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ARTERIAL SIGNAL TIMING OPTIMIZATION USING PASSER II-87

- MICROCOMPUTER USER'S GUIDE -

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Research Report Number 467-1

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Sponsored by

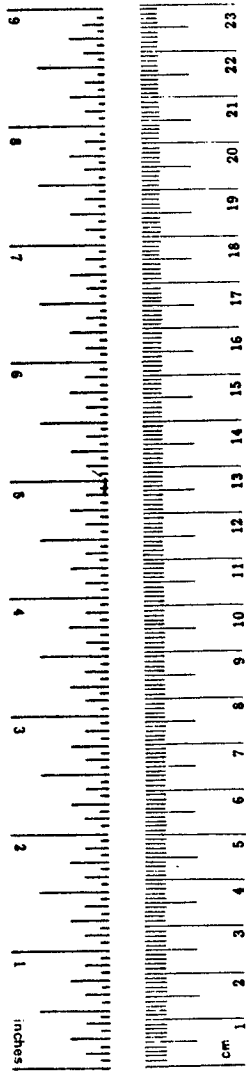
Texas State Department of Highways and Public Transportation

July 1988

METRIC CONVERSION FACTORS

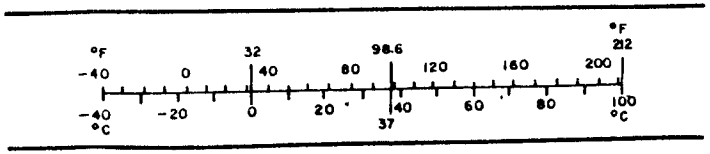
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



ABSTRACT

PASSER II-87 microcomputer program version 1.0 has been developed and is available for public distribution. PASSER II can be used to assist transportation professionals to analyze (1) Isolated intersection timing evaluations, (2) Progression signal timing optimization, and (3) "Existing" timing evaluations. The system contains the updated microcomputer version of the PASSER II program, advanced analyses similar to and beyond those used in the 1985 Highway Capacity Manual (HCM), and the latest Artificial Intelligence technology and Expert Systems designs. PASSER II-87 can analyze "Permitted," "Protected," and complicated permitted/protected or protected/permitted "Combined Phase" left turn signal treatments. The microcomputer system will be distributed with the intelligent, user-friendly, menu-driven, full-function, input/output processor, main executable program, optional user help information, and microcomputer user's guide. The new program provides the enhanced program output and improved signal timing reports, allows the user to modify all the embedded data, and accepts all the existing coded PASSER II or PASSER II-84 data without requiring any user revisions. The PASSER II-87 microcomputer system can provide alternative left turn analysis and advanced capacity evaluation well beyond the Left Turn Analysis Package (LTAP) and the 1985 Highway Capacity Software (HCS) packages.

KEY WORDS:

Traffic Signal, Signalization
Arterial Progression, Optimization
Left Turn Treatments, Permitted Left Turn
Computer Model, Expert Systems
Microcomputer Applications

SUMMARY

PASSER II-87 microcomputer version 1.0 has been developed and is available for public distribution. The system contains the updated version of PASSER II, advanced analysis procedures similar to those in the 1985 Highway Capacity Manual, and the latest Artificial Intelligence/Expert Systems technology. PASSER II-87 can analyze the complicated "Permitted," "Protected," and permitted/protected or protected/permitted "Combined Phase" left turn signal treatments. The PASSER II-87 microcomputer system will be distributed with the intelligent, user-friendly, menu-driven, full-function input/output processor, main executable program, optional user help information, and microcomputer user's guide. The program provides enhanced program output and improved signal timing reports, allows the user to modify all the embedded data, and accepts all the existing coded PASSER II or PASSER II-84 data without requiring any user revisions.

IMPLEMENTATION

This report provides the microcomputer user guide for applying the added unprotected left turn treatments and considerations for the heavy left turn maneuver of the SDHPT's PASSER II-84 model for the better coordination of arterial signal systems. A user-friendly microcomputer software system and microcomputer user's manual has been developed. This research effort developed computerized evaluation tools for improving the operational, environmental and economic analyses of arterial signal system control strategies based on current vehicle performance characteristics. This validated computer model, including useful engineering guidelines and improved signal timing and capacity analyses, can provide cost-effective reduction of urban congestion, fuel consumption and vehicle emission. Improvements in traffic safety due to fewer left turn accidents is also expected. The PASSER II model has received wide acceptance. As with all good computer models, there is a need to make modifications as new problems and new technology arises. The modifications in the PASSER II-87 microcomputer system will provide for widespread use among cities, counties, agencies, and consultants.

DISCLAIMER

The PASSER II-87 microcomputer program was developed under Texas State HP&R 2-18-86-467 study by the Texas Transportation Institute of Texas A&M University System. It was designed for use by traffic engineers and other transportation professionals. This program can be used to optimize or evaluate a single isolated signalized intersection or a coordinated arterial signal system of up to twenty (20) intersections. Care should be taken to make sure the program package, which includes the user's documentation, remains intact. If the package elements become separated, program effectiveness may be impaired severely.

Please be advised that no warranty is made by the Texas Department of Highways and Public Transportation, the Federal Highway Administration, the Texas Transportation Institute, or Texas A&M University System as to the accuracy, completeness, reliability, usability, or suitability of the computer program and its associated data and documentation. No responsibility is assumed by the above parties for the incorrect results or damages resulting from its use.

TRADEMARK

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

PASSER II-87, an acronym for the Progression Analysis and Signal System Evaluation Routine, is a powerful, easy-to-use, and user-friendly signal timing program for IBM PC/XT/AT or Intel compatible 8088/8086/80286/80386 based microcomputers that have PC DOS or MS DOS 2.1 or higher disk operating systems (DOS). The system operation does not require the use of 8087/80287 math co-processors. The program requires a microcomputer with a minimum of 512K RAM (Random Access Memory) and two 360KB double-sided double-density (DS DD) floppy drives, or one 1.2MB or 1.44MB double-sided high-density (DS HD) floppy disk drive, or a microcomputer system with a hard disk. The first diskette contains the input preprocessor and postprocessor, example data, configuration files, and batch files of the PASSER II-87 analysis system. The other diskette contains the main program and optional help information of the PASSER II-87 microcomputer system. However, it is highly recommended that the program be installed and used on hard disks for fast execution. The PASSER II-87 microcomputer program system is distributed with the input preprocessor, output postprocessor, executable main program, optional user help information, and microcomputer user's manual.

PASSER II-87 seeks to maximize arterial two-way progression and minimize signal delay by pursuing a series of arterial signal timing optimization processes. Signal timings are calculated to minimize the individual intersection delay based on traffic volumes, saturation flows, and minimum phase times for a given cycle length range. PASSER II-87 can optimize signal phasings ranging from two-phase operations to multiphase, variable sequence operations. In addition to the basic "Protected" or "Permitted" left turn phasing, PASSER II-87 can further analyze the complicated permitted/protected or protected/permitted "Combined Phase" left turn sequences. Maximum progression efficiency is calculated for the arterial system, given travel speeds and link distances. Optimal phase sequence, phase split timing, and coordinated offsets for each intersection are provided in the solution. Also provided, as requested by the users, is the optimal time-space diagram. Up to twenty (20) signalized intersections can be included in one arterial progressive system. Signal phasing is described on a "Permitted" or "Allowed" phase movement basis. Up to four (4) possible arterial phasing sequences are allowed at any one intersection. Each cross street can have one (1) of these four signal phase sequences.

A range of cycle lengths can be examined for the optimal progression operation in any one run. PASSER II-87 will select the cycle length that can provide the maximum progression efficiency. That is, the program will select the cycle that provides the largest percentage of the cycle for arterial progression. Delay-minimization guidelines are provided as program output for selecting a narrow range of cycle lengths which will yield delay efficient solutions. And last, the program automatically fine-tunes the coordinated progression offsets to further minimize delay to the arrival patterns of the arterial traffic flow. This system offset fine-tuning algorithm in PASSER II-87 will typically result in a further reduction of 5-15% in delay to the arterial's progressive movements. This system delay reduction is accomplished through the offset fine-tuning algorithm without any loss of arterial progression.

As previously described, PASSER II-87 is primarily designed to develop timing plans that provide optimal arterial two-way progression. In addition, two other program features should be noted at this time. The program can develop the time-space diagrams that provide one-way progression in either direction along the arterial street. Also, PASSER II-87 may be used as a traffic planning or capacity analysis tool if volumes, saturation flows, intersection geometrics, and existing signal timings are known. This is because up to a maximum of 20 "isolated" intersections instead of 20 coordinated intersections can be "timed" and "evaluated" simultaneously if desired. The system employs the most advanced highway capacity technology in the model formulation. Besides arterial progression, PASSER II-87 can also be used to examine isolated intersections by quantifying the geometric, signal control, and traffic flow quality effects. A "Highway Capacity Manual" analysis can be conducted in PASSER II-87. However, the 1985 HCM uses an approximation technique, and PASSER II-87 uses a more refined model for explicitly describing the left turn traffic maneuver.

SYSTEM FEATURES

PASSER II-87 is designed so that a traffic engineer who is not very familiar with a microcomputer can still effectively begin to use the system to solve his/her arterial signal timing and evaluation problems. The Texas Transportation Institute (TTI) and the Texas State Department of Highways and Public Transportation (SDHPT) have jointly developed the input/output processor (PASSETUP) which permits users to readily establish a traffic data input file. Therefore, it is not required to use the system editor, such as WordStar, WordPerfect, PE or other text editors, to create and modify the PASSER II-87 data sets in the data input process.

PASSETUP, the microcomputer input/output processor, helps users input their data through an interactive CRT screen format. Data input guidelines and a series of help menus are provided to assist users with data input. Routine checking for data coding errors is provided. A data modification facility also allows users to modify the data and provides a reference list of input guidelines for convenient reference without having to exit the PASSER II-87 system. After all data input is complete, PASSETUP collects the data, rearranges it into a standard 80-column card-image ASCII text data format, and then automatically stores it in a data file selected by the user for ready access or later modification.

PASSER II-87 provides an exceptional list of output features. The output is headed by an echo listing of the system embedded data, the coded input data structured around arterial system parameters, and the intersection variables. The output of the optimized solution provides a listing of the optimal timings for the arterial street, optimal signal timing plans for each intersection, a series of level of service evaluations for each phase, the signal controller phase interval setting report, an optimal time-space diagram, and the optional packed data array debug printouts. The implementation of the optimal signal timings is greatly aided by the provision of a complete set of phase interval tables with respect to the system master intersection. This is a new system programming feature for applications on the microprocessor-based traffic actuated signal equipment.

PROGRAM IMPLEMENTATION

PASSER II-87 is a computer program that can be used for arterial progression signal timing optimization and intersection capacity analysis. It has a complete stand-alone user interface for microcomputer applications. PASSER II-87 is an engineering tool used to calculate the green timings, phase sequence, and coordinated offsets for multiphase arterial signal systems. The generated solutions produce minimal delay and provide good arterial progression for a given set of geometric and traffic conditions.

The program permits the engineer to interact with the overall solution process while relieving the engineer from the tedious and repetitive calculations. Several program runs may be needed before the final solution set can be produced. Engineering judgment is frequently required in the selection of traffic input parameters. Saturation flow for the basic protected movement is an important program input. The use of a local traffic study or the program's new capacity features is recommended. Some estimation regarding saturation flow rate is provided in the input coding instructions and may also be used where no other guidance is available. Interactions of left turn bay geometrics, existing volume loadings, and apparent volume-to-capacity ratios must be subjectively and judgmentally evaluated to estimate their individual and collective effects on intersection capacity and resulting saturation flow.

Cycle length selection is the single most important decision that must be made by users of PASSER II-87 during arterial signal timing optimization. All intersections in the progressive system must operate on the same background cycle length. Due to the nature of the analysis capability of the PASSER II-87 system, no double cycling is permitted. Judgmental tradeoffs may be made between quality of arterial progression and total arterial delay. PASSER II-87 can automatically examine a range of cycle lengths and will select the cycle length providing the best progression. However, total arterial delay is highly dependent on the selection of cycle length. Consequently, the cycle range to be examined should be carefully selected if minimizing delay is an important objective. It is recommended that additional runs be made and examined using one reasonable cycle length, such as the "MAXIMUM CYCLE LENGTH" described below, which should be initially selected for the given data set.

One useful output of this initial program run would be a list of "minimum delay" cycle lengths for each intersection as if each were an isolated intersection. It is recommended that the "MAXIMIN CYCLE LENGTH," i.e., the maximum of the minimum delay cycle lengths, be included within the cycle length range examined. However, the range of cycle lengths should not exceed 10 seconds. The lower limit of the cycle length range should not be less than 90% of the maximin cycle. For example, assume that the maximin cycle is 94 seconds. 90% of 94 is 84.6 seconds. The recommended cycle range would be from 85-95 seconds. PASSER II-87 should be run using this particular range of cycle lengths to determine optimal arterial progression with the user knowing that the total arterial system delay will be near the minimum value.

Excessively long minimum delay cycle lengths are suggestive of a capacity problem. Methods should be sought to increase the capacity of the critical intersection(s). For example, a series of traffic engineering improvements can be made to the facilities, such as added lanes, restriped pavement, restricted parking, etc., to improve the capacity of the intersections.

In addition, excessively long cycle lengths tend to overflow left turn bays or back queues into the upstream intersections or driveways. These actions could further reduce signal capacity. The phase sequence selection process involves another series of traffic engineering judgments. In addition to considering the effects on coordinated arterial signal progression, several other factors should also be considered. These factors include the type of traffic signal control equipment, turning movement volumes, left turn bay storage capacity, and pedestrian signal timing requirements.

It is suggested that the first program runs be made separately for the AM peak, PM peak and Off-peak traffic conditions which will allow all the possible signal phase sequences to determine which phase sequences provide the best overall progression. The user may also wish to run a "preferred" set of phasing sequences for each time period in order to evaluate the relative loss in arterial progression that might occur when using only the preferred phase sequence choice at each intersection. If the arterial traffic control system permits only one phase sequence per intersection, then a final phase sequence must be selected for each intersection for all the AM, PM and Off-peak conditions. If the same phase sequence was selected for all three initial AM, PM and Off-peak runs, then it probably should be used in the final program runs. Finally, AM, PM and Off-peak program runs should be made after a thorough study of all the previous runs has been made. Local experience and traffic control capabilities can determine whether the phase sequence used in the final timing plans is the same or different for each intersection.

PASSER II-87 calculates phase green time requirements from volume data to develop optimum progression solutions. The program may, however, be used to develop an improved progression solution when the green times and cycle length are already known. The given cycle length is entered as is. The phase times for the movements, i.e., the green plus yellow and all-red, are entered as minimum phases. The user may enter actual volumes and saturation flows or dummy values. For example, the user may enter 1 for volume and 10 for saturation flow for each phase. The program will use the minimum phases as the actual greens. Phase selection by the program is made as appropriate.

Isolated timing and evaluation can also be performed through the PASSER II-87 system. The traffic data coding system expedites the data entry process. All the arterial progression aspects are automatically deleted from the input data coding procedure. PASSER II-87 is a program written by traffic engineers for traffic engineers. It only calculates; it does not engineer. It may or may not detect your errors or analysis intentions. As one gains experience with the program, personal skill will improve, and the number of alternative solutions that can be considered will greatly increase.

MICROCOMPUTER SYSTEM HIGHLIGHTS

The PASSER II-87 Microcomputer Environment System was developed by the Texas Transportation Institute (TTI) for the Texas Department of Highways and Public Transportation (SDHPT) to facilitate use of the microcomputer version of PASSER II-87. The analysis system is designed for use on an IBM PC/XT/AT or compatible microcomputer. The new system has the following advantages over the existing PASSER II-84 Microcomputer Program Version 3.0:

(1) Provides user-friendly, menu interface, and full-cursor movements.

(2) Accepts all existing PASSER II-84 data without user modification.

(3) Allows user modification of all embedded data for analysis.

(4) Uses the graphical traffic movement input and provides the "ASSISTANT" function for helping users to prepare data for 1985 HCM type signalized intersection capacity analysis.

(5) Is capable of analyzing all the commonly available left turn signal treatments. These features include:

   a. With or without a protected left turn bay.
   b. With or without a protected left turn phase.
   c. Combined phase analysis. This analysis includes the optional "Protected plus Permitted" or the "Permitted plus Protected" left turn signal phasing schemes.

(6) Provides an input scheme for developing an evaluation of existing or user-selected arterial signal offsets.

(7) Reports all the embedded data used in the analysis.

(8) Provides an improved user-specified controller Phase Interval Setting (PIN) report, progression bandwidth coordinates, and an enhanced Time-Space diagram.

This "Microcomputer User's Guide" was written for those users who are already familiar with the PASSER II program and desire to use the PASSER II-87 microcomputer program to analyze arterial signal system design problems. Any questions concerning how the PASSER II program operates or what type of data input it needs is specifically addressed in the "PASSER II User's Manual." Hopefully, the user will find the data input system to be easy to work with, but if one should have any unresolved questions, call the Texas Transportation Institute at (409) 845-9873 or TexAn 857-9873, or call the Texas SDHPT at (512) 465-8353 or TEXAn 258-8353. It will be appreciated if calls are placed only when this manual does not provide the needed information. Please consider that software support is in addition to the regular duties of the Texas Transportation Institute and the Texas SDHPT.

Please address all written correspondence to:

Texas Department of Highways and Public Transportation
File D-18STO
11th and Brazos Streets
Austin, Texas 78701

And questions concerning loading and obtaining of the disks to:

Texas Transportation
Technology Transfer
Texas A&M University
College Station, Texas 77843
Phone: 1-800-824-7303

or

McTrans Center
University of Florida
512 Weil Hall
Gainesville, Florida 32611
Phone: 904-392-0378

PASSER II-87 MICROCOMPUTER ENVIRONMENT SYSTEM

The basic theory of the PASSER II was originally developed at the Texas Transportation Institute (TTI), Texas A&M University System for the Dallas Corridor Project sponsored by the Federal Highway Administration (FHWA), U.S. Department of Transportation. The PASSER II program was originally developed for applications on the mainframe computer systems of the Texas State Department of Highways and Public Transportation (SDHPT). PASSER II-87 is the most recent and enhanced version of the PASSER II program.

PASSER II-87 is a computer program that can analyze both the individual signalized intersections and arterial progression optimization. It was originally designed for high-type arterial streets with the separate protected left turn lanes and protected left turn phases. Also, it provides optimized timing plans for modern eight-phase controllers. The theory, model structure, methodology, and logic of PASSER II-87 have been evaluated and documented. PASSER II has received widespread usage because of its ability to rapidly select multiple phase sequences for maximized arterial progression. PASSER II-87 maximizes total two-way progression bandwidth efficiency. In the optimization process, it varies the signal phasing and offset at each intersection with cycle and progression speed changes to find the optimal timing plan which both maximizes the arterial progression bands and minimizes the total arterial system delay.

The PASSER II-87 system is an engineering tool which combines the updated version of PASSER II-87, advanced analysis procedures similar to and beyond those in the 1985 Highway Capacity Manual (HCM), and the latest developments in microcomputer programming technology. The functional structure of PASSER II-87 is illustrated in Figure 1. It can be used to assist transportation professionals to analyze (1) Isolated intersection timing evaluations, (2) Progression signal timing optimization, and (3) "Existing Timing Evaluations" or "Simulation Evaluation." Much of the input data is similar to those input data required for other signal timing optimization programs. To analyze an isolated signalized intersection, traffic turning movements and intersection approach saturation flow rates are needed. Minimum phase times for each movement must also be provided. At present, the program assumes the isolated intersection evaluation if the input data pertain to only one intersection. On the other hand, this program assumes progression if the input data specified include more than one signalized intersection in the arterial system.

PASSER II-87 INPUT DATA REQUIREMENTS

Most input data required for the PASSER II-87 microcomputer system are the same as those used in the mainframe version of PASSER II-87. The user may input data from the microcomputer input processor or download the data files straight from the mainframe computer to execute the program. Since there are no input/output processors provided by the mainframe computer, it is then possible to create or modify the input data files on the microcomputer and upload the files to the mainframe for faster execution. The most important input data requirements are the National Electrical Manufacturers' Association (NEMA) phase movement designation, selection of signalization designation, and the phasing sequence inputs.

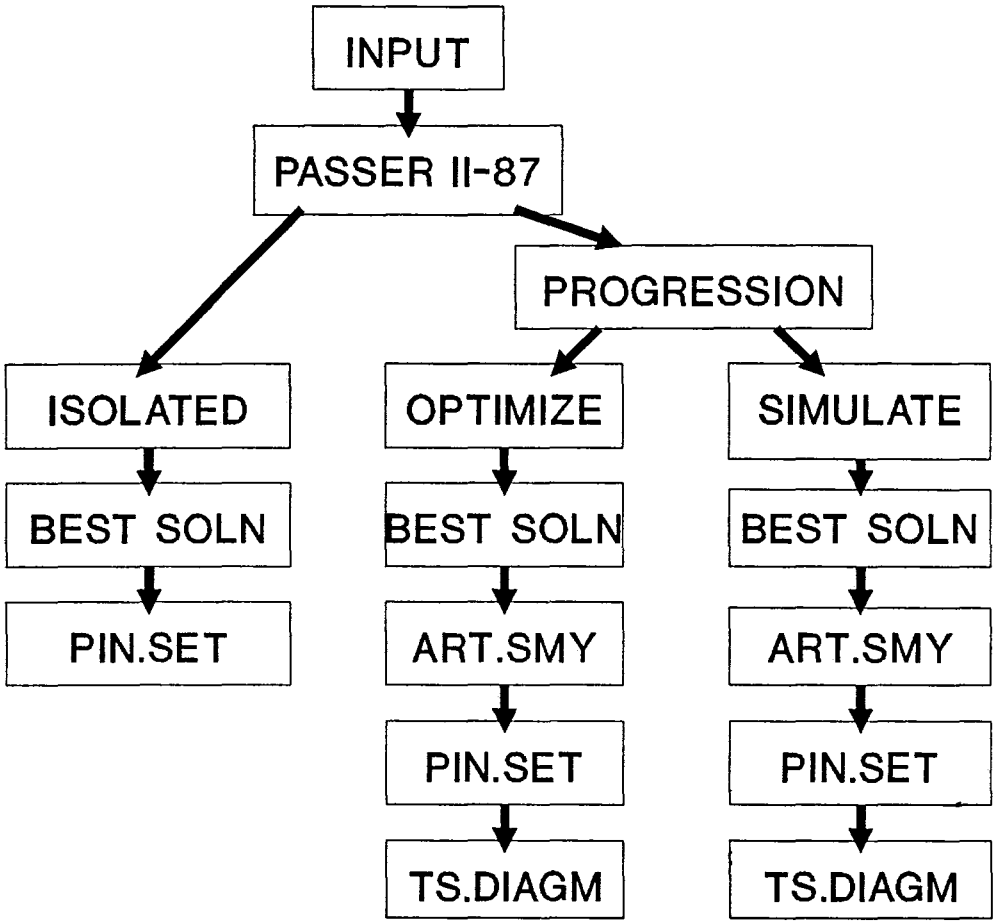


Figure 1. Functional Structure of PASSER II-87.

Movement Designation

Intersection specific movement data are input according to the NEMA movement designations shown in Figure 2. In this figure, separated left turning movements are represented by the odd numbers, Movements 1, 3, 5, and 7. The "left turn protection" may be provided either by a separate left turn lane, left turn bay, or by a protected left turn signal phase. On the other hand, left turning volumes not protected by an exclusive left turn lane and left turn phase will be combined with traffic volumes in the adjacent through lanes. As illustrated in Figure 3, the main and cross street phases are generated by the combinations of the eight numbered movements, starting at the beginning of each signal phase. Movements 1, 2, 5 and 6 are used exclusively for the main street. Likewise, movements 3, 4, 7 and 8 are used only for the cross street. In this NEMA movement numbering scheme, PASSER II calculates the progression operation beginning at the start of the first phase for the arterial street. At those signalized intersections that have no protected left turn phases, left turn movements 1, 3, 5, and 7 are merged into the adjacent through movements. Traffic volumes for each through phase movement are normally the total traffic volumes for the through plus right turns. Also, it may be desirable to provide some reduction in right turning volumes for considering the separate effects of right turning lanes or free right turn traffic movements.

It is highly recommended that all saturation flow adjustments for unprotected turns be made to the corresponding left turn phase movements using the "ASSISTANT" function. It is also recommended that no adjustment be made to the traffic volume for a more accurate estimate of the vehicular delay. PASSER II-87 outputs the traffic volumes, saturation capacity flow, and minimum phase times that are required to satisfy the necessary pedestrian crossing and minimum protected green phase with respect to the NEMA movement phase designation.

Signal Phasing

PASSER II-87 models a common, high-type, coordinated multiphase signal phasing in a "quad-left" traffic signal control system. PASSER II-87 input uses the minimum information to generate the possible left turn treatments as well as allowable signal phase sequences. The input data was designed to simplify the user's input for analyzing the various possible left turn signal treatments and capacity evaluations. These range from the most simple two-phase "Permitted Phase" and sophisticated "Protected Phase" operations, to the most complicated permitted/protected or protected/permitted "Combined Phase" left turn sequences. PASSER II-87 provides for different phase sequences to be displayed on each arterial street. In the analysis, there must be at least one (1) to the maximum of four (4) allowable phase sequences selected for the main street and only one (1) of the four possible phase sequences specified for the cross street. Phase sequences without overlap are also called "split phase.

