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16. Abstract

The basic objective of this study was to develop and incorporate into the Texas Travel Demand a peak hour or peak period travel demand modeling capability. Peak hour and peak period travel demand modeling techniques vary considerably in their level of sophistication. These techniques can generally be categorized into three basic approaches: factoring of 24-hour trip tables; factoring of 24-hour trip ends; and direct generation.

Two sets of data analyses were performed: (1) analyses of traffic count data from 254 locations in Houston; and (2) analyses of peak period data from the recent Houston travel survey. Based on the results of these analyses and some basic conceptual concerns, the use of three-hour peak periods instead of a single peak hour for travel demand modeling applications is strongly encouraged.

Perhaps the most important product of this study is the software. Three new routines were developed, tested and implemented in the Texas Travel Demand Package to provide for peak period modeling applications.

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DEVELOPMENT OF A PEAK PERIOD TRAFFIC ASSIGNMENT CAPABILITY

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Development of a Peak Period Traffic Assignment Capability

Research Report Number 454-1F

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Texas State Department of Highways and Public Transportation

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August 1988

METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	2.54	millimetres	mm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
		AREA		
in^2	square inches	645.2	millimetres squared	mm^2
ft^2	square feet	0.0929	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
mi^2	square miles	2.59	kilometres squared	km^2
ac	acres	0.395	hectares	ha
		MASS (weight)		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		VOLUME		
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.0328	metres cubed	m^3
yd^3	cubic yards	0.0765	metres cubed	m^3

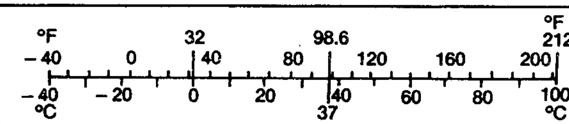
NOTE: Volumes greater than 1000 L shall be shown in m^3.

		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
		AREA		
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
km^2	kilometres squared	0.39	square miles	mi^2
ha	hectores (10 000 m^2)	2.53	acres	ac
		MASS (weight)		
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
		VOLUME		
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3

		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



These factors conform to the requirement of FHWA Order 5190.1A.

* SI is the symbol for the International System of Measurements

ABSTRACT

The basic objective of this study was to develop and incorporate into the Texas Travel Demand a peak hour or peak period travel demand modeling capability. Peak hour and peak period travel demand modeling techniques vary considerably in their level of sophistication. These techniques can generally be categorized into three basic approaches: factoring of 24-hour trip tables; factoring of 24-hour trip ends; and direct generation.

Two sets of data analyses were performed: (1) analyses of traffic count data from 254 locations in Houston; and (2) analyses of peak period data from the recent Houston travel survey. Based on the results of these analyses and some basic conceptual concerns, the use of three-hour peak periods instead of a single peak hour for travel demand modeling applications is strongly encouraged.

Perhaps the most important product of this study is the software. Three new routines were developed, tested and implemented in the Texas Travel Demand Package to provide for peak period modeling applications.

DISCLAIMER

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I. INTRODUCTION

The Texas Travel Demand Package does not provide the software support needed for the preparation of peak period or peak hour assignments. To estimate future peak hour volumes, 24-hour volume estimates are simply factored using an estimated peak hour factor and an estimated directional split. The estimates of future peak hour factors and directional splits must be based on available traffic count data. The selection of appropriate future peak hour factors and directional split for a given facility must be based on subjective analogy. This approach is generally not sensitive to the composition of traffic by trip purpose or to the upstream impacts of a peak period "bottle neck" in capacity. Nevertheless, this is by far the most widely used approach for forecasting peak hour volumes. Actually, this is probably not a bad approach for cities which experience minor or localized traffic congestion (which is the case for most cities in Texas and the U.S.). A peak period modeling capability is probably most useful in the very large urban areas where "super saturated" traffic conditions are being experienced or are expected to be experienced in the future.

The basic objective of this study was to develop and incorporate into the Texas Travel Demand Package a peak hour or peak period travel demand modeling capability. The specific products of the study include: this final report, the new software to provide a peak period modeling capability, and the software documentation.

At the outset of the study, a literature review on peak hour modeling as a component of urban travel demand modeling was performed. This literature review was supplemented by direct contacts with various agencies and practioners to gain more insight regarding the current practice related to peak period travel demand modeling. Chapter II of this report summarizes the general approaches for peak period modeling.

Two sets of peak period data analyses were undertaken as a part of this study: analyses of traffic count data; and analyses of travel survey data. Chapter III of this report summarizes the key results and findings from these analyses.

Perhaps the most important product of the study is the software for the implementation of a peak period or peak hour modeling capability. Three new routines were developed and implemented in the Texas Travel Demand Package to provide the software support for peak period traffic assignment applications. Chapter IV of this report focuses on the development and testing of this software.

II. TRAVEL DEMAND MODELING TECHNIQUES

There are a variety of techniques which may be used to estimate peak period travel demands. The objectives of this chapter are to review the basic alternative approaches for peak period travel demand modeling and to identify the software changes needed in the Texas Travel Demand Packages to provide a peak period assignment capability. Initially, some of the basic concepts relating to peak period travel demand modeling are reviewed and discussed. Next, the basic alternative approaches for peak period travel demand modeling are delineated and discussed.

Basic Concepts

The basic conceptual framework for peak period travel demand modeling is somewhat different from approaches normally used in the analyses of traffic count data. Also, some of the terminology used in conjunction with peak period travel demand modeling have a slightly different meaning or interpretation when compared with similar terminology used by traffic engineers relative to peak traffic counts. For example, a "peak hour assignment volume" should have a slightly different connotation than a "peak hour count." Since this is a potential source of confusion or misinterpretation, it is worthwhile to briefly review some of the basic concepts relating to peak period travel demand modeling and to highlight how these differ from the more conventional traffic engineering terminology.

Time of Day Nature of Models

In travel demand model applications, the trips being modeled are normally the trips which are expected to occur during a specific time period. For example, the traditional 24-hour assignment will normally use the average number of trips which are expected to begin within a 24-hour time period of an average weekday. Similarly, with peak period travel demand model applications, the trips being modeled are normally the average number of trips which are expected to begin (or originate) during a specific time period on an average weekday. For examples, a peak period model application could be dealing with the trips expected to begin during a three-hour period (e.g., from 6:30 a.m. to 9:30 a.m.) or during a two-hour period (e.g., from 7 a.m. to 9 a.m.), or during a one-hour period (e.g., from between 4 p.m. to 5 p.m.).

In travel demand surveys, it is common to ask the trip-maker the time each trip began (i.e., originated). This data can be used to estimate the portion of the average daily trips that can be expected to begin (or, originate) during a specific "peak time period" (e.g., the trips expected to begin from 6:30 a.m. to 9:30 a.m.). In some surveys, the trip-maker is also asked the time at which they arrived at their destination. In study areas where arrival time of survey trips are available, a second option available is to model the trips expected to end (or arrive at their destination) during a specific "peak time period." In study areas where both the start time and the arrival time of the survey trips are available, a third option available (and somewhat more complex option) would be to model the trips which have a majority of their traveltime occurring within the subject specific time period. Since the reported start-time of trips are available in most of the travel surveys and are generally felt to be more accurate than the reported arrival time of trips, peak period modeling applications generally focus on the trips expected to begin during the subject peak period.

A key point is that peak period travel demand model applications are for a specific time period. Also, there are definitional variations for which trips are being modeled for the specific time period.

Directional Nature of Models

It should also be recalled that travel demand modeling generally deals with the generation of trip productions and trip attractions and the distribution of trips from productions to attractions. In the modeling of 24-hour travel, the conversion of trip tables from a production-to-attraction format to a origin-to-destination format is handled in a relatively simple manner. For 24-hour trip tables, it is generally assumed that 50 percent of the trips move in the production-to-attraction direction and 50 percent of the trips move in the attraction-to-production direction. In peak period travel demand modeling, this simple "50-50" assumption is not applicable for converting a peak period production-to-attraction trip table to an origin-to-destination trip table. Hence, the travel survey data must be used not only to estimate the average portion of the trips which are likely to occur during the subject peak period but also to estimate the expected production-to-attraction directional split (i.e., the portion of the trips that are likely to move in the production-to-attraction direction versus the portion expected to move in the attraction-to-production direction). These production-to-attraction directional splits vary both by time of day and trip purpose. For example, in a morning peak period it is reasonable to expect that the vast majority of the home-based work trips would occur in the production-to-attraction direction. Conversely, in an afternoon peak period the vast majority of the home-based work trips will likely be in the work-to-home direction. By carefully converting the peak period production-to-attraction trip tables to peak period origin-to-destination trip tables, it is reasonable to expect that the peak period assignment should generally yield reasonable estimates of the directional split of the peak period volumes.

Peak Trips Versus Peak Counts

The time of day nature of travel demand modeling points to some key differences between peak period assignment volumes and peak period traffic counts. To illustrate this, let's assume that the travel demand models have been applied for the average trips that begin for a one-hour period from 7 a.m. to 8 a.m. The assigned volumes, therefore, represent the expected travel demands of trips that begin from 7 a.m. to 8 a.m. Let's also assume that 7 a.m. to 8 a.m. counts have been made for every link in our highway network. By comparing the composition of the one-hour assignment volumes versus the composition of the one-hour counted volumes, a fundamental difference between peak period assignment volumes and one-hour traffic counts becomes apparent. Trips with <u>both</u> a start time and an arrival time from 7 a.m. to 8 a.m. should generally be represented in <u>both</u> the traffic assignment and the traffic counts. The traffic counts on a given link will likely include some travel that began <u>before</u> 7 a.m. (i.e., trips which may not be well accounted for in the assignment volumes). Conversely, the assignment volumes will include some trips which <u>begin</u> from 7 a.m. to 8 a.m. but which will not reach their destination before 8 a.m. (i.e., the traffic counts on a given link may not account for some of the trips which generally begin in the specified time period but which had not reached that link before 8 a.m.) In applying a one-hour model, it is generally expected that these differences are offsetting and that the one-hour assignment volumes reasonably estimate the one-hour counted volumes.

The above example also leads to some interesting implications regarding the length of the time period being modeled. Generally, as the length of the time period being modeled increases, the greater the portion of the trips which <u>both</u> begin and end within the time period. Clearly, as the portion of the trips which <u>both</u> begin and end in the time period increases, it is reasonable to expect a better relationship between counted and assigned volumes. Hence, from a travel demand modeling perspective, it is advantageous to make the length of the time period being modeled and counted as long as possible. From this perspective, it is reasonable to expect that assignment volumes for a three-hour period (e.g., 6:30 a.m. to 9:30 a.m.) will better match counted volumes for the same three-hour period than one-hour counted and assigned volumes (e.g.,7:30 a.m. to 8:30 a.m.).

To be able to call a one-hour assignment a "peak hour" assignment, it is common practice to process the travel survey data to find the one-hour period which generates either the greatest VMT or the greatest number of trips. Clearly, the terminology "peak hour" assignment used in this context has a different meaning than the same terminology normally used in conjunction with traffic counts. Again, the travel demand model application for a "peak period" assignment is for a <u>specific</u> one-hour time period for the entire study area. In contrast, the terminology "peak hour count" is often used to refer to the highest volume which occurs in a 60-minute time period on a facility (i.e., the one-hour period in which the highest volumes occur may vary considerably from location to location within an urban area). For example, in suburban-fringe predominately residential area the highest morning hour volumes might occur around 6:30 a.m., while in the CBD the highest morning hour volumes might be observed around 8:00 a.m.

<u>Peak Spreading</u>

In some of the larger urban areas, "super saturated" traffic conditions may be observed in portions of these areas during peak periods. When this occurs, a phenomenon called "peak spreading" may occur. When this happens, the peak hour as a percent of the daily trips is considerably reduced and the "shoulder" hours (i.e., the hours on either side of the peak hour) have very heavy volumes. In effect, many trip makers are altering or adjusting their travel schedules to "leave a little earlier" or "leave a little later" to reduce the delays they expect to encounter.

From a travel demand perspective, this phenomenon poses an interesting dilemma for peak hour assignment modeling. Recall that these models are dealing with the average trips which are expected to occur within a specific one-hour period. While a capacity-restraint assignment can often divert trips to alternate routes when high volume-to-capacity ratios are encountered, the assignment algorithms cannot move trips to different time periods (i.e., the diversion of trips to different time periods).

Three-hour Peak Period Models

For many applications, strong consideration should be given to modeling a three-hour peak period rather than a single peak hour. The modeling of a three-hour peak period should minimize the "time shoulder problem" associated with peak spreading. Certainly, any three-hour assignment volumes which significantly exceed the three-hour capacities for the planned roadway improvements can be readily identified as potential major problems and should be subject to very careful subsequent analyses.

Also, as previously discussed, the modeling of a three-hour peak period should reduce potential problems with travel overlapping the boundaries of the time period being modeled. With a well-selected three-hour peak period, it is reasonable to expect that the vast majority of the trips being modeled would both begin and end within the period.

The use of three-hour peak period travel models are probably most desirable for our very large urban areas which are already experiencing or are expected to experience peak spreading into the "shoulder hours" of the peak hour. Indeed, it is in these very large urban areas that peak period modeling is most appropriate and desirable.

The development and application of peak period travel demand models for an urban area will require a very considerable level of effort and costs. For cities which experience relatively minor or localized traffic congestion (which is the situation for most cities in Texas and the U.S.), it is really questionable whether this level of effort would be cost-effective.

The use of a three-hour peak period for travel demand modeling creates the need for new factors to estimate peak hour volumes from the three-hour volumes. The need for these new factors raises some interesting questions.

Is there a good relationship between the three-hour volumes and the highest hour volume within the three-hour period? Is this relationship better than the relationship between the 24-hour volumes and the highest hour volume in the peak period of interest? The analyses of traffic count data presented in Chapter III of this report addresses these questions. These analyses clearly suggest that there is a very good relationship between the three-hour volumes and the highest hour volume within the period. These analyses also suggest that this relationship is a much better than the relationship between 24-hour volumes and the highest hour volume in the peak period of interest.

It should also be remembered that the estimation of peak hour volumes from 24-hour volumes requires estimates of both the peak hour factor and the directional split factor (i.e., the portion of the peak hour volume in the peak direction). Due to the directional nature of peak period modeling techniques, the need for directional split factors is eliminated. The traffic count data analyses presented in Chapter III also suggest that directional split for a three-hour peak period are generally almost identical to the peak hour directional split. These analyses also suggest that there is little relationship between the 24-hour volumes and the peak hour directional split.

Assignment Refinement

It is well recognized that the results from a 24-hour assignment **should not** be used directly for project planning and design. Such assignment results need to be substantially refined before they can be used for project planning. NCHRP 255 presents a number of methods for the refinement of assignment results. The State Department of Highways and Public Transportation have also developed methods for the refinement of assignment results. Likewise, peak period assignments will also need substantial refinement before they can be used for project planning and design.

Alternative Modeling Approaches

The techniques for peak period travel demand modeling vary considerably in their levels of sophistication and, similarly, in the level of effort required for their development and application. The approaches used for peak period travel models can generally be grouped into three categories: trip table factoring; trip end factoring; and direct generation. The following briefly describes each of these approaches.

Trip Table Factoring Approach

Under this approach, the various 24-hour trip tables by purpose are factored to estimate the trips which either begin or end within a specified peak time period. These factored trip tables are then converted to origin-to-destination trip tables using production-to-attraction directional split factors. The resulting origin-to-destination trip tables are merged and assigned to the highway network.

There are actually two basic variations of this approach. The first (and probably the most common approach) is to apply the factors to vehicle trip tables. If the 24-hour model chain includes a mode split model, the vehicle trip tables are ouput from the mode choice. The second (and more complex variation) would be to apply the factors to the person trip tables. The resulting peak period production-to-attraction person trip tables would be input to the mode choice model to produce peak period production-to-attraction vehicle trip tables. These vehicle trip tables are then converted to origin-to-destination trip tables using production-to-attraction directional split factors. The resulting origin-to-destination trip tables are merged and assigned to the highway network. Since the mode choice modeling is typically a very expensive and complex step, this second option is generally a much less desirable option.

There are also various levels of complexity or sophistication that can be employed in the trip table factoring process. The simplest would be to use a single peak period factor and production-to-attraction direction split factor for a trip purpose for an entire urban area (i.e., the peak period factors and production-to-attraction directional split factors would vary only by trip purpose). The most complex option would be to develop these factors for each zone in the urban area (i.e., the peak period factors and the production-to-attraction directional split factors would vary both by trip purpose and by zone). Typically these zone specific factors are applied either to the zone's productions or to the zone's attractions (i.e., the factors are either row factors or column factors).

Trip End Factoring Approach

This approach is a more complex approach than the trip table factoring approach since it typically involves more steps in the travel demand modeling chain. Under this approach, peak period factors would be developed and applied to the zonal productions and attractions prior to trip distribution to estimate peak period productions and attractions. Again there is a wide range of levels of sophistication that can be used in developing and applying these factors. These factors can be developed by trip purpose for application either to person trip ends or to vehicle trip ends (depending on the modeling chain being used). Typically, the peak factors will vary by zone. Production-to-attraction directional split factors will still be needed to convert the production-to-attraction peak period trip tables to origin-to-destination. Because this approach involves more steps in the travel model chain, it will generally require more time and effort both in it's development and application.

Direct Generation Approach

This is generally the most complex approach used in peak period travel demand modeling. Under this approach, peak period trip generation models are developed and applied to estimate the peak period productions and attractions. In essence, an entire peak period model chain is developed and applied under this approach. Perhaps the key difference in this approach and the trip end factoring approach is that the peak period factors can vary with the independent variables being used for trip generation.

Approach Selection

There are, of course, many factors that should be considered in the selection of a peak period modeling approach for an urban area. These factors include: the data available for the development of the models; the amount of additional data that is needed for model development; the time and resources available for model development; the level of effort that will be required for applications; the anticipated needs and uses for peak period model results; the levels of congestion being experienced or anticipated during peak periods; and the level of sophistication and confidence in the current 24-hour model chain. It should also be recognized that the difference in the accuracy attained using a very sophisticated direct generation approach as compared to a fairly straightforward trip table factoring approach may be relatively small in comparison to the differences in the levels of effort for development and application. It would not be surprising to find that a fairly straightforward peak period factoring approach in one urban area yields a better match to observed peak period counts than a very sophisticated trip end factoring approach or direct generation approach in another urban area. In other words, the successful application of an approach in one urban area will not necessarily assure that that approach will yield the same quality of results in another urban area or that a more sophisticated approach would yield better results. Perhaps this is just another way of saying that a very sophisticated modeling approach which uses relatively weak input data will not necessarily provide better results than a less sophisticated approach with very good input data. Similarly, the use of a more sophisticated modeling approach with relatively weak input data will likely not significantly enhance the quality of the results but only give the illusion of improved precision.

From an accuracy perspective, it is generally reasonable to expect that the more variables affecting peak period travel which can be directly accounted for in the modeling approach (i.e., the more sophisticated the modeling approach) the better the quality of the results. Conversely, from a cost-effectiveness perspective, the simplest approach (i.e., the least costly approach to develop and use) which provides an adequate quality of results is probably better. It is likely that a peak period trip table factoring approach will meet the planning needs for most cities in Texas.

III. DATA ANALYSES

Two sets of data analyses were undertaken as a part of this study: analyses of traffic count data and analyses of travel survey data. The following summarizes some of the results and findings from these analyses.

Traffic Count Analyses

As noted in Chapter II, there are two key questions relating to peak period modeling which should be addressed using traffic count data. First, is it reasonable to expect that there is a good relationship between three-hour peak period volumes and the highest hour volume within that period? Second, is it reasonable to expect that this relationship is better than the relationship between the 24-hour volumes and the highest hour within the subject peak three-hour period? The following summarizes some of the key results and findings from these analyses.

Data Base

The traffic count analyses used detailed directional traffic count data obtained from the Houston-Galveston Area Council for 224 arterial street segments located throughout the Houston metropolitan area. These counts represent a wide range of operating conditions. For each of these 224 arterial street segments, directional 15-minute counts for an entire 24-hour period were available. It is felt that these counts provide a strong data base for the traffic count analyses. It is likely that there are few areas with as rich a data base representing as wide a range of operating conditions.

Definitions

To substantially simplify the subsequent presentation of the results and findings of the traffic count analyses, it is worthwhile to briefly review some of the terminology and data conventions used in the analyses.

Peak Period: Two specific three-hour periods were used in these analyses: (1) 6:30 a.m. to 9:30 a.m. and (2) 4:00 p.m. to 7:00 p.m. It was felt that these two would be generally representative of a morning peak period and an afternoon peak period. By using a fixed time period for all locations, the peak period volumes do not necessarily represent the highest three-hour volume at any given location for either the morning or afternoon. The use of fixed three-hour time periods was felt to be desirable for these analyses since peak period travel demand models will use a fixed three-hour time period.

<u>A.M. Peak Period:</u> The 6:30 a.m. to 9:30 a.m. peak period.

<u>P.M. Peak Period:</u> The 4:00 p.m. to 7:00 p.m. peak period.

<u>Peak Hour:</u> The one-hour period within the subject peak period in which the highest directional volume was observed for a given location. Hence, the specific one-hour period varies from location to location. When a peak hour was identified for a location, the same one-hour time interval was used to compute the peak hour volume in the off-peak direction. Hence, the peak hour volume in the off-peak direction will not necessarily represent the highest hourly volume for the peak period in the off-peak direction. The peak hour volume in the peak direction will, of course, be the highest directional volume for the subject peak period.

<u>A.M. Peak Hour:</u> The peak hour within the a.m. peak period.

<u>P.M. Peak Hour:</u> The peak hour within the p.m. peak period.

Peak Hour to 24-hour Relationships

Figure III-1 graphically displays the relationship of the a.m. peak hour nondirectional volumes to the 24-hour nondirectional volumes for the 224 locations in the Houston area. Figure III-2 displays this relationship for the p.m. peak hour nondirectional volumes. As expected, it can be observed that the peak hour nondirectional volumes generally tend to increase as the 24-hour nondirectional volume increases. It should be noted, however, that both the a.m. and p.m. peak hour nondirectional volumes are generally subject to a rather significant variance of estimate for a given 24-hour nondirectional volume level. In other words, the peak hour factors for a given 24-hour volume level can generally be expected to vary considerably. Comparing Figures III-1 and III-2, it can be observed that, as expected, the p.m. peak hour volumes are generally somewhat higher and are subject to a somewhat smaller variance for a given 24-hour volume level.

