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16. Abstract

The Center for Highway Research at The University of Texas at Austin in cooperation with the State Department of Highways and Public Transportation and the Federal Highway Administration has developed a new microscopic traffic simulation package called the TEXAS Model for Intersection Traffic. The TEXAS Model is a computer program that can be used to aid in evaluating the operational effects of various traffic demands, types of traffic control, and/or geometric configurations at single intersections.

This report provides detailed guidance for the user of the TEXAS Model by outlining the input requirements and explaining the output format of the package. Input to the TEXAS Model has been designed to be user-oriented and minimal. The input for two pre-simulation processors which are called GEOPRO, the geometry processor, and DVPRO, the driver-vehicle processor, includes (1) geometric features of the intersection; (2) descriptive traffic data such as volumes, speeds, percent turns, etc.; (3) types of vehicles; and (4) types of drivers. Input to the simulation processor, called SIMPRO, contains (1) control parameters for the simulation process and (2) specifications for the traffic control scheme at the intersection.

The appendix deals with an auxiliary headway distribution analysis processor, called DISFIT, which aids the user in selecting an appropriate headway distribution to be used by DVPRO.

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THE TEXAS MODEL FOR INTERSECTION TRAFFIC - USER'S GUIDE

by

Clyde E. Lee, Glenn E. Grayson, Charlie R. Copeland,
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Research Report Number 184-3

Simulation of Traffic by a
Step-Through Technique (Applications)

Research Project 3-18-72-184

conducted for

Texas
State Department of Highways and Public Transportation

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U. S. Department of Transportation
Federal Highway Administration

by the

CENTER FOR HIGHWAY RESEARCH
THE UNIVERSITY OF TEXAS AT AUSTIN

July 1977

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

PREFACE

This is the third, in a series of four reports on Research Study 3-18-72-184, "Simulation of Traffic by a Step-Through Technique." The report describes the input requirements for a microscopic traffic simulation package called the TEXAS Model for Intersection Traffic and guides the user in applying the model for studying traffic movements at a single intersection.

The four reports which deal with the development, use, and application of the TEXAS Model are

Research Report No. 184-1, "The TEXAS Model for Intersection Traffic - Development," Clyde E. Lee, Thomas W. Rioux, and Charlie R. Copeland.

Research Report No. 184-2, "The TEXAS Model for Intersection Traffic - Programmer's Guide," Clyde E. Lee, Thomas W. Rioux, Vivek S. Savur, and Charlie R. Copeland.

Research Report No. 184-3, "The TEXAS Model for Intersection Traffic - User's Guide," Clyde E. Lee, Glenn E. Grayson, Charlie R. Copeland, Jeff W. Miller, Thomas W. Rioux, and Vivek S. Savur.

Research Report No. 184-4, "The TEXAS Model for Intersection Traffic - Analysis of Signal Warrants and Intersection Capacity," Clyde E. Lee, Vivek S. Savur, and Glenn E. Grayson.

Requests for copies of these reports should be directed to Mr. Phillip L. Wilson, Engineer-Director, Planning and Research Division, File D-10, Texas Highway Department, P. O. Box 5051, Austin, Texas 78763.

ABSTRACT

The Center for Highway Research at The University of Texas at Austin in cooperation with the State Department of Highways and Public Transportation and the Federal Highway Administration has developed a new microscopic traffic simulation package called the TEXAS Model for Intersection Traffic. The TEXAS Model is a computer program that can be used to aid in evaluating the operational effects of various traffic demands, types of traffic control, and/or geometric configurations at single intersections.

This report provides detailed guidance for the user of the TEXAS Model by outlining the input requirements and explaining the output format of the package. Input to the TEXAS Model has been designed to be user-oriented and minimal. The input for two pre-simulation processors which are called GEOPRO, the geometry processor, and DVPRO, the driver-vehicle processor, includes (1) geometric features of the intersection; (2) descriptive traffic data such as volumes, speeds, percent turns, etc.; (3) types of vehicles; and (4) types of drivers. Input to the simulation processor, called SIMPRO, contains (1) control parameters for the simulation process and (2) specifications for the traffic control scheme at the intersection.

Two examples of input include (a) data for the two pre-simulation processors, and (b) information needed to run the simulation processor. An example of the simulation processor output is shown to illustrate the concise and functional array of traffic performance indicators that result from the simulation, and key performance factors are discussed briefly to aid the user in interpreting results.

The appendix deals with an auxiliary headway distribution analysis processor, called DISFIT, which aids the user in selecting an appropriate headway distribution to be used by DVPRO.

The TEXAS Model for Intersection Traffic may be applied in evaluating existing or proposed intersection designs and for assessing the effects of changes in roadway geometry, driver and vehicle characteristics, flow conditions, intersection control, lane control, and signal timing plans upon traffic operations.

SUMMARY

This report provides the user with a complete input guide to the computer simulation package called the TEXAS Model for Intersection Traffic. The step-by-step input guide leads the user through the process of encoding all required information and using the available options. Selective caution statements help steer the user away from common input errors. The report includes samples of typical input coding sheets and samples of the computer output which results from the example input.

IMPLEMENTATION STATEMENT

Implementation of the TEXAS Model for Intersection Traffic is recommended to proceed in two stages in the State Department of Highways and Public Transportation. First, personnel in D-18T and D-19 should cooperate with engineers in the Districts in selecting intersections for study and in running the model to produce information needed for analysis of specific problems. Copies of this report should be made available to each user of the model so that familiarization with input and output can be developed as experience is gained. In the second stage, a decision should be made about adapting the model for access from remote terminals. This phase of implementation should not be attempted until utility of the model has been confirmed in the first stage. Assistance in implementing the TEXAS Model into the SDHPT will be provided by the Center for Highway Research.

