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16. Abstract <p>PASSER II-90 microcomputer program version 1.0 has been developed and is now available for public distribution. PASSER II can assist transportation professionals in (1) isolated intersection timing evaluation, (2) progression timing optimization, (3) "existing" timing evaluation, and (4) visualization of the signal timing results. The system contains the latest PASSER II features, advanced 1985 Highway Capacity Manual (HCM) analysis, Expert Systems design, and microcomputer graphics visual simulation. PASSER II-90 can analyze signal operations with "Permitted," "Protected," and permitted/protected or protected/permitted left turn signal treatments. The microcomputer system will be distributed with an intelligent, user-friendly, menu-driven input/output processor with the executable main program, optional help information, dynamic arterial visualization system, and a program user's manual. The new program provides enhanced analysis tools, outputs improved signal timing reports, allows the user to modify all embedded data, accepts all existing coded PASSER II, PASSER II-84, or PASSER II-87 data, and allows data file exchange with TRANSYT-7F through the FHWA's new Arterial Analysis Package (AAP). The PASSER II-90 microcomputer traffic engineering package can significantly improve arterial evaluation, signal design, and progression analysis.</p>					
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ARTERIAL SIGNAL TIMING OPTIMIZATION USING PASSER II-90

- PROGRAM USER'S GUIDE -

by

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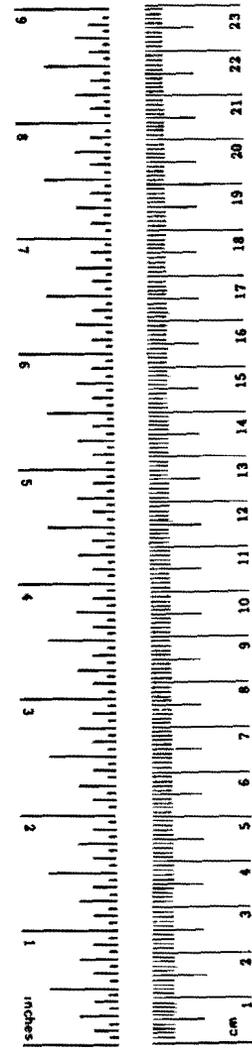
Texas Department of Transportation

June 1991

METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	2.54	millimetres	mm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km



Symbol	When You Know	Multiply By	To Find	Symbol
AREA				
in ²	square inches	645.2	millimetres squared	mm ²
ft ²	square feet	0.0929	metres squared	m ²
yd ²	square yards	0.836	metres squared	m ²
mi ²	square miles	2.59	kilometres squared	km ²
ac	acres	0.395	hectares	ha

Symbol	When You Know	Multiply By	To Find	Symbol
MASS (weight)				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg

Symbol	When You Know	Multiply By	To Find	Symbol
VOLUME				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft ³	cubic feet	0.0328	metres cubed	m ³
yd ³	cubic yards	0.0765	metres cubed	m ³

NOTE: Volumes greater than 1000 L shall be shown in m³.

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

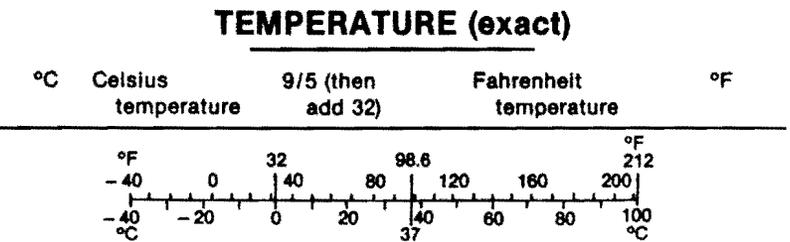
APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi

Symbol	When You Know	Multiply By	To Find	Symbol
AREA				
mm ²	millimetres squared	0.0016	square inches	in ²
m ²	metres squared	10.764	square feet	ft ²
km ²	kilometres squared	0.39	square miles	mi ²
ha	hectares (10 000 m ²)	2.53	acres	ac

Symbol	When You Know	Multiply By	To Find	Symbol
MASS (weight)				
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T

Symbol	When You Know	Multiply By	To Find	Symbol
VOLUME				
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m ³	metres cubed	35.315	cubic feet	ft ³
m ³	metres cubed	1.308	cubic yards	yd ³



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

* SI is the symbol for the International System of Measurements

ABSTRACT

PASSER II-90 microcomputer program version 1.0 has been developed and is now available for public distribution. PASSER II can assist transportation professionals in (1) isolated intersection timing evaluations, (2) progression timing optimization, (3) "existing" timing evaluations, and (4) visualization of the signal timing results. The system contains the latest PASSER II features, advanced 1985 Highway Capacity Manual (HCM) analysis, Expert Systems design, and microcomputer graphics visual simulation. PASSER II-90 can analyze signal operations with "Permitted," "Protected," and permitted/protected or protected/permitted "Combined Phase" left turn signal treatments. The microcomputer system will be distributed with an intelligent, user-friendly, menu-driven input/output processor with the executable main program, optional help information, dynamic arterial visualization system, and program user's manual. The new program provides enhanced analysis tools, outputs improved signal timing reports, allows the user to modify all embedded data, accepts all existing coded PASSER II, PASSER II-84, or PASSER II-87 data, and allows data exchange with TRANSYT-7F through the FHWA's new Arterial Analysis Package (AAP). The PASSER II-90 microcomputer traffic engineering package can significantly improve arterial evaluation, signal design, and progression analysis.

KEY WORDS:

Traffic Signal, Signalization
Arterial Progression, Optimization
Left Turn Treatments, Permitted Left
Turn Model, Expert Systems
PASSER

SUMMARY

Many computerized traffic analysis packages have been developed to improve intersection operations and arterial progression. The Texas Transportation Institute has developed PASSER (Progression Analysis and Signal System Evaluation Routine). This program is constantly being improved to assist in traffic engineering analysis for the Texas Department of Transportation (TxDOT). Several versions of PASSER II, including PASSER II-80, PASSER II-84, and PASSER II-87, have been developed and enhanced since the 1970's. Recently enhanced under Texas HPR Study 2-18-86-467, PASSER II-90 contains the latest developments in the PASSER II system. PASSER II-90 contains signalized left turn analysis, updated arterial progression, advanced highway capacity evaluation, improved fuel consumption estimation, interactive input/output assistance, help information, dynamic graphics simulator, and program documentation. In addition to regular time-space diagram outputs, the user can also select the dynamic simulator to observe animation of arterial signal coordination and traffic operations. PASSER II-90 has been enhanced to interface with FHWA's new Arterial Analysis Package (AAP) to allow data exchange with the TRANSYT-7F Release 6 program. This computerized traffic engineering package can significantly improve arterial evaluation, signal designs, and progression analysis.

IMPLEMENTATION

This report provides a program user's guide for applying the PASSER II-90 model to achieve better progression of traffic flow along arterial signal systems. A user-friendly software system and user's manual have been developed. This research effort developed computerized evaluation tools for assessing the operational, environmental, and economic impacts 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 emissions. Improvements in traffic safety due to fewer left turn accidents are also expected.

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DISCLAIMER

This program was developed under Texas State HP&R 2-18-86-467 study by the Texas Transportation Institute of the 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 having up to twenty (20) intersections. User comments are welcomed at (409) 845-9873.

Copyright restrictions are made on copying and distributing this program. Care should be taken to make sure the program package, which includes the user documentation, remains together. If the package elements become separated, program effectiveness may be impaired severely.

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TABLE OF CONTENTS

	<u>Page</u>
1. INTRODUCTION.	1-1
Features.	1-1
Implementation.	1-3
System Highlights.	1-3
Guide to User's Manual	1-3
2. PASSER II-90 MICROCOMPUTER SYSTEM	2-1
Traffic Control Input Data.	2-1
Cycle Length.	2-1
Phase Designation	2-3
Phase Sequences	2-5
Left Turn Treatment	2-6
Interval and Phase Length	2-10
Coordination Offset	2-12
Embedded Data.	2-12
Phaser Data Input.	2-16
System Design	2-16
System Operations.	2-18
System Files	2-18
Batch Files	2-18
Configuration Files	2-18
Executable Files.	2-19
Input and Output Files.	2-19
System Help Information	2-20
Installation Procedure.	2-20
System Preparation.	2-20
Backup Diskette	2-21
Backup Data	2-21
Program Installation	2-21
Floppy Disk Operation	2-21
Hard Disk Operation	2-22
System Error Recovery	2-22
3. PROGRAM OPERATIONS	3-1
Menu Structure	3-1
Main Menu.	3-1
Load Data File.	3-1
Store Data File	3-1
Execute Program	3-5
Input Menu	3-5
New Data.	3-5

	Embedded Data	3-7
	Phaser Data	3-13
	Edit Menu	3-13
	Arterial System	3-13
	Intersection Information.	3-13
	System Maintenance.	3-16
	Output Menu.	3-16
	Review Output	3-16
	Print Output	3-19
	Animation	3-19
	Assistant Functions	3-20
	Left Turn Bay	3-24
	Traffic Volume.	3-24
	Volume Calculation.	3-24
	Saturation Flow Rate.	3-27
	Minimum Phase Time.	3-27
	Help Information.	3-27
	Basic Keyboard Instructions	3-27
	System Help Instructions.	3-29
	DOS Shell Functions	3-29
4.	OUTPUT INTERPRETATION	4-1
	Cover Page (COVER).	4-1
	Embedded Data (EMBED.DAT)	4-1
	Input Data Echo (INPUT.DAT)	4-3
	Error Messages (ERROR.MSG).	4-3
	Type I. Error Messages	4-5
	Type II. Warnings	4-6
	Arterial Summary (ART.SUMY)	4-6
	Intersection Summary (INT.SUMY)	4-8
	Best Solution (BEST.SOLN)	4-8
	System Performance (ART.MOE).	4-10
	Intersection Signal Settings (PIN.SET).	4-12
	Time-Space Diagram (TS.DISGM)	4-14
	Animation (LEART)	4-16
	Traffic Modeling	4-16
	Vehicle Representation.	4-18
	System Statistics	4-18
	Cumulative Statistics	4-18

	Simulation Assumptions.	4-19
	Model Limitations	4-19
5.	ADDITIONAL CONSIDERATIONS	5-1
	Left Turn Treatments.	5-1
	Data Input.	5-1
	Phase Pattern Selection	5-3
	Left Turn Phase Sequence	5-3
	Summary of Operating Procedures	5-5
	Changing Left Turn Treatment to Permitted w/o Bays	5-5
	Changing Left Turn Treatment to Protected w/o Bays	5-6
	Changing Left Turn Treatment to Pro./Per. w/o Bays	5-7
	Changing Left Turn Treatment to Permitted with Bays.	5-8
	Changing Left Turn Treatment to Protected with Bays.	5-9
	Changing Left Turn Treatment to Pro./Per. with Bays.	5-10
	Simulation.	5-11
	Operational Efficiency.	5-13
	Subdirectory Structure.	5-13
	Batch File and Path Statement	5-13
	Routinely Backup and Purge.	5-13
6.	CONCLUSIONS AND RECOMMENDATIONS	5-14
7.	REFERENCES.	5-15

APPENDIX A.

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1-1. Functional Applications.	1-2
2-1. PASSER II-90 Phase Numbering System.	2-4
2-2. Signal Phase Definitions	2-7
2-3. Allowable Phase Sequences.	2-8
2-4. Left Turn Phase Operations	2-9
2-5. Signal Control Parameters	2-11
2-6. Progression Time-Space Diagram	2-13
2-7. System File Structure.	2-17
2-8. Disclaimer Screen.	2-23
2-9. System Installation Routine.	2-24
3-1. Example Data, Skillman Avenue.	3-2
3-2. PASSER II-90 Menu Structure.	3-3
3-3. Main Menu.	3-4
3-4. Input Menu	3-6
3-5. Data Input Sequence.	3-6
3-6. Intersection Movement Screen	3-8
3-7. Phase Sequence Selection	3-9
3-8. Permitted Phase Sequences.	3-10
3-9. Arterial Geometry Data	3-11
3-10. Embedded Data.	3-12
3-11. Phaser Data.	3-14
3-12. Edit Menu.	3-15
3-13. System Maintenance	3-17
3-14. Output Menu.	3-18
3-15. Print Menu	3-18
3-16. General Help Information	3-21
3-17. Arterial Help Information.	3-21
3-18. PVG Cumulative Statistics	3-22
3-19. DELAY Cumulative Statistics.	3-22
3-20. LEART Main Menu.	3-23
3-21. Assistant Function for Left Turn Movement.	3-25
3-22. Assistant Function for Through Movement	3-26
4-1. Cover Page	4-2
4-2. Embedded Data.	4-2
4-3. Input Data Echo.	4-4
4-4. Error Message.	4-4
4-5. Arterial Summary	4-7
4-6. Intersection Summary	4-7
4-7. Intersection Best Solution	4-9
4-8. Arterial System Performance.	4-11
4-9. Comparisons of Efficiency and Cycle Length	4-11
4-10. Intersection Signal Settings	4-13
4-11. Time-Space Diagram	4-15

4-12.	Dynamic Simulator.	4-17
5-1.	Signal Timing Methodology.	5-2
5-2.	Allowed Signal Phase Sequences	5-4
5-3.	Example of Simulation Run, Skillman Avenue	5-12

LIST OF TABLES

<u>Table</u>	<u>Page</u>
2-1. Summary of Input Data Requirements	2-2
3-1. Approximate Saturation Flow Rate	3-28

1. INTRODUCTION

PASSER is an acronym for Progression Analysis and Signal System Evaluation Routine. PASSER II is a microcomputer program that can assist traffic engineers in analyzing both individual signalized intersection and progression operations along an arterial street. The program can simulate existing timings or optimize a proposed signalization problem having a wide range of user-specified options. A unique feature of PASSER II is its optimization of multiphase traffic signals having variable phase sequences. PASSER II-90 also provides quality animation of the signal timing results.

Texas Transportation Institute of the Texas A&M University System developed the basic optimization theory in 1971 during the Dallas Corridor Project sponsored by the Federal Highway Administration (FHWA) of U. S. DOT. With additional support from the Texas State Department of Highways and Public Transportation (SDHPT), PASSER II was developed in 1974. This program was originally developed for application on mainframe computer systems and was later converted completely to microcomputer operations for the Texas SDHPT. PASSER II-80, PASSER II-84, and PASSER II-87 are later versions of PASSER II, released in 1980, 1984, and 1987, respectively. PASSER II-90 is the latest revision of PASSER II and contains the latest enhancements.

FEATURES

Figure 1-1 illustrates the functional applications of PASSER II-90. Much of the input data required is similar to other computerized signal timing programs. To analyze individual signalized intersections, both turning movements and saturation flow rates are needed. To perform a progression analysis, minimum phase times for each movement must be provided, along with the intersection distances, link progression speeds, and allowable coordination background cycle times. The user can also analyze existing system operations for given sets of signal timing parameters.

PASSER II calculates almost all timing information needed for field implementation. Recommended cycle lengths and green splits are calculated from Webster's method. It uses travel time to find the optimal coordination offsets that maximize arterial progression bandwidths. Alternative phase sequences are examined using heuristic time-space relationships. An offset fine-tuning algorithm examines all slack times and automatically adjusts the progression offsets for improved arterial operation. The program can provide optimal timing plans for signal operations ranging from a simple two-phase signal sequence to multiphasing arrangements.

PASSER II arterial progression optimization can analyze up to 20 intersections per arterial. The program selects the best available phase sequence at each intersection to maximize overall arterial progression. After selecting the optimum phase sequences, phase interval lengths and progression offsets are calculated. Measures of effectiveness are calculated for each traffic movement to evaluate the level of service. Optimum progression time-space diagrams are provided. PASSER II-90 can graphically illustrate the signal timing results of arterial signal coordination.

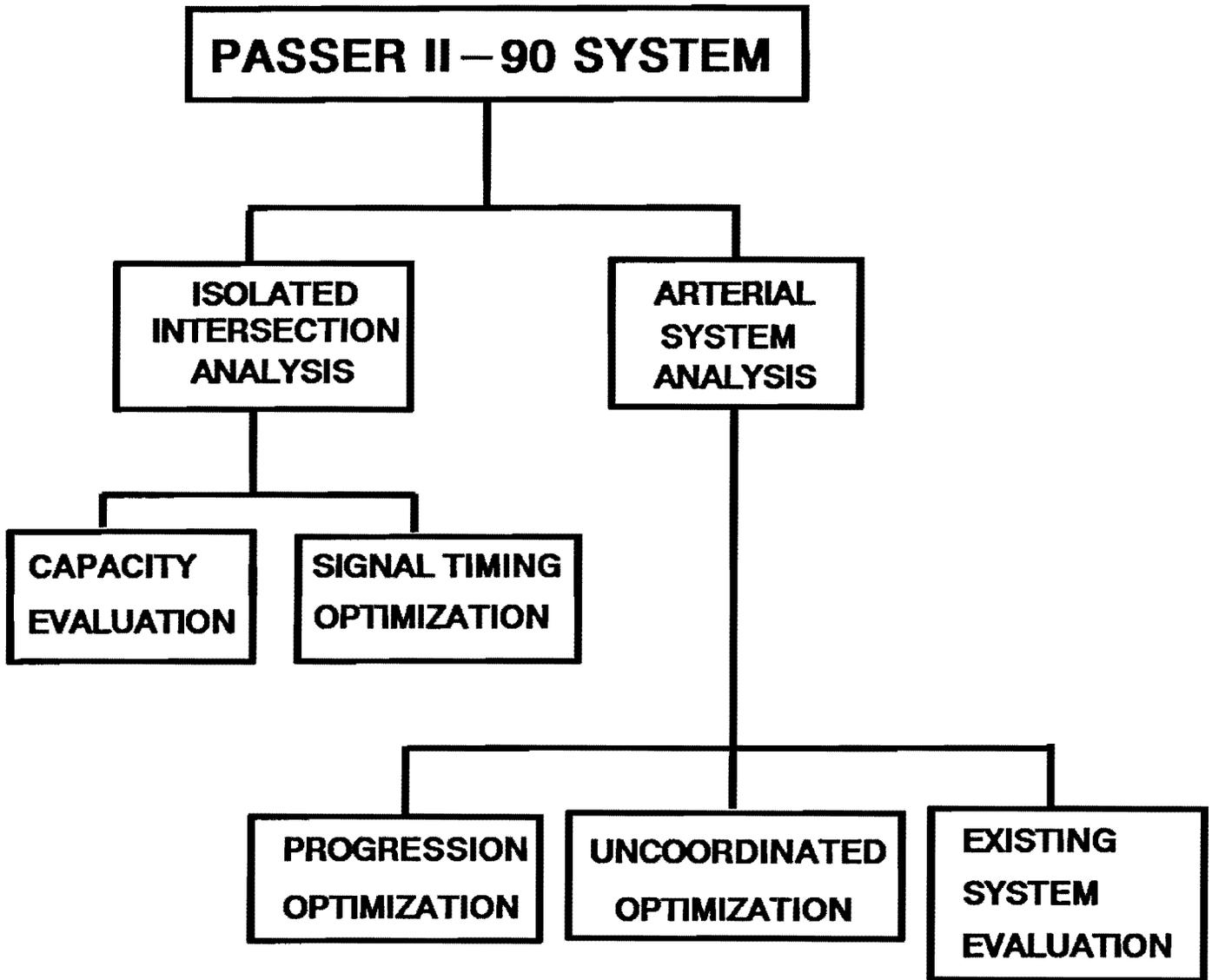


Figure 1-1. Functional Applications.

IMPLEMENTATION

PASSER II-90 can be effectively used for arterial progression signal timing optimization, existing system evaluation, and intersection capacity analysis. It is a complete, stand-alone, microcomputer package. As an engineering tool, it calculates the background cycle length, green timings, phase sequence, and coordination offsets for multiphase signal systems. The generated solutions can produce minimal delay and provide good arterial progression for the given geometric, traffic, and signal control conditions.

To time an arterial, make initial runs for the AM peak, PM peak, and Off-peak traffic conditions. This allows the user to determine which phasing sequences provide the best overall progression. The user may also run a "preferred" phasing sequence for each time period to examine the potential loss in progression that may occur when using only the preferred sequence at each intersection. If the arterial control system provides only one phase sequence per intersection, then a final phase sequence must be selected. If a phase sequence was selected for all three runs, use it in the final solution runs. Conduct final AM, PM, and Off-peak program runs after studying all previous results. Finally, make on-site field observations of the progression solutions and fine-tune the operational signal timing plans to improve flow.

SYSTEM HIGHLIGHTS

PASSER II-90 was developed by the Texas Transportation Institute (TTI) for the Texas Department of Transportation (TxDOT). The system is designed for use on IBM PC/XT/AT/386 or compatible microcomputers. This new system provides user-friendly, menu interface, full-cursor movements; accepts existing data files; and allows users to modify embedded data. The program allows graphical traffic input and provides an "ASSISTANT" function to prepare data for the 1985 HCM-type intersection capacity analysis. The program can analyze all common left turn signal treatments. These include optional "Protected plus Permitted" or "Permitted plus Protected" left turn signal phasing schemes, with or without a protected left turn bay or phase. The system can evaluate existing or user-selected arterial signal offsets. The program generates an improved user-specified intersection controller signal setting report, progression bandwidth coordinates, enhanced time-space diagram, and a dynamic arterial visualization system.

GUIDE TO USER'S MANUAL

This "Program User's Manual" was written to assist users in operating the PASSER II-90 microcomputer system. This manual is divided into five sections:

- o Microcomputer System - input data, system design, and installation,
- o Program Operations - menu structure and help information,
- o Output Interpretation - interpretation of program outputs,
- o Additional Operations - left turn treatment, simulation, controller settings, and operation efficiency, and
- o Data Description - detailed description of data files.

2. PASSER II-90 MICROCOMPUTER SYSTEM

PASSER II-90 can analyze both individual signalized intersections and arterial systems. It was designed for analyzing signal operations with or without separate protected left turn lanes and protected left turn phases. PASSER II has received widespread use because of its ability to select multiple phase sequences for maximum arterial progression. In the optimization process, it varies the signal phasing sequence and offset at each intersection concurrently with the needed cycle and progression speed changes to find the optimal timing plan that maximizes the arterial progression bands and minimizes total arterial system delay. In the simulation process, the system can be used to evaluate existing traffic signal control conditions.

TRAFFIC CONTROL INPUT DATA

The input data requirements and source of information for developing the PASSER II-90 input data are summarized in Table 2-1. These input include network data, speed data, volume data, timing data, and control data. The following section focuses on the definitions of eight signal timing parameters that are used to specify signal timing and traffic control.

- o Cycle Length
- o Phase Designation
- o Phase Sequence
- o Left Turn Treatment
- o Interval and Phase Length
- o Coordination Offset
- o Embedded Data
- o Phaser Data

CYCLE LENGTH

Cycle length is the time period showing the complete sequence of signal indications. In a coordinated signal system, the cycle length must be some multiple of a constant time period for all signals. Coordinated operations are usually needed during certain control periods, such as the AM, PM, or OFF peak periods. This is true whether the intersection uses pretimed or actuated signal controllers. It is important to point out that a full-actuated controller under coordinated control may often be operated as a semi-actuated controller with a coordinated background system cycle length.

PASSER II-90 assumes that all intersections operate on a common background cycle length. Therefore, double cycling cannot be evaluated. The model can select the best progression cycle length for arterial progression from a given range of values, or develop a timing plan for a given cycle length. The program permits the engineer to determine an overall solution without manual calculations. Several program runs may be needed before the final solution set is produced. Engineering judgment is frequently required in selecting the best cycle length to avoid side-street queue backup, link oversaturation, and wasted green time.

TABLE 2-1. SUMMARY OF INPUT DATA REQUIREMENTS.

MAJOR DATA CATEGORY	INPUT DATA TYPE	SOURCE OF INFORMATION
Network Data	Intersection Street names Intersection Spacing	Maps, Drawing Arterial photographs Field measurements
Speed Data	Post speed limit 85th percentile speed Floating car study	Field study
Volume Data	Total traffic volumes Turning movement counts	Field study
Timing Data	Left turn treatment Permissive phase sequence Number of phases Minimum phase times Existing cycle length (Optional) Existing phase sequence (Optional) Existing split (Optional) Existing offset (Optional)	Timing plan Field study
Control Data	Program control options Embedded parameters Bandwidth weighting Queue clearance time	User specified values

Selecting the most suitable cycle length is one single most important decision needed during signal coordination analysis. All intersections in the progressive system must operate on the same background cycle length. No double cycling is permitted in PASSER II-90 analysis. Judgmental tradeoffs may need to be made between the overall progression quality and total system delay. PASSER II-90 can automatically examine a range of cycle lengths and select the one providing the best progression. However, total arterial delay is highly dependent on the cycle length selected. Consequently, the cycle range should be chosen carefully to minimize the system delay and fuel consumption. Additional runs should be made to determine the most desirable cycle length considering the "MAXIMIN CYCLE LENGTH" described below.

PASSER II-90 provides a "MAXIMIN CYCLE LENGTH," i.e., the maximum of the minimum delay cycle lengths for each intersection, within the cycle length range investigated. The user should carefully examine the "Minimum Delay" cycle length for each intersection as if each were an isolated intersection. It is recommended to restrict the target cycle length to a 10-second range containing the MAXMIN CYCLE. For example, assume that the maximin cycle is 95 seconds. The recommended cycle search range would be from 90-100 seconds and includes the MAXMIN CYCLE. Running PASSER II-90 using this particular range of cycle lengths will enable the user to determine the optimal arterial progression settings, knowing that total arterial system delay will be near the minimum delay value.

Excessively long minimum delay cycle lengths (above 100 seconds) suggest a capacity problem. Look for ways to increase the capacity of the critical intersection(s). Possible options include added lanes, re-stripped pavement, restricted parking, etc. Excessively long cycle lengths tend to overflow left turn bays or back queues into upstream intersections or access driveways. This spillback could further reduce intersection signal capacity.