Figure III-3 graphically displays the relationship of the a.m. peak hour factor (needed to estimate the a.m. nondirectional volume) to the 24-hour nondirectional volumes for each of the 224 locations. Figure III-4 displays this relationship for the p.m. peak hour. As may be observed, both

FIGURE III-1

AM PEAK HOUR VS. 24-HOUR COUNT DATA

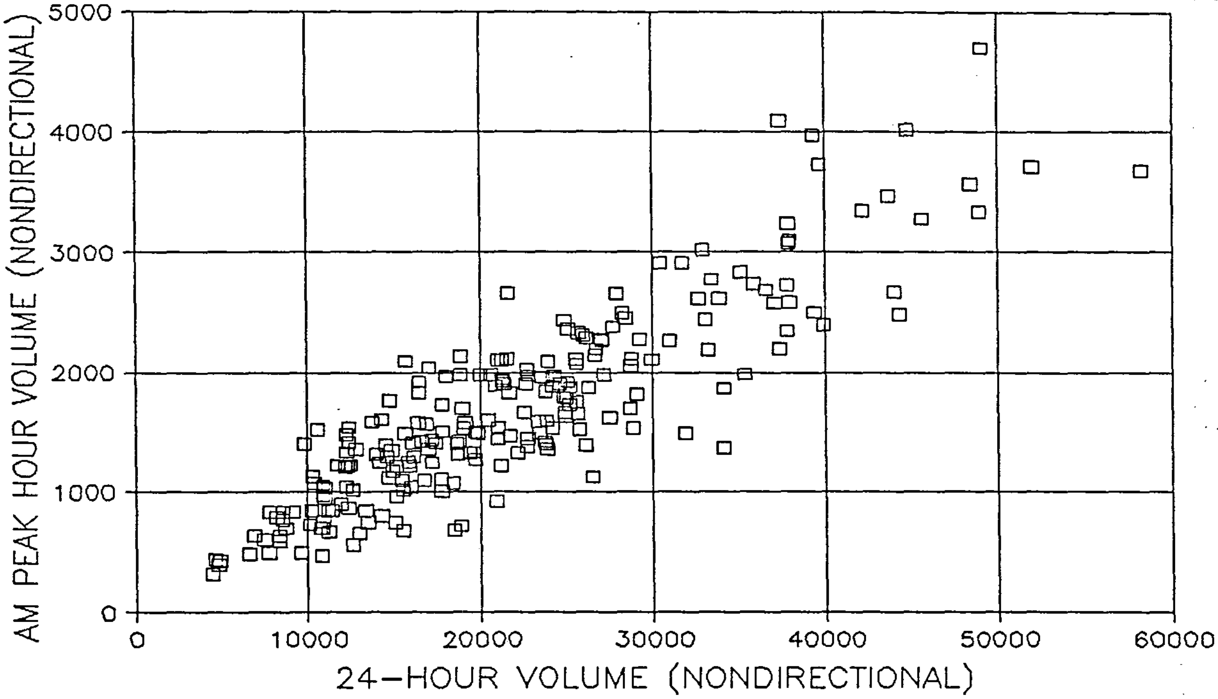


FIGURE III-2

PM PEAK HOUR VS. 24-HOUR COUNT DATA

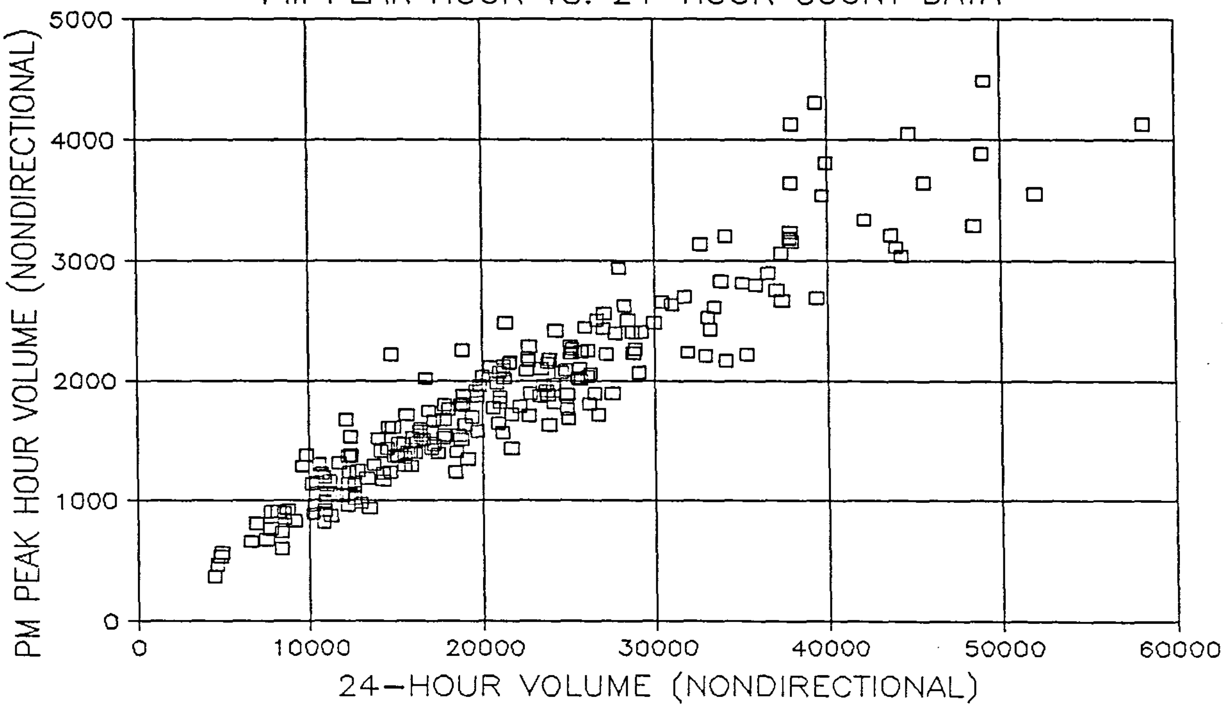


FIGURE III-3

AM PEAK HOUR VS. 24-HOUR COUNT DATA

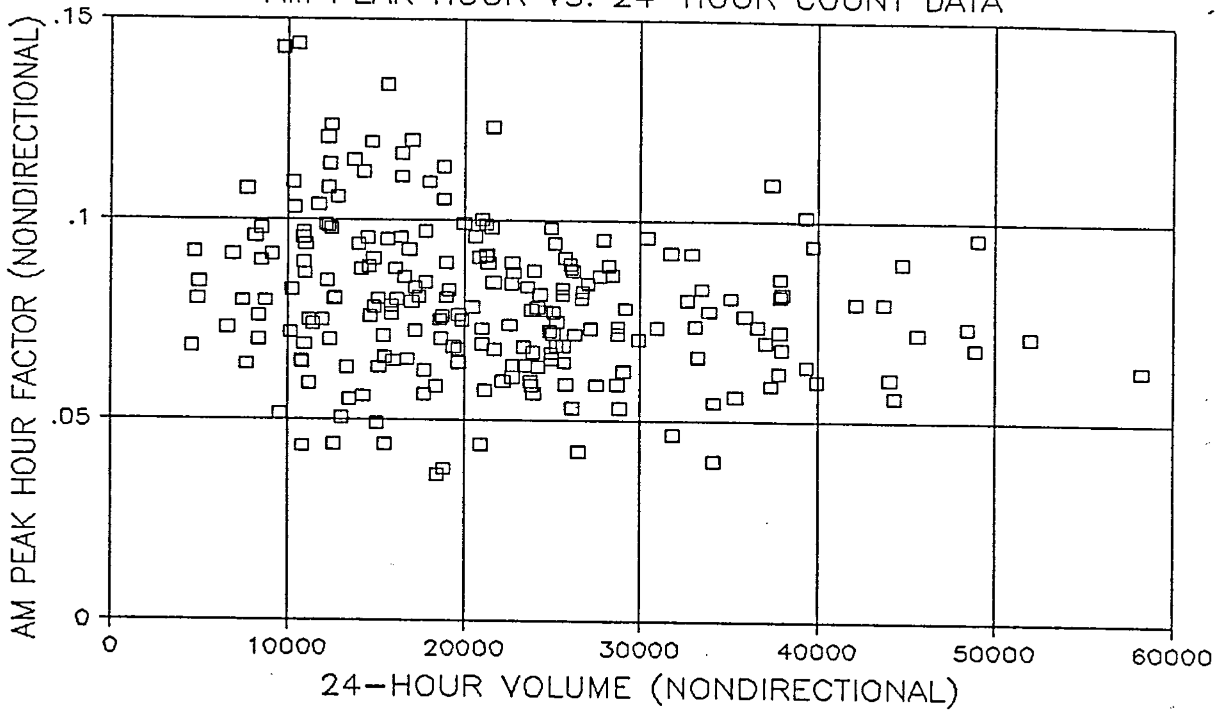
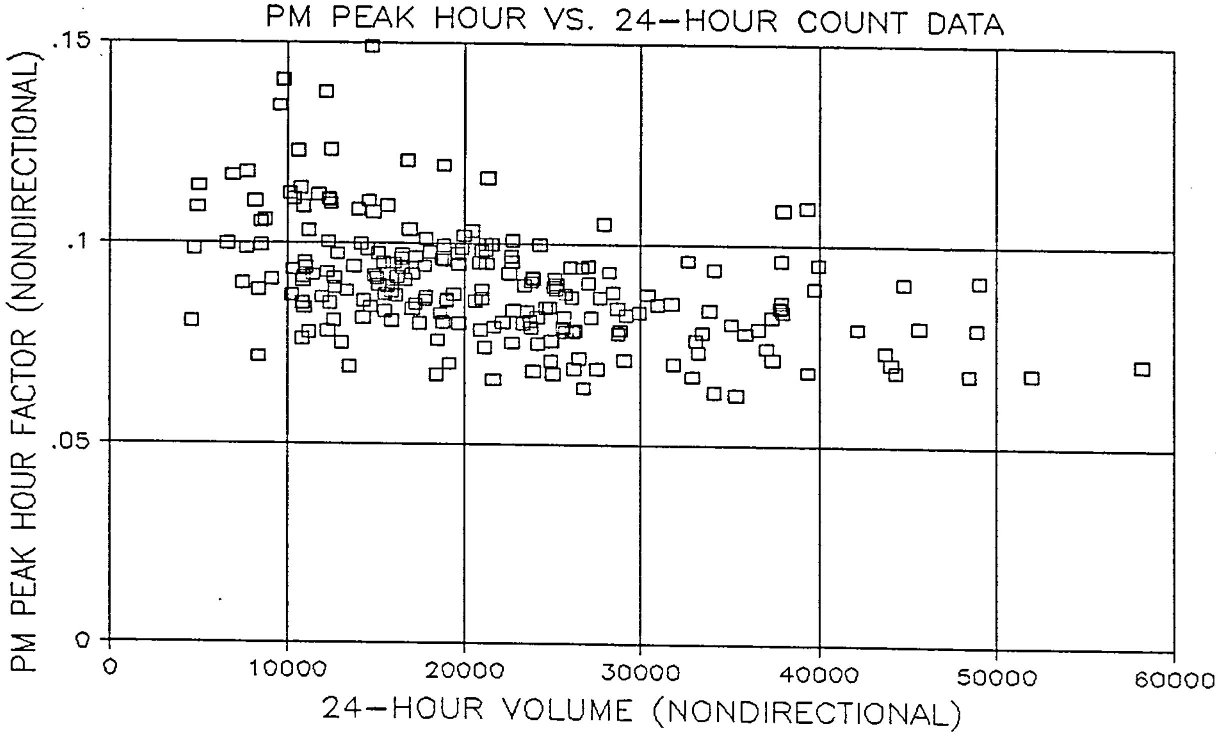


FIGURE III-4

PM PEAK HOUR VS. 24-HOUR COUNT DATA



the a.m. and p.m. peak hour factors are generally subject to a substantial variance of estimate for a given 24-hour volume level. The average p.m. peak hour factor is 0.09 which is clearly higher than the average a.m. peak hour factor of 0.08. It may also be observed that the p.m. peak hour factors are generally subject to a somewhat smaller variance of estimate for a given 24-hour volume level. It was felt that part of this variance of estimate might be attributable to the level of congestion which is not necessarily reflected in these data (e.g., a 4-lane street carrying 10,000 vehicles per day [vpd] is probably less congested during the peak hours than a 2-lane street carrying 10,000 vpd). To attempt to account for this, the 24-hour nondirectional volumes were divided by the number of through lanes. Figures III-5 and III-6 display the a.m. and p.m. peak hour factors, respectively, for the average 24-hour nondirectional volume per lane for the 224 locations. As may be observed from Figures III-5 and III-6, the average peak hour factor can generally be expected to decrease as the average daily nondirectional volume per lane increases. It may also be observed that the variance of peak hour factors for a given level of 24-hour volume per lane remains relatively large.

The average a.m. peak hour factor and the average p.m. peak hour factor were applied to the nondirectional volumes at each of the 224 locations to estimate the a.m. and p.m. peak hour nondirectional volumes. These estimated nondirectional peak hour volumes were compared to observed nondirectional peak hour volumes and the percent error for each of the locations was computed. Figures III-7 and III-8 display the percent errors for each of the 224 locations for the a.m. and p.m. peak hours, respectively. These data graphically depict the potential impacts of the variances observed with the peak hour factors.

To estimate the peak hour volume in the peak direction from nondirectional 24-hour volumes, both peak hour factors and peak hour directional split factors (i.e., the portion of the peak hour nondirectional volume in the peak direction) are needed. Figure III-9 graphically displays the relationship between the a.m. peak hour direction split factors and the average 24-hour nondirectional volume per lane. Figure III-10 displays this relationship for the p.m. peak hour directional split factors. As may be observed, the peak hour directional split factors are also subject to a very large variance. It is certainly reasonable to expect that this large variance in the directional splits accounts for much of the variance in the

FIGURE III-5

AM PEAK HOUR VS. 24-HOUR COUNT DATA

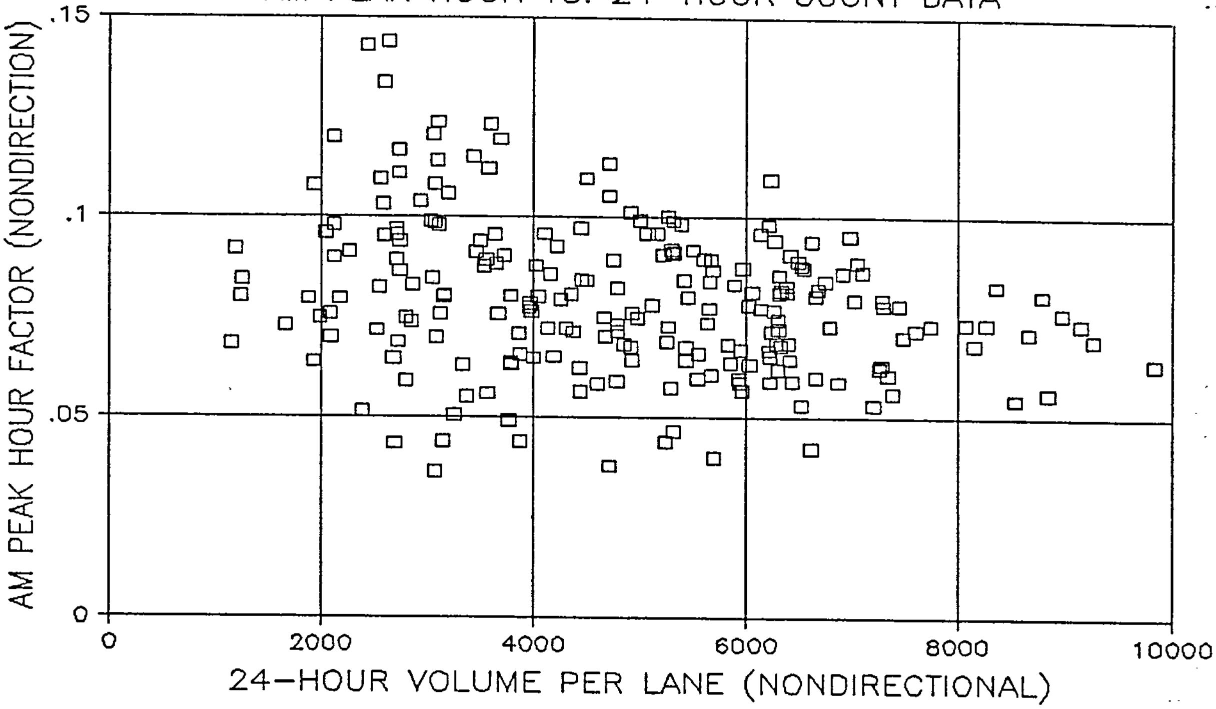


FIGURE III-6

PM PEAK HOUR VS. 24-HOUR COUNT DATA

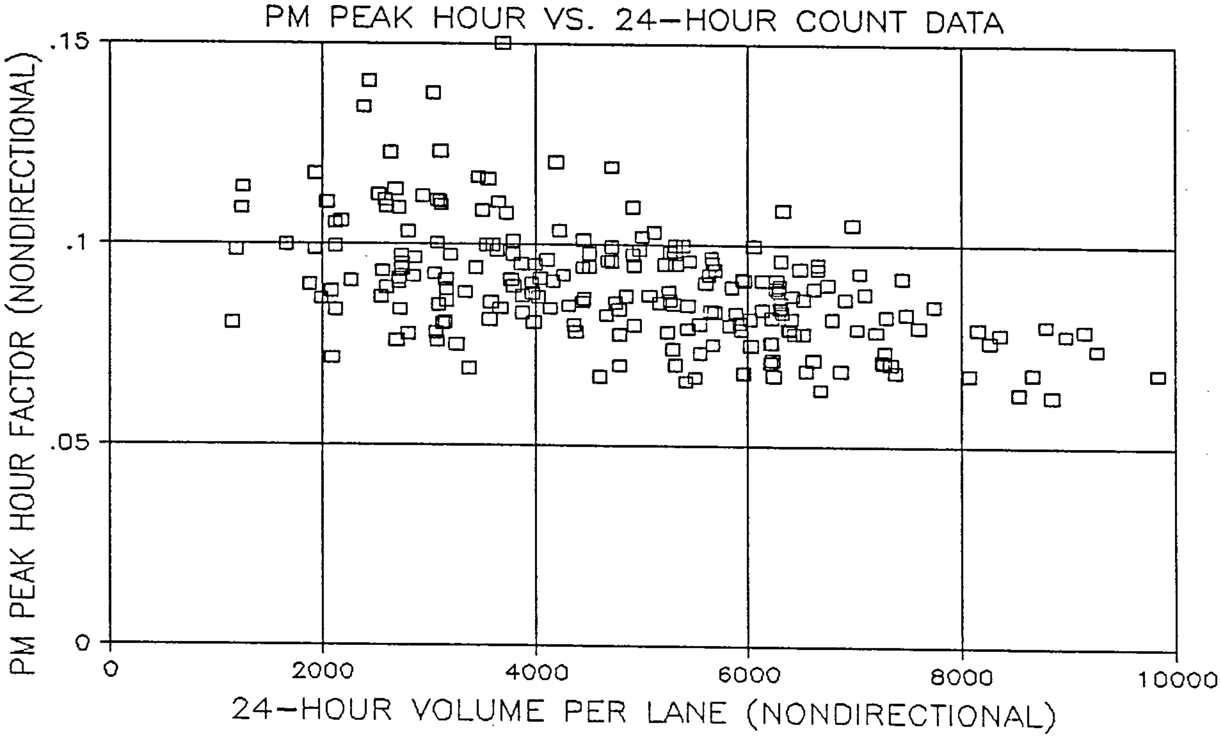


FIGURE III-7

AM PEAK HOUR VS. 24-HOUR COUNT DATA

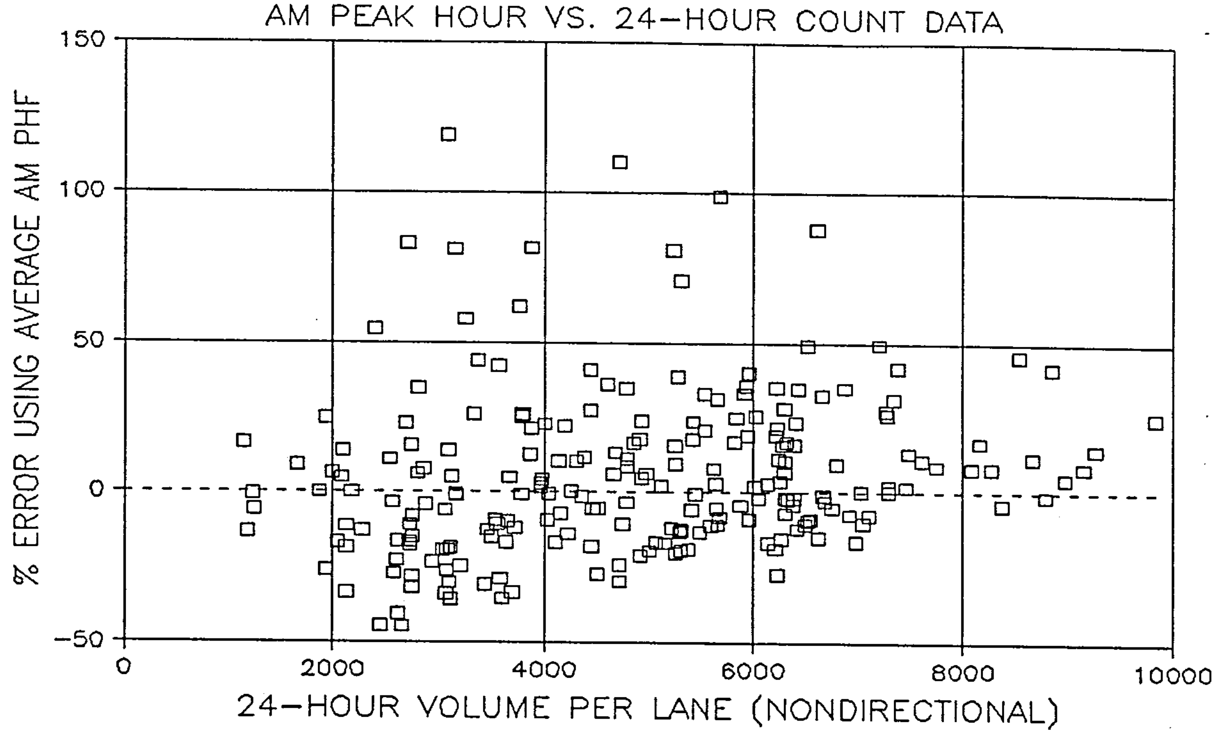


FIGURE III-8

PM PEAK HOUR VS. 24-HOUR COUNT DATA

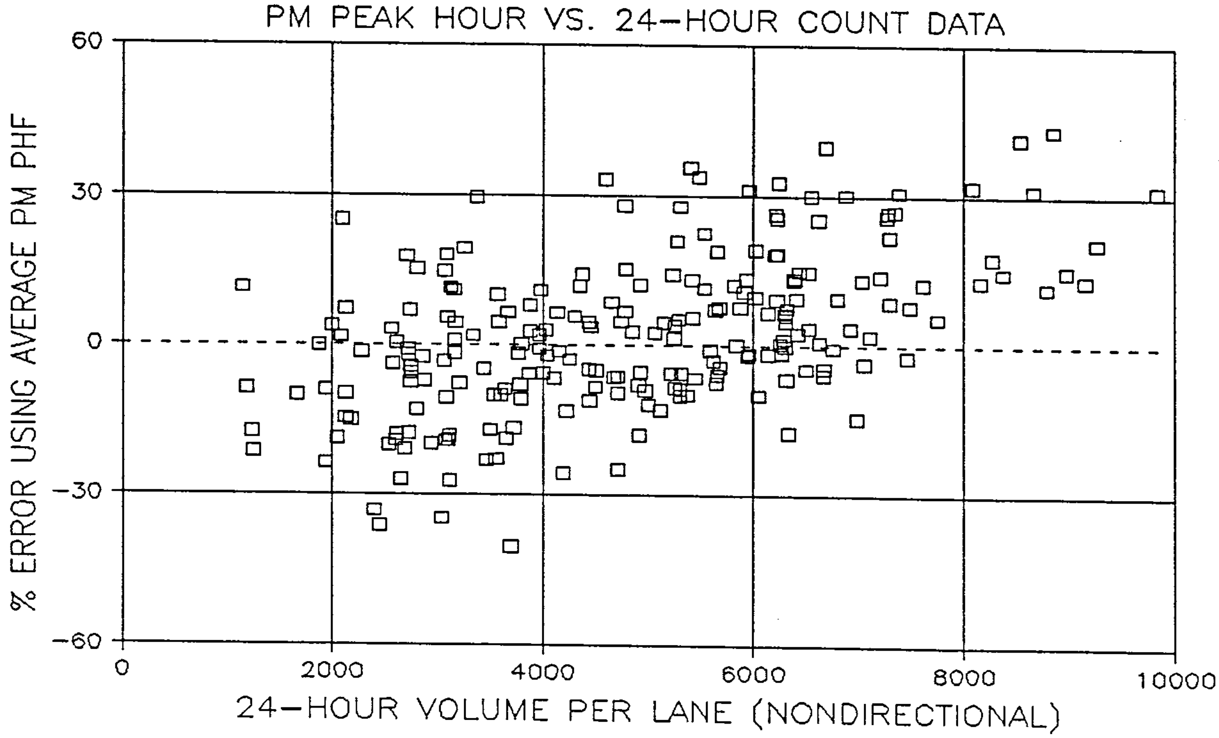


FIGURE III-9

AM PEAK HOUR VS. 24-HOUR COUNT DATA

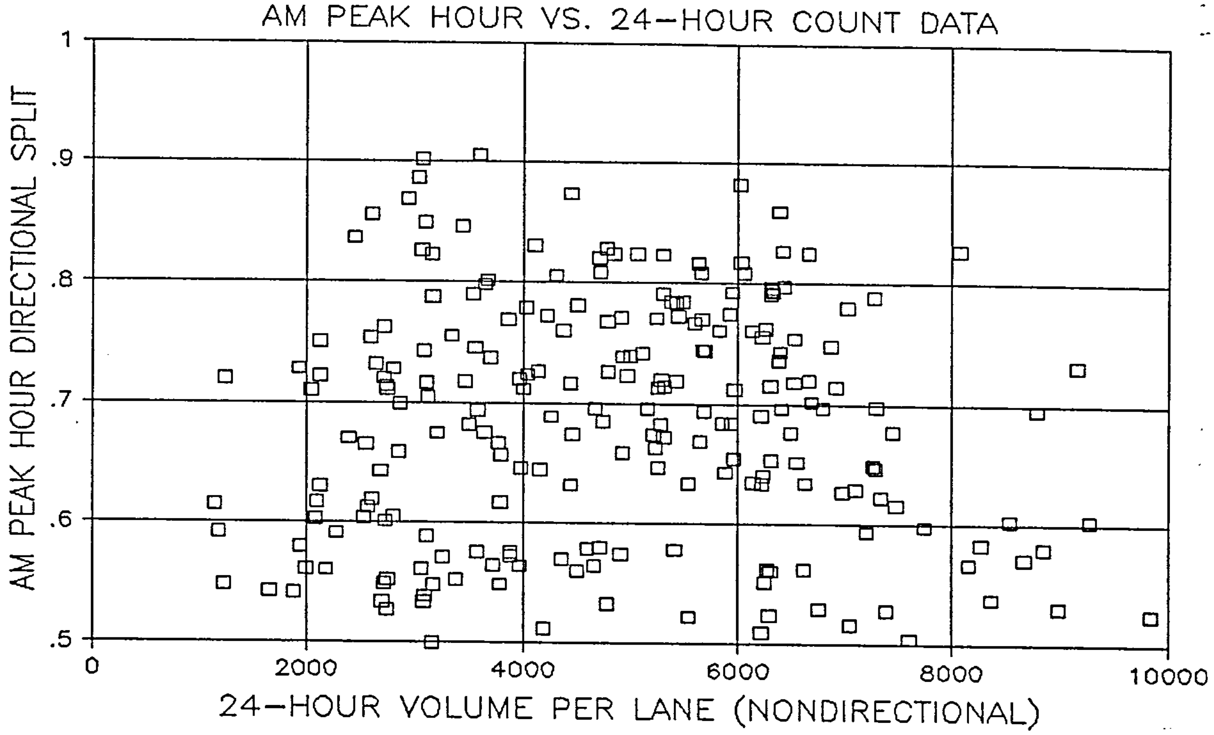
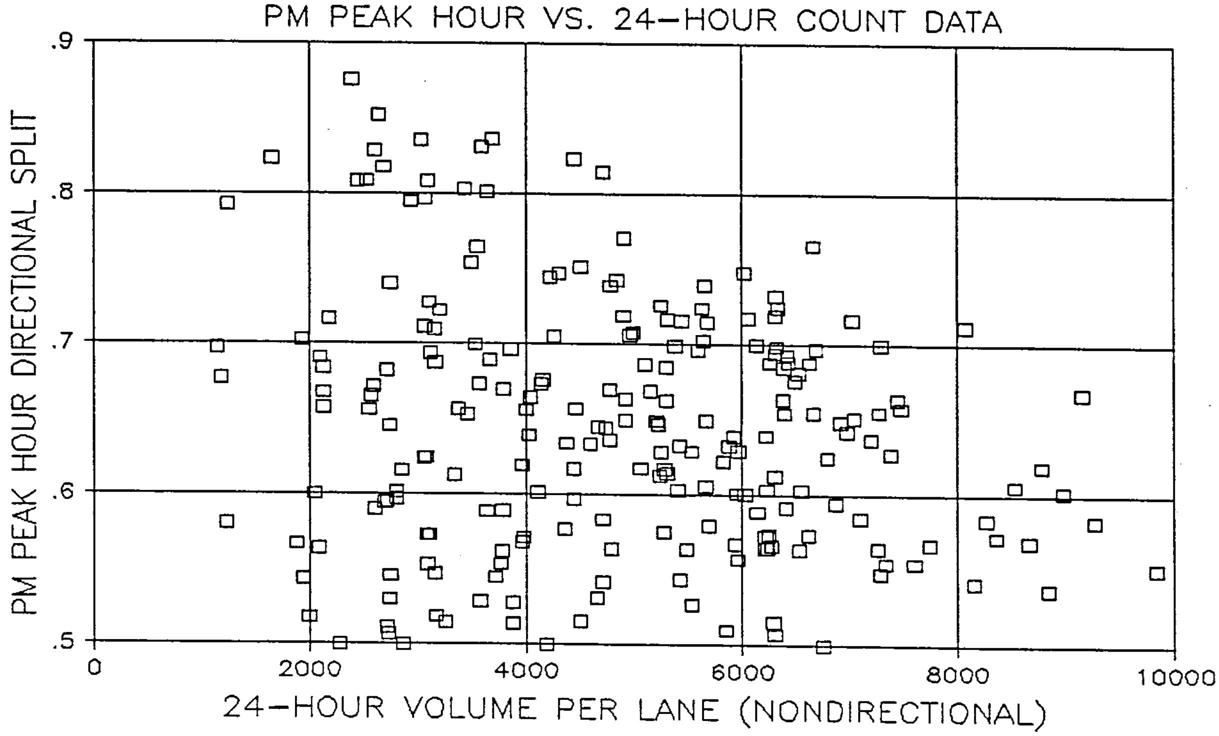


FIGURE III-10

PM PEAK HOUR VS. 24-HOUR COUNT DATA



peak hour factors.