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CHAPTER 1. DESCRIPTION OF THE TEXAS MODEL

The TEXAS (Traffic EXperimental and Analytical Simulation) Model, written in ANSI-standard FORTRAN IV computer language, is a microscopic simulator of traffic flow through an isolated street or highway intersection. It was developed under Research Study No. 3-18-72-184 as part of the Cooperative Highway Research Program of the Center for Highway Research in cooperation with the State Department of Highways and Public Transportation and the Federal Highway Administration. Development of the model was undertaken using the CDC 6600/6400 computer system at The University of Texas at Austin. Subsequent adaptation was made to the State Department of Highways and Public Transportation's IBM 370 computer in the Division of Automation, D-19.

Three computer programs comprise the TEXAS model.

(1) The pre-simulation Geometry Processor takes geometric information about the intersection, computes path geometry for all intersection paths, and optionally produces a plot of the intersection.

(2) The pre-simulation Driver Vehicle Processor takes traffic volume and other information about the traffic stream and produces a list of driver-vehicle pairs to be used in the simulation processor. Several driver types and vehicle classifications are used.

(3) The Simulation Processor examines sequentially each driver-vehicle unit in the system and, in response to surrounding traffic and to traffic control devices, forecasts its position, velocity, and acceleration into the next increment of simulation time. Each unit is thereby "stepped through" the system in small time increments. Delay, speed, and volume statistics are accumulated throughout the simulation process and reported at the end of a selected time increment.

A schematic representation of the TEXAS model is as shown in Fig 1. The remainder of this document contains input data forms, explanatory statements, and examples to guide the program user.

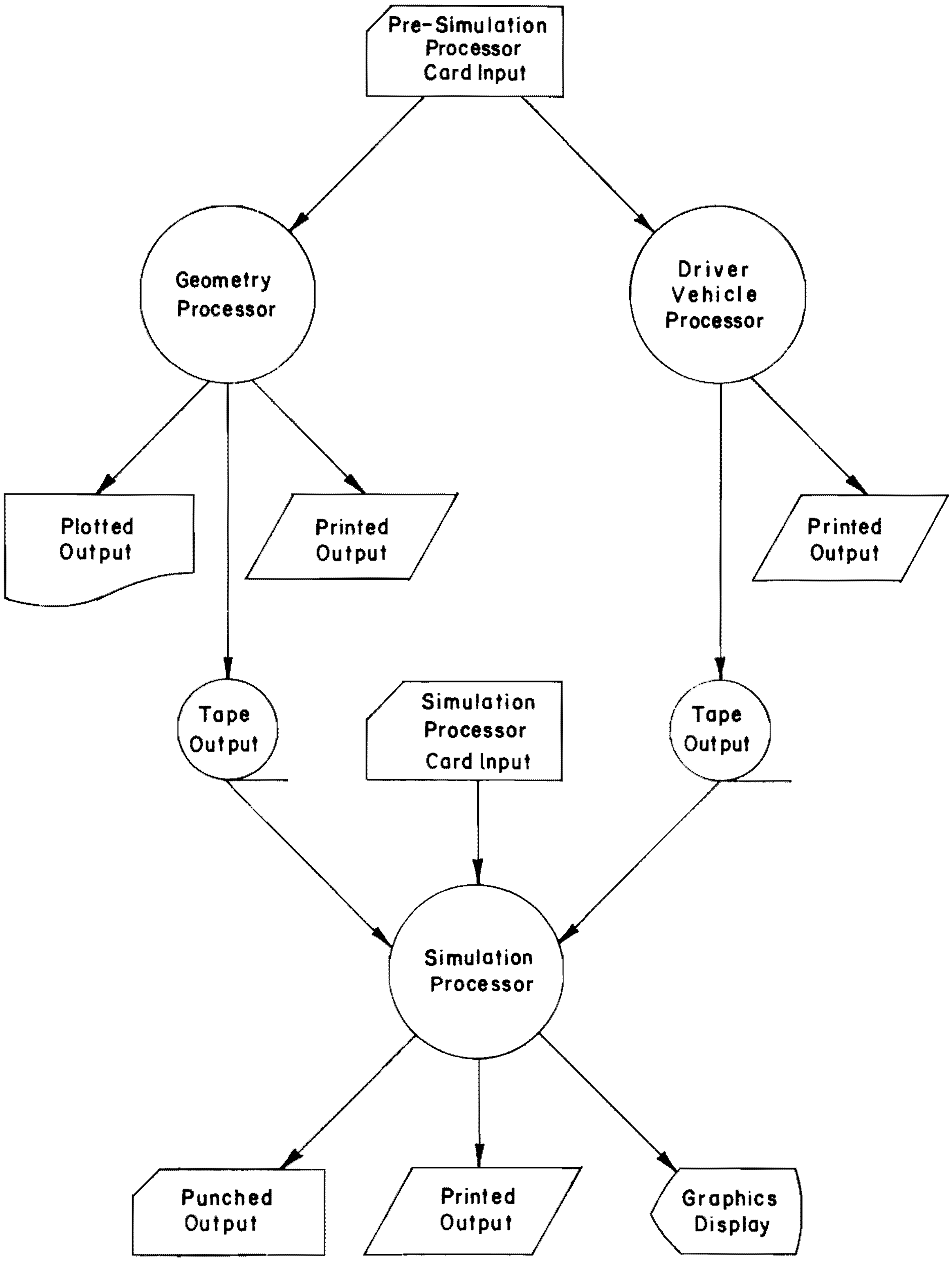


Fig 1. Flow process of the TEXAS model.