PHASE DESIGNATION

PASSER II-90 specifies the intersection turning movement demand according to the signal phase designations as shown in Figure 2-1. This is the basic eight-phase NEMA (National Electrical Manufacturers' Association) system as defined in the Traffic Control Systems Handbook. As illustrated, phases 1, 2, 5, and 6 always describe the phases that serve traffic movements along the arterial where progression is desired. Phases 3, 4, 7, and 8 are used for the streets crossing the arterial. Protected left turn phases are always given odd phase numbers. Through and right turning phases are assigned with even numbers. Opposing conflicting phases are numbered consecutively. Input left turn volumes for the odd movements even with permissive left turns. Traffic volumes for even (through) movements are the total volumes for through plus right turns.

The intersection diagram defines the numerical assignment of intersection turning movement volume and saturation flow rates. PASSER II uses the traffic movement volumes and saturation flow rates coded in vehicles per hour. Note that odd numbers (1, 3, 5, and 7) are used for left turning volumes only. "Protection" must be provided by a separate left turn lane, or bay, and by a protected left turn signal phase. Left turning volumes not protected by an

THE CROSS STREET

THE ARTERIAL

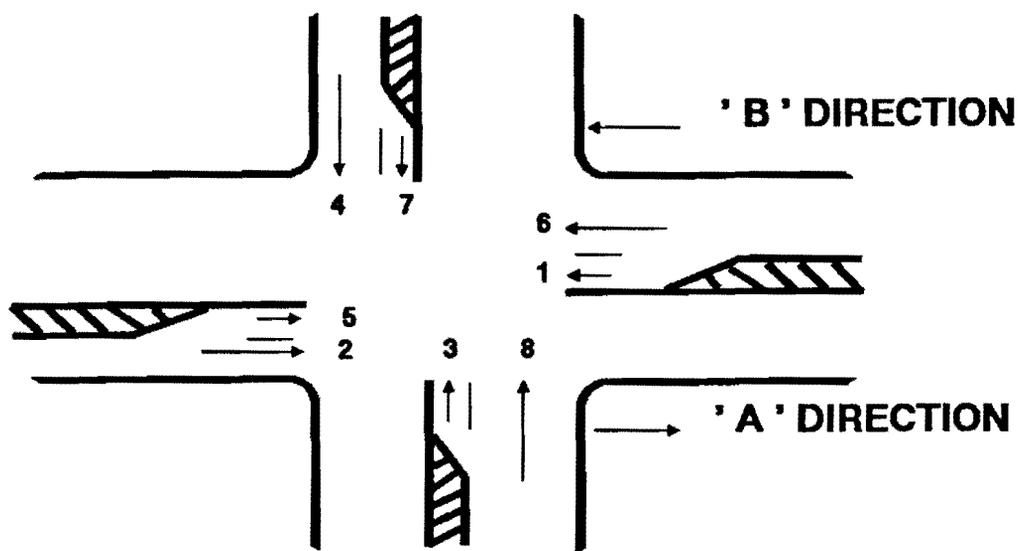


Figure 2-1. PASSER II-90 Phase Numbering System.

exclusive lane and phase are combined by the software with adjacent through movements. Traffic volumes for movements 2, 4, 6, and 8 are total volumes for through plus right-turning vehicles. The right turning volume should not be included in the through volume if there is a right turn lane or pocket providing free right turns. Some reductions in right-turning volumes are desirable for significant right turns on red. Traffic movements are usually defined by the phase numbers assigned to each movement. In PASSER II-90, movements 2 and 5 always describe the traffic movements in the "A" direction of the arterial. Movements 1 and 6 travel in the "B" direction, as illustrated. The user may arbitrarily select the "A" and "B" directions. The input data should also include the minimum phase times, in seconds, required to satisfy pedestrian crossing requirements. Input printouts echo the users' input data to the computer.

As noted, the intersection movements should be combined into lane groups, similar to the 1985 Highway Capacity Manual, except that the combined lane groups in PASSER II are conveniently described by their respective NEMA phase numbers rather than by cardinal direction and turning path, e.g., 5 rather than EBL. This scheme permits a phase, its associated lane group, and turning movements to be used somewhat interchangeably. Since the system will provide capacity evaluation, the use of traffic study to obtain local saturation flows or use of the program's saturation flow estimation feature is recommended. Interactions of left turn bay geometrics, existing left turn behavior, and volume-to-capacity ratios affect left turn saturation flow rates. Left turn storage bay lengths (in feet) that are less than the peak left turn volume (in vehicles per hour) should be considered restrictive.

Users should adjust all the left turn and through saturation flow rates to account for the operational effects of traffic mixes, geometric features, and local driver behavior characteristics. Users are encouraged to be familiar with the signalized intersection capacity analysis procedures of the 1985 Highway Capacity Manual before using similar procedures found in PASSER II. Most saturation flow adjustment tables found in Chapter 9 the 1985 HCM have been converted into equivalent analytic relationships provided in the PASSER II-90 Assistant function, using function key F3 to code in the respective traffic volumes. PASSER II-90 calculates phase green times from the volume data to develop optimum progression solutions. The program may also be used to improve a given progression solution when the green times and cycle length are already known. The given cycle length is entered as is. The phase times, i.e., green plus yellow and all-red, are entered as minimum phases. Precision in volumes and saturation flows, in this case, is not needed. The program will use the minimum phases lengths and calculate the optimal time-space diagram.

PHASE SEQUENCE

Phase sequence is the order that signal phases are displayed during the cycle. Phase sequences may consist of the combinations of the protected and permissive movements depending on the different left turn treatments. There may be one signal phase sequence for the main arterial street and another phase sequence for the cross street. Two to six phases make up a typical signal cycle, depending on how the left turns need to be protected.

As illustrated in Figure 2-2, the arterial street phases and cross street phases are generated from the combination of the eight basic NEMA phases, starting at the beginning of each barrier. The arterial phases use movements 1, 2, 5, and 6. Likewise, the cross street phases use only movements 3, 4, 7, and 8. In this numbering scheme, time reference begins at the start (bottom) for the basic phases on both main and cross streets. For instance, at intersections having protected left turn movements, i.e., 1, 3, 5, or 7, the phase sequence would be dual lefts on both the arterial and cross streets. A common, high-type multiphase signal phasing arrangement is usually this "quad-left" system. PASSER II will automatically select the best phase sequence combination, with or without overlapping, to maximize the progression bandwidth. PASSER II-90 can evaluate up to four phase sequences for the arterial progression. Only one phase sequence is used for the cross street. The allowable phase sequences are shown in Figure 2-3.

All phasing sequences shown in Figure 2-3 have overlap phasing. That is, a starting movement's display overlaps (lasts longer than) its initial companion movement display. With overlap timing, three secondary phases are produced within a basic phase. In Figure 2-2, timing phases (1+6) or (4+7) produce a phase sequence having overlap timing. This phase overlap timing is in no way related to NEMA controller phase overlap drivers. Overlap timing is desirable because it increases phase capacity and arterial progression, thereby resulting in lower traffic delays. "No Overlap" means that no overlap timing exists in the phase sequence, only two secondary phases are used. Again, only one phase option is input for the cross street movements. The software will calculate the overlap from the left turn phase times. In summary, the four allowable arterial sequences are:

- | | | |
|----------------------------|--------------------------|--------------------|
| 1. Left Turns First | or Dual Lefts Leading | or Dual Lefts Lead |
| 2. Through Movements First | or Dual Throughs Leading | or Dual Thrus Lead |
| 3. Leading Green | or Leading Left Leading | or NEMA No. 5 Lead |
| 4. Lagging Green | or Lagging Left Leading | or NEMA No. 1 Lead |

LEFT TURN TREATMENT

Left turns at an intersection can be made in either a protected or a permissive green interval. During a protected interval, drivers can turn left without interference from conflicting traffic. A left turn during a permissive interval requires the driver to find an adequate vehicular gap. The original PASSER II could only handle protected left turns. PASSER II-87 introduced analysis methods for permissive left turns.

There are three basic left turn treatments used today: permissive only, protected only, and a combination of permissive and protected as shown in Figure 2-4. Each of these treatments has its advantages and disadvantages which must be weighed when choosing which to use for a left turn movement. Permissive only is generally used for low left turning volumes. As a rule, it increases delay for left turns while decreasing delay for the heavier through movements. This can be very beneficial to progression and overall intersection delay when left turn volumes are low. Protected left turn phasing is inherently safer than permissive left turn operations because of fewer conflicts. Protected only is commonly used for high left turning

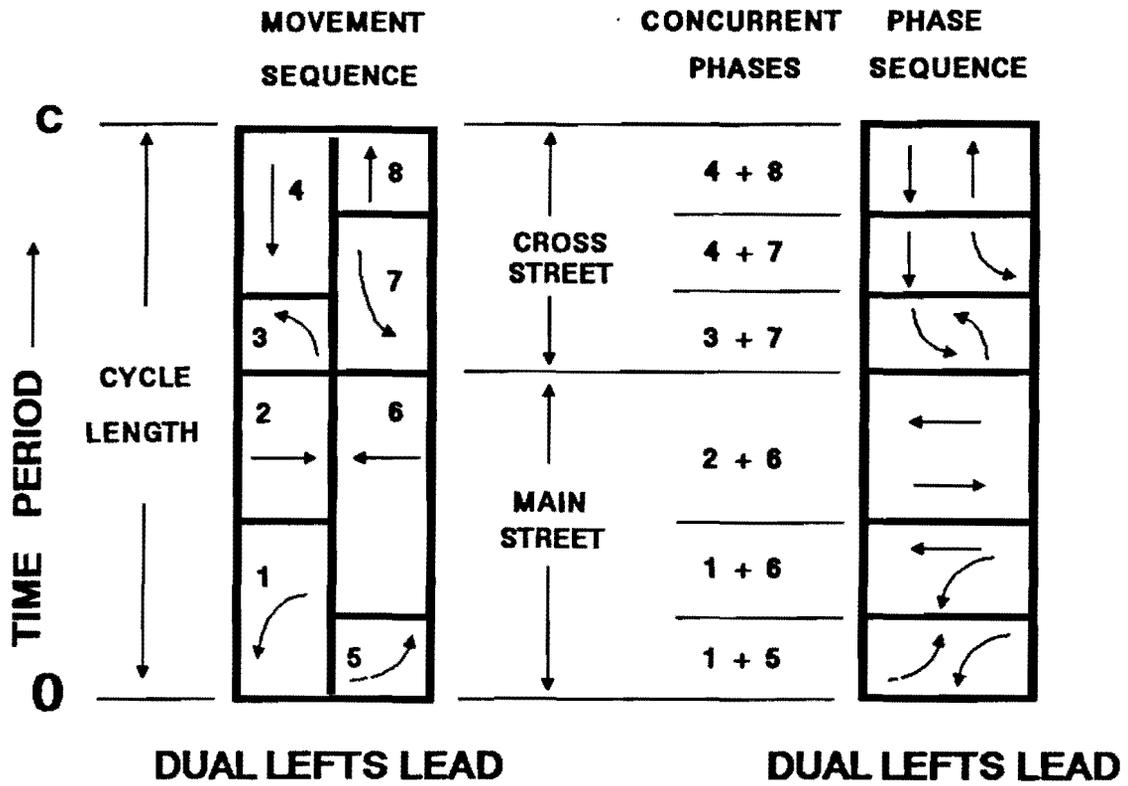
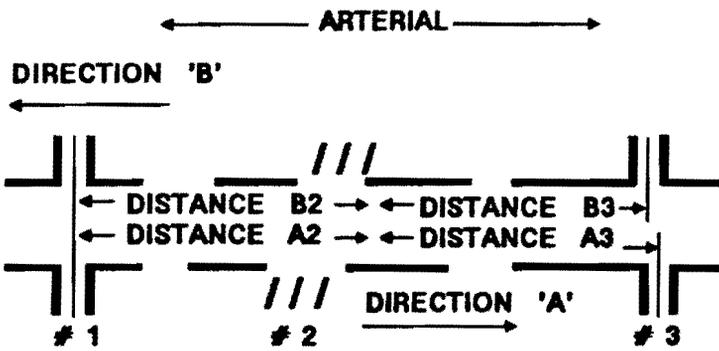


Figure 2-2. Signal Phase Definitions.

DIRECTION AND PHASING INFORMATION



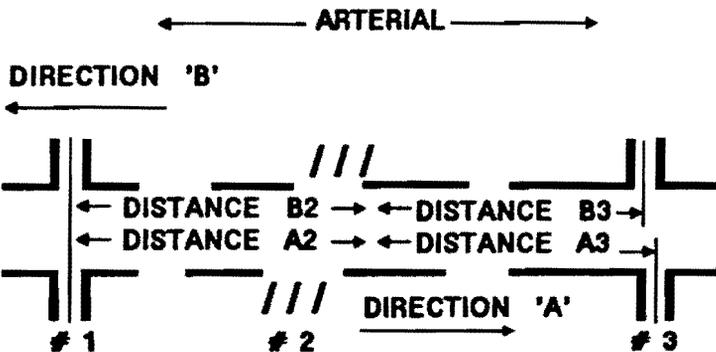
NOTE: DIRECTION A & B MAY BE REVERSED

ARTERIAL PHASE SEQUENCE

			2 + 5
2 + 6	1 + 5	1 + 6	
2 + 5	2 + 5	2 + 6	2 + 6
		2 + 5	
1 + 5	2 + 6		1 + 6
DUAL LEFTS	DUAL THRUS	NO. 5 LEADS	NO. 1 LEADS

*** Please press any key to continue. ***

DIRECTION AND PHASING INFORMATION



NOTE: DIRECTION A & B MAY BE REVERSED

CROSS STREET PHASE SEQUENCE

			3 + 8
4 + 8	3 + 7	4 + 7	
3 + 8	3 + 8	4 + 8	4 + 8
		3 + 8	
3 + 7	4 + 8		4 + 7
DUAL LEFTS	DUAL THRUS	NO. 3 LEADS	NO. 7 LEADS

*** Please press any key to continue. ***

Figure 2-3. Allowable Phase Sequences.

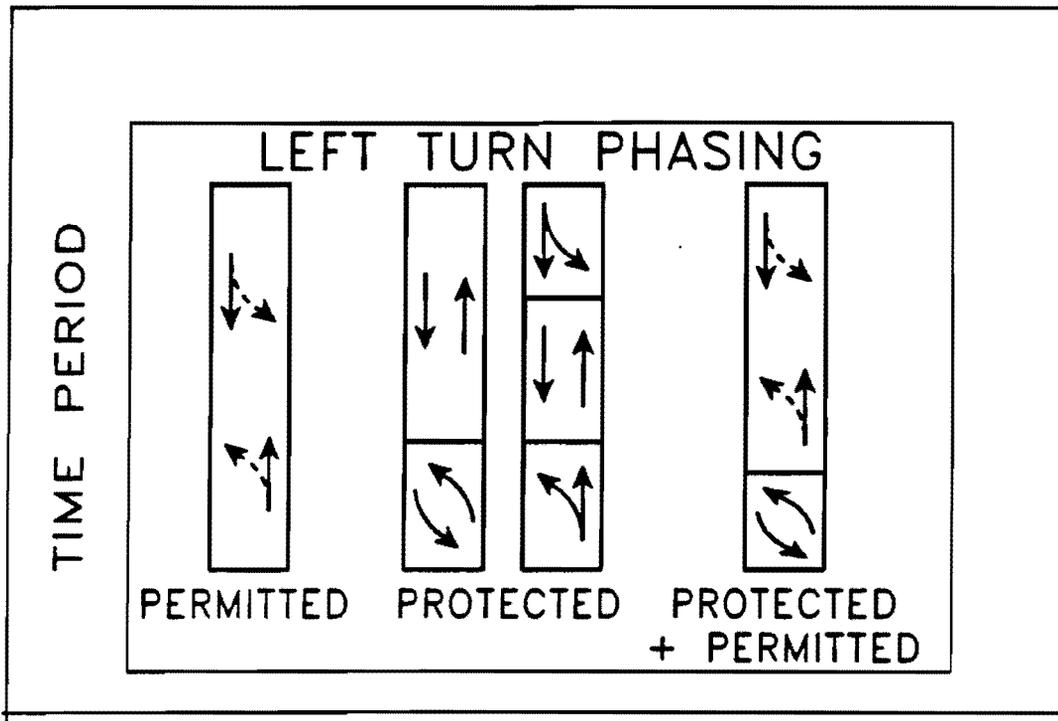


Figure 2-4. Left Turn Phase Operations.

fewer conflicts. Protected only is commonly used for high left turning volumes. It improves both the capacity and the safety of the left turn movement, but the added phase detracts from the green time available for the other movements at the intersection and increases their delay. Protected/Permissive phasing combines the positive and negative aspects of the prior two options. The permissive portion adds additional left turn capacity allowing the protected portion to be shortened. The permissive portion may again experience safety problems.

Optimization of signal timings at an intersection with permissive left turns, either solely or when combined with a protected movement, is a complex problem. To determine the phase time, the capacity must be estimated, but this capacity is heavily dependent on the phase times. A thorough solution of this problem requires many iterations. To reduce the computational overhead and time, PASSER II-90 only makes one pass through this process. The phase times, therefore, are based on permissive left turn capacities which may not be accurate. The delay output, however, will be accurate based on the phase times used. The user should carefully review the output at intersections with permissive left turns. If PASSER II-90 gives an unbalanced solution, the minimum phase green times may be used to provide a more equitable one.

PASSER II-90 allows engineer to try out different left turn treatments to determine the possible effects on delay and arterial progression. These factors must be balanced with safety concerns in choosing the appropriate left turn treatment. However, the phase selection involves a series of complex engineering decisions. Traffic engineers must consider their signal control equipment, turning movement volumes, left turn bay storage capacity, and pedestrian signal timing requirements to avoid excessive delays and accidents. Complicated geometrics and/or heavy left turns generally warrant a multiphase operation. In PASSER II, up to six vehicular phases can be specified and input. However, no provision exists for inputting exclusive pedestrian phases.

INTERVAL AND PHASE LENGTH

The amount of time provided to each phase, or traffic movement, is referred to as the phase length, or more commonly, the green split. A phase is composed of two or more signal timing intervals. The distinctions are:

1. An interval is a period of the signal cycle during which all signal displays, both vehicle and pedestrian, remains unchanged. For example, consider the Green and WALK interval shown in Figure 2-5.
2. A phase is the combination of intervals, during which the traffic movements given the right-of-way during green and clearance intervals, are unchanged. For example, Phase 2, as shown in Figure 2-5, is composed of four phase time intervals, that is, the WALK, FDW, Yellow, and All-Red.

Please note that PASSER II calculates phase lengths, not interval lengths, to minimize delays at each intersection, subject to the minimum phase time constraints. Both the minimum phase times and splits calculated by the model

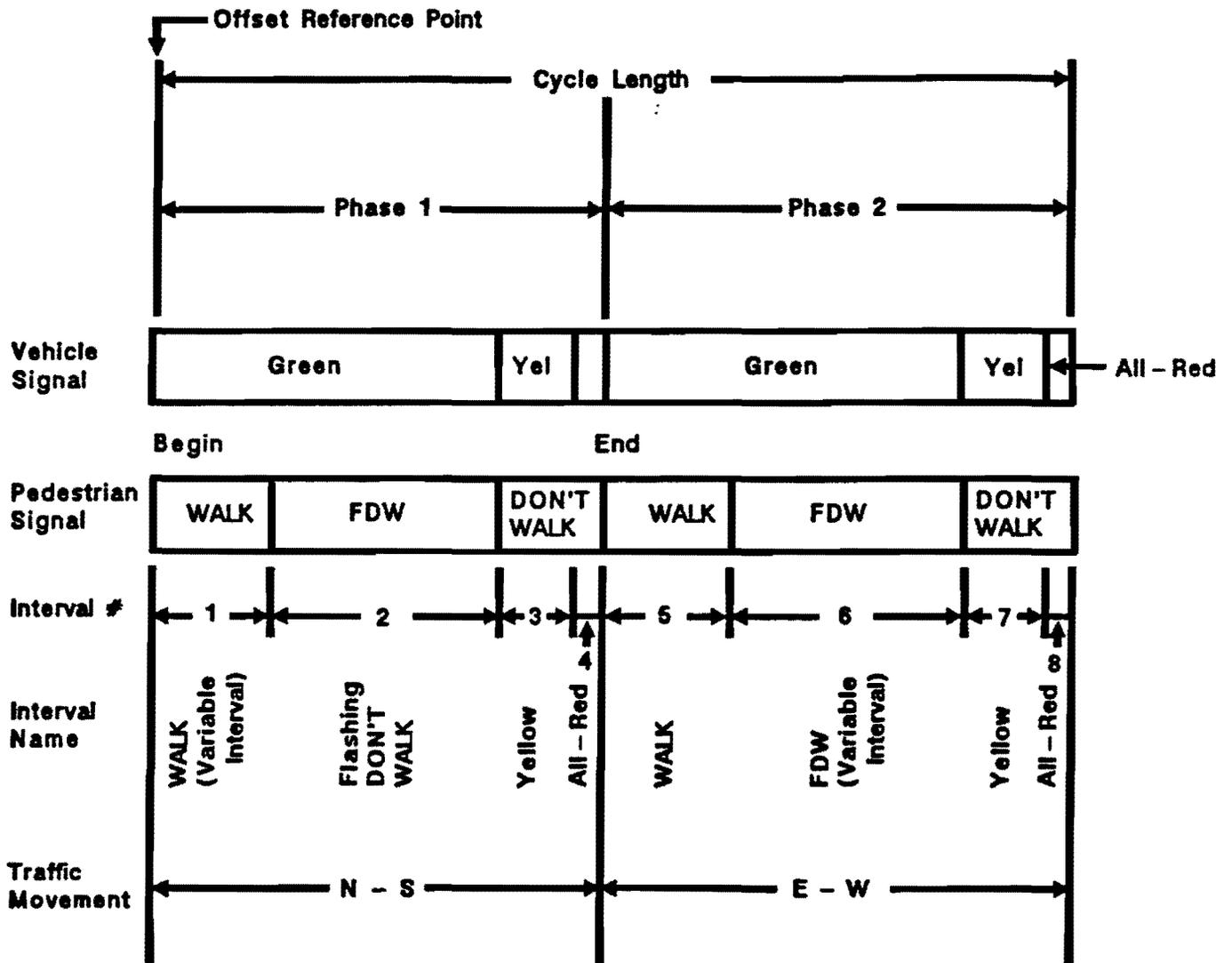


Figure 2-5. Signal Control Parameters.

include the change intervals. The best phasing and offsets are selected for optimal arterial progression for the given cycle length and splits. For existing timing cases, the actual splits, including the change intervals, are coded as minimum phase times. If possible, the user should calculate the minimum phase times for each movement from the intersection geometrics. The minimum phase times, including yellow and any all-red (red clearance) intervals, should comply with the following guidelines:

1. When pedestrians are not a factor, the absolute minimum phase length is generally 6-10 seconds green, plus the signal change intervals. Each agency will normally have its policy on pedestrian treatments.
2. If pedestrians are a factor, but no pedestrian signals are present, the minimum phase length should equal the pedestrian crossing time, usually calculated at 4 ft/sec, plus the change intervals.
3. If the pedestrian signals are present, the minimum phase length should be set to at least to equal to the walk time plus the pedestrian clearance time.

COORDINATION OFFSET

The coordination offset is the time period from a system reference point to the cycle's beginning point for each signal controller in the system. Offsets are generally determined, to the extent possible, so that traffic can flow through the maximum number of signalized intersections without having to stop. In PASSER II, offsets are calculated for each signalized intersection in the progression system. As default, the offsets are coordinated and referenced to the beginning of the main street green time of the first intersection in the time-space solution.

The coordination offset at an intersection is defined as the time difference between the start of the first arterial phase and the beginning of the first arterial phase at intersection 1 in the "A" direction in the time-space diagram. The offsets are expressed in seconds in the time-space diagram shown in Figure 2-6. PASSER II calculates the offsets to maximize the sum of the two-way progression bandwidths for the arterial. The model optimizes the traffic signal timing parameters for progression operations. Enhancements to PASSER II-90 allow it to also evaluate the current operations by inputting the existing coordination signal offsets.

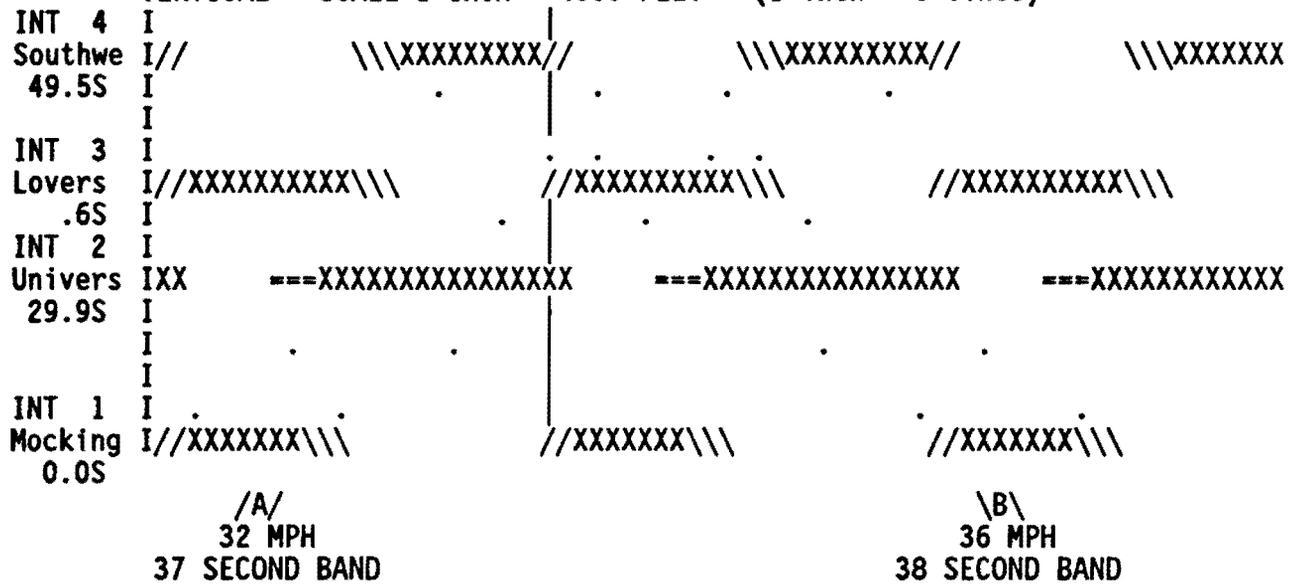
EMBEDDED DATA

The major deficiency of most computer programs is that their major study assumptions, calculation equations, and evaluation criteria used in analysis are often embedded and unchangeable. PASSER II-90 allows users to identify the important evaluation criteria and thresholds during signal timing development. The user may accept the values as provided or modify them during data entry. Since the user has coded the existing data, PASSER II-90 will accept user-entered default values in the analysis. The embedded data are listed below.