These results clearly indicate that the use of a single "rule of thumb" peak hour factor and directional split factor to estimate the peak hour volume in the peak direction from 24-hour volume data is not very desirable. It is also clear that more information than simply the 24-hour volume and the number of lanes is needed to estimate the peak hour factor and directional split factor for a given location.

The estimation of 24-hour capacities for 24-hour assignment networks should also use these peak hour factors and directional split factors. Essentially, this process is the reverse of the process to estimate the peak hour peak direction volume from a 24-hour volume. The estimated peak hour directional capacity far a facility is divided by the anticipated directional split factor to estimate the nondirectional peak hour capacity. This nondirectional peak hour capacity is then divided by the expected peak hour factor to estimate the nondirectional 24-hour capacity. In effect, transportation analysts must estimate these factors during the network coding process. These 24-hour capacity estimates are subsequently used by the capacity restraint assignment model. Careful attention should be given to the estimation of these factors since they can significantly affect the quality of the capacity restraint assignment results.

Peak Hour to Peak Period Relationships

As may be recalled, there are two key questions to be addressed by these traffic count analyses: (1) is it reasonable to expect that there is a good relationship between three-hour peak period volumes and the highest hourly volume within the subject peak period? and (2) is it reasonable to expect that this relationship is better than the relationship to 24-hour volumes? The following attempts to address these questions.

Figure III-11 graphically displays the relationship of the a.m. peak hour nondirectional volumes to the a.m. peak period (i.e., 6:30 a.m. to 9:30 a.m.) for the 224 locations in the Houston area. Figure III-12 displays this relationship for the p.m. peak hour and p.m. peak period (i.e., 4:00 p.m. to 7:00 p.m.). It is felt that these data show a relatively good relationship between the peak hour and peak period volumes. Comparing Figures III-11 and III-12 to Figures III-1 and III-2, respectively, it is felt that the peak hour to peak period relationship is clearly a much better

FIGURE III-11

AM PEAK HOUR VS. AM PEAK PERIOD COUNT DATA

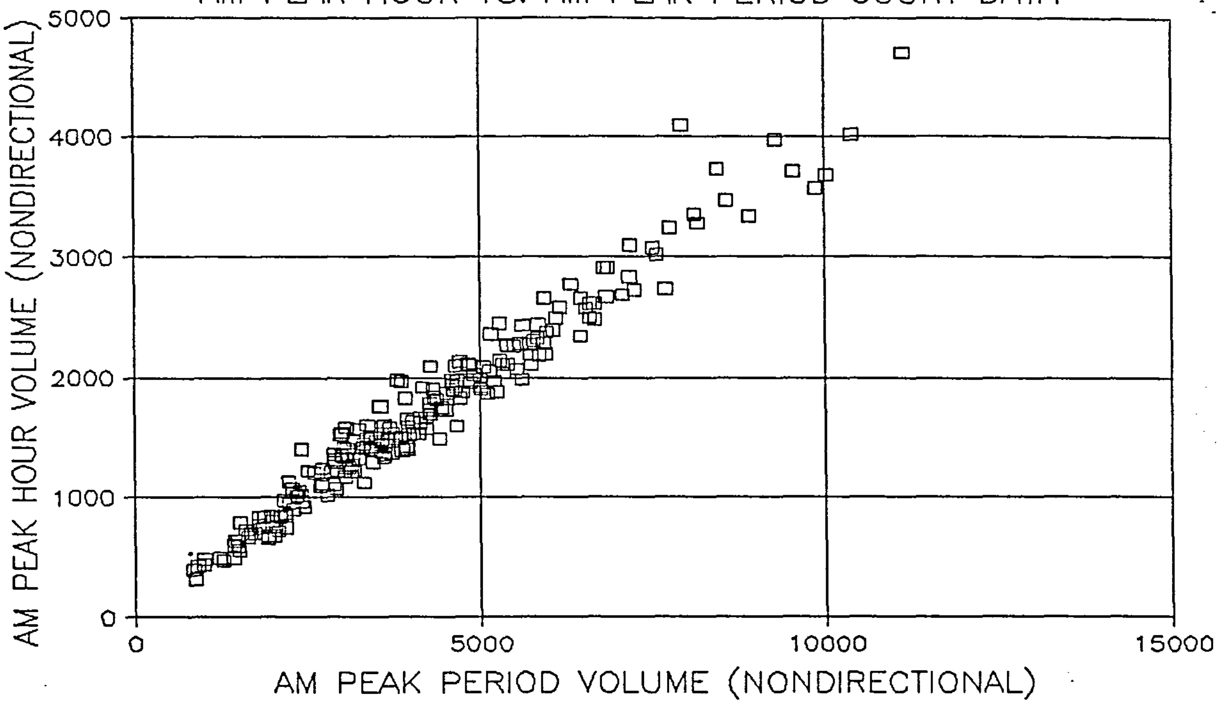
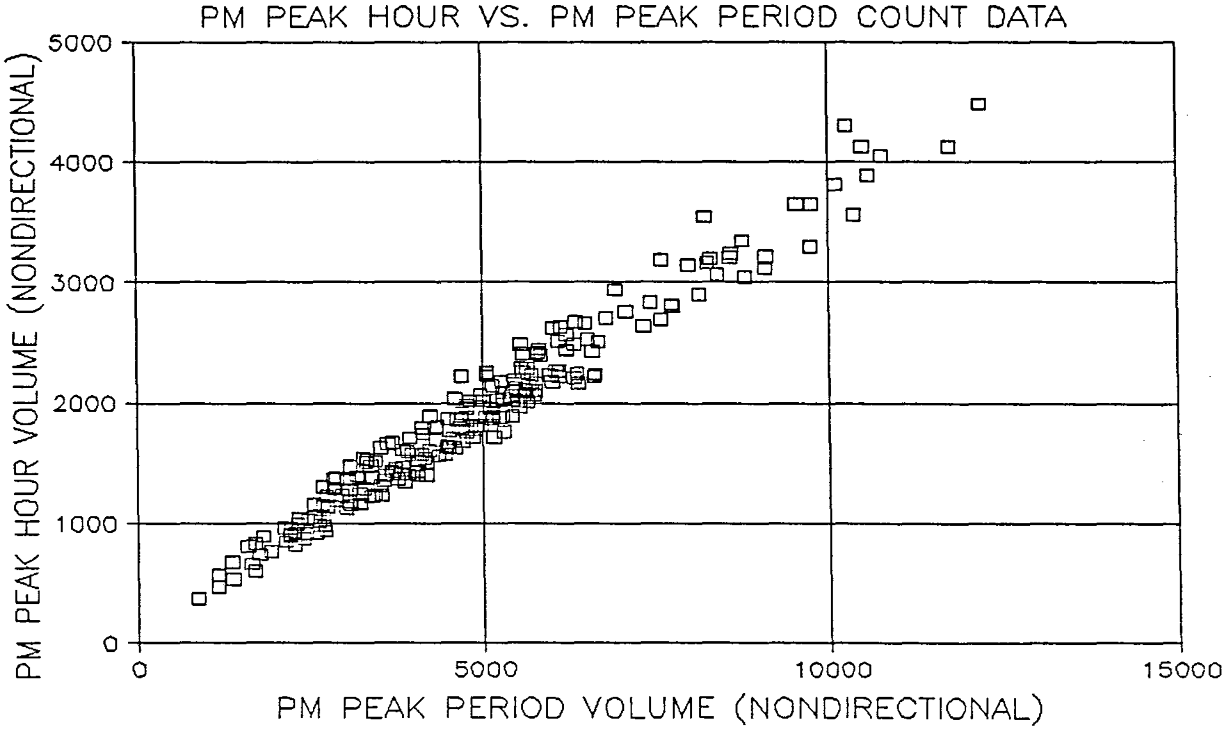


FIGURE III-12

PM PEAK HOUR VS. PM PEAK PERIOD COUNT DATA



relationship than the peak hour to 24-hour relationship. This is in part attributable to the fact that the peak period and peak hour nondirectional volumes implicitly include a directional split. Indeed, as will be shown later in this section, the peak hour directional splits track very closely with the peak period directional splits.

Unlike 24-hour assignments, peak period assignments focus on directional volumes. Figure III-13 graphically displays the relationship of the a.m. peak hour volume in the peak direction to the a.m. peak period volume in the peak direction. Figure III-14 displays this relationship for the p.m. peak hour and p.m. peak period. As with the nondirectional volumes, it was felt that these data show a relatively good relationship between the peak hour and peak period directional volumes.

In dealing with directional peak period data, a directional peak hour factor can be defined for the conversion of peak period volumes in the peak direction to the peak hour volume in the peak direction. Clearly such factors are **very** different from the traditional peak hour factors used with 24-hour volumes. Indeed the minimum value for such a directional peak hour factor is 0.33... (i.e., when the peak period volume is exactly three times the highest hourly volume in the peak period). Figures III-15 and III-16 displays these factors for the a.m. and p.m. peak periods respectively. While these data show some variance in the peak period factors at a given volume level, it is felt that this is a relatively small variance in comparison to the data shown in Figures III-3 - III-6. It can also be observed that these factors generally tend to decrease as the peak period volume increases.

The average a.m. peak hour factor and average p.m. peak hour factor were applied to the a.m. and p.m. peak period volumes in the peak direction at each of the 224 locations to estimate the a.m. and p.m. peak hour volumes in the peak direction. These estimated peak hour peak direction volumes were compared to the actual observed volumes and the percent error for each location was computed. Figures III-17 and III-18 display these percent errors for each of the 224 locations. Figures III-17 and III-18 use the same y-axis scale as Figures III-7 and III-8. It should be noted, however, that Figures III-7 and III-8 deal with nondirectional volumes while Figures III-17 and III-18 use peak direction volumes. Nevertheless, Figures III-17 and III-18 display much smaller percent errors than Figures III-7 and III-8.

