considerations that a State should think through before making a decision to reduce its sample panel size:

- (1) If a State is using the HPMS analytical package, or is using the HPMS file for other purposes, it may want to keep an oversampled panel in tact, or even consider using higher precision levels. The latter case would tend to increase the sample panel, of course.
- (2) If a State has a computerized inventory system already established for all or most of the roadways in the State, the number of samples now being maintained probably does not create any particular burden and could be easily retained, even if the panel is oversampled.
- (3) The sample reduction examination and actual deletion may require more work than the resulting benefit of maintaining fewer samples. This will almost certainly be the case where only a few volume groups are oversampled, or where only a few samples could be eliminated per volume group.
- (4) After a reduction in a volume group takes place, and when/if that volume group requires more samples for any number of reasons, new samples will again have to be drawn.

The State will have to assess its own needs and priorities and act accordingly. If a State decides to reduce its sample panel, its submitted report/plan will be evaluated at FHWA Headquarters. Appropriate remarks will be returned via the field offices. A summary of the eliminated sample sections that includes the county, functional system, sample number (ID) and volume group (items 4, 9, 24 and 26, respectively) will accompany the State's data tape submittal where the elimination action actually takes place. Sample elimination should not take place until FHWA Headquarters has reviewed and commented upon the State's submitted plan.

The "Estimates of Sample Adequacy" booklet (discussed under the "Sample Size Review" heading, above) contains information that would be beneficial for any review of the sample panel, including a reduction study. As stated under that discussion, the booklet is available from FHWA Headquarters (HPM-20), upon request.

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For example, a record for a sample section that contains three structures and has no railroad crossings would contain the following:

Universe Portion	158 digits
Continuation Code (10300)	5 digits
Sample Portion	264 digits
Structure ID's (3 x 15 digits)	45 digits

For a record length of 472 digits.

Required Format

The required dataset will contain a mixture of universe and sample section records varying in length from the minimum of 163 digits to the maximum of 1282 digits, although it is unlikely that the latter figure will ever occur. The following are the attributes of the file:

LRECL (Logical Record Length);	1286 (1282 + 4) bytes
BLKSIZE (Physical Record Length);	6233 bytes
RECFM (Record Format);	VB (Variable-Blocked)

The dataset must be written in Extended Binary Coded Decimal Interchangeability Code (EBCDIC) character representation.

The HPMS record format is contained in Appendix R.

NOTE: The HPMS Submittal Software will accept a variable-blocked HPMS dataset as input with any blocksize. However, all HPMS datasets output from the submittal software are blocked at 6233. The HPMS dataset submitted to FHWA Headquarters must be blocked at 6233.

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THE SUBMITTAL SOFTWARE PACKAGE

INTRODUCTION

This module of programs has been developed by the FHWA for State highway agency use in preparing the annual HPMS data submittal tape, maintaining the dataset, editing the data, and developing summary tables. This software will process a dataset with a variable length record format consisting of rural and urban universe records and sample records. The module consists of a main (driver/calling) program, FHWAHPMS, and seven dynamically called subprograms STHPMODU, STHPEDIT, STHPEXPF, STHPCALC, STHPSUMT, STHPB TAB, and STHPINTS . Each of the subprograms and the main program are written in COBOL. The subprograms STHPMODU, STHPCALC, and STHPB TAB each have dynamically called secondary subprograms written in COBOL and FORTRAN. The module of programs was designed and developed on an Amdahl 580 (compatible with IBM 370/3033) with full operating system (OS).

The execution of the module options are controlled by the user parameter cards through the main program, FHWAHPMS. The subprogram functions are as follows:

- o STHPMODU provides the following functions to keep the file current and to correct coding errors.
 - o Update individual data items
 - o Add new records to the file
 - o Delete records from the file
 - o Add or delete structure ID's and/or at-grade railroad crossing ID's
- o STHPEXPF can calculate the expansion factor for each sample section. It also produces two summary tables; one contains the number of sections, sampled mileage, expansion factor, and expanded sample mileage by volume group, functional system, and area type; the other contains the number of sections and accumulated universe mileage by volume group, functional system and area type for all sections open to traffic.
- o STHPEDIT reads the HPMS dataset, checks each record for coding errors, or lists each section without editing. The edits are performed in three groups determined by the user's selection on the parameter card -- each data item is checked for a valid code, various data items are crossed checked, or various data items are checked to see if they are within a range of reasonable values.

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- o STHPCALC calculates for the first time or recalculates all of the following data items and places (or replaces) them on the sample section record:
 - o Generated one-digit functional system code (all records)
 - o Rural peak capacity for paved sections
 - o Weighted design speed (WDS) using the reported curve data for applicable sections
 - o Volume-to-service flow (capacity) ratio (V/SF)
 - o Horizontal alignment adequacy code for rural sections with reported curve data
 - o Vertical alignment adequacy code for rural sections with reported grade data

The procedures used in the capacity calculations are based on service flow for level of service E (see Appendix L). The procedure for the WDS calculation is the same as outlined in Appendix D. The V/SF calculation is described in the edit specifications (see Appendix M).

STHPCALC also assigns the climate zone, based on the county FIPS code, for the first time or replaces all of the climate zones any time the option is chosen.

- o STHPSUMT is primarily used to verify functional system mileage and DVMT. It permits comparisons between the expanded sample, universe, and areawide values by providing sample and universe summaries in the same format as the areawide tables. A summary of Federal-aid system mileage by functional system is also produced to verify urban and rural Federal-aid mileage within a State.
- o STHPINTS develops and produces two Interstate system mileage data tables by route number from the universe data. Each table contains the number of records, miles, lane/miles, and DVMT for each route. One table contains mileage data for Interstate sections opened to traffic under Title 23 U.S.C. Sections 103(e)(1), 103(e)(2), 139(c), and 139(a), which are functionally classified as Interstate, on an Interstate Federal-aid system, and route signed as Interstate. A second table contains data for sections that meet some, but not all, of the Interstate characteristics mentioned above, plus Section 139(b) mileage.
- o STHPB TAB develops and produces a battery of performance summary tables based on the expanded sample inventory data. The battery consists of 9 rural tables and 6 urban tables from which the user may select the table(s) desired.

The module has been designed to enable a State to edit and update the universe sections only or sample sections only as long as the record is in the HPMS variable length record format and in sort by section ID within county. However, the final edit and summaries submitted to FHWA must be from only one dataset consisting of a State's complete data in sort by section ID within county. The dataset must also contain the variable length records with current (updated if the data was being updated by software other than provided by FHWA) calculated data items.

FHWAHPMS

A. IDENTIFICATION

Program Name: FHWAHPMS
Language: COBOL
Compiler: OS/VS COBOL with dynamic option
Written By: Beverly J. Harrison
Highway Performance Analysis Branch, HPN-21
Planning Analysis Division
Federal Highway Administration
Washington, D. C. 20590
Phone: 202-366-4048

Date: February, 1988

B. PURPOSE

FHWAHPMS edits the HPMS dataset, maintains the dataset, calculates various data items, develops and produces summary tables from the expanded sample data and universe data, and provides a battery of performance summary tables based on the sample data.

C. COMPONENTS

Written By: Beverly J. Harrison
Language: COBOL and FORTRAN
Compiler: OS/VS COBOL with dynamic option
VS Fortran

Date: February - March, 1988

FHWAHPMS is a dynamic calling program. The program dynamically calls STHPMODU, STHPXPF, STHPEDIT, STHPCALC, STHPSUMT, STHPBTAB, and STHPINTS. Each subprogram is linked with FHWAHPMS, if and only if, it is called during execution.

STHPMODU dynamically calls STHPADDS, STHPZONE and HPCALCDI which dynamically calls HPCAPR.

STHPCALC dynamically calls STHPZONE and HPCALCDI which dynamically calls HPCAPR.

STHPBTAB dynamically calls STHPR01 through STHPR04 and STHPU01, STHPU03 and STHPU04.

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D. PARAMETER CARDS

There are several types of parameter cards the user may use to execute FHWAHPMS. The program options selected determine the number and type of parameter cards required for execution. The parameter cards may be placed in the execution deck in any order.

1. State Name Card (STATECN)

The State name card is required for all executions. The keyword STATECN is coded in columns 1-7 followed by an equal sign (=) in column 8. Starting in column 9, 1-20 characters and blanks may be used to code the State name. The State name must be followed with the two-digit State code found in Appendix A. The State code must be coded as /xx/, where xx is the two-digit code, including a leading zero, where necessary.

e.g., STATECN= TEST STATE/89/
STATECN=TEST STATE_HPMS/99/

2. Inventory Year Card (INVYEAR)

This card is required for all executions. Starting in column 1, code the keyword INVYEAR followed by an equal sign (=) in column 8. In columns 9-12, code the inventory year in which the section data was collected.

The year (item 2) in the data record will be set to the year on the INVYEAR parm card when the program option, SELMODU, is selected and valid transaction cards are included.

e.g., INVYEAR=1988

3. Program Option Card (SELMODU, SELEXP, SELEDIT, SELCALC, SELSUMT, SELBTAB, SELINTS)

The user must select at least one program option card for each execution. SELMODU, SELEXP, SELEDIT, SELINTS, and SELSUMT may be included in the same execution under certain conditions. The option cards SELCALC and SELBTAB must be used alone. More information is provided under the heading "Restrictions for Program Option Combinations" at the end of this section (D).

a. SELMODU

This card enables the user to select the subprogram which maintains the HPMS dataset. It is selected when the user desires to modify (update) items for a section, add a new section, delete a section, or add/change structure or railroad crossing ID's. Code the program option name SELMODU in columns 1-7 followed by an equal sign (=) in column 8. Starting in column 9, the keyword for the subprogram option selected is coded. The possible keywords are as follows:

Only one of the following three keywords may be coded in an execution:

ADDONLY - Only new sections are to be added to the existing dataset.

ADDMOD - New sections are to be added and existing sections are to be modified or deleted.

MODONLY - Sections are to be modified or deleted and no new sections are being added.

Optional keywords that may be used in addition to the above:

NOLIST - The listing of the user supplied transaction cards is not produced.

NOMOD - The listing which summarizes the type(s) of update for the section by section identification and county is not produced.

The year (item 2) in the data record will be set to the year on the INVYEAR parm card when this program option (SELMODU) is selected and valid transaction cards are included.

e.g., SELMODU=ADDMOD - New sections are being added and existing sections modified.

SELMODU=ADDONLY,NOLIST - New sections are being added and the transaction card listing will not be printed.

The transaction cards required for updating are discussed in Section E, Control Cards, Item 1.

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b. SELEXP

The printed output of this option is to be submitted to FHWA Headquarters along with the submittal tape (see Chapter IV, Item 27).

This card enables the user to select the subprogram which calculates the expansion factors for sample sections, replaces the existing expansion factor on each sample record with the new one, and generates the expansion factor summary table. The subprogram will calculate the expansion factor for specified volume groups either using cards provided by the user containing the group's universe mileage (see Section E, Control Cards, Item 2) or from universe mileage accumulated from the input file, and produces a table listing all of the expansion factors in the dataset by volume group, functional system, and area type. The table produced can be used to check the accuracy of existing expansion factors and to ensure they are the same throughout each volume group, and that the expanded sample mileage for a volume group equals the universe mileage. SELEXP is coded in columns 1-7 followed by an equal sign (=) in column 8. Each keyword selected is then coded and separated by a comma. The keywords may be in any order and are as follows:

One keyword from the following set must be coded.

- R - Rural sections only are to have expansion factors calculated and/or summary tables produced.
- U - Urban sections only are to have expansion factors calculated and/or summary tables produced.
- RU - Rural and Urban sections are to have expansion factors calculated and/or summary tables produced.

One keyword from the following set must be selected.

- FACTCALC - New expansion factors are to be calculated and placed on appropriate sample section records. The summary table for all rural and/or urban volume groups on the dataset is produced automatically by the subprogram when new expansion factors are calculated.
- FACTTAB - Only the expansion factor summary table is to be produced. No new expansion factors will be calculated.

One keyword from the following set must be selected with the FACTCALC option.

MILEDATA - New expansion factors are to be calculated using universe mileage accumulated from the input master file. To use this option, AADT's must be coded and be greater than zero for all records (including universe). Only open to traffic arterial and collector system records are used. If arterial/collector records with zero AADT's are found, they will be listed, and expansion factors will not be calculated.

MILECARD - New expansion factors are calculated using input cards containing the volume group's universe mileage (see Section E, Control Cards, Item 2).

Optional keyword.

UNIVTAB - Produces a universe mileage table by AADT volume group for all arterial and collector sections open to traffic. To select this table, AADT's must be coded and be greater than zero for all non-local functional system records that are open to traffic.

e.g., SELEXPf=U,FACTTAB - Urban expansion factor summary table will be produced.

SELEXPf=FACTCALC,RU,MILECARD - An expansion factor will be calculated for each rural and urban volume group for which a universe mileage card is coded.

SELEXPf=R,UNIVTAB - Rural universe mileage summary table will be produced.

c. SELEDIT

The printed output of this option (SELEDIT=RU,FINAL) is to be submitted to FHWA Headquarters along with the submittal tape with appropriate explanations for all remaining messages.

This program option card enables the user to select the subprogram which edits each section in the HPMS dataset or lists each section without editing. The user also has the option of having the county name printed on the edit listing for each county code by providing control cards containing the county codes and names (see Section E, Control Cards, Item 4). Code the program option card name SELEDIT in columns 1-7 with an equal sign (=) in column 8. Starting in column 9, code the keywords for the subprogram option(s) selected, each separated by a comma. The order of the keywords is not significant.

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One of the following keywords is required for editing or listing:

- R - Only rural sections are to be edited or listed.
- U - Only urban sections are to be edited or listed.
- RU - Rural/Urban sections are to be edited or listed.

If the data records are to be listed, one of the following type of listing keywords must be coded:

- LISTSECT - All universe and sample section data are to be listed.
- LISTUNIV - Only universe section data are to be listed.
- LISTSAMPLE - Only sample section data are to be listed.

If the data records are to be edited, one of the following type of editing keywords must be coded:

- VALIDCODES - Each data item will be checked for a valid code. Valid codes should be present before other edits are run.
- CROSSCKS - Various data items will be cross-edited.
- RANGECKS - Various data items will be checked to see if the coded value is within a reasonable range.
- FINAL - All types of edits will be performed in one execution -- valid codes, cross edits and range edits.

More than one type of edit keyword may be coded in one execution. However, before cross-edits, range-edits or the final edit are performed, each data item must contain a valid code. It is recommended that the VALIDCODES edit be performed before the other edits.

(See Appendix M for edit specifications.)

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Optional keywords that may be used in addition to, and only with the editing keywords noted above:

SAMPNUMNO - The sample number (Item 24) will not be checked for uniqueness within county. Default is that the sample number will be checked. May only be coded with the keyword VALIDCODES.

VGRPNO - The volume group number and AADT will not be cross-checked. Default is that the volume group and AADT will be checked. The volume group numbers and AADT ranges have been set up according to the FHWA sample design. (See Appendix F for the AADT ranges used for this edit.) Use only with keyword CROSSCKS.

ERRMESS - Must be coded if the user desires a suppressed listing with section ID, item number in error, and messages only. Otherwise, the listing includes the value coded for every data item for sections containing an error(s), along with the item number in error and the message.

NOCURVE - The curve data will not be edited -- it is not provided or the user does not wish to edit the data. Default is to edit curve data.

NOGRADE - The grade data will not be edited -- it is not provided or the user does not wish to edit the data. Default is to edit grade data.

NOROUGH - The roughness data will not be edited -- it is not provided or the user does not wish to edit the data. Default is to edit roughness data.

e.g.,

SELEDIT=R,VALIDCODES,SAMPNUMNO - Each data item for a rural section is to be checked for a valid code. The sample number for sample sections will not be checked for uniqueness.

SELEDIT=RANGECKS,RU,ERRMESS - Selected data items on rural and urban sections will be checked for a value within a reasonable range with only error messages printed.

SELEDIT=R,LISTUNIV - List all rural universe sections with no editing.

SELEDIT=RU,FINAL,NOROUGH - Each section is to have all edits except roughness checks performed.

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* CNTYINC

This optional parm card enables the user to select sections to be listed or edited by specific county(ies). CNTYINC may be included only when the user has selected the program option SELEDIT. Code the parm card name CNTYINC in columns 1-7 with an equal sign (=) in column 8. Starting in column 9, code the three digit county FIPS code for the counties to be included in the listing or edit, each separated by a comma. The leading zero(es) must be coded for those county FIPS codes that are less than 100. Up to 15 counties may be selected; the county FIPS codes must be coded in ascending order. If more than 15 counties are required to be listed/edited, this option must be reselected in another computer run of FHWAHPMS.

* NOTE: This option must be coded on a card separate from the SELEDIT options, as shown in the following examples:

e.g., SELEDIT=R,LISTSAMPLE - List all rural samples in the three
CNTYINC=011,033,151 counties with FIPS codes of 11, 33
and 151.

SELEDIT=R,FINAL - Each rural section in counties 51 and 73
CNTYINC=051,073 are to have all types of edits performed
on the data.

d. SELSUMT

This program option card enables the user to select the subprogram which produces the summary tables to verify system mileage and DVMT by functional system. SELSUMT is coded in columns 1-7 followed by an equal sign (=) in column 8. Starting in column 9, code the keyword(s) for the summary table(s) desired. If more than one keyword is selected, each must be separated by a comma.

At least one keyword from the following set must be selected:

SAMPLEMT - The summary table containing sample mileage and travel by functional system is to be produced.

UNIVMT - The summary table containing universe mileage by functional system and Interstate travel is to be produced.

UNIVDVMT - The summary table containing universe travel by functional system for all open to traffic arterials and collectors is to be produced. This option should be selected only if AADT's are coded for all arterial and collector universe sections. Note that the table will still be produced whether or not AADT's exist on the universe sections -- it is left to the user to be particularly cognizant of this.

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CNTYMILE - The summary table containing universe mileage by jurisdiction and functional system within county is to be produced.

FEDAID - The summary table containing universe mileage by Federal-aid system and jurisdiction is to be produced.

FUTDVMT - The summary table containing current year DVMT, future year DVMT, and the percent change by functional system is to be produced.

e.g., SELSUMT=FEDAID,UNIVDVMT
SELSUMT=UNIVMT,CNTYMILE
SELSUMT=FUTDVMT,SAMPLEMT,UNIVMT

e. SELINTS

SELINTS enables the user to select the subprogram which produces the Interstate system mileage, lane-mileage and travel summary tables by route number. In columns 1-7, code the program option card name, SELINTS. The remainder of the card is blank.

f. SELCALC

This program option card enables the user to select the subprogram which determines the generated functional system code (item 10), calculates certain data items for the first time or recalculates the same data items and places/replaces them on the record, and assigns the climate zone by county. In columns 1-7, code the program option card name, SELCALC followed by an equal sign (=) in column 8. Starting in column 9, code the keyword(s) for the desired option. If both keywords are selected, they must be separated by a comma. This program option cannot be selected with any of the other program options. The items generated/calculated and the procedures used in the calculations are outlined on page VI-4.

At least one of the following keywords must be selected:

DCALC - All of the generated/calculated data items are to be calculated/recalculated and placed on the data record.

CZONE - The climate zone for each county is to be placed on the data record.

e.g., SELCALC=CZONE,DCALC - Climate zones are to be assigned and all data items calculated or recalculated and placed on the data record.

SELCALC=DCALC - All data items are to be calculated or recalculated and placed on the data records.

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This program option should be selected to calculate/generate the necessary data items before the program option, SELEDIT, is selected with the keywords FINAL, CROSSCKS or RANGECKS.

g. SELBTAB

SELBTAB enables the user to select the subprogram which produces the battery of rural/urban performance summary tables from the sample section data. The user may select from 1 to 9 rural tables and 1 to 6 urban tables. In columns 1-7, code SELBTAB followed by an equal sign (=) column 8. Starting in column 9, code the number and area type of each table and/or range of tables desired, each followed by a comma. This program option card cannot be included with any other program option. (See Appendix N for the titles and numbers of the tables.)

Optional keywords. (Use for urban table(s) only.)

UZASMU - The urban table(s) requested will be by the statewide total of urbanized areas, small urban areas, and total urban. Default is to show total urban only.

INDUZA - The urban table(s) requested will be by individual urbanized area (or by collective groups) , small urban, and total urban. Default is to show total urban only.

e.g.,

SELBTAB=R1,R9,U6,INDUZA - Rural tables 1 and 9 and urban table 6 showing individual urbanized areas are to be produced.

SELBTAB=U1-U6,R9 - Urban tables 1,2,3,4,5 and 6 showing total urban areas only, and rural table 9 are to be produced.

4. Maximum Number Edit Errors (MAXERRS)

This card is optional and is coded if the user wants the subprogram which edits the data to stop execution when a maximum number of sections with coding errors is reached. The MAXERRS card may be included only with the program option card SELEDIT. MAXERRS is coded in columns 1-7 followed by an equal sign (=) in column 8. Starting in column 9, code the numeric value for the maximum number of sections allowed to be in error. A number with 1-5 digits may be coded. The default value is for all sections to be edited.

e.g., MAXERRS=200 - Execution for the edit subprogram will terminate when 200 sections with at least one data item in error have been detected.

Restrictions for Program Option Combinations

SELMODU and/or SELEDIT and/or SELEXPFF and/or SELSUMT may always be included in the same execution.

SELINTS may be included with SELEDIT and/or SELSUMT for any execution.

SELINTS may be included with SELEXPFF with the keyword, FACTTAB. SELINTS cannot be included with SELEXPFF with the keyword, FACTCALC.

SELCALC cannot be included with any other program options. Before the program option SELCALC is selected, the HPMS dataset should be free of coding errors, i.e., all data items have valid codes. SELCALC will replace all calculated data items with recalculated values. If the dataset has been updated externally using non-HPMS software, this option should be executed in order to ensure that all calculated/generated data items are correct and current and that the climate zone is included. If the dataset is being updated using the program option SELMODU and a data item used in a calculation is updated, SELMODU will automatically call the subprogram to recalculate the data items. If SELMODU is being used to update the county code and the user is not updating the climate zone at the same time, SELMODU will call the subprogram to determine the correct climate zone.

SELBTAB cannot be included with any other program option. SELBTAB must have an input master dataset with current (updated) calculated data items as these data items are used in some of the summary tables produced by the subprogram.

If allowable multiple program options are selected, the subprograms are executed in the following order:

```
STHPMODU -- SELMODU
STHPEXPFF -- SELEXPFF
STHPEDIT -- SELEDIT
STHPSUMT -- SELSUMT
STHPINTS -- SELINTS
```

E. CONTROL CARDS

Several of the program options require control cards for execution. If the program option SELMODU has been selected by the user, control cards are required to indicate which transactions are to be performed by the subprogram STHPMODU. The program option SELEXPFF=FACTCALC,MILECARD requires control cards containing the universe mileage for the volume groups for which expansion factors are to be calculated. Urbanized area control cards are optional for the program option SELSUMT or SELBTAB which contain the urbanized area codes and names. County name control cards are optional for the program options SELEDIT or SELSUMT which contain the county codes and names.

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1. Transaction Sets

Required for the program option SELMODU with one of the keywords ADDONLY, MODONLY, or ADDMOD. There are five types of transaction set control cards used by the subprogram as follows.

N - Add a new section.

U - Update an existing section.

S - Add and/or delete structure ID's for an existing section.

R - Add and/or delete at-grade railroad crossing ID's.

D - Delete an existing section.

Each transaction card must contain the county code (item 4) and section ID (item 8) coded for the section which is to be altered. The delete card (D) and new section card (N) cannot be used with any other transaction card for the same section. The other three types of transactions may be included for the same section. If more than one transaction set is included for the same section, all the cards in one transaction set must be placed together.

These control cards are placed in the input dataset, UMODCARD (see Section F). The card format for each transaction set will be discussed separately.

a. Add a New Section Transaction Card (N)

This transaction card enables the user to add a new universe or sample section record to the master dataset. The number of cards in the transaction set depends on the type of section being added. Three cards are required to add a universe section; a sample section requires at least five cards. Adding a sample section will require from 1-23 cards depending on the individual section. This transaction set cannot be used with any other transaction set for the same section and all N1, N2, N3.. . . cards for one section must be together. See Appendix O for all card layouts to add a new section.

b. Update a Section Transaction Card (U)

This transaction card enables the user to correct coding errors and update the value coded for a data item. The update transaction set may be used in combination with the add/delete structure ID card and/or add/delete at-grade crossing ID card. Each card in the update transaction set for a section must have the following format:

Transaction Card Code--"U"	Column 1
Sequence Number--"1-9"	Column 2
County Code	Columns 3-5
Section ID	Columns 6-17
Data item number to be updated and data value in the following format:	Columns 18-80

/N1,D1/N2,D2/N3,D3/. . . /Ni,Di/

where N1...Ni = data item number to be updated*

D1...Di = new data value

*The data item numbers are listed in Appendix P.

Several updates may be coded on one card provided that the last column coded contains a "/" thereby requiring the last set of "N" and "D" values for a given update to be on the same card. The value coded for the data item must contain the same number of characters as the length of the data item, i.e., to update item 21, AADT, one must code 6 digits. Leading zeroes must be coded for all numeric data items.

If a section in the dataset is currently coded as a rural section and has become an urban section, all data items for the section which need to be updated must be updated at the same time, i.e., all urban data items must be updated at the same time the rural/urban code (item 5) is changed to urban (code = 2 or 3). This is because the update procedure includes calculation/generation of the calculated data items, and all values used in these calculations must be present. Similarly, if a section in the dataset is currently coded as an urban section and has become a rural section, all data items for the section which need to be updated must be updated at the same time, i.e., all rural data items must be updated at the same time the rural/urban code (item 5) is changed to rural (code = 1).

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The data items which have a part a, b, c, etc. (e.g., items 45, 51, 57, etc.) must have the letter coded as part of the item number as indicated in Appendix P, i.e., to correct the right shoulder width to "10" one would code /45-A,10/. The data items with more than one set of values (e.g., State Control Field, railroad crossing ID's or structure ID's) must have the position of the one to be corrected as part of the item number as indicated in Appendix P, i.e., to correct the third railroad crossing ID, one would code /78-03,007631A/. The position for the item number must be coded as two digits with leading zero.

The card sequence number must always start with 1, and indicates the location of the update card when there is more than one per section. The county code must have a three-digit numeric value and the section ID must be coded exactly the same as the ID for the section in the dataset, including leading/trailing zeroes or blanks. If all data item corrections required for a section cannot be coded on nine update cards, another execution will have to be made to correct the remaining data items. There cannot be more than nine update cards with the same county and section ID code.

e.g.,
U1017__000011289/20,001110/74-B,03/ Item 20, Section Length, is to be corrected to the value 001110; Item 74-B, Number of At-grade Intersections with stop signs is to be corrected to a value of "03".

U6020_____286/51-E,0201023/78-12,701936A/70,2/
Item 51-E, Curves, is changed to 0201023; Item 78, the 12th crossing ID is to be corrected to 701936A; Item 70, Type of Terrain is changed to "2".

c. Add or Delete Structure ID Transaction Card (S)

This transaction card enables the user to add structure ID's to an existing sample section with no ID's coded, add more structure ID's to a sample section which already has ID's coded (must be < 50), or delete one or more ID's from the existing set of ID's for a section. This card may be used in combination with the update card and/or the add/delete at-grade crossing ID card. The structure ID transaction card format is as follows:

Transaction Card Code--"S"	Column 1
Sequence Number--"1-9"	Column 2
County Code	Columns 3-5
Section ID	Columns 6-17
Function to be performed on Structure ID--"A" add ID's coded. --"D" delete ID's coded.	Column 18
Structure ID's to be added or deleted coded 15 characters each, 1 to 4 per card	Columns 19-78
Blank	Columns 79-80

The card sequence number must begin with 1 and be numeric. A three-digit numeric value must be coded for the county code and the section ID must be coded exactly the same as the existing section in the dataset including leading/trailing zeroes or blanks. Only one function ("D" or "A") may be coded per card and all ID's coded on that card will be added or deleted; however, existing structure ID's may be deleted for a section and new ID's added by coding one or more cards with a "D" and one or more with an "A". Each structure ID must be 15 characters (blanks included) in length.

e.g., S1171_____RT07628D2243CTYRT10RT25
S2171_____RT07628A_FED76982761072FED769871469352

Two structure transaction cards for one section. First, a structure ID is to be deleted and then two new ID's are to be added to the section.

If more than 36 structure ID's are to be deleted and/or added for a section, the subprogram STHPMODU will need to be executed more than once since the maximum number of ID's that can be coded in one execution is 36 (4 per card, 9 cards maximum).

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NOTE: The structure ID transaction card does not adjust the number of structures coded in item 75. The user must update this data item, separately.

d. Add or Delete At-grade Railroad Crossing ID Transaction Card (R)

The use of this transaction card enables the user to add crossing ID's to an existing sample section with no ID's coded, add more crossing ID's to a section which already has ID's coded (must be < 15), or delete one or more ID's from the existing set of ID's for a section. The crossing transaction card may be used in combination with the update card and/or the add/delete structure ID card. The card format is as follows.

Transaction Card Code--"R"	Column 1
Sequence Number--"1-9"	Column 2
County Code	Columns 3-5
Section ID	Columns 6-17
Function to be performed on Crossing ID--"A" add ID's coded. --"D" delete ID's coded.	Column 18
Crossing ID's to be added or deleted coded as 7 characters each, 1 to 8 per card	Columns 19-74
Blank	Columns 75-80

The card sequence number must be a numeric value and must start with 1. The county code must be a three-digit numeric value. The section ID coded must match the ID in the dataset exactly including leading/trailing zeroes or blanks. Crossing ID's may be deleted and added for the same section by using one or more crossing ID transaction cards with a function of "D" plus one or more with a function of "A", respectively. Each crossing ID coded must be seven characters in length--six numeric digits and one alphabetic.

e.g., R1273 _____ 12854D724329B816629F
R2273 _____ 12854A872131J923517D396424A157739H

Two crossing transaction cards for the same section. The first function deletes two crossing ID'S, while the second function adds four crossing ID's to the section.

NOTE: The crossing ID transaction card does not adjust the number of at-grade crossings coded in item 76. The user must update this data item, separately.

e. Delete a Section Transaction Card (D)

This transaction card enables the user to remove a section record from the dataset and cannot be used with any other transaction card. The card format is as follows.

Transaction Card Code--"D"	Column 1
Sequence Number--Always "1"	Column 2
County Code	Columns 3-5
Section Identification	Columns 6-17
Occurrence of section to be deleted	Column 18
Blank	Columns 19-80

The county code must be a three-digit numeric value. The section identification must be coded exactly as the one to be deleted (including embedded or leading/trailing zeroes or blanks). The occurrence of the section to be deleted must be numeric and tells which section is to be deleted if there is more than one in the dataset with the same section ID (item 8). In most cases, the occurrence will be coded "1".

e.g., D1124__RT11__10212 - Delete the second section with matching ID.