(TS.DIAGM)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
PASSER II-90 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 DEC 90

RUN NO 1 DISTRICT 18 Skillman Avenue 06/22/89 CYCLE = 95 SECONDS
HORIZONTAL SCALE 1 INCH = 40 SECS (1 inch = 10 characters)
VERTICAL SCALE 1 INCH = 4000 FEET (1 inch = 6 lines)



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

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

Figure 2-6. Progression Time-Space Diagram.

TRAFFIC CONTROL TYPE. Either pretimed control (P) or actuated control (A) for signal timing reference should be selected for delay estimation. The default uses pretimed signal control.

IDEAL SATURATION FLOW (VPHGPL). The default ideal saturation flow is 1800 vphgpl, or 1800 equivalent passenger car units per hour green per lane is assumed. The allowable range is between 1500 and 2400 vphgpl.

ANALYSIS PERIOD (MIN) . The default analysis period for PASSER II-90 is 15 minutes. The allowable range is from 15 to 300 minutes (5 hours).

LEFT TURN SNEAKERS. The default permissive left turns allowable during the yellow time or clearance interval is 2.0 vehicles per amber time period. Its range is from 0.5 to 3.0 vehicles.

PHASE LOST TIME (SEC). The default value of the individual signal phase lost times is 4.0 seconds. It ranges from 3.0 to 7.0 seconds per phase.

LEFT TURN PHASING. This designates the capacity evaluation methodology for combined (protected/permitted) phase operation. It can be either "APPROACH-BASED" or "RING-BASED". Traffic delay can be greatly reduced in ring-based operation due to improved left turn signal capacity with lead-lag phasing. The user can choose "A" for approach based or "R" for ring based as the designation for the combined phase operation. The default is "A" or approach based.

Approach-based protected/permitted phasing as produced by driving the permitted green ball, yellow and red indication of the left turn from the same approaches through signal indications (a NEMA overlap). This is the traditional MUTCD method and should be used in all cases where only two signal heads are used to control an approach. Ring-based protected/permitted operation derives its permitted green ball, yellow and red indications primarily from the opposing through signal phase on the same ring using controller overlap drivers. Ring-based operations should only be considered when separate left turn bays and signals are used with lead-lag phasing. In this case, left turn capacity can be significantly increased and the potential for misleading yellow signal entrapment for the protected-permitted left turn is eliminated, which would not be if approached based protected-permitted overlaps were used.

DELAY UNIT. HCM uses stopped delay while PASSER II-90 uses total delay as the default. The user can choose either total delay (T) or stopped delay evaluation (S). PASSER II-90 uses a default multiplier of 1.3 for converting stopped delay to total delay. The delay conversions from stopped delay to total delay can likewise be changed to match local calibrations or subsequent changes in HCM criteria. The allowable range for the conversion factor to total delay is 1.0 to 1.3.

LOS DELAY CRITERIA. The level-of-service evaluation can be performed using the default delay criteria supplied in the program or by user input. The user has two ways to adjust the delay thresholds for level-of-service evaluation. First, the user can change the multiplier of

stopped delay to total delay to adjust all of the delay thresholds in the same magnitude as described in the total delay multiplier. Second, the user can change the individual delay criteria. However, all the delay thresholds used in the evaluation analysis will be reported. The delay thresholds for stopped delay level-of-service evaluation and equivalent total delay criteria are presently as follows:

LOS	Stop Delay	Total Delay
A	= 5 secs/veh	6.5 secs/veh
B	= 15 secs/veh	19.5 secs/veh
C	= 25 secs/veh	32.5 secs/veh
D	= 40 secs/veh	52.0 secs/veh
E	= 60 secs/veh	78.0 secs/veh
F	> 60 secs/veh	78.0 secs/veh

PERMITTED LEFT TURN MODEL. Two different permitted left turn models can be selected for evaluation: Negative Exponential or Generalized Regression. The permitted left turn capacity model can be designated two ways: "N" for the Negative Exponential Model or "G" for the Generalized Regression Model. After selecting the model, the program will automatically change the model variables in the analysis. If the user wants to use his own model, he can select User's Model and input the needed data. PASSER II-90 uses the TTI Model as the default.

Negative Exponential Models		Generalized Regression Models	
1. Texas A & M	Analytical	1. HCM-Signalized	Analytical Model
2. Australian	Analytical	2. HCM-Unsignalized	Analytical Model
3. Univ. of Texas	Simulation	3. Univ. of Minn.	Regression Model
4. User's Model	Same Model	4. Ohio State Univ.	Regression Model
		5. User's Model	Same Model Form

MODEL COEFFICIENTS. These are coefficients used in the permitted left turn analysis models. For example, the default model coefficients for the TTI Negative Exponential Model are as follows:

$$\begin{aligned}
 S_0 &= \text{Opp Left Turn \# (vph)} = 1750 \\
 T &= \text{LT Critical Gap (sec)} = 4.5 \\
 H &= \text{LT Headway (sec)} = 2.5
 \end{aligned}$$

On the other hand, one of the optional model coefficients for the HCM-Signalized Generalized Regression Model are as follows:

$$\begin{aligned}
 S_0 &= \text{Opp Left Turn \# (vph)} = 1400 \\
 B &= \text{1st Power Coefficient} = 0.0 \\
 C &= \text{2nd Power Coefficient} = 0.0 \\
 D &= \text{3rd Power Coefficient} = 0.0
 \end{aligned}$$

PHASER DATA INPUT

PASSER II-90 allows the user to define different offset reference systems to implement the optimized signal timing plan. As a header, the user can type in any description up to 75 characters. The default values for the Master and System Intersection will be 1, or the first intersection in the arterial progression system. The user can also change the system offset reference from default intersection number 1 to the maximum intersection number in the current data set. The system offset can be any value from 0 to the lowest cycle length. The default is 0. Choose the movement for system reference from 0, 2, and 6. The default is 0 or the beginning of the arterial green phase. For Reference Point, the user can select the beginning or the end of the phase. The default offset reference is set to the beginning of the main street green, or 0.

COMMENT LINE. This comment line, made up of a maximum of 75 characters, allows the user to place remark lines for every set of criteria used to interpret the signal timing solutions. The comment line will also be printed in the phase interval setting report.

MASTER INTERSECTION. These fields provide different ways to lock in the offset reference calculations for the arterial. A Master Intersection designation refers to the zero offset calculation in the time-space diagram. The default Master Intersection is always the first intersection in the system.

SYSTEM INTERSECTION. The System Intersection is the intersection that connects the arterial to any adjacent signal system already timed. The System Intersection may or may not be the Master Intersection. The default System Intersection is the first intersection along the arterial in the A direction.

SYSTEM OFFSET. This is the system reference offset for all of the arterial relative offset calculations. The default value is zero. The allowable range is from zero to the cycle length.

MOVEMENT. Movement defines the arterial reference phase for all relative offset calculations. Allowable movements are the beginning of the arterial phase, the NEMA 2, or the NEMA 6 movement. The default is the beginning of the arterial phase.

REFERENCE POINT. The Reference Point is the point in the phase that all offsets are referring to. It can be either the beginning or end of the phase. The default is the beginning of the arterial phase.

SYSTEM DESIGN

The system hierarchy, illustrated in Figure 2-7, contains all the component files needed for program execution. PASSER II-90 contains several easy-to-use and user-friendly signal timing programs for the IBM PC/XT/AT or compatible 8088/8086/80286/80386 based microcomputers that have MS DOS 3.1 or

PASSER II-90 MICROCOMPUTER SYSTEM					
BATCH FILES	CONFIGURATION FILES	EXECUTABLE FILES	INPUT FILE	OUTPUT FILES	HELP FILE
PASSER2.BAT	HARDDISK.DAT	PASSETUP.EXE	DATA	DATA.OUT	MENU
NEXTDO.BAT	IOSPEC.DAT	P290AI.EXE		SCRATCH.DAT	
	PHASER.DAT	LEART.EXE		ARTDATA	
				DATA.GDP	

Figure 2-7. System File Structure.

higher operating systems. It is distributed with an input/output preprocessor, executable main program, user help information, and user's manual. The program requires a microcomputer with a minimum of 640K RAM (Random Access Memory). The system does not require 8087/80287/80387 math co-processors. However, program installation on hard disks is recommended.

SYSTEM OPERATIONS

The PASSER II-90 system is an engineering tool that combines the updated PASSER II program, advanced 1985 HCM type analysis, and the latest developments in microcomputer programming technology. As shown in Figure 1-1, PASSER II-90 can assist professionals in analyzing (1) Isolated intersection timing evaluations, (2) Progression signal timing optimization, and (3) Existing Timing Evaluations or a Simulation Evaluation. At present, the program assumes the isolated intersection evaluation option when the input data pertains to only one intersection. The program assumes a progression problem when the input data include more than one signalized intersection. PASSER II-90 is restricted to analyzing no more than twenty (20) signalized intersections. However, systems with more than 20 intersections can be analyzed by dividing the arterial into connected smaller systems.

SYSTEM FILES

PASSER II-90 uses five (5) types of microcomputer system files for interactive user-machine interface operation: configuration files, batch files, executable files, and the basic input and output files.

Batch Files

The PASSER II-90 system controls the system operation with two batch files. These files control program execution and, therefore, must be present during system installation and program analysis.

PASSER2.BAT - runs PASSER II-90 from an 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-90 program input and output operations.

Configuration Files

Three configuration files 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 program and default data storage. It will be used during both 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 a 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 the PASSER II-90 Phase Interval Setting (PIN.SET) reports. The elements of the input data for this particular analysis will be discussed in a later section.

Executable Files

Three executable files are used in the PASSER II-90 microcomputer system. These include the input/output processor (PASSETUP.EXE), main program (P290AI.EXE), and the arterial animation system (LEART.EXE).

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 - is the compiled FORTRAN 77 version of PASSER II-90 main program with all the necessary FORTRAN library calls.

LEART.EXE - is the animated arterial simulator using compiled TURBO C programming language and Borland Graphics Interface standard.

Input and Output Files

PASSER II-90 can allocate all data files and subdirectories having legal DOS file names. Once the PASSER II-90 system has been properly installed, the user can load data files from any pre-defined or user-created DOS subdirectory as 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 is being stored, which may be A, C, or any other logical device.

DATA - contains the PASSER II-90 default data in ASCII text format. The user can name the input data file using any legal DOS file name either with or without file extensions.

DATA.OUT - is a standard 80-column output. After the system has run, "PASSETUP.EXE" reformats this output for viewing on the screen. The output file name will be created with a user-specified name or with the default file extension ".OUT".

SCRATCH.DAT - is created automatically to provide a portion of the output data file. It will only be created when the output level has been specified to store the unwanted output pages in this file.

ARTDATA - stores the necessary data to execute the dynamic simulator for displaying optimized signal timing solutions.

DATA.GDP - contains information for program interface between PASSER II-90 and Arterial Analysis Package (AAP) with TRANSYT-7F.

System Help Information

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

The above files occupy two 360KB double-sided, double-density (DS DD) diskettes, or one 1.2MB or 1.44MB double-sided high-density (DS HD) diskette. The user must copy system files onto the working diskette for normal operations. The system command file includes the IBMBIOS.COM, IBMDOS.COM and COMMAND.COM files under MS DOS 3.1 or higher disk operating system. PASSER II-90 was designed for two-drive IBM PC/XT/AT/386 or compatible microcomputers having a minimum of 640K bytes of main memory equipped with or without a hard disk drive and having either one or two floppy disk drives. Program installation can be made in a straightforward manner as in floppy disk systems. All 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 should store data on floppy disks or on the hard disk.

INSTALLATION PROCEDURE

PASSER II-90 program has an intelligent and user-friendly interface. The installation procedure and operational questions can be resolved by following the procedures stated in this manual. The PASSER II-90 system has been designed to accept all current input data files produced by PASSER II-84, PASSER II-87, and provides the necessary input data adjustments when the user saves data using PASSER II-90. Users may modify these default data as desired or use the recommended values as starting points. A basic user's training guide follows this section to assist both the inexperienced as well as the experienced user in running this program. 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 using this program.

SYSTEM PREPARATION

The PASSER II-90 diskettes contain the entire PASSER II-90 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 onto a bootable disk, having operating system files, to serve as the working disk. The distributed diskettes can then be kept as backups. The program disk is pre-configured for IBM PC/XT/AT or compatible microcomputer systems having two floppy disk drives. If you have a microcomputer system with a hard disk, please read the section covering the installation of this system onto a hard disk. Users are urged to become familiar with their DOS manual before continuing. The following instructions will be brief; therefore, if more explanation is needed, please refer to your DOS manual.

First, the user should format a bootable diskette and insert in drive B. Insert PASSER II-90 diskette number 1 into drive A and transfer the PASSER II-90 system by typing in "COPY A:*. * B: /v". All of the files will be copied to the B drive. Make sure the COMMAND.COM file is already on the newly formatted working diskette.

Backup Diskette

Next, remove the two diskettes and label the new diskette PASSER II-90, Version 1.0. Insert PASSER II-90 diskette number 2 in drive A and a newly formatted diskette in drive B. Repeat "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-90 Files. After transferring the system to working diskettes, place the distribution diskettes in a safe place. The PASSER II-90 program is now ready for system configuration and traffic data input. Using the most recent Disk Operating System, version 3.0 or higher, is highly recommended for ease of operation.

Backup Data

Two program diskettes are provided with PASSER II-90. The first diskette 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-90 system. It is highly recommended to use formatted blank diskettes to backup these program files before beginning to store input data files produced by the input preprocessor and output postprocessor and before proceeding with any analysis.

PROGRAM INSTALLATION

Apply the following procedures to install the program system on either floppy disk or hard disk systems.

Floppy Disk Operation

The PASSER II-90 program package comes configured for use on a dual floppy drive system. The first diskette contains the input preprocessor and postprocessor, example data, configuration files, and batch files of the PASSER II-90 analysis system. The other diskette contains the main program and optional help information of the PASSER II-90 microcomputer system.

1. Insert the 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. The user will then be prompted to enter the time. Prompt A> will appear on the screen.
2. Remove the System Diskette from drive A and insert the diskette PASSER II-90 Version 1.0, configured previously, in drive A. Insert diskette labeled 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 <RETURN>. The Disclaimer Screen will appear as shown in Figure 2-8.
4. Press any key and the PASSER II-90 Configuration Routine screen will appear. The user may select from the choices shown in Figure 2-9.

Hard Disk Operation

To install PASSER II-90 on a hard disk or on a 1.2 MB or 1.44 MB floppy disk, the user should use subdirectory structures for storing the PASSER II-90 program by using the "MKDIR C:\P290" or "MD C:\P290" commands. Copy all files from both distribution diskettes to the hard disk directory by entering "COPY A:.* C:\P290 /V". Please refer to the DOS operating manual for operating the computer under different subdirectories.

When using PASSER II-90 on a hard disk machine, the current subdirectory must be the one on which the PASSER II-90 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, allowing the user to specify any default subdirectory path for the program, together with input and output files on floppy or hard disk microcomputer systems. To store or read a data file, the user will need to define a path name to the file where the working files are stored. Each time the user wants to store data sets, the system will also provide the user with options for selecting a different subdirectory for optional data storage. If the subdirectory selected for data storage has not been previously defined, the PASSER II-90 system will help the user create that particular subdirectory. Otherwise, the system will use the default subdirectory to store the information.

System Error Recovery

If PASSER II-90 must be moved from a hard disk system to another computer system using floppy disks, the user must copy all 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-90 system will be configured 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 that, regardless of the file name, the HARDDISK.DAT file will be generated for both the floppy disk based microcomputers as well as microcomputer systems equipped with hard disks.

Texas Department of Highways and Public Transportation
----- P A S S E R I I - 9 0 -----
Version 1.0

Configuration Routine

Will PASSER II-90 program be run on two Double-Sided and
Double-Density floppy drive ? (y or n) No

Texas Department of Highways and Public Transportation
----- P A S S E R I I - 9 0 -----
Version 1.0

Configuration Routine

Is PASSER II-90 installed in a subdirectory? (y or n) Yes
PASSER II-90 is in the D:\P2 subdirectory.

Figure 2-9. System Installation Routine.

3. PROGRAM OPERATIONS

This section describes the available PASSER II-90 microcomputer program functions and recommended operating procedures for efficient program analysis. The Skillman Avenue example, a four-intersection arterial as shown in Figure 3-1, illustrates the different aspects of the data input procedures and program menus as described in this section. After accessing the program, please refer to this example and related figures for further information.

MENU STRUCTURE

To start the program, type the command "PASSER2". Make sure the default jdata file, DATA, is in the same directory during the initial installation. The operating system will automatically set up the program execution environment. All the data needed by the input/output processor, main program, and dynamic arterial animation system will be generated after program execution. Figure 3-2 illustrates PASSER II-90's four basic menus: Main Menu, Input Menu, Edit Menu, and Output Menu. Supplemental submenus are used as needed. The user can access different portions of the program through these interactive menus. Since most menu items provide intuitive descriptions, the following sections focus on assessing the major program functions instead of explaining each menu item.

MAIN MENU

The Main Menu, Figure 3-3, has eight different choices. Enter the corresponding number or use the arrow keys to select the desired action. The following instructions describe how to use the program menus to input new data, load data, and run the program.

Load Data File

The user may read data from any disk drive using a legal DOS path or file name, or input new data through the Input Menu. During data loading, the user may use the directory assistant to review existing files by pressing function key [F4]. The system will warn the user that current data may be lost or abandoned if this option is selected. It is not necessary to reread data if the same data will be used during the next run. It is preferable to load only data created by this system. However, PASSER II-90 can also load existing PASSER II-80, PASSER II-84, and PASSER II-87 data, and automatically insert new information when the data is saved.

Store Data File

PASSER II-90 is an engineering tool. Successful results require program analysis and engineering judgment. Data files can be altered through the Edit Menu. Once edited, the data should be routinely stored onto a floppy disk or hard disk. Storing output files on hard disks can speed up execution. The user may print out input data before executing. Consider using the print screen function to obtain selected information instead of printing out entire files. These screen print-outs can also serve as data inventory sheets.

Skillman Avenue

Dallas, Texas

EXISTING SIGNAL TIMING PLAN

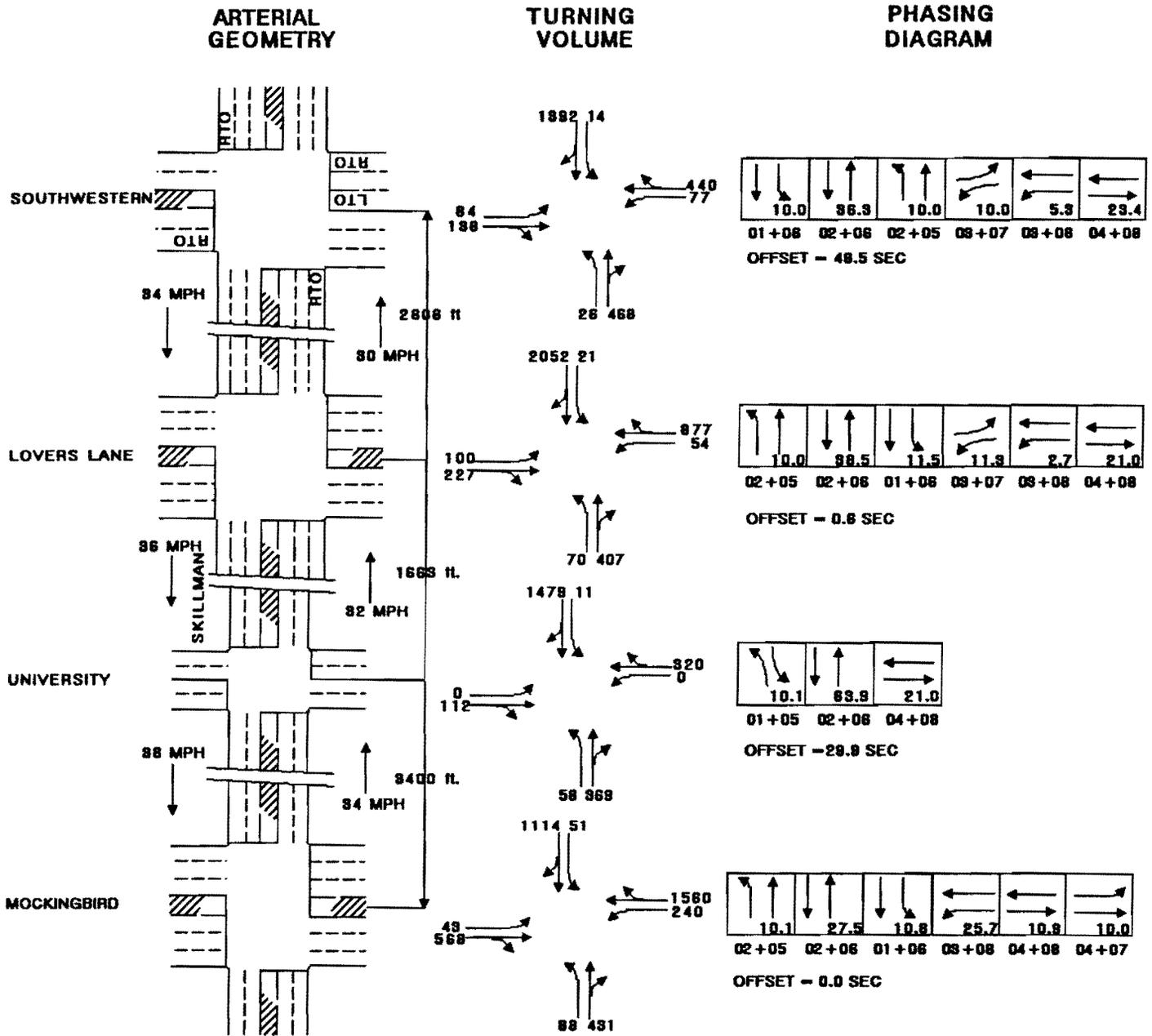


Figure 3-1. Example Data, Skillman Avenue.

HPR 2-18-86-467 STUDY
PASSER II-90 AI PROGRAM
ON-LINE HELP MENU SYSTEM

USE CURSOR KEY TO MOVE AROUND
<CR> RETURN KEY TO TOGGLE
SCREENS
<ESC> TO RETURN PASSER II-90

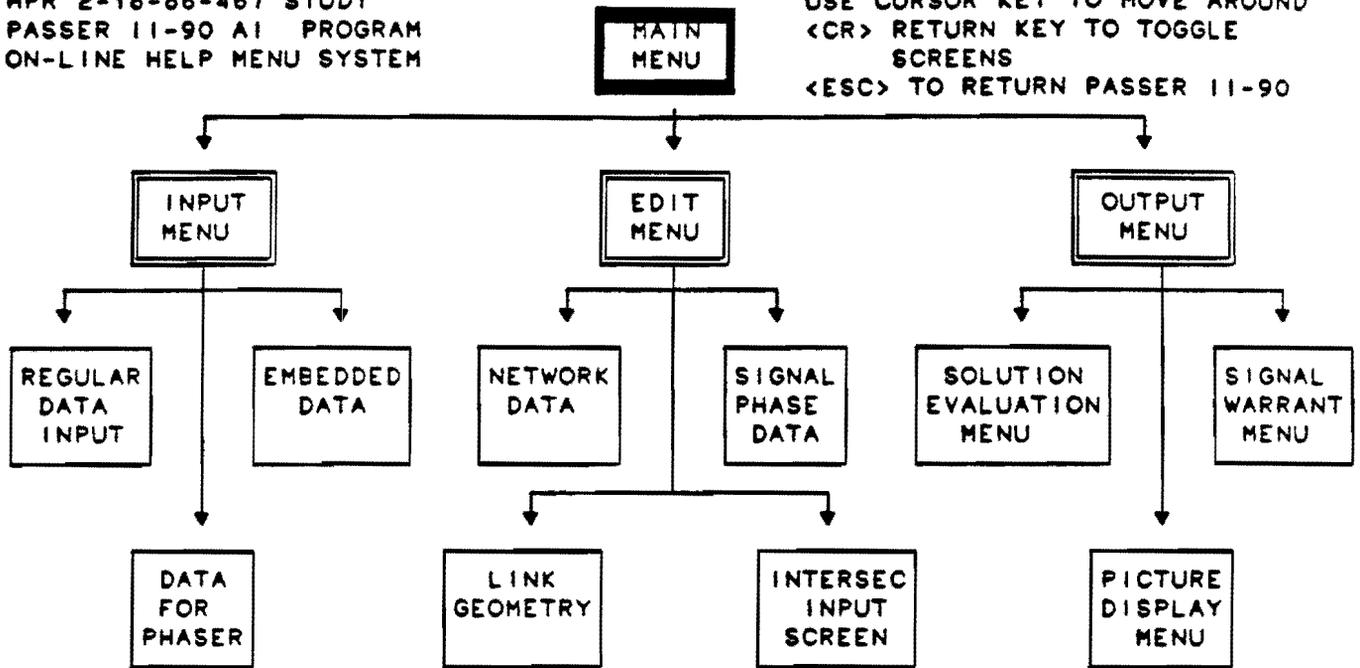


Figure 3-2. PASSER II-90 Menu Structure.