Figures III-19 and III-20 graphically display the relationship between

FIGURE III-13

AM PEAK HOUR VS. AM PEAK PERIOD COUNT DATA

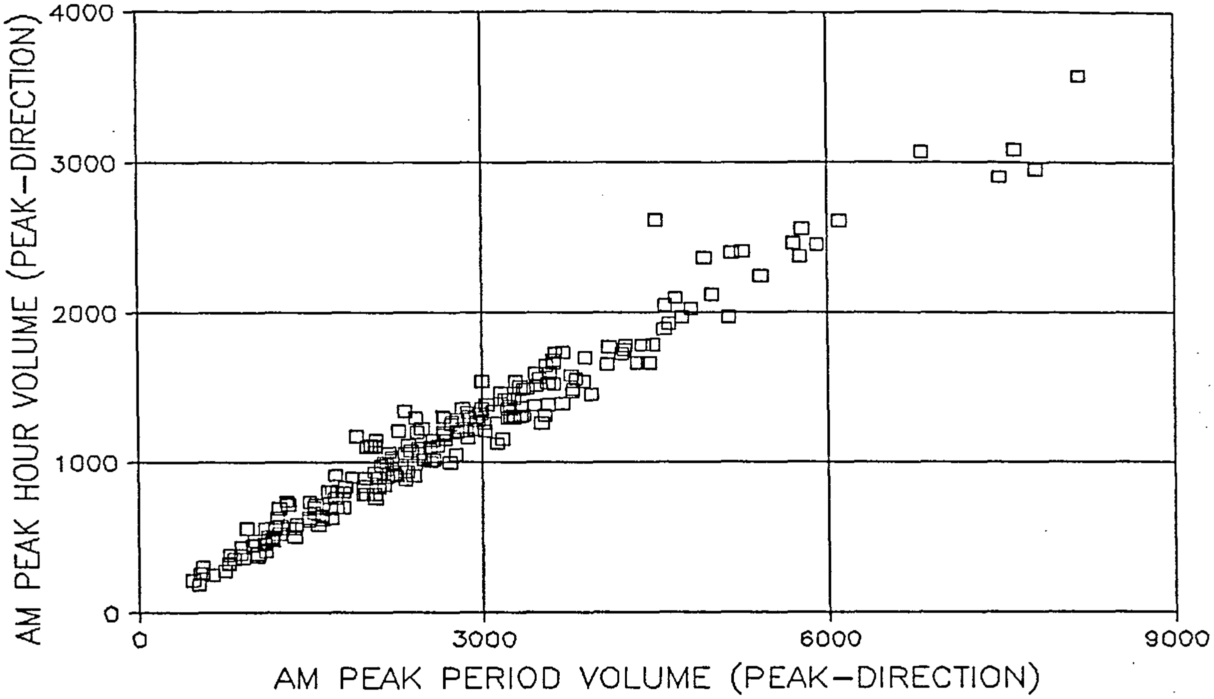


FIGURE III-14

PM PEAK HOUR VS. PM PEAK PERIOD COUNT DATA

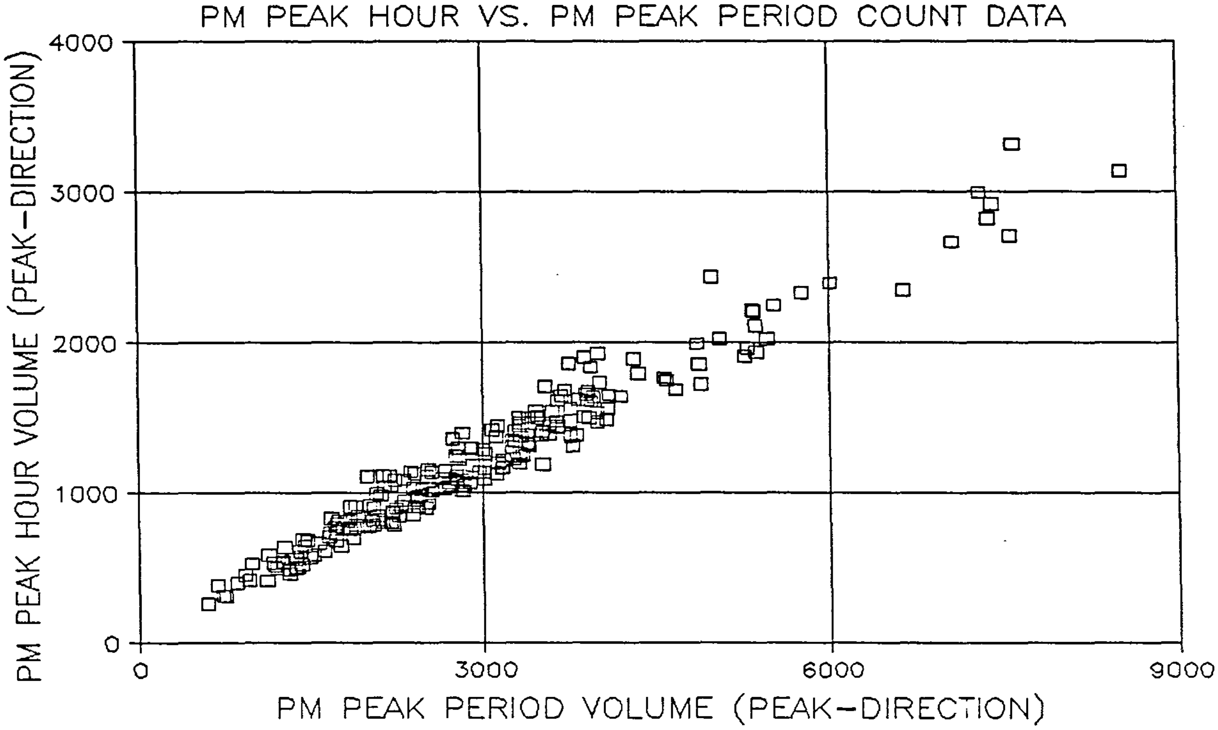


FIGURE III-15

AM PEAK HOUR VS. AM PEAK PERIOD COUNT DATA

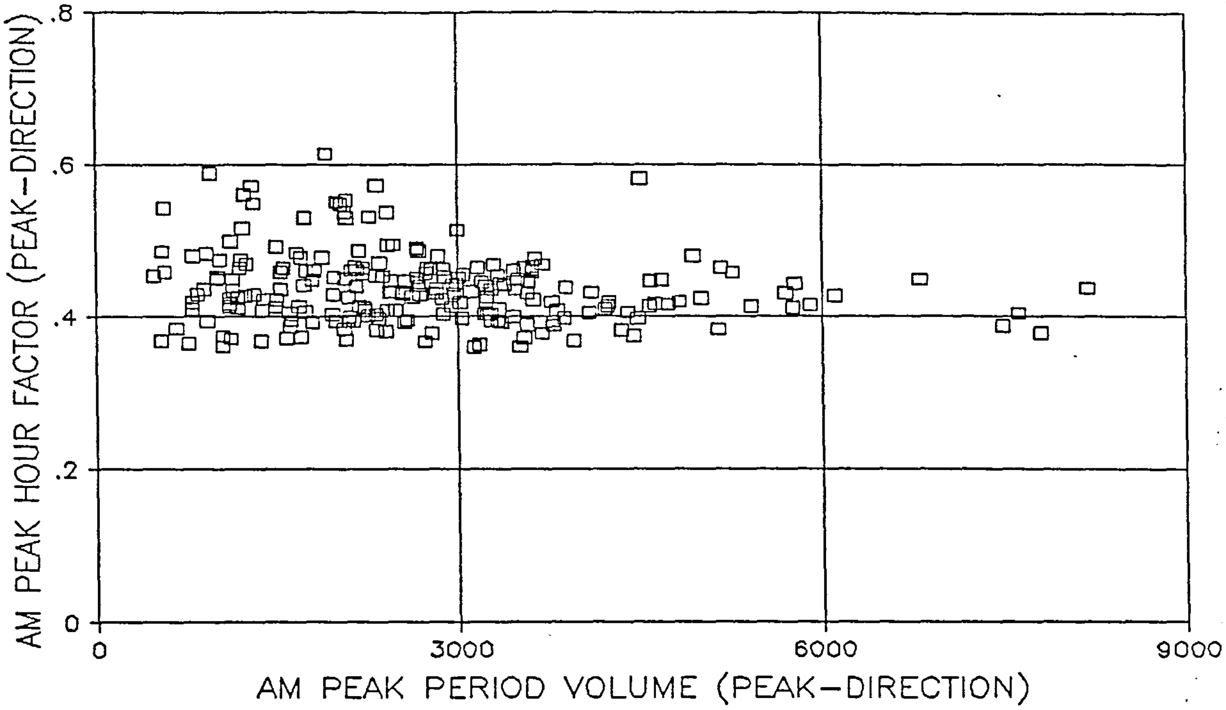


FIGURE III-16

PM PEAK HOUR VS. PM PEAK PERIOD COUNT DATA

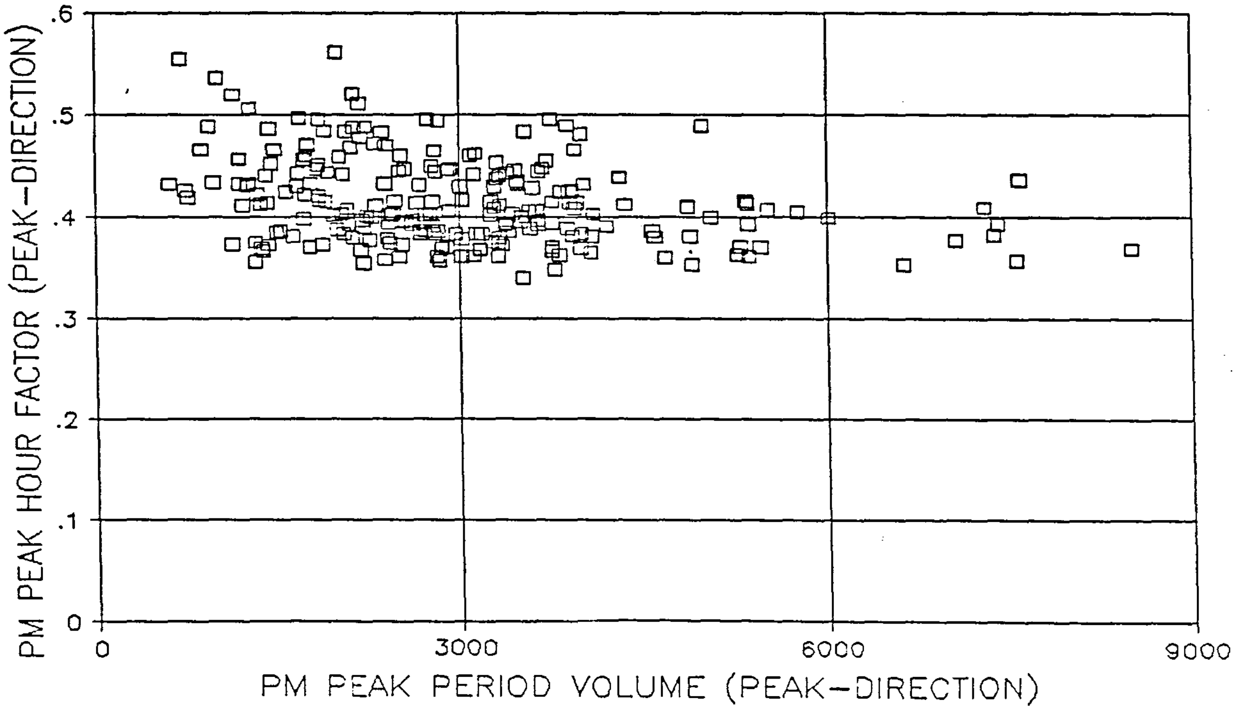


FIGURE III-17
AM PEAK HOUR VS. AM PEAK PERIOD COUNT DATA

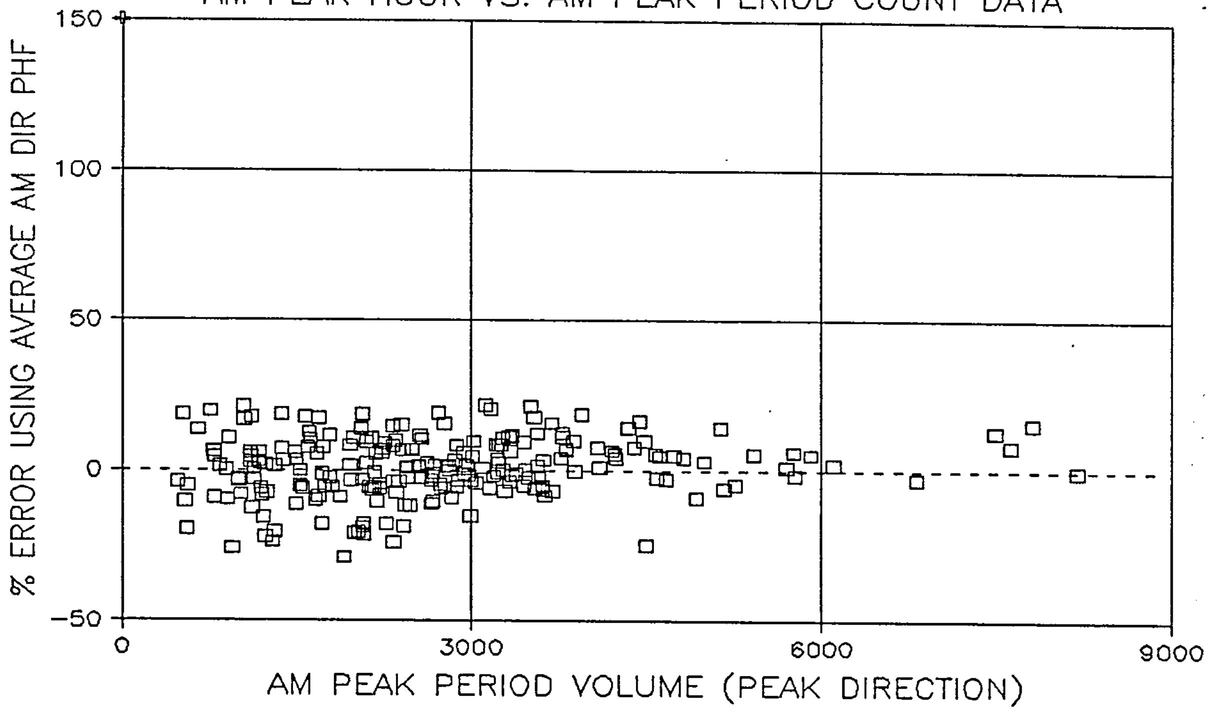


FIGURE III-18
PM PEAK HOUR VS. PM PEAK PERIOD COUNT DATA

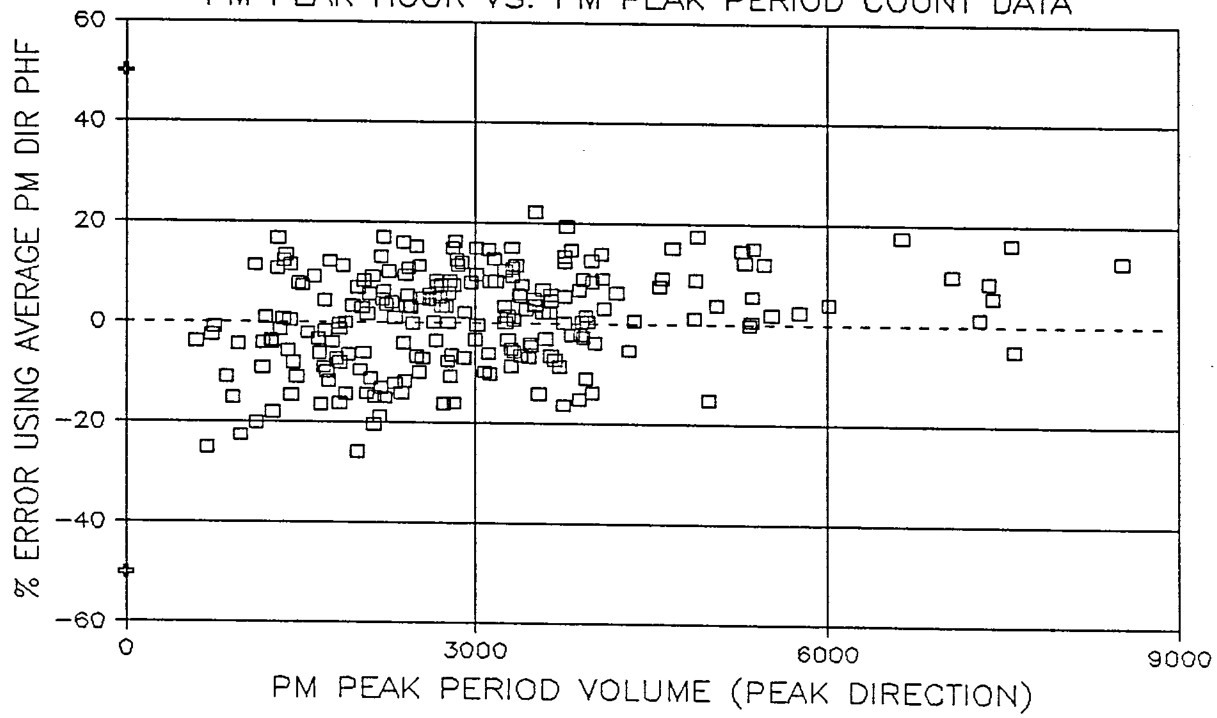


FIGURE III-19

AM PEAK HOUR VS. AM PEAK PERIOD COUNT DATA

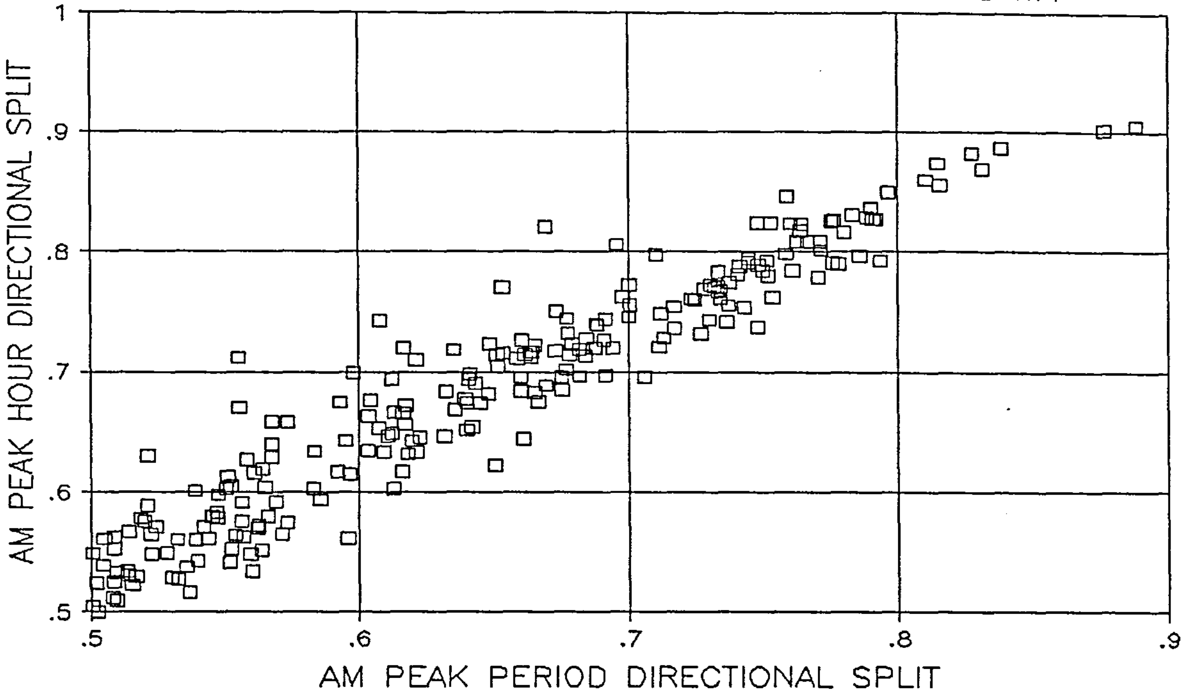
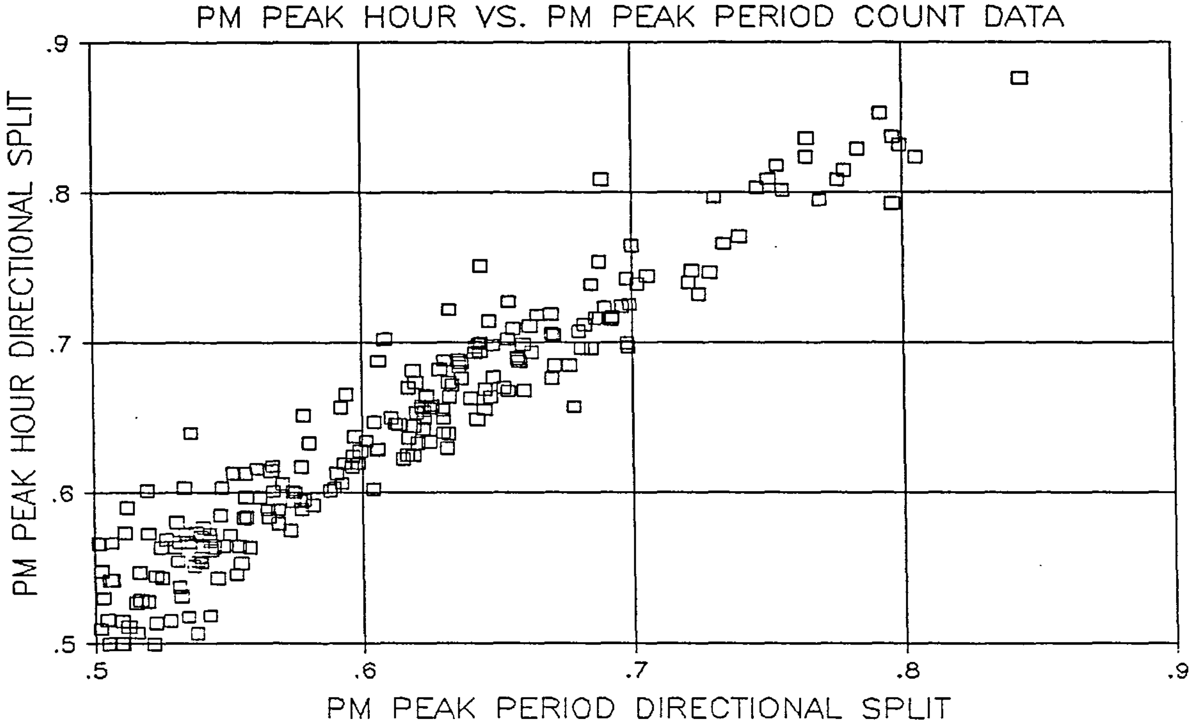


FIGURE III-20

PM PEAK HOUR VS. PM PEAK PERIOD COUNT DATA



the peak hour directional split and the peak period directional split for the a.m. and p.m. peak periods. It is felt that these data display a relatively good relationship between the peak hour and peak period directional splits and that the peak hour generally tracks very close to the peak period. Although close, the peak hour directional splits do tend to be slightly higher than the peak period directional splits. It should be remembered, however, that the peak hour factors are computed using the peak hour volume in the peak direction divided by the peak period volume in the peak direction. Hence, the use of these factors may generally tend to slightly overestimate the volumes in the off-peak direction.

In summary, it is felt that the count data for the 224 locations displayed a good relationship between the peak period volumes and the highest hourly volume within the peak period. Further, it is felt that this relationship is clearly better than the relationship between the peak hour volumes and the 24-hour volumes. One of the key factors accounting for this "better" relationship is that the peak period volumes by their nature have an implicit directional split which is generally very close to the peak hour directional split. Overall, it was felt that the data strongly support the feasibility of using a three-hour peak period travel demand modeling approach.

Travel Survey Data Analyses

Travel survey data represents a very important source of information needed for the application of peak period modeling techniques. Indeed it is travel survey data which must be relied upon to estimate the portion of the trips which are expected to occur during the subject peak period. As may be recalled from Chapter II, there are many approaches for estimating the trips expected to occur in the peak period ranging from a relatively straightforward factoring of 24-hour trip tables to the development of peak period trip generation rates. All these approaches rely on information from travel survey data to identify the portion of the daily trips by purpose expected to occur during the peak period.

The application of peak period modeling techniques also require the conversion of the peak period production-to-attraction trip tables to origin-to-destination trip tables. As discussed in Chapter II, this conversion process is considerably different from the procedures normally used with 24-hour trip tables. Again, the travel survey data for an urban area is normally the key data source for estimating the production-to-attraction directional splits for a subject peak period and trip purpose.

The portion of the urban travel expected to occur during a given peak period for a given trip purpose and the production-to-attraction directional splits for that trip purpose and time period can be expected to vary somewhat from urban area to urban area. In other words, it is unlikely that a single set of such factors can be developed for application in all urban areas. Nevertheless, it was felt that it would be worthwhile to process the travel survey for an urban area in Texas to provide some "typical" values for these factors. It must be **emphasized** that the data being presented in this section are simply examples and **are not** necessarily recommended factors for use in any urban area.

Data Base

The travel survey data used in these analyses were obtained from the Houston-Galveston Area Council (HGAC). This travel survey was conducted in the fall of 1984. The survey sampled 1,496 households throughout the Houston urban area.

In processing the data presented in this report, no household weighting or expansion factors were used. In essence, the results presented are direct observations from the travel survey data. By taking this approach, the actual number of observed trips used in the estimation of the factors presented is apparent from the data presented in the tables. Today's small sample travel surveys (such as the HGAC survey) **are not** random samples of an entire urban area like the travel surveys of the 1960's. Hence, in practice, it is generally desirable to process the expanded travel survey data or to use household weighting factors so that the results are more representative of the urban area.

Peak Period Data by Purpose

Three typical morning peak periods and three typical afternoon peak periods were selected for the data summaries presented. The morning peak periods selected were: 6:00 a.m. to 9:00 a.m.; 6:30 a.m. to 9:30 a.m.; and, 7:00 a.m. to 10:00 a.m. The afternoon peak periods selected were: 3:30 p.m.

to 6:30 p.m.; 4:00 p.m. to 7:00 p.m.; and 4:30 p.m. to 7:30 p.m. It should be noted that these examples selected **should not** be interpreted to imply that a peak period should begin on the hour or half-hour. Indeed, for a given application, it might be desirable to use a period such as 6:45 a.m. to 9:45 a.m. or 3:50 p.m. to 6:50 p.m. In practice, it is not unusual to use a time period such as 6:55 a.m. to 7:55 a.m. but to generally refer to the results as the 7:00 to 8:00 a.m. trips or travel.

In processing the travel survey data, the following were computed for each trip purpose and time period:

Total Trips for Trip Purpose: These results are simply the survey observed trips for the specified trip purpose and time period. The trips summarized were the trips with a reported start time within the specified time period.

Percent of Daily Trips: These results were computed by simply dividing the total trips for the time period by the 24-hour trips. It should be noted that this is the basic data needed for factoring from 24-hour trips to peak period trips.

Average Trip Length (miles): The HGAC used the zone-to-zone highway network distances (from the minimum time paths) to estimate the trip distance for each of the survey trips and appended the estimated distance to each trip report in the travel survey data set. These data were used to compute the average trip lengths reported.

Percent of Daily VMT: The vehicle miles of travel (VMT) was computed for each time interval by simply accumulating the estimated distance of each trip in the time interval.

Percent Directional Split: The production-to-attraction directional split is a key estimate needed to convert a production-to-attraction trip table to an origin-to-destination. The number of observed trips in the production-to-attraction direction and the number of observed trips in the attraction-to-production direction were accumulated for each time interval to compute this directional split. In the case of nonhome-based trips which are already handled in an origin-to-destination format in the modeling process, it can simply be assumed that these trips have a "50-50" production-to-attraction directional split. This nonhome-based directional split assumption is necessary to compute a more meaningful production-to-attraction directional split for the Total trips (i.e., the sum of the home-based work, the home-based nonwork, and the nonhome-based trips).

Table III-1 summarizes the home-based work trips from the travel survey data for the selected morning peak periods. Table III-2 displays the home-based work data for the selected afternoon time periods. As may be readily observed, the percent of the home-based work trips occurring in the morning

TABLE III-1

HOME-BASED WORK VEHICLE TRIPS

FROM THE HGAC TRAVEL SURVEY

	6:00 a.m. to 9:00 a.m.	6:30 a.m. to 9:30 a.m.	7:00 a.m. to 10:00 a.m.	24-hours
Total Trips for Trip Purpose:	1011	908	746	2274
Percent of Daily Trips:	44.46%	39.93%	32.81%	100.00%
Average Trip Length (miles):	10.79	9.97	9.51	10.86
Percent of Daily VMT:	44.18%	36.65%	28.72%	100.00%
Percent Directional Split:				
Production-to-Attraction:	98.52%	98.68%	98.53%	58.31%
Attraction-to-Production:	1.48%	1.32%	1.47%	41.69%

TABLE III-2

HOME-BASED WORK VEHICLE TRIPS

FROM THE HGAC TRAVEL SURVEY

	3:30 p.m. to 6:30 p.m.	4:00 p.m. to 7:00 p.m.	4:30 p.m. to 7:30 p.m.	24-hours
Total Trips for Trip Purpose:	650	626	561	2274
Percent of Daily Trips:	28.58%	27.53%	24.67%	100.00%
Average Trip Length (miles):	11.36	11.49	11.46	10.86
Percent of Daily VMT:	29.89%	29.13%	26.04%	100.00%
Percent Directional Split:				
Production-to-Attraction:	4.62%	4.31%	5.17%	58.31%
Attraction-to-Production:	95.38%	95.69%	94.83%	41.69%

time periods is **much higher** than for the afternoon periods. This difference is probably largely attributable to the fact that "trip linking" was not performed for the HGAC travel data. In view of this, these results would simply suggest that there is a greater tendency for people to make other trips or "stops" on their way home from work in the afternoon than on their way from home to work in the mornings. These data also suggest that there is a very significant portion of the home-based work trips which occur during time periods other than the morning and afternoon peak periods. In urban areas where "trip linking" is performed on the survey data, the percentage of the home-based work trips occurring in the morning and afternoon can be expected to differ from the results presented in these tables.

As would be expected, the vast majority of the morning home-based work trips are in the production-to-attraction direction and, conversely, in the attraction-to-production direction in the afternoon periods. Also as would be expected, the morning production-to-attraction directional split is slightly higher than the afternoon attraction-to-production directional split.

Tables III-3 and III-4 present the travel survey results for the home-based nonwork trip purpose. The nonhome-based travel survey results are presented in Tables III-5 and III-6. The travel survey results for all three trip purposes (i.e., the "total" trip purpose) are presented in Tables III-7 and III-8. It is felt that the data are probably fairly typical of the results that would be expected for most urban areas. Probably the key factor which must be considered in comparing the results with results from other urban areas is whether "trip linking" has been performed and, if so, the procedure used for "trip linking."

Sample Size Implications for Peak Hour Vs. Peak Period

As previously noted, the HGAC travel survey is probably typical of today's relatively small sample travel surveys (i.e., a sample size of 1,496 households). As reported in Tables III-7 and III-8, this small sample survey provides only 10,406 observed trips which must be stratified by trip purpose to develop the factors needed for peak period modeling. From Tables III-1 and III-2 it can be seen that there are only 2,274 home-based work trip observations for use in estimating the portion of the 24-hour work

TABLE III-3

HOME-BASED NONWORK VEHICLE TRIPS

FROM THE HGAC TRAVEL SURVEY

	6:00 a.m. to 9:00 a.m.	6:30 a.m. to 9:30 a.m.	7:00 a.m. to 10:00 a.m.	24-hours
Total Trips for Trip Purpose:	662	746	768	4590
Percent of Daily Trips:	14.42%	16.25%	16.73%	100.00%
Average Trip Length (miles):	6.40	6.39	6.12	6.16
Percent of Daily VMT:	15.00%	16.87%	16.62%	100.00%
Percent Directional Split:				
Production-to-Attraction:	80.06%	80.43%	78.26%	46.27%
Attraction-to-Production:	19.94%	19.57%	21.74%	53.73%

TABLE III-4

HOME-BASED NONWORK VEHICLE TRIPS

FROM THE HGAC TRAVEL SURVEY

	3:30 p.m. to 6:30 p.m.	4:00 p.m. to 7:00 p.m.	4:30 p.m. to 7:30 p.m.	24-hours
Total Trips for Trip Purpose:	1283	1358	1386	4590
Percent of Daily Trips:	27.95%	29.59%	30.20%	100.00%
Average Trip Length (miles):	5.98	6.03	5.98	6.16
Percent of Daily VMT:	27.16%	28.97%	29.35%	100.00%
Percent Directional Split:				
Production-to-Attraction:	33.67%	35.64%	39.68%	46.27%
Attraction-to-Production:	66.33%	64.36%	60.32%	53.73%

TABLE III-5

NONHOME-BASED VEHICLE TRIPS

FROM THE HGAC TRAVEL SURVEY

	6:00 a.m. to 9:00 a.m.	6:30 a.m. to 9:30 a.m.	7:00 a.m. to 10:00 a.m.	24-hours
Total Trips for Trip Purpose:	315	395	479	3542
Percent of Daily Trips:	8.89%	11.15%	13.52%	100.00%
Average Trip Length (miles):	8.22	8.13	8.41	7.31
Percent of Daily VMT:	10.00%	12.39%	15.55%	100.00%
Percent Directional Split:				
Production-to-Attraction:	50.00%	50.00%	50.00%	50.00%
Attraction-to-Production:	50.00%	50.00%	50.00%	50.00%

TABLE III-6

NONHOME-BASED VEHICLE TRIPS

FROM THE HGAC TRAVEL SURVEY

	3:30 p.m. to 6:30 p.m.	4:00 p.m. to 7:00 p.m.	4:30 p.m. to 7:30 p.m.	24-hours
Total Trips for Trip Purpose:	764	652	555	3542
Percent of Daily Trips:	21.57%	18.41%	15.67%	100.00%
Average Trip Length (miles):	7.78	7.91	7.99	7.31
Percent of Daily VMT:	22.95%	19.92%	17.13%	100.00%
Percent Directional Split:				
Production-to-Attraction:	50.00%	50.00%	50.00%	50.00%
Attraction-to-Production:	50.00%	50.00%	50.00%	50.00%

TABLE III-7

TOTAL VEHICLE TRIPS

FROM THE HGAC TRAVEL SURVEY

	6:00 a.m. to 9:00 a.m.	6:30 a.m. to 9:30 a.m.	7:00 a.m. to 10:00 a.m.	24-hours
Total Trips for Trip Purpose:	1988	2049	1993	10406
Percent of Daily Trips:	19.10%	19.69%	19.15%	100.00%
Average Trip Length (miles):	8.92	8.31	7.94	7.58
Percent of Daily VMT:	22.50%	21.60%	20.06%	100.00%
Percent Directional Split:				
Production-to-Attraction:	84.56%	82.77%	79.28%	50.12%
Attraction-to-Production:	15.44%	17.23%	20.72%	49.88%

TABLE III-8

TOTAL VEHICLE TRIPS

FROM THE HGAC TRAVEL SURVEY

	3:30 p.m. to 6:30 p.m.	4:00 p.m. to 7:00 p.m.	4:30 p.m. to 7:30 p.m.	24-hours
Total Trips for Trip Purpose:	2697	2636	2502	10406
Percent of Daily Trips:	25.92%	25.33%	24.04%	100.00%
Average Trip Length (miles):	7.79	7.79	7.66	7.58
Percent of Daily VMT:	26.63%	26.05%	24.30%	100.00%
Percent Directional Split:				
Production-to-Attraction:	31.41%	31.64%	33.97%	50.12%
Attraction-to-Production:	68.59%	68.36%	66.03%	49.88%

trips which will likely occur during a specified peak period. The number of home-based work trip observations for the three-hour peak periods ranged from 561 to 1,001. Similarly, the number of home-based nonwork trip observations (see Tables III-3 and III-4) for the three-hour peak periods ranged from 662 to 1,386 and the nonhome-based (Tables III-5 and III-6) ranged from 315 to 764.

If these data were processed for one-hour periods, it is certainly reasonable to expect that the number of observed trips for a one-hour period would be substantially less than for a three-hour period which encompasses the one-hour period. From a statistical perspective, it is certainly reasonable to expect that observations for a one-hour period will generally be more susceptible to the effects of sampling noise than the observations for a three-hour period encompassing the one-hour period. Stated differently, we can generally be more confident in the results for a three-hour period than for a one-hour period within the three-hour period. In view of today's small sample travel surveys, it is felt that this argument also clearly favors the use of three-hour peak periods for peak period travel demand modeling than the use of one-hour intervals.

IV. DEVELOPMENT AND TESTING

The Texas Trip Distribution Package and the Texas Assignment Package software did not provide some of the key capabilities needed for the implementation of a peak period travel demand modeling procedure. A major thrust of this research effort, therefore, focused on the development and testing of new routines in these software packages needed for the development of peak period traffic assignments. This chapter summarizes the new software developed in this study and the software testing performed.

Software Implementation

In reviewing the various peak period modeling approaches (discussed in Chapter II), it became apparent that three basic capabilities were not currently available in the Texas Trip Distribution and Texas Traffic Assignment Packages which are needed to support a peak period travel modeling. The three new capabilities needed are:

1. The capability of converting peak period production-to-attraction trip tables to origin-to-destination trip tables.
2. The capability of conveniently inputting directional link capacities and, if desired, directional link speeds.
3. The capability of applying a directional capacity restraint assignment procedure.