2. Universe Mileage Cards

Required control card(s) for the program option SELEXP with keywords FACTCALC and MILECARD containing the universe mileage for each volume group for which expansion factors are to be calculated. The subprogram will total the sample mileage in the volume group, divide it into the universe mileage to get the new expansion factor, and then replace the old expansion factors on the sample records for that volume group with the new expansion factors. These control cards are used with the input dataset, UNIVERSE (see Section F).

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Since the Interstate system requires the sampling of four mileage categories, the universe mileage card must contain a code indicating for which category (type) of Interstate mileage the expansion factors are being calculated, as well as the volume group. Interstate (functional system code 01 or 11) is the only functional system which must have a category of mileage coded on the universe mileage card. The codes for the Interstate category are listed under the card format, below. The universe mileage coded on the control card must be the total mileage for the volume group and category of Interstate mileage, i.e., for volume group 02 on Interstate toll (category code "2") the universe mileage would consist only of the Interstate which is toll in that AADT group. If an Interstate section falls in more than one category, apply the universe mileage to the category with the lower code, i.e., Section 139(a)/toll would be applied to category code "2". If this causes expanded mileage errors (i.e., one or both of the subcategory mileages do not expand to the universe mileage actually in each of the subcategories, individually), 100 % sampling of the conflicting mileage will be required.

This card format is:

Type of Area	Columns 1-3
--Rural: Code "RUR".	
--Small Urban: Code "SMU".	
--Individually Sampled Urbanized Areas: Code the three-digit urbanized area code.	
--Grouped Urbanized Area for Sampling: Code the letter "G" followed by the two-digit prefix (between 11 - 20) used for the group of urbanized areas, as coded in Item 6.	
Functional System	Columns 4-5
--Code the two-digit functional system code (Item 9).	
Volume Group Number	Columns 6-7
--Code the two-digit volume group number including leading zero, where necessary, for which the universe mileage is being entered.	
Universe Mileage	Columns 8-16
--Code the universe mileage for the volume group any place in these columns. The mileage for the volume group may be coded to the nearest thousandth of a mile. When coding to the nearest tenth, hundredth or thousandth of a mile the decimal point must be coded. Leading zeroes are optional.	

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Interstate Mileage Category Code	Column 17
--Interstate (non-toll, not 139(a), & not Secretarial Agreement)	code "1"
--Interstate toll (Item 19, code "2")	code "2"
--Interstate with Secretarial Agreement (Item 19, codes "3" & "4")	code "3"
--Interstate 139(a) addition (Item 16, code "40")	code "4"

All Other Functional Systems -- Column 17 Blank

Blank Columns 18-80

There must be a card for each volume group within a functional system for which a new expansion factor is to be calculated when using the MILECARD option.

e.g., G201102125 1
G20110200125.0001
G201102125.0 1

These three cards would all have the same effect. Expansion factors are to be calculated for urban Interstate, volume group 02 for grouped urbanized areas using the prefix "20", with universe mileage of 125.

RUR0604316.827 - Expansion factors are to be calculated for rural minor arterials volume group 04 with universe mileage equal to 316.827 miles.

3. Urbanized Area Name Cards

Optional for the program selection SELSUMT. Optional for SELBTAB when urban summary tables which show individual urbanized areas have been selected (INDUZA). These cards enable the subprogram to print the urbanized area name on the summary tables. One card is required for each urbanized area in a State. Up to 35 cards may be included. The card format is as follows:

Urbanized Area Code	Columns 1-3
--Individually sampled urbanized areas; code the three-digit urbanized area code.	
--Grouped urbanized areas for sampling; code the letter "G", followed by the two-digit prefix (between 11 and 20) used for the group of urbanized areas.	

Urbanized Area Name Columns 4-33

Blank Columns 34-80

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Since the Interstate system requires the sampling of four mileage categories, the universe mileage card must contain a code indicating for which category (type) of Interstate mileage the expansion factors are being calculated, as well as the volume group. Interstate (functional system code 01 or 11) is the only functional system which must have a category of mileage coded on the universe mileage card. The codes for the Interstate category are listed under the card format, below. The universe mileage coded on the control card must be the total mileage for the volume group and category of Interstate mileage, i.e., for volume group 02 on Interstate toll (category code "2") the universe mileage would consist only of the Interstate which is toll in that AADT group. If an Interstate section falls in more than one category, apply the universe mileage to the category with the lower code, i.e., Section 139(a)/toll would be applied to category code "2". If this causes expanded mileage errors (i.e., one or both of the subcategory mileages do not expand to the universe mileage actually in each of the subcategories, individually), 100 % sampling of the conflicting mileage will be required.

This card format is:

Type of Area	Columns 1-3
--Rural: Code "RUR".	
--Small Urban: Code "SMU".	
--Individually Sampled Urbanized Areas: Code the three-digit urbanized area code.	
--Grouped Urbanized Area for Sampling: Code the letter "G" followed by the two-digit prefix (between 11 - 20) used for the group of urbanized areas, as coded in item 6.	
Functional System	Columns 4-5
--Code the two-digit functional system code (item 9).	
Volume Group Number	Columns 6-7
--Code the two-digit volume group number including leading zero, where necessary, for which the universe mileage is being entered.	
Universe Mileage	Columns 8-16
--Code the universe mileage for the volume group any place in these columns. The mileage for the volume group may be coded to the nearest thousandth of a mile. When coding to the nearest tenth, hundredth or thousandth of a mile the decimal point must be coded. Leading zeroes are optional.	

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Interstate Mileage Category Code	Column 17
--Interstate (non-toll & not 139(a))	code "1"
Interstate toll	code "2"
Interstate with Secretarial Agreement	code "3"
Interstate 139(a) addition (item 16, code "40")	code "4"

All Other Functional Systems -- Column 17 Blank

Blank Columns 18-80

There must be a card for each volume group within a functional system for which a new expansion factor is to be calculated when using the MILECARD option.

e.g., G201102125 1
G20110200125.0001
G201102125.0 1

These three cards would all have the same effect. Expansion factors are to be calculated for urban Interstate, volume group 02 for grouped urbanized areas using the prefix "20", with universe mileage of 125.

RUR0604316.827 - Expansion factors are to be calculated for rural minor arterials volume group 04 with universe mileage equal to 316.827 miles.

3. Urbanized Area Name Cards

Optional for the program selection SELSUMT. Optional for SELBTAB when urban summary tables which show individual urbanized areas have been selected (INDUZA). These cards enable the subprogram to print the urbanized area name on the summary tables. One card is required for each urbanized area in a State. Up to 35 cards may be included. The card format is as follows:

Urbanized Area Code	Columns 1-3
--Individually sampled urbanized areas;	
code the three-digit urbanized area code.	
--Grouped urbanized areas for sampling;	
code the letter "G", followed by the two-digit prefix (between 11 and 20) used for the group of urbanized areas.	

Urbanized Area Name Columns 4-33

Blank Columns 34-80

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The three-digit urbanized area code must be coded with leading zeroes. 1-30 characters, including blanks, may be used for the name of the urbanized area. If the user does not desire the urbanized area name on the summary table(s), these cards may be omitted, or coded with columns 4-33 blank. If omitted, the urbanized area code (or the group code for collective urbanized areas) will be listed. These control cards are used with the input dataset, URBCARD (see Section F).

e.g., 247_NEW_TOWN_CHICAGO
G13_PEORIA-ROCKFORD-ALTON

4. County Name Cards

Optional for the program selection SELSUMT with keyword, CNTYMILE. Optional for the program selection SELEDIT. These cards enable the subprogram(s) to print the county name on the summary table CNTYMILE in SELSUMT and/or on the SELEDIT edit listings and messages for each county in a State. Up to 250 cards may be included. The card format is as follows:

County Code	Columns 1-3
--The three-digit county code.	
County Name	Columns 4-33
Blank	Columns 34-80

The three-digit county code must be coded with leading zeroes, where necessary. From 1-30 characters, including blanks, may be used for the name of the county. If the user does not desire the county name on the table(s), these cards may be omitted, or coded with columns 4-33 blank. If omitted, the county FIPS code will be listed. These control cards are used with the input dataset, CTYCARD (see Section F).

e.g., 012_ROCKFORD

F. INPUT/OUTPUT DATASETS

Several datasets are used during execution depending on the program options(s) selected.

1. SYSUDUMP Standard "system output" dataset used if the program abnormally terminates during execution. Routed to the printer. Required for all executions if a dump is desired for abnormal termination.
2. SYSOUT Standard "systems output" dataset for printing system messages. Required for all executions.
3. USERPARM Input dataset containing the parameter cards. Consists of 80-character records. Required for all executions.
4. LISTPARM Output dataset routed to the printer for listing of parameter cards, error messages and information messages for the user. Required for all executions.
5. CURMAST Input dataset which contains the current HPMS dataset. The type record format, variable blocked, and the record length, 163 to 1282 characters, are defined by the subprogram(s). The block size can vary and may be defined by the user or determined from the dataset labels. Required input dataset for SELMODU, SELBTAB and SELCALC for all executions. Input dataset for SELEXPf, SELEDIT, SELSUMT and SELINTS, depending on program option combinations requested.
6. NEWMAS T Input/output dataset which contains the updated HPMS dataset. The DCB parameters are defined by the subprogram(s). Required output dataset for SELMODU. Required input dataset for SELEXPf if selected with SELMODU; for SELEDIT if selected with SELMODU; for SELSUMT if selected with SELMODU.
7. CALMAST Required output dataset for SELCALC which contains the updated (current) calculated/recalculated data items and/or the updated (current) climate zones. The DCB parameters are defined by the subprogram.
8. CURUPMOD Temporary input/output dataset required for the program option SELMODU, which contains the updated HPMS dataset before the data is sorted or copied to the new master dataset. Required temporary input/output dataset for the program option SELEXPf with keyword, FACTCALC. The DCB parameters are defined by the subprogram.

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9. EXPFMAST Input/output dataset which contains the HPMS dataset with new expansion factors. Required output dataset for SELEXPf with keyword FACTCALC. Required input dataset for SELEDIT if selected with SELEXPf; for SELSUMT if selected with SELEXPf. The DCB parameters are defined by the subprogram(s).
10. TEMPFILE Temporary input/output dataset required for the program option SELEXPf with keyword UNIVTAB. Contains the sorted HPMS dataset later used to produce the summary universe mileage table. The DCB parameters are defined by the subprogram.
11. PRINTER Output dataset routed to the printer. Required output dataset for the program option SELEXPf and/or SELSUMT. Required output dataset for SELCALC or SELBTAB. Contains program messages, error messages and summary tables.
12. ERRPRINT Output dataset routed to the printer. Required output dataset for SELMODU and/or SELEDIT. Contains transaction cards found to be in error, and/or error messages and data sections with at least one data item in error along with error messages.
13. UMODCARD Input dataset which contains the 80-character transaction cards to add, modify and/or delete section records on the HPMS dataset. Required dataset for program option SELMODU with keyword ADDONLY or ADDMOD or MODONLY.
14. UMODFILE Temporary input/output dataset required for the program option SELMODU with keyword ADDONLY or MODONLY or ADDMOD. Contains the sorted valid transaction card sets to modify and/or delete HPMS sections. The DCB parameters are defined by the subprogram.
15. MODPRINT Output dataset routed to the printer. Required output dataset for the program option SELMODU. Contains summary tables and error messages.
16. UNIVERSE Input dataset which contains the 80-character universe mileage cards. Required for program option SELEXPf with keywords FACTCALC and MILECARD.
17. URBCARD Input dataset which contains the 80-character urbanized area name cards. Required dataset for program option SELBTAB when urban summary tables showing individual urbanized areas have been selected if the user desires the urbanized area name on the summary tables. Required dataset for SELSUMT. If urbanized area names are not desired on the tables from the program options SELSUMT or SELBTAB, this dataset must still be included as URBCARD DD DUMMY.

18. CTYCARD Input data set which contains the 80-character county name cards. Required dataset for program option SELSUMT with keyword CNTYMILE if user desires the county name on the output table. Required dataset for SELEDIT. If county names are not desired on the output, this dataset must still be included as CTYCARD DD DUMMY.
19. RURALIN Temporary input/output dataset required for the program option SELBTAB if rural summary tables(s) have been selected. The dataset contains the sample rural HPMS section records reduced in length. The DCB parameters are defined by the subprogram(s).
20. URBANIN Temporary input/output dataset required for the program option SELBTAB if urban summary table(s) have been selected. The dataset contains the sample urban HPMS section records reduced in length. The DCB parameters are defined by the subprogram(s).
21. SORTWK01 Intermediate storage datasets for sorting applications.
SORTWK02 The sort program requires at least three work datasets.
SORTWK03 A SORTLIB DD card may be needed on some systems.
SORTWK04 Required for program options SELMODU, SELINTS, SELEXP, SELSUMT and SELBTAB. Required for program option SELEDIT with keyword VALIDCODES and without keyword SAMPNUMNO (i.e., sample number is to be checked for uniqueness).

Required INPUT/OUTPUT datasets by program option.

All executions of FHWAHPMS require the following datasets:

SYSUDUMP (if a dump is desired for abnormal end)
SYSOUT
USERPARM
LISTPARM

Program option SELMODU

CURMAST
CURUPMOD
NEWMAST
ERRPRINT
UMODCARD
UMODFILE
MODPRINT
SORTWK01
SORTWK02
SORTWK03

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Program option SELEDIT

CURMAST
ERRPRINT
1/ CTYCARD
SORTWK01 . . . |
SORTWK02 . . . | If sample number is being checked for
SORTWK03 . . . | uniqueness.

1/ If county names are not desired on the listings, this card must be included as CTYCARD DD DUMMY.

Program option SELCALC

CURMAST
CALMAST
PRINTER

Program option SELEXP

SELEXP with keyword UNIVTAB

CURMAST
PRINTER
TEMPFILE
SORTWK01
SORTWK02
SORTWK03

SELEXP with keyword FACTTAB

CURMAST
PRINTER
SORTWK01
SORTWK02
SORTWK03

SELEXP with keyword FACTCALC

CURMAST
EXPMAST
CURUPMOD
PRINTER
2/ UNIVERSE with keyword MILECARD
SORTWK01
SORTWK02
SORTWK03

2/ If universe mileage is accumulated from the master file, this dataset may be omitted.

Program option SELBTAB

CURMAST
PRINTER
3/ URBCARD If urban tables are selected
RURALIN If rural tables are selected
URBANIN If urban tables are selected
SORTWK01
SORTWK02
SORTWK03

3/ If urbanized area names are not desired on the tables, this card must be included as URBCARD DD DUMMY.

Program option SELSUMT

CURMAST
PRINTER
4/ URBCARD
4/ CTYCARD If county mileage table is selected
SORTWK01
SORTWK02
SORTWK03

4/ If urbanized area names are not desired on the tables, the URBCARD DD card must be included as URBCARD DD DUMMY. If county names are not desired on the county mileage table, the CTYCARD DD card must be included as CTYCARD DD DUMMY.

Program option SELINTS

CURMAST
PRINTER
SORTWK01
SORTWK02
SORTWK03

G. PROGRAM OPERATION

The user parameter cards are read and each is checked for card name to determine which program option(s) has been selected and which keyword(s) was selected for the program option(s). Each parameter card read is edited for general type errors--valid parameter card name with valid keyword(s), invalid inventory year, invalid card format, and numeric value where required. If a general error is found, the remainder of the parameter cards are read and listed without being checked for card name and keyword(s) coded along with the appropriate general error message. If the end of the parameter cards is reached before any general errors are found, a more detailed edit is performed on the set of cards with specific error messages(s) listed for any error(s) detected. Some of the types of more detailed edits are:

1. INVYEAR card must be included in parameter card set.
2. SELCALC program option card cannot be included with any other program option card.
3. SELEXPf program option card must contain one of the keywords FACTCALC or FACTTAB.

Execution of FHWAHPMS will terminate if an error is found in the set of parameter cards (general or the more detailed editing). If execution terminates, all parameter cards will be listed for the user along with appropriate error message(s).

Once the end of the parameter cards is reached with no errors, each subprogram required to perform the program option(s) selected by the user will be dynamically called by FHWAHPMS. If multiple program options have been selected, the subprograms will be called in the following order:

STHPMODU (SELMODU)
STHPEXPf (SELEXPf)
STHPEDIT (SELEDIT)
STHPSUMT (SELSUMT)
STHPINTS (SELINTS)

After all selected subprograms have been called and execution has been returned to FHWAHPMS for the last time, a message is printed reminding the user which dataset should be kept as the latest HPMS master dataset.

Each subprogram operation is discussed briefly in Appendix Q.

H. OUTPUT

1. Datasets on Tape or Disk

- a. The program option SELMODU creates an updated HPMS dataset, NEWMAST.
- b. The program option SELEXPFF creates an HPMS dataset, EXPFMAST, with new expansion factors for sample sections.
- c. The program option SELCALC creates an HPMS dataset, CALMAST, with each section record containing the recalculated values for each calculated data item in the record.

2. Printed

- a. List of user parameter cards.
- b. List of program control cards.
- c. Error messages if invalid parameter card(s) are included.
- d. Error messages if invalid control cards are coded.
- e. Listing of section record(s) in error and error messages from editing of data.
- f. Listing of section records in dataset.
- g. Summary tables.
- h. Information messages for the user.

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I. ERROR MESSAGES/USER MESSAGES

The messages are listed below for FHWAHPMS and each subprogram that lists errors for the user. The error messages for the editing of the data items will not be included here -- see the edit specifications contained in Appendix M.

FHWAHPMS

1. "INVALID KEYWORD ON PARAMETER CARD" - Indicates the user has misspelled a keyword. Execution terminates.
2. "INVALID CARD NAME ON PARAMETER CARD" - Indicates the user has misspelled the name on one of the parameter cards. Execution terminates.
3. "YEAR IS NOT NUMERIC ON INVYEAR PARAMETER CARD" - Indicates the year coded is not a 4-digit number. Execution terminates.
4. "MAXIMUM NUMBER ERROR CODED IS NOT NUMERIC OR IS MORE THAN 5 DIGITS" - Self-explanatory. Execution terminates.
5. "MAXERRS CARD IS INCLUDED WITHOUT PROGRAM OPTION CARD SELEDIT" - Indicates the user has forgotten to include the program option card for the edit or should not have included the MAXERRS card as no editing of data is to be done. Execution terminates.
6. "REQUIRED STATE NAME CARD AND/OR INVENTORY YEAR CARD MISSING" - These two parameter cards are required for all executions. Execution terminates.
7. "INVALID FORMAT FOR TABLE SELECTION ON SELBTAB CARD OR INVALID TABLE NUMBER SELECTED" - Indicates the user has not coded the area type with the table number (U or R) or the number coded is 0 or greater than 9.
8. "RANGES ON SELBTAB CARD ARE INVALID" - Indicates the user has coded the end range table number smaller than the beginning range table number. Execution terminates.
9. "PARAMETER CARD SET DOES NOT CONTAIN AT LEAST ONE PROGRAM OPTION CARD" - Each execution of FHWAHPMS must contain one of the cards SELMODU, SELEDIT, SELEXP, SELSUMT, SELCALC, or SELBTAB. Execution terminates.
10. "BEGIN RANGE TABLE AREA TYPE AND END RANGE TABLE AREA TYPE ARE NOT THE SAME ON THE SELBTAB CARD" - The area types (R -rural, U - urban) coded on the range selection for tables must be the same. Execution terminates.

11. "ONE OF THE KEYWORDS - LISTSECT, LISTUNIV, LISTSAMPLE - IS CODED WITH A TYPE EDIT KEYWORD ON THE SELEDIT CARD" - The listing of sections and editing of the data items are mutually exclusive. Only one type of keyword may be coded in an execution. Execution terminates.
12. "SELEXPf CARD HAS BOTH KEYWORDS CODED--FACTCALC and FACTTAB; ONLY ONE MAY BE CODED" - Self-explanatory. Execution terminates.
13. "SELEXPf CARD HAS FACTCALC KEYWORD CODED. ONE OF KEYWORDS--MILEDATA OR MILECARD--MUST BE CODED" - Self-explanatory. Execution terminates.
14. "SELEXPf CARD HAS ONE OF KEYWORDS--MILEDATA OR MILECARD--CODED. KEYWORD FACTCALC MUST BE CODED" - Self-explanatory. Execution terminates.
15. "THE PROGRAM OPTION CARD SELBTAB MAY NOT BE INCLUDED WITH ANY OTHER PROGRAM OPTION CARD" - SELBTAB cannot be selected with any other program option since the dataset must be as free of errors and as complete as possible for the battery of summary tables to be useful. Execution terminates.
16. "INVALID CARD FORMAT ON PARAMETER CARD" - A comma has been omitted, the slashes for the State code, or the equal sign has been omitted. Execution terminates.
17. "STATE CODE IS NOT NUMERIC ON STATECN CARD" - Self-explanatory. Execution terminates.
18. "THE PROGRAM OPTION CARD SELCALC MAY NOT BE INCLUDED WITH ANY OTHER PROGRAM OPTION CARD" - SELCALC cannot be included with any other program option card. The dataset needs to contain valid codes before the calculated data items are calculated for the first time. Execution terminates.
19. "ONLY ONE KEYWORD MAY BE CODED ON THE SELMODU CARD" - All SELMODU keywords are mutually exclusive. Execution terminates.
20. "CNTYINC CANNOT BE INCLUDED WITHOUT THE PROGRAM OPTION CARD, SELEDIT" - self-explanatory. Execution terminates.
21. "PROGRAM OPTION SELSUMT WAS SELECTED WITH KEYWORD SAMPLEMT. IT WAS NOT EXECUTED. ZERO AADT'S WERE FOUND WHILE DETERMINING THE UNIVERSE MILEAGE FROM THE DATASET. NO NEW EXPANSION FACTORS WERE CALCULATED" - self-explanatory.
22. "PARAMETER CARDS CONTAIN AT LEAST ONE ERROR. CHECK ALL CARDS. EXECUTION TERMINATED" - self-explanatory. Execution terminates.
23. "***** INVALID COUNTY CODES IN DATA. SECTION WAS NOT INCLUDED IN SELECTION. MAY BE MISSING SECTIONS DESIRED" - self-explanatory.

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24. "NO ERRORS WERE DETECTED IN THE PARAMETER CARDS. EXECUTION OF PROGRAM OPTIONS SELECTED BY USER STARTED" - self-explanatory.
25. "***** PROGRAM OPTION SELEDIT WAS SELECTED WITH SPECIFIC COUNTIES DESIRED (CNTYINC)" - Reminds the user all counties in the dataset have not been edited.

STHPMODU (SELMODU)

1. "UPDATE CARD IMPROPER FORM" - Indicates the user has not coded the transaction card correctly. This card is not used.
2. "SEQ NUM MUST BE NUMERIC > 0" - Indicates the sequence number on the transaction card has been miscoded. The transaction is not used for building the valid transaction dataset.
3. "CK: SEQ NUM, ID or TRAN CODE" - The ordering of the transaction set should be verified, section ID and county code checked. In some situations, the transaction code may be invalid. The set with matching ID's is not used.
4. "DELETE CARDS > 1 WITH SAME ID" - More than one delete card has been included for the same section. The deletion is not performed for either card. Verify ID's on cards.
5. "INVALID TRANSACTION CODE" - The first column on the card does not contain an N, U, D, R or S. The transaction set with matching ID is not used.
6. "TRAN CODE NOT -; SEQ # > 1, ID -" - Different transaction codes coded for same ID with a sequence number not equal 01. Verify ID, transaction code, and sequence number. The set is not used.
7. "TOO MANY BRID/XING ID FOR SECT" - Indicates that the addition of bridge or crossing ID's exceeded the maximum number - bridge (structure), 50; crossing, 15. Only the ID's beyond the maximum number were not added. Card with these ID's is listed.
8. "INVALID ITEM NUMBER" - Indicates that particular update could not be performed. All valid updates on card are performed.
9. "ID TRANS NOT - ID FOR SECTION" - Indicates the county code and section ID on the transaction card does not match any in the dataset. No transaction performed.
10. "OCCURRENCE OF DELETION INVALID" - Indicates ID for deletion matched, but there was only one section with that ID. Deletion is not performed.
11. "INVALID FORMAT FOR UPDATE CARD" - Verify the coding of card. This particular card is not used, but all valid cards in set are used and updates are performed.

12. "INVALID FORMAT FOR UPDATE" - Indicates that particular update has a coding error--not of form /xx,xxxx/ or /xx-x,xx/. All valid coded updates on card are used.
13. "INVALID FORMAT FOR STRUCID CARD" - Indicates that particular structure transaction card is miscoded and is not used. Any valid cards in set are used with actions performed on the record.
14. "INVALID FORMAT FOR XINGID CARD" - Indicates that particular crossing transaction card is miscoded and is not used. Any valid cards in set are used with actions performed on section.
15. "INVALID FORMAT FOR DELETE CARD" - Indicates the card is miscoded. The deletion is not performed.
16. "INVALID FORMAT ITEM & SUB-ITEM" - Indicates the coding for a data item with a sub-item is invalid -- not of the form /xx-x,xxx/ or /xx-xx,xx/. All validly coded updates on the card are used.
17. "CALCULATED DATA ITEM" - A calculated data item, other than capacity (item 60), has been coded as a data item to be updated. The item is not updated, but all validly coded updates on the card are used.
18. "INVALID SUB-ITEM LETTER OR NUM" - Indicates the sub-item letter or number coded for item number 1, 45, 51, 53, 57 62 or 74 is miscoded or the structure ID referenced is > 50 or the crossing ID referenced is > 15. The update is not performed. Any other valid updates on card are performed.
19. "CODE NOT 'A' or 'D' FOR ID'S" - Indicates the action to be performed on structure or crossing ID is miscoded. This card is not used. Any other valid card in set is used.
20. "DEL BRID/XING ID DOESN'T MATCH" - Indicates the ID coded to be deleted from section structure (bridge) ID's or crossing ID's is not on data record. Verify. Any other valid ID to delete on card is deleted for section.
21. "INVALID ITEM NUM WITH SUB-ITEM" - Indicates a letter or number has been coded for an item number which has no subitems. See Appendix P to verify which data items have subitems. This particular update is not performed, but any valid update on card is performed.
22. "DEL CARD & OTHER TRAN CARD = ID" - Indicates a delete for a section has been coded with another transaction set. Verify transaction codes. Cards are not used.
23. "ITEM NUM MUST HAVE SUB-ITEM" - Indicates the coded item number must have a letter or number subitem. This particular update is not made. Any other valid updates on card are performed.

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24. "T-CODE N; 2 TYPE 1 CARDS = ID'S" - Check the transaction code N card type number. Cannot have two card type 1 for same section. Section record is not added to dataset.
25. "NEWSECT CARD & OTHER TRAN = ID'S" - Check the county code and section ID. Transaction code N cannot be coded with any other transaction for same section. Transaction sets are not used.
26. "NEWSECT CARD TYPE MUST BE 1-9" - Card type has been miscoded for a new section to be added. Check all card type numbers. Section is not added to the dataset.
27. "NEWSECT TYPE1 CARD MISSING" - To add a section - universe, or sample - there must be a transaction card N with card type 1.
28. "NEWSECT 2 TYPE2 CARDS INCLUDED " - Each section to be added must have one card type 1 and one card type 2. Section is not added.
29. "NEWSECT TYPE1/2 CARD MISSING" - See #28.
30. "NEWSECT 2 TYPE3 CARDS INCLUDED" - To add a new section, there must be one each of card type 1, card type 2, and card type 3. Section is not added.
31. "NEWSECT TYPE1/2/3 CARD MISSING" - The first N transaction card for a new section starts with a number > 3. See #30.
32. "TOO MANY CARDS FOR NEWSECTION" - The maximum number of cards to add a new sample section of maximum length is 23. Section is not added.
33. "ID FOR NEWSECT = ID ON DATASET" - Check the county code and section ID coded for the transaction set N. Section is not added since it already exists.
34. "TOO MANY ID'S CODED--NEWSECT" - More than 13 structure ID cards (card type 8) or more than 2 crossing ID cards (card type 9) have been included for the new section. Section is not added.
35. "CURVE CARD2 MISSING--NEWSECT"
"CURVE CARD1 MISSING--NEWSECT" - A new sample section must have curve data provided if it is a rural arterial or urban principal arterial. There must be two type 6 cards for these sections. Section is not added.
36. "STRUC CARD MISSING - CK CARD #'S" - A new section is to be added with structure ID's (card type 8). The sequence numbers for card type 8 are not in order or a card has been omitted. Section is not added.
37. "XING CARD MISSING - CK CARD #'S" - A new section is to be added with crossing ID's (card type 9). The sequence numbers for card type 9 are not in order or a card has been omitted. Section is not added.

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38. "UNIV SECT INVALID ITEM NUMBER" - The update item number is greater than 22 for a universe section. The update for the data item is not made. All other valid updates on card are made for the section.
39. "ITEM 23 CANNOT BE MODIFIED" - The user cannot change item 23, the continuation code. The subprogram makes any necessary changes when modifications are made to the section.
40. "STRUC ID'S NOT CODED FOR SECT" - An update has been coded for a structure ID on a section which does not have any. The transaction card, S, should be used. Other valid updates for the section are made.
41. "ID # TO BE UPDATED> #ID'S" - An update has been coded for a structure ID or crossing ID beyond the number of ID's for the section. Update is not made. Any other valid updates for the section are made.
42. "XING ID'S NOT CODED FOR SECT" - An update has been coded for a crossing ID on a section which does not have any. The transaction card, R, should be used. Any other valid updates for the section are made.
43. "NEWSECT 2 TYPE 4 CARDS INCLUDED" - To add a sample section, there must be one each of card type 1, card type 2, card type 3, card type 4 and card type 5. Section is not added.
44. "NEWSECT 2 TYPE 5 CARDS INCLUDED" - See # 43, above.
45. "INVALID SECTION TYPE FOR NEWSECT" - The transaction set N must contain a 1 or 2 in card type 1, column 80, to indicate type of section being added. Section is not added.
46. "CTYPE4/5 CODED SECTION TYPE UNIV" - The type of section being added coded in card type 1 disagrees with number of cards coded for a new section. Only a sample section (section type 2) has card type 4 and card type 5 provided. Check number of cards coded and section type. Section is not added.
47. "CTYPE 6-9 CODED SECT TYPE 1" - Too many cards coded for new section with type of section coded. Card types 6-9 indicate sample section. Check section type coded. Section is not added.
48. "CTYPE4/5 MISSING SECT TYPE IS 2" - The section type of 2 indicates a sample section is to be added which must have one card each of card type 1, 2, 3, 4 and 5. Check section type number. Section is not added.
49. "CUR CARD NUM = 0 or GREATER 2" - To provide curves for a new section on a required functional system there must be a card type 6 number 1 and card type 6 number 2. Section is not added.