Phasing Selections

The sequence of the numbered movements defines the phasing sequence for either the main or cross street phase movements. Four allowable phasing sequences are used in PASSER II-87. As shown in Figure 3, these alternative arterial phasing sequences include four possible signal phasing selections.

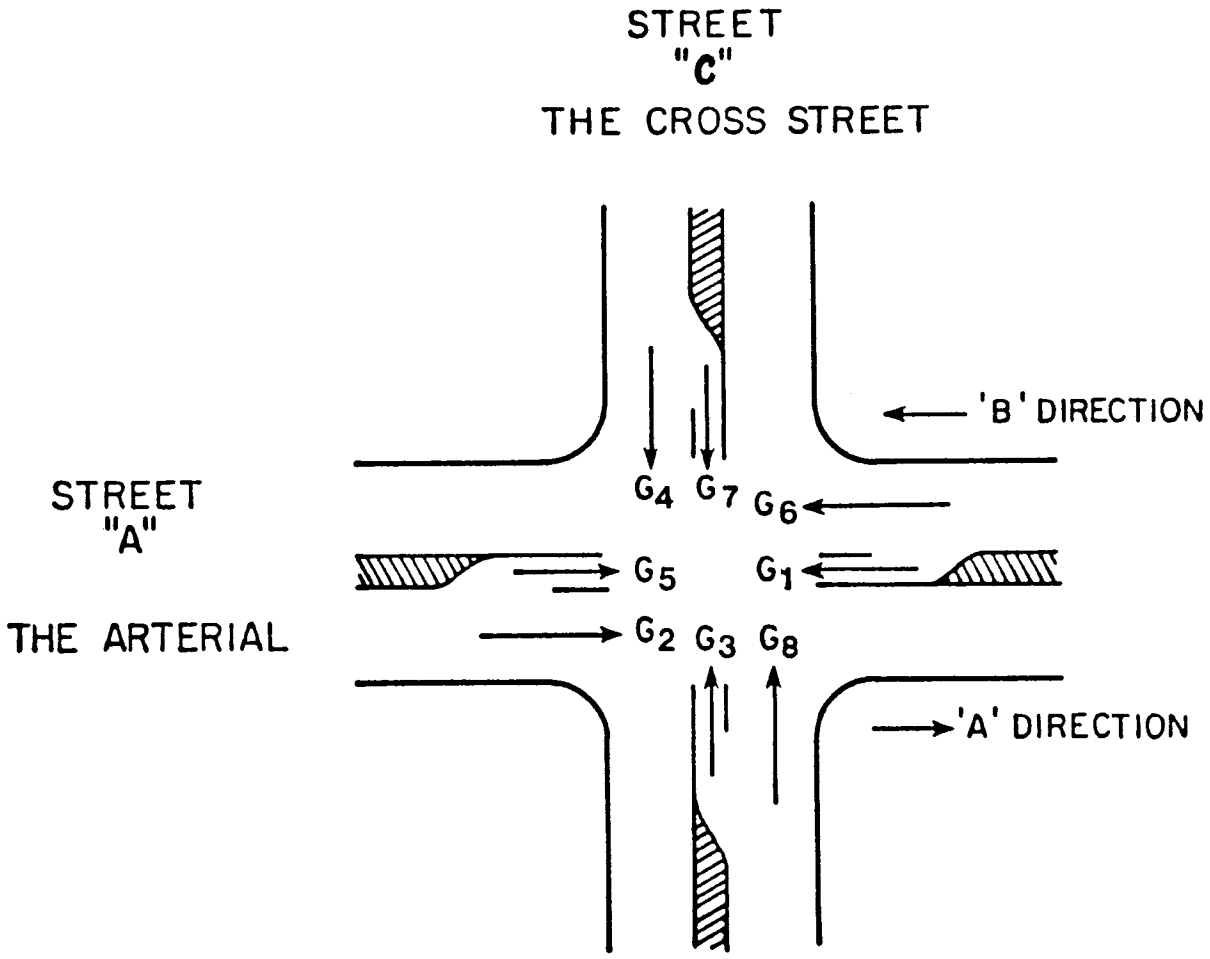


Figure 2. NEMA Numbering System.

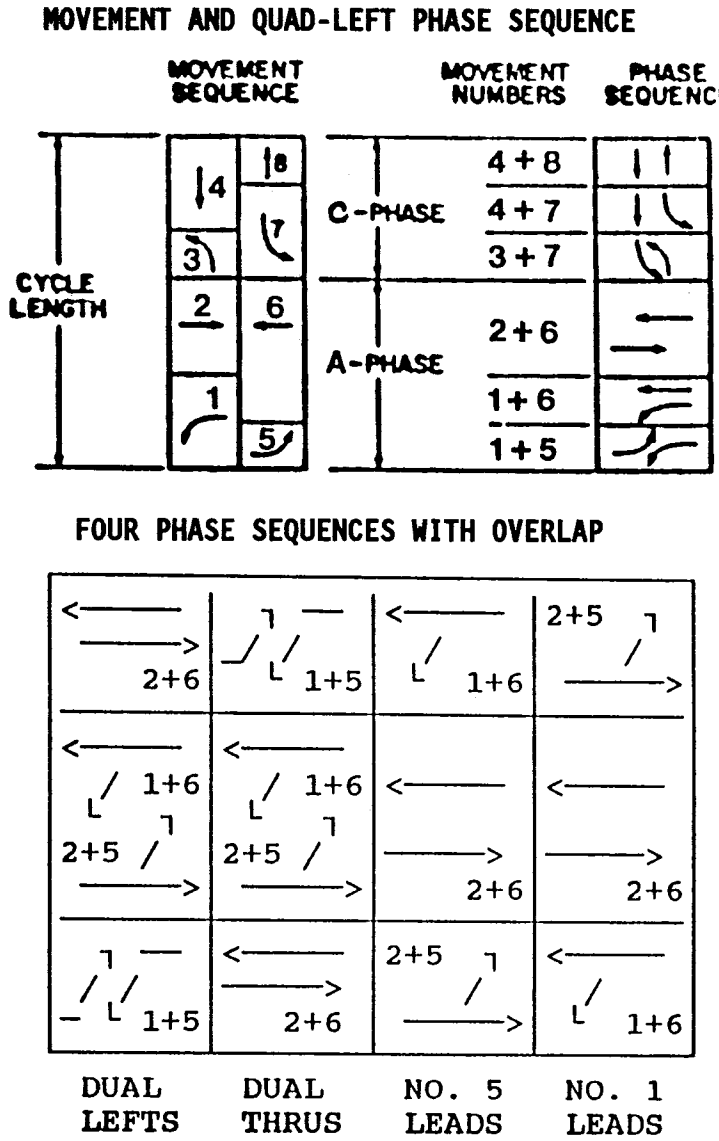


Figure 3. Alternative Phase Sequences in PASSER II-87.

- o Left-Turns First or Dual Lefts Leading or Dual Lefts Lead
- o Through Movements or Dual Throughs Leading or Dual Thrus Lead
- o Leading Green or Leading Left Leading or NEMA No. 5 Lead
- o Lagging Green or Lagging Left Leading or NEMA No. 1 Lead

Figure 3 illustrates a typical "overlap" signal phasing sequence in PASSER II-87. Concurrent timing of the non-conflicting pairs of phases, similar to the ring 1 and ring 2 concept in actuated control, are always assumed with overlapped phasing. Consequently, three compound phases can be displayed within the street's phase sequence. When no overlap exists in the phase sequence, only two compound phases may arise, as shown in Figure 3. PASSER II-87 can maximize arterial progression by optimizing the phase sequence, cycle length, progression speeds, and coordinated offsets. A total of eight phasing sequences are possible for both the arterial and cross street directions in the PASSER II-87 system. Since no explicit investigation is carried out to optimize the cross street phase sequence, the user must input one and only one phase option for the cross street movements in PASSER II-87.

The following study procedure is implemented in the PASSER II-87 input preprocessor to identify the logical input selection for determining the proper signal phasing arrangements.

Step 1. Identify the existing movements;

Step 2. Identify the possible phasings;

Step 3. Describe the phase order for each phase;

Step 4. Describe the phase overlap for each phase; and

Step 5. Determine the phase code for each phase.

A. Normal Phase Selection - System generated phase.

B. Special Phase Selection - User selected phase.

PASSER II-87 was programmed to assist the user in selecting the appropriate signal phasing patterns intelligently according to the user input data. The system first finds out which traffic movements have traffic volume inputs and then references the optional signal phasing selections from the logical phasing pattern tables defined in Figures 4 and 5. Finally, the system shows the user a list of the recommended phasing patterns as the logical phase choices so the user can input or modify the data sets.

In general, these two logical phase sequence tables, separately for the normal and special phase sequence table, can solve 95% of PASSER II-87 user problems for different left turn phasings. In the other cases, the user may choose to utilize the special phasing table for specifying particular phasing options. The allowable phase sequence in the PASSER II-87 system indicates each logical phase pattern alternative for every signal intersection according to the user's input volume. Please note that if all four traffic movements

NORMAL PHASING

Arterial							
Movements				Phasing Patterns			
1	2	5	6	LT	THRU	#1	#5
X				-	-	-	-
	X			-	1	-	-
		X		-	-	-	-
			X	-	1	-	-
X	X			-	-	-	-
X		X		-	-	-	-
	X	X		-	-	-	1
X			X	-	-	1	-
	X		X	-	1	-	-
		X	X	-	-	-	-
X	X	X		2	-	-	2
X	X		X	-	2	2	-
X		X	X	2	-	2	-
	X	X	X	-	2	-	2
X	X	X	X	3	3	3	3

Cross Street							
Movements				Phasing Patterns			
3	4	7	8	LT	THRU	#3	#7
X				-	-	1	-
	X			-	1	-	-
		X		-	-	-	1
			X	-	1	-	-
X	X			-	1	1	-
X		X		1	-	-	-
	X	X		-	-	-	1
X			X	-	-	1	-
	X		X	-	1	1	1
		X	X	-	2	-	2
X	X	X		2	-	-	2
X	X		X	-	2	2	-
X		X	X	2	-	2	-
	X	X	X	-	2	-	2
X	X	X	X	3	3	3	3

SPECIAL PHASING

Arterial or Cross Street Special Phasing Patterns							
Movements				Phasing Patterns			
1	2	5	6	LT	THRU	#1	#5
3	4	7	8	LT	THRU	#3	#7
X				-	-	1	-
	X			-	1	-	-
		X		-	-	-	1
			X	-	1	-	-
X	X			-	1	1	-
X		X		1	-	1	1
	X	X		1	1	-	1
X			X	1	1	1	-
	X		X	-	1	1	1
		X	X	-	1	-	1
X	X	X		3	1	1	3
X	X		X	1	3	3	1
X		X	X	3	1	3	1
	X	X	X	1	3	1	3
X	X	X	X	3	3	3	3

LEGEND:
- X - Movement has volume greater then zero
- \- - Pattern not allowed
- 1 - Pattern allowed without overlap
- 2 - Pattern allowed with overlap
- 3 - Pattern allowed with or without overlap

Figure 4. Normal and Special Phasing Selection Table in PASSER II-87 Microcomputer Environment System.

1. Normal Phase Pattern	Phase Sequence
Through Movements First with Overlap	2+6, 2+5
Left Turn 5 Leading with Overlap	2+5, 2+6
2. Special Phase Pattern	**Phase Sequence**
Left Turns First without Overlap	5, 2+6
Through Movements First without Overlap	2+6, 5
Left Turn 5 Leading without Overlap	2+5, 6
Left Turn 1 Leading without Overlap	6, 2+5

Figure 5. Example of Signal Phasing Selection in PASSER II-87.

have nonzero volumes, only one of the two possible overlap phases will be shown for the patterns with overlap. The other overlap phase is available and will be chosen by PASSER II-87 only if the overlapped signal phase can be warranted by the corresponding traffic volume.

Figure 4 illustrates the possible phase selection from the logical phasing selection procedure defined in the PASSER II-87 microcomputer environment system. The vertical rows indicate the four major logical phase sequences allowed for both the arterial and cross street directions as indicated earlier. The horizontal columns illustrate the combination of fifteen (15) movement possibilities according to the existence of one, two, three, or four traffic movements at the particular intersection. As described earlier, a total of four (4) possible phase sequences are allowed for the arterial street travel directions. At the same time, only one (1) signal phase sequence is allowed for the cross street traffic movements.

In the example signalized intersection, suppose that the arterial left turn movement 5 has a protected left turn phase, but the opposing left turn movement or NEMA number 1 does not have a separately protected left turn phase. The three arterial traffic movements 2, 5 and 6 have nonzero volumes. In the normal phasing pattern table for selecting arterial signal phasing, there are only two possible logical phase pattern choices that can be specified in the PASSER II-87 microcomputer environment system. These sequences are the "Through Movement First" and "NEMA No. 5 Lead" in the normal traffic signal phasing selection process.

In the protected left turn operation, the first logical choice is to use the "Through Movements First With Overlap." This option will give the user a phase sequence of combined movement 2+6 and then movement 2+5. The other choice will be the "NEMA Left Turn 5 Leading With Overlap." Specifying this option will give the user the selection of the opposite phase sequence, that is, movement 2+5 and then movement 2+6. In cases in which the user needs a more unusual phase sequence which has not been defined in this logical phasing selection table, the user can go to the special phase pattern table and obtain four more phase selection choices. As indicated in this particular example, there may be a total of six (6) alternative phasing options under the existing traffic volume combination that may be specified in PASSER II-87. These logical choices are the "Normal Phase Pattern" and "Special Phase Pattern" as indicated in Figure 5.

PASSER II-87 SYSTEM HIERARCHY

The PASSER II-87 system hierarchy, as illustrated in Figure 6, contains all the component files in the PASSER II-87 microcomputer environment system. Due to the storage limits on a single 360 KB DD DS floppy disk, PASSER II-87 is currently restricted to analyzing no more than twenty (20) signalized intersections in one arterial street system. However, systems with more than 20 signalized intersections can be analyzed by separating the arterial signal system into smaller systems in the analysis.

There are a total of five (5) types of microcomputer system files used in the PASSER II-87 system for the interactive analysis during the user-machine interface operation. The system includes the configuration files, batch files, executable files, and the basic input data and output files.

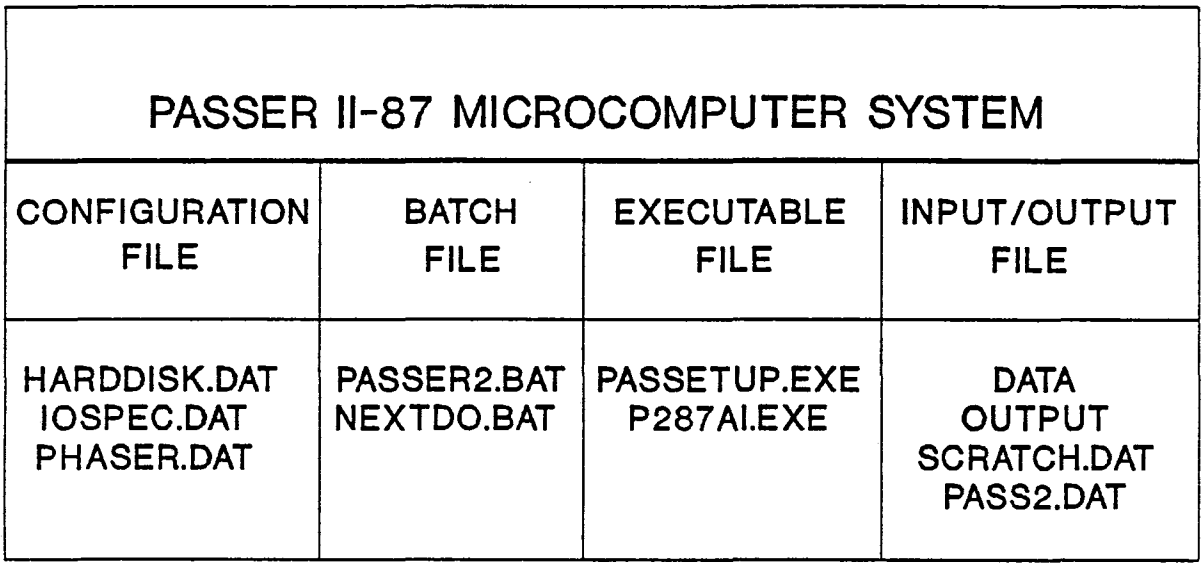


Figure 6. PASSER II-87 System Hierarchy.

Configuration Files

Three configuration files are provided in the PASSER II-87 system. These include the HARDDISK.DAT, IOSPEC.DAT and the PHASER.DAT files. The "HARDDISK.DAT" file stores the default input file path name for program file storage. These files are generated when the system is configured using the program package for defining the default program storage, file storage, and input data for both hard disk and floppy disk systems.

HARDDISK.DAT - configures the default path for storing program files. This is a generalized system configuration file for the program and default data storage. It will be used during both the floppy drive and hard disk operations.

IOSPEC.DAT - defines the path name and file name for storing user defined input data and output printout files. Every time the user saves the data file under the specified path name and file name, the program will update these file storage destinations along with the user's analysis.

PHASER.DAT - specifies the data format and different reference options of PASSER II-87 Phase Interval Setting (PIN.SET) reports. The detailed elements of the input data for this particular analysis will be discussed in a later section.

Batch Files

The PASSER II-87 microcomputer system uses two batch files to control the total system operation. The batch files assist the operating system by controlling PASSER II-87 operation in a user-friendly manner. The batch files are used as an integral part of the PASSER II-87 program system and must be present during installation and program analysis.

PASSER2.BAT - runs PASSER II-87 environment program from input menu. The user will not have to control the program analysis to shift between the data input, program execution, and output operation.

NEXTDO.BAT - controls PASSER II-87 program input and output operations.

Executable Files

The "PASSETUP.EXE" file is programed in the TURBO PASCAL version 4.0 executable binary file format. Compiled PASSER II-87 (P287AI.EXE) is contained in a linked Microsoft FORTRAN 77 object code. These two executable files must be present for successful PASSER II-87 program execution.

PASSETUP.EXE - contains input/output menus and data editing routines. This input and output processor is programmed in the TURBO PASCAL structured programming format.

P287AI.EXE - This executable code is the actual compiled FORTRAN 77 version of PASSER II-87 with all the necessary FORTRAN library calls.

PASSER Input Data and Output Files

PASSER II-87 can allocate any data files and subdirectories with the legal DOS file names. Once the PASSER II-87 system has been properly installed, the user can load the data files from any pre-defined or user-created DOS subdirectory as the input or output data files. These input and output data files do not have to be on the same logged DOS directory where the program being stored under, which may be A, C, or any other logical device.

DATA - This file contains the actual PASSER II-87 data in the ASCII text file format. The file can be specified by the user to be any legal DOS file name either with or without file extensions. This data file format is the same on the mainframe computer.

OUTPUT - When PASSER II-87 is executed, it writes the standard 80 column output. After the system is run, "PASSETUP.COM" reformats this output for viewing on a video screen. The output file name will be created by the PASSER II-87 system with the user-specified file name or with the default file extension of ".OUT".

SCRATCH.DAT - An additional output data file will be automatically created to provide a portion of the output data file. It will only be created when a different level of output printout is being specified. It will store the portion of the unwanted output pages in this standard file for later reference in case the user needs to use it.

PASS2.DAT - This data storage file saves a temporary backup work file under this file name while PASSER II-87 is running. The system will be automatically created and deleted in this file after its operation has been successfully completed in case the system crashes during the operations.

User Global System Help Information

MENU - Global system help information in the text file format. The user can modify or create their agency specific message in it.

These files occupy two 360KB double-sided double-density (DS DD) diskettes, one 1.2MB, or 1.44MB double-sided high-density (DS HD) diskette. The user must provide the system files on the working diskette for the normal program analysis. The system command file typically includes the IBMBIOS.COM, IBMDOS.COM and COMMAND.COM files under the MS DOS 2.1 or higher disk operating system. The PASSER II-87 system was first designed for the two-drive IBM PC/XT/AT or a compatible microcomputer with a minimum of 512K bytes of main memory for operation on two floppy diskettes. The system may also be used on an IBM PC/XT/AT or compatible microcomputer system equipped with or without a hard disk drive having either one or two floppy disk drives. Program installation for the hard disk system is made in a straightforward manner as in the floppy disk system operation. All the system files, user-created data sets and output are stored on the hard disk or the logical "C" or "D" drive or others. The user may choose to store the data on the floppy disks or on the hard disk to allow faster access time for the efficient system operation which can greatly improve the system running speed.

GETTING STARTED WITH PASSER II-87

To both first-time users and experienced users, the PASSER II-87 system, including the input preprocessor, main program, output postprocessor, and the program output listing, will appear familiar, intelligent, and extremely user-friendly. However, first-time users and experienced users of the PASSER II-84 may be faced with different types of operational problems when using the PASSER II-87 system.

Most first-time users of the PASSER II-87 system will be faced with two general operational questions:

1. How do I load up the program on the microcomputers?

2. How do I get the program to perform the needed tasks?

These operational questions can be resolved by following the procedures stated in this manual which accompanies the PASSER II-87 diskettes. Experienced users of PASSER II-84 microcomputer systems may have questions concerning the new terminology used in the new input/output systems. The PASSER II-87 microcomputer system has been designed to accept all the current input data files produced by PASSER II-84 and provide the necessary default input data adjustments when the user saves the data in the PASSER II-87 system. Users may modify these default data as desired or use these recommended values as starting points. A very basic user's training guide is provided in the following sections to assist both the inexperienced as well as the experienced user in "getting this program to run." Detailed operating instructions are given which supplement those provided by the input preprocessor and output postprocessor. All users should be familiar with these instructions and guidelines before beginning serious program execution.

SYSTEM PREPARATION

The PASSER II-87 program diskettes contain the entire PASSER II-87 microcomputer system. Since the original distribution program is not configured for booting on MS DOS or PC DOS based microcomputers, it is recommended that the system be copied to a bootable disk, with operating system files, to serve as the working disk. The distributed diskettes can then be kept as the backup diskettes. The program disk is pre-configured for the IBM PC/XT/AT or compatible microcomputer system with two floppy disk drives. If you have a microcomputer system with a hard disk, please read a later section for instructions on setting up and using the system.

It is recommended for users to become familiar with their DOS manual before continuing. the following instructions will be brief, thus, if more explanation is needed, please refer to your DOS manual. First, format a bootable diskette and insert it in drive B. Now, insert the PASSER II-87 distribution diskette number 1 into drive A and transfer the PASSER II-87 system by typing in "COPY A:*.* B: /v". All the files will be copied to the B drive. However, the user must make sure that the COMMAND.COM file is on the newly formatted working diskette.

The next step is to remove the two diskettes and label the new diskette PASSER II-87, Version 1. Then insert the number 2 PASSER II-87 distribution diskette in drive A and a newly formatted diskette in drive B. Repeat the "COPY A:*.* B: /v and the required files will be copied to the B drive.

Remove the diskettes and label the new diskette **PASSER II files**. Use of the most recent Disk Operating System, or version 3.0 or higher, is highly recommended for ease of the analysis operation. After transferring the system to working diskettes, place the distribution diskettes in a safe place. After these steps have been taken, the PASSER II-87 program is ready for system configuration and traffic data input.

Input Data Coding Using the Floppy Disk System

This section provides the step-by-step instructions for using the PASSER II-87 model on the IBM PC/XT/AT or compatible microcomputer with two disk drives. If you have a system with a hard disk, please refer to the next section which includes the full instructions for operating the microcomputer version of PASSER II-87. The input coding process is illustrated through coding a test arterial, as shown in the next section.

1. Insert the IBM System Diskette DOS 3.x or higher in Drive A, and then turn on the computer. After the light in Drive A goes off a message will appear on the screen to enter today's date. Type in the date and hit return. The user will then be prompted to enter the time. Enter it and press return. A prompt A> will appear on the screen.

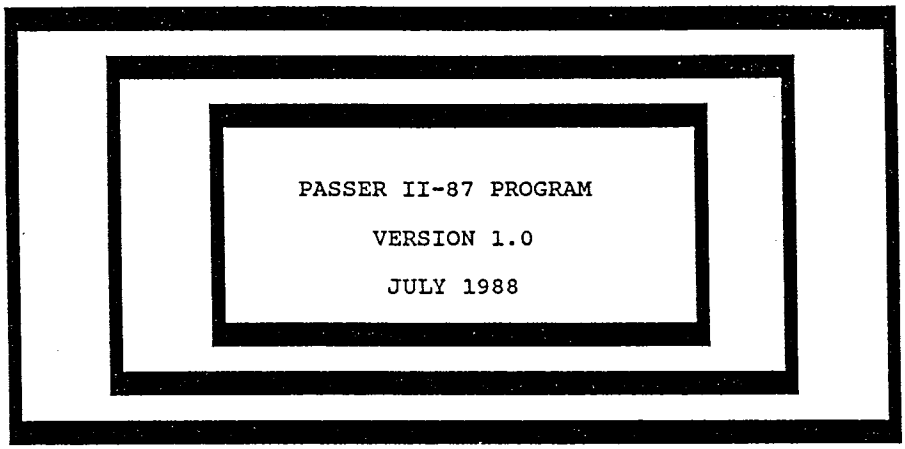
2. Remove the System Diskette from drive A and insert the diskette configurated previously with system files **PASSER II-87 Version 1.0** in drive A. Insert diskette labelled **PASSER II FILES** in drive B. It is recommended to use the B drive for storing data and output files.