Three new routines were developed and implemented to provide these new capabilities. The first (i.e., the new "PEAKOD" routine) was implemented in the Texas Trip Distribution Package. The remaining two (i.e., the new "ASSEMBLE PEAK NETWORK" routine and the new "PEAK CAPACITY RESTRAINT" routine) were implemented in the Texas Traffic Assignment Package. The following briefly discusses each of these three new routines.

The "PEAKOD" Routine

The primary need to be addressed by this new routine is the capability to convert a peak period production-to-attraction trip table to an origin-to-destination trip table. Since the preferred peak period modeling approach for most urban areas in Texas will likely be the factoring of the

24-hour trip tables to represent the peak period, it was very desirable to develop this software to provide for simultaneously factoring the 24-hour trip interactions and converting the resulting **unrounded** peak period interaction volumes from a production-to-attraction orientation to an origin-to-destination orientation. The following are some of the salient features of the new "PEAKOD" routine:

- The new routine provides the capability for factoring a 24-hour trip table to a peak period trip table and at the same time converting the unrounded peak period interaction volumes from a production-to-attraction orientation to an origin-to-destination format. The residual rounding to integer trips is not performed until after the conversion to origins-to-destinations.

- This routine also provides the capability of converting a peak period trip table from a production-to-attraction orientation to an origin-to-destination orientation. This is accomplished by simply using peak period factors of 1.0 and providing the desired production-to-attraction directional splits.

- The routine provides considerable flexibility in specifying the desired peak period factors and the desired production-to-attraction directional splits. For example, a single peak period factor and a single production-to-attraction factor can be simply specified for the entire trip table. At the other extreme, different peak period factors and production-to-attraction directional split factors can be specified for each zone. Alternatively, areawide default factors can be specified and, hence, individual zonal factors can be specified only for those zones which can be expected to differ significantly from the areawide default factors.

- The routine uses a new prioritized residual rounding technique. This new prioritized residual rounding technique was developed as a part of this study effort to reduce the "noise" in the resulting zonal attraction volume balances often experienced with the more traditional residual rounding techniques.

The operating instructions and data card specifications for the new "PEAKOD" routine are provided in Appendix A. These instructions and specifications were prepared for insertion into the operating manual for the Texas Trip Distribution Package.

The "ASSEMBLE PEAK NETWORK" Routine

The new "ASSEMBLE PEAK NETWORK" routine in the Texas Assignment Package is basically a modified version of the "ASSEMBLE NETWORK" routine. Some of the key features of this new routine are:

- O The new routine inputs link data in a new link data card format that provides for the input of directional counts, directional capacities, and directional speeds.
- O The new routine and link data format also provides the option of inputting the number of lanes by direction.
- O The new routine builds the "$NETWORK" data set which is input to the new "PEAK CAPACITY RESTRAINT" routine.

The operating instructions and data card specifications for this new "ASSEMBLE PEAK NETWORK" routine are included in Appendix B. These operating instructions and specifications were prepared for insertion into the Operating Manual for the Texas Assignment Package.

The "PEAK CAPACITY RESTRAINT" Routine

The "ASSIGN SELF-BALANCING" routine in the Texas Assignment Package is specifically implemented for application to 24-hour networks. Indeed, this old routine uses the nondirectional volumes and nondirectional capacities to estimate nondirectional speeds between iterations of the capacity restraint procedure. The nondirectional orientation of this routine is simply not appropriate for peak period applications. The new "PEAK CAPACITY RESTRAINT" routine developed and implemented under this study is essentially a modified version of the "ASSIGN SELF-BALANCING" routine designed to handle peak period assignments. Some of the salient features of this new routine are:

- O The new routine uses the directional volumes and directional capacities to estimate directional speeds between iterations of the capacity restraint procedure. The new routine provides the same capacity restraint functions as the old routine. Again, the key difference is that the function is applied directionally.
- O The tabular outputs summarizing the capacity restraint assignment results were also modified to summarize the directional volumes, the directional capacities, the directional speeds, the directional volume-to-capacity ratios, and the number of lanes by direction.

The operating instructions and data specifications for the new "PEAK CAPACITY RESTRAINT" routine are provided in Appendix C. Again, these instructions and specifications were prepared for insertion into the operating manual for the Texas Assignment Package.

Software Testing

Substantial testing was performed to try to assure that the new routines are functioning correctly. The initial testing and "debugging" of these routines were performed using some simple test data sets with a very small number of zones.

Subsequent testing was performed using data provided by the State Department of Highways and Public Transportation from the Tyler Urban Transportation Study. The preliminary tests (using Tyler data) of the "ASSEMBLE PEAK NETWORK" and the "PEAK CAPACITY RESTRAINT" routines used the 24-hour network and the 24-hour trip table. The 24-hour network was converted to a 24-hour directional network by simply dividing the nondirectional counts and nondirectional capacities by two and reformatting the resulting link data into the new link data format. The number of lanes by direction were estimated from the capacity data. The 24-hour link data in the new format was input to the new "ASSEMBLE PEAK NETWORK" routine to build the 24-hour network. The new "PEAK CAPACITY RESTRAINT" routine was applied to perform a five-iteration capacity restraint assignment. At the same time, the old "ASSIGN SELF-BALANCING" routine was applied to produce the customary 24-hour capacity restraint results. Comparison of the results from these two assignments confirmed that the new routine was functioning properly.

The next step was to test all three new routines. The "PEAKOD" routine was applied to the Tyler trip tables by purpose to convert the 24-hour production-to-attraction trip tables to peak period origin-to-destination trip tables. The peak period factors and production-to-attraction directional split factors used in this application were borrowed from the HGAC travel survey data. Trip end summaries (prepared using the "GET" routine) were carefully reviewed to be sure that the new routine was applying the peak period factors correctly and the peak period production-to-attraction directional split factors correctly. The resulting origin-to-destination peak period trip tables by purpose were summed (using the "SUM" routine) and prepared for input to the assignment package (using the "PACK" routine).

The next step was to prepare a set of peak period link data. Using the estimated number of lanes for each link in the 24-hour directional link data set, directional peak capacities were estimated and a peak period set of link data prepared. Using the peak period link data and the peak period trip table, the "ASSEMBLE PEAK NETWORK" and the "PEAK CAPACITY RESTRAINT" routines were applied to produce a five-iteration peak period capacity restraint assignment. The subsequent review of the assignment results did not find any problems in the new software. Based on these tests it was felt that the software was ready for applications and provides the desired peak period assignment capability.

APPENDIX A

OPERATING INSTRUCTIONS AND DATA SPECIFICATIONS

FOR THE "PEAKOD" ROUTINE

PEAKOD: Function

The PEAKOD routine is designed to perform two functions: (1) it factors a 24-hour trip matrix to a peak period trip matrix; and (2) it converts the factored trip matrix from a production-to-attraction trip matrix to an origin-to-destination trip matrix.

Execution Requirements

PEAKOD is an independent routine. It requires no initialization. PEAKOD destroys some key arrays.

Parameter References

Required	Defined
AMOUNT = [110000]	MT = SWTTRP
	SIZE

Data Set References

Input	Scratch	Output
MT = [2]	SORTIN = 9	SWTTRP = [24]
	SORTOUT = 10	

Data Card References

Input

PK-PARAMS (Required)

PK-FACTORS (Optional)

Operation

The PEAKOD routine reads the PK-PARAMS card and the optional PK-FACTORS cards. The routine then proceeds to read the input production-to-attraction trip matrix, applies the user specified peak period factor to each nonzero interaction to estimate the peak period production-to-attraction volume, applies the user specified directional split factor to split the peak period interchange volume by direction and outputs the portion expected to move in the attraction-to-production direction along with the zone pair numbers to the SORTIN data set. The SORTIN data set is sorted producing the SORTOUT data set. As the input trip matrix is read, the user specified factors are applied to estimate the peak period portion of each interaction expected to move in the production-to-attraction direction. These estimates are merged with the sorted peak period attraction-to-production directional interchange volumes to produce the origin-to-destination volumes. Residual rounding is performed on each row of the origin-to-destination trip matrix. The resulting origin-to-destination trip matrix is written on the SWTTRP data set.

Printed Output

The PK-PARAMS and PK-FACTORS cards read by the routine are printed. The total number of trips in the input trip matrix and the total number of trips in the output trip matrix are printed.

User Considerations

The information from the last HEADING card encountered and the run date are used in the header record of the new trip table output on the SWTTRP unit. The user is, therefore, encouraged to input a HEADING card with appropriate descriptive information regarding the trip table being built. The new HEADING card can be inserted in front of the PK-PARAMS card.

Sequence of Subroutines Called

```
                        MAIN
                         |
                       DIRECT
                         |
         ------------------------------
         |         |         |        |
       VERIFY    PKFAC      SORT    PKMRG
                   |         |        |
                  NAME     INVOKE   TTIRND
```

Summary of Individual Routines

DIRECT: In the execution of the PEAKOD routine, the subroutine DIRECT performs the following operations:

1. If the value of the parameter N is zero, the header record of the MT data set is read to define the value of N.
2. The subroutine VERIFY is called.
3. The subroutine PKFAC is called.
4. The subroutine SORT is called.
5. The subroutine PKMRG is called.
6. The value of the parameter MT is set equal to the value of the parameter SWTTRP.
7. Control is returned to the program MAIN.

VERIFY: This subroutine checks the parameters N, NF, and NR to determine if their values have exceeded the capacity of the package.

PKFAC: This subroutine first reads the PK-PARAMS card and the optional PK-FACTORS cards. The input trip matrix is read and the user specified factors are applied to estimate the peak period interchange volumes by direction. The portion of the volumes in the attraction-to-production direction are written to Unit 9 for subsequent sorting.

SORT: This subroutine specifies the fields in the records which are to be used as sort keys (the attraction zone number is used as the primary sort key and the production zone number is used as the secondary sort key). This subroutine specifies the record length and the record type to sort.

INVOKE: This is an assembly language subroutine which calls the system sort routine. The records on unit 9 are sorted and placed on unit 10.

PKMRG: This subroutine is an entry in the subroutine PKFAC. It rereads the input trip matrix and applies the user specified factors to estimate the peak period portion of the interchange volumes in the production-to-attraction direction. Thes estimates are merged with the sorted attraction-to-production directional volumes to estimate the origin-to-destination volumes. The TTIRND subroutine is called to perform residual rounding on each row of the origin-to-destination matrix. The resulting origin-to-destination trip matrix is written on the data set SWTTRP.

TTIRND: This subroutine performs residual rounding on a row of a trip matrix. This subroutine uses a new prioritized residual technique which was developed to reduce the "noise" in attraction volume balances due to residual rounding.

PK-PARAMS: Purpose

The PK-PARAMS card is required to enter the general (or default) parameters needed for factoring a 24-hour production-to-attraction trip matrix to peak period trips and converting (i.e., switching) the results from a production-to-attraction format to an origin-to-destination peak period trip matrix.

Associated Routines

Input

PEAKOD

Entry Sequence

The PK-PARAMS must be the first data card input to the PEAKOD routine.

Card Layout (fixed): FORMAT(3A4,3X,2F10.0,5X,A4)

Columns	Type	Contents
1 - 9	Literal	'PK-PARAMS'
10 - 15	--	Blank
16 - 25	Real	Peak Period Factor
26 - 35	Real	Peak Period Directional Split Factor
36 - 40	--	Blank
41 - 44	Literal	The OPER Parameter: A four character parameter value which provides the following information to the PEAKOD routine: (1) Notifies the routine whether optional PK-FACTORS cards will be input to override the above factors for selected zones; and, (2) If PK-FACTORS cards are being input, whether the new zonal factors being input are to be applied: (a) by column (i.e., by attraction zone); or (b) by row (i.e., by production zone). Refer to the "Data Description" section which follows for the valid parameter values and their meaning.

Data Description

The following discusses the data to be provided in each of the three data fields in the PK-PARAMS card:

Peak Period Factor Field

The Peak Period Factor is basically the factor used to convert a 24-hour trip matrix to a peak period trip matrix. The Peak Period Factor specifies the portion of a zone's trips that are expected to occur during the subject peak period. For example, if it is expected that 44.83% of a zone's HBW trips would be expected to occur during the subject peak period, then a value of 0.4483 should be entered in the Peak Period Factor field.

The value of the Peak Period Factor entered in the PK-PARAMS must be greater than or equal to zero. A value of less than zero (i.e., a negative factor) is considered a fatal error and will cause the termination of the PEAKOD routine. The value of the Peak Period Factor is generally expected to be less than or equal to one. If a value of greater than one is entered, the PEAKOD routine will print a warning message and proceed with processing the data using the input factor.

The PEAKOD routine provides the option of either applying the Peak Period Factors by column (i.e., attraction zone) or by row (i.e., production zone) but not both. The four character parameter in the third data field (discussed below) allows the user to specify the desired option. If a single Peak Period Factor and a single Peak Directional Split Factor are being used for all zones (i.e., no optional PK-FACTORS cards are being entered), then it doesn't matter whether the factors are applied by column or row.

Peak Period Directional Split Factor

The Peak Period Directional Split Factor is basically the factor used to convert production-to-attraction trip interchanges to origin-to-destination interchanges. The Peak Period Directional Split Factor specifies the portion of the peak period trips that would be expected to move in the production-to-attraction direction. The remaining portion of the interchange volume is assumed to move in the opposite direction (i.e., the attraction-to-production direction). For example, if it is expected that 91.24% of a zone's AM peak period trips would be in the home-to-work direction (i.e., the production-to-attraction direction) then a value of 0.9124 should be entered in the Peak Period Directional Split field. In this example, the conversion to origin-to-destination would split each interchange volume with 91.24% moving in the home-to-work direction and 8.76% moving in the work-to-home direction.

The value of the Peak Period Directional Split Factor entered in the PK-PARAMS must be greater than or equal to zero and less than or equal to one. A value of less than zero (i.e., a negative factor) or a value greater than one is considered a fatal error and will cause the termination of the PEAKOD routine.

The OPER Parameter

As previously noted, the PEAKOD routine provides the option of either applying the Peak Period Factors and the Peak Period Directional Split Factors by column (i.e., attraction zone) or by row (i.e., production zone) but not both. The OPER Parameter (i.e., the four-character parameter in the third data field) allows the user to specify the desired option. If a single Peak Period Factor and a single Peak Directional Split Factor are being used for all zones (i.e., no optional PK-FACTORS cards are being entered), then it doesn't matter whether the factors are applied by column or row since the same factors would be applied to each interchange volume. If the user wishes to vary these factors either by attraction zone (i.e., by column) or by production zone (i.e., by row) by inputting the optional PK-FACTORS cards for selected zones, then the user must specify the option desired by inputing the appropriate characters in the OPER parameter field. The following are the valid inputs for the OPER Parameter field:

OPER input	Meaning
' ' (i.e., blank)	No optional PK-FACTORS cards will be input; the Period Factor and the Peak Period Dirirectional Split Factor input on this card should be used for all zones.
'ATTR' or 'COLS'	One or more optional PK-FACTORS cards will be input for selected attraction zones. In other words, the Peak Period Factors and Peak Period Directional Split Factors will vary by column (i.e., by attraction zone). The Peak Period Factor and Peak Period Directional Split Factor input on this card (i.e., the PK-PARAMS card) will be used for attraction zones for which no PK-FACTORS card is provided.
'PROD' or 'ROWS'	One or more optional PK-FACTORS cards will be input for selected production zones. In other words, the Peak Period Factors and Peak Period Directional Split Factors will vary by row (i.e., by production zone). The Peak Period Factor and Peak Period Directional Split Factor input on this card (i.e., the PK-PARAMS card) will be used for production zones for which no PK-FACTORS card is provided.

PK-FACTORS: Purpose

The PK-FACTORS card is an optional card which allows the user to enter zone specific data for factoring a 24-hour production-to-attraction trip matrix to peak period trips and converting (i.e., switching) the results from a production-to-attraction format to an origin-to-destination peak period trip matrix.

Associated Routines

Input

PEAKOD

Entry Sequence

The PK-FACTORS card(s) must follow the PK-PARAMS card (the PK-PARAMS card must be the first data card input to the PEAKOD routine). The PK-FACTORS cards can be in any order. If more than one PK-FACTORS card is entered for a given zone, the factors provided in the last card encountered for the zone will be used by the PEAKOD routine.

Card Layout (fixed): FORMAT(3A4,2X,I4,2X,2F10.0)

Columns	Type	Contents
1 - 10	Literal	'PK-FACTORS'
11 - 14	--	Blank
15 - 18	Integer	Zone Number
19 - 20	--	Blank
21 - 30	Real	Peak Period Factor
31 - 40	Real	Peak Period Directional Split Factor

Data Description

The following discusses the data to be provided in each of the three data fields in the PK-FACTORS card.

Zone Number Field

The PEAKOD routine provides the option of either applying the Peak Period Factors and the Peak Period Directional Split Factors by column (i.e., attraction zone) or by row (i.e., production zone) but not both. The OPER Parameter (in the PK-PARAMS card which precedes the PK-FACTORS cards) allows the user to specify the desired option. If the option to apply the factors by column (i.e., attraction zone) is elected, then the zone number in this card should be the number of attraction zone for which the new factors are being entered. If the option to apply the factors by row (i.e., production zone) is elected, then the zone number in this card should be the number of production zone for which the new factors are being entered.

Peak Period Factor Field:

The Peak Period Factor is basically the factor used to convert the zone's 24-hour trips to peak period trips. The Peak Period Factor specifies the portion of the zone's trips that are expected to occur during the subject peak period. For example, if it is expected that 41.15% of the zone's HBW trips would be expected to occur during the subject peak period, then a value of 0.4115 should be entered in the Peak Period Factor field for the zone.

The value of the Peak Period Factor entered in the PK-FACTORS must be greater than or equal to zero. A value of less than zero (i.e., a negative factor) is considered a fatal error and will cause the termination of the PEAKOD routine. The value of the Peak Period Factor is generally expected to be less than or equal to one. If a value of greater than one is entered, the PEAKOD routine will print a warning message and proceed with processing the data using the input factor.

Peak Period Directional Split Factor

The Peak Period Directional Split Factor is basically the factor used to convert production-to-attraction trip interchanges to origin-to-destination interchanges for the specified zone. The Peak Period Directional Split Factor specifies the portion of the zone's peak period trips that would be expected to move in the the production-to-attraction direction. The remaining portion of the interchange volume is assumed to move in the opposite direction (i.e., the attraction-to-production direction). For example, if it is expected that 91.24% of the zone's AM peak period trips would be in the home-to-work direction (i.e., the production-to-attraction direction) then a value of 0.9124 should be entered in the Peak Period Directional Split field. In this example, the conversion to origin-to-destination would split each interchange volume for the specified zone with 91.24% moving in the home-to-work direction and 8.76% moving in the work-to-home direction.

The value of the Peak Period Directional Split Factor entered in the PK-FACTORS card must be greater than or equal to zero and less than or equal to one. A value of less than zero (i.e., a negative factor) or a value greater than one is considered a fatal error and will cause the termination of the PEAKOD routine.

APPENDIX B

OPERATING INSTRUCTIONS AND DATA SPECIFICATIONS

FOR THE "ASSEMBLE PEAK NETWORK" ROUTINE

ASSEMBLE PEAK NETWORK: Program Function

The ASSEMBLE PEAK NETWORK program reads peak format link data and produces a directional network. This network contains directional counts and direction capacities. Also this network contains the number of lanes (temporarily the lanes will be placed in the link volume field for assignment one).

Data Set References

Input:	$INLNK	(5)	Link Data Card images [1]
Scratch:		(83)	Sort input
		(84)	Sort output
		SORTWK1	Sort work unit
		SORTWK2	Sort work unit
		SORTWK3	Sort work unit
Output:		SORTMSG	Sort message print file.
	$NETWORK	(1)	Network data set [1]

Program Call Card

Column	Contents
1-22	$ASSEMBLE PEAK NETWORK
23-32	blank
33-80	ignored

Parameter and Data Card Images

Subnetwork Parameter Card

Column	Contents
1-6	ignored

[1] Default unit number

7-12	First centroid number (must be 1)
13-18	Last centroid number (4800 maximum)
19-24	Last node number
25-30	Last node number
31-80	Ignored

Link Data Card Images

Columns	Contents
1	One-way two-way Code 1 = One-way; 2 = Two-way
3-7	A-node number (valid range 1 to 16000)
9-13	B-node number (valid range 1 to 16000)
15	Direction sign
16	Sign change
18-20	Length in hundredths of miles (valid range 0 to 999)
22-23	Speed (A to B) in miles/hour (valid range 1 to 99)
25-30	Count (A to B) (valid range 0 to 999999)
32-37	Capacity (A to B) (valid range 0 to 999999)
39-40	Speed (B to A) in miles/hour (valid range 1 to 99)
42-47	Count (B to A) (valid range 0 to 999999)
49-54	Capacity (B to A) (valid range 0 to 999999)
56	Functional Class (valid values 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F)
58	Administrative Jurisdiction (valid values 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F)

60-61	Route Code (valid range 1 to 99)
63-64	Corridor Intercept (valid range 1 to 99?)
65	Dup Mileage Eliminator (valid values blank, 0 or 1)
66-70	Impedance (A to B) in hundredths of minutes (valid range blank, 0 to 1023)
71-75	Impedance (B to A) in hundredths of minutes (valid range blank, 0 to 1023)
76-77	Lanes (A to B) (valid range blank, 0 to 99)
78-79	Lanes (B to A) (valid range blank, 0 to 99)

End Link Data Card Image

Column	Contents
1	L
2-80	blank

or

Column	Contents
1-6	ENDLNK
7-80	blank

End Subnetworks Card Image

This is the last card in the Link Data Deck. It is included for consistency with other link data.

Column	Contents
1	N
2-80	blank

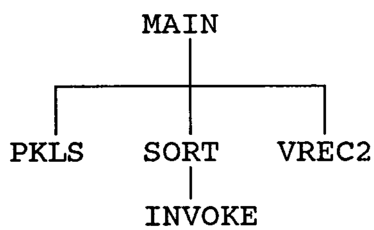
or

Column	Contents
1-6	ENDNET
7-80	blank

Normal Operation

The network parameter is read and processed. The last node number from this card is used in editing the maximum value for node numbers. The link data cards are read and each field is checked for a valid range or a valid value. The links are written to FORTRAN unit 83 in a modified one-way format. If the link contains a 2 in the two-way field, then two one-way links are written to unit 83. Error messages are written by link for any invalid ranges of fields. The link is written with the invalid fields underlined. The underline for one field consists of a one-character alphabetic indicator followed by periods. If the field is only one character long, then there are no following periods in the underline. The underline part of the error message is followed by a blank line. No check is made for a numeric field containing invalid characters. If a numeric field contains invalid characters, then FORTRAN will write an error message for each character and replace it with a zero. This may cause a range error or the error may not be detected by the ASSEMBLE PEAK NETWORK program. After all one-way sort links have been written to unit 83, then this data set is closed by a rewind. Then the system SORT program is invoked by an assembler LINK to the sort package. This will use more memory at this point as the SORT package is dynamically loaded into memory and opens buffers for it's sort work units. An additional approximately 200 Kbytes are needed when this SORT program is run. After the sort is run, then the one-way link records are read in from FORTRAN unit 84 and tests are made for isolated nodes. The NETWORK data set is written during this pass also.

Sequence of Subroutines Called



Summary of Individual Subroutines

MAIN: In the execution of ASSEMBLE PEAK NETWORK, the MAIN program performs the following steps:

1. Calls subroutine PKLS to read the link data, edits individual fields and writes sort records to unit 83.

2. Calls subroutine SORT to sort the one-way links and outputs them to unit 84.

3. Calls subroutine VREC2 to read the sorted link data and check for isolated nodes and more than six ways out. Also this subroutine writes the network data set.

PKLS: This subroutine reads the peak format link data. It checks all fields for range errors or valid values. It writes an intermediate sort record in character format to unit 83.

VREC2: This subroutine reads the sorted one-way link records from unit 84. It checks for errors of the type of isolated node or more than six ways out. This subroutine also writes the network data set. This subroutine currently formats the network data set with a dummy assignment 1 to contain the number of lanes.

SORT: This subroutine calls the subroutine INVOKE with a sort statement of SORT FIELDS=(1,80,CH,A) and a record statement of RECORD TYPE=F LENGTH=(80,80,80).

INVOKE: This subroutine dynamically loads the system sort load module and passes the sort statement and record statement to the system sort program. It also passes the number of input sort records in the sort statement.

ADDITIONAL JCL FOR ASSEMBLE PEAK NETWORK

```
//FT83F001DD  UNIT=SYSDA,DSN=&INSORT,SPACE=(6320,(800,200)),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=6320)
//SORTIN DD  DSN=&INSORT,VOL=REF=*.FT83F001,DISP=(OLD,PASS)
//SORTMSG      DD  SYSOUT=A
//SORTWK01     DD  UNIT=SYSDA,SPACE=(6320,(600),,CONTIG),SEP=SORTIN
//SORTWK02     DD  UNIT=SYSDA,SPACE=(6320,(600),,CONTIG),SEP=SORTWK01
//SORTWK03     DD  UNIT=SYSDA,SPACE=(6320,(600),,CONTIG),SEP=SORTWK02
//SORTOUT      DD  DSN=&OUTSORT,UNIT=SYSDA,SEP=SORTWK03,
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=6320),SPACE=(6320,(800,200))
//FT84F001     DD  DSN=&OUTSORT,VOL=REF=*.SORTOUT,DISP=(OLD,PASS)
```

Note that the placement of the FT83F001 and SORTIN statements must be in the listed order. Also the SORTOUT and FT84F001 statements must also be in the order listed. The reason that these statements must be in the order listed is that the first statement allocates the data set for the SORT package and the second statement allows it to be read by the FORTRAN program.