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50. "CTYPE8/9 CARD NUM NOT NUMERIC" - Card type 8 - structure ID's and card type 9 - crossing ID's - for a new section must have a card number to indicate the sequence of these multiple card types. Section is not added.
51. "INVALID DATA ITEM FOR SECTION" - Crossing ID's (transaction R), or structure ID's (transaction S) have been coded for a universe section. Check county code and section ID. Transaction is not performed.
52. "*****CLIMATE ZONE WAS NOT DETERMINED FOR ALL SAMPLE SECTIONS. NON-NUMERIC COUNTY CODES OR INVALID COUNTY CODES WERE FOUND. VERIFY ALL COUNTY CODES." - Zero is placed on data record for the climate zone. County code must be valid to determine the climate zone.

STHPEXPF (SELEXPf)

1. "NO UNIVERSE MILEAGE CARDS SUBMITTED. NO EXPANSION FACTORS WILL BE CALCULATED" - The program option SELEXPf-FACTCALC,MILECARD was selected, but no universe mileage cards were submitted.
2. "NO SAMPLE MILEAGE FOUND" - A universe mileage card was submitted for a volume group for which no sample sections could be found.
3. "UNIVERSE MILEAGE LESS THAN SAMPLE MILEAGE" - Universe mileage given on card is less than the sample mileage for this volume group.
4. "*****EXPANSION FACTOR CALCULATED" - Expansion factor has been successfully calculated for this volume group.
5. "UNMATCHED URBAN CODE" - No sample sections could be found that matched the urban code on the universe mileage card.
6. "INVALID FUNC CLASS" - Functional system in columns 4-5 of the universe mileage card is not among the valid codes.
7. "INVALID VOLUME GROUP" - Check columns 6-7 of the universe mileage card.
8. "MILEAGE NOT NUMERIC" - Check columns 8-16 of the universe mileage card.
9. "ERROR--MULTIPLE EXPANSION FACTORS" - More than one expansion factor for this volume group was found on the master file. All the sample sections within a volume group should have the same expansion factor.
10. "NO ZERO AADTS WERE DETECTED--THE UNIVERSE MILEAGE HAS BEEN ACCUMULATED AND EXPANSION FACTORS CALCULATED" - The program option SELEXPf-FACTCALC,MILEDATA was selected and expansion factors have been successfully calculated.

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11. "THE FOLLOWING RECORDS SHOW AN AADT - 0 FOR ROADS OPEN TO TRAFFIC. THE UNIVERSE MILEAGE COULD NOT BE DETERMINED; CHECK YOUR RECORDS AND TRY AGAIN" - The program option SELEXPFF=FACTCALC,MILEDATA was selected, however the input file contains records with zero AADTs.
12. "*****NO EXPANSION FACTORS CALCULATED" - Expansion factors were not calculated due to error(s).

STHPCALC (SELCALC)

1. "*****CLIMATE ZONE WAS NOT DETERMINED FOR ALL SAMPLE SECTIONS. NON-NUMERIC COUNTY CODES OR INVALID COUNTY CODES WERE FOUND. VERIFY ALL COUNTY CODES." - Zero is placed on data record for the climate zone. County code must be valid to determine the climate zone.

STHPBTAB (SELBTAB), STHPEDIT (SELEDIT), STHPSUMT (SELSUMT)

1. "TOO MANY URBAN AREA CARDS SUBMITTED; REMAINING CARDS IGNORED" - Program can only accommodate 35 urbanized area codes. At present no State has more than 30 urbanized areas.
2. "TOO MANY COUNTY NAME CARDS SUBMITTED; REMAINING CARDS IGNORED" - Program can only accommodate 250 county name codes.
3. "THE FOLLOWING CARDS SHOW COUNTY CODES WHICH ARE NOT NUMERIC. CORRECT CARDS AND TRY AGAIN. ****PROCESS TERMINATED"- Check columns 1-3 of the county name card. Leading zeroes must be coded.

J. CORE

The amount of core required depends on the program option selected or the combination of program options selected. The amount of core for execution varies from approximately 90K bytes to 280K bytes. The approximate amount of core by program option is as follows:

- 1/ SELMODU(STHPMODU) 128K bytes to 176K bytes
SELEXPFF(STHPEXPFF) 156K bytes
- 2/ SELEDIT(STHPEDIT) 128 bytes to 170K bytes
SELCALC(STHPCALC) 90K bytes
SELSUMT(STHPSUMT) 152K bytes
SELBTAB(STHPBTAB) 98K bytes
SELINTS(STHPINTS) 280K bytes
- 1/ STHPMODU requires approximately 158K bytes for the keyword MODONLY; approximately 160K bytes for the keywords ADDONLY or ADDMOD. If the county code or section ID is modified, approximately 176K bytes are required as the new master dataset is sorted by section ID within county code.
- 2/ STHPEDIT requires the larger amount of core for execution if the sample ID number is to be checked for uniqueness within county, as the dataset must be sorted.

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K. SAMPLE JCL SETUPS

Sample Run
Produce Battery of Summary Tables
for Individual Urbanized Areas

```
//TABLES EXEC PGM=FHWAHPMS,REGION=110K
//STEPLIB DD UNIT=DISK,VOL=SER-LP0001,DISP=SHR,
// DSN=LP.LP02XXBH.SUBMIT89.LOADLIB
//USERPARM DD *
STATECN=TEST STATE/30/
INVYEAR=1988
SELBTAB=R1-R9,U1-U6,INDUZA
/*
//LISTPARM DD SYSOUT=A,DCB=BLKSIZE=133
//CURMAST DD UNIT=DISK,VOL=SER-LP0001,DISP=SHR,
// DSN=NAME=ERROR.FREE.FILE
//URBCARD DD *
.
.
.
Place urbanized area cards here.
.
.
.
/*
//PRINTER DD SYSOUT=A,DCB=BLKSIZE=133
//SYSOUT DD SYSOUT=A
//SYSUDUMP DD SYSOUT=A
//RURALIN DD DSN=&TEMPRUR,UNIT=DISK,SPACE=(TRK,(30)),DISP=NEW
//URBANIN DD DSN=&TEMPURB,UNIT=DISK,SPACE=(TRK,(30)),DISP=NEW
//SORTWK01 DD UNIT=DISK,SPACE=(CYL,(1,1))
//SORTWK02 DD UNIT=DISK,SPACE=(CYL,(1,1))
//SORTWK03 DD UNIT=DISK,SPACE=(CYL,(1,1))
//SORTWK04 DD UNIT=DISK,SPACE=(CYL,(1,1))
//SORTWK05 DD UNIT=DISK,SPACE=(CYL,(1,1))
//SORTWK06 DD UNIT=DISK,SPACE=(CYL,(1,1))
//
```

Sample Run
Modify Dataset, Produce Expansion Factor Table,
Produce Summary Tables, and Edit Dataset

```
//TESTRUN EXEC PGM=FHWAHPMS,REGION=176K
//STEPLIB DD UNIT=DISK,VOL=SER=LP0001,DISP=SHR
// DSN=LP.LP02XXBH.SUBMIT89.LOADLIB
//USERPARM DD *
STATECN= TEST STATE/30/
INVYEAR=1988
SELEDIT=RU,CROSSCKS
SELMODU=ADDMOD
SELEXP=RU,FACTTAB
SELSUMT=SAMPLEMT,UNIVMT
/*
//LISTPARM DD SYSOUT=A,DCB=BLKSIZE=133
//CURMAST DD UNIT=DISK,VOL=SER=LP0001,DISP=SHR,
// DSN=OLD.FILE
//UMODCARD DD *
.
.
Place transaction cards to modify dataset here.
.
.
/*
//URBCARD DD *
063FIRST TEST CITY
204SECOND TEST URBANIZED AREA
/*
//CTYCARD DD *
049CLAY
115DADE
200GREEN
/*
//CURUPMOD DD UNIT=DISK,DISP=NEW,DSNAME=&TEMPMAST,SPACE=(CYL,(5))
//UMODFILE DD DSN=&TEMP,UNIT=DISK,SPACE=(TRK,(20)),DISP=NEW
//NEWMAST DD UNIT=DISK,VOL=SER=LP0001,DISP=(NEW,KEEP),
// DSN=UPDATED.FILE,SPACE=(TRK,(75,10),RLSE)
//MODPRINT DD SYSOUT=A,DCB=BLKSIZE=133
//ERRPRINT DD SYSOUT=A,DCB=BLKSIZE=133
//PRINTER DD SYSOUT=A,DCB=BLKSIZE=133
//SYSOUT DD SYSOUT=A
//SORTWK01 DD UNIT=DISK,SPACE=(CYL,(1,1))
//SORTWK02 DD UNIT=DISK,SPACE=(CYL,(1,1))
//SORTWK03 DD UNIT=DISK,SPACE=(CYL,(1,1))
//SORTWK04 DD UNIT=DISK,SPACE=(CYL,(1,1))
//SORTWK05 DD UNIT=DISK,SPACE=(CYL,(1,1))
//SORTWK06 DD UNIT=DISK,SPACE=(CYL,(1,1))
//SYSUDUMP DD SYSOUT=A
//
```

Because the subprograms in these runs are called dynamically, a second STEPLIB card may be required on some operating systems.

CHAPTER VII

ANNUAL DATA SUBMITTAL

This chapter is a synopsis of the annual submittal requirements as discussed in the preceding chapters of this Manual.

THE DATA TAPE

It should be emphasized that a clean data tape that has been created, edited and summarized with the latest HPMS Submittal Software, is of the utmost importance. Data records in the format discussed in Chapter IV must be submitted on magnetic tape by June 15 of each year reflecting the status of the State's roadway inventory as of December 31 of the preceding (data) year. Note that these records must contain the generated/calculated data items that are inserted into the records by the FHWA-developed software documented in Chapter VI (see keyword SELCALC). The magnetic tape will be returned as soon as the data has been copied and verified. It is advisable for the State to retain a copy of the data tape for reference and for historical/backup purposes.

The tape should be written in 1600 or 6250 bpi density, nine-channel (9-track), and should contain standard internal tape labels compatible with the IBM operating system. The data set name (DSNAME) should be HPxxzz, where xx is the last two digits of the data year and zz is the State FIPS code listed in Appendix A. The tape should have a volume serial number (VOL=SER) of HPMSzz, where zz is the same as above. If the above specifications cannot be met, the transmittal correspondence and external physical label on the tape reel should contain the following information at a minimum:

- Name and model of computer on which the tape was produced
- Number of channels (tracks)
- Whether or not the tape has standard labels and what they are
- Density
- Character Representation Code
- Blocking factor
- Other pertinent information

An external physical label should be attached to both the tape reel and shipping carton containing the State name and the words "Highway Performance Monitoring System Data File" and "Deliver to the Office of Highway Information Management, HPM-20, FHWA." The same or another external label should contain State identification -- the tape will be returned via the FHWA division office.

STATISTICAL INFORMATION

Expansion Factor Table

An expansion factor table stratified by area type (rural, small urban, and individual and/or grouped urbanized) by functional system volume group should be established for the sample sections by the State as outlined under Item 27, Expansion Factor, in Chapter IV. A copy of the table will be submitted at the same time as the other items being discussed in this chapter. Note that the expansion factors and the subject summary table must be developed automatically by the FHWA-developed software documented in Chapter VI (SELEXP option).

Volume Group Table

For those States that use volume groups other than those prescribed by the FHWA, a table of the number and ranges of the volume groups stratified by functional system and the required precision level should be submitted by the State. The format for this table should be similar to that shown in Appendix F, or in the example contained in Chapter IV under Item 27. A copy of the table will be submitted along with the other required annual data.

For both tables, the letter of transmittal (or notes on the tables themselves) should alert the FHWA of any unusual or large variation from previous years' submittals and include any other information deemed pertinent by the State.

AREAWIDE DATA

Areawide and statewide totals of the data discussed in Chapter II are to be reported on the forms shown in Figures II-1, Parts 1 and 2, (Mileage and Daily Travel Summary), II-2 (Motor Vehicle Accident Summary), II-3 (Local Functional System Mileage Summary), and II-4, Parts 1 and 2, (Travel Activity by Vehicle Type and Functional System). The forms may be copied from the appropriate pages in Chapter II. The forms are to be submitted in triplicate to the appropriate FHWA division office for forwarding to the address shown ahead to arrive in the FHWA Washington, D. C. Headquarters by June 15 of the year following the data year. Alternatively, a Lotus 1-2-3 spreadsheet may be submitted in lieu of the forms as described in Chapter II. Diskettes may be sent directly to FHWA Headquarters (HPM-20), but two printed copies should be forwarded to the division office.

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SUMMARY

The following items are to be submitted annually by June 15 of the year following the calendar data year:

1. Data tape, as discussed in Chapters IV and VI.
2. Statistical information:
 - a) Printout of final edit (option SELEDIT=RU,FINAL) including explanations for all remaining messages.
 - b) Expansion Factor Table as discussed in Chapters IV (Item 27) and VI (SELEXP option).
 - c) Number and Ranges of Volume Groups by Functional System and Required Precision Level (see Appendix F). This is to be submitted only by States using volume grouping other than that prescribed by FHWA.
3. Areawide Data Forms, as discussed in Chapter II:
 - a) Mileage and Daily Travel Summary (Figure II-1, Parts 1 and 2).
 - b) Motor Vehicle Accident Summary (Figure II-2).
 - c) Local Functional System Mileage Summary (Figure II-3).
 - d) Travel Activity by Vehicle Type and Functional System (Figure II-4, Parts 1 and 2).
4. Letter of transmittal containing the information discussed below.

The magnetic tape, the statistical information, and a letter of transmittal should be sent to:

Chief, Highway Systems Performance Division
Office of Highway Information Management, HPM-20
400 7th Street, S.W., Room 3306
Federal Highway Administration
Washington, D. C. 20590

The letter of transmittal should contain documentation describing the contents of the submittal, as follows: a summary of unusual changes in the contents from previous years, a discussion of any large variation in mileage or number of sections, comments in response to previous year HPMS data reviews, a summary of recurring unusual conditions (see heading, below), and any other information pertinent to the submittal.

The Areawide Data Forms should be submitted in triplicate to the appropriate FHWA division office.

Recurring Unusual Conditions

FHWA Headquarters reviews each State's annual data submittal in depth and returns comments about the review to the State via the FHWA field offices. It is not possible for headquarter's personnel to remember unusual conditions pertinent to specific States, nor is it reasonable or likely that all correspondence beyond the current and, perhaps, one previous data submittal year will be examined. To at least reduce or possibly eliminate the likelihood of repeat comments concerning unusual conditions that will exist in the data year after year, it is suggested that each State remind FHWA of these conditions by providing a concise summary of them with each data submittal.

Since microcomputer text editors seem to be widely available, we would suggest that a file of these comments be preserved, updated, printed and attached to each State submittal of HPMS data. The summary need not be formal; it should be concise, and may refer to correspondence where more detailed information may be found. It should be updated as things change, of course. Some examples of what this summary could include are as follows:

A State's Recurring Unusual Condition Summary

- o Interstate 95 in Bigtown does have 2 lane, 2 way roadways for 2.62 miles. The facility ends in the middle of downtown. This condition will remain that way as far as we know.
- o We have four sample sections with 18 foot shoulders. These will disappear when additional lanes are completed in 1993 -1995. See correspondence dated June 21, 1988 for more details.
- o We would like three State copies of the DRP booklet rather than the usual two.
- o Except for roadways that are improved where the PSR is updated upon completion of the construction, all PSR values reflect the same year. These data are collected in odd years, only. This method fits the two year update cycle called for in Chapter V of the HPMS Field Manual, and was approved by the FHWA Division office in 1984.
- o Etc.

MAINTAINING THE DATA TAPE

It is recommended that each State maintain a current HPMS submittal data file and make updates periodically, rather than rebuilding the entire file at the end of each year. It is further recommended that each State store a copy of each year's submittal for historical purposes. A complete new file will be submitted each year that incorporates all changes (individual item updates, additions, deletions, etc.) as discussed in Chapter V. Once coded, all other data items and records will remain as is unless changed due to update cycles, improvements, or the correction of errors.

APPENDIX A

Table of Standard Codes for States,
District of Columbia and Puerto Rico

<u>State</u>	<u>Code</u>	<u>State</u>	<u>Code</u>
Alabama	01	Nevada	32
Alaska	02	New Hampshire	33
Arizona	04	New Jersey	34
Arkansas	05	New Mexico	35
California	06	New York	36
Colorado	08	North Carolina	37
Connecticut	09	North Dakota	38
Delaware	10	Ohio	39
District of Columbia	11	Oklahoma	40
Florida	12	Oregon	41
Georgia	13	Pennsylvania	42
Hawaii	15	Rhode Island	44
Idaho	16	South Carolina	45
Illinois	17	South Dakota	46
Indiana	18	Tennessee	47
Iowa	19	Texas	48
Kansas	20	Utah	49
Kentucky	21	Vermont	50
Louisiana	22	Virginia	51
Maine	23	Washington	53
Maryland	24	West Virginia	54
Massachusetts	25	Wisconsin	55
Michigan	26	Wyoming	56
Minnesota	27	Puerto Rico	72
Mississippi	28		
Missouri	29		
Montana	30		
Nebraska	31		

APPENDIX B

Urbanized Area Codes

<u>State</u>	<u>Urbanized Area</u>	<u>Code</u>
Alabama	Anniston	254
	Auburn-Opelika	294
	Birmingham	035
	Columbus (GA)	109
	Decatur	295
	Dothan	296
	Florence	255
	Gadsden	192
	Huntsville	184
	Mobile	067
	Montgomery	115
	Tuscaloosa	183
Alaska	Anchorage	256
Arizona	Phoenix	033
	Tucson	073
	Yuma (CA)	287
Arkansas	Fayetteville-Springdale	297
	Fort Smith (OK)	202
	Little Rock-North Little Rock	092
	Memphis (TN, MS)	034
	Pine Bluff	219
	Texarkana (TX)	211
California	Antioch-Pittsburg	257
	Bakersfield	117
	Chico	298
	Fairfield	299
	Fresno	080
	Hemet	300
	Lancaster	301
	Los Angeles-Long Beach-Pomona-Ontario	002
	Merced	380
	Modesto	234
	Napa	302
	Oxnard-Ventura-Thousand Oaks	224
	Palm Springs	303
	Redding	304
	Sacramento	042
	Salinas	229
	San Bernardino-Riverside	048
	San Diego	023
	San Francisco-Oakland	006
	San Jose	032
Santa Barbara	187	
Santa Cruz	258	
Santa Maria	305	

Urbanized Area Codes

<u>State</u>	<u>Urbanized Area</u>	<u>Code</u>
California (Cont.)	Santa Rosa	235
	Seaside-Monterey	236
	Simi Valley	237
	Stockton	119
	Visalia	306
	Yuba City	307
	Yuma (AZ)	287
Colorado	Boulder	238
	Colorado Springs	153
	Denver	024
	Fort Collins	308
	Grand Junction	309
	Greeley	310
	Pueblo	149
Connecticut	Bridgeport	051
	Bristol	239
	Danbury (NY)	240
	Hartford	047
	Meriden	212
	New Britain	154
	New Haven	064
	New London-Norwich	259
	Norwalk	176
	Springfield-Chicopee-Holyoke (MA)	043
	Stamford	103
Waterbury	118	
Delaware	Wilmington (NJ, MD)	063
Dist. of Columbia	Washington (MD, VA)	008
Florida	Daytona Beach	260
	Fort Lauderdale-Hollywood	058
	Fort Myers	261
	Fort Pierce	311
	Fort Walton Beach	312
	Gainesville	241
	Jacksonville	050
	Lakeland	262
	Melbourne-Cocoa	263
	Miami	021
	Naples	313
	Ocala	314
Orlando	087	

Urbanized Area Codes

<u>State</u>	<u>Urbanized Area</u>	<u>Code</u>
Florida (Cont.)	Panama City	315
	Pensacola	125
	St. Petersburg	057
	Sarasota-Bradenton	264
	Tallahassee	220
	Tampa	059
	West Palm Beach	097
	Winter Haven	316
Georgia	Albany	209
	Athens	317
	Atlanta	025
	Augusta (SC)	131
	Chattanooga (TN)	086
	Columbus (AL)	109
	Macon	143
	Rome	318
	Savannah	100
Warner Robins	319	
Hawaii	Honolulu	052
	Kailua-Kaneohe	320
Idaho	Boise City	217
	Pocatello	321
Illinois	Alton	265
	Aurora	292
	Beloit (WI)	291
	Bloomington-Normal	227
	Champaign-Urbana	181
	Chicago-Northwestern IN (IN)	003
	Danville	322
	Davenport-Rock Island-Moline (IA)	074
	Decatur	169
	Dubuque (IA)	206
	Elgin	293
	Joliet	138
	Kankakee	323
	Peoria	093
	Rockford	099
Round Lake Beach	379	
St. Louis (MO)	011	
Springfield	146	

Urbanized Area Codes

<u>State</u>	<u>Urbanized Area</u>	<u>Code</u>
Indiana	Anderson	223
	Bloomington	324
	Chicago-Northwestern IN (IL)	003
	Elkhart-Goshen	325
	Evansville	114
	Fort Wayne	094
	Indianapolis	029
	Kokomo	326
	Lafayette-West Lafayette	222
	Louisville (KY)	031
	Muncie	182
	South Bend (MI)	077
	Terre Haute	178
Iowa	Cedar Rapids	148
	Davenport-Rock Island-Moline (IL)	074
	Des Moines	071
	Dubuque (IL)	206
	Iowa City	327
	Omaha (NB)	046
	Sioux City (NB, SD)	156
	Waterloo	150
Kansas	Kansas City (MO)	019
	Lawrence	328
	St. Joseph (MO)	179
	Topeka	134
	Wichita	062
Kentucky	Cincinnati (OH)	017
	Clarksville (TN)	280
	Evansville (IN)	114
	Huntington-Ashland (WV, OH)	105
	Lexington-Fayette	144
	Louisville (IN)	031
	Owensboro	242
Louisiana	Alexandria	266
	Baton Rouge	088
	Houma	329
	Lafayette	218
	Lake Charles	171
	Monroe	180
	New Orleans	022
	Shreveport	085

Urbanized Area Codes

<u>State</u>	<u>Urbanized Area</u>	<u>Code</u>
Maine	Bangor	330
	Lewiston-Auburn	196
	Portland	145
	Portsmouth-Dover-Rochester (NH)	283
Maryland	Annapolis	331
	Baltimore	012
	Cumberland (WV)	285
	Hagerstown (PA)	284
	Washington (DC, VA)	008
	Wilmington (NJ, DE)	063
Massachusetts	Boston	007
	Brockton	147
	Fall River (RI)	130
	Fitchburg-Leominster	189
	Lawrence-Haverhill (NH)	104
	Lowell (NH)	136
	New Bedford	127
	Pittsfield	199
	Providence-Pawtucket-Warwick (RI)	026
	Springfield-Chicopee-Holyoke (CT)	043
	Taunton	332
	Worcester	076
	Michigan	Ann Arbor
Battle Creek		267
Bay City		186
Benton Harbor		333
Detroit		005
Flint		065
Grand Rapids		061
Jackson		190
Kalamazoo		141
Lansing		102
Muskegon-Muskegon Heights		162
Port Huron		334
Saginaw		123
South Bend (IN)		077
Toledo (OH)	044	
Minnesota	Duluth-Superior (WI)	113
	Fargo-Moorhead (ND)	188
	Grand Forks (ND)	289
	La Crosse (WI)	243
	Minneapolis-St. Paul	013
	Rochester	244
	St. Cloud	268

Urbanized Area Codes

<u>State</u>	<u>Urbanized Area</u>	<u>Code</u>
Mississippi	Biloxi-Gulfport	231
	Hattiesburg	335
	Jackson	112
	Memphis (TN, AR)	034
	Pascagoula-Moss Point	336
Missouri	Columbia	245
	Joplin	337
	Kansas City (KS)	019
	St. Joseph (KS)	179
	St. Louis (IL)	011
	Springfield	157
Montana	Billings	204
	Great Falls	210
	Missoula	338
Nebraska	Lincoln	121
	Omaha (IA)	046
	Sioux City (IA, SD)	156
Nevada	Las Vegas	170
	Reno	191
New Hampshire	Lawrence-Haverhill (MA)	104
	Lowell (MA)	136
	Manchester	165
	Nashua	246
	Portsmouth-Dover-Rochester (ME)	283
New Jersey	Allentown-Bethlehem-Easton (PA)	068
	Atlantic City	128
	New York-Northeastern NJ (NY)	001
	Philadelphia (PA)	004
	Trenton (PA)	069
	Vineland-Millville	233
	Wilmington (DE, MD)	063
New Mexico	Albuquerque	070
	Las Cruces	339
	Santa Fe	340
New York	Albany-Schenectady-Troy	041
	Binghamton	110
	Buffalo	016
	Danbury (CT)	240
	Elmira	269
	Glen Falls	341
	Newburgh	342

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Urbanized Area Codes

<u>State</u>	<u>Urbanized Area</u>	<u>Code</u>
New York (Cont.)	New York-Northeastern NJ (NJ)	001
	Poughkeepsie	270
	Rochester	039
	Syracuse	056
	Utica-Rome	089
North Carolina	Asheville	193
	Burlington	271
	Charlotte	082
	Concord	343
	Durham	173
	Fayetteville	221
	Gastonia	272
	Goldsboro	344
	Greensboro	132
	Hickory	345
	High Point	195
	Jacksonville	346
	Raleigh	163
Wilmington	226	
Winston-Salem	124	
North Dakota	Bismarck-Mandan	347
	Fargo-Moorhead (MN)	188
	Grand Forks (MN)	289
Ohio	Akron	040
	Canton	079
	Cincinnati (KY)	017
	Cleveland	010
	Columbus	030
	Dayton	038
	Hamilton	168
	Huntington-Ashland (WV, KY)	105
	Lima	198
	Lorain-Elyria	116
	Mansfield	228
	Middletown	348
	Newark	349
	Parkersburg (WV)	273
	Sharon (PA)	290
Springfield	167	
Steubenville-Weirton (WV, PA)	177	
Toledo (MI)	044	
Wheeling (WV)	155	
Youngstown-Warren	049	

Urbanized Area Codes

<u>State</u>	<u>Urbanized Area</u>	<u>Code</u>
Oklahoma	Enid	350
	Fort Smith (AR)	202
	Lawton	200
	Oklahoma City	045
	Tulsa	060
Oregon	Eugene	161
	Longview (WA)	286
	Medford	351
	Portland (WA)	027
	Salem	225
Pennsylvania	Allentown-Bethlehem-Easton (NJ)	068
	Altoona	175
	Erie	095
	Hagerstown (MD)	284
	Harrisburg	083
	Johnstown	159
	Lancaster	164
	Monessen	352
	Philadelphia (NJ)	004
	Pittsburgh	009
	Reading	107
	Scranton(081)--Wilkes-Barre(072)	281
	Sharon (Ohio)	290
	State College	353
	Steubenville-Weirton (OH, WV)	177
Trenton (NJ)	069	
Williamsport	274	
York	152	
Puerto Rico	Aguadilla	376
	Arecibo	377
	Caguas	247
	Mayaguez	216
	Ponce	215
	San Juan	214
	Vega Baja-Manati	378
Rhode Island	Fall River (MA)	130
	Newport	354
	Providence-Pawtucket-Warwick (MA)	026

Urbanized Area Codes

<u>State</u>	<u>Urbanized Area</u>	<u>Code</u>
South Carolina	Anderson	355
	Augusta (GA)	131
	Charleston	108
	Columbia	106
	Florence	356
	Greenville	126
	Rock Hill	357
	Spartanburg	275
South Dakota	Rapid City	358
	Sioux City (IA, NB)	156
	Sioux Falls	194
Tennessee	Bristol (VA)	288
	Chattanooga (GA)	086
	Clarksville (KY)	280
	Jackson	359
	Johnson City	360
	Kingsport (VA)	276
	Knoxville	098
	Memphis (MS, AR)	034
	Nashville-Davidson	054
Texas	Abilene	166
	Amarillo	120
	Austin	090
	Beaumont	135
	Brownsville	248
	Bryan-College Station	249
	Corpus Christi	096
	Dallas-Fort Worth	282
	El Paso	066
	Galveston	137
	Harlingen-San Benito	201
	Houston	015
	Killeen	277
	Laredo	205
	Longview	361
	Lubbock	122
	McAllen-Pharr-Edinburg	230
	Midland	197
	Odessa	174
	Port Arthur	139
San Angelo	208	
San Antonio	028	
Sherman-Denison	232	

Urbanized Area Codes

<u>State</u>	<u>Urbanized Area</u>	<u>Code</u>
Texas (Cont.)	Temple	362
	Texarkana (AR)	211
	Texas City-La Marque	250
	Tyler	213
	Victoria	363
	Waco	140
	Wichita Falls	151
Utah	Odgen	133
	Provo-Orem	203
	Salt Lake City	053
Vermont	Burlington	364
Virginia	Bristol (TN)	288
	Charlottesville	365
	Danville	366
	Kingsport (TN)	276
	Lynchburg	207
	Newport News-Hampton	084
	Norfolk-Portsmouth	036
	Petersburg-Colonial Heights	251
	Richmond	055
	Roanoke	129
Washington (DC, MD)	008	
Washington	Bellingham	367
	Bremerton	368
	Longview (OR)	286
	Olympia	369
	Portland (OR)	027
	Richland-Kennewick	278
	Seattle-Everett	020
	Spokane	075
	Tacoma	078
	Yakima	279
West Virginia	Charleston	101
	Cumberland (MD)	285
	Huntington-Ashland (KY, OH)	105
	Parkersburg (OH)	273
	Steubenville-Weirton (OH, PA)	177
Wheeling (OH)	155	

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Urbanized Area Codes

<u>State</u>	<u>Urbanized Area</u>	<u>Code</u>
Wisconsin	Appleton	252
	Beloit (IL)	291
	Duluth-Superior (MN)	113
	Eau Claire	370
	Green Bay	158
	Janesville	371
	Kenosha	185
	La Cross (MN)	243
	Madison	111
	Milwaukee	014
	Oshkosh	253
	Racine	160
	Sheboygan	372
Wausau	373	
Wyoming	Casper	374
	Cheyenne	375

APPENDIX C

Determination of Available Sight Distance

In order to provide data for determining speed, it is necessary to estimate the percentage of a section length having at least 1,500 feet of sight distance (as measured from the height of the driver's eye to the road surface) available for paved, 2-lane roadways. Any available data, such as construction plans, etc., can be used for this determination. The procedure described below is suggested as a method of determining available sight distance when these data are not available from existing files.

The suggested procedure for the field inventory crew is as follows: First, the observer (sitting beside the vehicle driver) estimates ahead 1,500 feet. If the pavement surface is visible over this entire distance, he records the starting odometer reading as "in". If the pavement surface is not visible, he records the reading as "out". The crew then drives over the section and the observer records the odometer as "out" any time the pavement surface passes from view in the 1,500 foot distance estimated ahead and as "in" when the pavement surface 1,500 feet ahead comes back into view.