CHAPTER 2. PRE-SIMULATION PROCESSORS INPUT FORM

Both the geometry and the driver-vehicle processors use the same input form which follows. Although much of the input is self-explanatory, a guide to this input form is presented in Chapter 3.

RIGHT JUSTIFY NUMERIC CODE
LEFT JUSTIFY ALPHABETIC CODE

A. (MANDATORY) (See page 23)
(6 cards)

TITLE CARD

1

80

Approach numbers cannot be used more than once.

NIBA CARD

1 4

Number of inbound approaches
($1 \leq NIBA \leq 6$)

LIBA CARD

1 4

Inbound approach "A"
($1 \leq LIBA(1) \leq 12$)

5 8

Inbound approach "B"
($1 \leq LIBA(2) \leq 12$)

9 12

Inbound approach "C"
($1 \leq LIBA(3) \leq 12$)

13 16

Inbound approach "D"
($1 \leq LIBA(4) \leq 12$)

17 20

Inbound approach "E"
($1 \leq LIBA(5) \leq 12$)

21 24

Inbound approach "F"
($1 \leq LIBA(6) \leq 12$)

(continued)

A. (continued)

NOBA CARD

1 4

Number of outbound approaches
(1 ≤ NOBA ≤ 6)

LOBA CARD

1 4

Outbound approach "A"
(1 ≤ LOBA(1) ≤ 12)

5 8

Outbound approach "B"
(1 ≤ LOBA(2) ≤ 12)

9 12

Outbound approach "C"
(1 ≤ LOBA(3) ≤ 12)

13 16

Outbound approach "D"
(1 ≤ LOBA(4) ≤ 12)

17 20

Outbound approach "E"
(1 ≤ LOBA(5) ≤ 12)

21 24

Outbound approach "F"
(1 ≤ LOBA(6) ≤ 12)

PARAMETERS OPTION CARD

1 4

Total number of approaches
(1 ≤ NAP ≤ 12)

5 8

Number of minutes of simulation time
(12 ≤ ITSIM ≤ 65)
Default = 12

9 12

Minimum time between two vehicles in the same lane
(1.0 ≤ HMIN ≤ 3.0)
Default = 1.0

13 16

Number of vehicle classes
(1 ≤ NVEHCL ≤ 15)
Default = 10

17 20

Number of driver classes
(1 ≤ NDRICL ≤ 5)
Default = 3

21 24

Percent of left turns entering median lane
(50 ≤ FPERL ≤ 100)
Default = 80

25 28

Percent of right turns entering curb lane
(50 ≤ FPERR ≤ 100)
Default = 80

B.1 (MANDATORY) (See page 26)

APPROACH CARD

Field	Range / Scope	Card columns
Approach number	(1 ≤ IA ≤ 12) — Inbound and outbound	1–4
Azimuth	(0 ≤ IAAZIM ≤ 360) — Inbound and outbound	5–8
X coordinate — Left (median), beginning corner	(0 ≤ IAPX ≤ 2250) — Inbound and outbound	9–12
Y coordinate — Left (median), beginning corner	(0 ≤ IAPY ≤ 2250) — Inbound and outbound	13–16
Speed limit (mph)	(10 ≤ ISLIM ≤ 80) — Inbound and outbound	17–20
Number of lanes	(1 ≤ NLANES ≤ 6) — Inbound and outbound	21–24
Number of degrees left or right of straight to be considered straight (for this approach). Default = 20	(Inbound only)	25–27
Number of degrees left or right of 180° to be considered U-turn (for this approach). Default = 10	(Inbound only)	28–30
Distribution name (page 28)	(Inbound only)	32–38
Equivalent hourly volume (vph)	(Inbound only)	40–43
Parameter for distribution	(Inbound only)	44–49
Mean speed (mph)	(Inbound only)	51–54
85 percentile speed (mph)	(Inbound only)	56–59
Percent of vehicles go to linking outbound approach "A"	(Inbound only)	60–62
Percent of vehicles go to linking outbound approach "B"	(Inbound only)	63–65
Percent of vehicles go to linking outbound approach "C"	(Inbound only)	66–68
Percent of vehicles go to linking outbound approach "D"	(Inbound only)	69–71
Percent of vehicles go to linking outbound approach "E"	(Inbound only)	72–74
Percent of vehicles go to linking outbound approach "F"	(Inbound only)	75–77
YES/NO for user supplied percent of each vehicle class making up the traffic stream. Default = "NO"	(Inbound only)	78–80

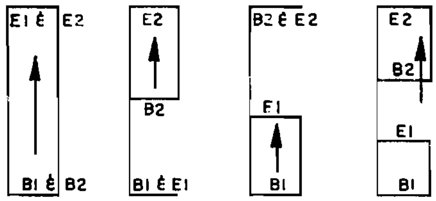
B.2. (Only if B.1 Columns 78-80 are YES)