Texas Department of Highways and Public Transportation
----- P A S S E R I I - 9 0 -----
Version 1.0

-- Main Menu --

1. Input new data.
2. Read old data from disk.
- D:\P2\DATA loaded. -
3. Edit data.
4. Store data on disk.
5. Print current input data.
6. Run PASSER II-90.
7. Go to Output Menu.
8. Quit.

Which item do you choose? 1

Figure 3-3. Main Menu.

Execute Program

During execution, the system will check data consistency and errors within the coded data to avoid any run-time errors. The user can select the optional directory path, output file names, or simply press <RETURN> to accept the default. After each run, the program will retrieve the output and return to the Output Menu. The user may also return to the Main Menu for additional processing. The user may exit the system, at any time, by pressing <ESC>. However, if the user has just input new data or edited existing data, the system will alert the user to save the data before exiting. If the user has just reviewed the data without modifications, the system will detect that no changes were made and exit without requiring the user to save the data.

First, the program examines the left turn treatments, checks the available the signal phase patterns, and deletes inappropriate patterns. Second, if a split phase without overlap is used, minimum phase times will be set equal to those simultaneous traffic movements. The larger green of the two phases are used if unequal greens are specified. Finally, the sum of the critical phase minimum phase times are checked to ensure that the sum of critical phases is less than the lower cycle length.

INPUT MENU

As shown in Figure 3-4, the new Input Menu has three choices. The user can input new traffic data, change embedded data for the whole system, and change phaser data referencing parameters as needed.

New Data

For new data input, the system will force the user to enter the arterial system information, geometric data, traffic volumes, and signal control data for the arterial system in a fixed sequence. After inputting the data, the user can modify the data, execute the program, or save the data files. The user may input new data, add more intersections, or change the cross street names in the existing system through the Edit Menu. This input routine will be activated when the user chooses to add new intersections to the existing system. However, two restrictions were built into the system.

1. All traffic movement data must be entered using the NEMA phasing numbers as defined in the 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 always assumed.

If the new input option is selected, the screen message will read "Abandon existing input data? (y or n)"; Type "y" and <RETURN>. Then, the system will process the fixed sequence shown in Figure 3-5. This sequence will depend on the number of intersections specified during input. For example, the user can specify only one cycle length if one isolated intersection is selected. In addition, the user will not be asked to provide progression information when only one intersection is specified.

Texas Department of Highways and Public Transportation
----- P A S S E R I I - 9 0 -----
Version 1.0

-- Input Menu --

1. Input New Traffic data.
2. Input Embedded data.
3. Input Phaser data.

Which item do you choose? (Press <ESC> for main menu.) 1

Figure 3-4. Input Menu.

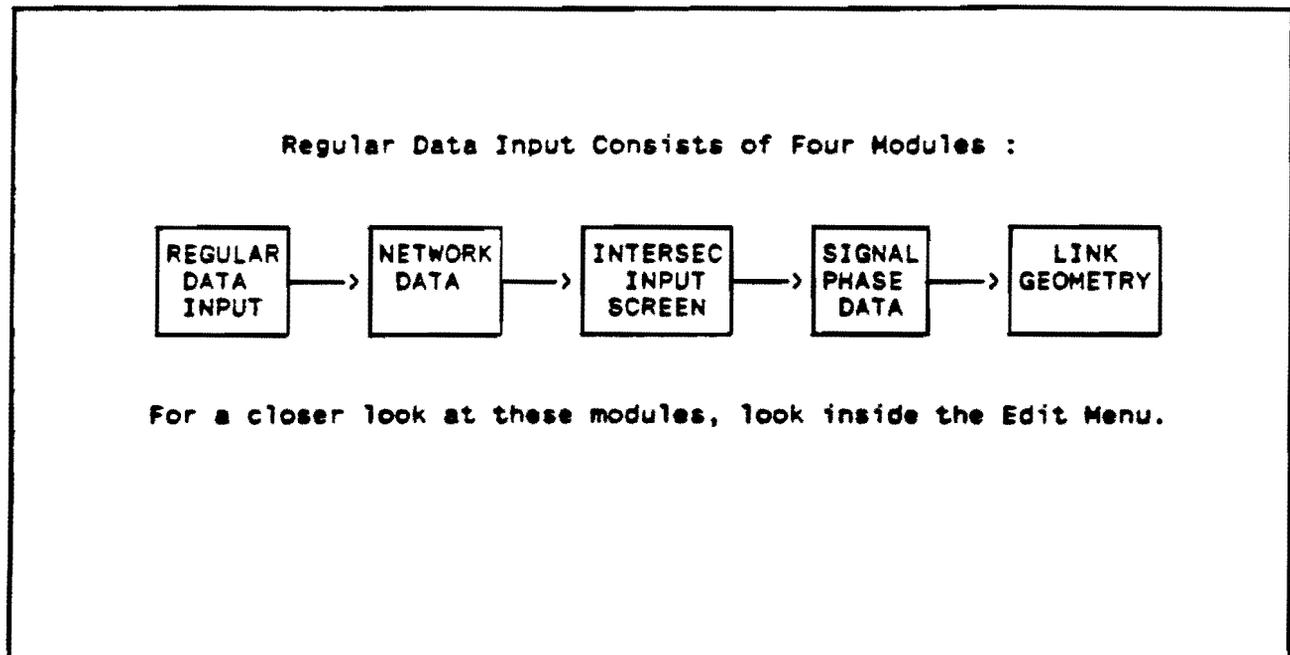


Figure 3-5. Data Input Sequence.

Second, for every signalized intersection, the program will ask the user for the input of cross street name, traffic volume, saturation flow, and minimum phase time. As shown in Figure 3-6, the movement screen will assist users in inputting traffic movement, saturation flow, and minimum phase according to their corresponding positions. Each movement's data can be input interactively as the respective movements appearing on the screen. If zero is chosen for the volume, the program will not require saturation flows and minimum phase input. A series of user input ASSISTANT functions can be activated by pressing function key [F3]. These functions are derived from Chapter 9 of the 1985 Highway Manual (HCM).

Third, the user will be required to select the appropriate phasing patterns to be analyzed by PASSER II-90 system. As shown in Figure 3-7, when coding the Phasing sequence, the screen displays all the logical phasings based on the input volumes entered previously by the user. The user can move the cursor to the desired pattern and select the needed phase sequence by toggling the <RETURN> or <ENTER> key. The user may also review the description of the allowable phasing selections by pressing function key [F3]. If the desired phasings can not be found from this list, the user can access other phase sequences not defined by choosing the special phase option. Figure 3-8 illustrates the permitted arterial and cross street phasing sequences for Intersection number 1 (MOCKINGBIRD) of the skillman example.

A maximum of four possible phasing sequences will be specified for the arterial. If "yes" is the response to a "with overlap" question, the program assumes that the "without overlap" option is unacceptable, based on the input volumes. Only one phasing pattern is allowed for the cross street. The user should select the acceptable phasing pattern(s) by moving the cursor to the allowable desired phasing pattern and press <RETURN> to select. Coding the signalized intersection must be repeated for each intersection. Please use the information described in the previous paragraph to enter data for the remaining signalized intersections in the arterial. Finally, the system will ask the user to input the geometry data for the intersection approaches of the arterial signal system as if the user were filling up a data inventory table, as shown in Figure 3-9. This is used to input data about consecutive intersection spacing, progression design speed, and queue clearance between intersections for each direction. As indicated, the system asks for distance and speed for each intersection in each direction. Then, the same link data will be generated as defaults for the other travel direction. Sometimes a queue clearance will limit the width of the progression band. In this case, PASSER II-90 will reduce the queue clearances to 10 seconds to provide the maximum bandwidth.

Embedded Data

The embedded data may be easily modified using features provided in the input screens. The embedded default data sets are shown in Figure 3-10. Be aware that once embedded data are changed, they will remain that way for the remainder of the session, but will reset to built-in values on program restart. 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-

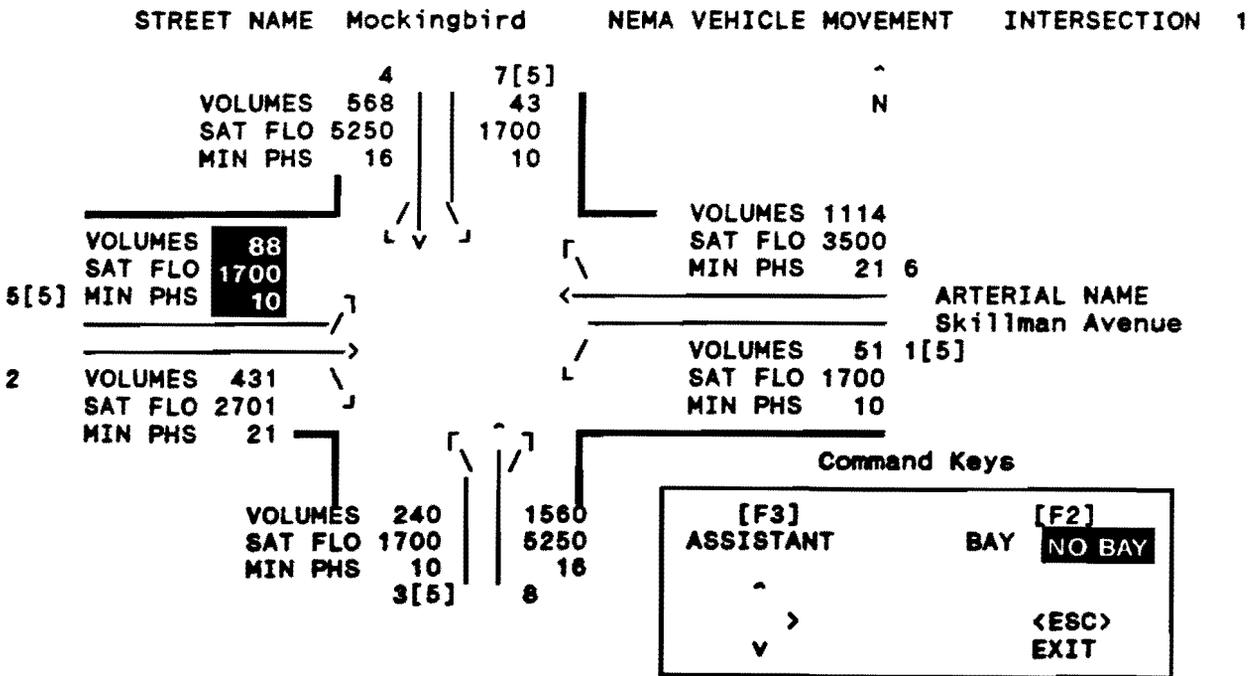
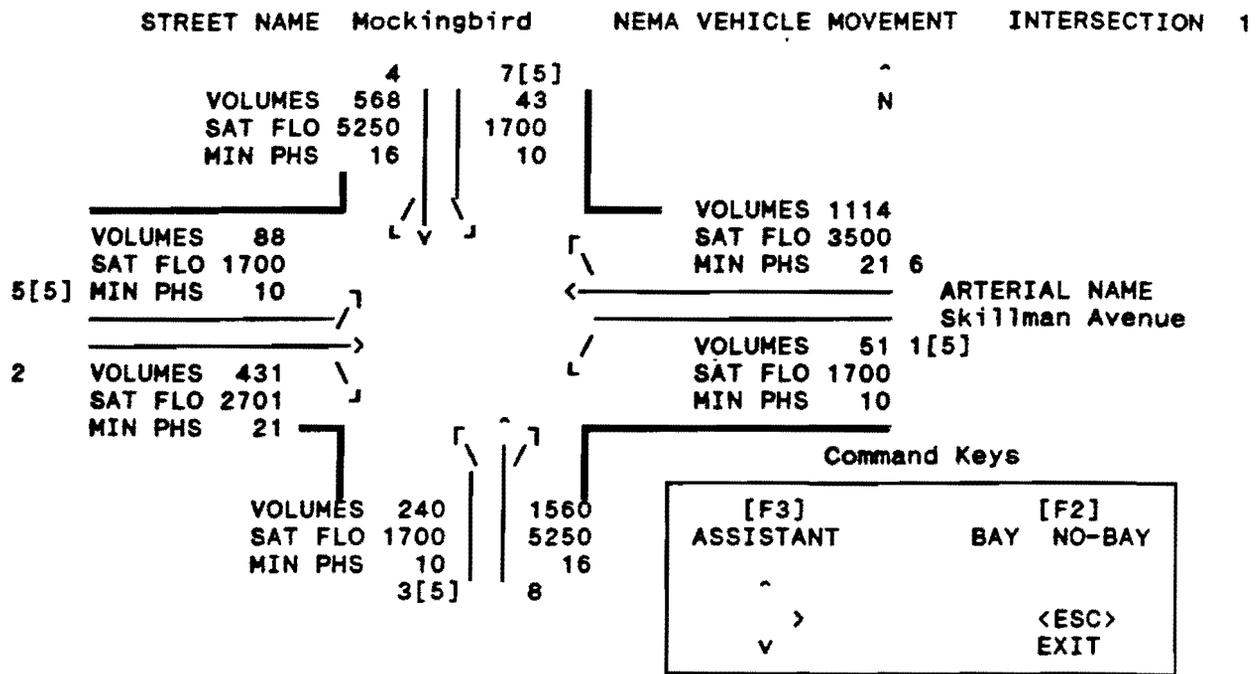


Figure 3-6. Intersection Movement Screen.

[F2]—[F3] <ESC>

Phasing Patterns Entry

Arterial Name : Skillman Avenue	Intersection Number : 1	
Cross Street : Mockingbird	Arterial	Cross Street
Dual Lefts Leading with overlap	Y	-
Dual Lefts Leading without overlap	-	-
Throughs First with overlap	Y	-
Throughs First without overlap	-	-
Left Turn # 1 Leading with overlap	Y	Y
Left Turn # 1 Leading without overlap	-	-
Left Turn # 5 Leading with overlap	Y	-
Left Turn # 5 Leading without overlap	-	-
Special Phasing Selection	-	-

Select which Phasing Patterns are needed. <CR> to select, and <ESC> to exit.
 "Y" = phasing selected, "-" = not selected, "=" = not possible.
 Note that "with overlap" and "without overlap" are mutually exclusive.

[F2]—[F3] <ESC>

Phasing Patterns Entry

Arterial Name : Skillman Avenue	Intersection Number : 1	
Cross Street : Mockingbird	Arterial	Cross Street
Dual Lefts Leading with overlap	Y	-
Dual Lefts Leading without overlap	-	-
Throughs First with overlap	Y	-
Throughs First without overlap	-	-
Left Turn # 3 Leading with overlap	Y	Y
Left Turn # 3 Leading without overlap	-	-
Left Turn # 7 Leading with overlap	Y	-
Left Turn # 7 Leading without overlap	-	-
Special Phasing Selection	-	-

Select which Phasing Patterns are needed. <CR> to select, and <ESC> to exit.
 "Y" = phasing selected, "-" = not selected, "=" = not possible.
 Note that "with overlap" and "without overlap" are mutually exclusive.

Figure 3-7. Phase Sequence Selection.

Arterial Phasing for the Mockingbird Intersection

Current Phasing Patterns

Dual Lefts Leading with overlap
Throughs First with overlap
Left Turn # 1 Leading with overlap
Left Turn # 5 Leading with overlap

Possible Phase Patterns (from input volumes) Phase Sequence

Dual Lefts Leading with overlap	(1+5, 1+6, 2+6) *
Dual Lefts Leading without overlap	(1+5, 2+6)
Throughs First with overlap	(2+6, 2+5, 1+5) *
Throughs First without overlap	(2+6, 1+5)
Left Turn # 1 Leading with overlap	(1+6, 1+5, 2+5) *
Left Turn # 1 Leading without overlap	(1+6, 2+5)
Left Turn # 5 Leading with overlap	(2+5, 2+6, 1+6) *
Left Turn # 5 Leading without overlap	(2+5, 1+6)

* another overlap phase is possible

*** Please press any key to continue. ***

Cross Street Phasing for the Mockingbird Intersection

Current Phasing Patterns

Left Turn # 3 Leading with overlap

Possible Phase Patterns (from input volumes) Phase Sequence

Dual Lefts Leading with overlap	(3+7, 3+8, 4+8) *
Dual Lefts Leading without overlap	(3+7, 4+8)
Throughs First with overlap	(4+8, 4+7, 3+7) *
Throughs First without overlap	(4+8, 3+7)
Left Turn # 3 Leading with overlap	(3+8, 3+7, 4+7) *
Left Turn # 3 Leading without overlap	(3+8, 4+7)
Left Turn # 7 Leading with overlap	(4+7, 4+8, 3+8) *
Left Turn # 7 Leading without overlap	(4+7, 3+8)

* another overlap phase is possible

*** Please press any key to continue. ***

Figure 3-8. Permitted Phase Sequences.

PASSER II-90 EMBEDDED DATA INPUT SCREEN	
Pretimed or Actuated (P or A) = P Ideal Saturation Flow = 1800 pcphgp1 Analysis Period, T = 15 minutes.	Sneakers, S = 2.0 Phase Lost Time, L = 4.0 Left Turn P+P (A or R) = A
LOS Delay Criteria : Total Delay, Multiplier M = 1.3	
A : 5 * M = 6.5	C : 25 * M = 32.5
B : 15 * M = 19.5	D : 40 * M = 52
E : 60 * M = 78	F > 60 * M = 78
Model Form : Negative Exponential	> Texas A & M Analytical Model < Australian Analytical Model Univ. of Texas Simulation Model Your Own Model Same Model Form
VD - Opp Sat Flow (vph) 1750 T - LT Critical Gap (sec) 4.5 H - LT Headway (sec) 2.5	
SL = Exponential Function of (VD, T, H)	
"P" for Pretimed or "A" for Actuated	

PASSER II-90 EMBEDDED DATA INPUT SCREEN	
Pretimed or Actuated (P or A) = P Ideal Saturation Flow = 1800 pcphgp1 Analysis Period, T = 15 minutes.	Sneakers, S = 2.0 Phase Lost Time, L = 4.0 Left Turn P+P (A or R) = A
LOS Delay Criteria : Total Delay, Multiplier M = 1.3	
A : 5 * M = 6.5	C : 25 * M = 32.5
B : 15 * M = 19.5	D : 40 * M = 52.0
E : 60 * M = 78.0	F > 60 * M = 78
Model Form : Generalized Regression	> HCM-Signalized Analytical Model < HCM-Unsignalized Analytical Model Univ. of Minn. Regression Model Ohio State Univ. Regression Model Your Own Model Same Model Form
SO - Opp Left Turn # (vph) 1400 B - 1st Power Coefficient 1.0 C - 2nd Power Coefficient 0.0 D - 3rd Power Coefficient 0.0	
SL = SO - B * VD + C * VD ² + D * VD ³	
"N" for Negative Exponential, "G" for Generalized Regression	

Figure 3-10. Embedded Data.

of-service evaluation, total delay adjustment factor, basic HCM delay criteria, permitted left turn models, and model coefficients. The embedded data, as modified by the user, will be printed out in the echo output.

Phaser Data

The program always provides two optimized intersection signal setting plans (PIN.SET). For each PIN.SET report, headers are coded, as shown in Figure 3-11. Help messages are displayed on the bottom half of the screen. The default value for Master Intersection and System Intersection will be 1 or the first intersection of the arterial system. The user can also change the offset reference from default System Intersection number 1 to any intersection in the current data set. System offset will be any value from 0 to the lower cycle length, with a default of 0. The movement for reference can be chosen from Movement 0, 2, and 6. The system default is "0", or the offset will be referred to the beginning of the arterial phases. As a reference point, the user can select the beginning or end of the coordinated phase. The default offset reference is the beginning of main street green, or the "Barrier Point" for dual-ring controllers found in the original PASSER II offset definition.

EDIT MENU

As shown in Figure 3-12, the Data Editing Menu will appear with eight (8) choices of data to edit. The user can press the <ESC> key to return to the Main Menu to either modify, load another data, or store data set on the disk.

Arterial System

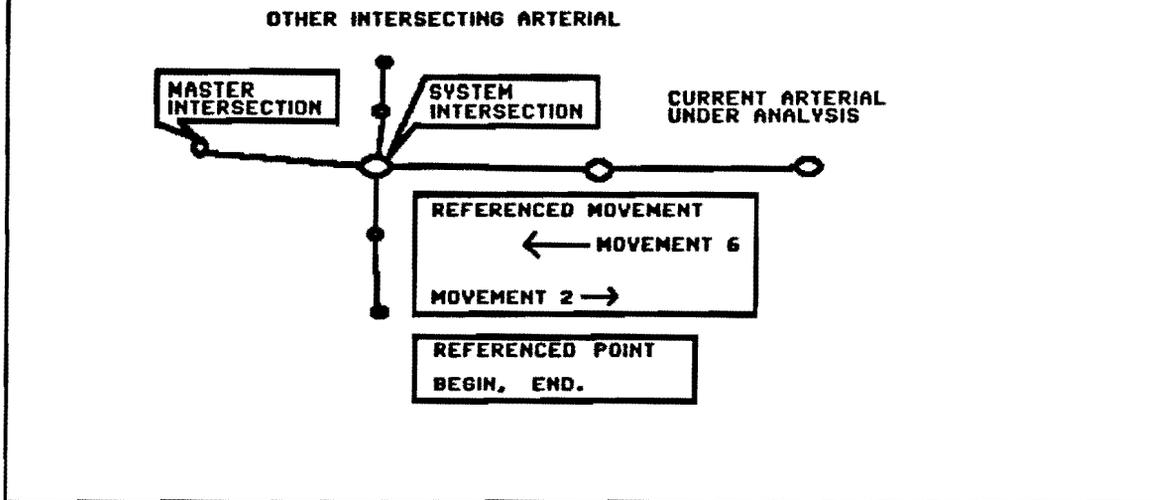
Once coded, the total number of intersections in the general arterial system can only be changed by adding or deleting particular intersections in the system. With that exception, the user can modify any data elements. This Edit Menu will also allow the user to select isolated, optimization, or simulation analysis. During simulation, the user can specify the offsets for each intersection. The user can store the existing offsets and ask for the optimization run. The offsets, as input, will be adjusted to the lower cycle length. The user may modify the intersection distance, travel speed, or queue clearance for all links by moving the cursor to the intersection which starts the link.

Queue clearance times are limited to 10 seconds. Sometimes a queue clearance will limit the width of the progression band. In this case, PASSER II-90 will reduce the queue clearance to provide the maximum bandwidth.

Intersection Information

The user can select the particular intersection to edit and change traffic volumes, saturation flows, and minimum phases for all intersections using the graphic intersection display. Follow procedures similar to Chapter 9 of the 1985 HCM when using the ASSISTANT function. Always use this option to modify left turn signal treatments in existing data sets. The

PASSER II-90 OFFSET REFERENCE



PASSER II-90 PHASER INPUT DATA

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

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

Two Signal Phase Interval Reports will be generated from this input data. These reports provide two signal timing plans from optimized PASSER II-90 settings. The first report "DEFAULT (1)" uses the arterial barrier as the default. The second report "DEFAULT (2)" uses Phase 2 to reference the offsets. The cursor key may be used to change settings as noted below.

Comment Line	: Remark line printed in output	[0-75 Characters]
Master Int	: Arterial Master Intersection	[Integer from 1 to 4]
Sys Int	: Arterial System Intersection	[Integer from 1 to 4]
Sys 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 3-11. Phaser Data.

Texas Department of Highways and Public Transportation
----- P A S S E R I I - 9 0 -----
Version 1.0

-- Edit Menu --

1. Edit arterial data.
2. Edit intersection movement data.
3. Edit intersection phasing data.
4. Simulate existing timing.
5. Edit arterial geometry data.
6. Add intersection.
7. Delete intersection.
8. Change cross street name.

Which item do you choose? (Press <ESC> for main menu.) 1

Figure 3-12. Edit Menu.

graphical input data screen can be used, without entering the ASSISTANT function, only if a protected left turn is used. The arterial name and intersection orientation will be displayed. Use the print screen feature to obtain a printout for data inventory.

The user can modify the phasing sequences for both the arterial and the cross street. The system will display all allowable signal phasing sequences for both the main street and cross street. Three different symbols are used in the phasing input screen. "Y" represents the phasing selected, "-" stands for an allowable phase sequence, and "=" represents the phase sequences not allowed. ASSISTANT function [F3] also displays the "allowable" selections. Note that the selection of "with overlap" and "without overlap" are mutually exclusive. In addition, the user may toggle the "Special Phasing" and then obtain phasing patterns when the normal phasing patterns defined in the "allowable" phase selection tables are not sufficient.

System Maintenance

The user may use the Edit Menu to add or delete an intersection, or change the cross street name by selecting the cross street names. However, remember that the system can only analyze up to 20 intersections. As shown in Figure 3-13, the user can select a specific intersection to be added, deleted, or modified. Enter the number of the intersection which the new intersection precedes. For example, select a "1" if the user wants to add it at the beginning of the system. However, if only one intersection is currently in the data set, the user will not be allowed to delete it. Any cross street name can also be changed using this menu. The user may simply select the number of that particular intersection and changes its name by typing in the new name.

OUTPUT MENU

After execution, the system will go to the Output Menu to review the results as shown in Figure 3-14. Be sure to run the program after changes have been made in the data set so that the current output file will match the input data. If the user selects the Output Menu from the Input Menu before PASSER II-90 is run, the output will be the file left from the last program run and may not correspond to the data now entered.

Review Output

The user can specify the different output level to be processed in the Input Menu and review or print specific output pages through the Output Menu as shown in Figure 3-15. The printouts include the arterial parameters (COVER), listing of system embedded data (EMBED.DAT), and intersection input (INPUT.DAT). It is important to recognize that, with the exception of the different offset reference schemes in the PIN.SET report, all other offset signal timing calculations are referenced to the beginning of main street green in the arterial travel direction "A". The program allows users to view the signal timing reports, intersection by intersection, and generates the best progression solution reports.