This method for identifying the "in" and "out" values of available sight distance applies whether restrictions are caused by vertical curvature, horizontal curvature, other facts of design within the right of way, or trees and permanent type billboards. Sight restrictions such as those caused by tall grass or shrubs that could be removed by routine maintenance would not be considered.

Lastly, the length of available sight distance is obtained by subtracting each "in" mileage reading from the succeeding "out" mileage reading and summing these differences. The percent of available sight distance is then calculated by dividing the total available length by the section length and multiplying by 100. This value should then be rounded to the nearest 10 percent and recorded.

Note that roadway beyond the end points of the section should be taken into consideration when obtaining this information, particularly on short sections. The 1,500 foot sight distance could prevail even on a section that is less than 1,500 feet (.28 mile). Striping may be used for making this estimate where it delineates unsafe passing zones.

Where there is a discernable directional difference, the more restrictive direction should be measured and reported. |

APPENDIX D

Procedures for Determining Weighted Design Speed

Weighted design speed is defined as the weighted average of the design speeds within the section, when each curve and tangent segment within the section is considered to have an individual design speed.

This Appendix contains a recommended procedure for computing weighted design speed where it is not already available. It utilizes the theory that approximately 800 feet (0.15 mile) is the effective length of each curve. Tangent segments and flat (less than 3.5 degrees) curves are assumed to have design speeds of 70 miles per hour. The maximum superelevation rate is assumed to be 0.08 ft./ft. Where the superelevation rate varies appreciably from this, the curvature range shown for each design speed may be adjusted to fit the appropriate rate of superelevation.

A worksheet for weighted design speed calculation is provided in Figure D-1. The steps to be taken are as follows:

1. For the section of highway being analyzed, tally the total number of curves in each design speed grouping, in the column headed "Number of curves."
2. For each design speed grouping in which curves have been tallied, select the travel time in minutes corresponding to that number of curves from Table D-1. Enter this value in the column labeled "Total travel time".
3. Total the number of all curves and post this value in the total line for the "Number of curves" column.
4. Determine the total curve length by multiplying the total number of curves by the constant 0.15. Subtract this value from the section length to determine the tangent length.
5. Compute tangent travel time by multiplying the tangent length by 0.86 min./mile. Enter the resulting tangent travel time in the column headed "Total travel time."
6. Sum all entries in the "Total travel time" column. Divide the length of the highway section by the total travel time and then multiply by 60 min./hr. to obtain the weighted design speed (WDS) in miles per hour.
7. Round to the nearest of the following values: 70, 60, 50, 45, 40, or 35.

A sample calculation is shown on the worksheet, Figure D-1. For a rural section, three 40 m.p.h. curves have been tallied, for a travel time of 0.68 minutes, and seven 50 m.p.h. curves for a travel time of 1.26 minutes. The total of ten curves multiplied by 0.15 gives a total curve length of 1.50 miles. This value is subtracted from the section length of 4.20 miles, giving a tangent length of 2.70 miles. The latter figure is multiplied by 0.86 minutes per mile (for 70 m.p.h. tangent speed), giving a tangent travel time of 2.32 minutes. This value is added to the previously posted curve travel times to obtain a total travel time of 4.26 minutes. The total section length divided by this value (4.26 min.) and multiplied by 60 (min./hr.) yields a weighted design speed of 59 m.p.h. This is then rounded to 60 m.p.h.

Figure D-1

Worksheet for Calculating Weighted Design Speed (WDS)

Degree of Curvature ^{1/}	Approximate Design Speed (mph)	Number of curves	Total travel time (minutes) (from Table D-1)
28.0 - 43.0	25		
19.5 - 27.9	30		
14.0 - 19.4	35		
11.0 - 13.9	40		
11.0 - 13.9	40	3	0.68
8.5 - 10.9	45		
7.0 - 8.4	50	7	1.26
5.5 - 6.9	55		
4.5 - 5.4	60		
3.5 - 4.4	65		
Totals =		10	1.94
Tangent travel time =			2.32
Total Travel Time =			4.26
Section Length <u>4.20</u> mi.			
Less, Total Curve Length <u>1.50</u> mi.			
-Tangent Length <u>2.70</u> mi. x 0.86 min./mi.			
-Tangent Travel Time <u>2.32</u> min.			
Weighted Design Speed = (Section Length <u>4.20</u> mi. divided			
by Total Travel Time <u>4.26</u> min.) x 60			
= <u>59</u> mph			
Rounded WDS = <u>60</u> mph			

^{1/} For maximum superelevation rate of 0.08 ft./ft.

Table D-1--Travel times for curves of various design speeds ^{2/}

Design Speed (mph)	Travel time in minutes for number of curves indicated							
	<u>Number of curves</u>							
	1	2	3	4	5	6	7	8
25	0.36	0.72	1.08	1.44	1.80	2.16	2.52	2.88
30	0.30	0.60	0.90	1.20	1.50	1.80	2.10	2.40
35	0.26	0.51	0.77	1.03	1.29	1.54	1.80	2.06
40	0.23	0.45	0.68	0.90	1.13	1.35	1.58	1.80
45	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60
50	0.18	0.36	0.54	0.72	0.90	1.08	1.26	1.44
55	0.16	0.33	0.49	0.65	0.82	0.98	1.15	1.31
60	0.15	0.30	0.45	0.60	0.75	0.90	1.05	1.20
65	0.14	0.28	0.42	0.55	0.69	0.83	0.97	1.11

Design Speed (mph)	Travel time in minutes for number of curves indicated						
	<u>Number of curves</u>						
	9	10	11	12	13	14	15
25	3.24	3.60	3.96	4.32	4.68	5.04	5.40
30	2.70	3.00	3.30	3.60	3.90	4.20	4.50
35	2.31	2.57	2.83	3.09	3.34	3.60	3.86
40	2.03	2.25	2.48	2.70	2.93	3.15	3.38
45	1.80	2.00	2.20	2.40	2.60	2.80	3.00
50	1.62	1.80	1.98	2.16	2.34	2.52	2.70
55	1.47	1.64	1.80	1.96	2.13	2.29	2.45
60	1.35	1.50	1.65	1.80	1.95	2.10	2.25
65	1.25	1.38	1.52	1.66	1.80	1.94	2.18

^{2/} Table D-1 was derived by multiplying the inverse of the speed (in minutes per mile) by the effective length of the curve (0.15 miles).

APPENDIX F

Prescribed Volume Groups and Precision Levels

Table F-1

RURAL AREA Volume Groups and Precision Levels

Vol. Grp.	Interstate (90-5)	Other Principal Arterial (90-5)	Minor Arterial (90-10)
01	0- 9,999	0- 4,999	0- 2,499
02	10,000- 19,999	5,000- 9,999	2,500- 4,999
03	20,000- 29,999	10,000- 14,999	5,000- 9,999
04	30,000- 39,999	15,000- 19,999	10,000-19,999
05	40,000- 49,999	20,000- 29,999	20,000-29,999
06	50,000- 59,999	30,000- 39,999	30,000-39,999
07	60,000- 69,999	40,000- 49,999	40,000-49,999
08	70,000- 79,999	50,000- 59,999	50,000-59,999
09	80,000- 89,999	60,000- 69,999	60,000-69,999
10	90,000-104,999	70,000- 84,999	70,000-79,999
11	105,000-119,999	85,000- 99,999	80,000-89,999
12	120,000-134,999	100,000-114,999	90,000-99,999
13	> or = 135,000	> or = 115,000	> or = 100,000

Vol. Grp.	Major Collector (80-10)	Minor Collector (80-10)
01	0- 2,499	0- 999
02	2,500- 4,999	1,000- 1,999
03	5,000- 9,999	2,000- 2,999
04	10,000-19,999	3,000- 4,999
05	20,000-29,999	5,000- 9,999
06	30,000-39,999	10,000-19,999
07	40,000-49,999	20,000-29,999
08	50,000-59,999	30,000-39,999
09	60,000-69,999	40,000-49,999
10	70,000-79,999	50,000-59,999
11	80,000-89,999	60,000-69,999
12	90,000-99,999	70,000-79,999
13	> or = 100,000	> or = 80,000

Prescribed Volume Groups and Precision Levels

Table F-2

SMALL URBAN AREA Volume Groups and Precision Levels

Vol. Grp.	Interstate (90-5)	Other Freeways and Expressways (90-5)	Other Principal Arterial (90-5)
01	0- 9,999	0- 9,999	0- 4,999
02	10,000- 19,999	10,000- 19,999	5,000- 9,999
03	20,000- 29,999	20,000- 29,999	10,000-14,999
04	30,000- 39,999	30,000- 39,999	15,000-19,999
05	40,000- 49,999	40,000- 49,999	20,000-24,999
06	50,000- 59,999	50,000- 59,999	25,000-29,999
07	60,000- 69,999	60,000- 69,999	30,000-34,999
08	70,000- 79,999	70,000- 79,999	35,000-39,999
09	80,000- 89,999	80,000- 89,999	40,000-44,999
10	90,000-104,999	90,000-104,999	45,000-54,999
11	105,000-119,999	105,000-119,999	55,000-64,999
12	120,000-134,999	120,000-134,999	65,000-74,999
13	> or = 135,000	> or = 135,000	> or = 75,000

Vol. Grp.	Minor Arterial (90-10)	Collector (80-10)
01	0- 2,499	0- 999
02	2,500- 4,999	1,000- 1,999
03	5,000- 9,999	2,000- 4,999
04	10,000-14,999	5,000- 9,999
05	15,000-19,999	10,000-14,999
06	20,000-24,999	15,000-19,999
07	25,000-29,999	20,000-24,999
08	30,000-34,999	25,000-29,999
09	35,000-39,999	30,000-34,999
10	40,000-49,999	35,000-44,999
11	50,000-59,999	45,000-54,999
12	60,000-69,999	55,000-64,999
13	> or = 70,000	> or = 65,000

Prescribed Volume Groups and Precision Levels

Table F-3

URBANIZED AREA Volume Groups and Precision Levels

Vol. Grp.	Interstate (80-10) <u>1/</u> (90-5) <u>2/</u>	Other Freeways and Expressways (80-10) <u>1/</u> (90-5) <u>2/</u>	Other Principal Arterial (80-10) <u>1/</u> (90-5) <u>2/</u>
01	0- 24,999	0- 24,999	0- 2,499
02	25,000- 49,999	25,000- 49,999	2,500- 4,999
03	50,000- 74,999	50,000- 74,999	5,000- 9,999
04	75,000- 99,999	75,000- 99,999	10,000-14,999
05	100,000-124,999	100,000-124,999	15,000-19,999
06	125,000-149,999	125,000-149,999	20,000-24,999
07	150,000-174,999	150,000-174,999	25,000-34,999
08	175,000-199,999	175,000-199,999	35,000-44,999
09	200,000-224,999	200,000-224,999	45,000-54,999
10	225,000-249,999	225,000-249,999	55,000-69,999
11	250,000-274,999	250,000-274,999	70,000-84,999
12	275,000-299,999	275,000-299,999	85,000-99,999
13	> or = 300,000	> or = 300,000	> or = 100,000

Vol. Grp.	Minor Arterial <u>3/</u> (90-10) <u>2/</u>	Collector <u>3/</u> (80-10) <u>2/</u>
01	0- 2,499	0- 999
02	2,500- 4,999	1,000- 1,999
03	5,000- 9,999	2,000- 4,999
04	10,000-14,999	5,000- 9,999
05	15,000-19,999	10,000-14,999
06	20,000-24,999	15,000-24,999
07	25,000-34,999	25,000-34,999
08	35,000-44,999	35,000-44,999
09	45,000-54,999	45,000-54,999
10	55,000-69,999	55,000-69,999
11	70,000-84,999	70,000-84,999
12	85,000-99,999	85,000-99,999
13	> or = 100,000	> or = 100,000

- 1/ Precision levels for individual urbanized areas.
- 2/ Precision levels for collective urbanized areas.
- 3/ For individual urbanized areas, use (70-15) precision level for States with 3 or more individual urbanized areas. Use (80-10) precision level for States with less than 3 individual urbanized areas.

APPENDIX G

Sample Size Estimation Procedures

The sample size estimates for each stratum are derived from the following formula:

$$n = \frac{z^2 c^2 / d^2}{1 + (1/N) ((z^2 c^2 / d^2) - 1)}$$

where n = required sample size,

Z = value of the standard normal statistic for an alpha confidence level (two-sided),

<u>Confidence Level</u>	<u>Value of Z</u>
90 %	1.645
80 %	1.282
70 %	1.040

C = AADT coefficient of variation from a State's AADT data,

d = desired precision rate (from Appendix F for HPMS), and

N = universe or population stratum size (# universe sections available for sampling in a volume group).

For example, the sample size for the first rural Interstate stratum with a desired precision rate of + or - 5-percent with a 90-percent confidence level, an AADT coefficient of variation of 0.40 and 300 available universe sections for sampling is estimated by:

$$n = \frac{(1.645)^2 (.40)^2 / (.05)^2}{1 + (1/300) ((1.645)^2 (.40)^2 / (.05)^2) - 1}$$

173.18

1 + (172.18/300)

= 110 required samples

The critical point in this process is the value designation of C, the AADT coefficient of variation. The original HPMS design was based on empirical estimates using data from a small number of States. The procedures presented here require the estimation of AADT coefficients of variation based on the latest State data. The results are then always up-to-date, based on the latest information, and are tailored to the specific State.

The AADT coefficients of variation may be generated from a State's universe data using standard statistical computer packages, if reasonably accurate AADT data are present on all, or most of the collector/arterial records. Otherwise, the existing sample data should be used for the coefficient generation. If a State is not able to generate its own coefficients, the FHWA headquarters can provide the "Estimates of Sample Adequacy" booklet which contains the coefficients from both the sample and from the universe (or from any portion of the universe that contains AADT data), among other information.

The booklets were distributed with the 1985 data reviews (in 1986), and will again be generated for the 1988 data (to be reported in 1989), and every three years, thereafter. However, if a State wishes the booklet to be generated from its data at any time, for any submittal, it only needs to be requested.

APPENDIX H

SELECTING THE SAMPLE OF HIGHWAY SECTIONS

BACKGROUND

The arterial and collector sample panel of sections selected for the HPMS will be the basis of the continuing monitoring effort. The data reported for the sampled sections will serve as the source of system condition, usage, and operational characteristics and will be used in the calculation of performance measures. Impacts -- the changes in performance over time -- will be determined by using these data as reference points. These data will also serve as the data base for various analytical models.

While it is assumed that there is a "technically best" way to collect sample data, it is necessary that the sample design be simple and cost efficient because of manpower and cost considerations. The original choice of an empirical method not involving preliminary pilot surveys in the field has the advantage of simplicity and general applicability. The required number of samples were derived empirically by formula from the normal dispersion characteristics of AADT values within the framework of preselected AADT groups (strata). The sample size requirements relate to the critical data element, AADT, whose values can be conveniently stratified.

With the availability of HPMS sample data the empirical procedure has been verified. The information gained from the existing sample or universe data in each State is used to optimize and refresh the sample. Procedures for determining necessary sample size based on the analysis of existing data are described in this Appendix.

In order to obtain cost-effective, valid comparisons of system performance over time, and to reduce administrative effort, the sample was designed as a fixed sample. Hence, the same sections that are inventoried now will be updated in future years on a cyclical basis. This means of obtaining data is efficient because: (1) the need for the periodic drawing of a complete new sample is eliminated, (2) the need to update or reinventory all data elements every cycle is eliminated, and (3) only those data elements that change over time need be updated on a cyclical basis. The length of the cycle is determined by the known statistical characteristics of individual elements, the intended use and accuracy needed, and the time and cost required to collect and report such data. However, the use of fixed panel sections is not without disadvantages. These include: the possible loss of the sample's representativeness as the highway networks and traffic patterns change, and the inability to assess the correctness of the estimates by comparing them with those of a different sample. Procedures have been developed to ensure the representativeness of the sample and therefore, the administrative practicability of the fixed panel approach outweighs the disadvantages.

It is emphasized that the sample sections are to be selected in full accordance with the instructions in this Manual in order to achieve the predetermined levels of desired precision. The sampling procedures described in this Appendix are both simple and efficient and, if applied properly, will yield an adequate sample for performance monitoring.

SCOPE

Data needs will vary for the rural, small urban, and urbanized areas. This variation is reflected in the sample design. The design is capable of producing valid estimates of the condition of the highway plant and its operating and performance characteristics on a State-by-State basis. Rural and small urban functional systems will be sampled on a statewide basis. The original HPMS design required that urbanized areas be sampled individually. In order to reduce the data collection burden and to increase flexibility, that requirement has been modified. Urbanized areas can be sampled individually, collectively on a statewide basis, or in any combination at the State's option. (Note, however, that the collective method is no longer recommended.) Before making a decision to consolidate urbanized areas, it is recommended that States fully evaluate the ramifications of such a decision. However, once a State has decided on using one of the urbanized area sampling options, the State should remain committed to applying the option chosen.

STRATIFICATION AND PRECISION LEVELS

The sampling plan consists of the random selection of a panel of road sections within predetermined AADT volume groups (strata) for each functional highway system in the rural, small urban, and urbanized (or optional collective urbanized) areas of the State. The stratification of sections (sampling units) into relatively homogeneous AADT groups produces estimates of greater accuracy with respect to VMT for a smaller number of samples at the functional system (summation) levels. Although stratification for sample selection is based on the critical data element AADT, tests have shown that AADT stratification is compatible with the sampling of nonvolume-related data elements.

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Sample size requirements per functional system will vary by State according to the total number of road sections, the number of predetermined volume groups, and the design precision level. The term "precision level" in this Manual is defined as the degree of confidence that the sampling error of a produced estimate will fall within a desired fixed range. Thus, for a precision level of 80-percent confidence with 10-percent allowable error (80-10), there is the probability that 80 times out of 100 the error of a data element estimate will be no greater or less than 10 percent of its true value. The precision levels determined for this sample design apply specifically to the individual volume strata. Aggregation of the estimated stratum values of volume-related data elements will result in an upgrading of the precision level for functional system estimates. Some States may wish to initiate concurrently a highway performance monitoring system that produces the State's desired precision level at the highway district, county, or other level. When such is the case, the FHWA developed approach should be applied to the area based on the State's desires. If a finer geographic breakdown than specified in this Manual is undertaken and the FHWA-specified precision levels are followed, the resulting volume group precision levels should meet or exceed those specified in this Manual. To that end, the precision levels specified in this Manual represent minimum requirements for rural, small urban, and urbanized area functional system volume groups.

The HPMS sample size requirements are more stringent for the arterials, where a higher level of precision is needed because of higher Federal interest. In rural, small urban, and collective urbanized areas, the sample sizes are based on a 90-5 precision level for the volume groups of the principal arterial system, 90-10 for the minor arterial system, and 80-10 for the collector system(s). For individual urbanized areas, the design precision levels for individual volume strata are 80-10 or 70-15, depending upon the number of urbanized areas designated as individual at the States' option. Those States with less than three designated individual urbanized areas will use a precision level of 80-10 for all functional systems, while those with three or more may use the lower precision level of 70-15 for minor arterials and collectors and 80-10 for principal arterials thereby requiring a smaller number of samples. The statewide summation of individual urbanized functional system data element estimates will result in an overall precision level of at least 80-10 at the State level. The higher precision levels at the State level are necessary for two important reasons: (1) to obtain comparable urban and rural precision levels and (2) to obtain precision levels that can adequately accommodate desired levels of accuracy for estimates of proportionate values.

The precision levels established above and the associated sample sizes relate solely to the measurement of AADT. The same samples will be used to estimate the proportionate values of data such as pavement condition. Given the same desired precision levels, larger sample sizes are required for estimates of proportionate values. Since the level of accuracy for estimated proportions is closely related to sample size, care was taken to set the above precision levels sufficiently high to produce reasonable proportionate estimates at the functional system level.

PREPARATION FOR SAMPLE SELECTION

Before a sample can be drawn, the universe from which it will be selected must be defined. This is of the utmost importance because expansion factors relate directly to the universe definition. The first step is to delimit the boundaries between rural, small urban, and urbanized areas using Federal-aid boundaries. Next, the functional system of all arterial and collector routes within each of these areas must be identified. These steps, presumably, have already been accomplished. Then, all road sections in each functional system must be assigned to predetermined AADT groups. (See Appendix F.) Either uniform or nonuniform section lengths can be used. The sections should be relatively homogeneous as to geometrics, traffic volume, cross section and condition, and should be long enough to constitute a logical section for various analyses such as needs appraisal. In general, rural section lengths should range from 0.30 to 10.00 miles, while urban access controlled facility section lengths should usually not exceed 5.00 miles. All other urban section lengths should range from 0.10 to 3.00 miles. A trade-off exists between the length of sections and future section subdivision. Longer sections reduce the universe size and result in a smaller number of initial samples. However, longer sections are likely to require subdivision in later years in order to maintain homogeneity, which will increase the universe size and result in an increase to the sample size.

The total number of road sections and total mileage in each volume group are also needed to determine the proper sample size necessary for each functional system. These data define the universe and will be needed for any future readjustments to the sample after adjustment to new AADT conditions. It is imperative that each State retain this information, and update it at least once per year. The information is also used to (re-) calculate expansion factors. If volume groups other than the predetermined volume groups used in the FHWA-developed approach (discussed below) are selected, the AADT limits of these volume groups shall be reported on a volume group form, modeled after the Appendix F tables.

SECTION DOCUMENTATION

The sampled sections described in this Manual and the resultant data will be used to monitor highway performance over an extended period of time. Consequently, it is extremely important that precise documentation of the exact location of each sampled section be made at the outset to assure that yearly and cyclical updates are provided for the appropriate roadway sections. The documentation should logically consist of appropriate maps and narratives to facilitate continuing use and availability of the sample section location, whenever needed.

CALCULATION OF EXPANSION FACTORS

The purpose of the HPMS panel of sections is to provide an expandable base for the rural, the small urban, and the defined urbanized area systems in each State, all stratified by functional system and traffic volume. An expansion factor must be calculated for each volume stratum within each functional system. This is accomplished by dividing the total mileage in the stratum by the mileage included in that stratum's sample. As noted above, the total universe mileage in each stratum must be known, retained and updated each year in order to calculate the expansion factors. Stratum universe mileage should be the best available whenever expansion factors are to be calculated. This expansion factor will be placed on each sample record, will be reported via the computer printout resulting from the SELEXP option of the HPMS Submittal Software (see Chapter IV, Item 27 and Chapter VI), and will allow the samples to be expanded to represent the entire functional subsystems for rural, small urban, and urbanized areas.

Example Factor Calculation 1/
Rural Interstate

Volume Group	Number of Sample Sections	(A) Total Mileage of Sample Sections	(B) Total Mileage in Volume Group	(C) Expansion Factor (Col. B Divided By Col. A)
1	9	38.4	1132.6	29.49
2	8	41.6	924.0	22.21
3	6	23.7	362.1	15.28
4	3	10.6	133.9	12.63
5	2	7.4	36.0	4.86
6	2	6.9	18.1	2.62

1/ Chapter VI contains the computerized procedure for calculating expansion factors (SELEXP option).

FHWA-DEVELOPED SAMPLING APPROACH

Rural and Small Urban Areas

Both rural and small urban area data will be sampled on a statewide basis, stratified only by functional system and volume group. The volume group for each universe section must be identified using the tables in Appendix F before sample selection can begin. Then the number of sections to be included in the sample is determined using the procedure in Appendix G. The number of sample sections per volume group, in general, is determined based on: (1) number of sections available for sampling (the universe), (2) the specified precision levels, and (3) the variances of the AADT's as stratified.

A minimum sample of three sections is required for each volume group. Obviously, if less than three universe sections exist in a volume group, they must all be sampled, or alternatively, the volume group may temporarily be combined with the next adjoining group, or split between the upper and lower adjoining groups based on the AADT's. The sections must be returned to their proper volume group(s) before the next submittal following the one being modified, and/or before a sample review takes place.

Sections are to be selected from the universe of each functional system and volume group using a random number table or random number generation computer software, until the required sample size is reached.

Individual Urbanized Areas

Each State has the option to determine which urbanized areas, if any, will be sampled individually (see collective urbanized areas, ahead). Each area defined for sampling purposes, (at the State's option, as an individual urbanized area or several areas collectively) will have its sample stratified by functional system and volume group. (The AADT volume groups to be used are shown in Appendix F). In situations where AADT's higher than those contained in this table are encountered, it is suggested that higher volume groups be added that contain a range similar to that for the highest volume group shown in the table for the appropriate functional system. All portions of bi-State and tri-State urbanized areas must be sampled -- if sampled as individual areas, the sample in each State should not be less than its pro rata share for the entire urbanized area by functional system volume group nor in any case less than one section per applicable volume group (this is the only allowable exception to the three sections per volume group rule). In such areas, expansion factors must be calculated separately for each State's portion.

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To ensure a consistent sampling approach, States concerned with bi- or tri-State urbanized areas are urged to coordinate with the appropriate neighboring State(s) so that all portions of an urbanized area are sampled in the same manner. It should be noted that an individual sampling approach must be applied to all parts of urbanized areas if estimates are desired for the complete urbanized area. For example, to develop estimates for the Kansas City urbanized area (Ks., Mo.), the two States must sample their respective portions of the area individually, as was done before the introduction of the optional collective procedure. If either Kansas or Missouri includes its portion of the Kansas City area in the collective category, then no estimates of the complete Kansas City urbanized area will be possible.

The required number of samples for the volume groups in each functional system is determined by the procedure in Appendix G. As with rural and small urban areas, the required number of sections must be randomly selected from the universe of each volume group, and a minimum of three sections per stratum is required.

Collective Urbanized Areas

Note that in view of possible future events concerning increased emphasis on urban areas, this method of sampling is no longer recommended.

A State may elect to redefine its urbanized area sampling panels to group individual urbanized areas into a collective panel (more than one collective panel can be developed if the State elects to do so). This option will reduce the reporting burden (sample size) in urbanized areas for many States by eliminating the requirement for individual urbanized area reporting. However, since the precision levels increase for collective urbanized area sampling (see Appendix F), the reporting burden will not decrease for all States, particularly those with a small number of urbanized areas. The biggest advantage is the significant reduction in sample size for highly urbanized States or States with large numbers of urbanized areas. When this Manual was printed, 13 States had exercised this option. Disadvantages include the elimination of individual urbanized area estimates which may reduce the usefulness of the HPMS to a State, the distortion of the original sample design, and the lack of continuity from the existing data. It is recommended that a State thoroughly assess the consequences of grouping urbanized areas in terms of actual reduction in sample size, effort involved in revising existing sample data, and usefulness of a collective vs. individual urbanized area sample prior to making a decision to group its urbanized areas. Once a decision is made concerning the sampling philosophy in a given State, the sampling approach should not change.

Modification of Existing Sample Panels -- Only the sample panels representing individual urbanized areas that are to be grouped into collective panel(s) are subject to modification. The volume groups and precision levels associated with the collective panels are provided in Table F-3, Appendix F. Note that the precision levels for collective panels are the same as the rural and small urban precision levels and are higher than those associated with individual urbanized areas.

Functional system and volume group stratifications remain the same for the collective area panel as for individual urbanized areas. Sample sizes for the new collective area panel(s) are determined by the procedure in Appendix G. The total number of sections available for sampling (universe) in the given volume groups are taken from all of the urbanized areas in the collective group. Each urbanized area should be represented in the sample panel for the collective group.

Assuming that the required number of sample sections for a given volume group is less than the existing number of sample sections (the reason for going to a collective group, normally), the required number can be randomly selected from the existing sample sections. If the required sample size is larger than the current number of samples, the additional samples will be randomly drawn from the total available sections excluding those sections which are already samples. Each volume group must have a minimum of three sample sections or all that are available, if less than 3 universe sections exist in the volume group. Excess existing sample sections may be eliminated, but consideration should be given to retaining 5-10 percent above the number of sections required to allow for the movement of sections from one volume group to another over time. Also, careful consideration must be given to the impact that new urbanized areas being added as a result of future Censuses will have on future sample size requirements. Sample ID's that are eliminated under this situation should be listed with appropriate remarks and sent to FHWA Headquarters with the HPMS tape submittal that contains the deletions.

Once the collective area panel has been established, the sample section expansion factors must be recomputed to be representative of the collective area panel, i.e., for a given functional system/volume group in the panel, the ratio of universe mileage to sample mileage.

Collective Area Panels for New Urbanized Areas -- Sample panels for this situation are established using procedures similar to those for rural or small urban areas. The number of sections available for sampling in the functional system and volume group strata (see Appendix F) for the new collective urbanized area must be established. Then the required number of samples for the volume groups in each functional system is determined from the procedure in Appendix G. Finally, the required number of sections are randomly selected from the universe of each volume group and a minimum of three sample sections per stratum is required. (See Chapter V for adding sample sections from new urbanized areas to an existing collective group.)

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Interstate System Sampling Procedures

The Interstate system must be sampled in such a way as to allow specific estimation of each mileage category contained within the system: (1) Interstate (other than (2) through (4) that follow), (2) Interstate toll, (3) Interstate with Secretarial Agreement and, (4) Interstate Section 139(a) additions. The procedures contained in this section of the Appendix will facilitate specific estimation, modeling, and assessment of the aforementioned categories. Such specific categorical estimations are a necessity for the complete assessment of the Interstate system components and the impact that future legislative actions and resultant policies could have on the overall Federal-aid Interstate System program.

The procedures that follow are applicable only if a State has Interstate system mileage in categories 2, 3, and/or 4 noted above; otherwise, no change is required in the current sample. In effect, each subcategory is to be treated as another "functional system" complete with its own universe mileage and expansion factors. The net result, however, is that the number of Interstate samples will increase. This procedure is applicable to either the optional collective or individual urbanized area sample panels as well as to the statewide rural and statewide small urban area sample panels. The procedure, applicable to each sample area, is as follows:

1. Determine the mileage and the number of universe sections in each of the four Interstate categories by area type (rural, small urban, urbanized) and volume group. The universe mileages in each category by area and volume group stratum for the four categories (less if appropriate) of Interstate, Interstate toll, Interstate with Secretarial Agreement, and Interstate Section 139(a) additions will be used later in the expansion factor computation. The number of universe sections for each category in each area and volume group stratum will be used in the sample selection process.
2. Subdivide the (existing) HPMS sample by the same categorial stratification as in step 1.
3. Using the universe data, compute coefficients of variation of AADT for each stratum. Apply the procedure in Appendix G to estimate the required sample size in each stratum. The precision requirements as contained in Appendix F remain the same for all Interstate strata. As with all HPMS sampling procedures, a minimum of three sample sections per stratum are required. Any universe stratum with less than 3 sections may be temporarily combined with the next adjoining volume group, or may be left in its own volume group, if all available universe sections are sampled. Sections that are moved to another volume group must be reinstated to their proper groups for subsequent sample reviews (i.e., each year when preparing for HPMS submittals).

4. By comparing the existing number of samples in each stratum (step 2) and the sample size estimates (step 3), determine the number of additional samples required. Additional samples in each stratum should be selected from the non-sampled universe sections using a simple random process (table of random numbers) or the established HPMS procedure.
5. Recompute the expansion factors for the complete sample using the HPMS expansion factor procedures, i.e., the ratio of universe to sample mileage in each individual stratum.