	TRAFFIC MIX CARD
Percent of Class 1 vehicles in traffic stream	1 – 5
Percent of Class 2 vehicles in traffic stream	6 – 10
Percent of Class 3 vehicles in traffic stream	11 – 15
Percent of Class 4 vehicles in traffic stream	16 – 20
Percent of Class 5 vehicles in traffic stream	21 – 25
Percent of Class 6 vehicles in traffic stream	26 – 30
Percent of Class 7 vehicles in traffic stream	31 – 35
Percent of Class 8 vehicles in traffic stream	36 – 40
Percent of Class 9 vehicles in traffic stream	41 – 45
Percent of Class 10 vehicles in traffic stream	46 – 50
Percent of Class 11 vehicles in traffic stream	51 – 55
Percent of Class 12 vehicles in traffic stream	56 – 60
Percent of Class 13 vehicles in traffic stream	61 – 65
Percent of Class 14 vehicles in traffic stream	66 – 70
Percent of Class 15 vehicles in traffic stream	71 – 75

B.3 (MANDATORY - Inbound and Outbound)
(Median lane first)

LANE CARD

1. Lane width (8 ≤ LWID ≤ 15) — 1–4
Lane geometry: (0 ≤ B1,E1,B2,E2 ≤ 1000)



BEGIN 1 (B1) — 5–8

END 1 (E1) — 9–12

BEGIN 2 (B2) — 13–16

END 2 (E2) — 17–20

"U" if 'U' turn legal — 22

"L" if left turn legal — 23

"S" if straight through movement legal — 24

"R" if right turn legal — 25

Inbound: movements which can be made from this inbound lane

Outbound: movements which can be accepted by this outbound lane

Percent of approach volume in lane upon entry (at Begin1) (Inbound only) — 32–34

2. Lane width (8 ≤ LWID ≤ 15) — 41–44
Lane geometry:
Begin 1 (0 ≤ B1,E1,B2,E2 ≤ 1000) — 45–48

End 1 (Same definition as 1 above) — 49–52

Begin 2 — 53–56

End 2 — 57–60

"U" if 'U' turn legal — 62

"L" if left turn legal — 63

"S" if straight through movement legal — 64

"R" if right turn legal — 65

(Same definition as 1 above)

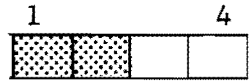
Percent of approach volume in lane upon entry (at Begin1) (Inbound only) — 72–74

(Repeat B.3 as required for all lanes on this approach)

(Repeat B.1 - B.3 as required for all approaches)

C.1. (MANDATORY) (See page 30)

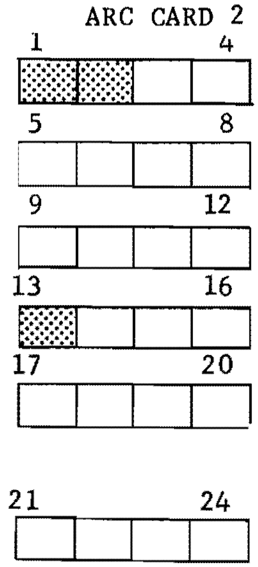
ARC CARD 1



Number of arcs
$(0 \leq NARCS \leq 20)$

C.2. (Only if C.1 NARCS > 0)

ARC CARD 2



Arc number
$(1 \leq N \leq 20)$

X coordinate of center of arc
$(0 \leq IARCX \leq 2250)$

Y coordinate of center of arc
$(0 \leq IARCY \leq 2250)$

Beginning azimuth of arc
$(0 \leq IARCAZ \leq 360)$

Number of degrees of arc (sweep)
$(-360 \leq IARCSW \leq 360)$

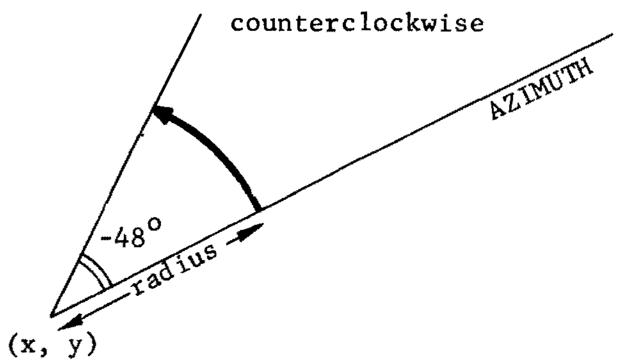
(clockwise = positive)

Radius of arc (feet)
$(1 \leq IARCR \leq 1000)$

(Repeat C.2 as required)

+ number of degrees is clockwise rotation from beginning azimuth

- number of degrees is counterclockwise rotation from beginning azimuth



D.1. (MANDATORY) (See page 30)

LINE CARD 1

Number of lines (0 ≤ NLINES ≤ 100)	1–4

D.2. (Only if D.1 NLINES > 0)

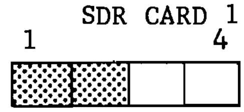
LINE CARD 2

Line number (1 ≤ N ≤ 100)	1–4
X coordinate of beginning of line (0 ≤ ILX1 ≤ 2250)	5–8
Y coordinate of beginning of line (0 ≤ ILY1 ≤ 2250)	9–12
X coordinate of end of line (0 ≤ ILX2 ≤ 2250)	13–16
Y coordinate of end of line (0 ≤ ILY2 ≤ 2250)	17–20

(Repeat D.2 as required)

E.1. (MANDATORY) (See page 30)

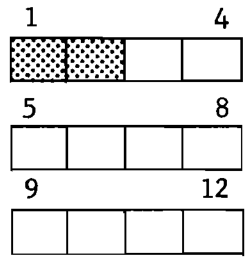
SDR CARD 1



Number of sight distance restrictions
(0 ≤ NSDRS ≤ 20)

E.2. (Only if E.1 NSDRS > 0)