List of Cross Street Intersections

1. Mockingbird
2. University
3. Lovers Lane
4. Southwest
5. SYSTEM'S END

Place the new intersection before which intersection? (<ESC> to exit) : 1

List of Cross Street Intersections

1. Mockingbird
2. University
3. Lovers Lane
4. Southwest

Delete which intersection? (<ESC> to exit) : 1

Are you sure? (Y/N)
YES <input type="checkbox"/> NO <input checked="" type="checkbox"/>

List of Cross Street Intersections

1. Mockingbird
2. University
3. Lovers Lane
4. Southwest

Which cross street name do you want to change? (<ESC> to exit) : 1

Figure 3-13. System Maintenance.

Texas Department of Highways and Public Transportation
----- P A S S E R I I - 9 0 -----
Version 1.0

-- Output Menu --

1. View Input Echo.
2. View Error Message.
3. View Best Solution.
4. View Arterial Summary.
5. View Measures of Effectiveness.
6. View Pin Setting.
7. View Time/Space Diagram.
8. Print Hardcopy.
9. Leart Simulation.

Enter Choice or <ESC> to return to main menu : 1

Figure 3-14. Output Menu.

Texas Department of Highways and Public Transportation
----- P A S S E R I I - 9 0 -----
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 3-15. Print Menu.

The next output reports the level of service evaluations for each phase movement (BEST.SOLN). The output summarizes 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. System-wide measures of effectiveness are summarized in the total arterial system performance (ART.MOE). The user can examine two sets of controller phase interval setting reports. These are 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 generate coordinated offsets with respect to the system intersection to facilitate the implementation of the optimal timing plans in an open-loop signal network.

The time-space diagram allows the user to examine the optimized timing plan corresponding to the best arterial progression solution, if the report (TS.DIAGM) is requested. Since only 80 columns of 24 lines are available on each screen display, two adjustments were made in PASSER II-90. The progression bands are pushed and scales adjusted so that the time-space diagram provides maximum viewing with the bands starting 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 accumulated distance measured on the left-hand side of the diagram. The progression bands in the PASSER II-90 time-space diagram are described by the different printer characters.

Print Output

All portions of PASSER II-90 output, as shown previously in Figure 3-15, will be sent to the printer. The output will be produced in the form of 66 lines per page with 80 columns per line; no special printer is required. The user can select portions of the program output not wanted by toggling the <RETURN> key to selectively turn off a particular portion of the output. The user can also hit <ESC> at any time to return to the Main Menu and compare the PASSER II-90 results 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 changes in the input data will not be visible in the output until the PASSER II-90 program is run again.

Animation

One of the major enhancements in PASSER II-90 is the capability to view dynamic traffic simulation of the given traffic conditions. The animation system, called LEART, was designed to provide an understanding of signal timing operations under dynamic traffic conditions. This section covers the basic modeling approach and how to interpret the dynamic graphics system. During program execution, a data file, ARTDATA, is generated after each PASSER II-90 program execution. All simulations in LEART are based on those data input for each PASSER II-90 data file. This information includes the number of lanes for the main street and each intersected road, the distance between two intersections, the amount of traffic flow, the cycle length, and the phasing times specified in the PASSER II-90 input and output processors.

The system will show the number of intersections specified in the data file, ARTDATA. Red blocks indicate cars stopped by red lights; white blocks indicate cars intending to turn left at the next intersection; yellow blocks indicate those turning right. The deep-blue rectangular boxes in the middle of the main street between two intersections represent a virtual extended road. The number above it shows the number of cars in the box currently going B Direction while the number below it indicates A Direction cars.

The operating speed, movement direction, intersection number, and lane number of a car are determined by a random generator to fit average conditions. Two different bar graphs show the percent of volume arriving during green, PVG, and the average delay, DELAY. The two bar graphs are updated and refreshed every quarter of a cycle, while the cumulative statistics are updated every cycle. The number of cars simulated in this program appears in the upper left of the screen. In the upper right part of the screen is the simulation clock, incremented every run-second. The percentage of its speed compared to a real clock is shown just below it. The [F1] key will display a brief on-line help menu for the user-selective functions. As illustrated in Figure 3-16, general help information is accessed through function key [F1]. The user can also press keys "h","H" or "l","L" to adjust vehicle speed, either slower or faster, from the normal maximum display speed. Figure 3-17 illustrates the [F2] key which provides information on the distance between each of the two consecutive signalized intersections for the case being simulated. Similar to the Help Key [F1], keys "i" and "I" can also be used to obtain the arterial information.

The LEART Main Menu can be toggled by hitting any nonreserved key, such as the space bar. The Main Menu shows the different options for selecting the number of intersections to simulate, displaying cumulative statistics, toggling back to the arterial simulation screen, viewing the overall signalized intersections, or exiting the system. Two sets of three-dimensional bar graphs, shown in Figures 3-18 and 3-19, display the cumulative PVG and DELAY statistics. DELAY statistics reflected on the bar graphs are incremented every cycle as output from the PASSER II-90 main program.

As shown in Figure 3-20, select either "e," "E," or <ESC> in the LEART Main Menu to exit the LEART simulation program and return to the PASSER II-90 main system. If LEART is run under the PASSER II-90 system, it will lead the user back to the PASSER II-90 Output Menu. If the program is run during stand-alone execution, it will lead back to the DOS environment.

ASSISTANT FUNCTIONS

The DATA INPUT ASSISTANT FUNCTION was designed to assist users inputting movement-related information, such as movement volume (VOLUME), saturation flow rate (SAT FLO), and minimum phase time (MIN PHS). The most practical enhancement to the PASSER II-90 input/output processor is the programming ASSISTANT that allows users to calculate saturation flow rates for protected operations using analysis procedures similar to and beyond those used in the 1985 Highway Capacity Manual (HCM). The recommended input sequence and data modification features are described in the following section.

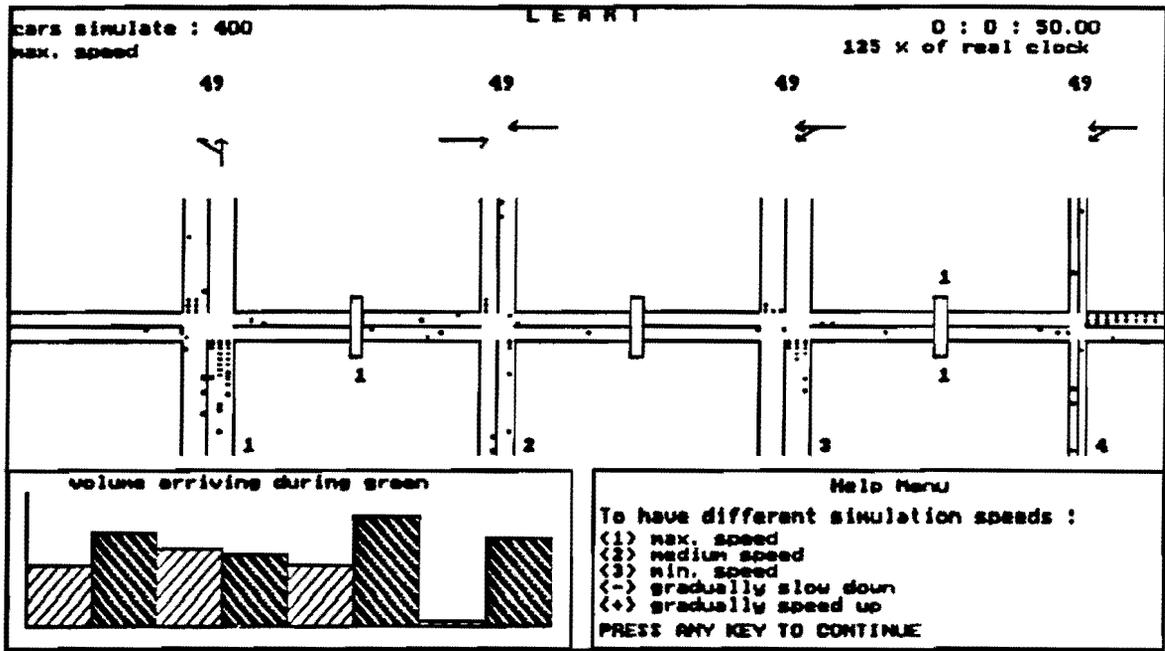


Figure 3-16. General Help Information.

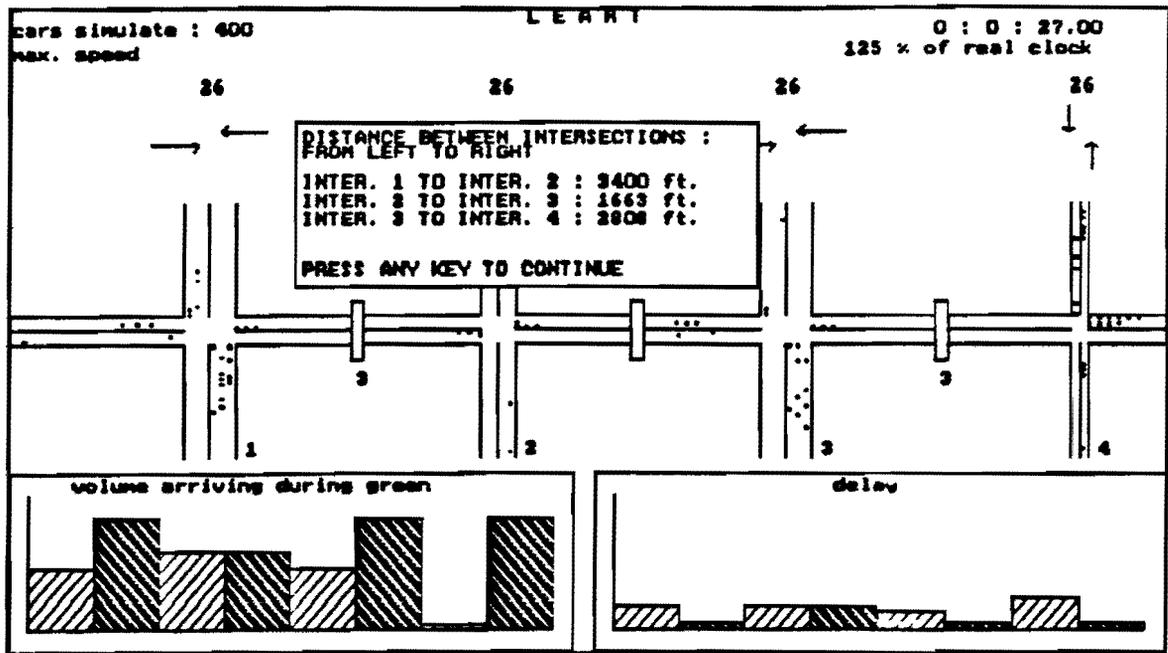


Figure 3-17. Arterial Help Information.

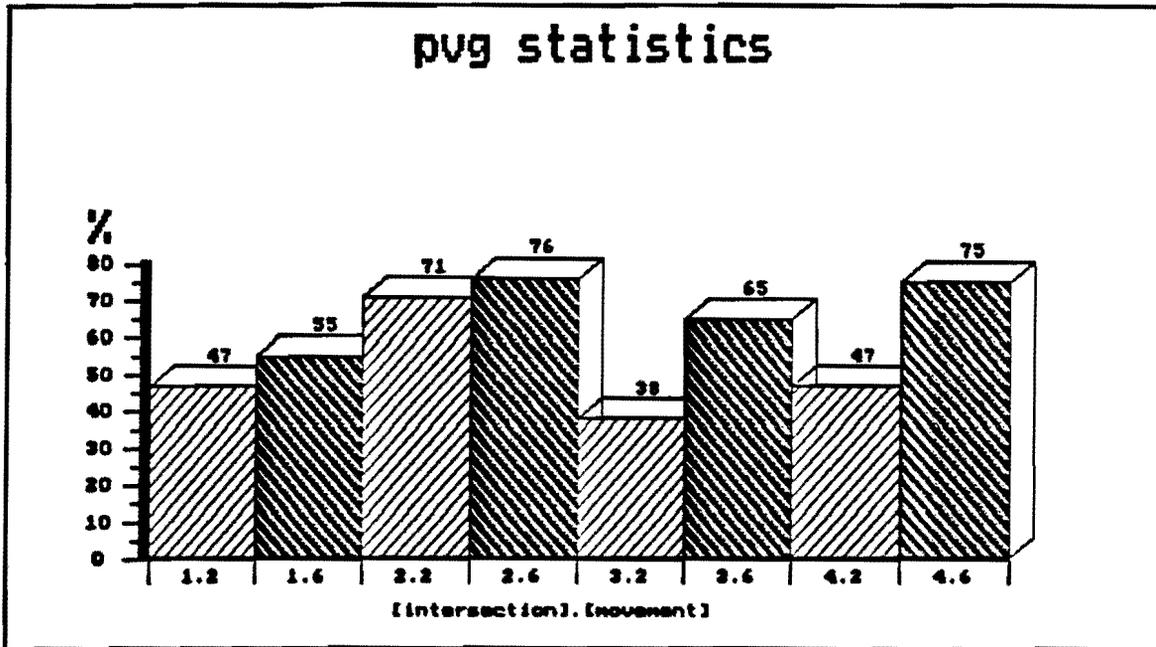


Figure 3-18. PVG Cumulative Statistics.

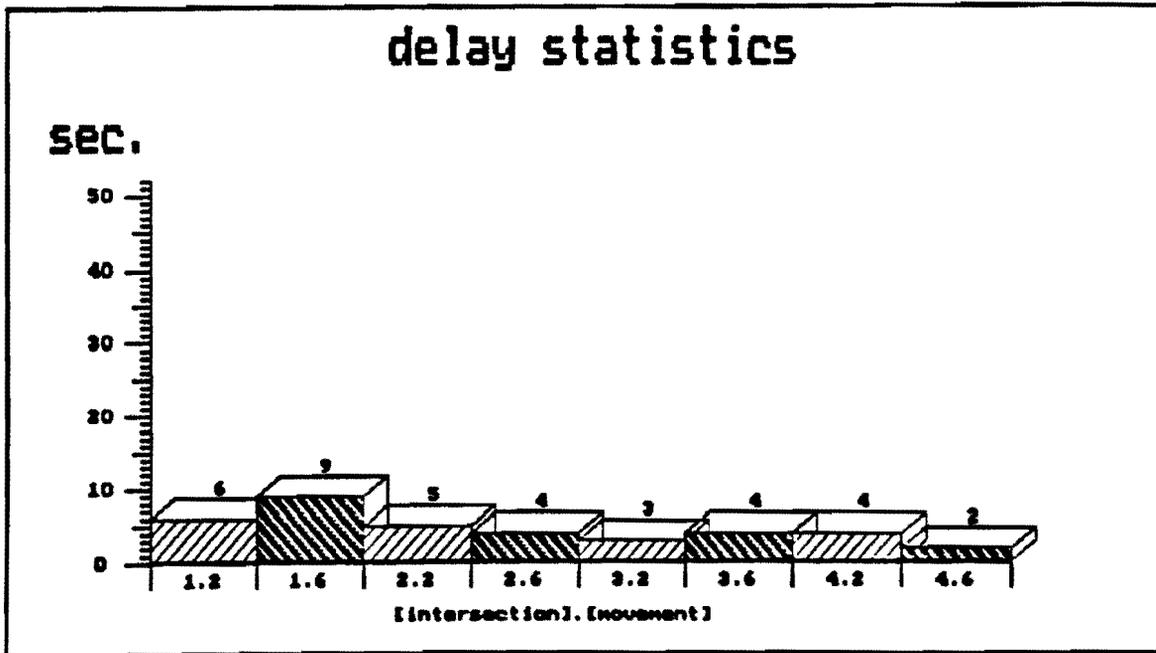


Figure 3-19. DELAY Cumulative Statistics.

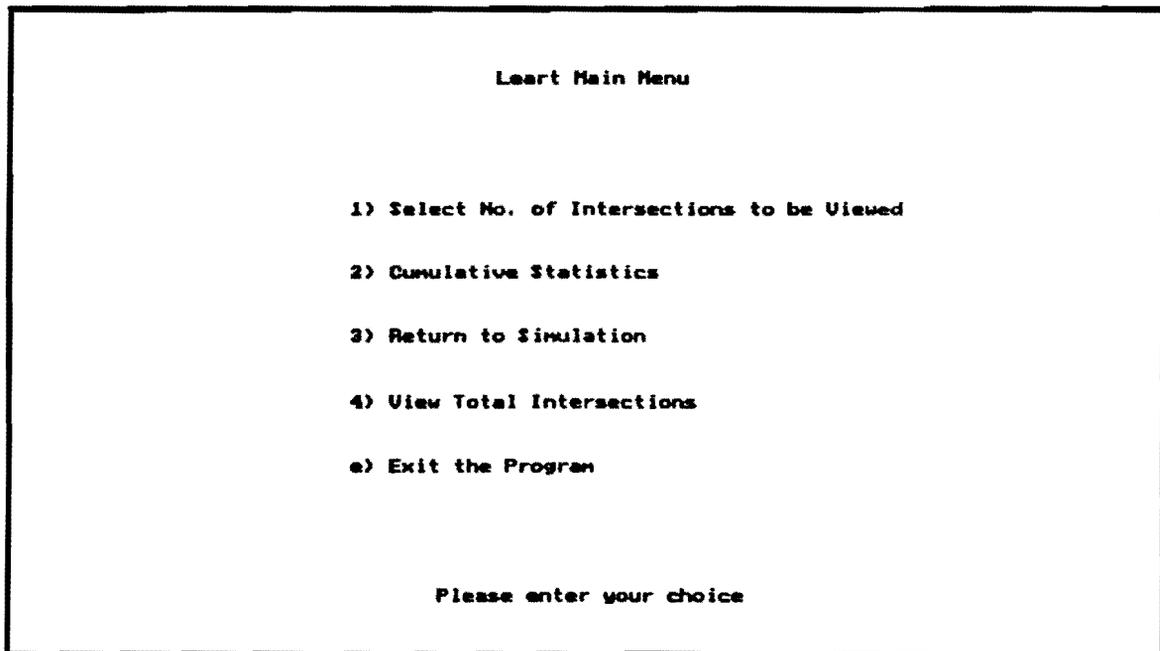


Figure 3-20. LEART Main Menu.

Left Turn Bay

The first question the user should answer is whether a left turn bay exists on each approach to the intersection. An example is shown in Figure 3-21. The user should identify the presence or absence of the left turn bay or dedicated left turn lane by toggling the function key [F2], until the correct left turn treatment is displayed. The difference between BAY and NO BAY conditions is shown by shading the area of the VOL, SAT FLO and MIN PHS for that movement and by the number displayed in the Left Turn Treatment box [].

Traffic Volume

The next action is to enter the traffic volumes for each approach to the intersection. Using the ASSISTANT [F3] function allows the user to calculate traffic volumes and adjust for the peak hour factor, as shown in Figures 3-21 and 3-22. 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.

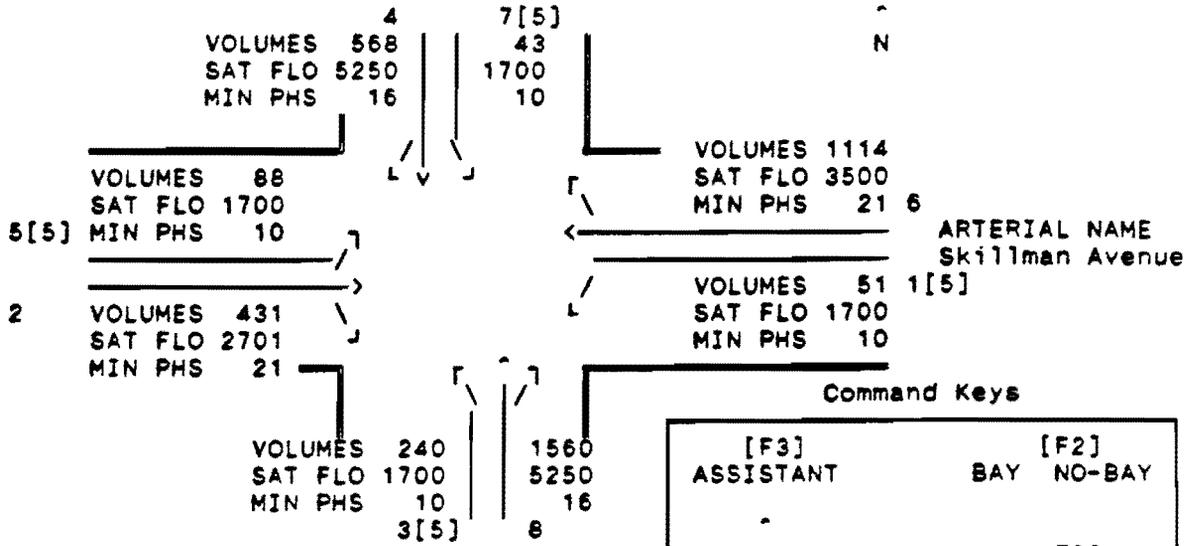
Volume Calculation

There are two distinct features in PASSER II-90 for handling the various left turn treatments for those cases with or without protected left turn bays. First, the program will allow the user to designate protected left turn bay while inputting corresponding left turn movements. Then, the program will generate the appropriate type of left turn signal treatment and prompt the user for the necessary actions in the ASSISTANT window, according to the given input volume data. Separate capacity approximation and performance evaluations have been made in PASSER II-90 to account for differences in left turn traffic movements with or without protected left turn bays.

As indicated in Figure 3-21, a unique number will be displayed in brackets or "[]" adjacent to the movement number to designate the particular left turn signal treatment that is being specified in the analysis. The "Left Turn Signal Treatment" or "NPP" values will also be displayed in both the Input Data Echo printout (INPUT.DAT) and the Best Solution printout (BEST.SOLN). NPP identifies the left turn signal treatment being input by the user through 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 [system default]
NPP = 6 - with left turn bay, protected/permitted

If the left turn movement has no bay, the program will request input 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 volume has been input with a left turn bay, the program will ask for THROUGH TRAFFIC and RIGHT TURN TRAFFIC. The total traffic volume is the sum of these. Note that RIGHT TURN TRAFFIC is not stored as an entry. Therefore, its effects on the calculation of SAT FLO are incorporated in the THROUGH TRAFFIC.



TRAFFIC VOLUME CALCULATION

LEFT TURN PROTECTED ONLY ? Y
 LT BAY, "PROTECTED PHASE" OPERATION
 NEED: VOLUMES, SAT FLO, MIN PHS
 LEFT TURN TRAFFIC (VPH) = 88
 PEAK HOUR FACTOR = 1.00
 LEFT TURN TRAFFIC (VPH) = 88

PLEASE PRESS ANY KEY TO CONTINUE.

SATURATION FLOW RATE CALCULATION

IDEAL SAT. FLOW (VPHGPL) = 1800
 NUMBER OF LANES (1 TO 2) = 1
 LANE UTILIZATION FACTOR = 1.00
 AVG. LANE WIDTH = 12
 % GRADE = 0.0
 % HEAVY VEHICLES = 0.0
 LEFT TURN FACTOR = 0.95
 IS THE AREA TYPE CBD (Y/N) ? N
 AREA TYPE FACTOR = 1.00
 SATURATION FLOW (VPHG) = 1710

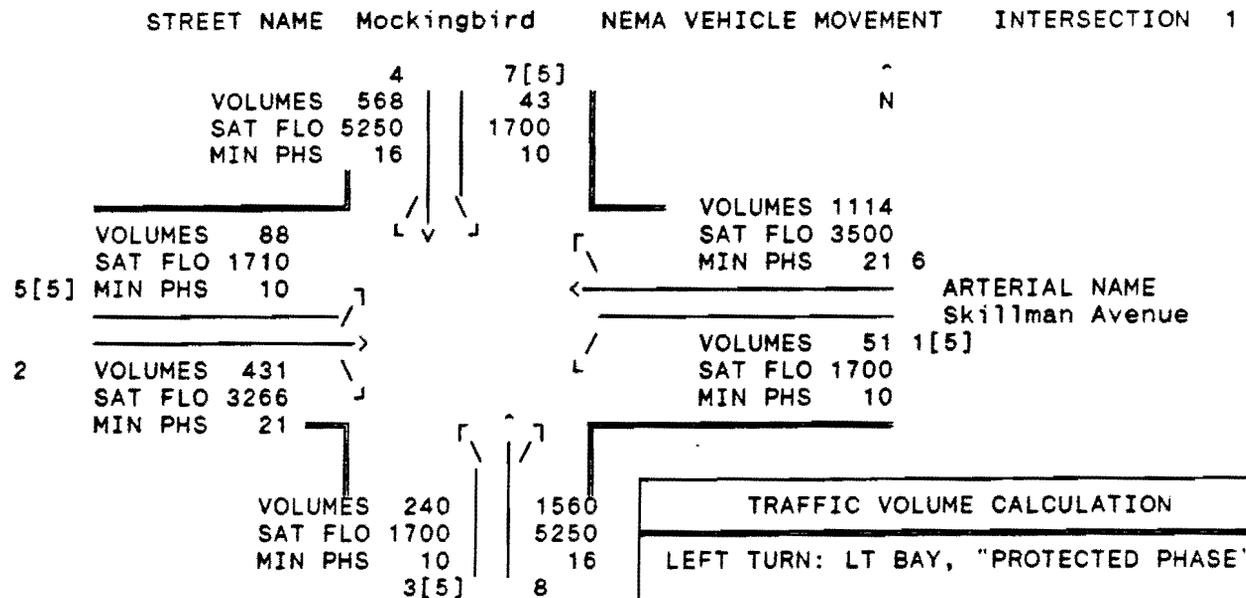
PLEASE PRESS ANY KEY TO CONTINUE.

MINIMUM PHASE TIME CALCULATION

MINIMUM PHASE TIME (SEC) = 10

PLEASE PRESS ANY KEY TO CONTINUE.

Figure 3-21. Assistant Function for Left Turn Movement.