Conflicting Mileage -- Under situations where Interstate mileage falls into more than one subcategory (i.e., toll and 139(a)), 100 percent sampling of the conflicting mileage will have to be realized. Otherwise, the calculated expansion factors will enable proper expansion to one of the subcategories, but erroneous expansion will likely result in the other subcategory.

Completion of the process will allow the existing HPMS expansion procedures to produce estimates for the categories of interest.

THEORETICAL APPROACH

The preceding instructions for the stratification and selection of sample size were developed for the convenience of the user. However, an individual State may wish to modify the FHWA approach because of special considerations or unusual characteristics in its highway system. The rationale for the FHWA sample design, which follows, should serve as a guide for possible modifications.

Stratification

The allocation of sampling units into relatively homogeneous volume groups reduces overall sampling error and sample size requirements. Important considerations in the stratification process are the required number of strata for a functional system and the range of AADT values within each of the strata. A reasonable balance between the numbers and ranges of the strata must be obtained, with range as the controlling factor. If the strata ranges are too narrow, the assignment of road sections to the correct AADT group strata becomes difficult or questionable; if the ranges are too wide, the homogeneity of the strata is reduced -- a judgment situation. A useful formula for approximating a suitable stratum range for the two lowest volume strata is:

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$$i = \frac{\text{Range}}{1 + 3.322 \log N}$$

where,

Range - the difference between the highest and lowest AADT in a given functional system.

N - the total number of road sections available for sampling (universe) in the same given functional system.

The value obtained for i may be rounded to the nearest value of 500 or 1,000, as preferred. The ranges for higher volume groups may be considerably larger than the value of i , depending on the AADT frequency distribution of the universe sections or based on individual State judgment.

In the FHWA approach, the above formula was used to a limited extent and the predetermined number of strata restricted to no more than thirteen for national coverage. However, other procedures for volume group stratification may also be applicable. In the original design, data from earlier studies were used to estimate the variability for the FHWA-developed stratification. For other stratification schemes, an empirical procedure was used to develop these estimates. Empirical procedures are applicable in cases where no prior data from other sources, or pilot studies are available. Since the HPMS has been implemented for some time, sufficient data is available to make the use of empirical procedures unwarranted. The AADT coefficients of variation may be generated for any State by standard statistical computer packages based on the State's own, current data.

Appendix G presents a procedure to estimate sample size. To apply the procedure for any volume group stratification, all that is needed is an estimate of the AADT coefficient of variation and the application of the formula as presented in Appendix G. As noted above, the State should generate its own AADT coefficients. If this is not possible, FHWA Headquarters can develop coefficient of variation estimates, on request, for any tape submittal made by a State. The resulting report can be used for sample size review, and contains, among other information, the coefficients of variation that reflect the State's reported AADT data. (See the booklet, "Estimates of Sample Adequacy", that was developed from the 1985 data submittal, and sent to each State with the data review information for that year.)

Sample Design Approval

Each State electing to use the theoretical approach shall submit a detailed plan of the sample design for review and approval by the FHWA Office of Highway Information Management. Once an alternative sample design is submitted and accepted, the State may proceed with sampling sections. Some States may wish to make an initial or intermediate stratification by county, highway district, or terrain (for in-State use of the HPMS) which is totally acceptable providing that the final stratification is by volume groups, functional systems, and areas as specified in this Manual. Each sample plan shall contain the following information:

1. A brief narrative description of the sample design.
2. The numbers and ranges of the volume group strata by functional system within each of the areas--rural, small urban, and urbanized panel(s)--see Appendix F.
3. The number of road sections to be sampled in each volume group by functional system within each area.
4. The total number of road sections available for sampling by volume group within each functional system and area.
5. The design precision level of accuracy at the volume group level for each functional system within each area. The minimum functional system volume group levels 1/ discussed earlier in this Appendix must be met.
6. The method by which random samples will be drawn for each volume group.

1/ If the sampling is by area subdivisions, e.g., highway districts, the precision level of estimates for combined subdivisions must conform to the rural, small urban, and urbanized area requirements as specified in this Manual.

Standard Method for Computing Sample Size

The AADT volume group strata are assigned areawide (rural, small urban, and urbanized) to each of the five functional systems in each area. The formula for calculating the sample size, n, for each volume stratum for a given precision level of accuracy by simple random sampling is presented in Appendix G. The procedure for estimating non-standard volume groups was described in the previous section.

December 1, 1987

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ALTERNATIVE RANDOM SAMPLE SELECTION METHOD

In some instances, a State may not have all of its system mileage, e.g., collector mileage, subdivided into sections with assigned AADT's for sample selection. One of the following approaches can be used in such a case.

The first step is to determine the distribution of functional system mileage by AADT group. Using existing records and traffic flow maps, the AADT volume group(s) of each arterial and collector should be identified and marked on a map. It is suggested that the identification of mileage assigned to volume groups start with the highest volume group and work downwards. When all mileage associated with the volume groups other than the lowest volume group has been identified, the total mileage for each completed volume group can be determined by scaling mileages from the maps. The sum of these mileages subtracted from the total functional system mileage yields the mileage in the lowest volume group. This approach will prove quite useful for functional systems with relatively high mileage in the lowest volume group.

After the mileage in each volume group has been established, the next step is to randomly select sample sections. The basic requirement is that each section has an equal probability of being selected. Without having specific sections identified, a sample location must be randomly selected and then a section containing the selected location must be established. Two alternative approaches for randomly sampling locations are presented below:

Sample Location Approach No. 1

1. Establish the following table for each volume group within each functional system and area.

Volume Group Mileage (Nearest Mile)

<u>Route</u>	<u>Miles</u>	<u>Cumulative Miles</u>
x	xx	xxx
y	yy	yyy, etc.

2. Using a random number table (a computerized random number generating program could also be used), select an area in the table containing numbers with the same number of digits as are contained in the total volume group mileage (to the nearest mile). Choosing a number from this area of the table, compare this number to the cumulative miles column of the table produced in step 1; if the random number falls within a mile contained in a given subtotal line of the table, this location within the route is sampled. As an illustration, working with the following example and a 2-digit random number table, the first random number selected is 12.

<u>Route</u>	<u>Miles</u>	<u>Cumulative Miles</u>
50	10	10
100	15	25
212	10	35

Looking at the cumulative miles column, this places the selected milepoint (12) 2 miles into the Route 100 mileage; therefore, the first location selected is mile 2 of Route 100. Additional random numbers are drawn and the process is repeated until the required sample size is obtained. Repeated random numbers and numbers larger than the total volume group mileage are ignored. Before the exact location to be sampled on a route can be established, a statewide convention must be established as to which end of a route will be the zero end. Using this convention and accumulating volume group miles from the maps, the sampled milepoints can be located. Reasonable homogeneous section lengths, within the guidelines set forth earlier in this Appendix, should be established either from maps or in the field.

Sample Location Approach No. 2

The second approach is much like the first except that only one random number is drawn and all other sample locations are chosen at fixed mileage intervals from the random start milepoint. The required fixed interval is calculated by dividing the total volume group mileage by the required number of samples for the volume group. For example, using information from step 2 above and assuming five samples are needed, the fixed interval will be $35/5 = 7$ miles. Therefore, with a random number of 12, as before, the locations sampled from the cumulative mileage column would be 12, 19, 26, 33, and 5 which translate to the following route locations:

Route 50, milepoint 5
Route 100, milepoints 2 and 9
Route 212, milepoints 1 and 8

Given the locations to be sampled, the States must establish homogeneous sections containing these locations that conform to section length requirements defined on page H-4 of this Appendix.

Sample Adequacy Review

This Appendix contains procedures for developing the HPMS arterial and collector sample panel. Since HPMS has been in existence for some time, the procedures should now be used for reviewing the adequacy of the existing sample panels, and to update them, where needed. It is recommended that a review be made at least every 3 years in order to preserve the integrity of the sample. Chapter V contains more details about, and methods for, performing these reviews.

APPENDIX I

Sample Size Requirements for Estimating Proportions

The sample size determined by the HPMS empirical method is based on the measurement of AADT and AADT sensitive variables. Although the sample size determined by the empirical method is appropriate for obtaining mean values of data elements such as average pavement condition of arterials, the same sample must also be used to estimate the proportion of mileage having specific characteristics (e.g., rural arterial mileage with a PSR rating of less than 2.0). Therefore, steps must be taken to ensure that the sample size requirements for averages and aggregates also allow for a sufficient sample size to produce estimates of proportions at desired accuracy levels for each functional system.

A method for determining an acceptable precision level for proportionate values is to find the functional system sample size required to detect a given percent change in proportions. This is essential to the monitoring process. The ability to detect change is a function of sampling size and sampling error, the true values of estimating proportions being unknown. The relationship between the smallest detectable true percent change in proportions and sample size is shown in the following formulas.

Given the formula:

$$(p_2 - p_1)^2 = Z^2 (\bar{p} \times \bar{q} (1/n_1 + 1/n_2))$$

where,

p_1 - the estimated proportion for a given data element attribute for a functional system at time period # 1.

p_2 - The same as above for time period # 2.

$(p_2 - p_1)$ - the smallest detectable true change, not concealed by sampling error.

Z - the normal variate for a given level of confidence.

\bar{p} - $(p_1 + p_2) / 2$

\bar{q} - $1 - \bar{p}$

n_1 - the total number of road sections in the sample panel for time period # 1.

n_2 - the same as above for time period # 2.

Assuming the "worst case" situation where $p_{\text{bar}} = q_{\text{bar}} = 0.50$, and $n_1 = n_2$ in the fixed sample, then let $2/n_0 = 1/n_1 + 1/n_2$.

Substituting, the formula reduces to:

$$(p_2 - p_1)^2 = 0.5Z^2 / n_0 \quad \text{or} \quad n_0 = 0.5Z^2 / (p_2 - p_1)^2$$

and,

$$n = n_0 / (1 + n_0/N)$$

giving the number of samples required in a functional system to detect a given change in proportions;

where,

n_0 = the number of samples required, without finite correction.

N = the total number of road sections available for sampling in a functional system.

As an example, if the above formulas are applied to a functional system having a statewide total of 200 sections (N), the required number of sample sections (n) to detect a 10 percent change ($p_2 - p_1$) with 80 percent confidence (Z) is:

$$n_0 = 0.5(1.282)^2 / (0.10)^2 = 0.822 / 0.01 = 82 \quad |$$

$$n = 82 / (1 + 82/200) = 58$$

The graph contained in Appendix Figure I-1 is plotted for sample size (n), and universe size (N) (for a complete functional system), based on 80 percent confidence in the detection of a 10 percent change.

The minimum detectable true change in proportions ($p_2 - p_1$) for any given number of sample sections at stratum of functional system level is obtainable from the formula given below. Thus, for a functional system sample of 103 sections out of a total of 3,338 in the universe, the minimum detectable percent change at 80 percent confidence is:

$$(p_2 - p_1)^2 = ((N - n) / N) (Z^2 (p_{\text{bar}} \times q_{\text{bar}}) (2 / n))$$

where,

$N - n / N$ = the finite correction factor

and, substituting values:

$$(p_2 - p_1)^2 = ((3338 - 103) / 3338) (1.282)^2 (0.50 \times 0.50) (2/103)$$

$$(p_2 - p_1)^2 = 0.007732$$

$$(p_2 - p_1) = 0.0879 = 8.8 \text{ percent}$$

I-3

It is required that the design sample size at the functional system level be such that the smallest detectable change in proportions is no greater than 10 percent, and preferably less at the 80 percent confidence level.

It also should be noted that the values for n in the above formulas refer to the total number of sampled sections in the functional system, whereas the values for p are the proportions for specific data element attributes obtained by the ratio of sampled attribute mileage to total sampled mileage in a functional system. In rural areas where the lengths of road sections are, as a rule, greater than those in urban areas, the computed value for the smallest detectable change is somewhat overestimated. This overestimate is reduced or nonexistent in urban areas as road section lengths approach 1 mile or less.

The formula in Appendix G that generates the required sample size for each stratum (volume group), relies heavily on the AADT coefficient of variation. In the past the coefficients used by most States were derived empirically from a few State's data and other estimating procedures and published in Appendix G. In almost all cases, the resulting sample size for each functional system was more than adequate for meeting this HPMS minimum requirement for estimating proportions. With the advent of methods for each State to generate its own coefficients, more careful consideration must be placed on this proportionality criteria, especially where a State's coefficients are very small when compared to the originally-used values (e.g., smaller coefficients will result in fewer samples per volume group and fewer samples in the functional system).

Each State should check its data against the graph in Figure I-1 (or by application of the above formula). Where it is found that additional samples are required for a functional system, the sample should be distributed among the volume groups based on the number that were required by application of the Appendix G formula. For example, if the number of required samples from the formula in Appendix G for some functional system was:

volume group 01 --	35
volume group 02 --	15
total	50

the total number of universe sections in this functional system	- 200
the number of required samples from the graph (Figure I-1)	- 60
the sample shortfall due to the proportionality criteria (60-50)	- 10

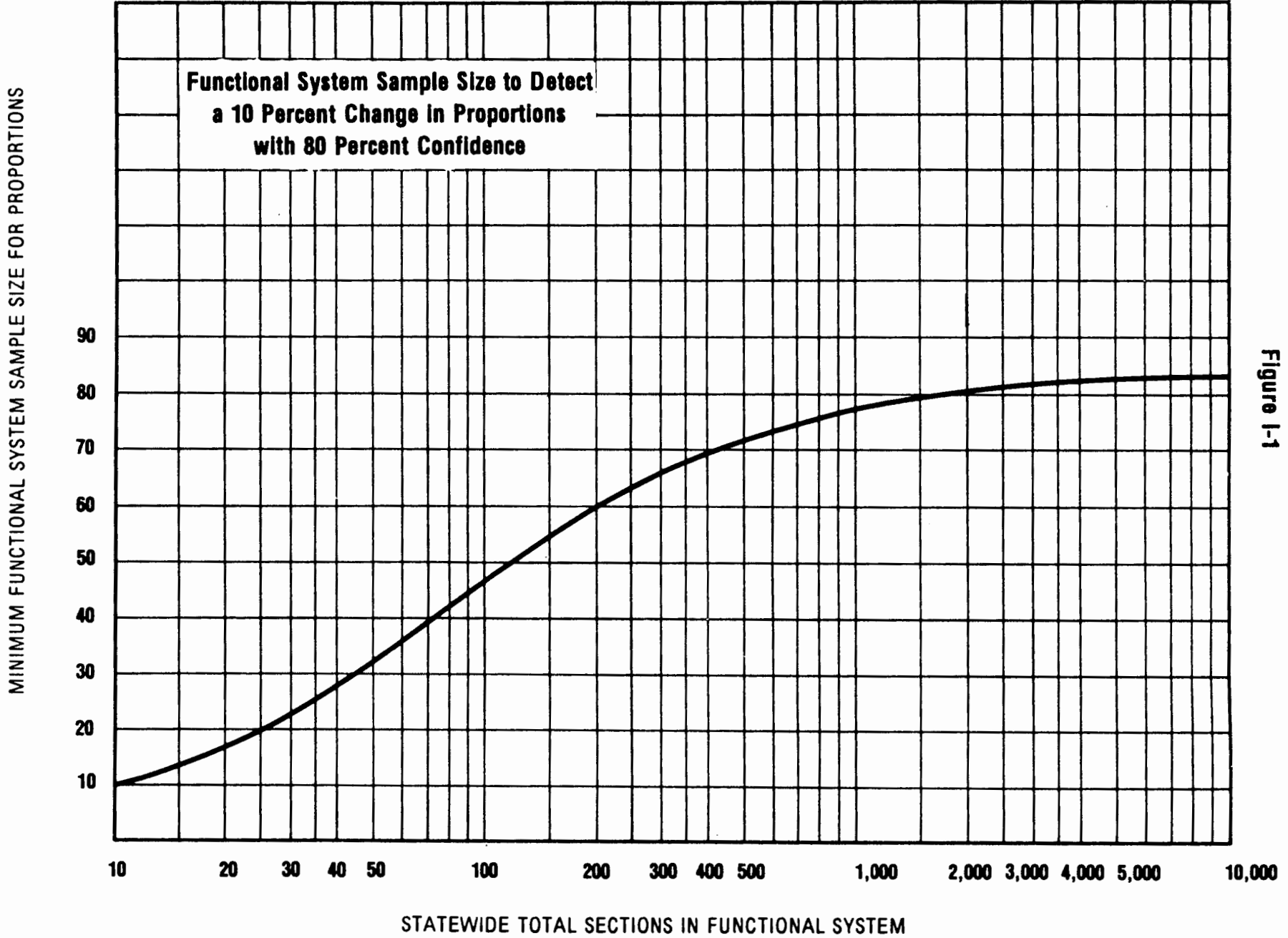
the actual sample distribution should be:

volume group 01	- 35 + ((35 / 50) x 10)	= 42 required samples
volume group 02	- 15 + ((15 / 50) x 10)	= 18 required samples

new total	60
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Both criteria (Appendix G and proportionality) are now satisfied.

Figure I-1



MINIMUM FUNCTIONAL SYSTEM SAMPLE SIZE FOR PROPORTIONS

STATEWIDE TOTAL SECTIONS IN FUNCTIONAL SYSTEM

APPENDIX J

Roughness Equipment, Calibration and Data Collection

Abbreviations and Acronyms used in this Appendix

AASHTO-- American Association of State Highway and Transportation Officials
AMRL -- AASHTO Materials Reference Lab
ARS -- Average Rectified Slope
ASTM -- American Society for Testing and Materials
HPMS -- Highway Performance Monitoring System
IRI -- International Roughness Index
LTPP -- Long Term Pavement Performance
NBS -- National Bureau of Standards
NCHRP -- National Cooperative Highway Research Program
PMCG -- Pavement Management Coordinating Group
PMS -- Pavement Management System
RQCS -- Reference Quarter Car Simulation
RRI -- Reference Roughness Index
RTRRM -- Response Type Road Roughness Meter
SHA -- State Highway Agency
SHRP -- Strategic Highway Research Program

Definitions

- o HPMS Roughness Reporting Units -- IRI in inches per mile.
- o RTRRM -- A system contained in a vehicle or in a trailer that utilizes a road meter to measure and accumulate suspension deflections (axle to body displacement or acceleration values) over a section of roadway, which are used to indicate the roughness of the pavement.
- o Calibration Section -- A section of roadway that is used to calibrate an RTRRM via correlation to the known profile.
- o Known Profile -- Refers to a roadway (usually a calibration section) whose profile has been accurately measured with a Class I or II device/procedure. (Classes are defined on page J-3.)
- o Calibration Checks -- Refers to the periodic RTRRM units remeasurements made on a calibration site to see if the RTRRM is still in calibration with the original measurements.
- o Validation Checks -- Refers to the initial and periodic Class II device units measurements made on a calibration site (known profile) to see if the device is obtaining the proper measurements.
- o Regression Analysis -- A statistical procedure to explain relationships between variables.
- o Profile Device -- A device used to measure the longitudinal profile of a roadway.

Introduction

In order to provide a measure of pavement condition that has nationwide consistency and is as realistic and practical as possible, a uniform, calibrated roughness measurement for paved roadways has been introduced to the HPMS. This came about as the result of the Pavement Management Coordinating Group's (PMCG) recommendation that additional pavement related data be added to HPMS. This was based on extensive work done by the Pavement Initiative 2 Task Force, a subgroup of the PMCG. The details and reporting requirements were established by an HPMS Pavement/Roughness Working Group made up of State Highway Agency and FHWA field and headquarters personnel and other interested parties, such as a World Bank representative.

Roughness is defined (in accordance with ASTM E 867-82A) as "The deviations of a surface from a true planar surface with characteristic dimensions that affect vehicle dynamics, ride quality, dynamic loads and drainage." After a detailed study of various methodologies and road profiling statistics by the FHWA/State Pavement/Roughness Working Group, the International Roughness Index (IRI) was chosen as the HPMS standard reference roughness index. It was concluded that the roughness reference statistic will be defined from the absolute longitudinal profile of the road surface, and that methods (equipment) which provide indirect measures of the profile (RTRRM's) must be calibrated against the "known profile" reference statistic. The IRI was chosen because it facilitates correlation to a variety of roadmeter vehicles over a range of surface types.

The summary numeric (HPMS data reporting unit) is the IRI in inches per mile. IRI is computed from elevation data ("known profile") in a wheelpath for use as a profile numeric for profile measuring methods and as a calibration standard for RTRRM's. The primary advantages of the IRI are:

1. It is a time-stable, reproducible mathematical processing of the known profile.
2. It is broadly representative of the effects of roughness on vehicle response and user's perception over the range of wavelengths of interest, and is thus, relevant to the definition of roughness.
3. It is a zero-origin scale consistent with the roughness definition.
4. It is identical to the Reference Quarter Car Simulation (RQCS) inches per mile statistic derived in the National Cooperative Highway Research Program (NCHRP) 228 Report.
5. It is compatible with all profile measuring equipment currently available, and projected, in the U.S. market. Through correlation, it is directly applicable as an Average Rectified Slope (ARS) statistic for the calibration of response-type roadmeters.

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6. It is independent of section length and amenable to simple averaging.
7. It is directly consistent with recently established international standards, and able to be related, through published correlations (Paterson, Reference 13) to other U.S. and foreign roughness measures. |

Equipment

The State must determine which class of equipment it will use to collect the roughness data for HPMS reporting; the following will provide the State with sufficient information to make this determination. The different methods of collecting profile and roughness data may be grouped into four classes (see Table J-1 for examples of each):

- Class I -- Includes all manual profiling techniques such as rod and level.
- Class II * - Includes direct profile measuring equipment. This group also includes noncontact devices such as laser, light beam and acoustic techniques which must be kept in calibration in accordance with manufacturer's specifications.
- Class III -- Includes the Response Type Road Roughness Meters (RTRRM) and is the most common equipment presently being used for extensive data collection. The RTRRM systems measure the dynamic response of a mechanical device as it travels over the roadway surface at a constant speed. These devices use a variety of displacement technologies including the use of axle/body displacement transducers and accelerometers mounted on axles and/or bodies. Such devices must be calibrated to known profiles. Traditional RTRRM's measure ARS values which make correlation to IRI very convenient.
- Class IV -- Subjective estimations of roughness made by an observer using a descriptive scale that approximates the IRI for different road conditions and ride sensations. This method is not suitable for HPMS purposes.

* The accuracy of Class II profiling equipment must be initially and periodically validated through field comparisons to known profiles (i.e., to measurements made from a Class I equipment/procedure), or to stringent manufacturer's specifications. Reference 15 contains more information. |

The following table summarizes equipment specifications for HPMS in each of the above classes. The maximum error for each class was determined through recent research by the World Bank (Reference 2). Units are shown in terms of the IRI in metric and English units.

TABLE J-1

List of Equipment Types and Maximum Error by Class

<u>Class</u>	<u>Equipment</u>	<u>Maximum Error</u>	<u>Measurement Interval</u>
I --	Manual Profiling Techniques	1.5 % bias; .3 m/km = 19 inches/mile	< or = 1.0 ft.
	Example: Rod and Level		
II --	Direct Profiling Equipment	5 % bias; .7 m/km = 44 inches/mile	< or = 2.0 ft.
	Example: South Dakota Profilometer		
III --	RTRRM's *	10 % bias; .5-1.0 m/km = 32-63 inches/mile	
	Example: Mays Ride Meter		
IV --	Not suitable for use in collecting roughness data for HPMS.		

We advise any State considering purchase of new equipment or enhancing older equipment to require the marketing agent/manufacture to demonstrate that the new equipment will perform at the precision of the stated class level prior to purchasing any new instrumentation to collect roughness data.

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The following concerns are noted with regard to the selection and use of equipment:

1. Class I or II devices/procedures must be used for profile measurement for calibration purposes. Equipment should be carefully evaluated to assure that proper equipment class designation is being applied in accordance with the maximum IRI error noted in the above table. Profiling devices should be validated to assure that proper profile measurements of a section with a known profile are being obtained.
2. Class III vehicle-mounted response-type devices are not as desirable as trailer-mounted equipment. Vehicle-mounted equipment, if used, must be calibrated and checked more often.
3. Extreme care must be exercised during the operation of all equipment to ensure that its use is within the manufacturer's specifications and that all guidelines are followed.

Reference 12 contains additional information on roughness and profile measurement equipment.

HPMS Roughness Measurement Procedure

Roughness must be reported for HPMS in IRI units converted to inches per mile ($1.0 \text{ m/km} = 63.36 \text{ in/mi}$). When Class I or II equipment is being used for roughness measurements (see Table J-1), the procedure is reduced to a matter of reporting the units required by HPMS (inches per mile). When Class III equipment is being used (commonly referred to as Response Type Road Roughness Meters or RTRRM's), the procedure requires calibration of the RTRRM to the IRI via correlation to accommodate the HPMS IRI reporting requirement. Most States will (or already) use RTRRM's for collecting roughness data and will follow the Class III procedures. The State must determine the class of its roughness measurement equipment based on the equipment descriptions and maximum IRI error given under the Equipment heading in Table J-1, and then proceed with one of the following two procedures.

Procedure 1 -- Class I or II Profiling Equipment

The profile information gathered with these types of devices is simply reported in IRI (inches per mile), and applied to the HPMS sample records. The profile information is also used for the calibration of Class III RTRRM's.

The procedures for the development of IRI are described in the World Bank Technical Paper # 46 (Reference 2), Chapter 3. Micro-computer software for converting rod and level profile data into the necessary HPMS units is described in Reference 8.

Procedure 2 -- Class III Roughness Measurement Equipment

The roughness measurement information gathered with RTRRM's must be converted to IRI in inches per mile using the calibration through correlation method described under the "RTRRM Calibration Procedure" heading, below. The resulting IRI is then applied to the appropriate sample section records. Additional information on calibration procedures is outlined in Chapter 4 of the World Bank Technical Report # 46 (Reference 2).

For consistency of data to be reported via HPMS, periodic verification of the equipment to ensure that the RTRRM is still in calibration must also be accomplished. This is described, below, under the heading "Conducting Periodic Calibration Tests." Supplemental information is contained in the World Bank Technical Paper # 46 (Reference 2), Chapter 4, Section 4.3.4, and in Reference 15.

Calibration of Equipment

Calibration is the key to good, sound data collection practices. It is essential to calibrate the equipment on a routine basis using calibration sections which have "known profiles" that have been established by a Class I or Class II device/procedure.

Each State must document and retain records of its calibration procedures (i.e., selection of calibration sites, description of sites, how and when profiles were obtained, frequency at which calibration will be conducted, speed(s) to be used, minimum number of passes, etc.), as well as the actual calibrations undertaken (i.e., dates the equipment are calibrated, the results of each calibration, etc.) It is the responsibility of the FHWA field offices to monitor the SHA's calibration procedures and to review the State's documentation of the process.

All roughness measurements reported in HPMS must be reported as IRI in inches per mile. If the procedure that the State is using does not provide an IRI in inches per mile (via Class I or II equipment), then the calibration through correlation procedure outlined below for RTRRM devices must be used to correlate the device output to IRI.

RTRRM Calibration Procedure

Roughness measurements obtained by RTRRM's are converted to IRI values by a calibration through correlation procedure. It is essential that each RTRRM be calibrated to a "known profile" determined by application of a Class I or II device/method. The need for calibration cannot be overemphasized in terms of collecting high-quality, consistent and comparable roughness measurements.

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The calibration procedure is best described by a series of steps that must be taken in order to allow for conversion and correlation of the RTRRM roughness measurement to the IRI. The following is a simplified step-by-step calibration via correlation procedure. These steps are intended to be HPMS guidelines and should be considered minimum requirements; manufacturer and/or State procedures may be more stringent. The good weather conditions outlined under the "Guidelines for the Collection of Roughness Data", ahead, should also be followed here.

1. Choose a minimum of nine calibration sections, each at least 0.2 miles long, such that there are at least three sections in each of the roughness ranges described in Table J-2. The sites should be representative of the surface types found in the State and be located, where possible, on low-volume roads where roughness properties will not rapidly change, and where traffic is less likely to interfere with the measurements. If, after initial data collection, there exists a significant variance of readings between pavement types, separate calculations can be performed for each type. Some States will choose more than nine sections because of equipment location, equipment manufacturer stipulations, ease of getting to a calibration site, size of the State, etc. In order to reduce costs and to conserve time, the calibration sites should be chosen as close together, and as near to the RTRRM storage facility as possible.

Table J-2

Roughness Calibration Ranges

<u>Group</u>	<u>IRI Roughness Range (inches per mile)</u>
a. Smooth	0 - 190
b. Medium	191 - 320
c. Rough	> 320

Additional guidance is as follows:

- o Minimum calibration section lengths are 0.2 miles.
- o Minimum approach distance for each site is 150 feet (or enough to bring the RTRRM to proper speed and to stabilize equipment).
- o Where possible, choose sites on low-travel roadways whose roughness properties will not change rapidly over time.
- o Sites should be chosen on tangent sections of roadways that have little or no grade.
- o Where possible, coordinate (use) calibration locations with SHRP/LTPP sites, SHA pavement management and other common use locations.

NOTE: It is recognized that roadway calibration sections in all three of the roughness ranges contained in Table J-2 may not be applicable or available in some States, particularly for roadways that have pavement roughness extending into the "rough" range (> 320 inches per mile, IRI). In such instances it is not necessary to have RTRRM calibration sections in the rough range. It should be noted, however, that calibration sections must include roadways that have a measured roughness that meets or goes beyond the range of actual values that will be collected, because extrapolation of the regression line/equation beyond the roughness ranges in which the calibrations are completed is considered poor practice, and is not suitable for HPMS use. States should choose calibration sections such that all RTRRM measurements taken will be encompassed by the regression line end points, as defined by the calibration sections.

2. Clearly mark the termini and the wheelpath (measurement) area of each calibration section in the field (chalk, flags, etc.), and measure the profile using a Class I or II device/procedure. For each calibration site, measure the longitudinal profile by determining elevation to the nearest 0.04 inches (or 1.0 mm) every 12 inches, using the procedures outlined in the World Bank Technical Paper Number 46 (Reference 2). This determines the "known profile."

3. For each calibration site, compute the International Roughness Index (IRI) in inches per mile based on the Class I or II device. Chapter 3 of World Bank Technical Paper Number 46 (Reference 2), contains more information about these calculations as do other references listed at the end of the Appendix. This is the Y value for each point plotted in the example correlation graph contained in step 6, below.