3. To run the program, type **PASSER2** after the A> prompt and hit the <RETURN> key. The Disclaimer Screen will appear as shown in Figure 7.

4. Press any key and the PASSER II-87 Configuration Routine screen will appear. The user may select from the choices shown in Figure 8.

Input Data Coding Using the Hard Disk System

The PASSER II-87 program package comes preconfigured for use on a dual floppy drive system. Since the disk storage space on its logical A: disk is critical, this configuration restricts the use of the logical B: disk drive to only the user data input files. Since there is no B: drive in most hard disk systems, the program package may cause DOS errors or require the user to change the diskettes during the system operation. To make the PASSER II-87 system more flexible without compromising these operating system error checks, the microcomputer package has been provided with preinstalled configuration routines. The user should install PASSER II-87 on either the hard disk or the double-sided high-density type floppy disk when used in the IBM AT or 80386-based microcomputer systems.



Texas Department of Highways and Public Transportation
----- P A S S E R I I - 8 7 -----
Version 1.0

This program was developed under Texas State HP&R 2-18-86-467 study by the Texas Transportation Institute of Texas A&M University System. It was designed for use by traffic engineers and other transportation professionals. This program can be used to optimize or evaluate a single isolated signalized intersection or a coordinated arterial signal system of up to twenty (20) intersections. User comments are welcomed at (409) 845-9873.

Please be advised that no warranty is made by the Texas Department of Highways and Public Transportation, the Federal Highway Administration, the Texas Transportation Institute, or Texas A&M University System as to the accuracy, completeness, reliability, usability, or suitability of the computer program and its associated data and documentation. No responsibility is assumed by the above parties for incorrect results or damages resulting from its use.

PASSER II-87 software and related documentation are copyrighted. This software and documentation may not be copied or reproduced for commercial purposes. Modifications or alterations in the meaning, intent, applications, or operations of the software or documentation is absolutely prohibited unless prior approval has been obtained from Texas Transportation Institute (TTI).

***** Press any key to continue ***** ■

Figure 7. PASSER II-87 INITIAL SCREEN.

```
Texas Department of Highways and Public Transportation
      -----  P A S S E R   I I - 8 7  -----
                    Version 1.0

                  Configuration Routine

Is PASSER II-87 installed in a subdirectory? (y or n)  Yes

PASSER II-87 is in the C:\P287 subdirectory.
```

Figure 8. PASSER II-87 System Configuration Routine.

To install the PASSER II-87 system on a hard disk machine or on a 1.2 MB or 1.44 MB floppy disk drive, the user should also consider the possible use of user-defined subdirectory structures for storing the PASSER II-87 program by using the **"MKDIR C:\P287"** or **"MD C:\P287"**. Then, copy all files from both the distribution diskettes to this user hard disk directory by entering **"COPY A:*.* C:\P287 /V"**. This assumes that the A drive is a floppy disk drive and C is the hard disk as used in the IBM PC XT/AT or compatible microcomputer systems. Please refer to the DOS operating manual for operating the computer under different subdirectories.

When using PASSER II-87 on a hard disk machine, the current subdirectory must be the one on which the PASSER II-87 program files are stored, but data and output can be stored on or read from many different subdirectories or disk drives. At the C> prompt, enter **"PASSER2"**, and the system will display the disclaimer information. A configuration routine will then execute which will allow the user to specify any default subdirectory path for the program, together with input and output files on the floppy or hard disk microcomputer systems. When the user desires to store or read a data file, the user will be asked to define a path name to the file where the working files are stored. Each time the user wants to store the data sets, the system will also provide the user with the options for selecting a different subdirectory for optional data storage. If the subdirectory that the user selected for data storage has not been previously defined, the PASSER II-87 system will help the user to create that particular subdirectory. Otherwise, the system will use the default subdirectory to store the user specified information.

If PASSER II-87 must be moved by floppy disks from a hard disk system to other computer systems, the user must copy all the files listed previously to an empty floppy disk or disks in drive A. Then, enter "A:" to get the A> prompt. Next, enter **"DEL HARDDISK.DAT"** and **"DEL IOSPEC.DAT"** to convert the system default file storage path back to the floppy disk system operation. The next time the user starts the system operation by typing in **"PASSER2"**, the PASSER II-87 system will be configurated according to user's instructions. If the user has a floppy disk system with high capacity drives, such as in the IBM AT or compatible 80286/80386 based microcomputers, the hard disk configuration should be used. In this case, the system can read and write all the data files from the default logged disk drive in the configuration file "HARDDISK.DAT". Please note, regardless of the file name, that the "HARDDISK.DAT" file will be generated for both the floppy disk based microcomputers as well as microcomputer systems equipped with hard disks.

STARTING THE TRAFFIC DATA INPUT SYSTEM

The following sections summarize the PASSER II-87 system operation with the most basic procedures. It illustrates to the users how to start the system, how to record the optional date and time, and the basic input/output keyboard instructions.

System Overview

Two program diskettes are provided to use the input preprocessor and output postprocessor. The first one is the main diskette provided with the PASSER II-87 program system which contains the input preprocessor and output

postprocessor program. The second diskette provides the main program and the optional help assistant menu of the PASSER II-87 system. It is highly recommended to use formatted blank diskettes to backup these program files before the users begin to store the input data files produced by the input preprocessor and output postprocessor and proceed with the analysis .

Start System

1. Insert input preprocessor and output postprocessor diskette in Drive A and data file diskette in Drive B.

2. Close drive doors.

3. Power up the system.

4. If system is already on, restart the system: press and hold down both the Ctrl and Alt keys; then, press the Del key to restart the system.

Date and Time

Once the system has been initialized, the following optional messages and prompt will appear if no resident real-time clock has been installed in the computer hardware. Otherwise, these steps can be avoided.

```
A>DATE
Current date is Tue 1-01-1980
Enter new date: _____________
```

Enter today's date in the format mm-dd-yy where:

```
mm - one or two digit number from 1-12 for month
dd - one or two digit number from 1-31 for day
yy - one or two digit number from 80-99 for year
```

After a valid date is entered, the following system message will appear on the CRT screen:

```
A>TIME
Current time is 0:00:00
Enter new time: _______
```

Enter current time as hh:mm:ss where:

```
hh - one or two digit number for 0-23 for hours
mm - one or two digit number from 0-59 for minutes
ss - one or two digit number from 0-59 for seconds
```

After a valid time is entered, the following caption should be typed in:

```
A>PASSER2
```

The input preprocessor and output postprocessor are now ready for data entry. Prepare to enter data interactively with the computer.

Basic Keyboard Instructions

Before one begins to enter data from the keyboard, there are a few basic keyboard instruction details that should be noted:

1. Entry data can be coded through the computer keyboard, or through the mouse interface moving to a specific screen location. Then data are entered by typing their values and pressing the RETURN key.

2. Default values can be entered by pressing the RETURN key. They can also be overwritten by typing over values displayed.

3. The global and local help window can be activated by pressing the FUNCTION KEY F1 or FUNCTION KEY F2 .

4. The ASSISTANT function can be activated by pressing the FUNCTION KEY F3.

5. The FILE DIRECTORY function can be reached and activated at any time by pressing the FUNCTION KEY F4.

6. The external DOS SHELL function can also be reached at any time by pressing the FUNCTION KEY F5 to enter the DOS command line.

7. The global PASSER II-87 program system help menu can be reached and activated at any time by using the FUNCTION KEY F6.

8. The program operator can always exit the current state at any time by pressing the ESC key.

9. It is recommended to use the cursor control keys for cursor movement when entering or modifying data for using the input preprocessor and output postprocessor in the PASSER II-87 program analysis.

10. To stop the input preprocessor and output postprocessor in the middle of a run, press the Ctrl and Break (Scroll Lock) keys at the same time to return to DOS. However, the input data will not be saved.

PROGRAM EXECUTION

The program user can follow this guide to run the PASSER II-87 microcomputer system. The instructions below include the basic operating steps needed to assist individual users with proper PASSER II-87 program execution. The program is set up with four basic menus: the main menu, input menu, edit menu, and output menu, and supplemented with supporting submenus. The basic program menu structure is shown in greater detail in Figure 9.

The program was designed to help the user pass through the data input process, progress through the input data edit menu, exit the microcomputer system when running the PASSER II-87 program, and view the resultant solution output for further analysis. This section includes the step-by-step operating procedures for inputting new data, loading input data on disks, editing data, running the program, and previewing the output under the PASSER II-87 analysis system.

MAIN MENU

The main menu gives the user eight choices, as shown in Figure 10. The user can either enter the number of the choice or use the arrow key to select the desired actions.

1. **Input new data.**

   This option includes three different functions. It can allow the user to input new traffic data, modify embedded data, or phase data for different offset references. It is used whenever there is a new system to be analyzed. However, choosing this option may also erase the data that is currently loaded in the computer's memory. A later section on input data describes the details of the input menu.

2. **Read old data from disk.**

   This option allows the user to read an existing data set from any disk drive under any path name or any file name. The user may utilize the PASSER II-87 "DOS SHELL" facility simply by pressing the FUNCTION KEY NUMBER 5 or F5 to manage the various input data files. The system will alert the user that the current data set in memory may be lost when this option is chosen to read another input data file. It is not necessary, however, to reread a data set if the user will still be working with the same data set last used to run PASSER II-87. More information on the routine for loading the data sets is described later.

3. **Edit data.**

   PASSER II-87 is an engineering tool. Several program runs and engineering judgements may be needed in order to obtain successful optimization results. The edit option is used when there is a mistake in the input or the user wishes to alter some of the variables for another PASSER II-87 run. More information on the data editing routine is provided in a later section.

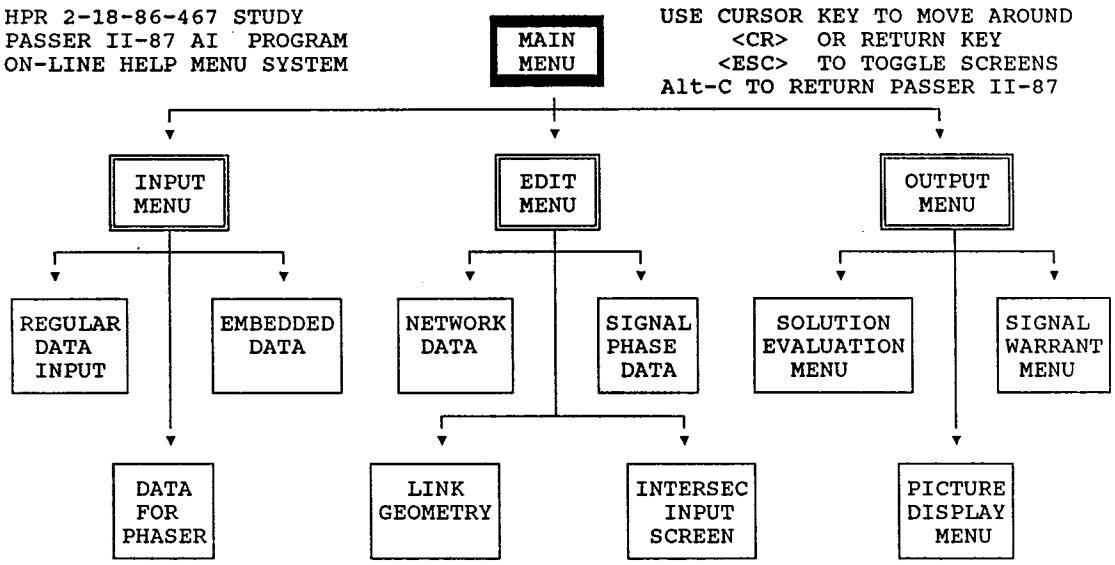


Figure 9. PASSER II-87 Microcomputer Menu Structure.

```
Texas Department of Highways and Public Transportation
      -----  P A S S E R   I I - 8 7  -----
                    Version 1.0

                    -- Main Menu --

                    1. Input new data.

                    2. Read old data from disk.

                       - C:\P287\DATA loaded. -

                    3. Edit data.

                    4. Store data on disk.

                    5. Print current input data.

                    6. Run PASSER II-87.

                    7. Go to output menu.

                    8. Quit.

Which item do you choose? 1
```

Figure 10. PASSER II-87 MAIN MENU.

4. **Store data on disk.**

   Data should be routinely stored on a disk. Data files can either be stored on a floppy disk drive or hard disk drive. However, the output data files will usually take up more space than the input data files. Therefore, it is highly recommended not to store any additional output files on the PASSER II-87 program disk in drive A during the dual floppy disk operation.

5. **Print current input data.**

   If this item is selected, the user is given a chance to adjust the printer, and then the entire data set will be printed. The user can also use the print screen feature on the IBM PC/XT/AT computers for obtaining selected printout pages during specific data input steps instead of printing out the entire output files. In addition, it is highly recommended to use these well-engineered screen printout pages as data inventory sheets for later reference.

6. **Run PASSER II-87.**

   The system will check the data file to keep consistency within the coded data set. The input processor will sense any major errors and, if there are none, it will proceed with PASSER II-87 execution. After execution, the program will return to the environment system, but it will return to the output menu if the PASSER II-87 program has been successfully executed. The user can return to the main menu for more data modifications by pressing the ESC key.

7. **Go to output menu.**

   This menu will allow the user to select, review or print out selected pages of the PASSER II-87 output. The program will always load the output files in memory after the program is executed. Otherwise, the user can select any other output data file having any path name or file name with the extension file name of ".OUT" that may exist in the system. This is discussed later in the PASSER II-87 output menu section.

8. **Quit.**

   The user can exit the system at any time by choosing this function, by pressing the ESC key several times, or by hitting choice number 8 then enter. However, if the user has just input new data or edited the existing data without saving the data file, the PASSER II-87 system will allow the user an opportunity to save the new data before exiting the system. On the other hand, if the user has just loaded and reviewed the new data on the screen without making any data modifications, the system will detect that no changes have been made in the existing data and exit the system without asking the user to save the data.

INPUT MENU

The new input menu has three (3) choices, as shown in Figure 11, that allow the user to input new traffic data, change embedded data for the whole system, and change phaser data to allow for various ways to reference signal timing parameters. When this desired choice is entered, the program will lead the user to input the data required for PASSER II-87 program execution. The input requires most of the same data as needed in the mainframe PASSER II-87 program but in a slightly different order to ease the data entry process. If desired, the user can also download the PASSER II-87 input data deck from the mainframe computer systems and read the existing data set for executing the PASSER II-87 microcomputer environment system. The options in the input menu ask the user to enter the arterial system, geometric data, traffic volume, and signal control data for the arterial system as required in the original mainframe "Arterial Header Card," "Intersection Header Card," "Intersection Detail Card," new "Embedded Data Card," and new "Phaser Data File." After completing the data input, the user can either modify the input data, execute the program, or save the data files, as desired. On the other hand, the user may chose to input new data or add more intersections to the existing arterial signal system. The data edit routine may be selected to modify existing coded data or add further input data to the current data file. A new menu, the edit menu, appears to give the user eight (8) choices. If the user desires to return to the input menu to restart the new data input, this can be done by returning to the main menu and selecting the input new data option again by selecting the proper number.

New Traffic Data Input

The input routine may be activated by entering a "1" on the main menu. This same input routine will also be automatically activated when the user chooses to add new intersections to the existing system form the edit menu. There are two restrictions which are built into the system that should be noted:

1. **All traffic movement data must be entered and will be returned using the NEMA phasing numbers, shown previously in Figure 2, as defined in the new Traffic Control Systems Handbook.**

2. **If only one intersection is used in the input data, it will be analyzed in default as an isolated intersection. Otherwise, a progression solution run will be assumed.**

The first section of the input new data menu corresponds to the Arterial Header Card as used in preparing the mainframe PASSER II-87 input decks. If only one intersection is to be input, the user will be asked for only one cycle length, since PASSER II-87 can only analyze one cycle length in an isolated operation at one time. The user will not be asked to provide information about progression operations. The new data input is made by selecting Option 1 by typing 1 and hitting <RETURN>. The next message on the screen will be "Abandon existing input data? (y or n): Type y and <RETURN>. Then, the computer will run one-by-one through the arterial input data as shown in Figure 12. The appropriate response should be typed in corresponding to the ARTERIAL HEADER information. After specifying the system information, the next step is to provide the input data for each intersection, starting with Intersection number 1.

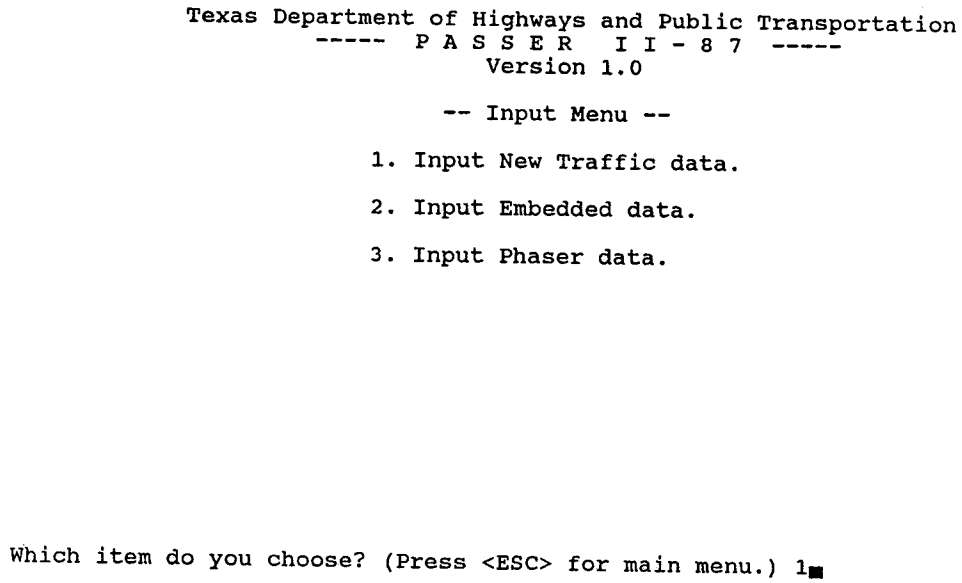


Figure 11. PASSER II-87 INPUT MENU.

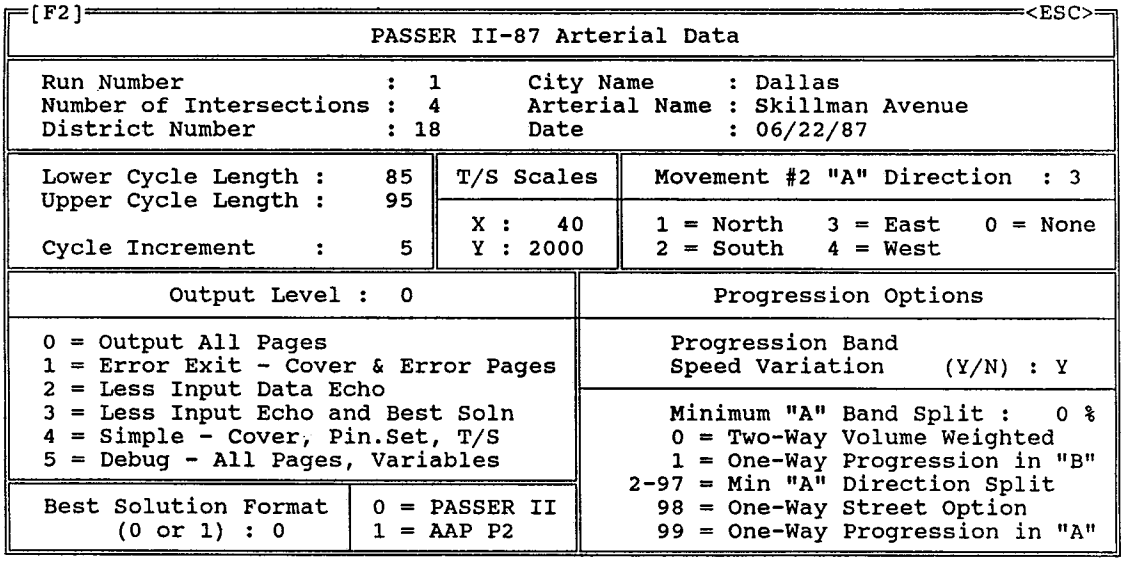


Figure 12. PASSER II-87 Arterial Data Input Screen.

As the second part of data input, the system will ask for the name of each cross street as well as the traffic volume, saturation flow and minimum phase for each NEMA phase movement. A NEMA traffic movement display input screen will assist the user to input the basic traffic movement, saturation flow, and minimum phase according to their corresponding positions as shown in Figure 13. In addition, a series of user input ASSISTANT functions can be activated by pressing FUNCTION KEY NUMBER 3 or F3 to access the saturation flow calculations as in Chapter 9 of the 1985 Highway Manual (HCM). For every signalized intersection, the computer will ask the name of the cross street and then ask for the following data for each movement: volumes, saturation flows, and minimum phase times. The data for each movement are input interactively and the movements appear on the screen according to the NEMA numbering system. Figure 13 shows the data for all the movements input for intersection **MOCKINGBIRD** based on the data provided in the Intersection Data Form. It should be noted that if a zero has been chosen for the volume input, then the program will not require the user to input the remaining saturation flows and minimum phase times.

In the third part of the input data section, the program will ask the user to choose the appropriate signal phasing patterns to be analyzed by toggling either the ENTER or the RETURN key as shown in Figure 14. In the coding of the Arterial Phasing, the program displays on the screen all the possible phasing sequence combinations based on the input volumes. The PASSER II-87 input/output processor system only uses those signal phase patterns which are logically compatible with the input traffic movement volumes the user has just entered according to the system's default phase sequence function. The user may also ask the system to recommend the allowable phasing selections by pressing the FUNCTION KEY NUMBER 3 or F3. However, the user can also select some other phase sequences not defined by the normal phase sequence by choosing the special phase option. Figure 14 illustrates the phasing for Intersection number 1 (MOCKINGBIRD). The user must move the cursor to the desired phasing pattern and select by pressing <RETURN> to toggle "Y" to each desired menu selection as shown in Figure 14. A maximum of four possible phasing sequences can be specified. Please note that if yes is the response to a "with overlap" question, the program assumes that the "without overlap" option is unacceptable. For coding the Cross Street Phasing, the program displays on the screen all the possible phasing arrangements for the cross street based on the input volumes. However, <u>only one phasing pattern</u> is allowed for the cross street. The program will allow the user to select the acceptable phasing pattern. The user should move the cursor to the allowable desired phasing pattern and press <RETURN> to select as shown in Figure 14. The coding of the signalized intersection will be repeated for each intersection. Please use the information described earlier to enter data for the remaining intersections of the arterial street system.

The fourth part of new input data will ask the user to provide the geometry data for the intersection approaches or links of the arterial signal system as if they are filling up a data inventory table, as shown in Figure 15. It is used to input data on consecutive intersection spacing and progression design speed between intersections for each direction, as well as for any desirable queue clearance time, if this option is desired. As indicated, the system asks for distance and speed for each intersection for each direction. Then, the same link data will be generated as the default to the other travel direction. Note that the queue clearance option is not specified or used in this example.

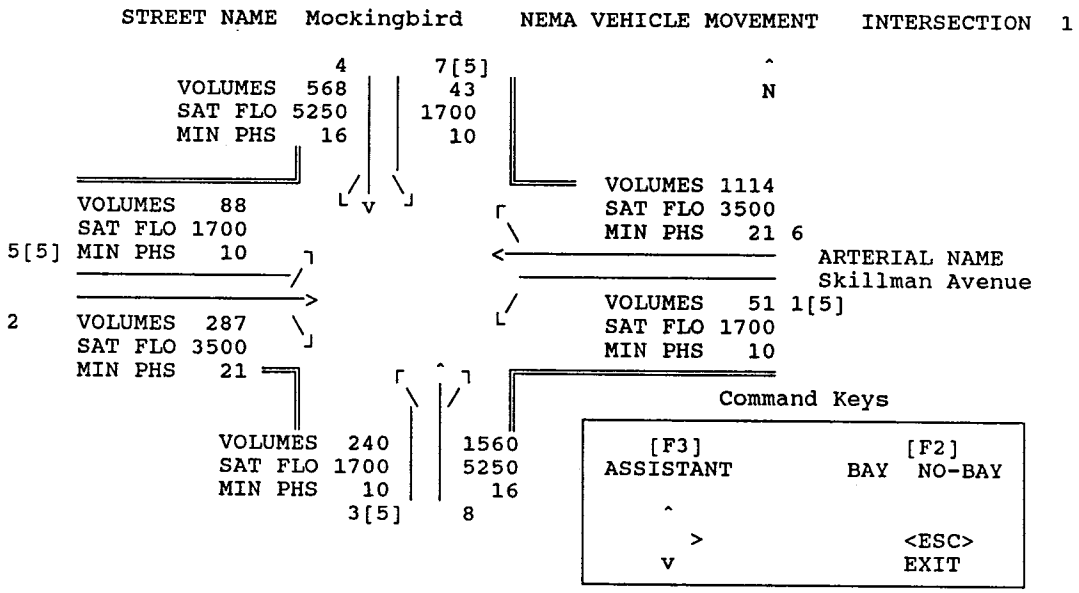


Figure 13. PASSER II-87 MOVEMENT INPUT SCREEN.