SDR CARD 2



Sight distance restriction number
(1 ≤ N ≤ 20)

X coordinate of sight distance restriction
(0 ≤ IXSDRC ≤ 2250)

Y coordinate of sight distance restriction
(0 ≤ IYSDRC ≤ 2250)

(Repeat E.2 as required)

F. (MANDATORY) (See page 30)
(2 cards)

PLOT CARD

Field	Columns
Path type < PRIMARY, OPTION1 > Default = "PRIMARY"	1–10
Plot option < NOPLOT, PLOT, PLOTI > Default = "PLOT"	11–20
Plot type < SAME, SEPARATE > Default = "SEPARATE"	21–30 (S)
Plot scale factors: Full approach (feet per inch)	31–40 (.)
Intersection	41–50 (.)
Maximum radius for paths (100.00 ≤ RADIUS ≤ 1000.00) Default = 500.00	51–60 (.)
Minimum distance between two paths for conflict to be detected (6 ≤ ICLOSE ≤ 20) Default = 10	61–65
Plot paper width (12 or 30) Default = 30	66–70

(DEFAULT = NO for all values on OPTIONS CARD)

OPTIONS CARD
INPUT

Field	Columns
YES/NO for user supplied percent of driver classes for each vehicle class	1–3
YES/NO for user supplied vehicle characteristics	4–6
YES/NO for user supplied driver characteristics	7–9

(continued)

F. (continued)

	OUTPUT
YES/NO for logout summary for vehicles in Vehicle Class 1	10 12
YES/NO for logout summary for vehicles in Vehicle Class 2	13 15
YES/NO for logout summary for vehicles in Vehicle Class 3	16 18
YES/NO for logout summary for vehicles in Vehicle Class 4	19 21
YES/NO for logout summary for vehicles in Vehicle Class 5	22 24
YES/NO for logout summary for vehicles in Vehicle Class 6	25 27
YES/NO for logout summary for vehicles in Vehicle Class 7	28 30
YES/NO for logout summary for vehicles in Vehicle Class 8	31 33
YES/NO for logout summary for vehicles in Vehicle Class 9	34 36
YES/NO for logout summary for vehicles in Vehicle Class 10	37 39
YES/NO for logout summary for vehicles in Vehicle Class 11	40 42
YES/NO for logout summary for vehicles in Vehicle Class 12	43 45
YES/NO for logout summary for vehicles in Vehicle Class 13	46 48
YES/NO for logout summary for vehicles in Vehicle Class 14	49 51
YES/NO for logout summary for vehicles in Vehicle Class 15	52 54
YES/NO for logout summary for vehicles in Driver Class 1	55 57
YES/NO for logout summary for vehicles in Driver Class 2	58 60
YES/NO for logout summary for vehicles in Driver Class 3	61 63
YES/NO for logout summary for vehicles in Driver Class 4	64 66
YES/NO for logout summary for vehicles in Driver Class 5	67 69

G. (Only if Section F, Options Card, Columns 1-3 are YES) (See page 33)

Driver class split for each vehicle class (I = 1 to NVEHCL)

DRIVER MIX CARD

	Columns	Field
Percent of drivers in Vehicle Class I Driver Class 1	1–5	☐☐☐.☐
Percent of drivers in Vehicle Class I Driver Class 2	6–10	☐☐☐.☐
Percent of drivers in Vehicle Class I Driver Class 3	11–15	☐☐☐.☐
Percent of drivers in Vehicle Class I Driver Class 4	16–20	☐☐☐.☐
Percent of drivers in Vehicle Class I Driver Class 5	21–25	☐☐☐.☐

(Repeat G as required for each vehicle class)

H. (Only if Section F, Options Card, Columns 4-6 are YES) (See page 33)
(6 cards)

VEHICLE LENGTH CARD

Length of Class 1 vehicle ($5 \leq$ LENV ≤ 99) (ft)	1 – 4
Length of Class 2 vehicle	5 – 8
Length of Class 3 vehicle	9 – 12
Length of Class 4 vehicle	13 – 16
Length of Class 5 vehicle	17 – 20
Length of Class 6 vehicle	21 – 24
Length of Class 7 vehicle	25 – 28
Length of Class 8 vehicle	29 – 32
Length of Class 9 vehicle	33 – 36
Length of Class 10 vehicle	37 – 40
Length of Class 11 vehicle	41 – 44
Length of Class 12 vehicle	45 – 48
Length of Class 13 vehicle	49 – 52
Length of Class 14 vehicle	53 – 56
Length of Class 15 vehicle	57 – 60

(continued)

H. (continued)

	VEHICLE OC CARD
Operating characteristics for Class 1 vehicle (50 ≤ IVCHAR ≤ 150) (< 100 = sluggish, 100 = average, > 100 = responsive)	1 – 4
Operating characteristics for Class 2 vehicle	5 – 8
Operating characteristics for Class 3 vehicle	9 – 12
Operating characteristics for Class 4 vehicle	13 – 16
Operating characteristics for Class 5 vehicle	17 – 20
Operating characteristics for Class 6 vehicle	21 – 24
Operating characteristics for Class 7 vehicle	25 – 28
Operating characteristics for Class 8 vehicle	29 – 32
Operating characteristics for Class 9 vehicle	33 – 36
Operating characteristics for Class 10 vehicle	37 – 40
Operating characteristics for Class 11 vehicle	41 – 44
Operating characteristics for Class 12 vehicle	45 – 48
Operating characteristics for Class 13 vehicle	49 – 52
Operating characteristics for Class 14 vehicle	53 – 56
Operating characteristics for Class 15 vehicle	57 – 60