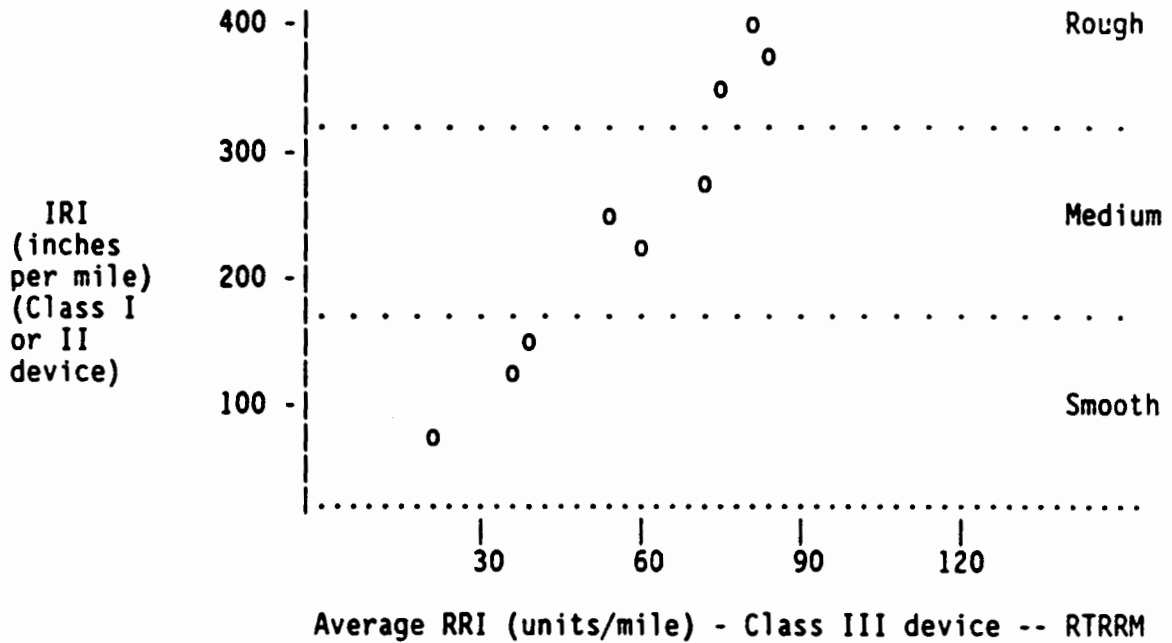
4. Measure the roughness on each of the calibration sections with each RTRRM device that the State intends to use. This should be done for each speed that will be used to collect roadway data, and should follow the manufacturer's specifications. The speed is to be held constant for the entire calibration site. A minimum of five passes for each device, at each speed on each calibration section is required in order to obtain an average reference roughness index (RRI) for the road profile. RRI's that are obviously far outside of the other readings (> 10 percent) should be eliminated if at least five readings still remain, or another pass should be made on the site to replace the questionable reading.

5. Calculate the average RRI for each calibration section, for each RTRRM device at each speed. The resulting average RRI's then become the X values of each point that is plotted (see example correlation graph in step 6, below). Note that each graph represents one given speed for a given RTRRM.

6. Plot the IRI (inches per mile) obtained from step 3 vs. the average RRI from step 5 for a given device, and a given calibration speed for each of the calibration sections. There should be a minimum of nine points on each graph as in the following example:

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Example RTRRM Correlation Graph
HPMS Calibration Sections for a State
50 M.P.H. -- Mays Meter # 2 (Oscar)



A line is drawn through the points in a "best fit" fashion using a linear or nonlinear regression calculation (the regression analysis is performed for the data plotted on each graph). The calibration equation is in the form $Y = bX + a$ (or $Y = cX^2 + bX + a$ or $Y = dX^3 + cX^2 + bX + a$, etc.), where "Y" = IRI in inches per mile, and "X" = the RRI reading in units per mile ("a", "b", "c", etc. are constants that result from the regression calculation). This line/equation becomes the HPMS correlation line/equation (where IRI will be reported in inches per mile) for all RTRRM measurements made on HPMS sample sections at the speed and with the device indicated.

For HPMS purposes, the simplest equation shown ($Y = bX + a$) will suffice. However, other more advanced linear or polynomial methods of curve-fitting may be used at the discretion of each State in order to improve the fit or to follow its normal procedures. Adequate documentation of any procedure used should be maintained to allow for technical evaluation reviews.

Conducting Periodic Calibration Verification Tests

The good weather conditions outlined under the "Guidelines for the Collection of Roughness Data", ahead, should also be followed here.

Verification of the "Known Profile"

Calibration sites will require periodic remeasurement with a Class I or II device (to ensure that the profile has remained stable), but this depends on the local conditions at the site and the length of time it will serve as a calibration site. Heavily travelled roadways and those subjected to severe weather conditions will require remeasurement to reestablish the "known profile" more often. To ensure that an accurate "known profile" is being used for calibration verification activities, it is expected that remeasurement would be performed once per year at a minimum, just prior to data collection activities (in the Spring, for instance). Year-round data collection activities may require more frequent remeasurements of the calibration sites. If the known profile IRI changes, complete recalibration will be necessary as described under the "RTRRM Calibration Procedure", above. Any time maintenance or resurfacing is performed on a calibration site, of course, the "known profile" must be reestablished or the site should be abandoned in favor of another site in its original roughness range.

RTRRM Calibration Check

To determine if the RTRRM has changed since the last calibration or calibration verification, and to check for RTRRM repeatability and its sensitivity to environmental conditions, calibration verification tests are required. This includes documentation of the same nature that is obtained for the RTRRM calibration (dates, results, site description, etc.). These tests should be run at least at the minimums noted below (see item 4). However, under the risk of discarding already collected data because an RTRRM is found to be out of calibration, a State may wish to increase the frequency of its verification tests. The following RTRRM calibration verification is based on the premise that the "known profile" is accurate:

1. Conduct periodic verification of equipment calibration using at least one calibration site per roughness group.
2. Five runs are required on each of the selected calibration sites for each test speed used. Variability of readings should be within 10 percent of each other.
3. The average Reference Roughness Index (RRI) must fall within + or - 5 percent of the previously established RRI (the average value obtained for the RTRRM at the given, constant speed when initially determining the point value for the calibration via correlation procedure) for each calibration site. If this comparison does not fall within these limits for each site, the equipment is out of calibration. When the equipment is out of calibration, it must be repaired and/or recalibrated using the calibration procedures outlined above. If repair is needed, recalibration will be necessary after the repair is completed.

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4. Calibration verification must be conducted prior to conducting roughness surveys, and in the interim, at least once each month or every 2,000 travelled miles, whichever comes first. If the risk of gathering inaccurate data is potentially high, calibration verification should be conducted on a more frequent basis (perhaps weekly) to avoid collection of inaccurate data.

Guidelines for the Collection of Roughness Data

To the maximum practical extent, HPMS roughness data should be obtained from ongoing State Pavement Management Systems (PMS), Long Term Pavement Performance (LTPP) and Strategic Highway Research Program (SHRP) activities. HPMS activities are not intended to change any existing PMS data collection procedures as long as the resultant data meet the minimum requirements of the HPMS. The goal of HPMS is to ensure nationwide consistency and repeatability of roughness measurements over time and the complete avoidance of duplicate State data collection efforts.

The following are some field survey guidelines for State use:

Where roughness data are collected in both directions, the State will select one direction for each HPMS sample section to be reported and will use this same direction for that sample section in all future applications. It would be useful to choose one direction, statewide, and use that for all sample sections (i.e., east to west, south to north).

For multilane facilities, it is recommended that roughness data for the outside (right) lane be reported. However, if this is not practical, whichever lane is measured must be used for all future HPMS reporting.

If a one-wheel device is used to collect roughness data, it is recommended that the right wheel path be measured. However, if this is not practical, whichever wheel path is measured must be used for all future HPMS reporting.

All roughness data collection must be performed when the pavement is in stable condition. Data should not be collected during winter (frost/freeze or freeze/thaw) or wet base conditions. Data collection should be performed during good weather conditions. Good practice rules are as follows:

Temperature: Between 40 and 100 degrees F.

Wind: Data collection should not be performed when wind conditions affect the stability of the equipment/vehicle.

Rain: Data collection should not be performed when there is any accumulation of water upon the roadway surface.

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Data should only be collected at the speeds which correspond to the manufacturer's recommended speed range and at the calibration speed(s); speeds should also be consistent with the posted speed limit. Constant speeds are to be maintained for all measurements. If the speed does not remain constant for the entire measurement site, the data should be rejected. Data collection should not begin until the vehicle accelerates to the calibration speed and the vehicle/equipment has stabilized.

The impacts of bridges and railroad crossings (or other obstacles which cause localized discontinuities) should be reflected in the roughness measurement.

Roughness measurements should be taken over a whole HPMS sample section and converted to units per mile. However, in order to achieve equipment and speed stability, a minimum of 150 feet (but consistent with the manufacturer's specification) is required prior to the measurement area. If this minimum cannot be met prior to the start of the sample section, some shorter portion of the HPMS section may be measured, but that same portion should always be measured in future roughness data collection activities. As noted in Chapter V, roughness data on HPMS sample sections are to be collected biennially, at a minimum.

Reporting Requirements

It is required that roughness data in IRI (in inches per mile) be reported for HPMS sample sections on all rural arterials and urban freeways and expressways. Roughness data reporting is suggested for all other sample section facilities where it is already collected or could be readily obtained by the State. (See Table IV-3, Page IV-27.) The lower functional systems (rural and urban collectors and urban other principal arterials and minor arterials) have been placed in the "suggested" category since it is recognized that there will be situations when it may not be possible to obtain roughness measurements with presently available RTRRM's. The major obstacles are identified as:

- o Speed restrictions (minimum or intermittent)
- o Section lengths
- o Traffic signals
- o Congestion

It should be noted that the road users' perception of roughness may not be reflected by response type device readings at low speeds, and therefore, erroneous results are likely. Furthermore, safety and related concerns must prevail under congested conditions, and therefore, use of RTRRM's under such circumstances is not always prudent.

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Wavelength Filtering Levels for HPMS IRI

It should be noted that the longitudinal road profile includes a broad spectrum of wavelengths, from surface texture (short wavelengths) to hills and valleys (long wavelengths). The upper and lower limits depend on the particular profiling equipment. In order to obtain an IRI for the "ride" qualities of interest to HPMS, the IRI analysis described in the World Bank Technical Paper Number 46 should be used. This algorithm effectively eliminates (filters) the profile data outside of the 1.3 - 30 meter (approximately 4 - 100 foot) wavelength band (Reference 2, Chapter 3, page 21). Additional discussion of wavelength filtering, including illustrations, may be found in the "Description and Evaluation of the South Dakota Road Profiler", Reference 16.

Those States that use roughness measuring equipment that does not yield roughness profiles can obtain the IRI statistic through the regression procedure described previously (i.e., calibration through correlation to a profile derived IRI).

Coordination Among Various Pavement Activities

A considerable number of activities are currently taking place within the highway community which deal with pavement data. Coordination among these activities is essential in order to optimize the return on the efforts expended in data collection, analysis, reporting and use.

The HPMS effort almost certainly needs to be coordinated with the following activities:

- a. Strategic Highway Research Program (SHRP)/Long Term Pavement Performance (LTPP)
- b. National Bureau of Standards (NBS)/AASHTO Materials Reference Lab (AMRL)
- c. State Pavement Management Systems (PMS)

The LTPP activities as part of the SHRP will monitor pavement performance and usage in detail for approximately 1,500 pavement sections, nationwide, over a 20-year period. Attempts should be made to ensure that as many LTPP sections as possible are also HPMS sample sections or at least representative (i.e., in close proximity) of HPMS samples. The pavement and traffic monitoring data collected on these LTPP sections should be used for the HPMS sample sections, where possible.

It is expected that all LTPP sections will be profiled at least every 2 years. Efforts should be made to utilize the LTPP established sections/profiles as multiple use HPMS/SHA calibration sections in each State.

Many State transportation agencies have operational or are developing a PMS to guide program development, improve life-cycle costs, and select the most effective pavement improvement strategy. The HPMS pavement data reporting must be consistent with State PMS as much as possible. For this reason, the roughness and/or condition statistic developed by the State PMS should include the IRJ statistic to be reported for HPMS. This would minimize the effort and/or expense of reporting HPMS pavement condition data from the State PMS database. One of the goals of HPMS is to advocate the complete avoidance of duplicate State data collection efforts, and the States are encouraged to coordinate roughness measuring activities, where possible, such that the same equipment and calibration sites are used for HPMS, PMS, LTPP, etc.

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APPENDIX K

Traffic Monitoring Procedures For The HPMS

Because of the use of Interstate System and other travel data for apportionment and allocation purposes, and because traffic data is so significant in the HPMS Analytical Process, particular attention should be given to these data.

In order to assure that each State is treated fairly in the apportionment process, these revised instructions for traffic monitoring (including documentation) are applicable starting with data to be submitted June 15, 1989. The FHWA regulation dealing with the administration of highway planning programs (23 CFR 420.105) outlines the States' responsibility for furnishing FHWA with adequate information for administering the program. The importance of the maintenance of valid HPMS data is emphasized as an item of national significance. Items of national significance are to be adequately addressed in each State's annual HPR work program. Adequately addressing the HPMS extends beyond simple submission of data each year and includes taking actions to assure that the data is complete and accurate.

The recommended procedures for the development of reliable estimates of travel characteristics including annual average daily traffic (AADT) on the HPMS sample sections, and systemwide travel (daily vehicle-miles of travel) by expansion of the sample section AADT are contained in the Traffic Monitoring Guide (TMG). 1/

States may decide to apply other procedures to develop the desired travel characteristics. States using other procedures should clearly state how these procedures differ from strict conformity to the TMG and this Appendix. To insure the reliability of the data reported and subsequently used in the critical apportionment process, States proposing to use alternative procedures must demonstrate that such procedures will produce estimates with reliabilities that equal or exceed those in the TMG. Thorough documentation of these procedures shall be furnished to the FHWA. These procedures are to be reviewed and approved by the FHWA.

Overview of Process

The integration of different aspects of traffic monitoring (traffic volume, vehicle classification, and truck weight), results in the direct linkage of estimates obtained by the three programs. This unified, supportive structure has a common estimation base. The traffic volume aspect consists of Continuous ATR's, the HPMS Sample Coverage Counts, and Interstate Universe Procedures.

Continuous ATR's

The continuous ATR's provide seasonal, day-of-week and growth factors which are used to adjust the short coverage counts to AADT. Analytical procedures to determine the appropriate level of effort and to develop the needed estimates are described in the TMG.

1/ Federal Highway Administration, Notice N5600.7, "Traffic Monitoring Guide," U. S. DOT, June 1985.

HPMS Sample Coverage Counts 2/

The HPMS sample provides an appropriate statistical base for the development of location-specific (AADT) estimates at each HPMS sample section and systemwide DVMT by expansion of the HPMS sample. By the incorporation of vehicle classification and truck weight, the structure provides a smooth-functioning estimation hierarchy.

The TMG recommends use of 48-hour counts covering the HPMS sample over a 3-year cycle. The counts should be randomly scheduled spatially (geographically) and temporally (over the calendar year) to insure adequate representation and to minimize bias. Axle correction factors to adjust raw counts obtained via axle counting equipment are derived from the vehicle classification sample.

The annual traffic volume sample to be counted on each functional system consists of a randomly selected one-third of the HPMS sample sections (see Section 3 of the TMG) by randomly dividing each stratum sample (volume group) into three parts. Minor adjustments are necessary for strata with numbers of sections not divisible by 3 or having less than 3 samples (for a full discussion refer to Section 3 of the TMG). One-third of the sample would be monitored each year. The full HPMS sample would be completely covered during a 3-year cycle.

The development of section AADT estimates must be comprehensive and include the use of appropriate adjustment factors to compensate for known unique characteristics, and to adjust short counts to AADT. All HPMS sample sections not counted during the current year must be updated to current AADT estimates by use of the appropriate growth factors prior to the annual HPMS data submittal. Estimates of DVMT can be developed by direct expansion of the HPMS sample on a functional system basis. The procedure is to multiply the sample section AADT by the section length and that product by the expansion factor; and then sum the sections up to the HPMS stratification level desired. Current HPMS Submittal Software described in Chapter VI (SELSUMT option) will perform these calculations by functional system. Since HPMS sample expansion procedures are based on the ratio of universe to sample mileage, mileage totals at any stratification level should be exact. These results, combined with a direct volume measurement and a well-distributed HPMS sample, should result in highly reliable DVMT estimates. The DVMT estimates derived from the HPMS sample can be used as the source of areawide form data or to verify independent areawide estimates.

To support counting on high volume controlled access facilities, the prudent use of ramp counts, in conjunction with limited mainline counting, is acceptable.

2/ The TMG references the HPMS sample as the "core sample."

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Interstate Universe Procedures

The national significance of the Interstate System coupled with the use of Interstate travel as apportionment factors for the I-4R program, requires an additional level of effort to enhance the level of precision; namely, monitoring each nonsampled Interstate universe section between interchanges at a minimum of once every 6 years. This requirement can be met by counting one-sixth of the nonsampled Interstate road sections each year. As with the the HPMS sample sections, the counts should be randomly scheduled, spatially and temporally, to minimize bias and insure adequate Statewide representation. All sections not counted during a given year must have the traffic data updated by applying an appropriately justified growth factor. In those situations where there are a number of sections on the link between contiguous interchanges, only one count during each 6-year cycle (assuming the absence of HPMS sample sections) need be taken, and the resultant count would be applied to all universe sections within the link.

These traffic counting procedures will result in a full HPMS sample counted every 3 years and a full Interstate System counted at a minimum of every 6 years.

Vehicle Classification and Truck Weight Data Collection

Beginning with calendar year 1990, data reported to the HPMS and also data reported as part of the Truck Weight Study (TWS) should reflect the use by the States of statistically based data collection procedures which employ weigh-in-motion and automatic vehicle classification equipment. In particular, these data should be reflected in:

1. Areawide data consisting of the "Percent of Travel by Vehicle Type and Functional System" (see Chapter II);
2. Sample data item 57, Percent Commercial Vehicles, (see Chapter IV); and
3. The reporting of the "HPMS Sample Number" (item 24) and the "HPMS Sample Section Subdivision Number" (item 25) for vehicle classification and truck weight data in the Station Description Record, as described in Chapter 6 of Section 5 of the "Traffic Monitoring Guide."

Documentation of Traffic Monitoring Procedures

All States are to develop and maintain documented procedures of their field and office activities for collecting and adjusting raw field counts to estimates of annual average daily traffic (AADT). The document should reflect that all items in this Appendix are addressed by the State's traffic monitoring program. Specifically, the documentation will explain field data collection procedures, testing methods for verifying the accuracy of traffic monitoring equipment, and procedures used in the office to adjust field counts to final travel estimates.

Documentation of field procedures should include all pertinent aspects of collection of the original data and cover all functional systems for which data are reported to the HPMS. The field procedures for collecting vehicle classification data for use in making axle corrections will be a part of the documentation. At a minimum, the documentation will include continuous counting and coverage counting. If control counts are also made, then these procedures are also to be documented. As a part of the documentation, a complete description of the procedures, including the number of counts, the period of monitoring, the cycle of monitoring, the spatial and temporal distribution of count sites, the AADT estimation process, the adjustment factor development and application processes, the assignment of counts to HPMS sample and/or universe sections, etc., should be included. Where significant deviation from the TMG guidelines is proposed for use, a comprehensive analysis demonstrating that the statistical reliability of the procedures will yield results that meet or exceed reliability levels prescribed in the TMG must be made, documented, and accepted by FHWA.

Quality Control for Counting Operations

The documentation should include an explanation of the steps taken to assure that the raw field data are accurate. If count or classification data are collected using manual procedures, the methods used by the State to assure that field crews were able to maintain a sufficiently high quality of data collection will be documented. If continuous count, coverage count or classification data are collected by machine, the documented field procedures will explain the methods used by the State to test equipment prior to its use, and periodically reassess machine accuracies. If no testing has been done, testing should be conducted during the following year. Retesting over a maximum 3-year cycle is recommended.

In addition to documenting its equipment testing procedures, the State should have a well described method for retaining the test results for each of its traffic monitoring machines. This documentation should include the accuracy of the machine as determined by the State and documented as follows:

- a. For counters using axle detectors, the percent of all axles that were sensed,
- b. For counters using vehicle detectors, the percent of all vehicles that were sensed,
- c. For automatic vehicle classifiers, the percent of all vehicles that were properly classified.

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Machines found to have large errors should be repaired or replaced. Maximum errors of 10 percent for portable counters and 2 percent for permanent counters are suggested. Classifiers should accurately classify 90 percent of all vehicles in the traffic stream. Coverage counts made by machines found to have excessive error are not to be used for HPMS, but should be replaced by counts estimated from a previous year count, factored for growth. Data from permanent counters or automatic classifiers with excessive error are not to be used.

Source Data Retention

There are to be clearly developed procedures for field data storage and retention. These procedures should ensure that the following data can be provided for each monitoring session:

- a. The count value or values collected in the field by the State and used as the basis for the value reported to the HPMS,
- b. The date on which each count was made,
- c. The location of the counting session,
- d. The hours during which the count took place, and
- e. The type/model of machine used.

Continuous Count Operations

The use of continuous count data is essential for converting coverage counts to AADT. The documentation of the continuous count program should indicate the number of continuous counters on the Interstate System and discretely identify the number on the rural and urban portions of the System. Whenever possible, the State should have at least one continuous counter on each one or two digit numbered route on the Interstate System. Further, there should be a minimum of three continuous counters on the rural portions of the Interstate System and three on the urban portions of the Interstate System. Similarly, there should be a minimum of three continuous counters on rural portions of non-Interstate System highways and three on urban portions of non-Interstate System highways. At a minimum, each continuous counter should have at least 14 full consecutive days of data for each month.

The methodology used by the State for assigning a coverage count to a particular continuous counter (or group of continuous counters) when assigning adjustment factors should be described. Maps with the location and identification number of the continuous counter or counters used for developing correction factors should be included.

Axle Correction Factors

Axle corrections will be necessary if the counting device uses axle sensors. If such devices are used, adjustments of the raw field count data must be made to equate axle counts to number of vehicles. Vehicle classification data is normally used to determine the average number of axles per vehicle. The documentation should illustrate that:

- a. The data is representative of the specific functional system.
- b. Each season of the year is represented in the development of the axle correction.
- c. The monitoring session durations are sufficient to account for the changes in vehicle mix from day to day. The Traffic Monitoring Guide recommends that vehicle classification sessions be of at least 48-hours duration. Data for less than 24 hours is insufficient for use.
- d. The total volume of vehicles observed is at least equal to that for an average day.
- e. Classification counts are well distributed among rural and urban locations. In the average State, system level correction factors would be based on 25 to 30 monitoring sessions for the rural Interstate and 35 to 40 sessions for the urban Interstate. These classification counts may have been spread over a 3-year period, but should include the current year as one of the three.
- f. There are sufficient categories to well represent vehicles with two to seven axles.
- g. The factor is updated annually.

Office Factoring Procedures

Office procedures are to be documented that clearly support the mathematical development and use of correction factors used in adjusting field counts to AADT's. This documentation and related discussion are to include factor derivation for month of the year, day of the week, axle adjustments, and growth. If the State makes other adjustments, these are also to be part of the documentation. The factors should be reevaluated annually. Tables should be available showing the month and day factors associated with each counter that is used to develop adjustment factors for coverage counts. The documentation of the development of axle corrections should show the number of axles assumed for each vehicle type in the State's vehicle classification scheme. The description of growth factors should include the factor calculation process and the data source(s) for such variables.

The process of rounding used in the AADT calculation should be documented. For example, it is recommended that all AADT's be rounded to hundreds and that all decimals in factors be rounded to two places after the decimal.

APPENDIX L

HIGHWAY CAPACITY IN HPMS SUBMITTAL SOFTWARE

RURAL CAPACITY

The procedures used in the HPMS submittal software for calculating highway capacity generally conform to the 1985 Highway Capacity Manual (HCM). The capacity calculations are based on service flow rates for level of service E. The procedures for general terrain are used. All references to chapters, tables, etc., are to the HCM. These tables are not reproduced in this Appendix. Assumptions for situations not explicitly covered in the HCM are given below.

For 3-lane highways, it is assumed that one direction is used as a single lane without passing, and the opposite direction has 2 lanes, allowing passing. The direction with one lane is analyzed as one direction of a 2-lane highway with no passing opportunities. The direction with 2 lanes is analyzed as one direction of a 2-lane with 100 percent passing sight distance.

For highways with odd numbers of lanes greater than 3, the odd lane is dropped and the capacity calculation is entered with the even number of lanes.

For one-way 1-lane sections, 2-lane capacity is used with a directional factor of 1.0. For one-way multilane sections, the capacity is calculated as one direction of a multilane highway. Obstructions on both sides are used for determining the lateral clearance factor.

Sections with dense rural development (when data item #71 is coded "2") are treated like other rural sections for capacity calculations (see note page L-5). For multilane highways, a factor for suburban development is used. The State should code the capacity for all sections with dense rural development where rural procedures would not give the correct capacity. The timing of such entries should be after calculations are made (SELCALC option), since these capacity values would be replaced any time a calculation computer run is made.

Shoulder width is used as the lateral clearance for entering the tables of adjustments for restricted lane width and lateral clearance. For 2-lane highways, right shoulder width is used. For multilane undivided highways, right shoulder width is used as the clearance to an obstruction on one side of the roadway. For divided multilane highways, including freeways, the average width of both left and right shoulders is used as the clearance to

obstructions on both sides of the roadway. This is done when the median is curbed (median type code 1) or when the median is unprotected (median type code 3). If there is a barrier median (median type code 2), right shoulder width only is used as the clearance to an obstruction on one side of the roadway.

TWO-LANE HIGHWAYS

For rural 2-lane highways, the following procedure from Chapter 8 is used:

$$SF = 2800 * v/c * fD * fW * fHV$$

Where: SF = service flow (actual capacity)
v/c = (service flow)/(ideal capacity), Table 8-1, for level of service (LOS) E
fD = adjustment for directional distribution, Table 8-4
fW = adjustment factor for lane width and lateral clearance, Table 8-5, LOS E; right shoulder width is used for lateral clearance
fHV = adjustment factor for trucks from the equation below

$$fHV = 1/[1+Pt(Et-1) + Pr(Er-1)]$$

Where: Pt = percent trucks (decimal)
Et = passenger car equivalent for trucks, Table 8-6, using LOS E
Pr = percent recreational vehicles:
For arterials, Pr = 0.04
For collectors, Pr = 0.0
Er = passenger car equivalent for recreational vehicles, Table 8-6, using LOS E

The term for busses is omitted, assuming zero percent busses.

THREE-LANE HIGHWAYS

For rural 3-lane highways, the following procedure is adapted from the 2-lane procedures in Chapter 8. The 4800 base service flow is used assuming that one direction of travel has a base service flow of 2800 (100 percent passing opportunity) and the opposing direction of travel has a base service flow of 2000 (no passing opportunities).

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$$SF = 4800 * v/c * fd * fw * fhv$$

Where: v/c = average of the two v/c values from Table 8-1.
(LOS E) using (1) no passing sight distance and
(2) 100 percent passing sight distance

All other terms in the equations are the same as for
2-lane highways.

MULTILANE (Divided and undivided)

For rural multilane highways, the following procedure from
Chapter 7 is used.

$$SF = MSF * N * fw * fhv * fe * fp$$

Where: SF = service flow (actual capacity)
 MSF = maximum service flow rate per lane, Table 7-1.
For 55 mph or greater average highway speed,
 $MSF = 2000$; For less than 55 mph, $MSF = 1900$
 N = number of lanes in one direction
 fw = adjustment factor for lane width and lateral
clearance, Table 7-2
 fhv = adjustment factor for trucks from equation below
 fe = adjustment factor for type of development
and type of highway uses Table 7-10; for rural
dense development, the suburban factor is used.
 fp = adjustment factor for type of driver population,
Table 7-11; the value 0.90 is used.

$$fhv = 1/[1+Pt(Et-1) + Pr(Er-1)]$$

Where: Pt = percent trucks (decimal)
 Et = passenger car equivalent for trucks, Table 7-3,
using LOS E
 Pr = percent recreational vehicles
For arterials, $Pr = 0.04$
For collectors, $Pr = 0.0$
 Er = passenger car equivalent for recreational
vehicles, Table 7-3, using LOS E

The term for busses is omitted, assuming zero percent busses.

FREEWAYS

For freeways, the following procedure from Chapter 3 is used. Freeways are divided highways with full control of access.

$$SF = MSF * N * fw * fhv * fp$$

Where: SF = service flow (actual capacity)
MSF = maximum service flow rate per lane, Table 3-1.
For 55 mph or greater average highway speed,
MSF = 2000; For less than 55 mph, MSF = 1900
N = number of lanes in one direction
fw = adjustment factor for lane width and lateral
clearance, Table 3-2
fhv = adjustment factor for trucks, from equation
below
fp = adjustment factor for the character of the
traffic stream, Table 3-10; the value 0.90 is
used.

$$fhv = 1/[1+Pt(Et-1) + Pr(Er-1)]$$

Where: Pt = percent trucks (decimal)
Et = passenger car equivalent for trucks, Table 8-6,
LOS E
Pr = percent recreational vehicles
For arterials, Pr = 0.04
For collectors, Pr = 0.0
Er = passenger car equivalent for recreational
vehicles, Table 3-3, using LOS E

The term for busses is omitted, assuming zero percent busses.

ONE-WAY HIGHWAYS

One-lane highways:

For 1-lane one-way highways the following procedure is adapted from Chapter 8. The equation for 2-lane highways is used with a directional factor always equal to 1.0.

$$SF = 2800 * v/c * fd * fw * fhv$$

Where: SF = service flow (actual capacity)
v/c = (service flow)/(ideal capacity), Table 8-1, for
LOS E
fd = adjustment for directional distribution,
Table 8-4

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fW = adjustment factor for lane width and lateral clearance, Table 8-5, LOS E; right shoulder width is used for lateral clearance
fHV = adjustment factor for trucks from the equation below

$$fHV = 1/[1+Pt(Et-1) + Pr(Er-1)]$$

Where: Pt = percent trucks (decimal)
Et = passenger car equivalent for trucks, Table 8-6, using LOS E
Pr = percent recreational vehicles
For arterials, Pr = 0.04
For collectors, Pr = 0.0
Er = passenger car equivalent for recreational vehicles, Table 8-6, using LOS E

The term for busses is omitted, assuming zero percent busses.

Two or more lanes:

For one-way highways with 2 or more lanes, multilane procedures from Chapter 7 are used.

$$SF = MSF * N * fW * fHV * fE * fP$$

Where: All terms in the equation are the same as for multilane highways. Shoulder width is used for lateral clearance. The average of right and left shoulder widths is used as the clearance to obstructions on both sides for entering Table 7-2.

URBAN CAPACITY

Urban capacity procedures are not included in the HPMS submittal software. Urban capacities are to be coded by the State.