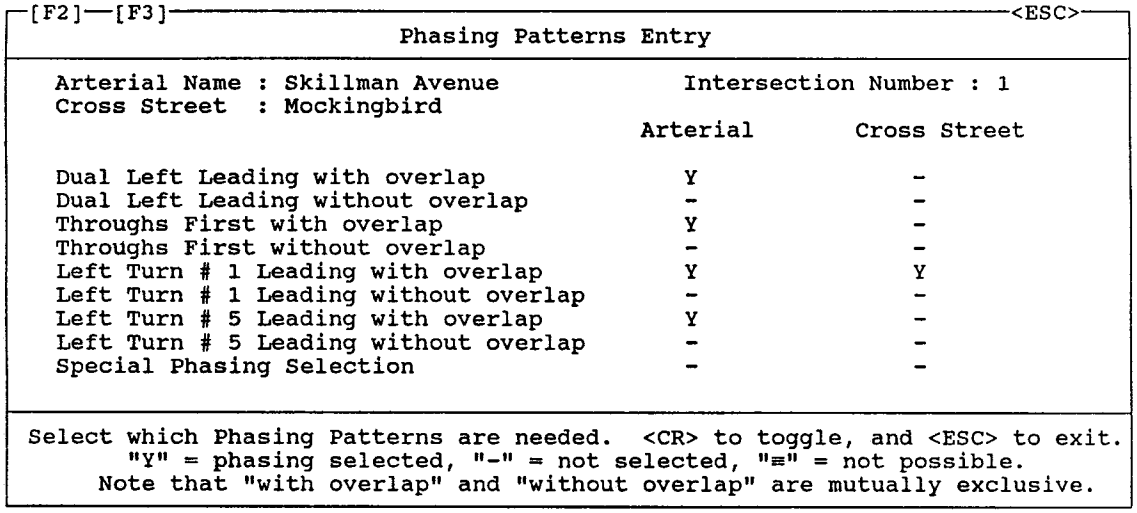


Figure 14. PASSER II-87 Signal Phase Sequence Screen.

[F2] <ESC>

Skillman Avenue — Arterial Link Geometry — 4 Intersections

Link	Queue Clear.	Speed (MPH)	Distance (FT)	Distance (FT)	Speed (MPH)	Queue Clear.	Link
1- 2	0	34	3400	3400	38	0	2- 1
2- 3	0	32	1663	1663	36	0	3- 2
3- 4	0	30	2808	2808	34	0	4- 3

Press any key to continue.■

Figure 15. PASSER II-87 Arterial Link Geometry Screen.

When the above data input steps are completed, the program will return to the main input menu shown in Figure 11. Selecting Item 5 will provide a printout of the coded input data to check against the data file being entered.

Embedded Data Input

In response to the expressed user desire to be able to modify embedded data used in PASSER II, new features have been added to the program to let users adjust all the embedded data. The default embedded data sets, as shown in Figure 16, have also been prepared for user information. Be aware that once the embedded data is changed, it will remain that way for subsequent data sets. These embedded data include traffic controller type, ideal saturation flow rate, analysis period, number of left turn sneakers, individual phase lost time, combined left turn phase reference, delay level-of-service evaluation, total delay adjustment factor, basic HCM delay criteria, permitted left turn models, and left turn model coefficients. The embedded data, as modified by the user, will also be printed out in the input data echo output.

TRAFFIC CONTROL TYPE The user has the choice of selecting either pretimed control (P) or actuated control (A) for the delay calculations of different signal timings. The selection of actuated control will provide an estimated 0.85 percent of the delay that would have been estimated for pretimed signal control, as suggested in the 1985 HCM. The default assumes pretimed signal control.

IDEAL SATURATION FLOW The default ideal saturation flow rate is 1800 vehicles per hour of effective phase per lane or vphgpl as used in the 1985 HCM. The default range in PASSER II-87 is from 1500 to 2400 vphgpl.

ANALYSIS PERIOD The default time period for PASSER II-87 analysis is 15 minutes, the same value used in the 1985 HCM. The allowable range is from 15 to 300 minutes, or 0.25 to 5 hours.

NUMBER OF SNEAKERS The default value for the number of sneakers making left turns from a left turn lane following the yellow signal to red is 2.0 vehicles per yellow change to red. Its range is 1.0 to 3.0 vehicles.

PHASE LOST TIME The default value of all individual signal phase lost times is 4.0 seconds. It ranges from 3.0 to 5.0 seconds per phase.

LEFT TURN P + P REFERENCE For the different protected-plus-permitted "combined phase" left turn phase operations the user can choose either the "A" for approach-based or "R" for ring-based designation, as recommended by the Manual of Uniform Traffic Control Devices (MUTCD), or the experimental practice implemented in Dallas, respectively. In "A", the approach-based operation, the left turn permitted phase usually ends earlier than the "R" or the ring-based operation. The default is the "A" designation or approach-based.

LOS DELAY CRITERIA The user has the choice of using either the total delay evaluation (T) or stopped delay evaluation (S) as used in the 1985 HCM evaluation. The default level of service evaluation is the total delay evaluation as used in the existing PASSER II analysis.

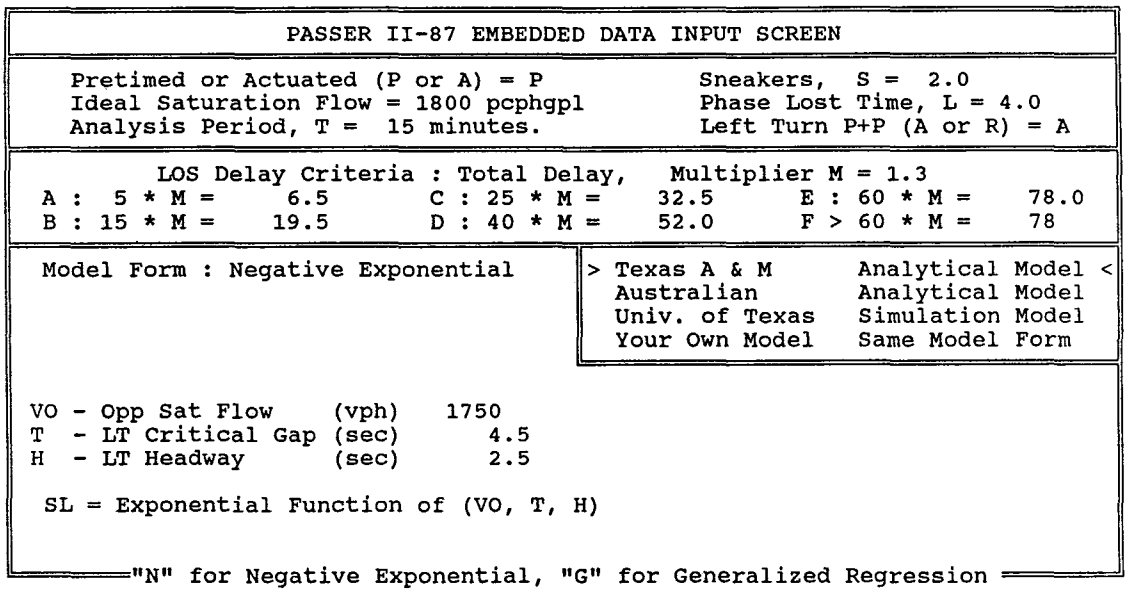


Figure 16. PASSER II-87 Embedded Data Input Screen.

TOTAL DELAY MULTIPLIER PASSER II-87 uses a default multiplier for converting the default stopped delay to total delay as recommended in the 1985 HCM. The default multiplier is either 1.3 for adjusting to total delay evaluation or 1.0 for using stopped delay evaluation. However, the user can also change this value, ranging from 1.0 to 1.3, if desired at some future date.

BASIC HCM DELAY CRITERIA The user has two ways to adjust the delay threshold for the level-of-service evaluation to be used in the PASSER II-87 signal delay estimation. At first, one can change the multiplier of the stopped delay to the total delay to adjust all of the delay thresholds in the same magnitude as described in the total delay multiplier. In addition, one can also separately change the individual delay criteria. All the delay thresholds used in the evaluation will be output in the PASSER II-87 embedded data report for detailed examination by the user. The basic delay thresholds for the default level-of-service evaluation are:

A (At) = 5 * Multiplier, range from 0 to 10.

B (Bt) = 15 * Multiplier, B $\geq$ A and B < 90.

C (Ct) = 25 * Multiplier, C $\geq$ B and C < 90.

D (Dt) = 40 * Multiplier, D $\geq$ C and D < 90.

E (Et) = 60 * Multiplier, E $\geq$ D and E < 90.

F (Ft) > 60 * Multiplier, F = E.

PERMITTED LEFT TURN CAPACITY MODEL The user has two choices for designating the desired opposing traffic flow model used in permitted left turn capacity analysis,"N" for the Negative Exponential Model or "G" for the Generalized Regression Model. The default model is the Negative Exponential - Texas A&M Analytical Model. After the user selects the model, the program will automatically change the parameters for each model. If the user wants to use another model, one can select the preferred model form, collect the site specific traffic information, and input all the needed model coefficients.

The Negative Exponential Models include the following:

1. Texas A & M Analytical Model
2. Australian Analytical Model
3. Univ. of Texas Simulation Model
4. Your Own Model Same Model with User specified coefficient.

The Generalized Regression Models include the following:

1. HCM-Signalized Analytical Model
2. HCM-Unsignalized Analytical Model
3. Univ. of Minn. Regression Model
4. Ohio State Univ. Regression Model
5. Your Own Model Same Model with User specified coefficient.

Phaser Data Input

The program provides the user with two default, alternative ways to specify the phase interval setting reports (PIN.SET) through the input screen as shown in Figure 17. Two sets of PIN.SET reports will be generated. All the help messages will be displayed on the bottom half of the screen. The default value for Master Intersection and Reference Intersection will be 1 or the first intersection of the arterial the system. The user can also change the offset reference from default intersection number 1 to any intersection in the current data set. Reference offset will be any value from 0 to the lower cycle length, and the default is 0. The movement for reference can be chosen from 0, 2, and 6, and the default is "0" or the beginning of the arterial phase. For reference point, the user can select the beginning of the phase or the end of that particular phase. The default offset reference is at the beginning of main street green, or the "Barrier Point" for dual-ring controllers.

COMMENT LINE The user can request the program to use these comments in this particular data file to interpret the basic set of optimized PASSER II-87 signal timing parameters. This comment line, made up of two lines with a maximum of 75 characters each, is provided for the user to place at the remark lines for every set of criteria used to interpret the signal timing solutions. The comment line will also be printed in the signal controller phase interval setting report (PIN.SET).

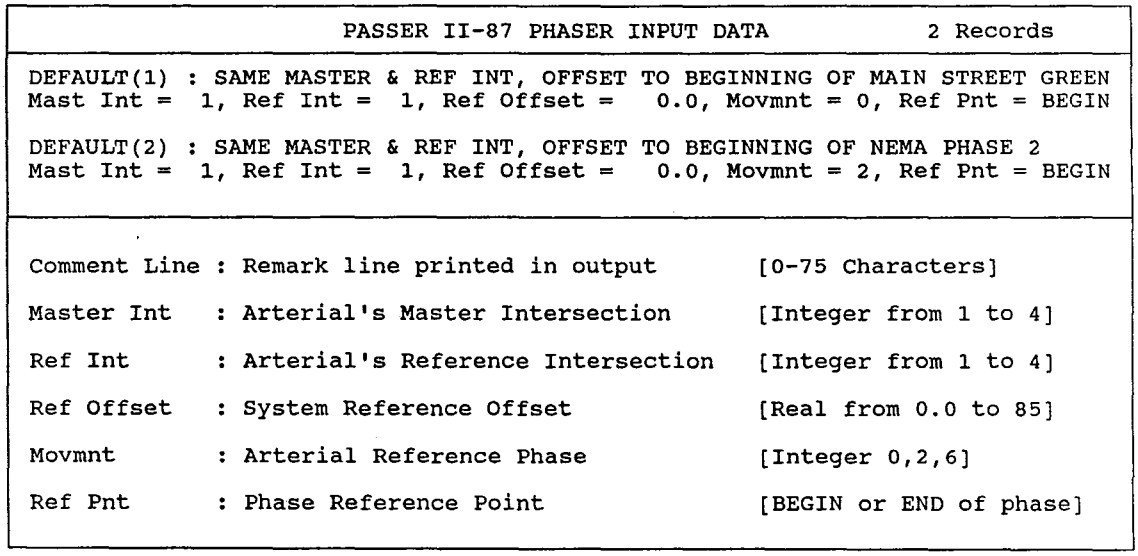
MASTER INTERSECTION The arterial's progression offset timing base is its "master" intersection, if not interconnected with a larger system. In PASSER II, a Master Intersection designation is used to refer to the zero offset coordination. The default master intersection is always set to be the first signalized intersection in the arterial street system.

REFERENCE INTERSECTION The reference intersection is the secondary offset reference point, used only if the arterial under analysis has its timing plan integrated (interlocked) into an existing coordinated timing plan. This is defined by the crossing arterial street at the "Reference Intersection." The designation of the Reference Intersection can supersede the specification of the Master Intersection. The default reference intersection is also the first intersection in the signal system.

REFERENCE OFFSET This is the system reference offset for all relative offset calculations. PASSER II-87 will adjust all the optimum signal timing settings with respect to this particular reference offset point. The default value of the reference offset is zero. The allowable range is from zero to the entire cycle of the lower cycle length.

MOVMNT The "MOVMNT" or movement is specified for all relative offset calculations. The allowable traffic movements could be either at the beginning of the arterial phasing "0", the "NEMA 2," or the "NEMA 6" movements. The default is the start of the arterial phasing or "0".

REFERENCE POINT The reference point is the point to which all the reference offsets are referring and with which they are calculated. It can be at either the beginning or end of the selected referenced phase. The default is at the beginning of the arterial phasing.



PASSER II-87 PHASER INPUT DATA 2 Records

DEFAULT(1) : SAME MASTER & REF INT, OFFSET TO BEGINNING OF MAIN STREET GREEN
Mast Int = 1, Ref Int = 1, Ref Offset = 0.0, Movmnt = 0, Ref Pnt = BEGIN

DEFAULT(2) : SAME MASTER & REF INT, OFFSET TO BEGINNING OF NEMA PHASE 2
Mast Int = 1, Ref Int = 1, Ref Offset = 0.0, Movmnt = 2, Ref Pnt = BEGIN

Comment Line	: Remark line printed in output	[0-75 Characters]
Master Int	: Arterial's Master Intersection	[Integer from 1 to 4]
Ref Int	: Arterial's Reference Intersection	[Integer from 1 to 4]
Ref Offset	: System Reference Offset	[Real from 0.0 to 85]
Movmnt	: Arterial Reference Phase	[Integer 0,2,6]
Ref Pnt	: Phase Reference Point	[BEGIN or END of phase]

Figure 17. PASSER II-87 Phaser Data Input Screen.

EDIT MENU

The edit routine is chosen by entering a 3 on the main menu. A new data editing menu will appear which will give the user eight (8) choices of data to edit, as shown in Figure 18. If the user wants to return to the main menu for either modifying the embedded data, loading another data set, or storing the data set on the disk, the user can press the ESC key.

1. **Edit general network data.**

   The data edit routine will modify the portion of the data which is on the Arterial Header Card or that pertains to the total arterial system for regular PASSER II input data. All the data can be changed except the total number of intersections. The number of intersections in the general network data must be changed by adding or deleting particular intersections in the arterial system of the existing coded data set.

2. **Edit intersection movement data.**

   The user will be asked which intersection is to be edited and then the user can change the volumes, saturation flows and minimum phases for all intersection movements from a graphic intersection display. In addition, the analysis procedure similar to and beyond the 1985 HCM analysis can also be performed through the ASSISTANT function. The user must use this option to input the necessary data for coding or specifying the different types of left turn signal treatments of existing PASSER II-87 data sets. On the other hand, current PASSER II-84 users can still take advantage of the graphical input data screen layout for coding the data input without having to use the ASSISTANT function at all. The arterial name and the intersection orientation direction will be displayed according to the user input in the arterial system data. It is highly recommended that the print screen capability of the IBM PC/XT/AT microcomputers be used to print the screen for data inventory purposes. The details of the ASSISTANT function will be discussed in a later section.

3. **Edit intersection phasing data.**

   The user will be asked which intersection is to be edited and then select the phasing sequences for both the arterial and the cross street. The system will display all the allowable signal phasing sequences for both the main street and cross street traffic movements. For which, the selection of Phasing Patterns are needed. As noted, three different symbols will be used in this intersection phasing input data screen. "Y" represents the phasing selected, "=" represents the phase sequences not allowed by the system, and "-" stands for the allowable phase sequence. ASSISTANT function F3 can display the "allowable" selection. The user can use the Return key <CR> to toggle, and <ESC> to exit. Note that "with overlap" and "without overlap" are mutually exclusive. However, if normal phasing patterns are not enough, the user can toggle the "Special Phasing" and then select phasing patterns not defined in the "Allowable" phase selection tables.

```
Texas Department of Highways and Public Transportation
      -----  P A S S E R   I I - 8 7  -----
                    Version 1.0

                  -- Edit Menu --

          1. Edit general network data.

          2. Edit intersection movement data.

          3. Edit intersection phasing data.

          4. Input signal offsets to simulate existing timing.

          5. Edit arterial geometry data.

          6. Add an intersection.

          7. Delete an intersection.

          8. Change a cross street name.

Which item do you choose? (Press <ESC> for main menu.) 2
```

Figure 18. PASSER II-87 EDIT MENU.

4. **Input signal offsets to simulate existing timing.**

   Each intersection may have the existing or different offset values during the simulation study. This menu selection will not only allow the user to input the existing offsets of each intersection to be evaluated but will also allow the user to select the optimization or simulation analysis. The user can store the existing offsets and still ask the program to perform the optimization run. The offsets, as input, will be adjusted to the lower cycle length input.

5. **Edit arterial geometry data.**

   All of the intersection distance, travel speed, and queue clearance for those links in the system will be shown, and the user can change any of them. To specify which link is to be changed, the cursor should first be moved to the number of the intersection which starts the link and then the user can modify the data for that particular signalized intersection.

6. **Add an intersection.**

   If the user wishes to add an intersection, this item should be selected. The user then sees a list of cross street names. The number of the intersection which the new intersection comes before should be entered. A "1" should be selected if the user wants to add it at the beginning of the system. If the user has already reached the maximum number of intersections, no more can be added.

7. **Delete an intersection.**

   The user can select the specific number of the signalized intersection to be deleted from a list of cross street names. However, if there is only one intersection currently in the data set, the user will not be allowed to delete it.

8. **Change a cross street name.**

   Any of the cross street names can be changed using this routine as if using any word processor. The user simply selects the number of the particular intersection and changes the name by typing in the new name of the cross street.

DATA INPUT ASSISTANT FUNCTIONS

One new feature in PASSER II-87 is the addition of the DATA INPUT ASSISTANT FUNCTION for assisting users to input the movement related information, such as the traffic movement volume (VOLUME), saturation flow rate (SAT FLO), and the minimum phase time (MIN PHS). Among them, the most practical enhancement of the PASSER II-87 input/output processor is the programming ASSISTANT that allows users to calculate the saturation flow rate following analysis procedures similar to and beyond those used in the 1985 Highway Capacity Manual (HCM) (8). The recommended sequence and usage of these different input data features, as used in the input data ASSISTANT function, are illustrated in Figures 19 through 21 and described as follows:

Left Turn Bay

The first problem that the user should resolve is whether there exists a left turn bay on each of the intersection approaches. As shown in Figure 11, the user should identify the presence or absence of a left turn bay or dedicated left turn lane by toggling the FUNCTION KEY 2 or F2 until the correct left turn treatment is displayed on that particular approach. The difference between the BAY and NO BAY conditions will be shown by the shading of the VOL SAT FLO and Min PHS for that movement or in the lower right hand of the command box.

Traffic Volume

The next action is to enter the traffic volumes for each approach to the intersection as shown in Figure 19. The use of the ASSISTANT function will allow the user to calculate the traffic volumes and adjust for the peak hour factors. When the peak left-turn volume is not greater than two vehicles per cycle, there is usually no need to provide a protected left-turn phase.

Volume Calculation

There are two distinct features in the PASSER II-87 program for handling the various left turn treatments for those cases with or without protected left turn bays. First, the program will provide the user with the capability to designate the protected left turn bay while inputting the corresponding left turn traffic movements. Then, the program will automatically generate the appropriate type of left turn signal treatments and prompt the user with the necessary actions in the ASSISTANT window according to the input data. Separate treatments have been made in the PASSER II-87 program to account for the difference in the left turn movements and the through traffic movements with or without using the protected left turn bay.

LEFT TURN MOVEMENT (1, 3, 5, 7)

1. If the MIN PHS equals 0, then the program will assume the permitted green operation. No separate protected phase will be provided.

2. If the MIN PHS is greater than 0, then the program will ask "LEFT TURN PROTECTED ONLY?". If the answer is yes, then the program will provide a protected-only phase; otherwise, the program will assume that a combined phase, having a protected phase combined with a permitted phase, will be used in the analysis.

After this, the program will ask for LEFT TURN TRAFFIC. If there is a bay, then left turn volume will be stored individually. Otherwise, the system will add the left turn traffic volume into through movement volume but keep a separate count of the left turn traffic being input by the user. Therefore, the numbers of the left turn traffic will still be shown on the screen with reverse color. If there is a bay, the program will ask the user to input the PEAK HOUR FACTOR, with a default value of 1, and the final LEFT TURN TRAFFIC = LEFT TURN TRAFFIC/PEAK HOUR FACTOR.

As indicated in Figure 19, a unique number will be displayed in the brackets or "[ ]" to designate the particular left turn signal treatments to be used in the analysis. The same "Left Turn Signal Treatment" or the

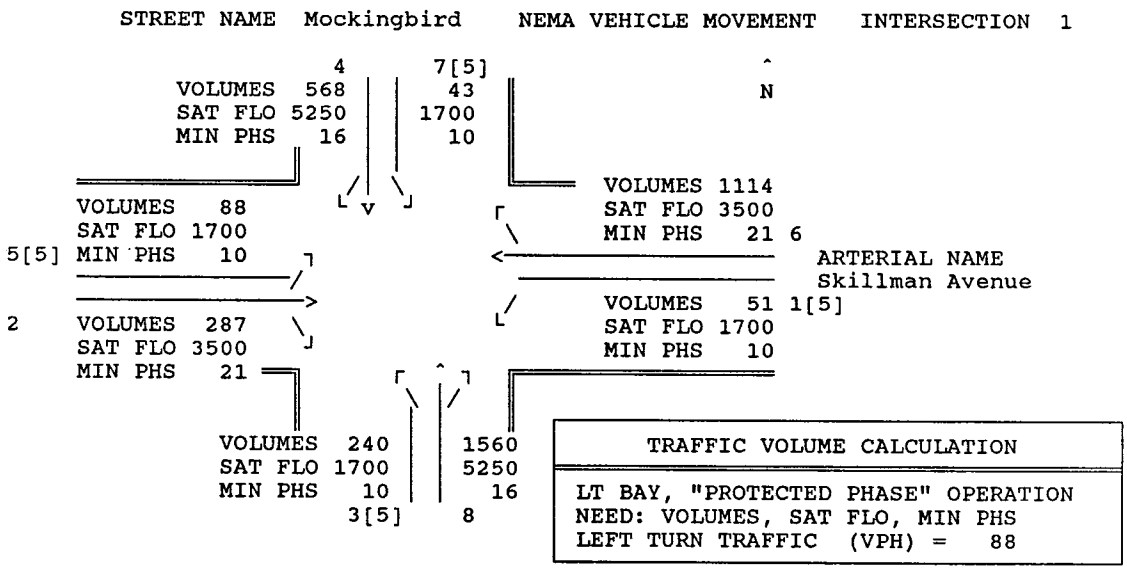


Figure 19. Traffic Volume Input Assistant.

"NPP" values will also be displayed both in the Input Data Echo printout (INPUT.DTA) and the Best Solution printout (BEST.SOLN) of the PASSER II-87. In particular, NPP identifies the different left turn signal treatments as input by the user and explained in the ASSISTANT window as:

```
NPP = 1 - without left turn bay, permitted
NPP = 2 - without left turn bay, protected
NPP = 3 - without left turn bay, protected/permitted
NPP = 4 - with    left turn bay, permitted
NPP = 5 - with    left turn bay, protected           [org.default]
NPP = 6 - with    left turn bay, protected/permitted
```

The NPP value can also be calculated as:

$$NPP = 3 * (1 - BAY) + PERM + 2 * PROT + 3 * COMB$$

where BAY = 1 if it has no bay, else BAY = 0.
PERM = 1 if it uses permitted left turn, else PERM = 0.
PROT = 1 if it uses the protected only left turn, else PROT = 0.
COMB = 1 if it uses the combined phase operation, else COMB = 0.