(continued)

H. (continued)

DECEL CARD

	Card columns
Maximum uniform deceleration for Class 1 vehicle ($4 \leq$ IDMAX ≤ 12) (ft/sec/sec)	1–4
Maximum deceleration for Class 2 vehicle	5–8
Maximum deceleration for Class 3 vehicle	9–12
Maximum deceleration for Class 4 vehicle	13–16
Maximum deceleration for Class 5 vehicle	17–20
Maximum deceleration for Class 6 vehicle	21–24
Maximum deceleration for Class 7 vehicle	25–28
Maximum deceleration for Class 8 vehicle	29–32
Maximum deceleration for Class 9 vehicle	33–36
Maximum deceleration for Class 10 vehicle	37–40
Maximum deceleration for Class 11 vehicle	41–44
Maximum deceleration for Class 12 vehicle	45–48
Maximum deceleration for Class 13 vehicle	49–52
Maximum deceleration for Class 14 vehicle	53–56
Maximum deceleration for Class 15 vehicle	57–60

(continued)

H. (continued)

ACCEL CARD

Maximum uniform acceleration for Class 1 vehicle (3 ≤ IAMAX ≤ 18) (ft/sec/sec)	1–4
Maximum acceleration for Class 2 vehicle	5–8
Maximum acceleration for Class 3 vehicle	9–12
Maximum acceleration for Class 4 vehicle	13–16
Maximum acceleration for Class 5 vehicle	17–20
Maximum acceleration for Class 6 vehicle	21–24
Maximum acceleration for Class 7 vehicle	25–28
Maximum acceleration for Class 8 vehicle	29–32
Maximum acceleration for Class 9 vehicle	33–36
Maximum acceleration for Class 10 vehicle	37–40
Maximum acceleration for Class 11 vehicle	41–44
Maximum acceleration for Class 12 vehicle	45–48
Maximum acceleration for Class 13 vehicle	49–52
Maximum acceleration for Class 14 vehicle	53–56
Maximum acceleration for Class 15 vehicle	57–60

(continued)

H. (continued)

VELOCITY CARD

	Card columns
Maximum velocity for Class 1 vehicle (10 ≤ IVMAX ≤ 235) (ft/sec)	1–4
Maximum velocity for Class 2 vehicle	5–8
Maximum velocity for Class 3 vehicle	9–12
Maximum velocity for Class 4 vehicle	13–16
Maximum velocity for Class 5 vehicle	17–20
Maximum velocity for Class 6 vehicle	21–24
Maximum velocity for Class 7 vehicle	25–28
Maximum velocity for Class 8 vehicle	29–32
Maximum velocity for Class 9 vehicle	33–36
Maximum velocity for Class 10 vehicle	37–40
Maximum velocity for Class 11 vehicle	41–44
Maximum velocity for Class 12 vehicle	45–48
Maximum velocity for Class 13 vehicle	49–52
Maximum velocity for Class 14 vehicle	53–56
Maximum velocity for Class 15 vehicle	57–60

(continued)

H. (continued)

VEHICLE RADIUS CARD

	Card columns
Minimum turning radius for Class 1 vehicle ($4 \leq IRMIN \leq 300$) (ft)	1–4
Minimum turning radius for Class 2 vehicle	5–8
Minimum turning radius for Class 3 vehicle	9–12
Minimum turning radius for Class 4 vehicle	13–16
Minimum turning radius for Class 5 vehicle	17–20
Minimum turning radius for Class 6 vehicle	21–24
Minimum turning radius for Class 7 vehicle	25–28
Minimum turning radius for Class 8 vehicle	29–32
Minimum turning radius for Class 9 vehicle	33–36
Minimum turning radius for Class 10 vehicle	37–40
Minimum turning radius for Class 11 vehicle	41–44
Minimum turning radius for Class 12 vehicle	45–48
Minimum turning radius for Class 13 vehicle	49–52
Minimum turning radius for Class 14 vehicle	53–56
Minimum turning radius for Class 15 vehicle	57–60

I. (Only if Section F, Options Card, Columns 7-9 are YES) (See page 33)
(2 cards)

DRIVER O.F. CARD

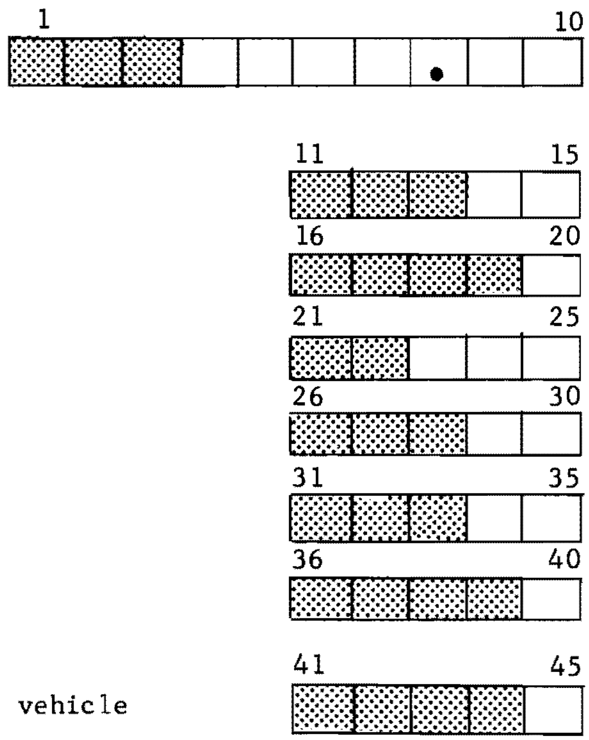
Driver operational factor for Class 1 driver ($50 \leq$ IDCHAR ≤ 150) ($<$ 100 = slow, 100 = average, $>$ 100 = aggressive)	1 – 4
Driver operational factor for Class 2 driver	5 – 8
Driver operational factor for Class 3 driver	9 – 12
Driver operational factor for Class 4 driver	13 – 16
Driver operational factor for Class 5 driver	17 – 20