APPENDIX M

EDIT SPECIFICATIONS FOR HPMS DATA

DATA ITEM	EDIT PERFORMED 1/
1 - State Control Field	No edit.
2 - Year	Must equal the last two digits of the inventory data year coded on the user parameter card.
3 - State Code	Must match the State code on the user parameter card.
4 - County Code	Must contain a nonzero numeric value.
5 - Rural/Urban Designation	Must be a "1", "2", or "3".
6 - Urbanized Area Code	Must be numeric. a. If a rural or small urban section (Item 5 = 1 or 2), item reserved for State use, no edit. b. If an urbanized section (Item 5 = 3), positions 109 and 110 must be 00 or 11 - 20; positions 111 - 113 must be 001 to 400.
7 - Type of Section ID	Must contain a value from 1 to 4. a. If functional class is Interstate (Item 9 = 01 or 11), type of section ID must equal "1" (route-milepoint). b. If non-Interstate sample section, type of section ID must equal "1" or "2" (route-milepoint or A-node, B-node, segment).
8 - Section Identification	Must be nonzero alphanumeric and be unique countywide. If type of section is route-milepoint (Item 7 = 1), the milepoint field must be numeric.

1/ When data items do not apply, zero fill.

DATA ITEM	EDIT PERFORMED														
9 - Functional System	Must contain one of the following: Rural (Item 5 = 1): "01", "02", "06", "07", "08", or "09". Urban (Item 5 = 2 or 3): 11 thru 17 or "19". If sample section, must not be "09" or "19".														
10 - Generated Functional System Code (No Edit)	Generated by the calculation software. The two-positional functional system code (Item 9) is converted to a one-positional code for matrix use in the FHWA software and placed on the data record. The conversions are as follows: <table><thead><tr><th><u>Item 9</u></th><th><u>Item 10</u></th></tr></thead><tbody><tr><td>01, 11</td><td>1 (Interstate)</td></tr><tr><td>02, 12, 13</td><td>2 (Principal Arterial; Other Freeways or Expressways)</td></tr><tr><td>06, 14, 15</td><td>3 (Minor Arterial; Other Principal Arterial)</td></tr><tr><td>07, 16</td><td>4 (Major Collector; Minor Arterial)</td></tr><tr><td>08, 17</td><td>5 (Minor Collector; Collector)</td></tr><tr><td>09, 19</td><td>6 (Local)</td></tr></tbody></table>	<u>Item 9</u>	<u>Item 10</u>	01, 11	1 (Interstate)	02, 12, 13	2 (Principal Arterial; Other Freeways or Expressways)	06, 14, 15	3 (Minor Arterial; Other Principal Arterial)	07, 16	4 (Major Collector; Minor Arterial)	08, 17	5 (Minor Collector; Collector)	09, 19	6 (Local)
<u>Item 9</u>	<u>Item 10</u>														
01, 11	1 (Interstate)														
02, 12, 13	2 (Principal Arterial; Other Freeways or Expressways)														
06, 14, 15	3 (Minor Arterial; Other Principal Arterial)														
07, 16	4 (Major Collector; Minor Arterial)														
08, 17	5 (Minor Collector; Collector)														
09, 19	6 (Local)														

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DATA ITEM	EDIT PERFORMED
11 - Federal-Aid System	<p>Rural: Must contain a "1", "2", "4", or "8".</p> <ul style="list-style-type: none">a. If F.C. (Item 9) equals "01", then this item must equal "1".b. If F.C. equals "02", then this item must equal "2" or "8".c. If F.C. equals "06", then this item must equal "2" or "8".d. If F.C. equals "07", then this item must equal "4" or "8".e. If F.C. equals "08" or "09", then this item must equal "8". <p>Urban: Must contain a "1", "2", "3", or "8".</p> <ul style="list-style-type: none">a. If F.C. (Item 9) equals "11", then this item must equal "1".b. If F.C. equals 12 thru 16, then this item must equal "2", "3", or "8".c. If F.C. equals "17", then this item must equal "3" or "8".d. If F.C. equals "19", then this item must equal "8".
12 - Federal-Aid System Status	<p>If non-Federal-aid open to traffic (Item 12 = 8), this item must equal "8".</p> <p>Must contain a "1", "2", or "8". If non-Federal-aid (Item 11 = 8), this item must equal "8".</p> <p>If sample section, Item 23 contains a "1" in position 159, this item must be coded "1" or "8".</p>
13 - Route Signing	<p>Must contain a value from 0 to 7. If Interstate (Item 9 = 01 or 11), this item must equal "1". If this item equals "1" then functional system (Item 9) must be coded 01 or 11 and Federal-aid system (Item 11) must be coded 1.</p>
14 - Route Number	<p>If Interstate (Item 9 = 01 or 11), this item must be nonzero alphanumeric.</p>

DATA ITEM	EDIT PERFORMED
15 - Governmental Level of Control	Must contain a "01", "02", "03", "04", "11", "12", "21", "25", "26", "31", "32", "60", "62", "64", "66", "68", or "70". If this item equals "26", Items 11 and 12 must equal "8".
16 - Special Systems	Must contain a "01" thru "06", "10", "15", "20", "25", "30", "40", "41", or "42". a. If 139(a) mileage (Item 16 = 40) then the functional system must be Interstate (Item 9 = 01 or 11) and Federal-aid system must be Interstate (Item 11 = 1). b. If 139(b) mileage (Item 16 = 42), then must be Federal-aid primary (Item 11 = 2). c. If 139(b) mileage (Item 16 = 42), then functional system (Item 9) must be coded "02" or "06" if rural; or coded "12", "14" or "16", if urban.
17 - Type of Facility	Must contain a "1" or "2".
18 - Designated Truck Route/ Parkway	Must contain a "1", "2", "3" or "4".
19 - Toll	Must contain a "1", "2", "3" or "4". Toll segment under Secretarial Agreement (Item 19 = 3, 4) must be coded Interstate (Item 9 = 01 or 11).
20 - Section/Group Length	Must contain a nonzero numeric entry.
21 - AADT	Must be numeric. a. If an Interstate section (Item 9 = 01 or 11) and open to traffic (Item 12 = 1), this item must be nonzero. b. If a non-Interstate sample section, this item must be nonzero.

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DATA ITEM	EDIT PERFORMED
22 - Number of Through Lanes	Must be numeric. If Interstate open to traffic (item 12 - 1) or non-Interstate sample section: a. This item must be nonzero. Rural: Should contain a value from 01 to 10. Urban: Should contain a value from 01 to 14. b. If type of facility is two-way (item 17 = 2), and paved section (item 28 > 50) must be two or more lanes.
23 - Record Continuation Code	Must be numeric. a. If the continuation code contains "00000", this must be a universe section with items 1-22 coded. c. If the continuation code contains a "1" in the first position (position 159) of this field, this must be a sample section with items 1 thru 76 coded where applicable. Record length is 427 plus the sum of the following: (1) If positions 160-161 are nonzero, add value times 15. (2) If positions 162-163 are nonzero, add value times 7. Maximum record length is 1,282 digits.
24 - Sample Number	Must be a nonzero alphanumeric entry, unique count;wide.
25 - Sample Subdivision	Must be numeric.
26 - AADT Volume Group Identifier	Must be nonzero numeric for sample sections. For FHWA Standard Sample Design, AADT's must correspond to ranges specified in Appendix F and this item must contain a value from 01 thru 13.
27 - Expansion Factor	Must be nonzero numeric and contain a value of 001000 thru 100000.

DATA ITEM	EDIT PERFORMED
28 - Surface/Pavement Type	Must contain one of the following: "20", "30", "40", "51", "52", "53", "61", "62", "71", "72", "73", "74", "75", "76" or "80". If Interstate (item 9 = 01 or 11), this item should contain a value of "61", "62", "71", "72", "73", "74", "75" or "76".
29 - Concrete Joint Spacing	Must be numeric. If this item is > 00, the surface type (item 28) must be portland cement concrete, coded 71-76.
30 - Load Transfer Devices	Must be 0, 1 or 2. If Interstate, Other Freeways/Expressways or Other Principal Arterial and surface type (item 28) is coded "71" or "72", then this item must be "1" or "2". If surface type (item 28) is coded "51", "52", "53", "61" or "62", then this item must be coded "0".
31 - Pavement Section	If a paved section (item 28 > 50), this item must contain a value from 1 to 5. If surface/pavement type is "rigid" (item 28 = 71, 72, 73, 74, 75 or 76), this item must be a 2 thru 5. If surface/pavement type is "flexible" (item 28 = 51, 52, 53, 61, 62 or 80), this item must be a "1", "3", "4", or "5". If Interstate, Other Freeways/Expressways or Other Principal Arterial, this item must be "1" or "2". If an unpaved section (item 28 < 50) it must contain "0".

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DATA ITEM	EDIT PERFORMED
32 - Structural Number or Slab Thickness	Must be numeric. a. If structural number is known (Item 31 = 1), this item should contain a value from 10 to 70. b. If thickness is known (Item 31 = 2), this item should contain a value from 06 to 14. c. If Item 31 does not contain "1" or "2", this item must contain "00". d. If Interstate, Other Freeways/Expressways or Other Principal Arterial, this item must <u>not</u> be coded "00".
33 - Type of Base	Must be 0, 1, 2, 3, 5, 8 or 9. If Interstate, Other Freeways/Expressways or Other Principal Arterial, then this item must <u>not</u> be coded "0".
34 - Type of Subgrade	Must be 0, 1, 2 or 5. If Interstate, Other Freeways/Expressways or Other Principal Arterial, then this item must be coded "1", "2" or "5".
35 - Subsurface Drainage	Must be 0, 1, 2, 3, 4 or 5. If Interstate, Other Freeways/Expressways or Other Principal Arterial, then this item must be coded "1", "2", "3", "4" or "5".
36 - Measured Roughness	Must be numeric. a. If surface type is unpaved (Item 28 < 50), this item must be coded "000". b. This item must be greater than zero for all paved (Item 28 > 50) rural arterials. c. This item must be greater than zero for urban Interstate and Other Freeways/Expressways.
37 - Reserved for Federal Use	Must contain zeroes.

DATA ITEM	EDIT PERFORMED
38 - Pavement Condition	If a paved section (Item 28 > 50), this item must contain a value from 01 to 50. Otherwise, it must contain "00".
39 - Overlay or Pavement Thickness	Must be numeric. If this item is greater than zero, then year of surface improvement (Item 40) and type of improvement (Item 41) must <u>not</u> be coded zero.
40 - Year of Surface Improvement	Must be numeric. If this item is <u>not</u> coded zero, then overlay or pavement thickness (Item 39) and type of improvement (Item 41) must <u>not</u> be coded zero.
41 - Type of Improvement	Must be 00, 10, 20, 31, 32, 33, 34, 35, 40, 50, 60, 71, 72, 77 or 78. If this item is not = 40, 50 or 60, then year of surface improvement (Item 40) and overlay or pavement thickness (Item 39) must <u>not</u> be coded zero.
42 - Access Control	Must contain a value of "1", "2", or "3". If Interstate (Item 9 = 01 or 11), full control of access should exist (this item = 1).
43 - Lane Width	Must be numeric and should contain a value from 06 to 18.
44 - Shoulder Type	Must contain a value from 1 to 8.

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DATA ITEM	EDIT PERFORMED
45 - Shoulder Width	Must be numeric and should contain a value from 00 to 12.
a. Right Shoulder:	a. If shoulder exists (item 44 = 2 through 7), this item must be greater than "00".
	b. If curbed or no shoulder exists (item 44 = 1 or 8), this item must contain "00".
b. Left Shoulder:	If no median exists, this item must contain "00". Otherwise, left shoulder should contain a value from 00 to 12.
46 - Median Type	Must contain a value from 1 to 4.
47 - Median Width	Must contain a numeric value from 00 to 99.
	a. If a median exists (item 46 = 1, 2, or 3), median width must be greater than zero and must be greater than or equal to twice the left shoulder width (item 45b).
	b. If no median exists (item 46 = 4), this item must be equal to "00".
48 - Existing Right-of-Way Width	Must be nonzero numeric.
	a. If median width (item 47) > 00, then this item must contain a value greater than or equal to the number of lanes times lane width, plus right shoulder widths, plus median width.
	b. Otherwise, this item must contain a value greater than or equal to the number of lanes times lane width, plus shoulder widths, left and right.
49 - Is Widening Feasible?	Must contain a value from 1 to 5.
50 - Horizontal Alignment Adequacy (Rural Data Item) (Calculated based on curve data for <u>all</u> paved rural sections.)	Must contain a value from 0 to 4. If a paved rural section, this item must contain a value from 1 to 4. If curves are not reported for a paved rural section and the coded value is "0", a "2" will have been inserted in this field.

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DATA ITEM	EDIT PERFORMED
51 - Curves By Class	<p>Must contain a nonzero numeric entry for at least one curve class for all paved (item 28 > 50) rural arterials (item 9 = 01, 02 or 06) and all paved urban principal arterials (item 9 = 11 to 15). Otherwise, may be zero filled.</p> <p>The number of curve fields and curve length fields must contain a numeric value for each curvature class.</p> <ol style="list-style-type: none">If the number of curves is greater than zero, the corresponding curve length field must contain a nonzero numeric value.If the number of curves equals "00", the corresponding curve length field must contain "00000".The sum of the curve length fields must equal the section length.
52 - Vertical Alignment Adequacy (Rural Data Item) (Calculated based on grade data for <u>all</u> paved rural sections.)	<p>Must contain a value from 0 to 4. If a paved rural section, must contain a value from 1 to 4.</p> <p>If grades are not reported for a paved rural section and the coded value is "0", a "2" will have been inserted in this field.</p>
53 - Grades By Class	<p>Must contain a nonzero numeric entry for at least one grade class for all paved (item 28 > 50) rural arterials (item 9 = 01, 02, or 06) and all paved urban principal arterials (item 9 = 11 to 15). Otherwise, may be zero filled.</p> <p>The number of grade fields and grade length fields must contain a numeric value for each grade class.</p> <ol style="list-style-type: none">If the number of grades is greater than zero, the corresponding grade length field must contain a nonzero numeric value.If the number of grades equals "00", the corresponding grade length field must contain "00000".The sum of the grade length fields must equal the section length.

M-11

DATA ITEM	EDIT PERFORMED
54 - Percent of Length with Sight Distance equal to or greater than 1500 Feet (Rural Data Item)	Must be numeric. If coded, must be equal to or less than 100.
55 - Speed Limit	Must be a nonzero numeric value from 10 to 65. If within urbanized area, should be 55, or less.

56 - Weighted Design Speed	Must be numeric. If a paved (Item 28 > 50) rural collector (Item 9 = 07 or 08) with type of development rural (Item 71 = 1) and <u>if curves are not reported</u> , this item must contain a value from 35 to 70.
(Calculated from curve data.)	Rural: For all paved arterials and for paved rural collectors with type of development rural (Item 64 = 1), this item must contain a value from 35 to 70. Otherwise, it should be "00". Urban: If an urban Interstate or a freeway or expressway by design type, this item must contain a value from 35 to 70. Otherwise, it must contain a "00".

Calculation procedure is the same as outlined in Appendix D.

If curve data are not reported and a value of "00" has been coded, default values will be inserted as follows:

Rural by functional system (Item 9) and type of terrain (Item 70);

Item 9	Item 70 Coded:		
	1	2	3
01	70	70	70
02	70	70	65
06	70	65	60
07	60	55	45
08	55	50	45

Urban Interstate, "70"; Freeways and Expressways by design type, "65".

M-12

DATA ITEM	EDIT PERFORMED
57 - Percent Commercial Vehicles: a. Peak b. Off-Peak	Must be numeric and should contain a value less than or equal to "40". Must be numeric and should contain a value less than or equal to "45".
58 - K-Factor	Must be numeric and should contain a value from 01 to 24.
59 - Directional Factor	Must be nonzero numeric. If one-way (Item 17 = 1), this item must contain "100". Otherwise, it should contain a value from 050 to 075.
60 - Peak Capacity	Urban: Must contain a nonzero numeric entry. a. Maximum Capacity (service flow): One-Way (Item 17 = 1): Should contain a value less than or equal to the number of lanes (Item 22) times 1,600. For example, the maximum capacity for a two-lane, one-way street would be 3,200 vehicles per hour. It is highly unlikely that this figure would be exceeded. Two-Way (Item 17 = 2): The capacity applies to one direction but the edit check utilizes all lanes of the two-way roadway. The capacity should contain a value less than or equal to the number of lanes (Item 22) times 1,000. For example, the maximum capacity for a four-lane city street should not exceed 4,000 vehicles per hour in one direction. It is highly unlikely that this figure would be exceeded.

M-13

DATA ITEM

EDIT PERFORMED

60 - Peak Capacity (Cont.)

- b. Minimum Capacity (service flow):
For two-way (item 17 = 2), multilane (item 22 > 3) sections with full or partial access control (item 42 = 1 or 2) and no at-grade intersections (sum of items 74a, 74b, and 74c = 0), should contain a value > or = the number of lanes (item 22) times 450. For all others, should contain a value > or = the number of lanes (item 22) times 150.

(The calculation procedure for rural sections is outlined in Appendix L.)

Rural: If capacity not reported, must contain "000000" and capacity will be calculated from inventory data (for paved facilities only). If capacity is reported, it must be nonzero numeric and meet the following conditions:

- a. Maximum Capacity (service flow):
One-Way: Should contain a value less than or equal to the number of lanes (item 22) times 2,000.
Two-Way: (1) If the number of lanes (item 22) equals "2", it should contain a value < or = 2,800.
(2) If the number of lanes (item 22) equals "3", it should contain a value < or = 4,800.
(3) Multilane -- it should contain a value < or = the number of lanes (item 22) times 1,000. For example, the maximum capacity in one direction for a four-lane facility (item 26 = 4) is 4 times 1,000 or 4,000 vehicles per hour (2,000 per lane in one direction).
- b. Minimum Capacity (service flow):
Should contain a value > or = the number of lanes (item 22) times 450 for flat terrain (item 70 = 1) or times 300 for rolling terrain (item 70 = 2) or times 175 for mountainous terrain (item 70 = 3).

DATA ITEM	EDIT PERFORMED
61 - Volume-to-Service Flow (V/SF) Ratio: Equations for V/SF ratio: Rural 2 or 3 lanes: $V/SF = [AADT \text{ (item 21)} \times K\text{-Factor (item 58)}] / \text{Peak-Hour Capacity (item 60)}$ Rural Multilane and all Urban Sections: $V/SF = [AADT \text{ (item 21)} \times K\text{-Factor (item 58)} \times \text{Direction Factor (item 59)}] / \text{Peak-Hour Capacity (item 60)}$	Should be a value less than 1.50.
62 - Turning Lanes (Urban Data Item)	Left: Must be numeric value 0 to 5. If the number of intersections (item 74) is all zeroes, this item must be zero. If number of intersections (item 74) > 0, this item must be coded 1-5. Right: Must be numeric value 0 to 5. If the number of intersections (item 74) is all zeroes, this item must be zero. If number of intersections (item 74) > 0, this item must be coded 1-5.
63 - Prevailing Type of Signalization (Urban Data Item)	Must contain a value from 1 to 4. If signals are reported on this section (item 74a > 00), this item must contain a value from 1 to 3. Otherwise, it must contain a "4".
64 - Typical Peak Percent Green Time (Urban Data Item)	Must contain a numeric value and should be less than "86". If signalized intersections are reported for this section (item 74a > 00), this item must be greater than "00".
65 - Peak Parking (Urban Data Item)	Must contain a value from 1 to 3.

M-15

DATA ITEM	EDIT PERFORMED
66 - Future AADT	Must contain a nonzero numeric value. The future AADT is compared with the current AADT (Item 21). It is flagged to be checked if: a. The growth is 4 times or more when compared to the current AADT. b. The growth is less than or equal to .4 when compared to the current AADT.
67 - Year of Future AADT	Must contain a numeric value (last two digits of the forecast year) that is at least 17 years beyond the inventory year and less than or equal to 22 years from the inventory year.
68 - General Climate Zone	Must be a numeric value from 01 to 09.
69 - Drainage Adequacy	Must contain a value from 1 to 3.
70 - Type of Terrain (Rural Data Item)	Must contain a value from 1 to 3.
71 - Type of Development (Rural Data Item)	Must contain a "1" or "2".
72 - Urban Location (Urban Data Item)	Must contain a value from 1 to 5.
73 - Number of Grade-Separated Interchanges	Must contain a numeric value.
74 - Number of At-Grade Intersections	
a. Signals	Must be numeric. If full access control (item 42 = 1), this item must equal "00".
b. Stop Signs	Must be numeric. If full access control (item 42 = 1), this item must equal "00".
c. Other or No Controls	Must be numeric. If full access control (item 42 = 1), this item must equal "00".

DATA ITEM	EDIT PERFORMED
75 - Number of Structures	Must be numeric less than "51".
76 - Number of At-Grade Railroad Crossings	Must be numeric less than "16". If full access control (item 42 = 1), this item must equal "00".
77 - Structure Identification Numbers	Must be alphanumeric. The number of ID's provided must equal the number of structures reported in item 75.
78 - At-Grade Railroad Crossing Identification Numbers	The first six positions of each crossing ID must be a numeric value. The seventh character must be alphabetic. The number of ID's provided must equal the number of railroad crossings reported in item 76.

APPENDIX N

BATTERY OF SUMMARY TABLES FROM THE HPMS SUBMITTAL SOFTWARE

<u>Table Number</u> *	<u>Title</u>	<u>Data Set</u>
1	System Mileage and Travel (In Thousands) by Type Facility and Functional System	Rural, Urban
2	Lane Miles by Type Facility and Functional System	Rural, Urban
3	Paved Mileage and Travel (In Thousands) by Terrain Type and Weighted Design Speed	Rural
4,3	System Paved Miles and Peak Hour Travel (In Thousands) by Volume Service Flow Ratio and Development	Rural, Urban
5,4	Paved Mileage and Travel (In Thousands) by Shoulder Width and Shoulder Type	Rural, Urban
6,5	Paved Mileage and Travel (In Thousands) by Pavement Condition and Pavement Type	Rural, Urban
7,6	Mileage and Travel (In Thousands) by Lane Width	Rural, Urban
8	Paved Mileage and Travel (In Thousands) by Functional System and Horizontal Alignment Adequacy	Rural
9	Paved Mileage and Travel (In Thousands) by Functional System and Vertical Alignment Adequacy	Rural

* Where two table numbers are shown, the number to the left refers to the rural table while the one to the right refers to the urban table.

APPENDIX O

CARD FORMATS TO ADD NEW HPMS SECTIONS

Transaction Code "N" (New)

The number of cards required to add a section depends on the type of section being added.

Leading zeroes must be coded. All nonapplicable data items on a card type must be zero-filled.

Universe Section

All universe sections added must have card type 1, and card type 2, and card type 3 (card layouts follow).

Sample Section

All sample sections must have card types 1-5. All nonapplicable data items for a section should be zero-filled. Card types 6-9 are:

- Curve Data (Card Type 6)
- Grade Data (Card Type 7)
- Structure ID's (Card Type 8)
- At-grade Crossing ID's (Card Type 9)

Only the appropriate card types 6-9 should be coded for the section.

1/ UNIVERSE SECTION (Type Section "1")

	<u>Length</u>	<u>Column</u>
Transaction Code: Code "N"	1	1
Card Type: Code "1"	1	2
County Code (Item 4)	3	3-5
Section ID (Item 8)	12	6-17
State Control Field (Item 1), First 50 Characters	50	18-67
Blank (these columns must be blank)	12	68-79
Type of section being added (Universe always code "1")	1	80

Transaction Code: Code "N"	1	1
Card Type: Code "2"	1	2
County Code (Item 4)	3	3-5
Section ID (Item 8)	12	6-17
State Control Field (Item 1), Second 50 Characters	50	18-67
Blank (these columns must be blank)	13	68-80

NOTE: Card type "1" and card type "2" must be included for all universe sections. Whether none, part or all 100 characters are being used, include the cards, but leave unused portions blank.

Transaction Code: Code "N"	1	1
Card Type: Code "3"	1	2
County Code (Item 4)	3	3-5
Section ID (Item 8)	12	6-17
Year (Item 2)	2	18-19
State Code (Item 3)	2	20-21
Rural/Urban Designation (Item 5)	1	22
Urbanized Area Code (Item 6)	5	23-27
Type of Section/Grouped Data ID (Item 7)	1	28
Functional System (Item 9)	2	29-30
Federal-Aid System (Item 11)	1	31
Federal-Aid System Status (Item 12)	1	32
Route Signing (Item 13)	1	33
Route Number (Item 14)	5	34-38
Governmental Level of Control (Item 15)	2	39-40
Special Systems (Item 16)	2	41-42
Type of Facility (Item 17)	1	43
Designated Truck Route/Parkway (Item 18)	1	44
Toll (Item 19)	1	45
Section/Group Length (Item 20)	6	46-51
AADT (Item 21)	6	52-57
Number of Through Lanes (Item 22)	2	58-59
Blank (These columns must be blank)	21	60-80

1/ All non-applicable data items for a section should be zero-filled.

0-3

1/ SAMPLE SECTION (Type Section "2")

	<u>Length</u>	<u>Column</u>
Transaction Code: Code "N"	1	1
Card Type: Code "1"	1	2
County Code (Item 4)	3	3-5
Section ID (Item 8)	12	6-17
State Control Field (Item 1), First 50 Characters	50	18-67
Blank (these columns must be blank)	12	68-79
Type of section being added (Sample always code "2")	1	80

Transaction Code: Code "N"	1	1
Card Type: Code "2"	1	2
County Code (Item 4)	3	3-5
Section ID (Item 8)	12	6-17
State Control Field (Item 1), Second 50 Characters	50	18-67
Blank (these columns must be blank)	13	68-80

NOTE: Card type "1" and card type "2" must be included for all sample sections. Whether none, part or all 100 characters are being used, include the cards, but leave unused portions blank.

Transaction Code: Code "N"	1	1
Card Type: Code "3"	1	2
County Code (Item 4)	3	3-5
Section ID (Item 8)	12	6-17
Year (Item 2)	2	18-19
State Code (Item 3)	2	20-21
Rural/Urban Designation (Item 5)	1	22
Urbanized Area Code (Item 6)	5	23-27
Type of Section/Grouped Data ID (Item 7)	1	28
Functional System (Item 9)	2	29-30
Federal-Aid System (Item 11)	1	31
Federal-Aid System Status (Item 12)	1	32
Route Signing (Item 13)	1	33
Route Number (Item 14)	5	34-38
Governmental Level of Control (Item 15)	2	39-40
Special Systems (Item 16)	2	41-42
Type of Facility (Item 17)	1	43
Designated Truck Route/Parkway (Item 18)	1	44
Toll (Item 19)	1	45
Section/Group Length (Item 20)	6	46-51
AADT (Item 21)	6	52-57
Number of Through Lanes (Item 22)	2	58-59
Blank (These columns must be blank)	21	60-80

1/ All non-applicable data items for a section should be zero-filled.

1/ SAMPLE SECTION (Cont.)

	<u>Length</u>	<u>Column</u>
Transaction Code: Code "N"	1	1
Card Type: Code "4"	1	2
County Code (Item 4)	3	3-5
Section ID (Item 8)	12	6-17
Sample Number (Item 24)	12	18-29
Sample Subdivision (Item 25)	1	30
AADT Volume Group Identifier (Item 26)	2	31-32
Expansion Factor (Item 27)	6	33-38
Surface/Pavement Type (Item 28)	2	39-40
Concrete Joint Spacing (Item 29)	2	41-42
Load Transfer Devices (Item 30)	1	43
Pavement Section (Item 31)	1	44
SN (Structural Number) or D (Slab Thickness)	2	45-46
Type of Base (Item 33)	1	47
Type of Subgrade (Item 34)	1	48
Subsurface Drainage (Item 35)	1	49
Measured Pavement Roughness (Item 36)	3	50-52
Pavement Condition (PSR) (Item 38)	2	53-54
Overlay or Pavement Thickness (Item 39)	3	55-57
Year of Surface Improvement (Item 40)	4	58-61
Type of Improvement (Item 41)	2	62-63
Access Control (Item 42)	1	64
Lane Width (Item 43)	2	65-66
Shoulder Type (Item 44)	1	67
Shoulder Width; Right (Item 45-A)	2	68-69
Left (Item 45-B)	2	70-71
Median Type (Item 46)	1	72
Median Width (Item 47)	2	73-74
ROW Width (Item 48)	3	75-77
Widening Feasibility (Item 49)	1	78
Blank (These columns must be blank)	2	79-80

1/ All non-applicable data items for a section should be zero-filled.

1/ SAMPLE SECTION (Cont.)

	<u>Length</u>	<u>Column</u>
Transaction Code: Code "N"	1	1
Card Type: Code "5"	1	2
County Code (Item 4)	3	3-5
Section ID (Item 8)	12	6-17
Horizontal Alignment Adequacy (R) (Item 50)	1	18
Vertical Alignment Adequacy (R) (Item 52)	1	19
% Passing Sight Distance (R) (Item 54)	3	20-22
Speed Limit (Item 55)	2	23-24
Weighted Design Speed (R) (Item 56)	2	25-26
Percent Commercial Vehicles: Peak (Item 57-A)	2	27-28
Off-Peak (Item 57-B)	2	29-30
K-Factor (Item 58)	2	31-32
Directional Factor (Item 59)	3	33-35
Peak Capacity (Item 60)	5	36-40
Turning Lanes: Left (U) (Item 62-A)	1	41
Right (U) (Item 62-B)	1	42
Prevailing Signalization (U) (Item 63)	1	43
Typical Percent Green Time (U) (Item 64)	2	44-45
Peak Parking (U) (Item 65)	1	46
Future AADT (Item 66)	6	47-52
Year of Future AADT (Item 67)	2	53-54
Drainage Adequacy (Item 69)	1	55
Type of Terrain (R) (Item 70)	1	56
Type of Development (R) (Item 71)	1	57
Urban Location (U) (Item 72)	1	58
Number of Grade-Separated Interchanges (Item 73)	2	59-60
Number of At-Grade Intersections: Signals (Item 74-A)	2	61-62
Stop Signs (Item 74-B)	2	63-64
Other or No Controls (Item 74-C)	2	65-66
Number of Structures (Item 75)	2	67-68
Number of At-Grade Railroad Crossings (Item 76)	2	69-70
Blank (These columns must be blank)	10	71-80

NOTE: R: Rural Data Item
 U: Urban Data Item

1/ All non-applicable data items for a section should be zero-filled.

SAMPLE SECTION (Cont.)

	<u>Length</u>	<u>Column</u>
Transaction Code: Code "N"	1	1
Card Type: Code "6"	1	2
County Code (Item 4)	3	3-5
Section ID (Item 8)	12	6-17
Curves by Class (Item 51):		
Curve Card Number: Code "1"	1	18
Curve Classes:		
Degree of Curvature	No. of Curves & Total Length	
a. 0.0 - 0.4	7	19-25
b. 0.5 - 1.4	7	26-32
c. 1.5 - 2.4	7	33-39
d. 2.5 - 3.4	7	40-46
e. 3.5 - 4.4	7	47-53
f. 4.5 - 5.4	7	54-60
g. 5.5 - 6.9	7	61-67
Blank (These columns <u>must</u> be blank.)	13	68-80

Transaction Code: Code "N"	1	1
Card Type: Code "6"	1	2
County Code (Item 4)	3	3-5
Section ID (Item 8)	12	6-17
Curve Card Number: Code "2"	1	18
Curve Classes:		
Degree of Curvature	No. of Curves & Total Length	
h. 7.0 - 8.4	7	19-25
i. 8.5 - 10.9	7	26-32
j. 11.0 - 13.9	7	33-39
k. 14.0 - 19.4	7	40-46
l. 19.5 - 27.9	7	47-53
m. 28+	7	54-60
Blank (These columns <u>must</u> be blank.)	20	61-80

NOTE: Number of curves must be right-justified in first 2 positions and length of curves right-justified in last 5 positions (xx.xxx assumed decimal).