APPENDIX C

OPERATING INSTRUCTIONS AND DATA SPECIFICATIONS

FOR THE "PEAK CAPACITY RESTRAINT" ROUTINE

PEAK CAPACITY RESTRAINT: Program Function

The function of this program is to produce a multi-path assignment in which the assigned volumes are in relative balance with traffic counts or else conform to link directional capacities. This is an iterative technique which adjusts directional link impedances to obtain the desired balance. The program produces several cross classification tables and comparison tables to indicate how well the above function is being achieved.

Data Set References

Input:	$NETWORK	(1)	Directional Network (contains network, lanes, previous assignments and iteration assignments) [1]
	$CTVOUT	(8)	Trip Matrix [1]
		(49)	Trees for COPY option
		(50)	Trees for SKIP option
		(3)	Directional assigned volumes and turn volumes from previous iterations [2]
Scratch:		(83)	Sort input
		(84)	Sort output
		SORTWK1	Sort work unit
		SORTWK2	Sort work unit
		SORTWK3	Sort work unit
Output:		SORTMSG	Sort message print file.
	$NEWNET	(9)	Directional Network (updated for next iter.) [1]
	$SEPARAT	(20)	Separation Matrix [1]
	$ROUTE	(25)	Route Profile [1]

[1] Default unit number

[2] Required as input when the First Iteration Number is not 1.

(SELTRP) Selected interchanges [3]

(3) Directional assigned volumes and turn volumes from all iterations run

(50) Trees

(85) Non-Directional Network Data Set

(4) Scratch [4]

(4) Save Parameter cards

(11) Save Parameter data

$SUBAREA (0) Subarea Network Abstract (optional) [4]

Program Call Card

Column	Contents
1-24	$PEAK CAPACITY RESTRAINT
25-32	Blank
33-80	Ignored

Parameter Cards and Data Cards

Weights Card

This card provides the user the opportunity of electing one of the following options:

1. Specifying the iteration weightings (i.e., percent each iteration is to be weighted) for the computation of the final weighted (or combined) assignment.

[3] DDName, this data set is written only if an iteration is run which has its iteration number equal to the Selected Links Iteration number.

[4] If Subarea Assignment is used, this unit must be defined.

2. Allowing the program to compute the iteration weightings using a regression technique.

If option 1 is elected, an iteration weight (i.e., an integer percent) must be specified for each iteration to be executed (i.e., Iteration 1 through the Maximum Iteration Number) such that the sum of the iteration weights is equal to exactly 100. If option 2 is elected, the fields for the iteration weights should either be left blank or contain only zeros.

It is best to specify percents to load, or one or two iterations can be dropped from the weighted assignment. For 5 iterations, 15%, 15%, 20%, 20%, 30% are recommended.

Column	Contents
1-4	*WGT
3-6	Blank
7-12	Percent weight for iteration 1
13-18	Percent weight for iteration 2
19-24	Percent weight for iteration 3
25-30	Percent weight for iteration 4
31-36	Percent weight for iteration 5
37-42	Percent weight for iteration 6
43-48	Percent weight for iteration 7
49-54	Percent weight for iteration 8
55-80	Ignored

Turn Penalty Card

This card not only specifies the amount of time to be added as a penalty for each turn but provides the user the opportunity to elect a number of options available in the program. These options include:

- Specify the use of capacities rather than counts in the balancing process.
- Limit or extend the maximum number of iterations to be performed (default value is 5 iterations).

- Stop and restart the program between iterations (or between the list iteration and the weighted assignment) thereby allowing the program to be executed as a series of jobs.

- Selected Link output may be obtained from one iteration during a run. (NOTE: if the preceding multiple run option is used, Selected Link output may be obtained from each run).

- Restart the program in case a machine problem is encountered during the iteration process.

- Allows the user the option of obtaining an additional all-or-nothing assignment using weight impedances.

The format for the turn penalty card is:

Column	Contents
1-5	*TURN
6	Blank
7-12	Turn penalty in hundredths of a minute (a decimal point is assumed between Columns 10 and 11). Not used if *TRN card image is included.
13-16	Optional field which may be used to take advantage of a partially built TREES data set. If the field contains the word "COPY", the partially built TREES data set will be read from Unit 49 and copied to Unit 50. Missing trees and trees containing invalid codes will be rebuilt and included in the TREES data set on Unit 50. (NOTE: It is important that the First Iteration Number parameter in Columns 39-42 specifies the iteration number in which the partial TREES data set on Unit 49 was built.)
17-30	Blank
31-34	<u>CAP</u> - to perform a capacity restraint assignment using the old impedance function. <u>NCAP</u> - to perform a capacity restraint assignment using the new impedance function. Blank - to perform a volume restraint assignment using input traffic count data.

35-37	WGT - to produce an all-or-nothing traffic assignment using weighted impedances; otherwise, this assignment is not produced.
38	Blank
39-42	First Iteration number (default value = 1).
43-48	Stop Iteration number (default value = 0).
49-54	Minimum Iteration Number (default value = 3).
55-60	Maximum Iteration Number (default value = 5).
61-66	Selected Links Iteration Number (default value = 0).
67-68	Blank
69-72	SKIP to skip building trees on the First Iteration Number and use the trees input on Unit 50 for this iteration. These trees will be destroyed if another iteration or the second weighted assignment is run. <u>This option cannot be used with a Subarea PEAK CAPACITY RESTRAINT run</u>.
73-80	Blank

The parameters in Columns 39-66 are used as follows:

First Iteration Number: This parameter is used when a PEAK CAPACITY RESTRAINT run is to be continued from another job. This parameter should be set to one more than the previous number of iterations run. If it is greater than the Maximum iteration number, then the weighted iteration will be the next one run. If it is zero or blank, it will default to 1. If this parameter is greater than 1, then the last updated NETWORK data set and the data set from Unit 3 are required from the previous PEAK CAPACITY RESTRAINT run.

Stop Iteration Number: This parameter can be used to stop the ASSIGN SELF-BALANCING process at the end of any iteration except the weighted iteration. If it is left blank or zero, the process will run to completion.

Minimum Iteration Number: If the user elects the option whereby the iteration weights are specified on the Weights Card, the value parameter will be automatically set equal to the Maximum Iteration Number (regardless of the number in Columns 49-54) and subsequently ignored. If the user elects the option whereby the iteration weights are computed using a regression technique, the actual number of iterations performed may vary between the Minimum and Maximum Iteration Numbers. (NOTE: Normally the maximum number of iterations will be performed regardless of this parameter since the termination of the iterative process prior to the Maximum Iteration Number requires the T value, computed from the regression analysis, to be less than or equal to 1.96 .) Under the regression weighting option, the parameter defaults to 3 if the field in the card is blank or zero.

Maximum Iteration Number: This is the maximum iteration number which will be run. If it is zero or blank, it defaults to 5. This parameter must not be greater than 8.

Selected Links Iteration Number: This is the iteration number on which the selected links parameter cards following the last *TREE card will be read, and the SELTRP data set will be written. If this output is not desired, then this field should be left blank and the selected links parameter cards will not be read.

New Turn Penalties

This card image specifies 16 turn penalties or turn prohibits. This card image specifies all combinations of the new link direction codes. The turn penalties must be in the range of 0 to 10.23 minutes. A turn prohibit is specified by -1 or any other negative value. The *TURN card image must still be present because it has several optional flags which are still examined. This card image is optional and should only be used if the 16 turn penalty/prohibit scheme is being used.

Column	Contents
1-4	*TRN
5-8	Blank
9-12	Turn penalty from W to W in hundredths
13-16	Turn penalty from W to X in hundredths
17-20	Turn penalty from W to Y in hundredths
21-24	Turn penalty from W to Z in hundredths
25-28	Turn penalty from X to W in hundredths
29-32	Turn penalty from X to X in hundredths
33-36	Turn penalty from X to Y in hundredths
37-40	Turn penalty from X to Z in hundredths

41-44	Turn penalty from Y to W in hundredths
45-48	Turn penalty from Y to X in hundredths
49-52	Turn penalty from Y to Y in hundredths
53-56	Turn penalty from Y to Z in hundredths
57-60	Turn penalty from Z to W in hundredths
61-64	Turn penalty from Z to X in hundredths
65-68	Turn penalty from Z to Y in hundredths
69-72	Turn penalty from Z to Z in hundredths

Tree Selection Card [5]

This card image specifies those centroids from which trees will be built. One Tree Selection Card per subnetwork is required; a minimum of one to a maximum of 4,800 centroids is permissible. The Tree Selection Cards may specify various groups of one or more trees in any order, but proper functioning of the load process requires that the trees be built in a serial sequence order. In the format of the Tree Selection Card the six character fields are each composed of two subfields, A and B, of five characters and one character, respectively:

Column	Contents	
1-5	TREE [5]	
6-7	blank	
8-12	Subfield A	First selection field
13	Subfield B	
14-18	Subfield A	Second selection field
19	Subfield B	
20-24	Subfield A	Third selection field
25	Subfield B	
26-30	Subfield A	Fourth selection field

[5] Tree Selection Cards are not read if unit $SUBAREA is used.

31	Subfield B	
32-36	Subfield A	Fifth selection field
37	Subfield B	
38-42	Subfield A	Sixth selection field
43	Subfield B	
44-48	Subfield A	Seventh selection field
49	Subfield B	
50-54	Subfield A	Eighth selection field
55	Subfield B	
56-60	Subfield A	Ninth selection field
61	Subfield B	
62-66	Subfield A	Tenth selection field
67	Subfield B	
68-72	Subfield A	Eleventh selection field
73	Subfield B	

NOTE: A comma (,) may be entered in Column 73 if desired when subfield 68-72 is used. However, Columns 73-80 are not read; the program places the comma when entries are made in Columns 68-72.

Subfield A may contain any valid centroid number in the network. Subfield B functions as a delimiter and may contain a blank, comma, or period. Any other character will give an error message. A period used as a delimiter causes all trees built within the control range to have BCD Minimum Path Descriptions printed for inspection. This does not affect the tree building process otherwise, except it causes a delay due to writing the output.

In processing selection fields from left to right, the occurrence of two consecutive A subfields separated by a blank B subfield will initiate a control setup for inclusive tree building, beginning with the centroid specified by the first A subfield and ending with the centroid specified by the second A subfield. A comma in the second B subfield is optional for this situation, since the starting and ending centroids have been found for a search group. The occurrence of two successive B subfields containing either commas (may be implied as mentioned above) or periods, causes a single centroid to be specified; i.e., a control setup for inclusive tree building beginning and ending with the centroid specified in the intermediate A subfield.

For example, to build trees 1 through 90, with BCD Minimum Path Descriptions of trees 1 and 50, the following Tree Selection Card would be required:

Column	Contents
1-5	*TREE
6-7	bb
8-13	bbbb1.
14-19	bbbb2b
20-25	bbb49b
26-31	bbb50.
32-37	bbb51b
38-43	bbb90b

In the above example, lower case b's are used to indicate blanks.

Turn Suppression Option

The Turn Suppression Card denotes the assigned network output that is desired. Columns 7-80 are ignored.

Columns 1-6	Action
*ALL	Write link volumes, turn volumes, and the vehicle-hour and vehicle-mile summary.
*LINKS	Write link volumes and the vehicle-hour and vehicle-mile summary only.

The LIST Card, LINKS Cards, EQUAL Cards, and END Card (for EQUALS Cards not for Selected Link Cards are read only if $SUBAREA is used.

If the SUBAREA file number is set to nonzero by a $SUBAREA, XX card, then a set of cards (i.e., LIST cards, DIRECT cards, and optional LINKS cards) which define the portion of the network within the subarea are read. These cards are:

List Card

This card (or cards) specifies a continuous ring of links (and/or centroid connectors) which completely surrounds the subarea. The LIST cards must be chained to the next LIST card but must specify one complete ring of links. For error checking, it is convenient to keep the LIST cards in order. Each card may contain up to twelve node (or centroid) numbers. A link is defined between the first and the second number on this card; between the second and third number; etc. The first zero or blank field on this card ends the data on this card, which means that a LIST card can define from one to eleven links to be in the ring.

Column	Contents
1-4	LIST
5-6	Blank
7-12	First node (or centroid) number
13-18	Second node (or centroid) number
19-24	Third node (or centroid) number
25-30	Fourth node (or centroid) number
31-36	Fifth node (or centroid) number
37-42	Sixth node (or centroid) number
43-48	Seventh node (or centroid) number
49-54	Eighth node (or centroid) number
55-60	Ninth node (or centroid) number
61-66	Tenth node (or centroid) number
67-72	Eleventh node (or centroid) number
73-78	Twelfth node (or centroid) number

Direct Card

This card specifies on which side of the ring of links the subarea lies.

Columns	Contents
1-6	DIRECT
7-12	Node on the subarea ring of links

13-18	Node that is inside the subarea is connected to the first node in Columns 7-12, and is further connected to another node in the subarea.

Links Card

These cards may define other links to be included in the summaries produced after the assigned network listing of the assignment output from a subarea assignment. This card will be necessary for any part of the network inside the ring of links which is isolated from the other part of the network inside the ring of links. The most likely use for this card is for centroid connectors where the centroid only connects to the nodes (or centroids) in the ring of links. This card also may define links which cannot be surrounded by the ring of links.

Column	Contents
1-5	LINKS
6	Blank
7-12	First node (or centroid) number
13-18	Second node (or centroid) number
19-24	Third node (or centroid) number
25-30	Fourth node (or centroid) number
31-36	Fifth node (or centroid) number
37-42	Sixth node (or centroid) number
43-48	Seventh node (or centroid) number
49-54	Eighth node (or centroid) number
55-60	Ninth node (or centroid) number
61-66	Tenth node (or centroid) number
67-72	Eleventh node (or centroid) number
73-78	Twelfth node (or centroid) number

Last Centroid Card

Column	Contents
1-6	*LASTC
7-12	Last (i.e., highest) centroid number for trees
13-80	Ignored

Equal Cards

These cards define the sector centroids and also the centroids which are equated to the sector centroids. Trees will not be built for centroids equated to sector centroids. The exception to this is that trees will be built for all zones equated to the same zone (sector centroids). An entry is generated for each sector centroid and if it is additionally equated to itself, a warning message will be printed. The numbers to the right of the EQUAL on these cards may specify ranges of centroids by placing the beginning of the range on the card in one field and immediately following this field by a field with the last centroid of the range with a minus sign in front of the centroid number. A range must all be specified on one EQUAL card.

Column	Contents
1-4	Sector Centroid Number
5	Blank
6-10	EQUAL
11-80	14 fields for centroids or centroid ranges (Format: 14I5)

End Card

This card defines the end of the EQUAL cards:

Columns	Contents
1-5	Blank
6-8	END
9-80	Blank

Selected Links Parameter Cards

The following parameter cards are required only if the Selected Links Iteration Number is set equal to an iteration that is run.

Selected Link Cards

A Selected Link Card must be provided for each desired link. This card also limits the number of interchanges to print. If any of the limits are omitted or zero, it will be set for the maximum number permitted. None of the options should be set greater than the allowable maximum. After any one of the three limits has been reached, the output will be terminated.

Column	Contents
1-4	*SEL
5-6	Blank
7-12	A-node
13-18	B-node
19-24	Percentage of total volume to be included (range 1 to 100)
25-30	Minimum two-way volume to be allowed (range 1 to 32767)
31-36	Number of zone pairs to be included (range 1 to 32767)
37-80	Ignored

End Selected Links

Column	Contents
1-4	*END
5-80	Blank

Normal Operation

The Weights Card, the Turn Penalty Card, optionally the *TRN card with 16 turn penalties/prohibits, and the Tree Selection Cards are read and interpreted. The following messages are printed if these cards are correct:

> THE TREE CARDS HAVE ESTABLISHED THE FOLLOWING PARAMETERS

TURN PENALTY = ---.---

LINK COUNTS WILL BE USED IN THE LINK IMPEDANCE FUNCTION
or LINK CAPACITIES WILL BE USED IN THE OLD LINK IMPEDANCE FUNCTION

or LINK CAPACITIES WILL BE USED IN THE NEW LINK IMPEDANCE FUNCTION

AN INCOMPLETE TREE DATA SET WILL BE READ FROM UNIT 49 AND MISSING TREES OR TREES WITH INVALID CODES WILL BE BUILT [6]

A SECOND WEIGHTED ASSIGNMENT USING THE WEIGHTED IMPEDANCES WILL BE PRODUCED [6]

FIRST ITERATION = -

STOP AFTER ITERATION = -

MINIMUM NUMBER OF ITERATIONS = -

MAXIMUM NUMBER OF ITERATIONS = -

ITERATION TO GET SELECTED LINKS OUTPUT -

PERCENTS TO LOAD ARE -- -- -- -- --
THE PERCENTS CALCULATED FROM A REGRESSION WILL BE USED AS THE PERCENTS TO LOAD*

TREE BUILDING WILL BE SKIPPED AND A SET OF TREES PREVIOUSLY BUILT WILL BE USED TO ASSIGN ITERATION -

FOR SUBNETWORK - SEARCH MINIMUM PATHS FROM ZONES------ TO ------ INCLUSIVE AND OUTPUT
or
SUPPRESS OUTPUT

The appropriate portions of the messages are repeated as often as necessary to describe the various control ranges for the tree search. The steps described below are repeated for each of three to five iterations.

---

[6] Optional

The link impedances are updated using directional link volumes. Directional capacities and ground counts are also used. The initial network data set must be from an ASSEMBLE PEAK NETWORK.

The NETWORK data set is read. Minimum path trees are traced according to the Turn Penalty Card and Tree Selection Card, and the Trip Matrix is assigned to the minimum paths. When the iteration number is one, the entire assignment is printed. This will correspond to a minimum time path assignment if impedances have been calculated from speed and distance.

The variable C is set to either directional traffic counts or directional capacities, depending upon which of three options are entered on the Turn Penalty Card (Columns 31-34). If C is zero for a given link (again dependent on the option selected), the impedance for that link is not changed.

The three options available for updating link impedances are:

<u>Traffic Counts</u>

$$I(n + 1) = (0.75 + 0.25*(V/C))*I(n)$$

NOTE: If $I(n - 1)/I(n) > 1.43$, $I(n + 1)$ is set to $1.43*I(n)$

<u>Capacities - OLD Impedance Function</u> (<u>CAP</u>)

The link impedance is not changed in this option unless the link volume has exceeded capacity for one or more iterations. When the link impedance is updated, the following function is used:

$$I(n + 1) = (0.75 + 0.25*(V/C))*I(n)$$

NOTE: If $I(n + 1)/I(n) > 1.43$, $I(n + 1)$ is set to $1.43*I(n)$

<u>Capacities - NEW Impedance Function</u> (<u>NCAP</u>)

$$I(n + 1) = (0.95 + 0.15 (V(n)/C)**4)*I(1)$$

NOTE: If $I(n + 1)/I(n) > (n + 1)$, $I(n + 1)$ is set to $(n + 1)*I(n)$

The following constraints are applied for all updated impedances:

If $I(n + 1) > 10.23$ - turn penalty, $I(n + 1)$ is set to 10.23 - turn penalty

If $I(n + 1) = 0.0$ and $I(n) = 0.0$, then $I(n + 1)$ is set to 0.01

The new network containing the revised impedances is written on the NEWNET data set. The route profile and separation matrix data sets also are written. Data will also be included in the NEWNET data set from the last assignment (and all previous assignments up to a maximum of 19) describing directional link volumes and the corresponding directional link impedances. The following tables and summaries also are produced:

CROSS CLASSIFICATION OF V/C FREQUENCIES FROM LAST TWO ASSIGNMENTS.[7]

CROSS CLASSIFICATION OF LINK COUNTS BY V/C RATIO FROM LAST TWO ASSIGNMENTS.[7]

JURISDICTION SUMMARY (This table is not printed if there are functional class codes on the link data).

JURISDICTIONAL/FUNCTIONAL CROSS CLASSIFICATION OF ASSIGNED VOLUMES (This table is not written if more than 95 percent of the links have no functional class code).

JURISDICTIONAL/FUNCTIONAL CROSS CLASSIFICATION OF COUNTED VOLUMES (This table is not written if more than 95 percent of the links have no functional class code or if all locations in the table are zero).

JURISDICTIONAL/FUNCTIONAL CROSS CLASSIFICATION OF LINK CAPACITIES (This table is not written if more than 95 percent of the links have no functional class code or if all locations in the table are zero).

COMPARISON OF ASSIGNED VOLUMES WITH COUNTED VOLUMES[7]

COMPARISON OF ASSIGNED VOLUMES WITH LINK CAPACITIES[7]

COMPARISON OF ASSIGNED VOLUMES (from last assignment) WITH ASSIGNED VOLUMES FROM (assignment before last)[7]

ITERATION WEIGHTING - MULTIPLE REGRESSION ANALYSIS

The iteration number is printed in the Heading record of each of the above tables. Then the unit numbers of the NETWORK and NEWNET data sets are switched. If the calculated T value for the last entry in the ITERATION WEIGHTING-MULTIPLE REGRESSION ANALYSIS table is less than 1.96, and the minimum Iteration Number of iterations have been completed, the repetitions are terminated. If an iteration is run

[7] Directional Table

which is equal to the stop iteration number, the process stops at the end of that iteration. The maximum iterations allowed is the Maximum Iteration Number.

After the iterative process terminates, the B values from the final ITERATION WEIGHTING-MULTIPLE REGRESSION ANALYSIS table are multiplied by 100 (B(0) is disregarded). Any negative values are set to zero, and the integer portion of the other B values is selected after scaling the sum to 10 percent. If the *WGT card contained weight, these are used instead of the ones calculated. These values are then printed in a table entitled ITERATION WEIGHTS APPLIED.

A weighted assignment is calculated by applying the iteration weights (percentages) to their respective assigned volumes and summing. An updated Network data set is prepared which includes the weighted assigned volumes, and the weighted assignment is printed with all assigned volumes and turning movements. A set of printed tables similar to those already described for the individual iterations is written for the weighted assignment.

Using the same iteration weights applied with the assigned volumes, a set of directional weighted impedances is calculated in an analogous manner. If WGT option is specified on the *TURN Card, the weighted impedances are used for one final assignment, and everything written for the calculated weighted assignment is also produced for the weighted impedance assignment. All assigned volumes and turning movements are printed for the weighted impedance assignment. Finally, the Route Profile and Corridor Intercept tables are printed, followed by a table of assigned volumes and impedances from all iterations (including the weighted assignments). The last assignment produces new data sets on the NETWORK or NEWNET, SEPARAT, and ROUTE units. A message is written at the end indicating the unit number on which the final NETWORK data set has been written:

THE FINAL LOADED NETWORK IS ON --

If the PEAK CAPACITY RESTRAINT run is to be restarted, this is the data set which must be Unit NETWORK on the restart run.

When a machine malfunction or an Abnormal Program Termination occurs, the following things should be considered when setting up a restart. The Unit 3 data set, the Network data set and the First Iteration Number used in a restart of PEAK CAPACITY RESTRAINT must be consistent in respect to the number of iterations previously completed. The data for an iteration is written on Unit 3 before the assigned network is printed or if it is not printed, then before the Network data set is updated. The Unit 3 data set is closed and reopened after being written so that it will be complete. When PEAK CAPACITY RESTRAINT is restarted, Unit 3 is positioned to the end of the First Iteration Number -1 and partially checked for errors. If there are additional iterations or records written on this data set, they are ignored and written over.

The data written on a Network data set is written concurrently with the printing of the assigned network or if the printing is skipped, then it is written before the first output following the assignment of the network is printed. The writing of the directional Network data set is an update process and there is an old Network data set and a new Network data set for each iteration. Each new Network data set is closed immediately after being written. The first Network data set used by the iteration indicated by First Iteration Number parameter is Unit NETWORK. At the end of this iteration, Unit NEWNET becomes the new Network data set. Units NETWORK and NEWNET alternately become the Network data sets used on succeeding iterations. When the PEAK CAPACITY RESTRAINT process ends through the Stop Iteration Number option, a message "THE FINAL LOADED NETWORK IS ON X" gives the Unit number of the new directional Network data set for the last iteration run. If the program ends abnormally, the Unit to use as the Network data set on a restart must be determined by the number of iterations which have completed the assignment process. If there is any doubt of which data set to use, NETWORK or NEWNET, then one or both of the data sets can be printed with the OUTPUT NETWORK program and the header records examined to determine the appropriate data set. A check should also be made to see that all links for the last node in the Network are printed. Also a network with nondirectional volumes is written to Unit 85. This data set is written when table L1 is produced.

Error Messages

INVALID TURN PENALTY OR TREE CARD READ

The program prints this line under the card which has an error in its identification field (Columns 1-6). The correct contents for Columns 1-6 for the two cards are *TURN and *TREE. The program stops with a STOP 0 after examining both cards for errors.

ILLEGAL FIELD SEPARATION CHARACTER IN TREE CARD

This message is printed if a field separation character is found which is not a comma, a period, or a blank. The program stops with a STOP 0 after it examines the rest of the Tree Card.

---- ERROR(S) DETECTED IN ABOVE PARAMETER CARDS, EXECUTION TERMINATED

The program stops with a STOP 0.