TRAFFIC VOLUME CALCULATION

LEFT TURN: LT BAY, "PROTECTED PHASE"

THROUGH TRAFFIC (VPH) = 400
 RIGHT TURN TRAFFIC (VPH) = 31
 TOTAL TRAFFIC (VPH) = 431
 PEAK HOUR FACTOR = 1.00
 TRAFFIC VOLUME (VPH) = 431

PLEASE PRESS ANY KEY TO CONTINUE.

SATURATION FLOW RATE CALCULATION

IDEAL SAT. FLOW (VPHGPL) = 1800
 NUMBER OF LANES (1 TO 3) = 2
 LANE UTILIZATION FACTOR = 0.95
 AVG. LANE WIDTH = 12
 % GRADE = 0.0
 % HEAVY VEHICLES = 10.0
 # PARKING MANEUVERS = 0
 # BUSES STOPPING = 0
 RIGHT TURN FACTOR = 1.00
 LEFT TURN FACTOR = 1.00
 AREA TYPE IS NOT CBD.
 AREA TYPE FACTOR = 1.00
 SATURATION FLOW (VPHG) = 3266

PLEASE PRESS ANY KEY TO CONTINUE.

MINIMUM PHASE TIME CALCULATION

PEDESTRIAN "WALK" TIME (SEC) = 4
 PEDESTRIAN WALK SPEED (FPS) = 4.00
 PEDESTRIAN WALK DISTANCE (FT) = 50
 LESS HALF LANE WIDTH (FT) = 6.00
 MINIMUM PHASE TIME (SEC) = 15

PLEASE PRESS ANY KEY TO CONTINUE.

Figure 3-22. Assistant Function for Through Movement.

Saturation Flow Rate

The SAT FLO (Saturation Flow Rate) estimation is one of the most important pieces of information required in the input. Reasonably accurate values should be established since the movement phase is calculated based on the movement's volume-to-saturation flow ratio. Saturation flow, in vehicles per hour of effective green, must have the same time unit as the traffic volume. Consistent use of the ASSISTANT function to determine saturation flow rates for both paired left turn and through traffic volumes is highly recommended. The user will be prompted to use a number of input variables for left turn and through movements as shown in Figures 3-21 and 3-22. Please be advised that the saturation flow rates for left turns are to be calculated for unopposed turning as given by the ASSISTANT function. Do not manually change the left turn factors to those suggested by the 1985 Highway Capacity Manual as these factors will be determined within the program. Approximate saturation flow rates per lane can also be obtained from Table 3-1.

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 for a particular movement's phase. PASSER II-90 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 total 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. It is important that the minimum cycle length not exceed the sum of the minimum phase times of the conflicting or critical traffic movements on the arterial or cross streets.

The use of the ASSISTANT function is not mandatory but is recommended to provide on-line assistance for the engineering calculations. The use of the ASSISTANT function should be consistent for at least the same intersection or paired left and through traffic coming from the same approach to the intersection. The program will only recommend one possible value to be used. The user still needs to decide whether to overwrite it with a better value.

HELP INFORMATION

The following sections summarize the basic operation of the PASSER II-90 system. It illustrates how to start the system, record the optional date and time, and provides basic input/output keyboard instructions.

Basic Keyboard Instructions

Several operator interface functions have been added to PASSER II-90 to help user to achieve efficient operations. These computer keyboard help commands can be accessed by pressing the function key [F1]. These keyboard instructions are as follows:

TABLE 3-1. APPROXIMATE SATURATION FLOW RATE.

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

* Note - The through movement values indicated that if the ASSISTANT function was not to be used the user can still use these suggested values by combining the left turn effects in the through movement.

1. Entry data can be coded through the keyboard, or through the mouse interface, moving to a specific screen location. Data are entered by typing their values and pressing <RETURN>.
2. Default values can be entered by pressing <RETURN>. They can also be overwritten by typing over the displayed values.
3. The global and local help windows can be activated by pressing function key [F1] or function key [F2].
4. The ASSISTANT function is activated by pressing function key [F3].
5. The FILE DIRECTORY function can be activated at any time by pressing function key [F4].
6. The external DOS SHELL function can also be reached at any time by pressing function key [F5] to enter the DOS command line.
7. The global PASSER II-90 help menu can be reached and activated at any time by pressing function key [F6].
8. Press <ESC>, at any time, to exit the current program.
9. It is recommended to use the cursor keys when entering or modifying data using the input and output processor.
10. To stop the input and output processor, press the [Ctrl] and [Break] (Scroll Lock) keys and return to DOS. However, the data will not be saved.

It should be noted that answering "Yes" or "No", or using the cursor keypad, is allowed. The user may either use "YES", "yes", "Y", or "y" for a positive answer, and "NO", "no", "N", and "n" for a negative answer. On the other hand, the user can also use to the cursor key pad for these questions. For example, the "<->" represents "YES", and ">->" shows "NO".

System Help Instructions

Three information keys can be used at any time. The [F1] key illustrates all functions of the keyboard. The [F2] key explains the terminology used in PASSER II. The [F6] key explains the system menu structure. The user can also use a wordprocessor to modify the contents for agency-specific help information by changing the contents of the MENU file.

DOS Shell Functions

The DOS Shell Function, accessed through the [F5] key, enables users to assess additional system maintenance functions by entering any DOS command within the PASSER II-90 system. For example, the user can check the storage capacity of the floppy disk before executing the program, format the data diskette, or use the communication program to download the data files from other computers, without having to exit from the system.

4. OUTPUT INTERPRETATION

PASSER II-90 output is divided into eleven report types and grouped into six parts. The first part contains a simplified restatement or echo printout of the input data per intersection. The second part contains all error messages. The third section summarizes the optimized solution parameters for arterial progression or the evaluation of the signal timing settings. The fourth section contains signal timing and phase evaluations for all phases at each intersection. The fifth part of the output interprets the user-specified signal timing of each intersection. It should be noted that all other signal timings are still referred to the beginning of main street green of master intersection number 1 in the output. The last portion of the output is the optional time-space diagram and dynamic visualization simulation. As illustrated, all output reports are shown with an abbreviation.

- o Cover Page (COVER)
- o Embedded Data (EMBED.DAT)
- o Input Data Echo (INPUT.DAT)
- o Error Message (ERROR.MSG)
- o Arterial Summary (ART.SUMY)
- o Intersection Summary (INT.SUMY)
- o Intersection Best Solution (BEST.SOLN)
- o Arterial System Performance (ART.MOE)
- o Intersection Signal Settings (PIN.SET)
- o Time-Space Diagram (TS.DIAGM)
- o Dynamic Simulator (LEART)

In PASSER II-90, signal timing is provided for each intersection. Every intersection is identified by a unique sequential integer number and cross street name. Coordination offsets are defined from the start of the signal phasing of intersection 1 to the start of the arterial phasing or the end of the cross street of each intersection. Note that in the best solution report and time-space diagram, the offsets are always referenced to the beginning of the arterial green phase of the first intersection. However, PASSER II-90 will automatically produce two sets of signal controller phase interval setting reports (PIN.SET), basic optimal signal timing solutions having offsets calculated to the user's specifications.

COVER PAGE (COVER)

Figure 4-1 lists the user's input data, including information related to the arterial, individual intersection, and corresponding movements.

EMBEDDED DATA (EMBED.DAT)

This section summarizes all default data in PASSER II-90. The major components, as shown in Figure 4-2, include:

TRAFFIC CONTROL TYPE: This provides different delay calculations for either pretimed or actuated operations.

(COVER)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
PASSER II-90 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 DEC 90

Dallas Skillman Avenue DISTRICT 18 06/22/89 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	4.0

Figure 4-1. Cover Page.

(EMBED.DAT)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
PASSER II-90 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 DEC 90

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
ANALYSIS PERIOD:	LEFT TURN PHASING:	B - 19.5 SECS/VEH
15 MINUTES	APPROACH-BASED	C - 32.5 SECS/VEH
		D - 52.0 SECS/VEH
		E - 78.0 SECS/VEH
		F - 78.0 SECS/VEH

PERMITTED LEFT TURN MODEL: (6) TTI MODEL

MODEL COEFFICIENTS: VO = Opp Sat Flow (vph) = 1750
T = LT Critical Gap (sec) = 4.5
H = LT Headway (sec) = 2.5

Figure 4-2. Embedded Data.

LEFT TURN SNEAKERS: This provides the default left turn movements allowed during the yellow or clearance interval of a permitted phase; a value of 2.0 vehicles is used as the default value.

IDEAL SATURATION FLOW: 1800 vphgpl, or 1800 equivalent passenger car units per hour green per lane, is assumed for the default operation.

PHASE LOST TIME: The time of 4.0 seconds is assumed for default.

ANALYSIS PERIOD: The period of 15 minutes is assumed for default.

LEFT TURN PHASING: This designates the delay or output evaluation for the combined phase operation. It can be either "APPROACH-BASED" or "RING-BASED." Approach based is assumed.

DELAY UNIT: As default, PASSER II-90 uses the total delay calculated from the stop delay as defined in the 1985 Highway Capacity Manual. Either "TOTAL DELAY" or "STOP DELAY" can be used.

LOS DELAY CRITERIA: The level-of-service evaluation uses either the default delay criteria supplied in the program or user input. Total delay evaluation will be displayed initially.

PERMITTED LEFT TURN MODEL: Two categories of permitted left turn models can be selected: the Negative Exponential or the Generalized Regression model. PASSER II-90 uses the TTI model (6) as the default.

MODEL COEFFICIENTS: These are coefficients for the permitted left turn models. The default model coefficients are for the TTI model.

The user should carefully review this embedded data output to verify whether the data are correct, double-check questionable default data settings, and if necessary, and supply the correct data to the program. Each data file will be provided with the needed embedded data automatically if local data do not exist or incorrect values have been added.

INPUT DATA ECHO (INPUT.DAT)

The first output is the restatement of the coded input data as shown in Figure 4-3. Traffic volumes, saturation flow rate, and minimum green times, as coded, are provided for each intersection phase movement. Even though the program has built-in error-checking, the user should always make sure the numbers are correctly entered. For example, the computer cannot distinguish whether a coded volume of 430 should have been 340. It is recommended that the user check for coding errors before proceeding with the analysis.

ERROR MESSAGES (ERROR.MSG)

PASSER II-90 checks are made in the interactive PASSETUP and in the signal timing routine. The error messages, as shown in Figure 4-4, covered

(INPUT.DATA)

PASSER II-90 TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 DEC 90

**** 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
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
LT 3 LEADS (3+8)
WITH OVERLAP

		ARTERIAL STREET				CROSS STREET			
PHASES	(NEMA)	5[5]	6	1[5]	2	3[5]	4	7[5]	8
VOLUMES	(VPH)	88	1114	51	431	240	568	43	1560
SAT FLOW RATE	(VPHG)	1700	3500	1700	2701	1700	5250	1700	5250
MINIMUM PHASE	(SEC)	10	21	10	21	10	16	10	16

Figure 4-3. Input Data Echo.

(ERROR.MSG)

PASSER II-90 TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 DEC 90

**** CODING ERROR MESSAGES ****

NO APPARENT CODING ERRORS

Figure 4-4. Error Message.

in this section will run only after the majority of the input has successfully passed the input/output processor. PASSER II-90 has two main types of error messages and program codes to alert the user of any remaining data errors and/or any potential coding problems to continue the analysis. The first error message occurs in the CODING ERROR MESSAGE which immediately follows the input echo reports. The program will terminate due to these input data coding errors. The second type of error message will not terminate the program execution but merely produce a warning message in the BEST SOLUTION output section following the message NO APPARENT CODING ERRORS. However, only limited messages will be displayed due to the memory limitation. It is recommended that the user check the first several messages since most errors are related. The error messages and suggested actions are as follows:

TYPE I. ERROR MESSAGES

NO ARTERIAL PHASE PATTERNS ARE SPECIFIED

At least one signal phase sequence option must be specified for all signalized intersections in the system.

MAIN ST MIN GREENS OF LEFT TURNS DO NOT EQUAL THE MIN GREENS OF THEIR CORRESPONDING THROUGH MOVEMENTS AS REQUIRED FOR PHASE SEQUENCES WITH NO OVERLAP

When phase sequencing with no overlap has been specified, left turn movements on the major street (1,5) must equal their corresponding through movements' (6,2) minimum green. Please check the minimum phase times specified in the input data file.

CROSS ST MIN GREENS OR LEFT TURNS DO NOT EQUAL THE MIN GREENS OF THEIR CORRESPONDING THROUGH MOVEMENTS AS REQUIRED FOR PHASE SEQUENCES WITH NO OVERLAP

When specifying phase sequencing with no overlap, the left turning movements on the minor street (3,7) must equal the corresponding through movement's (8,4) minimum green. Check your minimum phase time and the necessity of the NO OVERLAP PHASE option.

THE SUM OF CRITICAL MINIMUM GREENS EXCEEDS THE LOWER CYCLE LENGTH LOWER CYCLE = SEC. --- SUM MIN GREENS = SEC.

The largest sum of the minimum phases of the following movement combinations exceeds the lowest cycle length:

$$\begin{array}{l} 1 + 2, 5 + 6 \\ 3 + 4, 7 + 8 \end{array}$$

Recheck your minimum phase time requirements or increase your lowest cycle length used for the arterial.

NUMBER OF INTERSECTIONS REQUESTED DOES NOT MATCH NUMBER OF INTERSECTIONS FOUND

Please check the number of intersections specified in the ARTERIAL HEADER against the INTERSECTION HEADER.

VOLUMES FOUND WITHOUT SAT. FLOW RATE ON MOVEMENT n

A saturation flow rate must be specified for all the movements having traffic volumes. Saturation flows may have been unintentionally omitted for movement "n" at the intersection.

TYPE II. WARNINGS

X - RATIO EXCEEDS 1.20 OVER-SATURATED STATISTICS CANNOT BE ESTIMATED

When the movement is oversaturated, an excessively long queue may exist and not be able to clear throughout the study period. The probability of queue clearance will remain zero due to ineffectual signal operations. Increase saturation flow or reduce volume to alleviate this problem.

PLOTTING LIMITS EXCEEDED

Errors may occur because of an improper scale coded in the ARTERIAL HEADER for the timespace plot. Plotting may not be completed. Adjust the "Y-Scale" to a larger number.

If no errors are detected, the "NO APPARENT CODING ERRORS" message will be printed as shown in Figure 4-4.

ARTERIAL SUMMARY (ART.SUMY)

Figure 4-5 illustrates the arterial's progression report. Selected optimal cycle length, maximum progression bands in the "A" and "B" (outbound and inbound) directions, and average progression speeds are displayed. Maximum efficiency and attainability are noted. General "comments" regarding the quality of the progression solution are given along with suggestions on how to increase arterial progression attainability. These include:

CYCLE: The common cycle length (seconds) selected as the best cycle for progression should be used at each intersection.

BAND A.: The "A" direction bandwidth, in seconds, indicates the period of time available for traffic to flow within the band from one end of the arterial to the other intersections.

BAND B.: The "B" direction bandwidth in seconds.

EFFICIENCY: The average fraction of the cycle used for progression, ranging from 0.00 through 0.50, or more. Efficiency is equal to $(\text{Band A} + \text{Band B}) / (2 \times \text{Cycle})$. Acceptable values for the desirable progression solutions should normally be greater than 0.25.

(ART.SUMY)

PASSER II-90 TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 DEC 90

Dallas Skillman Avenue DISTRICT 18 06/22/89 RUN NO. 1

CYCLE LENGTH = 95 SECS (MAXIMIN CYCLE = 99 SECS)
EFFICIENCY = .40 (GREAT PROGRESSION)
ATTAINABILITY = 1.00 (INCREASE MIN. THROUGH PHASE)

BAND A = 37 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"

ATTAINABILITY 1.00 - 0.99 - "INCREASE MIN THRU PHASE"
0.99 - 0.70 - "FINE-TUNING NEEDED"
0.69 - 0.00 - "MAJOR CHANGES NEEDED"

Figure 4-5. Arterial Summary.

(INT.SUMY)

PASSER II-90 TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 DEC 90

**** INTERSECTION PERFORMANCE SUMMARY ****

CYCLE LENGTH = 95 SECS SYSTEM MAXIMIN CYCLE = 99 SECS

INT NO	CROSS STREET INTERSECTION	PHASE ART CRS	MIN. DELAY CYCLE (SECS)	INTERSECTION V/C RATIO	AVERAGE DELAY (SECS/VEH)	INT NO
1	Mockingbird	3 3	97	.92	34.2	1
2	University	1 2	69	.76	14.1	2
3	Lovers Lane	3 1	87	.88	27.0	3
4	Southwest	4 1	99	.93	32.6	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 THRU LEADING OR DUAL THRU (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)

Figure 4-6. Intersection Summary.

Attainability: The average fraction of the minimum through movement greens used for progression. The value can range from 0.00 through 1.00. Acceptable values for a desirable solution should normally be greater than 0.90. The attainability is calculated with the following formula:

$$\text{Attainability} = \frac{B_a + B_b}{G_a + G_b}$$

where:

- B_a = Bandwidth in the "A" direction, sec.
- B_b = Bandwidth in the "B" direction, sec.
- G_a = Smallest through green in the "A" direction, sec.
- G_b = Smallest through green in the "B" direction, sec.

AVERAGE SPEED THRU SYSTEM: The average slope of the through band, which represents the average progressive speed of the traffic on the arterial.

BAND A SPEED = NN: Average speed (mph) along the arterial in the "A" direction. Even though each link has its own optimal progression speed.

BAND B SPEED = NN: Average speed (mph) along the arterial in the "B" direction. Even though each link has its own optimal progression speed.

Note that the "MAXIMIN" cycle length of all the signals along the arterial is strategically placed alongside the selected optimal progression cycle length. Where delay is an important consideration, research indicates that the optimal progression cycle should be kept within plus or minus 10% of the maximin cycle length, if possible.

SYSTEM MAXIMIN CYCLE: The maximin cycle is the maximum of each intersection's minimum delay cycle length (Webster's Theory) shown in the Average Intersection Delay Summary. Included in this summary are each intersection's average delay and the average critical volume to intersection signal capacity ratios as defined in the 1985 HCM.

INTERSECTION SUMMARY (INT.SUMY)

PASSER II-90 determines the optimal timing plan for maximum arterial progression. It prints the "Best Solution" reports and the optimized signal settings and measures of effectiveness (MOEs) for each intersection and a summarized evaluation report for the entire arterial. Figure 4-6 shows the intersection performance summary output.

BEST SOLUTION (BEST.SOLN)

PASSER II-90 prints out an intersection summary for every signalized intersection along the entire arterial street. As shown in Figure 4-7, the optimal solution printout includes the selected cycle length, relative offset,

(BEST.SOLN)

PASSER II-90 TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 DEC 90

**** 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)

CONCURRENT PHASES	ARTERIAL STREET				CROSS STREET			
	2+5	2+6	1+6	TOTAL	3+8	4+8	4+7	TOTAL
PHASE TIME (SECS)	10.1	27.5	10.8	48.4	25.7	10.9	10.0	46.6
PHASE TIME (%)	10.6	28.9	11.4	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	10.8	37.6	25.7	20.9	10.0	36.6
V/C-RATIO	.81	.88	.42	.45	.62	.61	.40	.87
LEVEL OF SERVICE	D	E	A	A	B	B	A	E
DELAY (SECS/VEH)	73.5	33.4	44.0	23.9	35.6	37.1	44.5	33.6
LEVEL OF SERVICE	E	D	D	C	D	D	D	D
QUEUE (VEH/LANE)	1.8	10.3	.6	2.9	2.4	5.8	.5	14.5
STOPS (STOPS/HR)	109.	1028.	46.	302.	205.	481.	40.	1387.
TOTAL INTERSECTION DELAY	34.22 SECS/VEH				FUEL CONSUMPTION		MINIMUM DELAY CYCLE	
					82.37 GAL/HR		97 SECS	

Figure 4-7. Intersection Best Solution.

phase sequence, and phase interval length for both the arterial street and cross street directions. The relative offsets and individual phase length are expressed in both seconds and percentage of cycle length. Then the primary measures of performance or measure of effectiveness are provided to evaluate the solution quality at every intersection. The best solution outputs the analysis results for every intersection. First, the calculated offset is printed, expressed in both seconds and percent of cycle, followed by the selected arterial phase sequence as optimized by PASSER II-90. Next, the green times, including clearances, are printed for each movement, expressed in seconds and percent of cycle length. The sum of the green time for the arterial and the cross street are also given. Sometimes a queue clearance will limit the width of the progression band. In this case, PASSER II-90 will reduce the queue clearances to 10 seconds to provide the maximum bandwidth.

MOVEMENTS (NEMA): PASSER II-90 provides the best solution evaluation according to the default NEMA phase movements.

PHASE TIME (SEC): The optimal timing plan or signal timing parameters are indicated for each NEMA phase movement and expressed in seconds.

V/C-RATIO: The volume-to-signal capacity ratio, or V/C-ratio, is expressed as a fraction.

DELAY (SECS/VEH): The delay, either stopped or total, is calculated for each phase movement. It is expressed in seconds per vehicle.

LEVEL OF SERVICE: The level-of-service is evaluated for both the V/C-RATIO and the DELAY.

QUEUE (VEH/LANE): The maximum queue length per lane predicted to occur during the study duration is expressed in vehicles per lane.

STOPS (STOPS/HR): The average number of vehicular stops, including both full or partial stops, is expressed in stops per hour.

TOTAL INTERSECTION DELAY: The average total delay (veh-hr/hr) of all vehicles at this particular intersection. This value represents the average number of vehicles in queue at the intersection at any moment.

MINIMUM DELAY CYCLE: This is Webster's minimum delay cycle length estimated for each intersection. This value can serve as a guide for selecting the system cycle length for the progression solution.

SYSTEM PERFORMANCE (ART.MOE)

System Performance is a printed summary of the entire arterial as shown in Figure 4-8. The optimal solution printout includes the selected cycle length, bandwidth, and progression speed for each travel direction. The primary measures of performance related to progression efficiency and attainability evaluate the quality of the optimal solution. The following MOEs are provided for the entire arterial:

(ART.MOE)

PASSER II-90 TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 DEC 90

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

Dallas Skillman Avenue DISTRICT 18 06/22/89 RUN NO. 1

CYCLE LENGTH = 95 SECS BAND A = 37 SECS BAND B = 38 SECS
AVERAGE PROGRESSION SPEED - BAND A = 32 MPH BAND B = 36 MPH

.40 EFFICIENCY 1.00 ATTAINABILITY

AVERAGE INTERSECTION DELAY TOTAL SYSTEM DELAY TOTAL NUMBER VEHICLES
28.1 SECS/VEH 100.3 VEH-HR/HR 12861.

TOTAL SYSTEM FUEL CONSUMPTION TOTAL SYSTEM STOPS MAXIMIN CYCLE
260.11 GAL/HR 10060. STOPS 99 SECS

Figure 4-8. Arterial System Performance.

(ART.MOE)

PASSER II-90 TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 DEC 90

EFFICIENCY VERSUS CYCLE LENGTH

	CYCLE LENGTH	CUMULATIVE EFFICIENCY
	85	.33
	90	.38
	95	.40
BEST SOLUTION	95	.40

Figure 4-9. Comparisons of Efficiency and Cycle Length.

TOTAL SYSTEM DELAY: Total delay (veh-hr/hr) of all vehicles in system.

AVERAGE INTERSECTION DELAY: The average delay per vehicle (sec/veh), estimated from the total system delay and the total number of vehicles.

TOTAL SYSTEM STOPS: Total number of stops in the system (stops/hour).

TOTAL SYSTEM FUEL CONSUMPTION: The total fuel consumed is estimated from the travel at cruise speed, delays, and stops at the signals (gal/hour).

MAXIMIN CYCLE: This is the maximum of the minimum delay cycles estimated at each intersection. This value can serve as a guide for selecting the system cycle length for progression.

CYCLE LENGTH VERSUS EFFICIENCY: PASSER II-90 selects the optimal cycle length, based on the maximum bandwidth efficiency. A table is produced, as shown in Figure 4-9, to exhibit the best efficiency found to that cycle and the selected cycle length for the best solution.

INTERSECTION SIGNAL SETTINGS (PIN.SET)

The intersection signal setting report, or "PIN.SET" report presents the optimized signal timing solutions for all the intersections in the analysis. This controller pin-setting report, as shown in Figure 4-10, was also designed for direct implementation of PASSER II-90's signal timing solutions on eight-phase, microcomputer-based signal controllers having the "Easy Programming" feature. In this report, all offsets are referenced to the system intersection, and to the systemwide background cycle length selected. The reports are then repeated for each signalized intersection in the network. All the phase intervals are expressed by the NEMA movement numbers in which the odd numbers 1, 3, 5, and 7 are used for protected left turning movement volumes only. The "protection" must be provided by a protected left turn signal phase. Left turning volumes not protected by an exclusive lane and phase are combined with the adjacent through movements. Traffic volumes for movements 2, 4, 6, and 8 are total volumes for through plus right-turning vehicles, plus the left turns if not protected.

The signal timing information is summarized for each intersection on each page. Phase interval timings are listed by seconds, percent of cycle, and cumulative percent of cycle. Use this report for developing phase interval charts or a signal timing plan inventory. Note that the signal's progression offsets are calculated with respect to the designated system intersection as shown in Figure 4-10. The system intersection can be any intersection, including the master, in the progression system. All offsets are referenced with respect to the start of the arterial phase sequence, or equivalent to the end of the cross street phases. Offsets are given in seconds and percent (%) of the cycle. On the other hand, the "Cycle Count" will be referenced to the user's specification. This position is equal to the cross-to-main street phase barrier in the actuated controllers. The phase data will be illustrated for either the beginning or ending points with respect to the master or system intersection as specified by the user.

(PIN.SET)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
PASSER II-90 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 DEC 90

**** SUMMARY OF PASSER II-90 BEST SIGNAL TIMING SOLUTION ****
Dallas Skillman Avenue DISTRICT 18 06/22/89 RUN NO. 1

CYCLE = 95. SECONDS SPLIT = 1 2 3. OFFSET = 1 2 3.