THROUGH MOVEMENTS (2, 4, 6, 8)

If the left turn movement has no bay, the program will ask for LEFT TURN TRAFFIC, RIGHT TURN TRAFFIC, and THROUGH TRAFFIC. The total traffic volume is the sum of these three. However, if the left turn movement has been input as a left turn bay, the program will ask for THROUGH TRAFFIC and RIGHT TURN TRAFFIC. The total traffic volume is the sum of these. It should be noted that the Right Turn traffic is not stored as an entry. Therefore, the effects on the calculations of SAT FLO rate will be lost when using the Assistant.

Saturation Flow Rate

The proper estimation of the **SAT FLO (Saturation Flow Rate)** is one of the most important pieces of information required in the PASSER II-87 input. Reasonably accurate values should be established since the movement phase time is calculated based heavily on the movement's volume-to-saturation flow ratio. Thus, saturation flow, in vehicles per hour of effective green, must have the same time unit as the traffic movement volume. The saturation flow rate in vehicles per hour of effective green can be obtained for each phase movement from the 1985 Highway Capacity Manual or by using the ASSISTANT feature described in the next section. The consistent use of the ASSISTANT function to determine saturation flow rates for both paired left turn and through traffic volumes is highly recommended.

An alternate approach to determining the movement's saturation flow is to assume that it is "n" times the saturation flow rate for one lane, where "n" is the number of lanes used by the specific traffic movement. Approximate saturation flow rates per lane can also be obtained from Table 1.

Saturation Flow Calculation

When traffic volume equals 0 or the traffic volume does not exist for a particular movement, then saturation flow can be equal to 0. Otherwise, the

TABLE 1. APPROXIMATE SATURATION FLOW RATES FOR GENERAL CONDITIONS IN TEXAS.

Traffic Conditions	Estimated Maximum Saturation Flow Rate Per Lane (Vehicles Per Hour of Green Per Lane)		
	Protected Left (single lane)	Protected Left (double lane)	Protected Through (main lanes only)
Bay Length Adequate	1700	1600/lane	1750
Bay Not Adequate	1500	1350/lane	1650
No Bay	1400	Not Recommended	1450

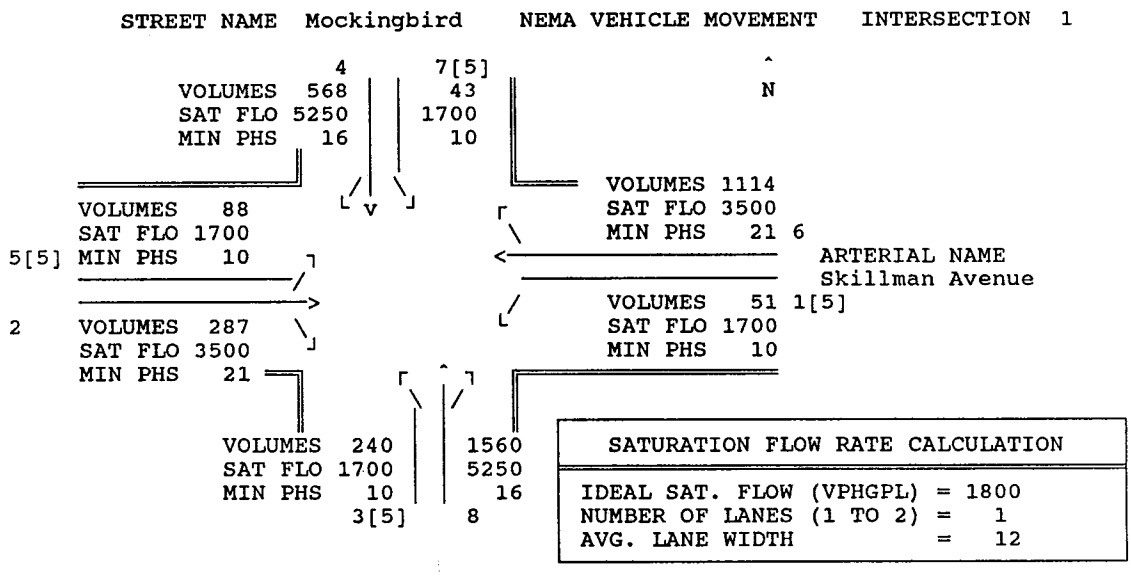


Figure 20. Saturation Flow Input Assistant.

program will require the user to input the saturation flow by proceeding with a series of detailed questions, shown in Figure 20, to assist the user to calculate the saturation flow rate similar to the procedures and the exact definitions used in Chapter 9 of the 1985 HCM.

IDEAL SAT. FLOW The user has the choice to change the systemwide ideal saturation flow rate as specified previously in the embedded data screen to account for the specific approaches to the intersection.

NUMBER OF LANES (LANE) For left turn movements, the allowable number of lanes range from 1 to 2 lanes, and for through movements it is from 1 to 3 lanes. The default value is defined by the existing SAT FLO divided by the value of 1700, and the minimum is 1 lane.

AVERAGE LANE WIDTH (AL) The range is from 8 to 15 feet, and the default is 12 feet. If the Average Lane Width (LW) is greater than 8 feet but less than 15 feet, the average lane width will be set to the lane width. If lane width as input by the user is greater than 15 feet, the average lane width will be set to be lane width/no. of lanes. The ASSISTANT function of the PASSER II-87 program for the saturation flow rate will calculate the lane width adjustment factor as FLW = 0.606 + 0.23 * AL/7.

LANE UTILIZATION FACTOR (FLU) The lane utilization factor is defined as:

FLU = 1/FACTOR

where FLU is used to adjust the saturation flow; and

FACTOR is: 1 lane = 1.00 as given in the 1985 HCM
2 lanes = 1.05
3 lanes = 1.10

The default value is dependent upon the number of lanes for the movement.

% GRADE (GRADE) The default is 0%, and its range is from -20 to 20%. With this value, the program can calculate the adjustment factor for the approach grade (FG) as FG = 1 - 0.005 * GRADE.

% HEAVY VEHICLES (PHV) The default value for the percent of heavy vehicles is 0%, and its range is from 0 to 50%. The effect of the heavy vehicles or the EHV adjustment factor is defined as 1.5. The program will calculate the adjustment factor for heavy vehicles (FHV) with the equation FHV = 1/(1 + 0.01 * PHV * (EHV - 1)), where EHV = 1.5.

 # PARKING MANEUVERS (NM) For through movements, the default value is 0, and the range is from 0 to 100 maneuvers per hour. The program will calculate the adjustment factor for the equivalent hourly parking maneuver (FPK) as defined in the 1985 HCM. These factors are defined as:

1 lane: FPK = 0.90 - 0.005 * NM

2 lanes: FPK = 0.95 - 0.0025 * NM

3 lanes: FPK = 0.97 - 0.002 * NM

If there is no parking maneuver such that NM = 0, then FPK = 1. The minimum value for this factor is set at 0.4.
For a left turn movement, FPK = 1.

 # BUSES STOPPING (NBUS) For through movements, the default value is 0, and its range is from 0 to 100 buses per hour. The program will calculate the adjustment factor (FBUS) for the effective hourly bus blockage as defined in the 1985 HCM. These two factors are related as:

1 lane: FBUS = 1 - 0.004125 * NBUS
2 lanes: FBUS = 1 - 0.002 * NBUS
3 lanes: FBUS = 1 - 0.00142 * NBUS

If there are no estimated buses stopping during the analysis period or NBUS = 0, then FBUS = 1. The minimum for this factor is 0.4. For a left turn movement, FBUS = 1.

RIGHT TURN FACTOR (FRT) For left turn movements, the right turn adjustment factor FRT = 1. For through movement, if there is no free right turn traffic volume, FRT = 1.

Otherwise, the program will calculate PRT, the ratio between right turn traffic and total traffic, where the total traffic is the sum of right turn traffic, through traffic, and left turn traffic for the movement.

If the percentage of right turns or PRT is less than 0, then input is the "% OF RIGHT TURN IN PERMITTED PED PHASE" (PTB). The default of PTB is 0, and when PTB = 0, FRT = 1.0. If PTB is between 0 and 100, the program will ask for "CONFLICTING PED FLOW IN PERMITTED PED PHASE" (PEDS). The default of PEDS is 0. If PEDS is greater than 1700, PEDS is set to 1700.

When PRT is greater then 0.99 and PEDS is less than 1.0, then the right turn factor FRT = 1.0 - 0.15. Otherwise, FRT is defined as:

1 lane: FRT = 0.9 - 0.9 * 0.15 * PRT - PEDS * PRT * PTB/2100

2 or more lanes: FRT = 1.0 - 0.15 * PRT - PEDS * PRT * PTB/2100

The minimum and maximum value for Right Turn Adjustment factor or RT are 0.05 and 0.85, respectively.

LEFT TURN FACTOR (FLT) For through movements, the default FLT is 1.00 or the program will calculate PLT, the ratio between left turn traffic and total traffic, PLT = total volume * Peak hour factor/ Left volume. If PLT is less than the Number of lanes then set PLT equal to the Number of lanes. Then left turn factor FLT = 1-(1/20 * PLT + No. lanes). For protected left turn movements without using left turn bay, the adjustment factor FLT is defined as:

1 lane: FLT = 0.95
2 lanes: FLT = 0.92.

The 1985 HCM uses an approximation technique, and PASSER II-87 uses a more refined model for explicitly describing the permitted left turn

maneuver. The improvements include the input procedure, input data structure, green split calculations, progression calculations, and program output evaluations. The effects of PASSER II-87 coordinated operations on the left turn traffic will be different from the 1985 HCM.

AREA TYPE FACTOR (FAREA) If the arterial is in the CBD area then the area type factor or FAREA = 0.9, otherwise FAREA = 1.0. All the approaches to one intersection must be either in the CBD or outside the CBD area. The system will ask this only once for every intersection.

TOTAL SATURATION FLOW (SAT) The ideal saturation flow (ISF) is set to be 1800 as the embedded value. The user can also adjust the ideal saturation flow rate for each of the approaches to the signalized intersection. The total saturation flow is calculated by considering all the adjustment factors described above through the following equation as used in the 1985 Highway Capacity Manual (HCM).

SAT = ISF * LN * FLW * FLU * FG * FHV * FPK * FBUS * FAREA * FRT * FLT

Minimum Phase Time

The **MIN PHS (Minimum Phase Time)**, expressed in seconds, is the minimum amount of green plus yellow plus all-red or the total phase time needed to be allocated for a particular movement's phase. PASSER II-87 calculates the total phase time, if any, for that movement. Therefore, no separate calculations are performed except for the sum of the green, yellow, and all-red time. For example, if the desired minimum phase time interval was 10 seconds followed by a 3-second yellow interval and a 1-second all-red interval, the coded minimum phase time would be a total of 14 seconds for the pretimed signal. The minimum phase times for movements 2, 4, 6 and 8 must be long enough to insure adequate walk and pedestrian clearance time for crossing the street. It is important to note that the minimum cycle length must not exceed the sum of the minimum phase times of the conflicting or the critical traffic movements on arterial or cross streets as shown in Figure 21.

Minimum Phase Calculation

For left turn movements or the traffic movements of NEMA numbers 1, 3, 5, 7, if the saturation flow rate or the SAT FLO equals 0, then minimum phase time (MING) will be set to 0. Otherwise, the default minimum phase time will be set to 10 seconds as the absolute minimum. However, the user can still choose to overwrite with any other number, as desired.

For through movements or the NEMA movement numbers 2, 4, 6, 8, if both the saturation flow rate = 0 and the traffic volume = 0, then minimum phase time will be set to 0 seconds, since the traffic volume input indicates there are no traffic volumes to be served by the phase time.

On the other hand, when SAT FLO is not equal to 0 or VOLUME is nonzero, the program will proceed and help the user calculate the minimum phase time requirements. The program will assist the user in calculating the minimum phase time through the series of questions and answers from the pedestrian walk time, pedestrian walk speed, pedestrian walk distance, and the less half lane width. The "PEDESTRIAN WALK TIME" (PWALK), the length of time provided for the pedestrian to start across the street, is based on the number of

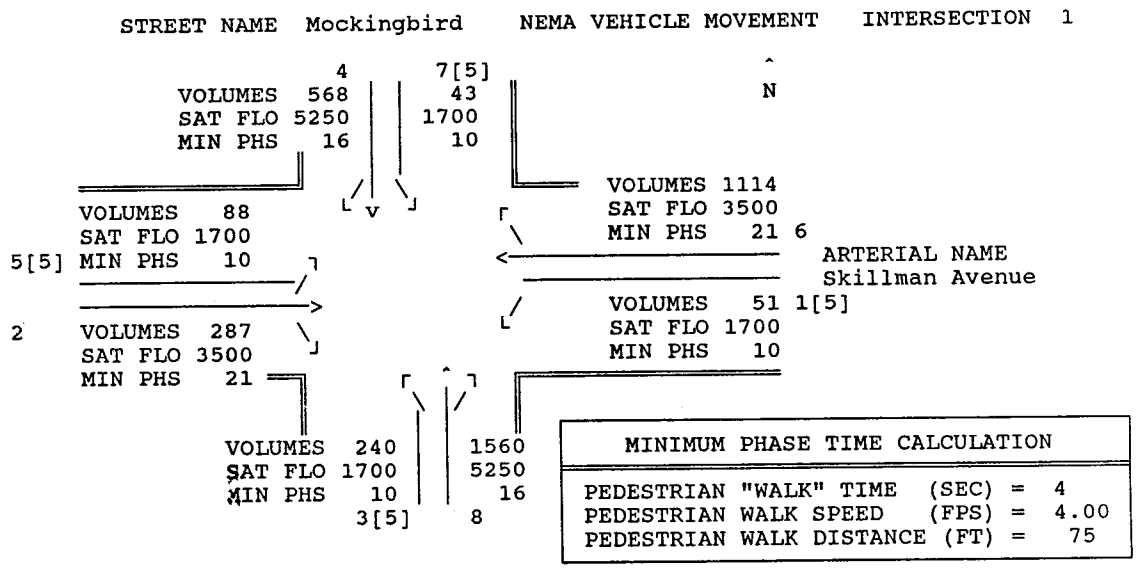


Figure 21. Minimum Phase Time Input Assistant.

pedestrians counted during the traffic volume count. If there is a sufficiently high volume of pedestrians to justify the use of pedestrian "Walk" and "Don't Walk" signals, the "Walk" period should be 7 seconds or more in length. On the other hand, if the pedestrian volume is relatively high but not high enough to justify the installation of "Walk" and "Don't Walk" signals, a minimum of 5 seconds is used for this initial interval. And last, if there is only an occasional pedestrian, a minimum of 3 seconds may be used for the initial interval. The default pedestrian walk time is 4 seconds.

Next, the program will ask the user to input "PEDESTRIAN WALK SPEED" (PSPEED). The default value for the pedestrian walk speed is 4 feet per second, and its range is from 3 to 5 feet per second. Then, the user will be asked to input "PEDESTRIAN WALK DISTANCE" (PDIST) and "LESS HALF LANE WIDTH" (HLW). The default value for PDIST is 0 feet, and the default value for HLW is 6 feet or half of a typical lane width.

The minimum through movement phase time (MING) equation is MING = ((PDIST - HLW)/PSPEED) + PWALK. The ASSISTANT will not recommend a value for minimum phase time or for a through movement of less than is 15 seconds. The values of the ASSISTANT function should only serve as recommended values.

The user may use this function to assist in the calculation of the traffic volume, saturation flow rate, and the minimum phase time. The use of the ASSISTANT function is not mandatory but it is recommended to provide on-line assistance for the engineering calculations. However, it is recommended that the use of the ASSISTANT function be consistent at least for the same intersection or the paired left and through traffic coming from the same approach to the intersection. The program will only recommend one possible value to be used. In the end, the user still needs to decide whether to use the recommended values or overwrite it with any other numbers.

SAVING AND LOADING DATA SETS

Both saving and loading data sets can be accomplished by selecting proper actions in the main menu. To save a data set, the user selects item 4 and is prompted for the default path name and file name. Since there exists only limited room on the A drive for program storage, all the input data sets should be stored on the B drive for the two disk drive operation. On the other hand, selecting number 2 on the main menu will allow the user to read an existing data set; the program will check if the existing data loaded has been changed or not. If it does, the program will ask the user if he wishes to abandon the old data. If the old data is kept, the program will not load in the new data set, the system will return to the main menu. It is preferable to load only data sets which were created by this system. However, PASSER II-87 can also load the existing PASSER II-84 data sets and mainframe data sets and insert the needed information when the data is saved.

RUNNING PASSER II-87

After all data elements have been successfully entered, the system directs the user to save the data before any other data can be loaded or before the program can be executed. Once PASSER II-87 has been run, the output prepared for that run will be automatically reloaded into the system to be reviewed in the output menu. The only time the user needs to save a data set is when the user wants to run that problem later or load another data set

for further editing. The system remembers the last path name and file name used while saving or loading a data set. If no additional input is being made, it displays on the screen the last filename being used and automatically loads the data set when the system is restarted. The user may change the data file to be used if desired. When the user wants to exit the system, the system will require the user to save the data file if no file save operation has been performed since the last modifications. Therefore, the contents and the filename will not be forgotten. The input menu allows the user to load files from other disks in order to modify or execute them in PASSER II-87.

After the user chooses to run PASSER II-87, the system checks for user data input errors to avoid any possible program run-time errors. First, left turn treatment and signal phase patterns are selected for volume input and inappropriate patterns will be deleted. Secondly, minimum phase times will automatically be set equal for those simultaneous movements in the phase sequences without overlap options. The larger green of the two phase movement will be used if unequal greens are specified. The sum of the critical phase minimum greens will also be checked to ensure that the sum will always be less than the lower cycle length as specified by the user. After the user chooses 6 on the main menu to run the program, the system will check the data for possible major data input errors which may cause PASSER II-87 to malfunction. This check insures that:

1. The phase patterns selected correspond to the movement volumes. If the user input is not allowed according to the logical phase table, inappropriate patterns will be deleted from the user's input data.
2. The minimum phase times are set equal to those simultaneous movements in phase patterns without overlap. The larger green will be used if unequal greens were specified.
3. The sum of both the arterial and cross street critical phase minimum greens is less than the amount of the lower cycle length which is considered a FATAL ERROR.
4. Each arterial and cross street must be selected with at least one phase pattern selected. Otherwise, a FATAL ERROR may occur.

Errors 3 and 4 are fatal and will stop the user from running the PASSER II-87 main program. Otherwise, the system will load the PASSER II program and run it. The run time version of PASSER II-87 is very efficient without requiring the use of the 8087/80287/80387 math coprocessor. After PASSER II has been run, the program will then return to the output postprocessor of the PASSER II-87 microcomputer system, and the output menu will be displayed again. The output menu is explained in the next section.

OUTPUT MENU

After the user runs PASSER II-87, the system will return to the output menu for the user to review the optimized signal timing plan. Therefore, it is recommended that PASSER II-87 always be run after changes have been made in the data set so that the current output can always be matched with the input data file. After the program is executed, the system will return to the output menu as shown in Figure 22. If the user selects the output menu from the input menu before PASSER II-87 is run, the output may be the file left from the last time the program was run and may not correspond to the data that was entered. Therefore, the program should always be run after changes have been made in the data so that the output will match the input data.

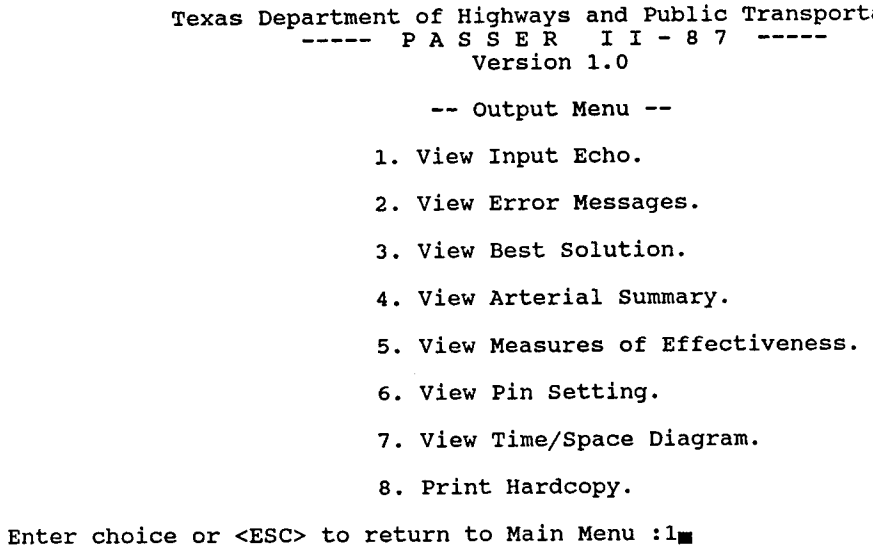


Figure 22. PASSER II-87 OUTPUT MENU.

An example printout from PASSER II-87 is provided at the end of this manual. PASSER II-87 provides an exceptional list of output features. For example, the user can specify the output level to be processed in the input menu and review or print specific portions of the program results from the output menu. The typical output is headed by the echo printout of arterial parameters (COVER), listing of system embedded data (EMBED.DATA), intersection input (INPUT.DATA), and error report (ERROR.MSG). The optimized program solution output provides a listing of the optimal timing evaluation for the arterial street (ART.SUMY), optimal signal timing plans for each intersection (INT.SUMY), a series of level of service evaluations for each phase movement (BEST.SOLN), total arterial system performance (ART.MOE), two controller phase interval setting report (PIN.SET), and optimal time-space diagram (TS.DIAGM) if requested. The implementation of the optimal timing plans in the open-type signal network can be greatly facilitated by using the controller phase interval tables to genterate coordinated offsets with respect to the system master intersection for microprocessor-based traffic actuated signal equipment. The available output menu choices are:

1. **View Input Echo.**

   Allows the user to view, page by page, an echo printout of the input data which is generated by PASSER II-87. This portion of the program output includes the echo printout of arterial parameters (COVER), listing of system embedded data (EMBED.DATA), and intersection input (INPUT.DATA).

2. **View Error Messages.**

   Allows the user to review the input data error report (ERROR.MSG).

3. **View Best Solution.**

   Allows the user to view the signal timing reports, intersection by intersection, and the best progression solution generated. This reports a series of level of service evaluations for each phase movement (BEST.SOLN).

4. **View Arterial Summary.**

   The optimized program solution output provides a listing of the optimal timing evaluation for the arterial street (ART.SUMY) and optimal signal timing plans for each intersection (INT.SUMY). This output is not available when only one intersection is analyzed.

5. **View Measures of Effectiveness.**

   Allows the user to review the program displaying the system-wide measures of effectiveness, including the bandwidth efficiency and the optimized cycle in total arterial system performance (ART.MOE).

6. **View Pin Setting.**

   Allows the user to examine the two sets of controller phase interval setting reports generated to translate the optimized signal timing results to user-specified parameters in the controller phase

interval setting report (PIN.SET). The controller phase interval tables can greatly facilitate timing implementation in the open-type network.

7. **View Time/Space Diagram.**

   Allows the user to examine the optimized timing plan graphically corresponding to the best progression solution for the arterial street under analysis, if the report (TS.DIAGM) is requested. Since there are only 80 columns of 24 lines available on each screen display, two actions were made in PASSER II-87. The progression bands were pushed and scales were adjusted so that the time-space diagram could provide the maximum viewing and the bands could start at the origin. Arterial and intersection names are illustrated as they are coded. Time reads from left to right on the horizontal axis. The distance scale reads from bottom to top with the accumulation distance measured on the left-hand side of the diagram. The progression bands are described by the different printer characters. In the PASSER II-87 time-space diagram, a blank or " " indicates the red or the cross street phase; "===" is DUAL LEFTS (1+5), "XXX" is DUAL THRUS (2+6), "///" is LT 5 LEADS (2+5), "\\\" is LT 1 LEADS (1+6). The "A" Direction Progression Band goes up and to the right; the "B" Direction Progression Band comes down and to the right. The default coordinated progression offsets, expressed either in seconds or the % of cycle length, are with respect to the start of the arterial phases at intersection 1. Note that both the left and the through movement phases are expressed separately in the time-space diagram.

8. **Print All Output.**

   All portions of PASSER II-87 output, as shown in Figure 23, will be sent to the printer. The PASSER II-87 program output will be produced in the form of 66 lines per page with 80 columns per line; no special printer is required for the program printout. The user can select portions of the program output by selectively turning off the particular portion of the output not wanted by toggling the RETURN key.

The user can also press the ESC key at any time to return to the main menu to compare the results of the PASSER II-87 to the input data. The user may then return to the output menu by selecting the appropriate choice on the main menu. Data may be edited at will, but the changes in the input data will not be visible in the output until the PASSER II-87 program is run again.