**** TURN TYPE FOR NODE -----, ILLEGAL, = ----------, SET TO 28

This message should be printed only if an input error has occurred in reading the NETWORK data set. It indicated that no turning movements will be saved for the node in the message.

NODES .GT. 16000, = ------

This message is self-explanatory. The program stops with a STOP 0 at this point.

NUMBER OF SUBNETS FROM BINARY NETWORK = ---

NUMBER OF SUBNETS FROM VOLUME FILE = ---

NUMBER OF SUBNETS FROM TREE FILE = --- ARE NOT EQUAL, LOAD DELETED.

There is a conflict in the number of subnetworks in one of the three data sets. The program does not load the network, and ends with a STOP 7.

FIRST NODE, LAST CENTROID INFORMATION FROM TREE FILE AND VOLUME FILES DOES NOT AGREE, OR ONE IS GREATER THAN ------ OR THE NUMBERS ARE NOT INCREASING ORDER LOAD DELETED.

FILE FSTND(1) LSTND(1) FSTND(2) LSTND(2) FSTND(3) LSTND(3) FSTND(4) LSTND(4)

LOAD ----- ----- ----- ----- ----- ----- ----- -----

TREE ----- ----- ----- ----- ----- ----- ----- -----

The first number printed is the last centroid number of the last subnetwork from the Network data set. No centroid number from the trip matrix or Path data set can be larger than this number. Another condition for which the message is written is when the first node number for a subnetwork in the Trip Matrix data set is not equal to the corresponding first node number from the Network data set. These conditions both indicate that the Path, Trip Matrix, and Network data sets are not for the same network. The program continues after this message is printed.

NUMBER OF TURNING MOVEMENTS TO SAVE EXCEED 60000, = ------

This message indicates that more than 60000 locations in the turning movement table are needed to load the network. The actual number of locations needed is printed after the comma. The program ends with a STOP 50 after this message. One way to bypass this problem is to use the LOAD SELECTED LINKS program with the option to output the loaded network without the turning movements.

I/O ERROR ON TREE FILE AFTER A NODE -----

This indicates that there was a possible error on reading a path record. The program continues and attempts to use the path record.

I/O ERROR ON TRIP FILE AFTER A NODE -----

The program skips the Trip Matrix record and continues.

ABEND U101

This abend code indicates that one of the turn type code numbers, which has a valid range of from 1 to 28, has been destroyed during the load process. The job abended without a dump. The probable cause of this error would be an I/O error from the Path data set.

ABEND U102

This error code could indicate several things, some of which are: (1) the three data sets which are input to this program are not for an identical network; (2) there has been an I/O error in reading one of the data sets; or (3) a CPU error has occurred. The job is abended without a dump.

TRMV ERR

This error message is printed in the loaded network output if one or more of the turning movements cannot be calculated. This message indicates that the network has not been loaded correctly. This message could occur if a network which contains errors is assigned.

MORE THAN TWO LINKS FROM NODE -----

This message occurs during the processing of the Route Profiles and indicates that a node has three or more links with the same route code. Only two of the links will be retained. This will cause links to be lost in the Route Profile output for this route.

ROUTE -- HAS NO ENDS, A LINK WILL BE CHOSEN AS A STARTING POINT.

The links included in this route form a closed loop. The link with the lowest node number will be chosen as the starting point for the Route Profile output.

ERROR ON UNIT 3, EXECUTION TERMINATED WITH STOP 21.

There was an error in reading the parameter record from Unit 3 when the First Iteration Number on the *TURN card was not 1. The program is terminated with STOP 21.

ERROR IN PARAMETER RECORD FROM UNIT 3, EXECUTION TERMINATED WITH STOP 21 PARAMETER RECORD.

There was an error in the values in the parameter record. The values in the parameter record are printed. The program execution is terminated with STOP 21.

ERROR, MISSING RECORDS OR I/O ERROR ON UNIT 3, ------ RECORDS READ ------ RECORDS WERE TO BE READ EXECUTION TERMINATED WITH STOP 21.

PARAMETER RECORD

The number of records to skip position Unit 3 is determined from the values of the parameter record and the number of iterations previously run. Then the program tries to skip this number of records on Unit 3. If the end of data set condition or an I/O error is encountered, then this message is printed. This message will be printed when the First Iteration Number is set larger than one more than the previous number of iteration run.

INVALID *WGT CARD READ

The card following the program call card does not contain *WGT in Columns 1-4.

ERROR IN ABOVE PERCENTS, SUM IS ----

The percents in the *WGT card for iterations one to the Maximum Iteration Number do not sum to 0 or 100. The sum is printed.

SORT ERROR; LINK READ FROM NET IS ----- ----- LINK READ FROM SORT IS ----- -----

The Anode-Bnode of the link read from the sort did not match the expected Anode-Bnode of the link being processed. This is probably a sort error or a JCL error. The Anode and Bnode of the expected link are printed in the first two dash fields. The Anode and Bnode of the link from the sort are printed in the third and fourth dash fields. Up to three sort records are used for each link. The first sort record contains assignments 1 through 6 (including the lanes as the first assignment).

SORT ERROR IN SECOND SORT RECORD; LINK READ FROM NET IS ----- ----- LINK READ FROM SORT IS ----- -----

The Anode-Bnode of the link read from the sort did not match the expected Anode-Bnode of the link being processed. This is probably a sort error or a JCL error. The Anode and Bnode of the expected link are printed in the first two dash fields. The Anode and Bnode of the link from the sort are printed in the third and fourth dash fields. Up to three sort records are used for each link. The second sort record is written when 7 assignments have been done (including the lanes as the first assignment).

SORT ERROR IN THIRD SORT RECORD; LINK READ FROM NET IS ----- -----
LINK READ FROM SORT IS ----- -----

The Anode-Bnode of the link read from the sort did not match the expected Anode-Bnode of the link being processed. This is probably a sort error or a JCL error. The Anode and Bnode of the expected link are printed in the first two dash fields. The Anode and Bnode of the link from the sort are printed in the third and fourth dash fields. Up to three sort records are used for each link. The third sort record is written when 15 assignments have been done (including the lanes as the first assignment).

STOPPING FOR 100 OR MORE SORT ERRORS WITH STOP 9

This error message indicates that there have been 100 SORT error messages printed while printing table L1.

Order of Input Card Images for a Non-Subarea Run

$PEAK CAPACITY RESTRAINT

*WGT

*TURN

*TRN (only if 16 turn penalty/prohibits)

*ALL or *LINKS

*SEL (only if selected links iteration)

.
.
.

*END (only if selected links iteration)

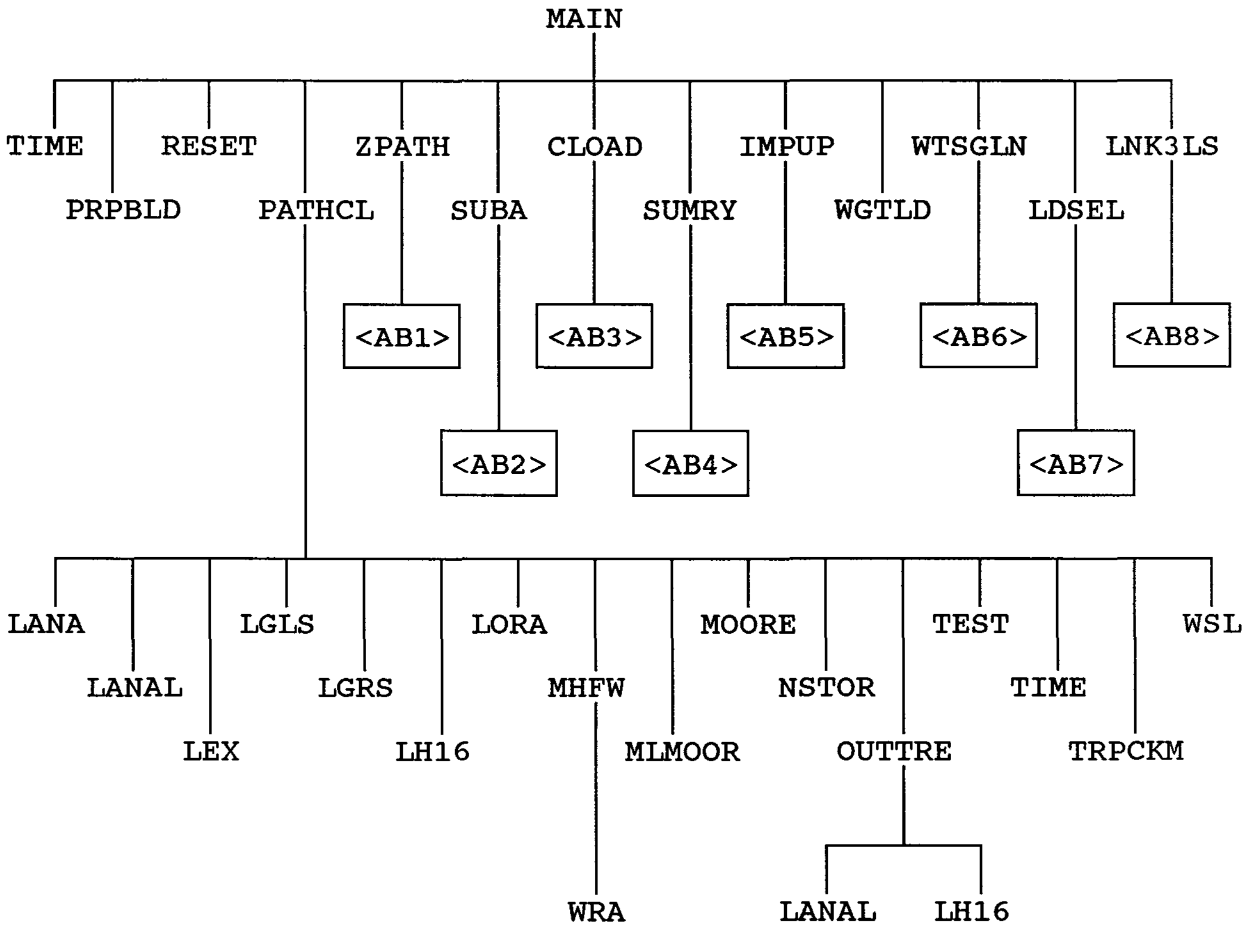
Order of Input Card Images for a Subarea Run

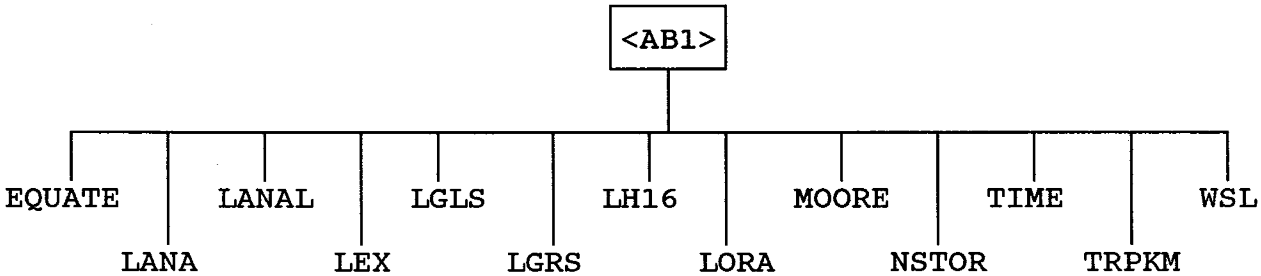
$SUBAREA, xx

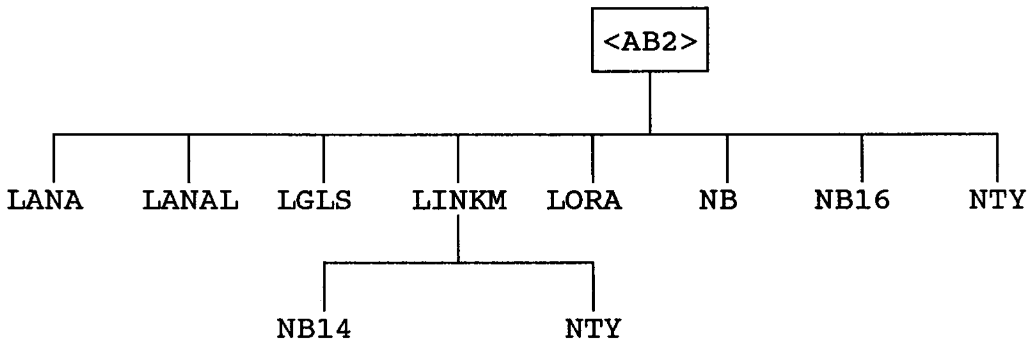
$PEAK CAPACITY RESTRAINT

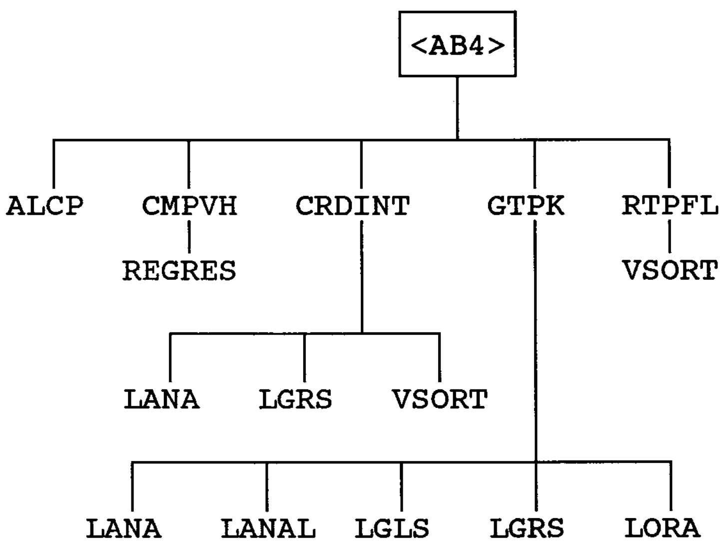
*WGT	
*TURN	
*TRN	(only if 16 turn penalty/prohibits)
*ALL or *LINKS	
*LASTC	
XXXX EQUAL END	
LIST	
. . .	
DIRECT LINKS	(optional)
. . .	
END	
*SEL	(only if selected links iteration)
. . .	
*END	(only if selected links iteration)

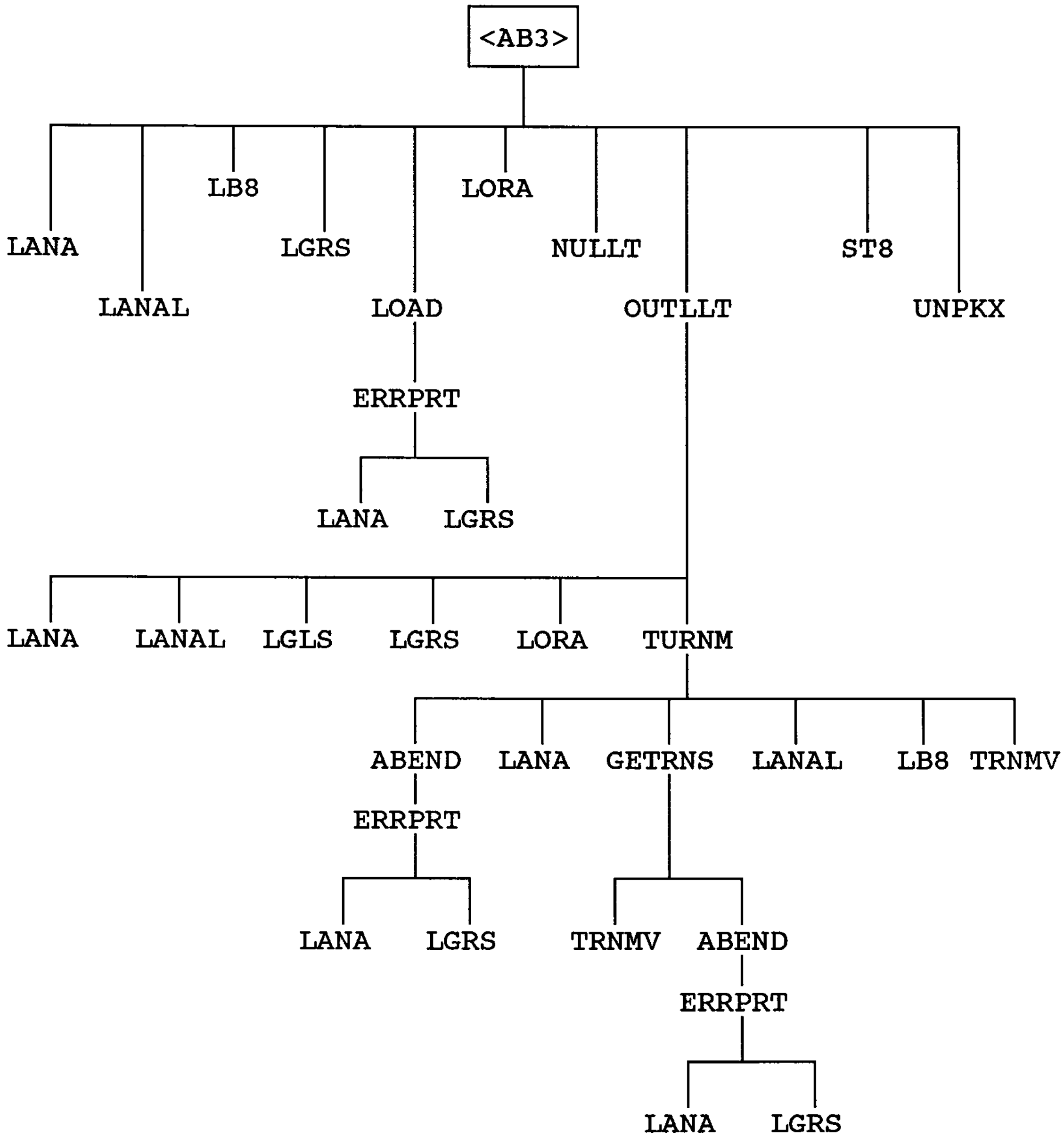
Sequence of Subroutines Called

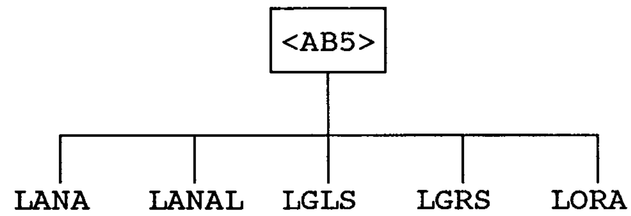


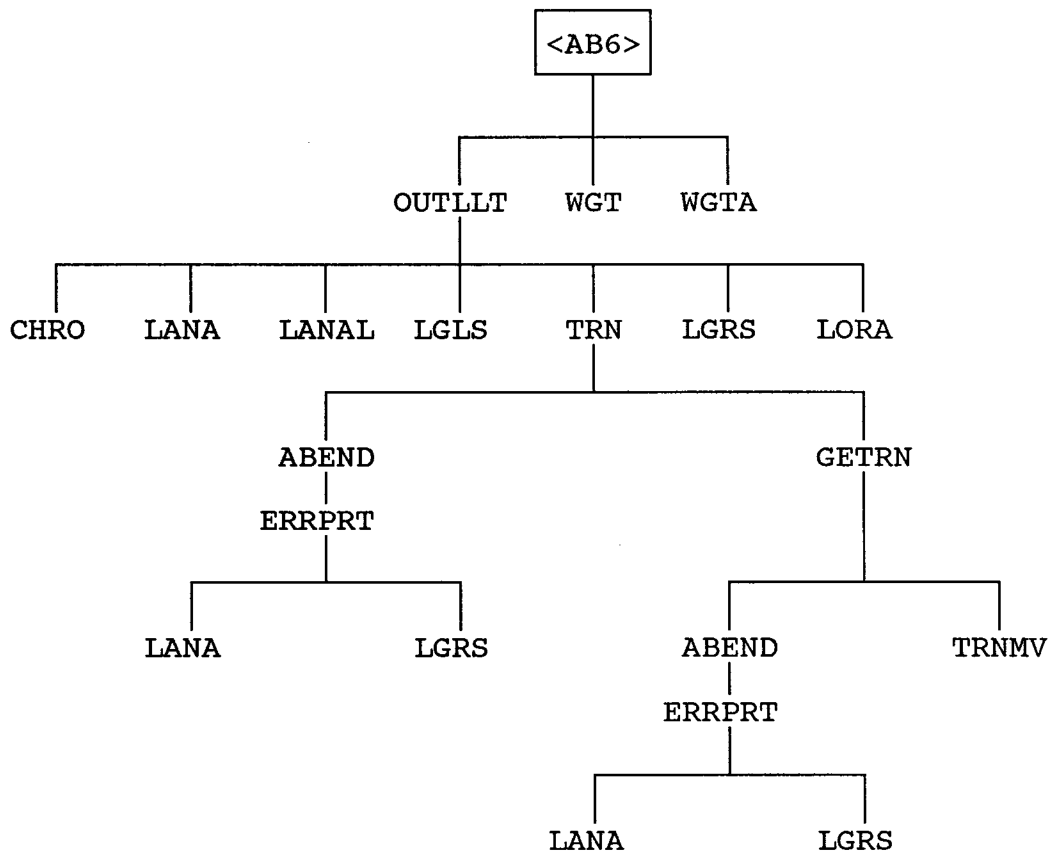

<AB1>
EQUATE
LANA
LANAL
LEX
LGLS
LGRS
LH16
LORA
MOORE
NSTOR
TIME
TRPKM
WSL


<AB2>
LANA
LANAL
LGLS
LINKM
LORA
NB
NB16
NTY
NB14
NTY


<AB4>
ALCP
CMPVH
CRDINT
GTPK
RTPFL
REGRES
VSORT
LANA
LGRS
VSORT
LANA
LANAL
LGLS
LGRS
LORA


<AB3>
LANA
LANAL
LB8
LGRS
LOAD
LORA
NULLT
OUTLLT
ST8
UNPKX
ERRPRT
LANA
LGRS
LANA
LANAL
LGLS
LGRS
LORA
TURNM
ABEND
LANA
GETRNS
LANAL
LB8
TRNMV
ERRPRT
LANA
LGRS
TRNMV
ABEND
ERRPRT
LANA
LGRS