DEFAULT(1) : SAME MASTER & REF INT, OFFSET TO BEGINNING OF MAIN STREET GREEN
MAST INT = 1 SYS INT = 1 SYS OFFSET = .0 REF MOVMT = 0 REF PNT = BEGIN

INTRSC 1 : Mockingbird COORD PHASE : 0 OFFSET : .0 SEC : .0%
*-[MASTER AND SYSTEM INTERSECTION]

DUAL-RING PHASE #	5	6	1	2	3	4	7	8
PHASE SPLIT (SEC)	10.1	38.3	10.8	37.6	25.7	20.9	10.0	36.6
PHASE SPLIT (%)	11.%	40.%	11.%	40.%	27.%	22.%	11.%	39.%
PHASE REVERSAL	--	--	2	1	--	--	8	7
LEFT TURN	LEAD	--	LAG	--	LEAD	--	LAG	--
CONCURRENT PHASES	2+5	2+6	1+6	3+8	4+8	4+7	MAIN	CROSS
DURATION (SEC)	10.1	27.5	10.8	25.7	10.9	10.0	48.4	46.6
CYCLE COUNT (SEC)	.0	10.1	37.6	48.4	74.1	85.0	.0	48.4
CYCLE COUNT (%)	0.%	11.%	40.%	51.%	78.%	89.%	0.%	51.%

Figure 4-10. Intersection Signal Settings.

In the PIN.SET report, PASSER II-90 summarizes all related traffic signal timing settings for the signalized intersections. These include the master intersection, system intersection, offset reference point, relative offset, forced offset point for each phase, and the left turn phase reversals on each ring. It should be noted that the coordination offsets are based on the relative offset of the "master" intersection and the base offset point of the "system" intersection. The offset is not automatically referenced to intersection number 1 as in other portions of the output.

As defaults, two sets of intersection signal setting reports will be generated automatically. The first default offset point, expressed both in seconds and fractions of a cycle, is referenced to the start of phase number 1 of the master intersection. The second default progression offset point is referenced to the start of NEMA phase 2 of the master intersection. Each phase interval includes the green time expressed both in seconds and percent of cycle length. The cycle counts are the cumulative percentages of each phase interval from the beginning of the cycle.

TIME-SPACE DIAGRAM (TS.DIAGM)

The final part of the PASSER II printout is a time-space diagram for the arterial problem, as seen in Figure 4-11. The time-space diagram includes optimal offsets, bandwidths for each direction, and selected cycle length. An optimized time-space diagram is provided. This permits the user to examine the optimized timing plan graphically. Therefore, it is important to optimally select the time-scale and distance-scale. Since there are only 80 columns of 25 lines on each screen display, two alternatives were created for outputting the time-space diagram. First, the progression bands were pushed so that the diagram could be fitted on the screen. Second, the time-space diagram was pushed to the vertical or distance scale to start the bands at the origin. A vertical reference line or "Zero-Offset Line" was added for easy evaluation of the optimized arterial signal timing solution. It is suggested that a larger vertical scale be used for the optimal time-space diagram if the arterial has a long spacing. This optional output can be optimized by providing the proper scale of the time-space diagram.

PASSER II-90 provides a time-space diagram to illustrate the optimal solution. The arterial and intersection names are illustrated as coded. The time scale is expressed in X seconds per character (default = 3 sec/char) on the horizontal axis. Time reads from left to right on the horizontal axis. The distance scale is expressed in Y feet per line (default = 150 feet/line) on the vertical axis. It reads from bottom to top with the accumulation distance measured on the left hand side of the time-space diagram.

The optimal time-space diagram is in an 80-column format. Its progression bands are described by the different printer characters. The arterial red or cross street phases is the space between characters at the designated intersection. Note that both the left and through movement phases are expressed as outbound or inbound green, and left turns are not expressed separately. The various green states of the arterial phases and bands are indicated by the following printout characters:

(TS.DIAGM)

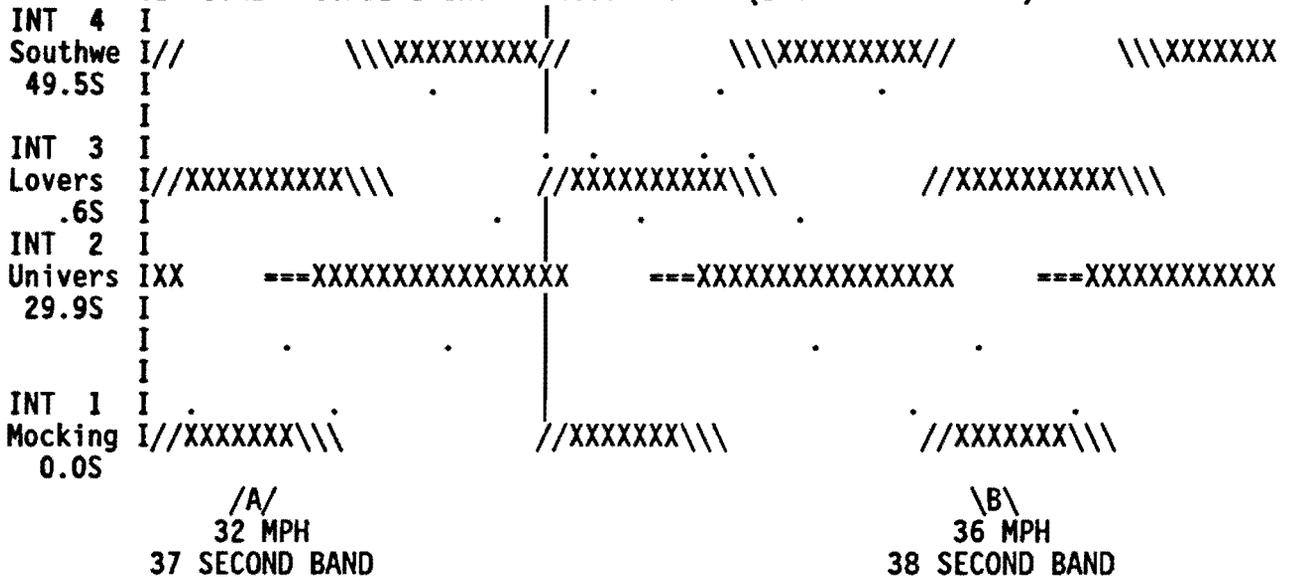
TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PASSER II-90

MULTIPHASE ARTERIAL PROGRESSION - 145101

VER 1.0 DEC 90

RUN NO 1 DISTRICT 18 Skillman Avenue 06/22/89 CYCLE = 95 SECONDS
HORIZONTAL SCALE 1 INCH = 40 SECS (1 inch = 10 characters)
VERTICAL SCALE 1 INCH = 4000 FEET (1 inch = 6 lines)



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

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

Figure 4-11. Time-Space Diagram.

- o A blank or " ", indicates the red or the cross street phase;
- o "==" DUAL LEFTS (1+5), indicates both left turn phases moves;
- o "XXX" DUAL THRU (2+6), indicates both through phases moves;
- o "///" LT 5 LEADS (2+5), indicates NEMA No.2 and No.5 lead;
- o "\\\" LT 1 LEADS (1+6), indicates NEMA No.6 and No.1 lead.

The "A" Direction Progression Band goes up and to the right, and "B" Direction Progression Band comes down and to the right. The coordination progression offsets, expressed in seconds, are referenced to the start of the arterial phases at the intersection I in the time-space diagram. Note that only the arterial left and through phases are illustrated. In addition, the program can only display the likely vehicular trajectory during a simulation run instead of the real achievable bandwidth.

ANIMATION (LEART)

One major advantage of PASSER II-90 is its new ability to provide dynamic animation the traffic operations. A simulator was designed to illustrate the signal timing control under dynamic traffic conditions. This section covers the basic modeling approach used in this new dynamic simulator.

TRAFFIC MODELING

The dynamic arterial animation system, LEART, was written in the Turbo C 2.0 programming environment. The program uses five components to support the operation of the arterial street graphics simulator: i.e., main program, data base management, interactive menu, statistics, and graphics simulation. LEART consists of two functional parts: the simulation operation and the interactive user's menu. While the simulation operation is a major portion of the program, the interactive menu allows users to select different portions of the arterial or signalized intersections to be analyzed and to review the cumulative simulation statistics.

The arterial system is represented as a series of signalized intersections through coordinated signal timing plans on a coordinate plane called world. The graphics simulation is performed on the world domain. Users can decide on the particular viewpoint by choosing a specific intersection. After mapping world coordinates to the selected viewpoint coordinates, the viewpoint coordinates will then be converted to absolute screen locations on a specific type of monitor with a different type of graphics display resolution. At present, the simulator will automatically determine the type of graphics display card used and adjust the resolution for that particular monitor type. The program currently supports CGA/EGA/VGA/HGC/8514 graphics standards.

To better illustrate operational details, the signalized intersections are equally spaced on the screen, and actual intersection distances are represented by the "black box" on the main street. As shown in Figure 4-12, the numbers to the side of the "black box" represents the number of vehicles that have been simulated in the arterial street system but are not shown on the screen. The screen also illustrates the relative speed ratio of the simulated time clock versus the real time clock. For efficient operation,

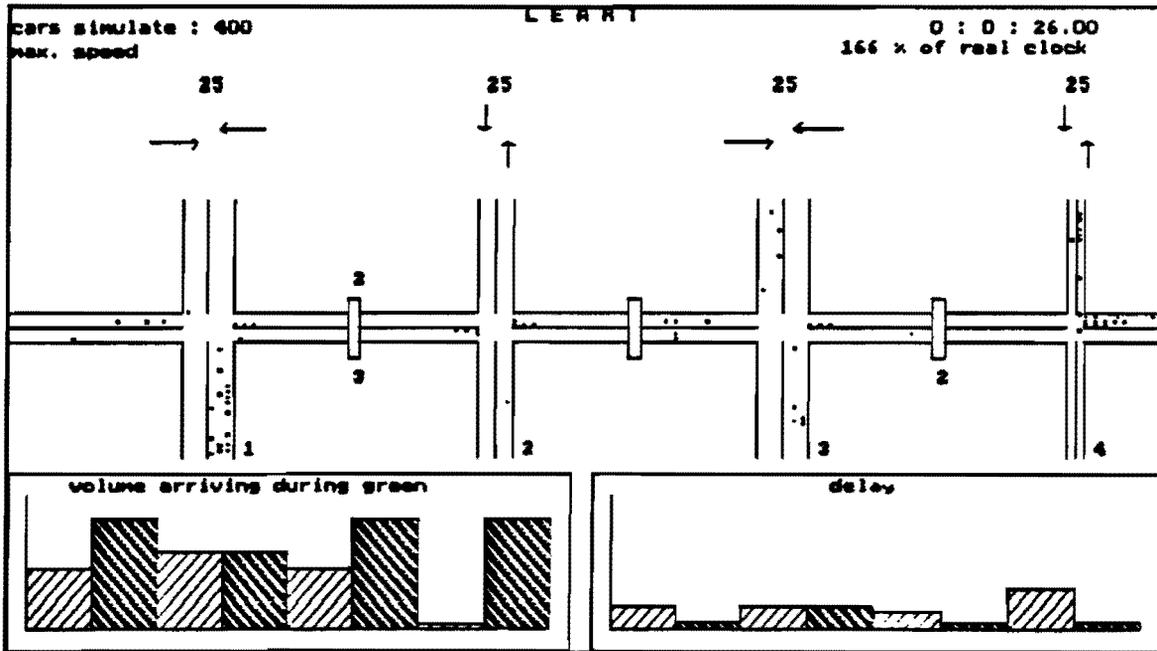


Figure 4-12. Dynamic Simulator.

all vehicles shown on the screen are stored in a data structure created by indexing an array of size 400. Because the length of the list may vary according to the total number of cars in the simulation at any given time, the run time will change dynamically with the total number of cars in the system. During simulation, the system will refer the simulation speed to a real time clock expressed as a percentage. Users can adjust the simulation display speed by pressing the <+> or <-> keys during operation.

Vehicle Representation

Cars are represented as rectangular blocks on the screen. To be consistent with the dynamic enlargement ratio, their size will vary in relation to the total number of intersections being viewed. Different colors represent different traffic movements and states of the vehicle at each intersection. The color specifications during initial traffic movement, during stop time at the intersection, and after the vehicle crosses the intersection are as follows:

vehicle movement	initial color	stop at intersection	after crossing intersection
left turn	white	white	green
right turn	yellow	yellow	green
straight	green	red	green

System Statistics

Two performance measures, PVG and DELAY, will be compiled and analyzed by the graphic simulator, as illustrated previously in Figures 3-18 and 3-19. The definition of each follows those used in Chapters 9 and 10 of the 1985 Highway Capacity Manual. As illustrated in Figure 3-18, PVG is the percentage of the total vehicles passing through a particular arterial approach during the green indication. As illustrated in Figure 3-19, DELAY is the average delay, expressed in seconds per vehicle, when cars pass through a signalized intersection. Both PVG and DELAY for each signalized intersection will be plotted in bar graphs at the bottom of the computer screen. The system will maintain the PVG and DELAY statistics. These include the graphs being refreshed at each quarter (1/4) of the cycle length of the traffic signal timing plan. This is similar to a manual traffic count gathered at intersections of the arterial being studied. The statistics displayed after each new refreshment represents the total amount of data collected since the start of each refreshment point.

Cumulative Statistics

The cumulative statistics can be selected and accessed through the menu options. Both PVG and DELAY will be represented in 3-dimensional graphs, with the actual percentage or seconds displayed on top of each bar. The data for calculating PVG and DELAY are collected at the end of each cycle.

PVG = (number of cars passing through a specific intersection without stopping) / (number of cars passing through a specific intersection for all cycles that have elapsed).

DELAY = (number of seconds all cars have been delayed at a specific intersection) / (number of cars passing through a specific intersection for all cycles that have elapsed).

Simulation Assumptions

Each vehicle is generated with its own travel direction, traffic movement, and signalized intersections from the random number functions as calibrated from the progressive traffic platoons. For instance, if the input traffic volumes, from the artdata file, of three lanes at intersection 1 Westbound have three cars turning left, three cars going straight, and four cars turning right per hour, the next car with the random number five, as generated from a procedure, will be assigned to go straight because of the statistical allocation method used in the model.

The total number of cars that can possibly arrive in one second is also determined by a random number generator which calibrates against the Poisson statistical distribution function. For more realistic operation, each car is assigned one second initial delay in response to the signal interval. For example, if car A, which is in front of car B, has just started moving, car B will delay for one second before it starts to move. When the signal light has turned from red to green, the response delay will be two seconds.

Model Limitations

The simulation program will accept optimized timing for the maximum of 20 signalized intersections. The screen can only accommodate eight or less intersections at a time, even though the whole arterial is being simulated. The maximum number of vehicles that can be displayed depends on the total volume, as specified by the user. For simplicity, the maximum number of vehicles to be analyzed at any given time in the whole system is set at 400. The scan time is fixed at one-second intervals.

To execute the program, two data files must present: (1) ARTDATA, automatically generated by the main program, and (2) the appropriate Graphics interface or BGI file for a specific monitor. While the number of lanes on the main street is fixed, the number of through lanes on the side street can vary from one to three. Currently, LEART can handle 20 intersections through the PASSER II-90 main program. However, the program can have a virtually unlimited number of intersections with any possible combination of potential phasing patterns. These optional changes can be modified by changing the data elements in the system and some constant numbers in the overall system.

The LEART traffic animation system is provided mainly for informational purposes. The system should not be used to conduct capacity studies nor to assess traffic operations. Rather, it was designed to provide the user with a mode of communicating traffic control concepts relative to the arterial progression problem being studied.

5. ADDITIONAL CONSIDERATIONS

This section covers additional guidance on left turn signal treatments, phase pattern selection, simulation runs, parameters for actuated controllers, and operational efficiency.

LEFT TURN TREATMENTS

PASSER II-90 has been modified to assist users in analyzing coordinated left turn signal treatments. These include enhancements to the input procedure, data structure, green-split calculations, progression optimization, and output performance evaluations. Compared with the approximation techniques in the 1985 HCM, PASSER II-90 uses a refined model for explicitly describing left turn maneuvers, signal capacity, and delay.

Intersection input data determine the left turn treatments and allowable signal phase sequences. These treatments include simple two-phase "Permitted Phase" and sophisticated "Protected Phase" operations as well as the most complicated permitted/protected or protected/permitted "Combined Phase" left turn sequences. However, PASSER II-90 will still use the default "Protected" phase operation found in the existing PASSER II-84 program, if a left turn bay is used. On the other hand, the new program will use the default "Permitted" phase when no left turn bay exists or if the user does not specify a particular left turn treatment in the analysis.

Data Input

PASSER II-90 was designed to generate data from user input, display operating instructions, and review solution analysis through the screen display. The program will examine user inputs such as possible left turn treatments and allowable signal phase sequences. The recommended data input sequence for PASSER II-90 analysis can be summarized in Figure 5-1. It describes the basic study procedure for analyzing different left turn signal treatments. However, the proper analysis of different left turn operations requires that a large amount of information about left turn signal treatments be provided in the data "ASSISTANT" window for each signalized intersection approach. The PASSER II-90 system was designed to provide 1985 "Highway Capacity Manual" type analysis with a flexible and simplified input data file structure for all left turn signal treatments.

During data input, the system will determine whether there is a protected left turn bay. Then, the program will detect the minimum phase to indicate whether additional information is needed. By asking "IS LEFT TURN PROTECTED ONLY?", the choice of using either "Protected Phase" or "Combined Phase" operation can quickly be determined. The program will check different signal phase sequences and select the best phase for maximum progression. That is, the program will also analyze the operation effectiveness of the complicated permitted/protected or protected/permitted "Combined Phase" left turn sequence should be used by specifying the left turn phase sequence.

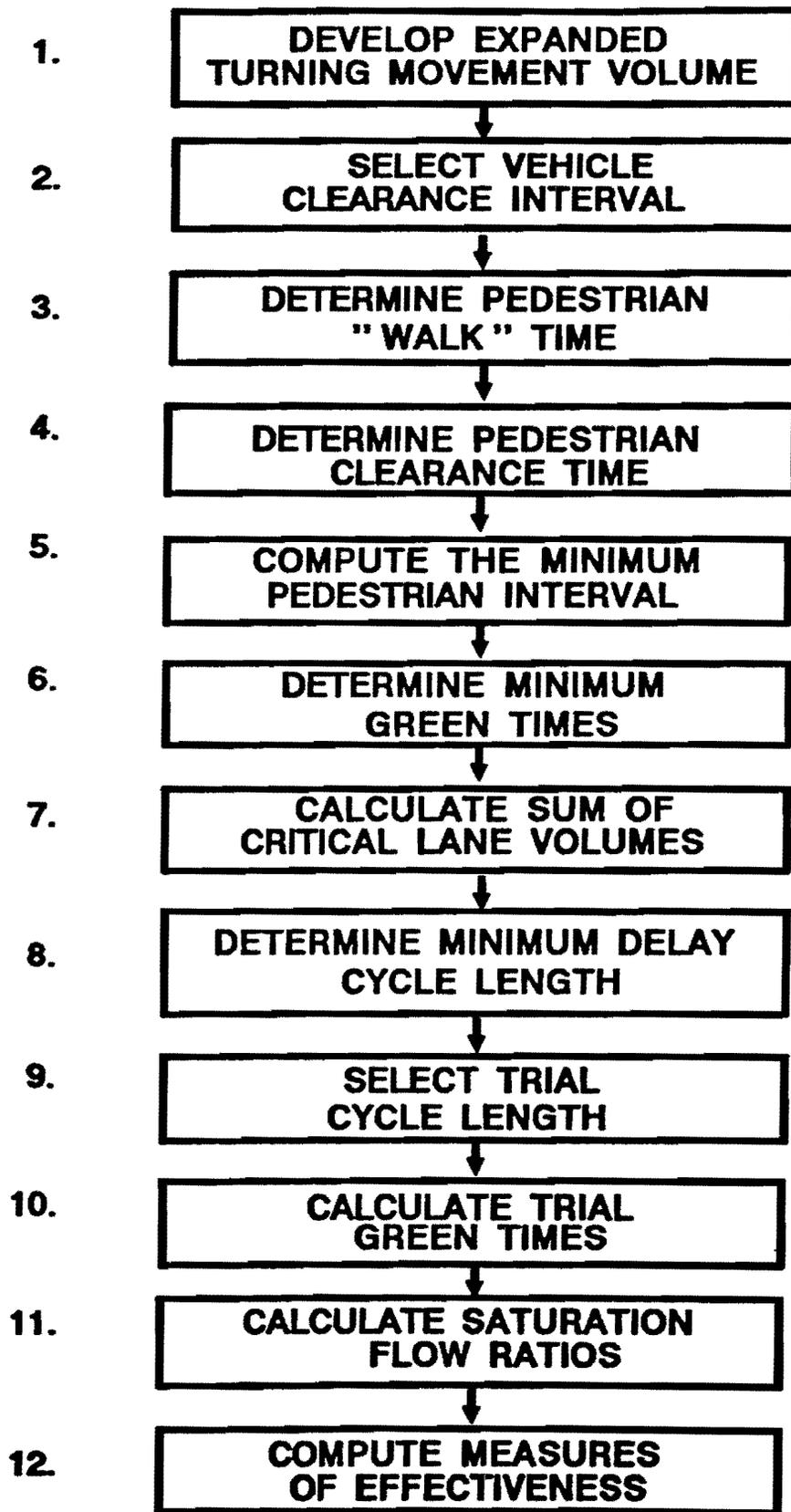


Figure 5-1. Signal Timing Methodology.

In the intersection movement screen shown previously in Figure 3-6, the "BAY" represents a protected left turn bay for left turn traffic movements. "PERMITTED" indicates the "Green Ball" signal indication. "PROTECTED" shows the "Green Arrow" signal indication for protected traffic movements. "COMBINED" is the permitted/protected or protected/permitted "Combined Phase" left turn sequences. The left turn volume stored in the "shaded" left turn bay indicates the no left turn bay will be used in the analysis. Some information about left turn signal treatments can not be coded automatically. The ASSISTANT function will be required for using different left turn signal treatments and 1985 HCM type capacity analysis. The user must interact with the computer program through the ASSISTANT function, use the ASSISTANT function, routinely check the values in the "[]."

PHASE PATTERN SELECTION

PASSER II-90 will assist in choosing an allowable signal pattern(s). The system detects which movements have volumes entered and then checks these choices against the logical phase tables. It will then give the user a list of allowable patterns which may be applicable. The user can review the recommended signal phase sequences by pressing function key [F3]. This will indicate the actual signal phase sequence the user has chosen for further analysis. As shown in Figure 5-2, PASSER II-90 uses three logical signal phasing pattern tables to determine allowable phase sequences according to the user's input. The first two allowable tables are designed to determine the allowable phase sequences for both the arterial and cross streets. These two tables are sufficient for 90% of the analysis. The user may explore other phasing patterns by choosing the special phasing table to achieve any possible phase sequence for the movements that have nonzero traffic volumes.

Left Turn Phase Sequence

PASSER II-90 will first require information on the status of the protected left turn bay. The program will automatically determine left turn treatments, show traffic lane groups, and display related intersection traffic information. The program will determine the types of treatments, suggest needed data, check input, and add the data left out by the user. For example, the system will detect whether there is a protected left turn bay during input and instruct the user to input additional information. By asking the user "IS LEFT TURN PROTECTED ONLY?", the choice of either "Protected Phase" or "Combined Phase" can be determined from the specified lead or lag phasing.

Due to the different possible left turn treatments that can be used, the allowable phase sequence has also been revised to reflect the phase sequences the user can select. The program will check the allowable phase sequence tables and display the allowable phase sequence selection by pressing function key [F3]. The user can also overwrite these selections by choosing special phase sequence selections. To allow the program to examine different left turn signal treatments, it is recommended that the users select from the original signal phase sequences suggested by the program. But, the user must utilize the designated protected left turn bay and allow optimization from all the left turn signal phase movements.

Normal Phasing Patterns *

(a) Arterial				(b) Cross Street											
Movements				Phasing Patterns				Movements				Phasing Patterns			
1	2	5	6	LT	THRU	#1	#5	3	4	7	8	LT	THRU	#3	#7
X				-	-	-	-	X				-	-	1	-
	X			-	1	-	-		X			-	1	-	-
		X		-	-	-	-			X		-	-	-	1
			X	-	1	-	-				X	-	1	-	-
X	X			-	-	-	-	X	X			-	1	1	-
X		X		-	-	-	-	X		X		1	-	-	-
	X	X		-	-	-	1		X	X		-	-	-	1
X			X	-	-	1	-	X			X	-	-	1	-
	X		X	-	1	-	-		X		X	-	1	1	1
		X	X	-	-	-	-			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	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	X	X	X	X	3	3	3	3

(c) 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

*** EXPLANATION OF SYMBOLS**

- X** Movement has a volume greater than zero
- Pattern not allowed
- 1** Pattern allowed only without overlap
- 2** Pattern allowed only with overlap
- 3** Pattern allowed with or without overlap

Figure 5-2. Allowed Signal Phase Sequences.

SUMMARY OF OPERATING PROCEDURES

Alternative left turn treatments have very profound effects on the overall traffic operations. To obtain the needed solutions, the user must select the most appropriate traffic signal timing solutions among the possible alternatives by providing the options to be analyzed. The following section describes the detailed operating procedure for users to switch among different left turn treatments.

Changing Left Turn Treatment To Permitted Without Bays

1. Press the <ESC> key to return to the Main Menu.
2. Type "3" to edit the data in the Main Menu.
3. Type "2" to edit the intersection movement data in the Edit Menu. The movement input screen should appear with the cursor at the data entry field for the NEMA 5 movement.
4. Move to the volume field for the desired left turn movement and press "F2" until the "NO-BAY" in the lower right-hand corner is highlighted.
5. Type "0" (zero) for the volume.
6. Move to the data entry field for the minimum phase time and type "0" (zero).
7. Return to the left turn volume field and enter the previous volume or another desired volume.
8. Press the [F3] key. This will activate the ASSISTANT window.
9. Enter the traffic volume.
10. Press <RETURN> to retain the specified volume or enter another volume and press <RETURN>.
11. Press <RETURN> to retain the specified peak hour factor or enter another peak hour factor and press <RETURN>.
12. Press <RETURN> if the displayed volume is the correct volume or enter the desired volume.
13. Press <RETURN> and the cursor will appear in the volume field along with the specified volume. A value, "[1]", should be present in the brackets next to the left turn volume.
14. Other left turn movements may be changed by following steps four through thirteen.