EXITING THE INPUT PREPROCESSOR AND OUTPUT POSTPROCESSOR

When all the input data have been entered and approved, the input preprocessor and output postprocessor will automatically save the data in a data file on the designated data diskette, for example, in the default drive B, or the alternative hard drive. The user can save the current data set into the file in order to use the data file later, and then exit the PASSER II-87 system by selecting number 8 from the main menu.

```
Texas Department of Highways and Public Transportation
      -----  P A S S E R   I I - 8 7  -----
                    Version 1.0

              Output Menu - Print Selection

        0.  Begin Printing ?     NO
        1.  (COVER)              YES
        2.  (EMBED.DAT)          YES
        3.  (INPUT.DATA)         YES
        4.  (ERROR.MSG)          YES
        5.  (ART.SUMY)           YES
        6.  (INT.SUMY)           YES
        7.  (BEST.SOLN)          YES
        8.  (ART.MOE)            YES
        9.  (PIN.SET)            YES
       10.  (TS.DIAGM)           YES

Use cursor to select, press enter to toggle, or <ESC> to exit : 0
```

Figure 23. PASSER II-87 Printout Selection Menu.

ADDITIONAL CONSIDERATIONS

Several of the most important topics concerning the use of the PASSER II-87 program are discussed in the following section. These topics include left turn signal treatments, phase pattern selection, basic keyboard commands, optimization of arterial signal systems with up to 20 intersections, a summary of the operating procedures, and operational efficiency.

LEFT TURN SIGNAL TREATMENTS

In order to assist users in analyzing and evaluating the operational effects of different left turn traffic signal treatments under coordinated progression operations, PASSER II-87 has been significantly enhanced with advanced methods beyond the 1985 HCM technology. These PASSER II-87 improvements include the enhancements made in the input procedure, input data structure, green split calculations, progression calculations, and output performance evaluations. In addition, compared with the approximation techniques used in the 1985 HCM, PASSER II-87 uses a much more refined model for explicitly describing the left turn maneuvers and resulting capacity.

The PASSER II-87 program uses a minimum amount of information to generate left turn treatments as well as to examine allowable signal phase sequences according to user traffic data. The input data was designed to simplify the user's input and still be able to provide the necessary user assistance for analyzing the various left turn signal treatments and capacity evaluations. These treatments include those with simple two-phase "Permitted Phase" and sophisticated "Protected Phase" operations as well as those with the most complicated permitted/protected or protected/permitted "Combined Phase" left turn sequences. However, PASSER II-87 will still assume the use of the default "Protected" phase operation, as used in the existing PASSER II-84 program, if a left turn bay is used. On the other hand, the new program will assume the use of the default "Permitted" phase when no left turn bay exists or if the user does not specify a particular left turn signal treatment being used in the analysis.

Left Turn Treatment Data Input Method

The PASSER II-87 left turn data input was basically designed to accept all available user information through the on-line help display screen to generate all the necessary data as well as provide user with instructions for solution analysis. User input will be examined and evaluated to generate the possible left turn treatments and to investigate the allowable signal phase sequence. However, the proper analysis of the different left turn signal operations requires that a large amount of information about left turn signal treatments be provided in the data "ASSISTANT" window for each approach to the signalized intersection. The PASSER II-87 system was designed to utilize all input information in order to provide 1985 "Highway Capacity Manual" type analysis with the most flexible and simplified input data file structure for all possible left turn signal treatments. In addition, the system preserves the straightforward input data editing and modification functions now available in the existing PASSER II-84 program, if the user wishes to do so.

During the input process, the system will first note whether there is a protected left turn bay. Then, the program will detect the use of the minimum phase time to indicate whether the use of the protected left turn phase will be needed and instruct the user to input additional information as now required in the analysis. By asking the user whether this particular left turn movement "IS LEFT TURN PROTECTED ONLY?", the choice of using either the "Protected Phase" or "Combined Phase" operation can be quickly determined. The program will also use the different signal phase sequences to separate "which" of the two combined phases will be used in the analysis. That is, the program will then determine whether the complicated permitted/protected or protected/permitted "Combined Phase" left turn sequence will be used in the program analysis.

The basic left turn phase treatments that can be analyzed by PASSER II-87 are illustrated in Figure 24. The program input follows the input data matrix shown below. It illustrates the information required to provide maximum user assistance for analyzing the different left turn signal treatments. Among them, the "BAY" represents the use of a protected left turn bay for left turn traffic movements. "PERMITTED" indicates the use of the "Green Ball" signal indication. "PROTECTED" shows the application of the "Green Arrow" signal indication for protected traffic movements. The "COMBINED" reveals the use of permitted/protected or protected/permitted "Combined Phase" left turn sequences. "VOLT" indicates that the left turn traffic volume will be stored in the "shaded" left turn bay as shown in the movement data input screen with the "NO BAY" option. "VOLL" indicates that the left turn traffic volumes will be input and stored in the separate protected left turn bay as shown in the movement data screen with the "LT BAY" option. The "SAT" illustrates the need to input saturation flow rate. "MING" indicates the use of the length of the "Protected" portion of the left turn signal phase during the "PROTECTED" or "COMBINED" left turn operations. For each left turn approach, there will be a separate left turn treatment or the use of a different "NPP" value as illustrated previously.

As indicated in the design matrix below, PASSER II-87 will assume the default use of "Protected" phase or "NPP = [5]", if the left turn bay has been used. Alternatively, the program will assume the default use of the "Permitted" phase or "NPP = [1]", when no left turn bay has been used or the user does not specify a particular left turn signal treatment.

PASSER II-87 LEFT TURN SIGNAL TREATMENT DESIGN MATRIX.

BAY	PERMITTED	PROTECTED	COMBINED	VOLL	VOLT	SAT	MING	NPP
Y	N	N	N	N	Y	Y	N	1
Y	N	Y	N	N	Y	Y	Y	2
Y	N	N	Y	N	Y	Y	Y	3
N	Y	N	N	Y	N	Y	N	4
N	N	Y	N	Y	N	Y	Y	5
N	N	N	Y	Y	N	Y	Y	6

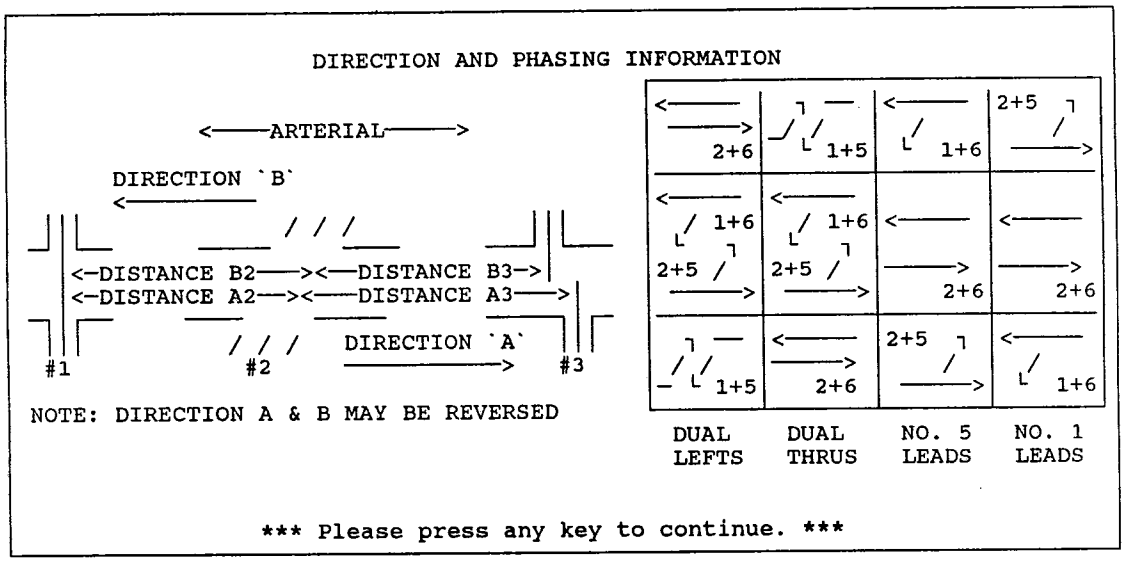


Figure 24. Input Permissible Phasing for the Arterial.

Six of the left turn signal phase treatments can be easily analyzed in PASSER II-87. As shown in Figure 21, a unique "NPP" number or "Left Turn Signal Treatment" will be assigned in the "[ ]" to designate the particular left turn treatments being used. These exact "NPP" values will also be displayed in the Input Data Echo, and a new line is provided in the Best Solution section which gives the Phase Direction. As in PASSER II-84, PASSER II-87 will the default "Protected phase" or "NPP=[5]" if a left turn bay is used. Otherwise, the program will assume the default "Permitted phase" or "NPP=[1]" when no left turn bay is used or the user does not specify a particular left turn signal treatment. The "NPP" value represents the left turn signal treatment input by the user. It is explained in the input data ASSISTANT window as follows:

A. WITHOUT LEFT TURN BAY

1. NPP = [1] PERMITTED PHASE OPERATION

   NO BAY, "PERMITTED PHASE" OPERATION
   NEED: VOLUMES, SATURATION FLOW

2. NPP = [2] PROTECTED PHASE OPERATION

   NO BAY, "PROTECTED PHASE" OPERATION
   NEED: VOLUMES, SATURATION FLOW, MINIMUM GREEN TIME

3. NPP = [3] COMBINED PHASE OPERATION

   NO BAY, "COMBINED PHASE" OPERATION
   NEED: VOLUMES, SATURATION FLOW, MINIMUM GREEN TIME

B. WITH LEFT TURN BAY

1. NPP = [4] PERMITTED PHASE OPERATION

   LT BAY, "PERMITTED PHASE" OPERATION
   NEED: VOLUMES, SATURATION FLOW

2. NPP = [5] PROTECTED PHASE OPERATION

   LT BAY, "PROTECTED PHASE" OPERATION
   NEED: VOLUMES, SATURATION FLOW, MINIMUM GREEN TIME

3. NPP = [6] COMBINED PHASE OPERATION

   LT BAY, "COMBINED PHASE" OPERATION
   NEED: VOLUMES, SATURATION FLOW, MINIMUM GREEN TIME

It is extremely important for the user to understand that some information about left turn signal treatments can not be automatically provided. The user must interact with the program through the ASSISTANT function to instruct the program what to do in order to choose the proper left turn signal treatments as well as perform the necessary saturation flow calculations. The consistent use of the program ASSISTANT function will only be required when different left turn signal treatments and the 1985 HCM type

capacity analysis are needed. The existing PASSER II-84 users can still use the interactive input to perform the regular program input if desired. However, the use of the ASSISTANT function as well as checking the proper "NPP" values in the "[ ]" is highly recommended. The system requires much information in order to perform the 1985 HCM type capacity analysis for evaluating the traffic signal timing results. The following instructions are provided explicitly for the user to apply the necessary traffic data for coding the "PERMITTED," "PROTECTED," and "COMBINED" phase signal treatments in addition to the ASSISTANT function.

FOR CODING THE LEFT TURN BAY

Determine the physical presence of a protected left turn bay and then identify this case by toggling the FUNCTION KEY 2 or F2 KEY.

The following three coding instructions can be displayed on the screen by hitting F1 when the intersection graphics is displayed.

FOR CODING THE "PERMITTED" PHASE

Activate the ASSISTANT function through the FUNCTION KEY 3 or the F3 KEY for left turn TRAFFIC VOLUME input. Answering "YES" to "LEFT TURN PERMITTED GREEN?" selects the permitted phase operation. Then proceed with the traffic volume input, noticing the words "PERMITTED PHASE" in the ASSISTANT window. Check the "NPP" value as either "[1]" or "[4]" in the "[ ]" for the corresponding left turn traffic movement for the "NO BAY" and "LT BAY" cases.

FOR CODING THE "PROTECTED" PHASE

Activate the ASSISTANT function through FUNCTION KEY 3 or the F3 KEY. Answering "NO" to "LEFT TURN PERMITTED GREEN?" and "YES" to "LEFT TURN PROTECTED GREEN?" selects "PROTECTED PHASE" operation. Then proceed with the volume input, checking "PERMITTED PHASE" in the ASSISTANT window and the "NPP" value as either "[2]" or "[5]" in the "[ ]" for the "NO BAY" and "LT BAY" cases.

FOR CODING THE "COMBINED" PHASE

Activate the ASSISTANT function through FUNCTION KEY 3 or the F3 KEY. Answering "NO" to the question, "LEFT TURN PERMITTED GREEN?" and "NO" to the question "LEFT TURN PROTECTED ONLY?" selects "COMBINED PHASE" operation. Proceed with the traffic volume input by checking the words "COMBINED PHASE" in the ASSISTANT window. The indication of the "NPP" value as either "[3]" or "[6]" for the "NO BAY" and "LT BAY" cases, respectively, should be noticed.

PHASE PATTERN SELECTION

The PASSER II-87 environment system will assist the user in choosing allowable signal phasing pattern(s). The system first finds out which movements have had volumes entered for them and then references these choices to the logical phase sequence tables shown previously in Figure 4. It will then give the user a list of the phasing patterns which the table indicates

are applicable. The user can review the signal phase sequences recommended by the program by simply pressing the FUNCTION KEY 3 or F3 KEY. This will indicate the actual signal phase sequence the user has chosen for analysis.

The PASSER II-87 program uses three logical signal phasing pattern tables, as shown in Figure 4, to help the user determine the different allowable phase sequences according to the traffic volume input by the user. The first two allowable signal phase tables are designed to determine the allowable phase sequences under the normal operation on the arterial and the cross street movements. These two tables should be sufficient for 90% of the PASSER II-87 analysis requirements. Occasionally, however, the user will need the full range of phasing patterns available. In this case, the user can choose to use the special phasing table. This table will give the user the additional phasing patterns needed to achieve any possible phase sequence for the movements that have nonzero traffic volumes.

For example, assume that there is a signalized intersection where the left turn movement 5 has a protected phase but the opposing left turn, movement 1, does not have a protected phase. Therefore, movements 2, 5 and 6 have nonzero volumes. Looking at the normal phasing pattern table for arterial phasing, we find only two possible choices of phase patterns. The first, through movements first with overlap or dual throughs with overlap, provides a phase sequence of 2+6, 2+5. The other option, left turn 5 leading with overlap, will give the user the opposite sequence choice: 2+5, 2+6. If, however, a more unusual phase sequence is needed, the user can use the special phase pattern selection and be allowed the phase sequences for four more choices as shown below. The phase sequence will be shown for each of the allowable phase patterns. Please note that if all four movements have nonzero volumes, only one of the two possible overlap phases will be shown for patterns with overlap. The other overlap phase is also available and will be chosen by the PASSER II-87 system if the traffic volume input warrants it.

Phase Pattern	Phase Sequence
Left Turns First without Overlap	5, 2+6
Through Movements First without Overlap	2+6, 5
Left Turn 1 Leading without Overlap	6, 2+5
Left Turn 5 Leading without Overlap	2+5, 6

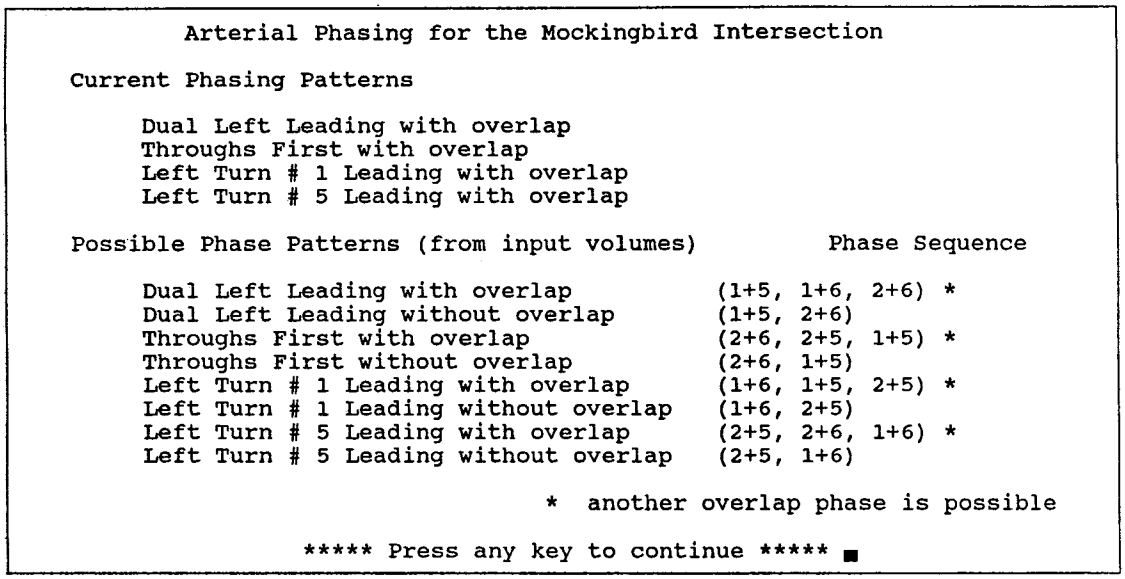


Figure 25. Permissive Arterial Phasing.

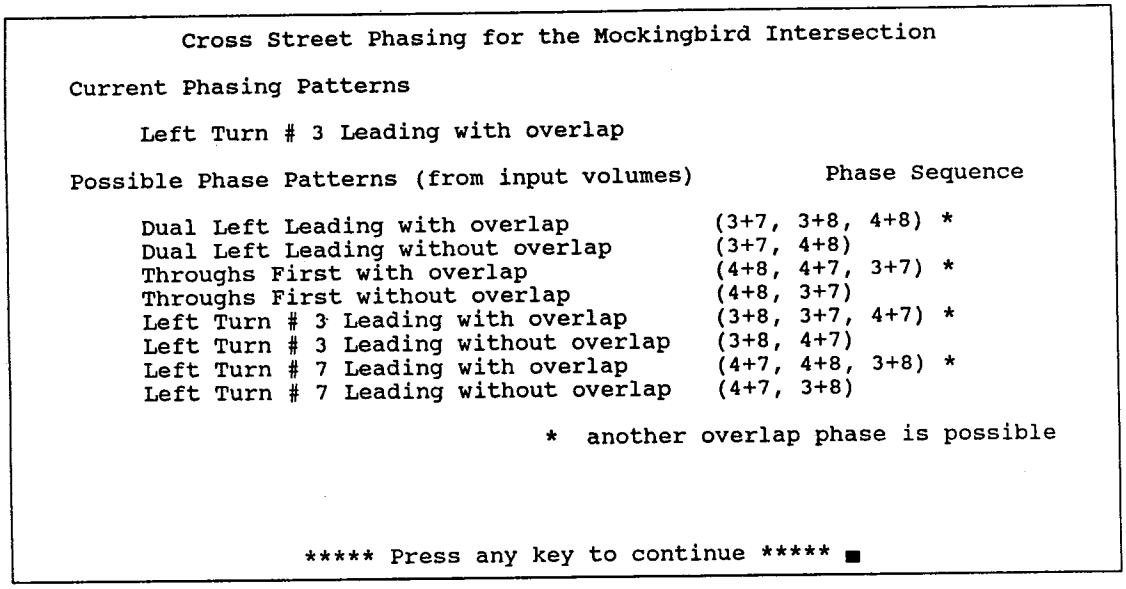


Figure 26. Permissive Phasing for Cross Street.

Effect on the Left Turn Phase Sequence

For the different left turn treatments, PASSER II-87 will first require the user to provide information concerning the use of the protected left turn bay. Then, the program will automatically generate the appropriate treatments for the different left turn and through traffic lane groups. Finally, the left turn treatments and the traffic information will be displayed. The intelligence implemented in the program will allow the system to determine the proper types of treatments, suggest the needed data, check the input, and put in those data left out by the user. The system will analyze the user's input information in order to handle the complicated left turn signal treatments and 1985 Highway Capacity Manual type evaluations. During the input process, the system will detect whether there is a protected left turn bay. The program will also examine the use of the minimum phase time to indicate whether the use of the protected left turn phase will be needed and instruct the user to input the needed information in the analysis. By asking the user whether this particular left turn movement "IS LEFT TURN PROTECTED ONLY?", the choice of using either the "Protected Phase" or "Combined Phase" operation can be determined. The program will also examine the different signal phase sequences to separate "which" of the two combined phases will be used. That is, the program will determine from the lead or lag phaseing specified by the user which of the two complicated permitted/protected or protected/permitted "Combined Phase" left turn sequences should be used.

Due to the different possible left turn signal treatments, the allowable signal phase sequence in PASSER II-84 has also been revised to reflect the phase sequences that can be allowed in the PASSER II-87 program.

SIGNAL PHASE SEQUENCE SELECTION

"NPP" TYPE	LT 1ST	THRU 1ST	NO 5 LEAD	NO 1 LEAD
1	-	Y	-	-
2	Y	Y	Y	Y
3	Y	Y	Y	Y
4	-	Y	-	-
5	Y	Y	Y	Y
6	Y	Y	Y	Y

In PASSER II-87, the allowable signal phase sequence selections are designed to follow the logical phase selection defined in the program. The program will generate the optional phase sequence while the user finishes the traffic data input for the entire signalized intersection. These options will be displayed in the phase sequence selection menu. They are also available in the background which the user acquires by pressing FUNCTION KEY 3 or the F3 KEY. The user can also overwrite these selections by choosing the special phase sequence selections. In order to allow the program to help the user examine the operational effects of the different left turn signal treatments, it is recommended that the users utilize the original signal phase sequences suggested by the program. But, the user must utilize the designated protected left turn bay and available left turn phase to allow the optimization and evaluation of all the left turn signal phase movements.

Summary of Operating Procedure

(A) Intersection Movement Designation -

a. if no bay then input left turn traffic in through movements 2,4,6,8

b. if no bay then program

i. adds left turn volume to through
ii. sets sat flow equal to "0"
iii. displays volume in reverse video
iv. input left turn volume either:

1. in the through movement help window
but display in shade in the left turn movement
2. in left turn with [F2] and shaded the left turn bay

(B) Left Turn Phase Signal Selection -

a. Definition of NPP

1 - w/o bay, permitted
2 - w/o bay, protected
3 - w/o bay, protected+permitted
4 - w/ bay, permitted
5 - w/ bay. protected [org.default for with left turn bay]
6 - w/ bay, protected+permitted

b. Value of NPP

BAY	MING	USER	NPP	VOLUME IN
N	=0	permitted phase	1	VOLT
N	>0	protected phase	2	VOLT
N	>0	combined phase	3	VOLT
Y	=0	permitted phase	4	VOL
Y	>0	protected phase	5	VOL
Y	>0	combined phase	6	VOL

SUMMARY OF KEYBOARD COMMANDS

A series of user-friendly user interface functions have been added to the PASSER II-87 microcomputer program to help users with the efficient program operation. These computer keyboard commands, as shown in Figure 27, can be accessed in the program by pressing the FUNCTION KEY 1 or the F1 KEY. These keyboard commands are summarized as follows.

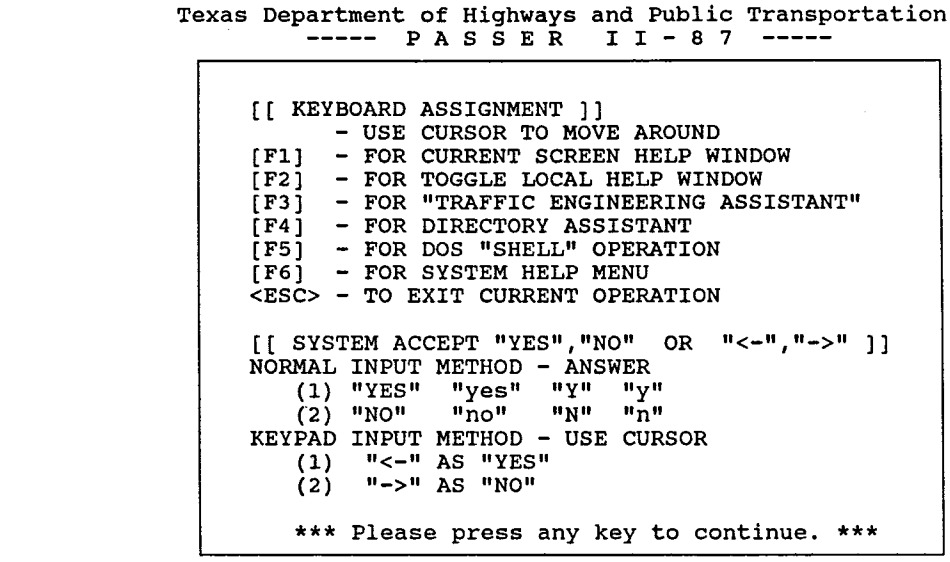


Figure 27. Basic Keyboard Instructions.