<AB5>
LANA
LANAL
LGLS
LGRS
LORA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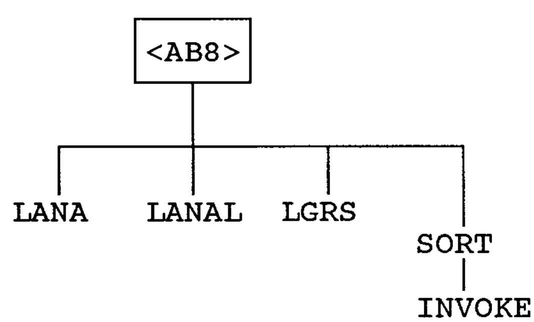
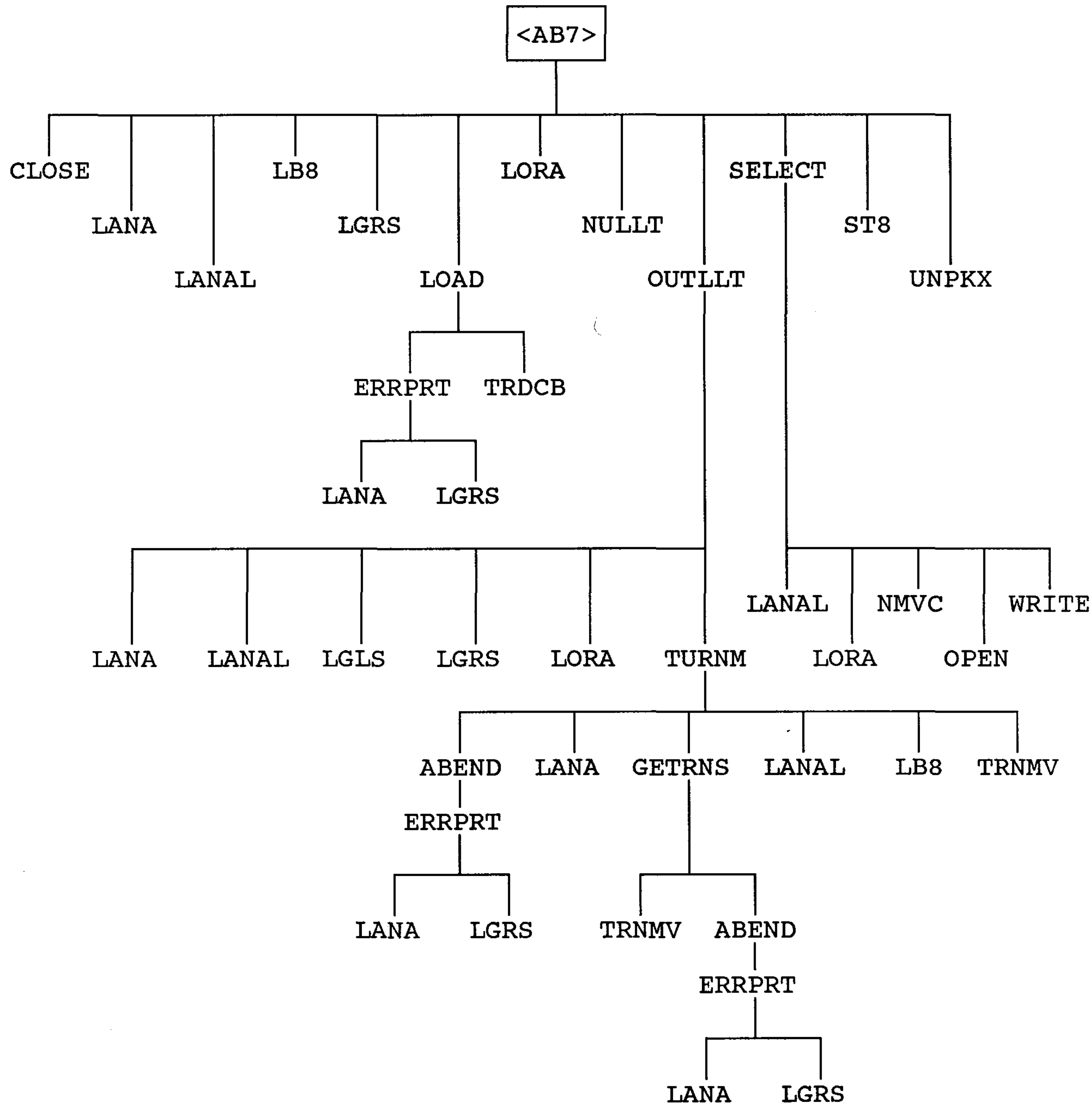
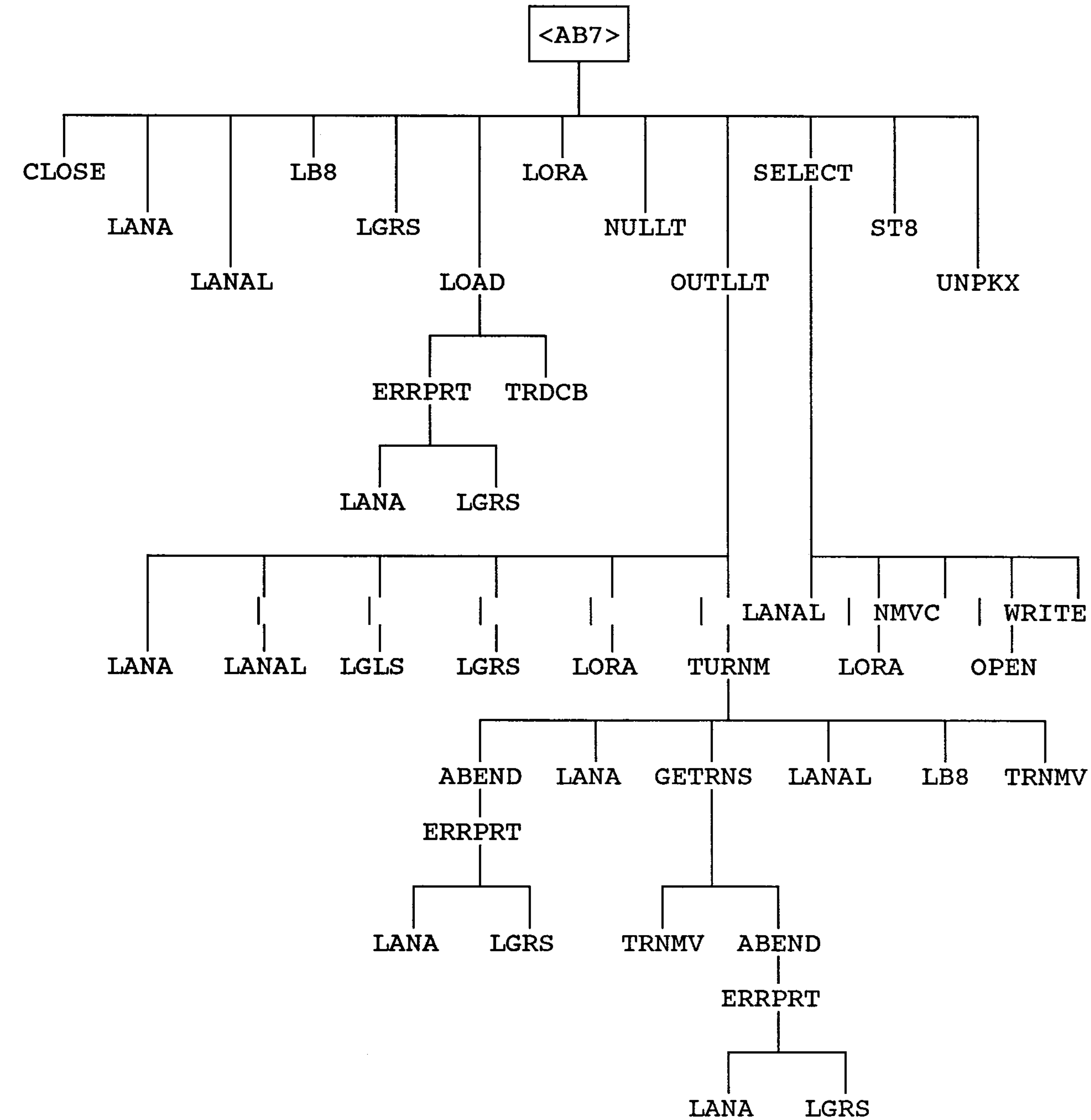
OUTLLT
WGT
WGTA
CHRO
LANA
LANAL
LGLS
TRN
LGRS
LORA
ABEND
GETRN
ERRPRT
LANA
LGRS
ABEND
TRNMV
ERRPRT
LANA
LGRS


<AB8>
LANA
LANAL
LGRS
SORT
INVOKE


<AB7>
CLOSE
LANA
LANAL
LB8
LGRS
LOAD
LORA
NULLT
OUTLLT
SELECT
ST8
UNPKX
ERRPRT
TRDCB
LANA
LGRS
LANA
LANAL
LGLS
LGRS
LORA
TURNM
LANAL
LORA
NMVC
OPEN
WRITE
ABEND
LANA
GETRNS
LANAL
LB8
TRNMV
ERRPRT
LANA
LGRS
TRNMV
ABEND
ERRPRT
LANA
LGRS


<AB7>
CLOSE
LANA
LANAL
LB8
LGRS
LOAD
LORA
NULLT
OUTLLT
SELECT
ST8
UNPKX
ERRPRT
TRDCB
LANA
LGRS
LANA
LANAL
LGLS
LGRS
LORA
TURNM
LANAL
NMVC
WRITE
LORA
OPEN
ABEND
LANA
GETRNS
LANAL
LB8
TRNMV
ERRPRT
LANA
LGRS
TRNMV
ABEND
ERRPRT
LANA
LGRS

Summary of Individual Subroutines

MAIN: In the execution of PEAK CAPACITY RESTRAINT, the MAIN program performs the following steps:

1. The logical variable PEAK in the PK labeled common is set to true to allow subroutines ALCP, CLOAD and IMPUP to work using a directional capacity restraint.

2. The subroutine PRPBLD is called to read the *WGT, *TURN, *TREE and loaded network output specification card images.

3. If this is a restart of PEAK CAPACITY RESTRAINT, then subroutine RESET is called to position FORTRAN Unit 3 correctly.

4. If the SUBAREA data set is zero, then the subroutine PATHCL is called to build minimum path trees for this iteration; otherwise the subroutine ZPATH is called to build trees if the subarea option is used with PEAK CAPACITY RESTRAINT.

5. If this is not the iteration for selected links, then the subroutine CLOAD is called to load the trees built for this iteration. If this is the selected link iteration, the subroutine LDSEL is called instead to load the trees.

6. If the SUBAREA data set is not zero, then the subroutine SUBA is called to prepare the network data set for summaries.

7. The subroutine SUMRY is called to produce summary tables for this iteration.

8. If no weights were input on the *WGT card image and this is the new impedance update, then subroutine IMPUP is called to update the link impedances.

9. Steps 3 through 7 are repeated for the number of iterations.

10. Subroutine WGTLD is called.

11. Subroutine WTSGLN is called.

12. If an extra weighted iteration is specified, then subroutines PATHCL and then CLOAD are called.

13. If the SUBAREA data set is not zero, then the subroutine SUBA is called to prepare the network data set for subroutine LNKLST.

14. Subroutine SUMRY is called to produce summaries.

15. Subroutine LNK3LS is called to produce a directional summary of the links with updated link impedances. The summary lists both directions of each link together but does not sum the directional link volumes. As both directions are listed the first directional link listed has its Anode less than the Bnode. The second directional link is labeled (B-A). This subroutine writes all directional links to Unit 83. It then calls subroutine SORT to sort these links into Bnode-Anode order. The sorted links are then read back in from Unit 84. This requires a special set of JCL which is also used by the ASSEMBLE PEAK NETWORK program. As the sorted links are read again, a nondirectional network data set is written to Unit 85. It is anticipated that this nondirectional network data set would be used to plot nondirectional volumes.

ABEND: This subroutine builds a message which contains the FORTRAN internal statement number of the line that called it. Next the subroutine calls subroutine ERRPRT. Then the subroutine abends with a user code of 100. This subroutine is written in Assembly language and is a CSECT named ABEND which is contained in the deck with subroutine GETVOL.

ALCP: This subroutine calculates a multiple regression analysis to determine the iteration weighting for a PEAK CAPACITY RESTRAINT process and prints the results of this analysis. The summations for the regressions are done in subroutine GTPK. Only the links with a nonzero count (or capacity depending on which is specified) are considered and centroid connectors are ignored. The count (or capacity) is the dependent variable and the assigned directional volumes from each of the iterations are the independent variables in the analysis. This subroutine is called by subroutine SUMRY. This subroutine contains the labelled common HEADER, CAPRES and TBL. This subroutine is written in FORTRAN IV.

CHRO: This subroutine moves character data from noncharacter variables to character variables. The first argument is the destination of the move. The second argument is the origin of the move. The third argument of is the length of the move. This function is an entry point in the Assembly language CSECT NMVC.

CLOAD: It reads the network from Unit NETWORK and modifies this to the format needed for the LOAD subroutine. It initializes the directional link volume array and the turn volume array to zero. It calls subroutine SELECT if it is a LOAD SELECTED LINKS run. It reads the trip matrix and the paths data sets. These are assumed to be in sort on the origin zones. It calls subroutine LOAD to load trips in the network if there is both a tree record and one or more trip records for an origin zone. After the network is loaded CLOAD calls subroutine SVLOAD to save the loaded network on Unit 3 if a PEAK CAPACITY RESTRAINT run is in iterations 1 through 5. CLOAD then calls subroutine OUTLLT to print the loaded network.

CLOSE: This subroutine closes data set SELTRP.

CMPVH: This subroutine prints the Jurisdiction Summary or the Jurisdictional/FUNCTIONAL Cross Classification Tables and the three Comparison of Assigned Volumes with link volumes, Counted volumes, and Capacities.

CRDINT: This subroutine calls VSORT (which sorts the corridor intercept records) and prints the corridor intercept tables.

EQUATE: The primary function of this subroutine is to establish zone to sector zone equivalences. EQUAL card images containing the sector zone numbers and the zone numbers which are in those sectors are read and an array is established containing the zone to sector zone equivalences. If any zone in the network has not been equivalenced to a sector, that zone is equivalenced to itself which then indicates it is in the subarea window or the boundary surrounding it. If no EQUALS cards are encountered, all zones are equivalenced to sector one. This subroutine is written in FORTRAN IV VS 77.

ERRPRT: This subroutine prints error messages from assembly language subroutines. The first argument is an array of length 17. The first index of the first argument is the address where ERRPRT was called from. The next 16 elements of this array are the 16 general purpose registers at the time ERRPRT was called. The second argument is the home zone if it applies; otherwise it is zero. The third argument is a character variable of length 50. This subroutine is written in FORTRAN IV VS.

GETRN: This subroutine gets the weighted turn volumes which were saved and places them in the turn volume matrix.

GETRNS: This subroutine gets the turn volumes which were saved and places them in the turn volume matrix.

GTPK: This subroutine prints the V/C cross classification table if there are two or more assignments on Unit NETWORK. It computes the summations necessary for the tables printed by subroutine CMPVH and for the curve fit printed by subroutine ALCP. It saves corridor intercept information in core in labeled common CD. It writes route profile records on Unit ROUTE. If logical variable SUM is true, GTPK calculates weighted directional volumes and updates the network data set, writing it on Unit NETWORK. All comparisons and tables are made from the weighted directional volumes if SUM is true.

IMPUP: This subroutine uses directional volumes when run with PEAK CAPACITY RESTRAINT and nondirectional volumes when run with ASSIGN SELF-BALANCING. This subroutine implements the new capacity restraint function when no weights are input. When no weights are input for PEAK CAPACITY RESTRAINT with the new impedance update function, then the percents to load are calculated by regression by subroutines GTPK and ALCP at the end of each iteration. This subroutine then reads Unit NET, which is the first argument of IMPUP, and updates the link impedances using the percents calculated from the regression for calculating the weighted link volumes. The updated network is written to Unit NNET, which is the second argument of IMPUP.

LANA: This integer function does a logical 'and' of the first argument and the second argument. This function is an entry point in the Assembly language CSECT LOPS.

LANAL: This integer function does a logical 'and' of the first argument and a fixed mask of X'00003FFF'. This extracts 14-bit integers in the range of 0 to 16383 from other data. This function is an entry point in the Assembly language CSECT LOPS.

LB8: This integer function indexes into an array of 8-bit integers and returns the value. The first argument is the array and the second argument is the index. This function is an entry point in the Assembly language CSECT NMVC.

LDSEL: This is an entry point in subroutine CLOAD. It sets the Selected Links option to true, then loads a network with selected links output to data set SELTRP. This subroutine is written in FORTRAN I VS 77.

LEX: This integer function does a logical exclusive 'or' of the first argument and the second argument. This function is an entry point in the Assembly language CSECT LOPS.

LGLS: This integer function does a logical left shift. The first argument is the 32-bit data to be shifted and the second argument is the number of bits to shift left. This function is an entry point in the Assembly language CSECT LOPS.

LGRS: This integer function does a logical right shift. The first argument is the 32-bit data to be shifted, and the second argument is the number of bits to shift right. This function is an entry point in the Assembly language CSECT LOPS.

LH16: This integer function does a shift left logical 16 followed by a shift right logical of 16 on the half word argument. This extracts a 16-bit integer in the range of 0 to 65535 from the half word. This function is an entry point in the Assembly language CSECT NMVC.

LINKM: This subroutine reads the card images which describe a subarea for focusing. It checks that the links on these card images are actually in the network. It then flags the links as BOUNDARY, AREA, or ADDED which are in these card images. This subroutine is written in FORTRAN IV VS 77.

LNK3LS: This subroutine lists the data by directional link for the 1 to 8 iterations of PEAK CAPACITY RESTRAINT and outputs Table L1. This subroutine calls subroutine SORT to sort the links into Bnode-Anode order so that it can print Anode-Bnode directional volumes and also Bnode-Anode directional volumes on the next line. This subroutine prints A-node, B-node, Distance, and Functional Class by link. Also by iteration the directional Link Volume, the Volume to capacity ratio code (a single character), the link impedance and the link speed. This subroutine also writes a nondirectional network data set on Unit 85. This subroutine is written in FORTRAN IV VS 77.

SORT: This subroutine calls subroutine INVOKE to sort the records written to Unit 83.

INVOKE: This subroutine links dynamically to the system SORT package. It also places the number of sort input records on the sort statement which it passes to the sort package.

LOAD: This subroutine loads a trip record by adding each trip interchange volume to all of the directional link volumes in the path connected between the origin and destination zones of the trip interchange. Some turn volumes are also summed in this process. This subroutine also writes a record on Unit SELTRP for each selected link crossed in loading each trip interchange volume.

LORA: This integer function does a logical 'or' of the first argument and the second argument. This function is an entry point in the Assembly language CSECT LOPS.

MHFW: This subroutine moves an array of half words to an array of full words. The subroutine changes -1 inputs to an output value of X'OOFFFFFF'. Other values which were not -1 are divided by 2. The subroutine then calls subroutine WRA to write the resulting full word array. This subroutine is written in Assembly language and is the only subroutine in this deck.

MLMOOR: This subroutine builds one minimum time path tree each time it is called. It also sums the distance along this minimum time path. This subroutine is written in Assembly language and is the only control section in this deck.

MOOR: This control section builds one minimum path tree each time it is called. Its entry point is MOORE.

NB: This subroutine extracts the node number and flags from a link. The first argument is the link contained in a full word. The second argument returned by NB is the node number of the link. The third argument is also returned by NB and is one or more flags indicating if the link is in the area. This subroutine is written in Assembly language and is the CSECT name.

NB14: This integer function does a logical 'and' of a half word argument and a fixed mask of X'00003FFF'. This extracts a 14-bit integer in the range of 0 to 16383 from the half word. This function is an entry point in the Assembly language CSECT NB.

NB16: This integer function does a logical 'and' of a half word argument and a fixed mask of X'0000FFFF'. This extracts a 16-bit integer in the range of 0 to 65535 from the half word. This function is an entry point in the Assembly language CSECT NB.

NMVC: This subroutine is a character move subroutine. The first argument is the destination character variable. The second argument is the destination offset in bytes. The third argument is the origin offset in bytes. The fourth argument is the length of the move in bytes. The fifth argument is the origin character variable. Arguments 2, 3, and 4 are full word arguments while the first and fifth arguments can have any alignment. This subroutine is written in Assembly language and is a CSECT.

NSTOR: This subroutine stores a value into a half word array. This first argument is the half word array. The second argument is an index into the array. Bits 6 through 31 of the third argument are stored into the indexed half word array. This subroutine is written in Assembly language and is an entry point in CSECT NMVC.

NTY: This integer function obtains a half word argument which it then shifts right by 14 bits. Then the shifted argument is logical anded[8] with the value X'00000003'. This extracts a 2 bit integer in the range of 0 to 3 from the half word. This function is an entry point in the Assembly language CSECT NB.

[8] Boolean algebra operation.

NULLT: This subroutine changes the turn codes in the first argument for the number of zones set in the second argument. The turn code is saved in bits 3 through 7 of the high order byte of each full word. The turn code is set to the value of 28 which indicates that no turns should be saved for this node zone. The name of this subroutine is derived from null turns. This function is an entry point in the Assembly language CSECT LOPS.

OPEN: See ASORT.

OUTLLT: This subroutine controls the printing of the loaded network. It prints page headings, calls subroutine TURNM to get the link volumes and turn volumes for a node and formats the directional link volume, nondirectional link volumes, and turn volumes.

OUTTRE: This subroutine prints one tree each time it is called.

OUTWLT: This subroutine prints the loaded network for one segment of the loaded network. It calls subroutine TRN to calculate the turn volumes for one node. It reads the node numbers and the node names from Unit NETWORK, and it writes the updated Network Data Set with the weighted assignment volumes added on Unit NEWNET.

WGT: This subroutine multiplies a group of volumes by an integer percent and places the results in another array.

PATHCL: This is the control subroutine for building trees. It defines arrays used by subroutines called from this division. It reads the network into core from Unit NETWORK and changes it to the form used by the tree builder subroutine. It controls the building of trees, the printing of trees, the packing of the paths, and writes the paths data set and the separation matrix data sets and the MILESEP separation matrix.

PRPBLD: This subroutine reads the *TURN card and the *TREE cards which specify the turn penalty and the trees to be built and printed. The COPY parameter is also specified on the *TURN card if it is used.

REGRES: This subroutine performs a linear regression analysis and prints the results of this analysis.

RESET: This subroutine repositions FORTRAN Unit 3 to the correct place to do a restart of PEAK CAPACITY RESTRAINT. This subroutine is written in FORTRAN IV VS 77.

RTPFL: This subroutine reads the route profiles from Unit ROUTE and prints the route profile tables.

SELECT: This subroutine reads the parameter cards of LOAD SELECTED LINKS. For each *SEL card it writes one record on Unit SELTRP, and it marks both of the one-way directional links as selected. This subroutine also reads one of the following parameter cards: *ALL, *LINKS, or *NONE. If the *LINKS card is read, this subroutine sets all turn codes in memory to 28. If the *NONE card is read, a logical variable is set to specify that the loaded network will not be printed.

ST8: This subroutine saves the last byte of a full word in the address accessed by the first argument. The location where the byte is saved is indexed by the second argument. The data saved is the fourth byte of the third argument. This function is an entry point in the Assembly language CSECT NMVC.

SUBA: This subroutine reads the card images that describe a subarea of a network. Then this subroutine extracts the subarea part of the network to the Unit SUBAREA data set. This subroutine is written in FORTRAN IV VS 77.

SUMRY: This is the control program for the summaries produced after an assignment. The subroutines called by SUMRY are determined by 3 logical variables. One of the logical variables, SUM, if true causes GTPK to produce a weighted assignment on Unit NETWORK and produce all tables and comparisons from this weighted assignment. Subroutine ALCP is called only if logical variable RES is true. If logical variable RTP is false, then the corridor intercept and route profile tables are skipped.

TEST: This subroutine tests whether the data contained in a path record contains any values of 6. A path record contains relative link indices of the path back to the origin. There are only six ways out of each node maximum. The relative index starts at 0 for the first link. Only values between 0 and 5 will be used for link indices. A value of 7 is used to indicate the origin zone. The third argument is set to a count of the number of 6 path indices found; a count of zero indicates no error. This subroutine is written in Assembly language and is an entry point in the TRPCKM CSECT.

TIME: This subroutine returns the time of day in units of 0.01 of a second.

TRDCB: This is the DCB (data control block) for the SELTRP data set. It is defined as an entry point in CSECT CLOSE, which is part of the LOAD deck. It is written in Assembly language.

TRN: This subroutine gets the weighted directional volumes, the weighted nondirectional volumes, and the weighted turn volumes saved. It also calculates the other weighted turn volumes and marks which turn volumes should not be printed because of one-way links.

TRNMV: This subroutine adds 2 indices together and gets the assigned volumes indexed by the sum from a full word array.

TRPCKM: This subroutine packs an array of path indices from 16-bit integers to ten 3-bit integers per word. The control section also contains the entry point TEST which checks to see that an array of packed path contains no indices of 6.

TURNM: This subroutine gets the directional volumes, nondirectional volumes, and turn volumes saved. It also calculates the other turn volumes and marks which turn volumes should not be printed because of one-way links.

UNPKX: This subroutine unpacks the path indices and places them in full words.

VSORT: This subroutine sorts records in core. The first argument in the calling sequence is the address of the array of records to be sorted. The second argument is the number of records. The third argument is the length of each record in bytes (must be between 1 and 256 bytes). The fourth argument is the length of the sort key in bytes (must be between 1 and 256 bytes), which cannot be longer than the record length. The sort key starts at the first byte of the record. The sort key is treated as an unsigned binary number and the records are sorted into ascending order on the sort keys.

WGTA: This subroutine multiplies a group of volumes by an integer percent and adds the results into another array.

WGTLD: This subroutine converts the positive weights output from a regression of the iteration volumes from PEAK CAPACITY RESTRAINT into a set of percents which sum to 100. This subroutine is written in FORTRAN IV VS 77.

WRA: This subroutine writes a record of separations for one tree for the centroids only. This subroutine is called by subroutine MHFW.

WRITE: This subroutine writes one record to the data set whose DDname is SELTRP. This subroutine has one argument which is the address of a location containing 18 bytes of data to be written as the next record. This subroutine is written in Assembly language, and it is an entry point in the CLOSE CSECT which is part of the LOAD deck.

WSL: This subroutine writes a record of separations for one tree for the centroids only.

WTSGLN: This subroutine reads Unit 3, and using the weights for each iteration, sums up the weighted directional link volume, reverses directional link volumes, and turn volumes for one segment in memory. It then rewinds Unit 3 and calls subroutine OUTWLT to print this segment of the loaded network. It repeats the above steps for other segments. The line counter used by subroutine OUTWLT to print page headings is only initialized for the first call to OUTWLT.

ZPATH: This subroutine controls building trees for BUILD AREA TREES. This subroutine calls subroutine EQUATE, and then it builds trees for sector centroids not equated to sector centroids. This subroutine is written in FORTRAN IV VS 77.

ADDITIONAL JCL FOR PEAK CAPACITY RESTRAINT

```
//FT83F001    DD  UNIT=SYSDA,DSN=&INSORT,SPACE=(6320,(1600,400)),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=6320)
//SORTIN      DD  DSN=&INSORT,VOL=REF=*.FT83F001,DISP=(OLD,PASS)
//SORTMSG     DD  SYSOUT=A
//SORTWK01    DD  UNIT=SYSDA,SPACE=(6320,(1200),,CONTIG),SEP=SORTIN
//SORTWK02    DD  UNIT=SYSDA,SPACE=(6320,(1200),,CONTIG),SEP=SORTWK01
//SORTWK03    DD  UNIT=SYSDA,SPACE=(6320,(1200),,CONTIG),SEP=SORTWK02
//SORTOUT     DD  DSN=&OUTSORT,UNIT=SYSDA,SEP=SORTWK03,
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=6320),SPACE=(6320,(1600,400))
//FT84F001            DD  DSN=&OUTSORT,VOL=REF=*.SORTOUT,DISP=(OLD,PASS)
```

Note that the placement of the FT83F001 and SORTIN statements must be in the listed order. Also the SORTOUT and FT84F001 statements must also be in the order listed. The reason that these statements must be in the order listed is that the first statement allocates the data set for the SORT package and the second statement allows it to be read by the FORTRAN program. The space allocations above are enough for 41000 one way links with 19 assignments.