Changing Left Turn Treatment To Protected Without Bays

1. Press the <ESC> key to return to the Main Menu.
2. Type "3" to edit the data in the Main Menu.
3. Type "2" to edit the intersection movement data in the Edit Menu. The movement input screen should appear with the cursor at the data entry field for the NEMA 5 movement.
4. Move to the volume field for the desired left turn movement and press "F2" until the "NO-BAY" in the lower right-hand corner is highlighted.
5. With a non-zero value of the Minimum Phase Time coded, press the [F3] key. This will activate the ASSISTANT window with the question, "Left Turn Protected Only?" appearing in the upper left-hand corner.
6. Type "Y".
7. Press <RETURN> to retain the specified volume or enter another volume and press <RETURN>.
8. Press <RETURN> to retain the specified peak hour factor or enter another peak hour factor and press <RETURN>.
9. Press <RETURN> if the displayed volume is the correct volume or enter the desired volume.
10. Press <RETURN> and the cursor will appear in the volume field along with the specified volume. A value, "[2]", should be present in the brackets next to the left turn volume.
11. Other left turn movements may be changed by following steps four through ten.

Changing Left Turn Treatment To Protected/Permitted Without Bays

1. Press the <ESC> key to return to the Main Menu.
2. Type "3" to edit the data in the Main Menu.
3. Type "2" to edit the intersection movement data in the Edit Menu. The movement input screen should appear with the cursor at the data entry field for the NEMA 5 movement.
4. Move to the volume field for the desired left turn movement and press "F2" until the "NO-BAY" in the lower right-hand corner is highlighted.
5. With a non-zero value of Min Phase Time coded, press the [F3] key. This will activate the ASSISTANT window with the question, "Left Turn Protected Only?" appearing in the upper left-hand corner.
6. Type "N". This will cause the left turn analysis to default to the protected/permitted ("combined") phase.
7. Press <RETURN> to retain the specified volume or enter another volume and press <RETURN>.
8. Press <RETURN> to retain the specified peak hour factor or enter another peak hour factor and press <RETURN>.
9. Press <RETURN> if the displayed volume is the correct volume or enter the desired volume.
10. Press <RETURN> and the cursor will appear in the volume field along with the specified volume. A value, "[3]", should be present in the brackets next to the left turn volume.
11. Other left turn movements may be changed by following steps four through ten.

Changing Left Turn Treatment To Permitted With Bays

1. Press the <ESC> key to return to the Main Menu.
2. Type "3" to edit the data in the Main Menu.
3. Type "2" to edit the intersection movement data in the Edit Menu. The movement input screen should appear with the cursor at the data entry field for the NEMA 5 movement.
4. Move to the volume field for the desired left turn movement and press "F2" until the "BAY" in the lower right-hand corner is highlighted.
5. Type "0" (zero) for the volume.
6. Move to the data entry field for the minimum phase time and type "0" (zero).
7. Return to the left turn volume field and enter the previous volume or another desired volume.
8. Press the [F3] key. This will activate the ASSISTANT window.
9. Enter the traffic volume.
10. Press <RETURN> to retain the specified volume or enter another volume and press <RETURN>.
11. Press <RETURN> to retain the specified peak hour factor or enter another peak hour factor and press <RETURN>.
12. Press <RETURN> if the displayed volume is the correct volume or enter the desired volume.
13. Press <RETURN> and the cursor will appear in the volume field along with the specified volume. A value, "[4]", should be present in the brackets next to the left turn volume.
14. Other left turn movements may be changed by following steps four through thirteen.

Changing Left Turn Treatment To Protected With Bays

1. Press the <ESC> key to return to the Main Menu.
2. Type "3" to edit the data in the Main Menu.
3. Type "2" to edit the intersection movement data in the Edit Menu. The movement input screen should appear with the cursor at the data entry field for the NEMA 5 movement.
4. Move to the volume field for the desired left turn movement and press "F2" until the "BAY" in the lower right-hand corner is highlighted.
5. With a non-zero value of Min Phase Time coded, press the [F3] key. This will activate the ASSISTANT window with the question, "Left Turn Protected Only?" appearing in the upper left-hand corner.
6. Type "Y".
7. Press <RETURN> to retain the specified volume or enter another volume and press <RETURN>.
8. Press <RETURN> to retain the specified peak hour factor or enter another peak hour factor and press <RETURN>.
9. Press <RETURN> if the displayed volume is the correct volume or enter the desired volume.
10. Press <RETURN> and the cursor will appear in the volume field along with the specified volume. A value, "[5]", should be present in the brackets next to the left turn volume.
11. Other left turn movements may be changed by following steps four through ten.

Changing Left Turn Treatment To Protected/Permitted With Bays

1. Press the <ESC> key to return to the Main Menu.
2. Type "3" to edit the data in the Main Menu.
3. Type "2" to edit the intersection movement data in the Edit Menu. The movement input screen should appear with the cursor at the data entry field for the NEMA 5 movement.
4. Move to the volume field for the desired left turn movement and press "F2" until the "BAY" in the lower right-hand corner is highlighted.
5. With a non-zero Min Phase Time coded, press the [F3] key. This will activate the ASSISTANT window with the question, "Left Turn Protected Only?" appearing in the upper left-hand corner.
6. Type "N". This will cause the left turn analysis to default to the protected/permitted ("combined") phase.
7. Press <RETURN> to retain the specified volume or enter another volume and press <RETURN>.
8. Press <RETURN> to retain the specified peak hour factor or enter another peak hour factor and press <RETURN>.
9. Press <RETURN> if the displayed volume is the correct volume or enter the desired volume.
10. Press <RETURN> and the cursor will appear in the volume field along with the specified volume. A value, "[6]", should be present in the brackets next to the left turn volume.
11. Other left turn movements may be changed by following steps four through ten.

SIMULATION

Once the model parameters, embedded data, and operational characteristics have been satisfactorily calibrated in the computer model, one may use the program to simulate existing conditions to establish a basis for a "before and after" study. The conditions simulated include existing geometric layouts, traffic loading, operational characteristics, and traffic signal control. It is also important to evaluate existing operations, document the study assumptions, and acquire optional model parameters for the "before-and-after" system evaluations. It is essential to use a consistent set of embedded data during the before-and-after study for fair comparisons.

Several steps are needed when using the PASSER II simulation option to study any existing or specific signal timing plans as shown in the example in Figure 5-3. The user must verify and manually check for the correct cycle, green splits, phase sequences, and verify that forced-offsets have been input properly. The following exercise will duplicate the results of the "Skillman Optimization Example" through the simulated option.

To make a PASSER II-90 simulation run, follow the instructions below to input the needed information.

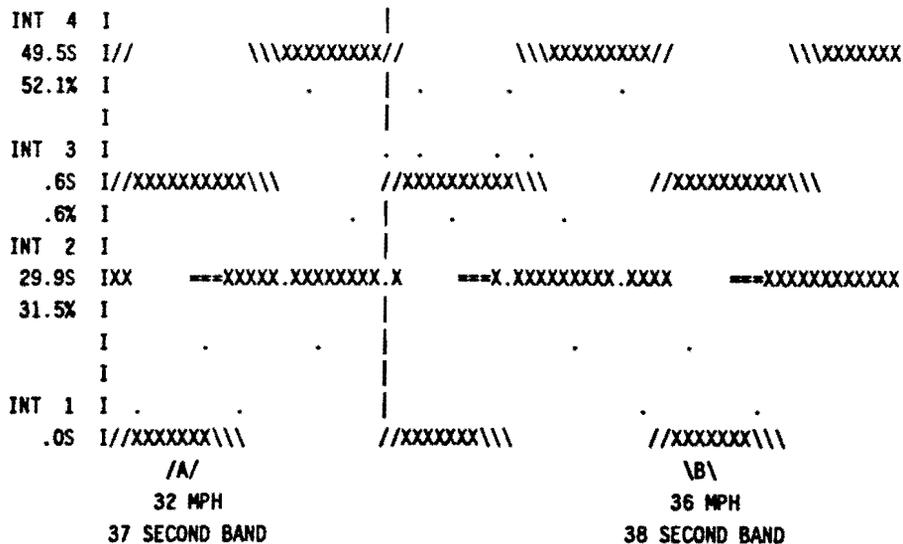
1. Specify one cycle length for the existing condition, instead of a range of possible cycle lengths.
2. Add the conflicting phase splits for both the main and cross streets, and then add them to the cycle. Check for consistency.
3. Specify only one left turn signal phase sequence for both the main street and cross street.
4. Input the needed simulated offsets, referred to the beginning of main street green, into the data file through the Edit Menu.
5. Select "Simulation Run" in the "Simulate existing timing" options. All five steps are required.

The most important effort during the data coding process for simulation is to check for the correct green time inputs so that the sum of the conflicting greens won't exceed the coded cycle length. Otherwise, if any "data errors" are detected, the error-checking routine may report "user-input errors," and quit the execution run. Once the initial adjustments to green splits and phase sequences have been made and the PASSER II-90 simulation run has been successfully produced, any changes to the offset combinations can be evaluated. However, the PASSER II program will not calculate the bandwidth information on the progression bands during simulation run, only the front edge or the projected travel time lines will be produced for system illustration. The correct result for the simulation run is provided in Figure 5-3. This simulation run tries to duplicate the same optimized run, as documented at the back of this manual. Please study this data coding example before proceeding with your own data sets.

INTRSC 1 : Mockingbird	COORD PHASE : 0 OFFSET : .0							SEC :	.0%
CONCURRENT PHASES	2+5	2+6	1+6	3+8	4+8	4+7	MAIN	CROSS	
DURATION (SEC)	10.1	27.5	10.8	25.7	10.9	10.0	48.4	46.6	
DUAL-RING PHASE #	5	6	1	2	3	4	7	8	
PHASE SPLIT (SEC)	10.1	38.3	10.8	37.6	25.7	20.9	10.0	36.6	
INTRSC 2 : University	COORD PHASE : 0 OFFSET : 29.9							SEC :	31.5%
CONCURRENT PHASES	1+5	1+6	2+6	4+8	3+8	3+7	MAIN	CROSS	
DURATION (SEC)	10.1	.0	63.9	21.0	.0	.0	74.0	21.0	
DUAL-RING PHASE #	5	6	1	2	3	4	7	8	
PHASE SPLIT (SEC)	10.1	63.9	10.1	63.9	.1	21.0	.1	21.0	
INTRSC 3 : Lovers Lane	COORD PHASE : 0 OFFSET : .6							SEC :	.6%
CONCURRENT PHASES	2+5	2+6	1+6	3+7	3+8	4+8	MAIN	CROSS	
DURATION (SEC)	10.0	38.5	11.5	11.3	2.7	21.0	60.0	35.0	
DUAL-RING PHASE #	5	6	1	2	3	4	7	8	
PHASE SPLIT (SEC)	10.0	50.0	11.5	48.5	14.0	21.0	11.3	23.7	
INTRSC 4 : Southwest	COORD PHASE : 0 OFFSET : 49.5							SEC :	52.1%
CONCURRENT PHASES	1+6	2+6	2+5	3+7	3+8	4+8	MAIN	CROSS	
DURATION (SEC)	10.0	36.3	10.0	10.0	5.3	23.4	56.3	38.7	
DUAL-RING PHASE #	5	6	1	2	3	4	7	8	
PHASE SPLIT (SEC)	10.0	46.3	10.0	46.3	15.3	23.4	10.0	28.7	

(TS.DIAGM)

TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
 PASSER II-90 MULTIPHASE ARTERIAL PROGRESSION - 145101 VER 1.0 DEC 90
 RUN NO 1 DISTRICT 12 Skillman Avenue 06/22/90 CYCLE = 95 SECONDS



.40 EFFICIENCY 1.00 ATTAINABILITY
 AVERAGE INTERSECTION DELAY TOTAL SYSTEM DELAY TOTAL NUMBER VEHICLES
 28.1 SECS/VEH 100.3 VEH-HR/HR 12861.

Figure 5-3. Example of Simulation Run, Skillman Avenue.

OPERATIONAL EFFICIENCY

To facilitate the speed and efficiency of the PASSER II-90 program runs, the following actions are highly recommended for IBM PC/XT/AT or compatible microcomputers.

Subdirectory Structure

Tap the power of DOS's tree-structured directory to organize file storage. Subdirectories can help the user set up hard disk files as filing folders. Creating a separate subdirectory for each application program is recommended. The current directory is displayed with DOS commands. Do not clutter the root directory; that may slow down DOS operations. It is suggested to keep only the essential DOS files such as COMMAND.COM, ANSI.SYS, AUTOEXEC.BAT, CONFIG.SYS, and subdirectories. Creating the CONFIG.SYS file to use "DEVICE=ANSI.SYS, FILES=20, BUFFERS=40" will speed up program operation.

Batch File and Path Statement

After using the subdirectory to organize files, retain the freedom to run other application programs for further data reduction and analysis. Three standard subdirectories are recommended: \BAT for batch files, \DOS for DOS programs, and \UTIL for preferred utility programs. By accessing through the DOS command PATH = C:\BAT;C:\DOS;C:\UTIL; - the user can run any application program in any one of these subdirectories from anywhere on the hard disk. For programs not in one of these standard subdirectories, the user can use batch files located in C:\BAT among different application programs.

The normal DOS shell program is COMMAND.COM. Some new users often find it very unfriendly. Others wish it had abilities like file tagging, unerasing, and directory renaming. Several commercial software developers, such as Peter Norton and others, have developed different commercially available utilities programs, such as XTREE, QDOS, NORTON UTILITY, and WordPerfect SHELL. These programs can be very powerful in preparing the application program menu system and organizing the Disk Operating System (DOS). Some utility programs have been improved to incorporate many powerful new features, such as a friendly command "integrator" with menus and help screens, new speed benchmarks, and a visual file directory and subdirectory tree. Running PASSER II-90 under these programs is not recommended since they will reduce the accessible memory space for effective program execution.

Routinely Backup and Purge

An important task when running a computer program is determining how and when to backup data files and purge unwanted information. To maintain operational efficiency and have the most updated information readily available, design and prepare a regular backup system and purge plan for routine microcomputer file system maintenance. It is also necessary to provide a routine system backup and file purge plan for the PASSER II-90 program. This will always keep all the original data files and corresponding output files up to date for easy reference on the microcomputer and for efficient file maintenance operations.

6. CONCLUSIONS AND RECOMMENDATIONS

PASSER II-90 microcomputer program version 1.0 can assist professionals in analyzing (1) isolated intersection timing evaluations, (2) progression signal timing optimization, (3) "existing" timing evaluations, and (4) to visualization of the signal timing results. The system contains the most updated microcomputer version of the PASSER II program, advanced 1985 Highway Capacity Manual (HCM) analysis, latest Expert Systems designs, and microscopic microcomputer graphics simulation. It can analyze "Permitted," "Protected," and permitted/protected or protected/permitted "Combined Phase" left turn signal treatments.

The system is distributed with a user-friendly, menu-driven, input/output processor; main executable program; optional help information; dynamic graphic simulator; and microcomputer user's guide. The new program provides enhanced and improved signal timing reports, allows the user to modify all embedded data, and accepts all existing coded PASSER II-80, PASSER II-84, or PASSER II-87 data without requiring any user revisions. PASSER II-90 can provide alternative left turn analysis and advanced capacity evaluation well beyond the Left Turn Analysis Package (LTAP), 1985 Highway Capacity Software (HCS) packages, and the existing PASSER II-84 and PASSER II-87 programs.

This "Program User's Manual" was prepared for distribution with the PASSER II-90 program package. It was developed to assist users with the microcomputer operations when analyzing individual intersection and arterial signal system design problems. Please address all the written correspondence or requests to the Texas Department of Transportation (TxDOT), File D-18TMS (PASSER II-90), 125 E. 11th Street, Austin, Texas 78701.

7. REFERENCES

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APPENDIX A.
SPECIFICATION OF PASSER II-90 DATA FILES.

PASSER II-90 DATA FILE

```

1Dallas      Skillman Avenue      18062290 401 85 95 5 0110404000051301
Mockingbird 1 0 0 0 0 0 0222200205555N00000      [Arterial Header]
University   2340034340038 0 0222201005151N00000
Lovers Lane  3166332166336 0 0222220005555N00000
Southwest    4280830280834 0 0222220005555N00000      [Intersection Header]
1 51 287 240 568 881114 431560
117003500170052501700350017005250
1 10 21 10 16 10 21 10 16      [Intersection Data]
2 11 369 0 112 581479 0 330
217003500180026001700350018002600
2 10 15 0 16 10 15 0 16
3 21 407 54 227 702052 100 877
317005250170052501700525017005250
3 10 21 10 21 10 21 10 21
4 14 468 77 138 261392 84 400
417003500170017501700350017001750      [Parameter]
4 10 19 10 21 10 19 10 21
P1800 152.04.0A0.90T6.519.532.552.078.061750 4.50000000 2.50000000 0.00000000
    
```

PHASER.DAT FILE - PHASE REFERENCE DATA

```

DEFAULT(1) : SAME MASTER & REF INT, OFFSET TO BEGINNING OF MAIN STREET GREEN
1 1 0.0 0 BEGIN
DEFAULT(2) : SAME MASTER & REF INT, OFFSET TO BEGINNING OF NEMA PHASE 2
1 1 0.0 2 BEGIN
    
```

HARDDISK.DAT - LOCATION OF THE PROGRAM FILE

C:\P290

IOSPEC.DAT - LOCATION OF THE DATA FILE

```

C:\P290\DATA
C:\P290\PHASER.DAT
C:\P290\DATA.OUT
C:\P290\ARTDATA
C:\P290\DATA.GDP
N
    
```

DATA.GDP - INTERFACE FILE TO AAP PACKAGE

```

SRDMPDallas      Skillman Avenue      95 4 11 3
1 0 3400 0 3831475855106324531579270511471053 0 300 021002500
2 3400 1663 34 3621500051106367262211 0 0 0 6001000 273714001800
3 1663 2808 32 34314675551053405312111189 284221110001400 957911001500
4 2808 0 30 0413675551053382110531053 558246317002000 5053 500 900
SWMOE 95
1Dallas      Skillman Avenue
<TOTALS> 12717 99 28.2 9972( 78) 347 37.7 N/A 100.0
    
```

Table A-1. Input Data for PASSER II-90.

ITEM	PASSER II CARD	COL.	AAP CARD	FLD.	AAPEX SCREEN
Run Number	Arterial Header	1-2	RUN	1	Setup
City Name	" "	3-14	PARAMETER	19	Setup
Arterial Name	" "	15-38	SETUP	19	ArtD
District Number	" "	39-40	SETUP	12-13	Setup
Date	" "	41-46	Mapped automatically.		
No. of Intersections	" "	47-48	SETUP	8-9	RunP
Isolated/ Coordinated Flag	" "	49-50	RUN	TBD	RunI
Cycle Range and Incr.	" "	51-58	ARTERIAL	2-4	RunI
Directional Band Priority	Arterial Header	59-60	ARTERIAL	5	RunP
Speed Search	" "	61	RUN	TBD	RunI
TSD, Line Plot	" "	62	Not Supported.		
TSD, Printer Plot	" "	63	PLOTS	Varies	RunI
X-Y Scales	" "	64-69	PARAMETER	TBD	OptD
Debug Report	" "	70	OPTIONS	Varies	OptD
Output Level	" "	71	PLOT/REPORT	Varies	RunI
NEMA Flag	" "	72	No longer used in PASSER II.		
NEMA "A" Direction	" "	73	SETUP	11	ArtD
Best Solution Format	" "	74	SETUP	1	RunI
Debug Arrays	" "	75	OPTIONS	Varies	OptD
SWMOE Flag	" "	76	REPORT	Varies	RunI

ITEM	PASSER II CARD	COL.	AAP CARD	FLD.	SCREEN
Intersection Name	Intersection Header	1-12	MAP	19	ArtD
Intersection No.	"	"	13-14	MAP	1
'A' Distance	"	"	15-18	LENGTH	3,5,7,9
'A' Speed	"	"	19-20	SPEED	3,5,7,9
'B' Distance	"	"	21-24	LENGTH	3,5,7,9
'B' Speed	"	"	25-26	SPEED	3,5,7,9
Queue Clearances	"	"	27-30	QUEUE	3,5,7,9
Phase Sequence Codes	"	"	31-38	SEQUENCE	11-18
Left Turn Protection	"	"	39-42	LEFT/ CAPACITY	Varies
Area Type	"	"	43	PARAMETER	TBD
Offset	"	"	44-48	OFFSET &	2

ITEM	PASSER II CARD	COL.	AAP CARD	FLD.	SCREEN
Intersection No.	Intersection Data	1-2	MAP	1	AppD
Volumes	"	"(1)	3-34	VOLUME	2-10
Saturation Flows	"	"(2)	3-34	CAPACITY	2-10
Minimum Phase Leng.	"	"(3)	3-34	MINPHASE6	2-10

ITEM	PASSER II CARD	COL.	AAP CARD	FLD.	SCREEN
Pretimed/Actuated Flag	Parameter Card	1	SEQUENCE	17	TimP
Ideal Sat. Flow	" "	2-5	PARAMETER	TBD	RunP
Analysis Period	" "	6-8	PARAMETER	TBD	RunP
Sneakers	" "	9-11	LEFT	4,6,8	AppD
Phase Lost Time	Parameter Card	12-14	ARTERIAL	10	RunP
Special Ring Flag	" "	15	AAP will map default.		
Left Turn Factor	" "	16-19	PARAMETER	TBD	RunP
Total/Stopped Delay	" "	20	PARAMETER	TBD	RunP
Delay Model Parameters	" "	Rest	AAP will map PASSER II defaults.		
Comment Line	Phaser Data	Line 1	Arterial name + run title.		
Master Node	" " (Line 2)	1-3	SETUP	10	RunP
Arterial Reference	" " "	4-6	Same as above.		
System Ref. Offset	" " "	7-11	Not supported (0).		
Arterial Reference Phase	" " "	12-13	SEQUENCE8	11,15	TimP
Reference Point	" " "	16+	Default to beginning.		

Note:

1. ArtD = Arterial Data,
- AppD = Approach Data,
- Opt = Optional Data
- ProD = Progression Data,
- RunP = Run Parameter,
- RunI = Run Instruction,
- Setup = Setup/Options,
- TimP = Timing Plan.

DATA.GDP - AAP INTERFACE FILE FORMAT

The file is described line by line below. Please note that all numeric data must be right justified in the fields and all alphameric are left justified.

LINE FIELD FORMAT SAMPLE DESCRIPTION

1	1	-	SRDMP	Keyword for identifying this file. Stands for Single Ring DuMP. (Note, PASSER II-84 and TRANSYT-7F, Release 6 and prior say "GDDMP.)
	2	A32	T7F etc.	Run Title.
	3	I5	120	Cycle length in seconds.
	4	I5	4	Number of intersections.
	5	I5	22	Fixed for program versions as follows:

Code	Program, Ver.	Code	Program, Ver.
1	PASSER II-84*	2	T7F, Release 5*
11	-90	21	Release 6
		22	Release 7

* These are no longer supported

<PASSER II-90>
 "___11" FIXED FORMAT WAS USED.

6	I5	1		Route orientation (1,2,3,4 = N,S,E,W).
---	----	---	--	--

The phase codes are constant with respect to direction for PASSER II; however, for TRANSYT they depend on the direction of the artery being plotted - namely north-south or east-west. The codes are given below (where "A and B-Dir" are the PASSER directional codes; "N,S,E, and W" mean northbound, southbound, etc.; and "T and L" are thru and left):

ARTERIAL/ CROSS	CODE	PASSER MOVEMENT	TRANSYT MOVEMENT	
			N-S ARTERY	E-W ARTERY
Artery	1	Thrus	N-S thrus	E-W thrus
	2	Lefts	N-S lefts	E-W lefts
	3	A-Dir T&L	S T&L	E T&L
	4	B-Dir T&L	N T&L	W T&L
Cross	5	Thrus	E-W thrus	N-S thrus
	6	Lefts	E-W lefts	N-S lefts
	7	A-Dir T&L	W T&L	N T&L
	8	B-Dir T&L	E T&L	S T&L

Note: The "thru" phase may or may not include permitted left turns.

System-Wide MOE File Format

System-wide measures of effectiveness (SWMOEs) will be written to the same file to which PPD and/or SRF--namely the GDF data--are written. An example of the file is given below:

```
SWMOE 120
RIDGEWOOD AVE      CHAP 7 BWC EX    BANDWIDTH CONSTRAINED OPTIMIZATION
<TOTALS>      850    101    77  26.5    6214( 60)    130  13.5  414    97.8
```

The file is described by line below.

LINE	FIELD	FORMAT	SAMPLE	DESCRIPTION
1	1	-	SWMOE	Keyword for identifying this file, which stands for System-Wide MOEs.
	2	I5	120	Cycle length in seconds.
2	A11	A80	RIDGEWOOD+	Run Title.
	A2	9A4	4A2	
3	1	A8	<TOTALS>	Label for total.
	2	I8	850	Vehicle-miles of travel.
3	3	I7	101	Total travel time in veh-hrs.
	4	I6	77	Total delay in veh-hrs.
	5	F6.1	26.5	Average Delay in veh/sec.
	6	I8	6214	Total stops in vph.
	7	(I3)	(60)	Percentage stops.
	8	I8	130	Total fuel consumption in gal.
	9	F7.1	13.5	Average system speed (TRANSYT) or attainability (PASSER).
	10	I6	414	Total cost in dollars (not available in PASSER, " N/A" is coded).
	11	F8.1	97.8	Performance Index (TRANSYT) or bandwidth efficiency (PASSER).