1. KEYBOARD ASSIGNMENT

   a. - USE CURSOR TO MOVE AROUND
   b. [F1] - FOR CURRENT SCREEN HELP WINDOW
   c. [F2] - FOR TOGGLE LOCAL HELP WINDOW
   d. [F3] - FOR "TRAFFIC ENGINEERING ASSISTANT"
   e. [F4] - FOR DIRECTORY ASSISTANT
   e. [F5] - FOR DOS "SHELL" OPERATION
   f. [F6] - FOR SYSTEM HELP MENU
   g. <ESC> - TO EXIT CURRENT OPERATION

2. DATA MODIFICATION ACCEPT "YES", "NO" OR "<-","->"

   a. THIS ALLOW THE CONVENTION FOR USING THE KEYPAD
   b. NORMAL INPUT METHOD
      i. QUESTION & ANSWER
      ii. (1) "YES" "yes" "Y" "y"
      iii. (2) "NO" "no" "N" "n"
   c. KEYPAD INPUT METHOD
      i. THIS ALLOW THE USE OF KEYPAD
      ii. (1) "<-" AS "YES"
      iii. (2) "->" AS "NO"

ARTERIALS WITH A MAXIMUM OF 20 INTERSECTIONS

Currently, the PASSER II-87 system has the capability to analyze an arterial street with a maximum of 20 intersections in a single optimization run. The limitation was designed for both optimum program execution efficiency and realistic arterial operations. Moreover, the 20-intersection limitation provides a logical break point for determining the reasonable limit of the total number of signalized intersections to be analyzed in an effective arterial progression system. This pre-set limitation allows the program to perform the efficient analysis and store every file needed in the analysis, which includes the input data files, output data files, and the PASSER II-87 configuration files. At present, the system can prepare the input data for the arterial signal system, run the compiled PASSER II-87 program, produce the output pages in the same manner as the mainframe version of the PASSER II-87 program, and review the resultant arterial signal timing plan for a signal system having as many as 20 signalized intersections.

SUMMARY OF OPERATING PROCEDURES

There are several possible ways to execute the PASSER II-87 system. These include running PASSER II-87 through the PASSER II-87 input/output processor on a microcomputer with a system with two 360 KB double-sided double-density (DS DD) floppy disk drives, a one or two 1.2 MB or 1.44 MB double-sided double-density (DD HD) disk drive system, or a hard disk drive system. It is also possible to run PASSER II-87 through the cold start with data modification using other text editors or wordprocessors. This section summarizes these operating procedures for easy user reference.

Running PASSER II-87 Through the PASSER II-87 System

I. Direct execution from input data using input preprocessor and output postprocessor on two 360 kb DS DD floppy disk drive system.

   A. Copy the input preprocessor and output postprocessor program (PASSETUP.EXE) and the batch file (PASSER2.BAT) to the system diskette with the MS DOS "COMMAND.COM" file to the diskette in drive A. Copy the optional help information (MENU) onto drive A.

   B. Copy the PASSER II-87 program (P287AI.EXE) file to drive B and the leave DATA diskette in drive B. Type DOS command "PATH A:\;B:\;".

   C. Type "PASSER2"; the batch file will then execute PASSER II-87.

   D. Two program diskettes are provided for the input/output process and main program execution.

   E. After the execution of PASSER II-87 provided on the diskette in the B drive, output will be stored on the diskette under the user specified path name and file name and displayed on the screen for easy reference before the printout.

II. Direct execution from the input data deck using the input preprocessor and output postprocessor on a microcomputer with one or two 1.2 MB or 1.44 MB DD HD floppy diskette drive.

   A. Go to subdirectory where input preprocessor, output postprocessor (PASSETUP.EXE), and main program file (P287AI.EXE) are stored.

   B. Put the optional PASSER II-87 data diskette in another floppy diskette drive, if desired, or store all the files on one 1.2 MB or 1.44 MB DS HD floppy disk in the same drive.

   C. Type "PASSER2"; the batch file will execute PASSER II-87.

   D. After the execution of PASSER II-87 on the floppy diskette, the output will be stored on the high density floppy diskette under the specified data file name and displayed on the screen for easy reference before printing out the program output file.

III. Direct execution from input data deck using the input preprocessor and output postprocessor on the hard disk system.

   A. Go to the subdirectory where the input preprocessor and output postprocessor programs are stored.

   B. Put PASSER II-87 data diskette in drive A, if desired, to store the data on the floppy drive when using the hard drive.

   C. Type "PASSER2"; the batch file will execute PASSER automatically.

   D. After execution of PASSER II-87 on the hard disk drive, output will be stored on the hard disk under the specified file name and displayed on screen before printing the output file.

Running PASSER II-87 Through Cold Start with Data Modification

PASSER II-87 data modification can also be performed using other types of text editor programs without using the input and output processor provided by the program. The PASSER II-87 program data files are basically in the standard ASCII format. Therefore, they can be easily modified, if desired, by using text editors, such as WORDSTAR, EDLIN, TURBO PASCAL or the PE editor. Two PASSER II-87 data files need to be modified in order to run the program outside the microcomputer environment system. First, the "data file" to be revised must be checked to see that it is in the proper data format. Then, the "IOSPEC.DAT" is needed to specify the DOS path name and the input and output data file names in order to run the program. The process can begin by placing the text editor program in drive A and the input preprocessor and output postprocessor data diskette in drive B.

A. Using WORDSTAR:

1. Type "WS".
2. Modify data in non-document file mode to access the data file in drive B.
3. Modify without changing or inserting extra spaces in the data.
4. Save the file by pressing "Ctrl KD" and resume regular PASSER II-87 program execution.
5. Type "P287AI" to proceed with program execution.

B. Using EDLIN:

1. Type "EDLIN B: file name".
2. When "*" appears, type "LIST".
3. Replace a whole line of data by typing the line number. and the corrected data. Repeat as necessary.
4. Type "E" to save the modified data.
5. Resume regular PASSER II-87 program execution.
6. Type "P287AI" to proceed with the program execution.

C. Using TURBO:

1. Type "TURBO".
2. Modify data by specifying the data files name.
3. Modify without changing or inserting extra spaces in the data.
4. Save the file by pressing "Ctrl KD" and "Save" to resume regular PASSER II-87 program execution.
5. Type "P287AI" to proceed with the program execution.

D. Using PE:

1. Type "PE".

2. Modify data by specifying "Edit" or "E" at the command line.

3. Modify without changing or inserting extra spaces in the data.

4. Save the file by pressing "ESC" and "FILE" to resume regular PASSER II-87 program execution.

5. Type "P287AI" to proceed with the program execution.

OPERATIONAL EFFICIENCY

To facilitate the speed and efficiency of the PASSER II-87 program runs, the following actions are highly recommended for IBM PC/XT/AT or compatible microcomputers.

Use Subdirectories

The user may tap the power of DOS's tree-structured directory system to help the user manage the work. Subdirectories may be used to help the user setup the hard disk files just as filing folders do in paper files. It is recommended to create a separate subdirectory to contain each application program and each work problem. The current directory is displayed with the DOS **PROMPT PG** command. Don't clutter the root directory - this slows the DOS down and makes operation more complicated than necessary. In the root, there should be only the four essential DOS files: COMMAND.COM, ANSI.SYS, AUTOEXEC.BAT, CONFIG.SYS, and subdirectories. Additional subdirectories, as recommended in Figure 28, can be managed through three simple DOS commands, MKDIR, CHDIR, RMDIR, for efficiently creating, switching, and removing subdirectories. It is highly recommended to create the CONFIG.SYS file to use "DEVICE=ANSI.SYS, FILES=20, BUFFERS=40" to speed up program operation.

Use BAT Files and the PATH Commands

After using the subdirectory structure to organize the files stored on the hard disk, it is also important to retain the freedom to run other application programs for further data reduction and analysis. For example, it is recommended to create three standard subdirectories: \BAT for batch files, \DOS for the DOS programs, and \UTIL for preferred utility programs. Place these three subdirectory names in the PATH of the AUTOEXEC.BAT file using the DOS command **PATH = C:\BAT;C:\DOS;C:\UTIL;** - so the user can run any application program in any one of these subdirectories from anywhere on the hard disk. For those programs that are not in one of these standard subdirectories, the user can use small batch files located in C:\BAT to change among the different directories and run the different application programs.

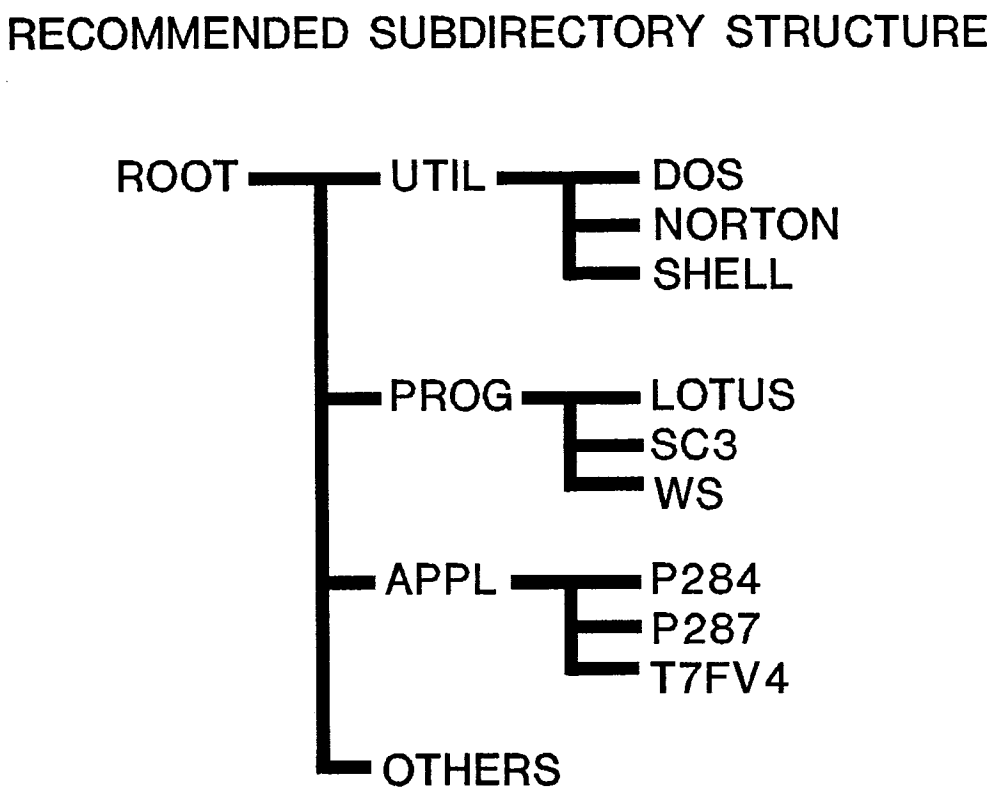


Figure 28. Recommended Subdirectory Structure.

Choose a DOS Shell Program

The normal DOS shell program is COMMAND.COM. Some new users often find it intimidating and uninstructive. Other experts wish it had abilities like file tagging, unerasing, and directory renaming. Many commercial software developers, such as the computer software package developed by Peter Norton and others have developed different Utilities programs, such as XTREE, QDOS, NORTON UTILITY, WordPerfect SHELL, and other commercially available computer utility programs. These programs can be very powerful in preparing the application program menu system and organizing the Disk Operating System (DOS). Many utility programs have gone through several improvements to incorporate many powerful new features, such as the friendly command "integrator" with menus and help screens, new speed benchmarks, and a visual file directory and subdirectory tree.

Routinely Backup and Purge

One of the most important tasks in working with computers or microcomputers is determining how and when to make the routine backup and regular purge for saving and deleting data files and unwanted information. In order to maintain operational efficiency and have the most updated information readily available for reference, the user must design and prepare a **regular backup system and purge plan** for routine microcomputer file system maintenance on those electronically created data. Therefore, it is also necessary to provide routine system backup and file purge for the PASSER II-87 application program. This will always keep all the original data files and the corresponding output files up to date for easy reference on the microcomputers and for efficient and file maintenance operations.

CONCLUSIONS AND RECOMMENDATIONS

PASSER II-87 Microcomputer program Version 1.0 has been developed by TTI for the Texas SDHPT to facilitate arterial signal design and capacity evaluation. The system was developed for use on the IBM PC/XT/AT or compatible microcomputer. Efforts were made to improve the analysis, interpretation, and understanding of PASSER II-87 for both arterial street and individual intersection analysis. The new system has many advantages over the existing PASSER II-84 program currently being distributed. It provides a very user-friendly, menu interface, full-screen cursor movement, and accepts all the existing coded PASSER II-84 data without requiring user modification. If desired, the user can freely modify any embedded data for analysis. In the end, the system will faithfully report all the data being applied in the analysis. PASSER II-87 has been enhanced tremendously to provide the graphical traffic input and the "ASSISTANT" function to help users with the 1985 HCM type capacity analysis. The system can analyze all the commonly available left turn signal treatments either with or without protected left turn phases or protected left turn bays and the "Combined Phase" operation. The new system provides an improved analysis scheme that allow the input of the existing or user-selected timing for arterial capacity evaluation. The PASSER II-87 microcomputer system can provide alternative left turn analysis and advanced capacity evaluation well beyond the Left Turn Analysis Package (LTAP) and the 1985 Highway Capacity Software (HCS) packages.

This "Microcomputer User's Guide" was written to be distributed with the microcomputer program package. It was developed for those users who are already familiar with the PASSER II program and desire to use the PASSER II-87 microcomputer program to analyze arterial signal system design problems. Any questions concerning how the PASSER II-87 program operates or what type of data input it needs will be best answered in the user's manual. Please address all written correspondence or requests to the Texas Department of Highways and Public Transportation, File D-18STO (PASSER II-87), 11th and Brazos Streets, Austin, Texas 78701.

ACKNOWLEDGEMENTS

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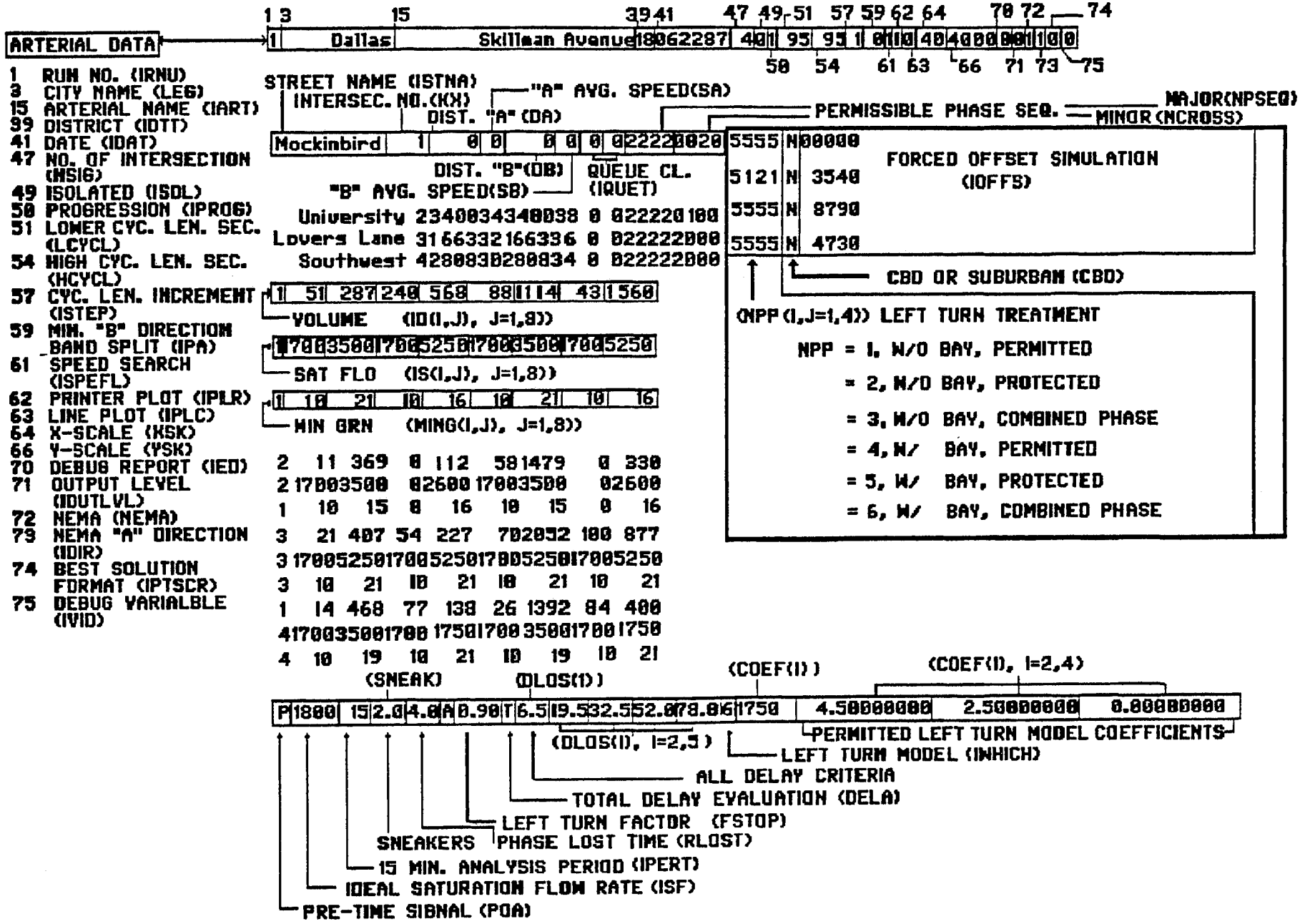
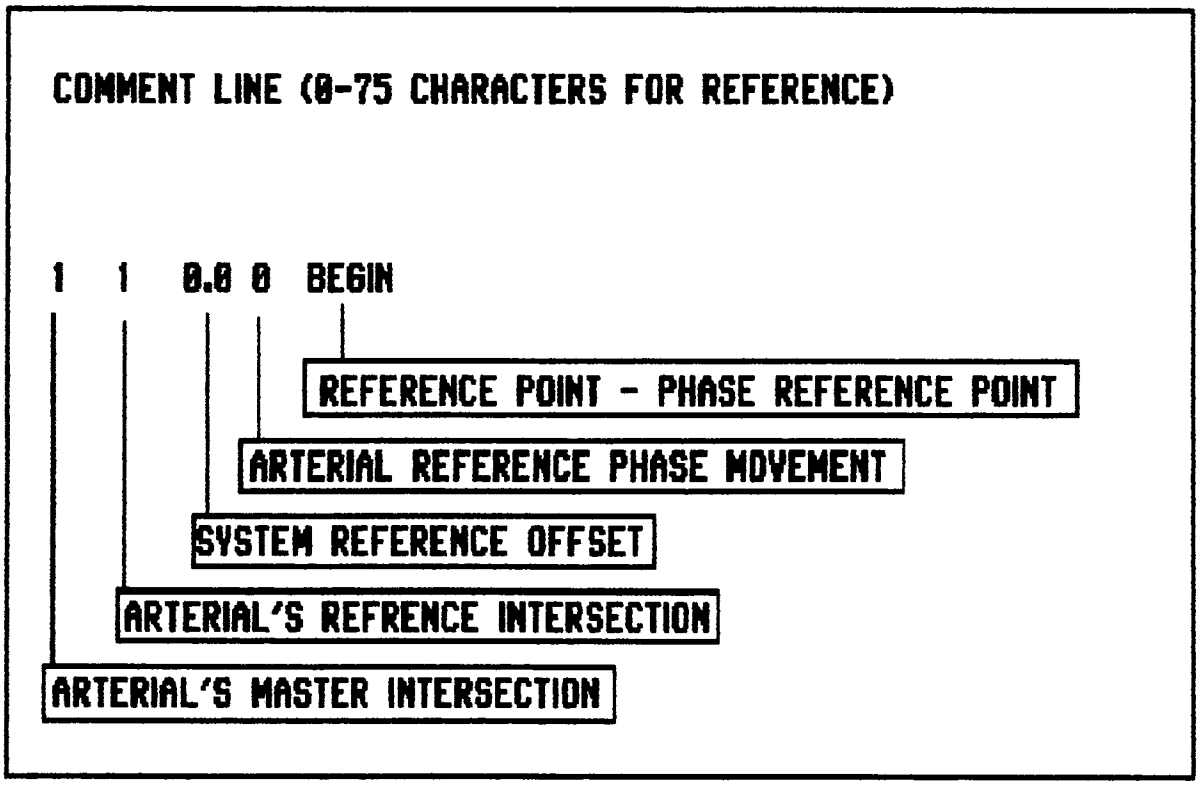
APPENDIX A.

Example Input of PASSER II-87 Program.

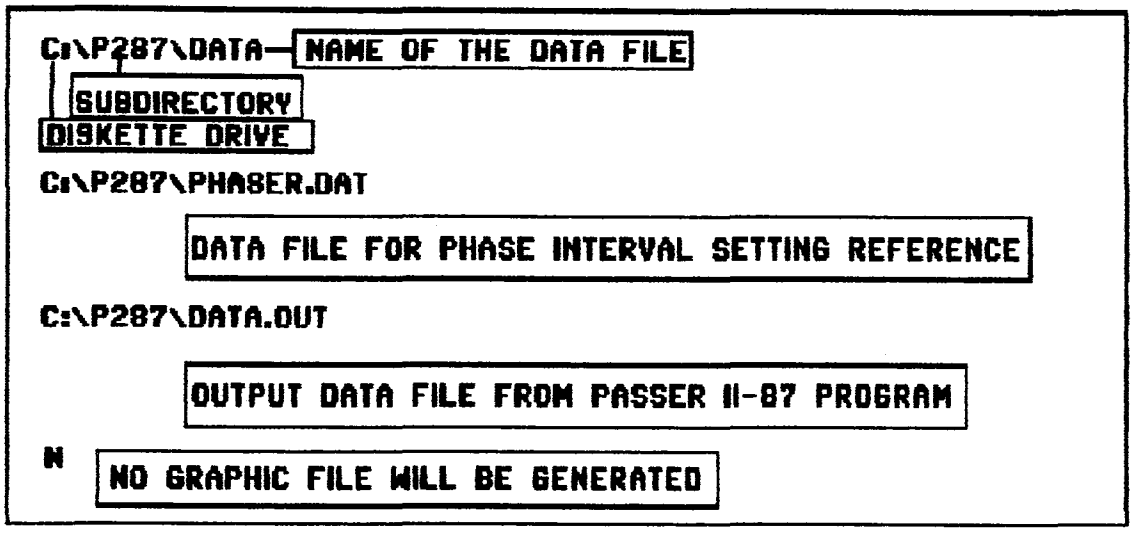
PASSER II-87 DATA FILE NEW



PASSER II-87 DATA FILE (PHASER.DAT)



PASSER II-87 DATA FILE (IOSPEC.DAT)



APPENDIX B.

Example Output of PASSER II-87 Program.

(COVER)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

Dallas Skillman Avenue DISTRICT 18 06/22/87 RUN NO. 1

- PROGRESSION MODE.
- SPEED VARIATION.