PIJR CARD

Perception reaction time for Class 1 driver ($0.25 \leq$ PIJR ≤ 5.00) (sec)	1 – 5 (_ _ . _ _)
Perception reaction time for Class 2 driver	6 – 10 (_ _ . _ _)
Perception reaction time for Class 3 driver	11 – 15 (_ _ . _ _)
Perception reaction time for Class 4 driver	16 – 20 (_ _ . _ _)
Perception reaction time for Class 5 driver	21 – 25 (_ _ . _ _)

J. (OPTIONAL) (See page 33)

SPECIAL VEHICLE CARD



Queue in time (sec)
(start-up plus simulation time)

Vehicle class
($1 \leq$ IVEHCL $\leq$ NVEHCL)

Driver class
($1 \leq$ IDRICL $\leq$ NDRICL)

Desired speed (ft/sec)
($10 \leq$ ISPD ≤ 161)

Desired outbound approach
($1 \leq$ NOBAPD ≤ 12)

Inbound approach
($1 \leq$ IA ≤ 12)

Inbound lane
($1 \leq$ ILN $\leq$ NLANES(IA))
(Median lane = 1)

1/0 for (Yes/No) logout summary for this vehicle

(Repeat J as desired)

CHAPTER 3. PRE-SIMULATION PROCESSORS GUIDE

The TEXAS model incorporates two pre-processor packages which are instrumental in its efficient operation. These pre-processors perform those tasks that are normally performed only once.

(1) The geometry pre-processor program takes engineering data which describes the physical geometry of the intersection approaches and the intersection area to be studied and creates input to the traffic simulator defining the approaches, the vehicle paths in the approaches, the vehicle paths within the intersection, the traffic conflicts between the different paths within the intersection, and the available sight distances between inbound approaches.

(2) The driver-vehicle pre-processor program accepts descriptive traffic parameters and provides the traffic simulator with driver-vehicle characteristics such as queue-in time, velocity, inbound approach and lane, outbound approach, length and turning radius of the vehicle, and the reaction time and attitude of the driver.

Both pre-processors use a common input data file from which the necessary information is taken. This input guide will aid in coding the input form (i.e., the common data file).

The input coding form has 10 sections labeled A through J. Each section contains information pertaining to a certain aspect of the intersection or driver-vehicle pair. See Fig 2 for a deck schematic.

A. There are 6 cards in this section: (MANDATORY)

(1) Title card - use the whole card for any information which you want echo-printed on the pre-processor outputs and the simulation processor output.

(2) In column 4 - the total number of inbound approaches at the intersection - maximum 6.

(3) On this card, the identification number for each inbound approach is listed. Any arbitrary integer between 1 and 12 may be used once.