Leading zeroes must be coded.

A curve class must be zero-filled if curves do not exist for that class.

These cards are required for the functional systems for which curve data is a required item, but may be coded for other facilities. All other sections will have the curve data fields zero-filled by the program. Must use both cards when coding curve data.

SAMPLE SECTION (Cont.)

	<u>Length</u>	<u>Column</u>
Transaction Code: Code "N"	1	1
Card Type: Code "7"	1	2
County Code (Item 4)	3	3-5
Section ID (Item 8)	12	6-17

Grades by Class (Item 53):

Gradient (%)	No. of Grades & Total Length	
a. 0.0 - 0.4	7	18-24
b. 0.5 - 2.4	7	25-31
c. 2.5 - 4.4	7	32-38
d. 4.5 - 6.4	7	39-45
e. 6.5 - 8.4	7	46-52
f. 8.5+	7	53-59
Blank (These columns <u>must</u> be blank.)	21	60-80

NOTE: No. of grades must be right-justified in first 2 positions. Total length of grades should be right-justified in last 5 positions (xx.xxx assumed decimal). A grade class must be zero-filled if grades do not exist for that class. This card is required for functional systems for which grades are a required data item, but may be coded for other facilities. All other sections will have the grade data field zero-filled by the program.

	<u>Length</u>	<u>Column</u>
Transaction Code: Code "N"	1	1
Card Type: Code "8"	1	2
County Code (Item 4)	3	3-5
Section ID (Item 8)	12	6-17

Structure ID's (Item 77)

Structure ID Card Number	2	18-19
Structure ID's:		
ID #1	15	20-34
ID #2	15	35-49
ID #3	15	50-64
ID #4	15	65-79
Blank (This column <u>must</u> be blank.)	1	80

NOTE: Up to 13 structure ID cards may be coded to contain the maximum 50 structure ID's per section. All cards must be coded 8 in column 2. In columns 18-19, number the type 8 cards beginning with 01, 02, . . . 13.

Card(s) 8 is included only if the section has structures (item 75 is greater than zero).

SAMPLE SECTION (Cont.)

	<u>Length</u>	<u>Column</u>
Transaction Code: Code "N"	1	1
Card Type: Code "9"	1	2
County Code (Item 4)	3	3-5
Section ID (Item 8)	12	6-17
At-grade Railroad Crossing ID's (Item 78):		
At-grade Railroad Crossing ID Card Number	1	18
At-grade Railroad Crossing ID's:		
ID #1	7	19-25
ID #2	7	26-32
ID #3	7	33-39
ID #4	7	40-46
ID #5	7	47-53
ID #6	7	54-60
ID #7	7	61-67
ID #8	7	68-74
Blank (These columns <u>must</u> be blank.)	6	75-80

NOTE: Up to 2 at-grade crossing ID cards (card type 9) may be used to code the maximum of 15 at-grade crossing ID's per section. In column 18, number the type 9 cards--1 on the first one and 2 on the second one, if used.

Card(s) 9 is included only if the section has at-grade railroad crossings (item 76 is greater than zero).

APPENDIX P

UPDATE DATA ITEM NUMBERS FOR HPMS SUBMITTAL SOFTWARE

<u>Item No.</u>	<u>Field Length</u>	<u>Data Item Name</u>
<u>State Control Field</u>		
01-01 *	10	First 10 positions of the State Control Field
01-02 *	10	Next 10 positions of the State Control Field
01-03 *	10	" " " " " " " "
01-04 *	10	" " " " " " " "
01-05 *	10	" " " " " " " "
01-06 *	10	" " " " " " " "
01-07 *	10	" " " " " " " "
01-08 *	10	" " " " " " " "
01-09 *	10	" " " " " " " "
01-10 *	10	Last 10 positions of the State Control Field
2	2	Year
3	2	State Code
4	3	County Code
5	1	Rural/Urban Designation
6	5	Urbanized Area Code
7	1	Type of Section/Grouped Data ID
8	12	Section/Grouped Data Identification
9	2	Functional System
10	1	Generated Functional System Code (The software will make the necessary changes. Cannot be changed by the user.)
11	1	Federal-Aid System
12	1	Federal-Aid System Status
13	1	Route Signing
14	5	Route Number
15	2	Governmental Level of Control
16	2	Special Systems
17	1	Type of Facility
18	1	Designated Truck Route/Parkway
19	1	Toll
20	6	Section/Group Length
21	6	AADT
22	2	Number of Through Lanes
23	5	Record Continuation Code (The software will make the necessary changes. Cannot be changed by the user.)
<u>END OF UNIVERSE RECORD</u>		
24	12	Sample Number
25	1	Sample Subdivision
26	2	AADT Volume Group Identifier
27	6	Expansion Factor
28	2	Surface/Pavement Type
29	2	Concrete Joint Spacing
30	1	Load Transfer Devices

* - Leading zero is required to update Item 1.

<u>Item No.</u>	<u>Field Length</u>	<u>Data Item Name</u>
31	1	Pavement Section
32	2	SN (Structural Number) or D (Slab Thickness)
33	1	Type of Base
34	1	Type of Subgrade
35	1	Subsurface Drainage
36	3	Measured Pavement Roughness
37	12	Reserved for Federal Use
38	2	Pavement Condition
39	3	Overlay or Pavement Thickness
40	4	Year of Surface Improvement
41	2	Type of Improvement
42	1	Access Control
43	2	Lane Width
44	1	Shoulder Type
45-A	2	Shoulder Width: Right
45-B	2	" " Left
46	1	Median Type
47	2	Median Width
48	3	ROW Width
49	1	Widening Feasibility
50	1	Horizontal Alignment Adequacy
<u>Curves by Class</u>		
51-A	7	# & Length of Curves fr. 0.0 degrees to 0.4 degrees
51-B	7	" 0.5 " " 1.4 "
51-C	7	" 1.5 " " 2.4 "
51-D	7	" 2.5 " " 3.4 "
51-E	7	" 3.5 " " 4.4 "
51-F	7	" 4.5 " " 5.4 "
51-G	7	" 5.5 " " 6.9 "
51-H	7	" 7.0 " " 8.4 "
51-I	7	" 8.5 " " 10.9 "
51-J	7	" 11.0 " " 13.9 "
51-K	7	" 14.0 " " 19.4 "
51-L	7	" 19.5 " " 27.9 "
51-M	7	" 28 degrees +
52	1	Vertical Alignment Adequacy
<u>Grades by Class</u>		
53-A	7	Number and Length of Grades 0.0% to 0.4%
53-B	7	" 0.5% to 2.4%
53-C	7	" 2.5% to 4.4%
53-D	7	" 4.5% to 6.4%
53-E	7	" 6.5% to 8.4%
53-F	7	" 8.5%+
54	3	% Passing Sight Distance
55	2	Speed Limit
56	2	Weighted Design Speed

<u>Item No.</u>	<u>Field Length</u>	<u>Data Item Name</u>
57-A	2	Percent Commercial Vehicles: Peak
57-B	2	" " " " Off-Peak
58	2	K-Factor
59	3	Directional Factor
60	5	Peak Capacity
61	3	Volume/Service Flow (V/SF) Ratio (Calculated -- the software will make the necessary changes. Cannot be changed by the user.)
62-A	1	Turning Lanes: Left
62-B	1	Right
63	1	Prevailing Signalization
64	2	Typical Percent Green Time
65	1	Peak Parking
66	6	Future AADT
67	2	Year of Future AADT
68	2	General Climate Zone
69	1	Drainage Adequacy
70	1	Type of Terrain
71	1	Type of Development
72	1	Urban Location
73	2	No. of Grade-Separated Interchanges
74-A	2	No. of At-Grade Intersections: Signals
74-B	2	" " " " Stop Signs
74-C	2	" " " " Other/ No Controls
75	2	No. of Structures
76	2	No. of At-grade Railroad Crossings

Structure I.D. Nos.

77-01	15	The <u>exact</u> ID for the 1st Structure ID on the File
77-02	15	" " 2nd "
.	"	" " "
.	"	" " "
.	"	" " "
77-50	15	" " 50th "

At-Grade R.R. Crossing I.D. Nos.

78-01	7	The <u>exact</u> ID Code for the 1st RR X'ing on the File
78-02	7	" " 2nd "
.	"	" " "
.	"	" " "
.	"	" " "
78-15	7	" " 15th "

APPENDIX Q

HPMS Submittal Software Subprogram Operation

STHPMODU (SELMODU)

The options selected for the subprogram are listed for user information.

For all keywords coded on SELMODU, the transaction card sets are read and checked for general format errors, sequence errors, and valid transaction codes. Each valid transaction set is placed in a temporary dataset with one record consisting of all cards in a transaction set. Invalid transaction sets are listed for the user along with an error message. When the end of the transaction set is reached, if the temporary dataset contains valid transactions, it is sorted by section ID within county to match the sort of the input master dataset. Next, the process of matching the section ID on the master dataset with the section ID coded on the transaction set begins. If the section ID on the dataset (including the county code) is less than the ID on the transaction set, the section record is written on the new master dataset without any change. If the section ID on the dataset is greater than the transaction set ID and the transaction code is N, the subprogram STHPADDS is called to check and process the cards for the new section to be placed on the new master dataset. When the section ID on the dataset equals the transaction set ID, the following applies:

- (1) The section is not written on the new master dataset for a delete transaction.
- (2) The section is written on the new master dataset with modifications for an update transaction, structure ID's added or deleted, or crossing ID's added or deleted.

If the data item used in a calculation is updated, the subprogram HPCALCDI is called to recalculate the "calculated data items"; if the county FIPS code is updated, subprogram STHPZONE is called to assign the climate zone before the modified section is written on the new master. If a new section is being added, HPCALCDI is called to calculate the "calculated data items", and STHPZONE is called to assign the climate zone based on the county FIPS code, before the added section is written on the master.

This matching process continues until the end of the transaction card sets are reached or the end of the existing master is reached. A summary is printed indicating the transactions by section ID, county code, and functional system. A listing is also given showing all transaction sets found in error during the matching process along with error messages. If a county code or section ID was updated, the new master dataset is sorted by section ID within county. Execution then returns to FHWAHPMS.

STHPEDIT (SELEDIT)

Each subprogram option in effect is listed for the user's information. A check is made to determine if a listing of sections is to be produced or editing is to be performed. If one of the keywords LISTSECT, LISTUNIV, or LISTSAMPLE is coded, each section record is read with all sections being listed or all universe sections being listed or all sample sections being listed. A summary report is also listed with execution then returning to FHWAHPMS. If editing is selected, a check is made to determine the type(s) of edits to be performed. Each section record is read with the type(s) of edit(s) performed in the following order:

- (1) If valid code edits were selected, each data item is checked for a valid code.
- (2) If cross-edit checks were selected, various data items are cross-edited to see if the coding between the two or more data items agree.
- (3) If cross-edit checks were selected and volume groups are to be checked with AADT, this editing is performed.
- (4) If range edits were selected, various data items will be checked to see if the coded value is within a reasonable range.
- (5) If all edits were selected (SELEDIT=FINAL), all of the above edits will be performed.

If no errors are detected, the next section record is read and the editing for that section is performed. If at least one data item is found to be in error, a check is made to see which print option was selected--section ID's with error messages or section ID's, all coded values for data items and error messages. The appropriate listing is then printed along with counts made for the summary report. After the section with errors is printed, a check is made to see if the number of sections in error exceeds the maximum number of errors allowed, if not, a new section is read and the editing is performed for that section. When the maximum number of errors allowed is reached or the end of the dataset is reached, the edit summary report is printed. Upon reaching the end of all other editing, if the valid code edits were selected and the sample number is to be checked for uniqueness, the master dataset is sorted by sample number within county. Each section is then read with the sample number compared to the sample number of the previous section for uniqueness. Any section with duplicate sample numbers is listed with county code and section ID. A summary report is printed and execution returns to FHWAHPMS.

Q-3

STHPCALC (SELCALC)

The options in effect for STHPCALC are listed for the user's information. Each section record on the input master dataset is read. A work functional system code of one position is determined from the coded two-position code and placed on the data record. If the record is for a universe section, the record is written on the new dataset and the next record is read. If the record is a sample section, the State code and county code are passed to STHPZONE to determine the climate zone and/or the data record is passed to the subprogram HPCALCDI which calculates the rural peak capacity, volume-to-service flow (capacity) ratio, weighted design speed, horizontal alignment adequacy and vertical alignment adequacy for each applicable section. The record with the calculated data items is passed back to STHPCALC which writes the record on the new dataset, and the next section record is read. Upon reaching the end of the input dataset, a summary report is printed. Execution then returns to FHWAHPMS.

STHPZONE (called by STHPMODU or STHPCALC)

The State and county FIPS codes passed by the calling program are used to search a matrix and determine the climate zone, which is passed back to the calling program.

If an invalid county code -- nonnumeric value or not valid for the State -- is detected, the climate zone is set to zero, and is returned to the calling program.

HPCALCDI (called by STHPMODU or STHPCALC)

Each passed sample section is checked to determine which data items are to be calculated for that particular section and calculated if needed in the following order:

- (1) Weighted design speed is calculated for all urban Interstate and freeways/expressways by design type; all paved rural arterial sections for which curve data are provided, and all paved rural collectors with type of development coded rural, and for which curve data are provided.
- (2) Rural peak capacity is calculated for all paved sections (if the rural peak capacity was coded, this is not calculated) by the FORTRAN subprogram HPCAPR.
- (3) Volume-to-service flow ratio is calculated for all sections with nonzero peak capacity.
- (4) Horizontal alignment adequacy is calculated for all paved rural sections for which curve data are provided.
- (5) Vertical alignment adequacy is calculated for all paved rural sections for which grade data are provided.

Q-4

Any data item that cannot be calculated because a data item used in the calculation is not numeric, is set to zero. Weighted design speed is set to default values by functional system and terrain type for rural, or by design type for urban, if curves are not provided and the weighted design speed is coded zero. Horizontal alignment is set to 2 if curves are not provided and the coded value is zero. Vertical alignment is set to 2 if grades are not provided and the coded value is zero.

After all calculations have been made, the section record with the new calculated values is passed back to the calling program STHPMODU or STHPCALC.

STHPADDS (called by subprogram STHPMODU when a new section is to be added to the master dataset)

The transaction set N is passed along with the HPMS record. Each card in the set is checked to determine the card type (1-9). The data on card type 1 is moved to the appropriate place in the HPMS record and a switch is set indicating the type of section being added--universe, or sample. The coding on card type 2 is moved to the appropriate place in the HPMS record. The coding on card type 3 is moved to the appropriate place in the HPMS record. Switches are checked to determine if card types 1-3 have been coded. If not, an error switch is set and control is returned to STHPMODU and the section is not added. For each of the other card types (4-9), a check is made to see if the type section switch is set for a universe section. If so, an error switch is set, passed back to STHPMODU and the section is not added. If the type section switch is set for a sample, each card type 5-9 which is coded has the data moved to the appropriate storage location. The following editing is performed on card types 6, 8, and 9:

- (1) Card type 6
 - Curve card number 1 is coded.
 - Curve card number 2 is coded.

- (2) Card type 8
 - Structure ID card number is numeric.
 - Number structure cards equals number coded on card.
 - Number structure ID's coded is not greater than 50.

- (3) Card type 9
 - Crossing ID card number is numeric
 - Number crossing cards equals number coded on card.
 - Number crossing ID's coded is not greater than 15.

Q-5

An error switch is set if an error is detected, passed back to STHPMODU, and the new section is not added. When all cards in the transaction set have been checked and edited for general errors, and the coded data has been moved, if a universe section is being added and an error was found, control returns to STHPMODU; if a sample section is being added, more editing is performed before control is returned to STHPMODU. Since the section being added is a sample, if card types 4 and 5 were not coded, the section is not complete and is not to be added. If only one of the curve data cards (type 6) was coded, curve data is missing and the section will not be added. All data in storage and error switches are now passed back to STHPMODU.

STHPEXPF (SELEXPF)

This subprogram calculates the expansion factor (if that option is requested) and produces the expansion factor table.

If expansion factors are to be calculated, the input file is sorted and the sample mileage is accumulated in a table by volume group within functional system and urban area. If the MILECARD option is chosen, the universe mileage cards are then read and new expansion factors are calculated for the volume group for which cards have been provided; if the MILEDATA option is chosen the universe mileage is accumulated from the input file and new expansion factors are calculated for the volume group provided there are no zero AADTs. Finally, the input file is read again and the new expansion factors are substituted on the output file.

Regardless of whether any new expansion factors have been calculated, a table showing the factors on the file is generated. The file is sorted by urban area code, functional system, and volume group. Then break logic is used to produce the table.

STHPSUMT (SELSUMT)

This subprogram produces five summary tables: the Federal-aid table, the sample mileage table, the universe mileage table, the county mileage table, and the future DVMT table. The program reads the cards which contain the names associated with the urbanized area codes. These names are sorted in a matrix and are used in printing some of the tables. Only the tables requested are produced. If the county mileage table is requested, the program reads the cards which give the names associated with the county codes. These names are sorted in a matrix and used in the printing of the table. The input file is read twice (once to extract rural data and once to extract urban data) to produce the Federal-aid table. The file is sorted to produce each of the other three tables.

STHPINTS (SELINTS)

This subprogram produces two Interstate system mileage summary tables by route number. The input file is read and only those records which meet certain conditions are selected and sorted. The sorted file is then read and the two tables are produced showing the number of records, mileage, lane-miles, and DVMT by route number for each category of Interstate (free, toll, 139, etc.).

STHPBTAB (SELBTAB)

This subprogram of FHWAHPMS governs the creation of the battery of 15 summary tables from the sample data. If the program option INDUZA is selected the program reads the cards which contain the names associated with the urbanized area codes. These names are stored in a matrix and used in printing the tables showing individual urbanized areas. Depending on which tables are requested, STHPBTAB creates urban and/or rural workfiles consisting of sample records. These files are sorted and the subprograms required to produce the requested tables are called. STHPBTAB has 7 subprograms--STHPR01 through STHPR04 and STHPU01, STHPU03 and STHPU04.

STHPR01

This subprogram of STHPBTAB produces rural tables 1 and 2. The rural workfile is read once for each table requested.

STHPR02

This subprogram of STHPBTAB produces rural table 3. The rural workfile is read once for each table requested.

STHPR03

This subprogram of STHPBTAB generates rural tables 4, 5, 6 and 7. The rural workfile is read once for each table requested.

STHPR04

This subprogram of STHPBTAB produces rural tables 8 and 9. The rural workfile is read once for each table requested.

STHPU01

This subprogram of STHPBTAB generates urban tables 1 and 2. The urban workfile is read once for each table requested.

STHPU03

This subprogram of STHPBTAB creates urban tables 3, 4 and 5. The urban workfile is read once for each table requested.

STHPU04

Urban table 6 is generated by this subprogram of STHPBTAB. The urban workfile is read once for each table requested. Notice there is no urban table 7, 8 or 9.

APPENDIX R

HPMS RECORD FORMAT

FORMAT: Variable Length, Blocked
 LOGICAL RECORD LENGTH: Min: 167 Max: 1286
 PHYSICAL RECORD LENGTH: 6233

N - Numeric AN - Alphanumeric

PART I: ALL SECTIONS

Item No.	Data Item	Position	Length	Type
1	State control field	1-100	100	AN
2	Year	101-102	2	N
3	State code	103-104	2	N
4	County code	105-107	3	N
5	Rural/Urban Designation	108	1	N
6	Urbanized Area Code	109-113	5	N
7	Type of Section/Grouped Data	114	1	N
8	Section/Grouped Data Identification	115-126	12	AN
9	Functional System	127-128	2	N
10 <u>1/</u>	Generated Functional System Code	129	1	N
11	Federal-aid System	130	1	N
12	Federal-aid System Status	131	1	N
13	Route Signing	132	1	N
14	Route Number	133-137	5	AN
15	Governmental Level of Control	138-139	2	N
16	Special Systems	140-141	2	N
17	Type of Facility	142	1	N
18	Designated Truck Route/Parkway	143	1	N
19	Toll	144	1	N
20	Section/Group Length (xxx.xxx)	145-150	6	N
21	AADT	151-156	6	N
22	Number of through lanes	157-158	2	N
23	Record Continuation Code	159-163	5	N

Indicates Universe Record (00000)

1/ Generated Functional System Code:

The two-positional code for item 9, Functional System, is converted to a one-positional code by the FHWA software to be used in the software as a subscript for storage matrices. The conversions are as follows:

<u>Item 9</u>	<u>Item 10</u>	<u>Description</u>
01, 11	- 1	(Interstate)
02, 12, 13	- 2	(Principal Arterial; Other Freeways or Expressways)
06, 14, 15	- 3	(Minor Arterial; Other Principal Arterial)
07, 16	- 4	(Major Collector; Minor Arterial)
08, 17	- 5	(Minor Collector; Collector)
09, 19	- 6	(Local)

PART II: SAMPLE DATA SECTIONS

R - Rural Data Item; U - Urban Data Item

Item No.	Data Item	Position	Length	Type
23	Indicates Sample Section (code 1)	159	1	N
	Indicates Number of Structure ID's Provided (00 = none; > 00 = # ID's)	160-161	2	N
	Indicates Number of Railroad Crossing ID's Provided (00 = none; > 00 = # ID's)	162-163	2	N
24	Sample Number	164-175	12	AN
25	Sample Subdivision	176	1	N
26	AADT Volume Group Identifier	177-178	2	N
27	Expansion Factor (xxx.xxx)	179-184	6	N
28	Surface/Pavement Type	185-186	2	N
29	Concrete Joint Spacing	187-188	2	N
30	Load Transfer Devices	189	1	N
31	Pavement Section	190	1	N
32	SN (Structural Number) or D (Slab Thicknes)	191-192	2	N
33	Type of Base	193	1	N
34	Type of Subgrade	194	1	N
35	Subsurface Drainage	195	1	N
36	Measured Pavement Roughness	196-198	3	N
37	Reserved For Federal Use	199-210	12	-
38	Pavement Condition (PSR) (x.x)	211-212	2	N
39	Overlay or Pavement Thickness	213-215	3	N
40	Year of Surface Improvement	216-219	4	N
41	Type of Improvement	220-221	2	N
42	Access Control	222	1	N
43	Lane Width	223-224	2	N
44	Shoulder Type	225	1	N
45-A	Shoulder Width: Right	226-227	2	N
45-B	Left	228-229	2	N
46	Median Type	230	1	N
47	Median Width	231-232	2	N
48	ROW Width	233-235	3	N
49	Widening Feasibility	236	1	N
50 <u>2/</u>	Horizontal Alignment Adequacy (R)	237	1	N
51	Curves by Class	238-328	91	N
52 <u>2/</u>	Vertical Alignment Adequacy (R)	329	1	N
53	Grades by Class	330-371	42	N
54	% Passing Sight Distance, 1500 Feet (R)	372-374	3	N
55	Speed Limit	375-376	2	N

2/ For a rural section, these data items must be coded for paved collectors if curve/grade data is not provided. If curve/grade data is provided, these data items will be calculated by FHWA software for paved arterials and paved collectors.

R-3

PART II: SAMPLE DATA SECTIONS (Cont.)

R - Rural Data Item; U - Urban Data Item

Item No.	Data Item	Position	Length	Type
56 3/	Weighted Design Speed (WDS)	377-378	2	N
57-A	Percent Commercial Vehicles: Peak	379-380	2	N
57-B	Off-Peak	381-382	2	N
58	K-Factor	383-384	2	N
59	Directional Factor	385-387	3	N
60	Peak Capacity (Calculated - R; Coded - U)	388-392	5	N
61	Volume / Service Flow (V/SF) Ratio (Calculated)	393-395	3	N
62-A	Turning Lanes: Left (U)	396	1	N
62-B	Right (U)	397	1	N
63	Prevailing Signalization (U)	398	1	N
64	Typical Percent Green Time (U)	399-400	2	N
65	Peak Parking (U)	401	1	N
66	Future AADT	402-407	6	N
67	Year of Future AADT	408-409	2	N
68	General Climate Zone	410-411	2	N
69	Drainage Adequacy	412	1	N
70	Type of Terrain (R)	413	1	N
71	Type of Development (R)	414	1	N
72	Urban Location (U)	415	1	N
73	# Grade-Separated Interchanges	416-417	2	N
	# At-Grade Intersections:			
74-A	Signals	418-419	2	N
74-B	Stop Signs	420-421	2	N
74-C	Other or No Controls	422-423	2	N
75	# Structures	424-425	2	N
76	# At-Grade Railroad Crossings	426-427	2	N

3/ For an urban section, weighted design speed is calculated for all Interstate and applicable freeways and expressways by design type. For a rural section if curve data is provided, WDS is calculated for paved collectors in rural development; otherwise, it must be coded by the State. For rural arterials, WDS is calculated by FHWA software for all paved sections.

PART III: VARIABLE (SAMPLE DATA SECTIONS, ONLY)

The remaining part of the record is variable and applies only to sample sections when applicable. The number of characters varies from 7 to 855, depending on the number and combination of structure I.D.'s and at-grade railroad crossing I.D.'s provided. The applicable data will be coded in the following order:

77	Structure ID's	15-750 Characters	AN
78	At-Grade Railroad Crossing ID's	7-105 Characters	AN

APPENDIX S

CLIMATE ZONE DEFINITIONS

The HPMS climate zones and the following definitions for the zones have been taken from the report, "A Pavement Moisture Accelerated Distress (MAD) Identification System", Vol. 2, September 1981, report number FHWA/RD-81/080. The report is the result of research done by the University of Illinois for the FHWA Office of Research.

Should an HPMS sample section appear to belong to a different climate zone than has been assigned on a countywide basis via the HPMS Submittal Software, the State may change the climate zone (item 68) based on the definitions contained in this Appendix. Note that the definitions have repetitive portions -- there are three different interpretations of winter conditions and three different interpretations of wet/dry conditions. Using all possible combinations, they account for the nine possible climate zones.

Since the HPMS Submittal Software contains and assigns the climate zones internally, the timing for changing the climate zones will have to be after all modifications (SELMODU) and calculations/generations (SELCALC) with the software are complete. Note, however, that the climate zone is changed by the software only if the county FIPS code is updated under the SELMODU option, and/or only if the CZONE sub-option is chosen under the SELCALC option.

CLIMATE ZONE 01; Wet; Freeze

This zone experiences long winters with the temperature below freezing for extended periods. The potential for a slowly advancing freezing front into the subgrade is extremely high. Frost damage is to be expected accompanied with other low temperature problems.

Due to the climatic influences, the subgrade will remain wet for the majority of the year and very little moisture variation will occur. Performance relationships indicate that the zone will maintain a moisture level that will produce low load related performance.

CLIMATE ZONE 02; Wet; Freeze-Thaw

This zone experiences winters with more fluctuation of the temperatures about the freezing point. Freeze-thaw cycling into the base course is to be expected. Some thermal fatigue problems could be expected, with hot summers being a problem in the West due to radiation.

Due to the climatic influences, the subgrade will remain wet for the majority of the year and very little moisture variation will occur. Performance relationships indicate that the zone will maintain a moisture level that will produce low load related performance.

CLIMATE ZONE 03; Wet; No Freeze

This zone is characterized by relatively mild winters (compared to 01, 02, 04, 05, 07 or 08) and damage may range from minimal thermal fatigue in the North, to high temperature stability problems in the South.

Due to the climatic influences, the subgrade will remain wet for the majority of the year and very little moisture variation will occur. Performance relationships indicate that the zone will maintain a moisture level that will produce low load related performance.

CLIMATE ZONE 04; Intermediate; Freeze

This zone experiences long winters with the temperature below freezing for extended periods. The potential for a slowly advancing freezing front into the subgrade is extremely high. Frost damage is to be expected accompanied with other low temperature problems.

The state of moisture in the subgrade will vary during the year, but the average moisture condition is very much drier than zones 01, 02, and 03. This zone produces a moisture state that produces load related performance in a transitional portion between good and poor. Seasonal concentration of moisture will be important in determining which level of performance would be present.

CLIMATE ZONE 05; Intermediate; Freeze-Thaw

This zone experiences winters with more fluctuation of the temperatures about the freezing point. Freeze-thaw cycling into the base course is to be expected. Some thermal fatigue problems could be expected, with hot summers being a problem in the West due to radiation.

The state of moisture in the subgrade will vary during the year, but the average moisture condition is very much drier than zones 01, 02, and 03. This zone produces a moisture state that produces load related performance in a transitional portion between good and poor. Seasonal concentration of moisture will be important in determining which level of performance would be present.

CLIMATE ZONE 06; Intermediate; No Freeze

This zone is characterized by relatively mild winters (compared to 01, 02, 04, 05, 07 or 08) and damage may range from minimal thermal fatigue in the North, to high temperature stability problems in the South.

The state of moisture in the subgrade will vary during the year, but the average moisture condition is very much drier than zones 01, 02, and 03. This zone produces a moisture state that produces load related performance in a transitional portion between good and poor. Seasonal concentration of moisture will be important in determining which level of performance would be present.

CLIMATE ZONE 07; Dry; Freeze

This zone experiences long winters with the temperature below freezing for extended periods. The potential for a slowly advancing freezing front into the subgrade is extremely high. Frost damage is to be expected accompanied with other low temperature problems.

In this zone, the annual moisture state is dry. The load related performance is good for all materials. Seasonal concentrations of moisture will be responsible for producing slightly lower performance in one area than another where the moisture is not concentrated in one time period.

CLIMATE ZONE 08; Dry; Freeze-Thaw

This zone experiences winters with more fluctuation of the temperatures about the freezing point. Freeze-thaw cycling into the base course is to be expected. Some thermal fatigue problems could be expected, with hot summers being a problem in the West due to radiation.

In this zone the annual moisture state is dry. The load related performance is good for all materials. Seasonal concentrations of moisture will be responsible for producing slightly lower performance in one area than another where the moisture is not concentrated in one time period.

CLIMATE ZONE 09; Dry; No Freeze

This zone is characterized by relatively mild winters (compared to 01, 02, 04, 05, 07 or 08) and damage may range from minimal thermal fatigue in the North, to high temperature stability problems in the South.

In this zone the annual moisture state is dry. The load related performance is good for all materials. Seasonal concentrations of moisture will be responsible for producing slightly lower performance in one area than another where the moisture is not concentrated in one time period.