**** INPUT DATA SUMMARY ****

NUMBER OF INTERSECTIONS	LOWER CYCLE LENGTH	UPPER CYCLE LENGTH	CYCLE INCREMENT
4	85	95	5

MASTER INTERSECTION	REFERENCE INTERSECTION	REFERENCE POINT	SYSTEMWIDE LOST TIME
1	1	BEGIN	4

(EMBED.DAT)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

TRAFFIC CONTROL TYPE:	LEFT TURN SNEAKERS:	DELAY UNIT:
PRETIMED OPERATION	2.0 VEHICLES	TOTAL DELAY
IDEAL SATURATION FLOW:	PHASE LOST TIME:	LOS DELAY CRITERIA:
1800 PCPHGPL	4.0 SECONDS	A - 6.5 SECS/VEH
		B - 19.5 SECS/VEH
ANALYSIS PERIOD:	LEFT TURN PHASING:	C - 32.5 SECS/VEH
		D - 52.0 SECS/VEH
15 MINUTES	APPROACH-BASED	E - 78.0 SECS/VEH
		F - 78.0 SECS/VEH

PERMITTED LEFT TURN MODEL: (6) TTI MODEL

MODEL COEFFICIENTS:

SO	= Opp Left Turn # (vph) =	1750
B	= 1st Power Coefficient	4.5
C	= 2nd Power Coefficient	2.5
D	= 3rd Power Coefficient	.0

```
(INPUT.DATA)
            TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
PASSER II-87      MULTIPHASE ARTERIAL PROGRESSION - 145101     VER 1.0  JUL 88

                        **** INPUT DATA CONTINUED ****
 ********************************************************************
   **** INTERSECTION  1      Mockingbird
        DISTANCE  0 TO  1     SPEED     DISTANCE  1 TO  0     SPEED
             0. FT             0. MPH        0. FT             0. MPH

        A SIDE QUEUE CLEARANCE          B SIDE QUEUE CLEARANCE
                 0 SECS                          0 SECS

 ARTERIAL PERMISSIBLE PHASE SEQUENCE         CROSS ST PHASE SEQUENCE
  DUAL LEFTS    (1+5)  WITH OVERLAP           LT 3 LEADS   (3+8)
  DUAL THRUS    (2+6)  WITH OVERLAP           WITH OVERLAP
  LT 5 LEADS    (2+5)  WITH OVERLAP
  LT 1 LEADS    (1+6)  WITH OVERLAP

                           ARTERIAL STREET          CROSS STREET
MOVEMENTS      (NEMA)  5[5]    6   1[5]    2   3[5]    4   7[5]     8
VOLUMES        (VPH)    88  1114    51  287   240  568    43   1560
SAT FLOW RATE (VPHG) 1700  3500  1700 3500  1700 5250  1700   5250
MINIMUM PHASE (SEC)    10    21    10   21    10   16    10     16

(INPUT.DATA)
            TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
PASSER II-87      MULTIPHASE ARTERIAL PROGRESSION - 145101     VER 1.0  JUL 88

                        **** INPUT DATA CONTINUED ****
 ********************************************************************
   **** INTERSECTION  2      University
        DISTANCE  1 TO  2     SPEED     DISTANCE  2 TO  1     SPEED
          3400. FT            34. MPH      3400. FT            38. MPH

        A SIDE QUEUE CLEARANCE          B SIDE QUEUE CLEARANCE
                 0 SECS                          0 SECS

 ARTERIAL PERMISSIBLE PHASE SEQUENCE         CROSS ST PHASE SEQUENCE
  DUAL LEFTS    (1+5)  WITH OVERLAP           DUAL THRUS   (4+8)
  DUAL THRUS    (2+6)  WITH OVERLAP             NO OVERLAP
  LT 5 LEADS    (2+5)  WITH OVERLAP
  LT 1 LEADS    (1+6)  WITH OVERLAP

                           ARTERIAL STREET          CROSS STREET
MOVEMENTS      (NEMA)  5[5]    6   1[5]    2   3[1]    4   7[1]     8
VOLUMES        (VPH)    58  1479    11  369     0  112     0    330
SAT FLOW RATE (VPHG) 1700  3500  1700 3500  1800 2600  1800   2600
MINIMUM PHASE (SEC)    10    15    10   15     0   16     0     16
```

(INPUT.DATA)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

**** INPUT DATA CONTINUED ****

****

**** INTERSECTION 3 Lovers Lane

DISTANCE 2 TO 3	SPEED	DISTANCE 3 TO 2	SPEED
1663. FT	32. MPH	1663. FT	36. MPH

A SIDE QUEUE CLEARANCE 0 SECS

B SIDE QUEUE CLEARANCE 0 SECS

ARTERIAL PERMISSIBLE PHASE SEQUENCE

DUAL LEFTS	(1+5)	WITH OVERLAP
DUAL THRUS	(2+6)	WITH OVERLAP
LT 5 LEADS	(2+5)	WITH OVERLAP
LT 1 LEADS	(1+6)	WITH OVERLAP

CROSS ST PHASE SEQUENCE

DUAL LEFTS (3+7) WITH OVERLAP

		ARTERIAL STREET				CROSS STREET			
MOVEMENTS	(NEMA)	5[5]	6	1[5]	2	3[5]	4	7[5]	8
VOLUMES	(VPH)	70	2052	21	407	54	227	100	877
SAT FLOW RATE	(VPHG)	1700	5250	1700	5250	1700	5250	1700	5250
MINIMUM PHASE	(SEC)	10	21	10	21	10	21	10	21

(INPUT.DATA)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

**** INPUT DATA CONTINUED ****

****

**** INTERSECTION 4 Southwest

DISTANCE 3 TO 4	SPEED	DISTANCE 4 TO 3	SPEED
2808. FT	30. MPH	2808. FT	34. MPH

A SIDE QUEUE CLEARANCE 0 SECS

B SIDE QUEUE CLEARANCE 0 SECS

ARTERIAL PERMISSIBLE PHASE SEQUENCE

DUAL LEFTS	(1+5)	WITH OVERLAP
DUAL THRUS	(2+6)	WITH OVERLAP
LT 5 LEADS	(2+5)	WITH OVERLAP
LT 1 LEADS	(1+6)	WITH OVERLAP

CROSS ST PHASE SEQUENCE

DUAL LEFTS (3+7) WITH OVERLAP

		ARTERIAL STREET				CROSS STREET			
MOVEMENTS	(NEMA)	5[5]	6	1[5]	2	3[5]	4	7[5]	8
VOLUMES	(VPH)	26	1392	14	468	77	138	84	400
SAT FLOW RATE	(VPHG)	1700	3500	1700	3500	1700	1750	1700	1750
MINIMUM PHASE	(SEC)	10	19	10	19	10	21	10	21

(ERROR.MSG)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

**** CODING ERROR MESSAGES ****

NO APPARENT CODING ERRORS

(ART.SUMY)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

**** PASSER-87 BEST PROGRESSION SOLUTION SUMMARY ****

Dallas Skillman Avenue DISTRICT 18 06/22/87 RUN NO. 1

CYCLE LENGTH = 95 SECS (MAXIMIN CYCLE = 99 SECS)
EFFICIENCY = .38 (GREAT PROGRESSION)
ATTAINABILITY = 1.00 (INCREASE MIN. THROUGH PHASE)

BAND A = 33 SECS AVERAGE SPEED = 32 MPH
BAND B = 38 SECS AVERAGE SPEED = 36 MPH

NOTE: ARTERIAL PROGRESSION EVALUATION CRITERIA

EFFICIENCY	0.00 - 0.12 -	"POOR PROGRESSION"
	0.13 - 0.24 -	"FAIR PROGRESSION"
	0.25 - 0.36 -	"GOOD PROGRESSION"
	0.37 - 1.00 -	"GREAT PROGRESSION"
ATTAINABLITIY	1.00 - 0.99 -	"INCREASE MIN THRU PHASE"
	0.99 - 0.70 -	"FINE-TUNING NEEDED"
	0.69 - 0.00 -	"MAJOR CHANGES NEEDED"

(INT.SUMY)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

**** INTERSECTION PERFORMANCE SUMMARY ****

CYCLE LENGTH = 95 SECS SYSTEM MAXIMIN CYCLE = 99 SECS

INT NO	CROSS STREET INTERSECTION	PHASE ART	PHASE CRS	MIN. CYCLE	DELAY (SECS)	INTERSECTION V/C RATIO	AVERAGE DELAY (SECS/VEH)	INT NO
1	Mockingbird	3	3	97		.92	34.6	1
2	University	1	2	69		.76	14.3	2
3	Lovers Lane	3	1	87		.88	27.0	3
4	Southwest	4	1	99		.93	32.7	4

NOTE: PHASE SEQUENCE CODE FOR ARTERIAL (ART) CROSS STREET (CRS)

1 - LEFT TURN FIRST	OR DUAL LEFTS LEADING	OR DUAL LEFTS (1+5)
2 - THROUGH FIRST	OR DUAL THRUS LEADING	OR DUAL THRUS (2+6)
3 - LEADING GREEN	OR NO. 5 LEADING	OR LT 5 LEADS (2+5)
4 - LAGGING GREEN	OR NO. 1 LEADING	OR LT 1 LEADS (1+6)

(BEST.SOLN)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

**** BEST SOLUTION.... NEMA PHASE DESIGNATION ****

*** INT. 1 .0 SEC OFFSET ART ST PHASE SEQ IS LT 5 LEADS (2+5)

Mockingbird .0 % OFFSET CROSS ST PHASE SEQ IS LT 3 LEADS (3+8)

	ARTERIAL STREET				CROSS STREET			
CONCURRENT PHASES	2+5	2+6	1+6	TOTAL	3+8	4+8	4+7	TOTAL
PHASE TIME (SECS)	10.1	23.3	15.0	48.4	25.7	10.9	10.0	46.6
PHASE TIME (%)	10.6	24.5	15.8	50.9	27.1	11.5	10.5	49.1
MEASURES OF EFFECTIVENESS								
PHASE (NEMA)	5[5]	6	1[5]	2	3[5]	4	7[5]	8
PHASE DIRECTION	EBLTPR	WBTHRU	WBLTPR	EBTHRU	NBLTPR	SBTHRU	SBLTPR	NBTHRU
PHASE TIME (SEC)	10.1	38.3	15.0	33.4	25.7	20.9	10.0	36.6
V/C-RATIO	.81	.88	.26	.27	.62	.61	.40	.87
LEVEL OF SERVICE	D	E	A	A	B	B	A	E
DELAY (SECS/VEH)	73.4	33.4	38.4	24.7	35.6	37.1	44.5	33.6
LEVEL OF SERVICE	E	C	C	B	C	C	D	C
QUEUE (VEH/LANE)	1.8	10.3	.5	2.0	2.4	5.8	.5	14.5
STOPS (STOPS/HR)	109.	1029.	43.	195.	205.	481.	40.	1387.

TOTAL INTERSECTION DELAY 34.6 SECS/VEH

MINIMUM DELAY CYCLE 97 SECS

(BEST.SOLN)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

**** BEST SOLUTION CONTINUED.... NEMA PHASE DESIGNATION ****

*** INT. 2 25.7 SEC OFFSET ART ST PHASE SEQ IS DUAL LEFTS (1+5)

University 27.1 % OFFSET CROSS ST PHASE SEQ IS DUAL THRUS (4+8)

	ARTERIAL STREET				CROSS STREET			
CONCURRENT PHASES	1+5	1+6	2+6	TOTAL	4+8	3+8	3+7	TOTAL
PHASE TIME (SECS)	10.1	.0	63.9	74.0	21.0	.0	.0	21.0
PHASE TIME (%)	10.6	.0	67.3	77.9	22.1	.0	.0	22.1
MEASURES OF EFFECTIVENESS								
PHASE (NEMA)	5[5]	6	1[5]	2	3[1]	4	7[1]	8
PHASE DIRECTION	EBLTPR	WBTHRU	WBLTPR	EBTHRU	NBLTPM	SBTHRU	SBLTPM	NBTHRU
PHASE TIME (SEC)	10.1	63.9	10.1	63.9	.0	21.0	.0	21.0
V/C-RATIO	.54	.67	.10	.17	.00	.24	.00	.71
LEVEL OF SERVICE	A	B	A	A		A		C
DELAY (SECS/VEH)	48.5	7.4	38.3	6.0	.0	33.4	.0	41.0
LEVEL OF SERVICE	D	A	C	A		C		D
QUEUE (VEH/LANE)	.8	3.0	.1	.6	.0	1.0	.0	3.8
STOPS (STOPS/HR)	57.	685.	10.	113.	0.	88.	0.	300.

TOTAL INTERSECTION DELAY 14.3 SECS/VEH

MINIMUM DELAY CYCLE 69 SECS

(BEST.SOLN)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

**** BEST SOLUTION CONTINUED.... NEMA PHASE DESIGNATION ****

*** INT. 3 91.3 SEC OFFSET ART ST PHASE SEQ IS LT 5 LEADS (2+5)

Lovers Lane 96.1 % OFFSET CROSS ST PHASE SEQ IS DUAL LEFTS (3+7)

	ARTERIAL STREET				CROSS STREET			
CONCURRENT PHASES	2+5	2+6	1+6	TOTAL	3+7	3+8	4+8	TOTAL
PHASE TIME (SECS)	10.0	38.5	11.5	60.0	11.3	2.7	21.0	35.0
PHASE TIME (%)	10.5	40.5	12.1	63.2	11.9	2.8	22.1	36.8
MEASURES OF EFFECTIVENESS								
PHASE (NEMA)	5[5]	6	1[5]	2	3[5]	4	7[5]	8
PHASE DIRECTION	EBLTPR	WBTHRU	WBLTPR	EBTHRU	NBLTPR	SBTHRU	SBLTPR	NBTHRU
PHASE TIME (SEC)	10.0	50.0	11.5	48.5	14.0	21.0	11.3	23.7
V/C-RATIO	.65	.81	.16	.17	.30	.24	.77	.81
LEVEL OF SERVICE	B	D	A	A	A	A	C	D
DELAY (SECS/VEH)	55.1	20.0	41.0	14.5	39.6	33.5	63.5	39.9
LEVEL OF SERVICE	E	B	D	B	D	C	E	D
QUEUE (VEH/LANE)	1.1	11.4	.2	1.6	.6	2.1	1.8	9.7
STOPS (STOPS/HR)	74.	1581.	18.	212.	46.	176.	113.	794.

TOTAL INTERSECTION DELAY 27.0 SECS/VEH

MINIMUM DELAY CYCLE 87 SECS

(BEST.SOLN)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

**** BEST SOLUTION CONTINUED.... NEMA PHASE DESIGNATION ****

*** INT. 4 47.5 SEC OFFSET ART ST PHASE SEQ IS LT 1 LEADS (1+6)

Southwest 50.0 % OFFSET CROSS ST PHASE SEQ IS DUAL LEFTS (3+7)

	ARTERIAL STREET				CROSS STREET			
CONCURRENT PHASES	1+6	2+6	2+5	TOTAL	3+7	3+8	4+8	TOTAL
PHASE TIME (SECS)	10.0	36.3	10.0	56.3	10.0	5.3	23.4	38.7
PHASE TIME (%)	10.5	38.2	10.5	59.3	10.5	5.6	24.6	40.7
MEASURES OF EFFECTIVENESS								
PHASE (NEMA)	5[5]	6	1[5]	2	3[5]	4	7[5]	8
PHASE DIRECTION	EBLTPR	WBTHRU	WBLTPR	EBTHRU	NBLTPR	SBTHRU	SBLTPR	NBTHRU
PHASE TIME (SEC)	10.0	46.3	10.0	46.3	15.3	23.4	10.0	28.7
V/C-RATIO	.24	.89	.13	.30	.38	.39	.79	.88
LEVEL OF SERVICE	A	E	A	A	A	A	C	E
DELAY (SECS/VEH)	42.5	30.8	38.4	14.8	39.4	33.1	70.2	49.8
LEVEL OF SERVICE	D	C	C	B	D	C	E	D
QUEUE (VEH/LANE)	.3	11.9	.1	1.9	.8	1.3	1.6	5.5
STOPS (STOPS/HR)	23.	1250.	13.	243.	66.	110.	101.	415.

TOTAL INTERSECTION DELAY 32.7 SECS/VEH

MINIMUM DELAY CYCLE 99 SECS

(ART.MOE)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

**** TOTAL ARTERIAL SYSTEM PERFORMANCE ****

Dallas Skillman Avenue DISTRICT 18 06/22/87 RUN NO. 1

CYCLE LENGTH = 95 SECS BAND A = 33 SECS BAND B = 38 SECS
AVERAGE PROGRESSION SPEED - BAND A = 32 MPH BAND B = 36 MPH

.38 EFFICIENCY 1.00 ATTAINABILITY

AVERAGE INTERSECTION DELAY	TOTAL SYSTEM DELAY	TOTAL NUMBER VEHICLES
28.2 SECS/VEH	99.5 VEH-HR/HR	12717.

TOTAL SYSTEM FUEL CONSUMPTION	TOTAL SYSTEM STOPS	MAXIMIN CYCLE
347.42 GAL/HR	9973. STOPS	99 SECS

(ART.MOE)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

EFFICIENCY VERSUS CYCLE LENGTH

	CYCLE LENGTH	CUMMULATIVE EFFICIENCY
	85	.33
	90	.38
	95	.38
BEST SOLUTION	95	.38

(PIN.SET)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

**** SUMMARY OF PASSER II-87 BEST SIGNAL TIMING SOLUTION ****

Dallas Skillman Avenue DISTRICT 18 06/22/87 RUN NO. 1

CYCLE = 95. SECONDS (A) BAND COORDINATE (B)

DEFAULT(1) : SAME MASTER & REF INT, OFFSET TO BEGINNING OF MAIN STREET GREEN

MAST INT = 1 REF INT = 1 REF OFFSET = .0 REF MOVMNT = 0 REF PNT = BEGIN

*-[MASTER AND REFERENCE INTERSECTION]

INTRSC 1 OFFSET	2+5	2+6	1+6	3+8	4+8	4+7	BEGIN	END	BEGIN	END
PIN (SEC) .0	10.1	23.3	15.0	25.7	10.9	10.0	.0	33.4	200.1	238.4
PIN (%) .0	10.6	24.5	15.8	27.1	11.5	10.5	.0	35.2	210.6	250.9
PIN SET (SEC) .0	10.1	33.4	48.4	74.1	85.0		.0	33.4	200.1	238.4
PIN SET (%) .0	10.6	35.2	50.9	78.0	89.5		.0	35.2	210.6	250.9

INTRSC 2 OFFSET	1+5	1+6	2+6	4+8	3+8	3+7	BEGIN	END	BEGIN	END
PIN (SEC) 25.7	10.1	.0	63.9	21.0	.0	.0	66.2	99.6	140.7	179.0
PIN (%) 27.1	10.6	.0	67.3	22.1	.0	.0	69.7	104.8	148.1	188.4
PIN SET (SEC) 25.7	35.8	35.8	4.7	25.7	25.7		66.2	99.6	140.7	179.0
PIN SET (%) 27.1	37.7	37.7	4.9	27.1	27.1		69.7	104.8	148.1	188.4

(PIN.SET)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

DEFAULT(1) : SAME MASTER & REF INT, OFFSET TO BEGINNING OF MAIN STREET GREEN

INTRSC 3 OFFSET	2+5	2+6	1+6	3+7	3+8	4+8	BEGIN	END	BEGIN	END
PIN (SEC) 91.3	10.0	38.5	11.5	11.3	2.7	21.0	100.5	133.9	110.1	148.4
PIN (%) 96.1	10.5	40.5	12.1	11.9	2.8	22.1	105.8	140.9	115.9	156.2
PIN SET (SEC) 91.3	6.3	44.8	56.3	67.6	70.3		100.5	133.9	110.1	148.4
PIN SET (%) 96.1	6.6	47.2	59.3	71.2	74.0		105.8	140.9	115.9	156.2

INTRSC 4 OFFSET	1+6	2+6	2+5	3+7	3+8	4+8	BEGIN	END	BEGIN	END
PIN (SEC) 47.5	10.0	36.3	10.0	10.0	5.3	23.4	162.2	195.6	55.5	93.8
PIN (%) 50.0	10.5	38.2	10.5	10.5	5.6	24.6	170.7	205.9	58.4	98.7
PIN SET (SEC) 47.5	57.5	93.8	8.8	18.8	24.1		162.2	195.6	55.5	93.8
PIN SET (%) 50.0	60.5	98.7	9.3	19.8	25.4		170.7	205.9	58.4	98.7

(PIN.SET)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

**** SUMMARY OF PASSER II-87 BEST SIGNAL TIMING SOLUTION ****

Dallas Skillman Avenue DISTRICT 18 06/22/87 RUN NO. 1

CYCLE = 95. SECONDS (A) BAND COORDINATE (B)

DEFAULT(2) : SAME MASTER & REF INT, OFFSET TO BEGINNING OF NEMA PHASE 2

MAST INT = 1 REF INT = 1 REF OFFSET = .0 REF MOVMNT = 2 REF PNT = BEGIN

*-[MASTER AND REFERENCE INTERSECTION]

INTRSC 1 OFFSET		2+5	2+6	1+6	3+8	4+8	4+7	BEGIN	END	BEGIN	END
PIN (SEC)	.0	10.1	23.3	15.0	25.7	10.9	10.0	.0	33.4	200.1	238.4
PIN (%)	.0	10.6	24.5	15.8	27.1	11.5	10.5	.0	35.2	210.6	250.9
PIN SET (SEC)		.0	10.1	33.4	48.4	74.1	85.0	.0	33.4	200.1	238.4
PIN SET (%)		.0	10.6	35.2	50.9	78.0	89.5	.0	35.2	210.6	250.9

INTRSC 2 OFFSET		1+5	1+6	2+6	4+8	3+8	3+7	BEGIN	END	BEGIN	END
PIN (SEC)	25.7	10.1	.0	63.9	21.0	.0	.0	66.2	99.6	140.7	179.0
PIN (%)	27.1	10.6	.0	67.3	22.1	.0	.0	69.7	104.8	148.1	188.4
PIN SET (SEC)		15.6	25.7	25.7	89.6	15.6	15.6	76.3	109.7	150.8	189.1
PIN SET (%)		16.4	27.1	27.1	94.3	16.4	16.4	80.3	115.5	158.7	199.1

(PIN.SET)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

DEFAULT(2) : SAME MASTER & REF INT, OFFSET TO BEGINNING OF NEMA PHASE 2

INTRSC 3 OFFSET		2+5	2+6	1+6	3+7	3+8	4+8	BEGIN	END	BEGIN	END
PIN (SEC)	91.3	10.0	38.5	11.5	11.3	2.7	21.0	100.5	133.9	110.1	148.4
PIN (%)	96.1	10.5	40.5	12.1	11.9	2.8	22.1	105.8	140.9	115.9	156.2
PIN SET (SEC)		91.3	6.3	44.8	56.3	67.6	70.3	100.5	133.9	110.1	148.4
PIN SET (%)		96.1	6.6	47.2	59.3	71.2	74.0	105.8	140.9	115.9	156.2

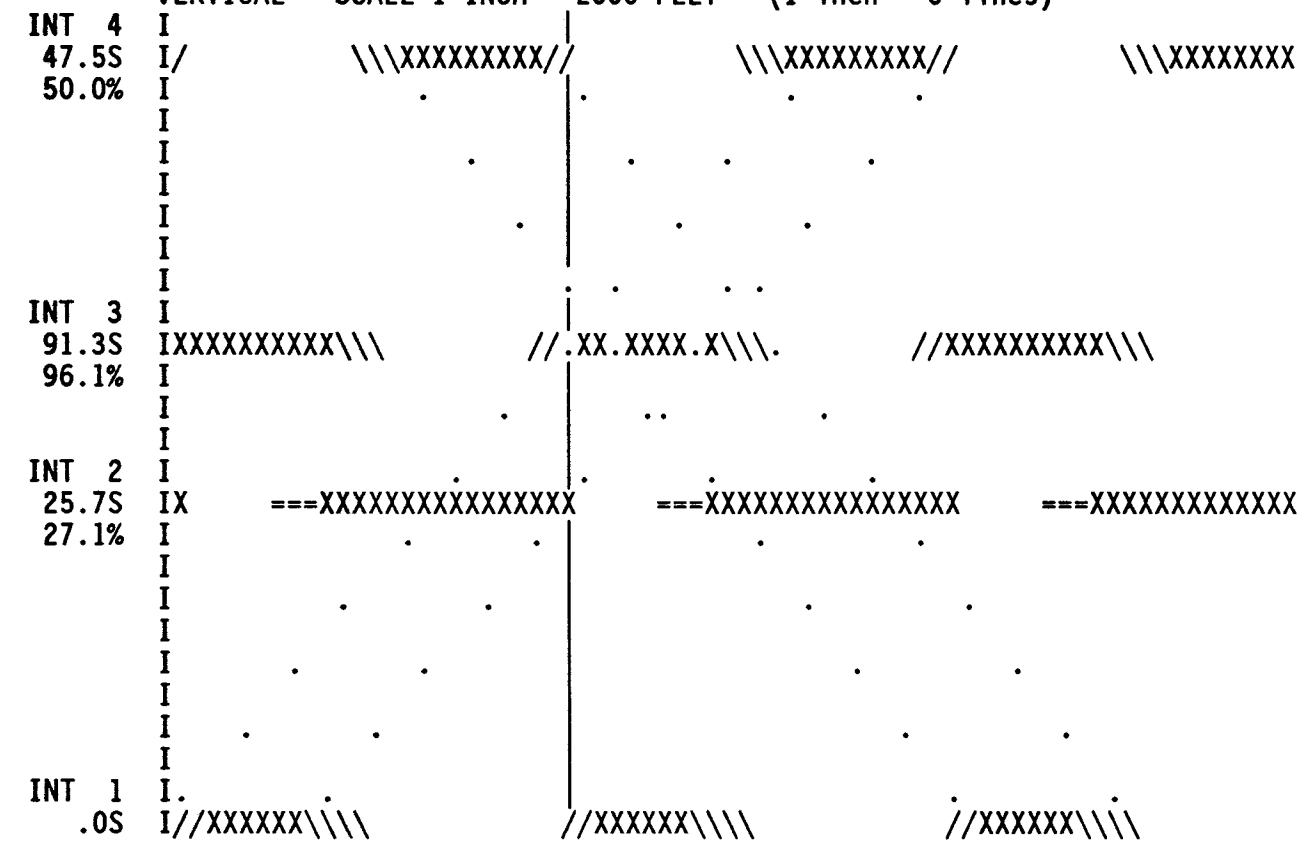
INTRSC 4 OFFSET		1+6	2+6	2+5	3+7	3+8	4+8	BEGIN	END	BEGIN	END
PIN (SEC)	47.5	10.0	36.3	10.0	10.0	5.3	23.4	162.2	195.6	55.5	93.8
PIN (%)	50.0	10.5	38.2	10.5	10.5	5.6	24.6	170.7	205.9	58.4	98.7
PIN SET (SEC)		37.5	47.5	83.8	93.8	8.8	14.1	172.2	205.6	65.5	103.8
PIN SET (%)		39.5	50.0	88.2	98.7	9.3	14.8	181.3	216.4	68.9	109.3

(TS.DIAGM)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-87 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 JUL 88

RUN NO 1 DISTRICT 18 Skillman Avenue 06/22/87 CYCLE = 95 SECONDS
HORIZONTAL SCALE 1 INCH = 40 SECS (1 inch = 10 characters)
VERTICAL SCALE 1 INCH = 2000 FEET (1 inch = 6 lines)



/A/
32 MPH
33 SECOND BAND

\B\
36 MPH
38 SECOND BAND

=== DUAL LEFTS (1+5)
/// LT 5 LEADS (2+5)

XXX DUAL THRUS (2+6)
\\\ LT 1 LEADS (1+6)