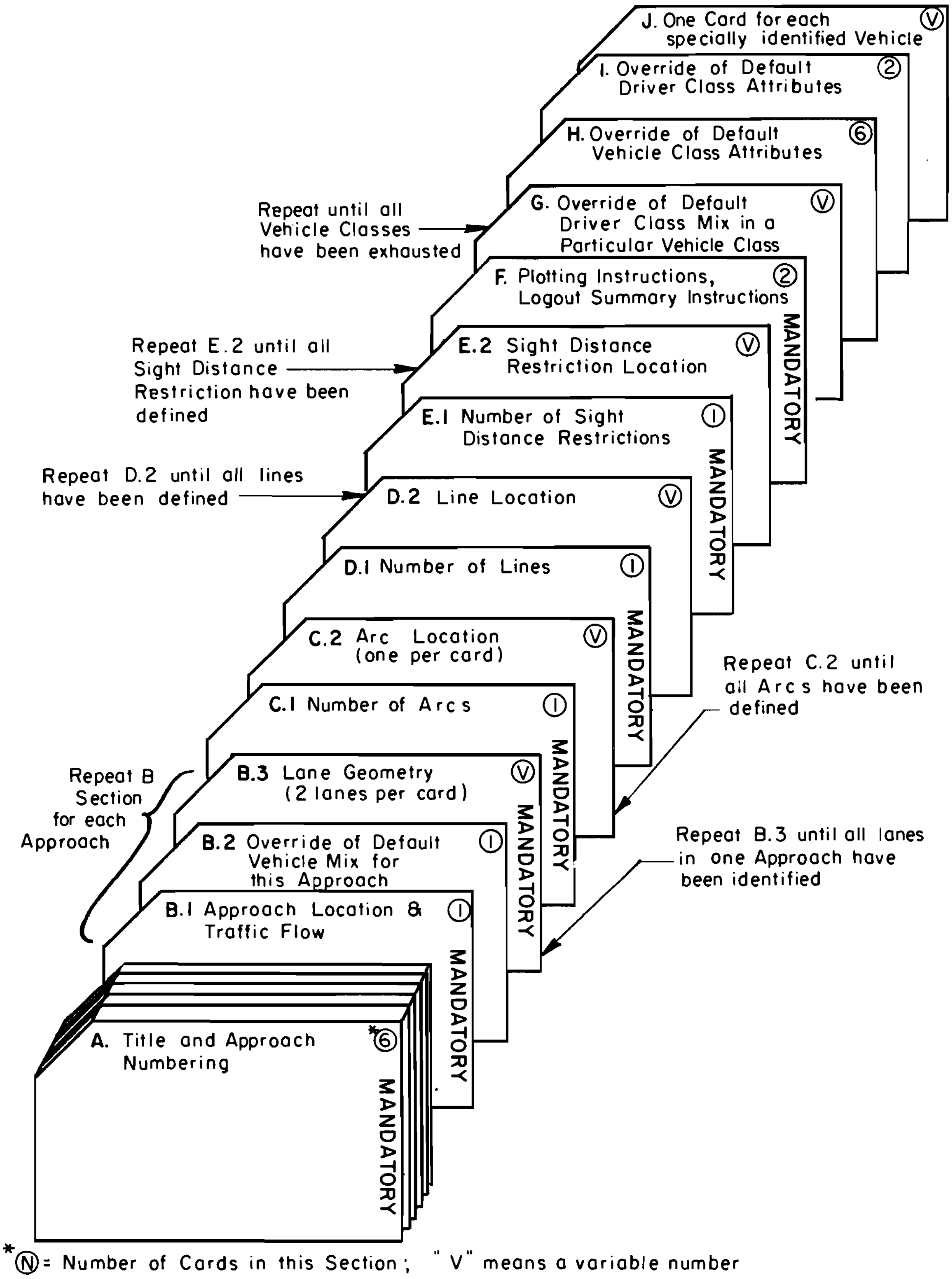


Fig 2. Pre-simulation processors input deck schematic.

(4) In column 4 - the total number of outbound approaches at the intersection - maximum 6.

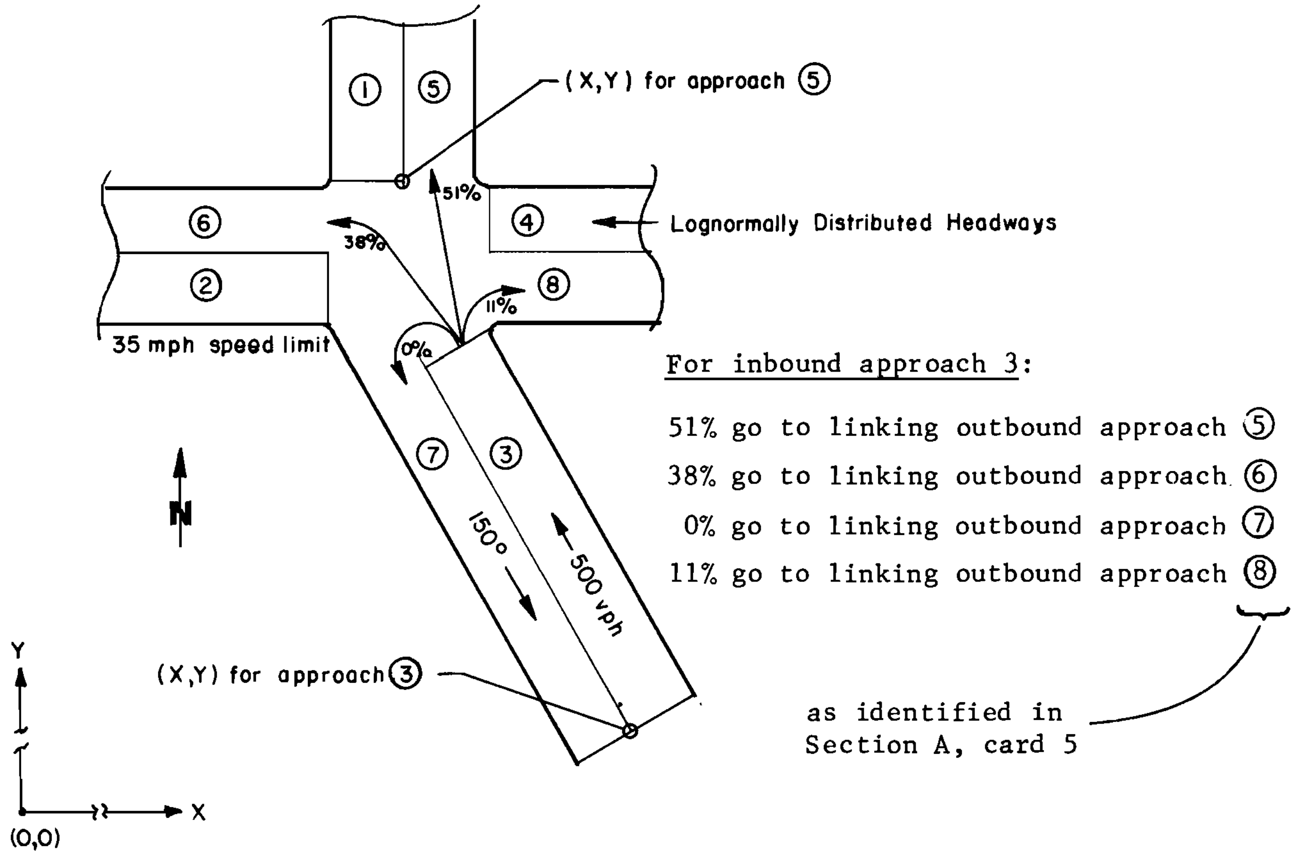
(5) The identification number of each outbound approach. All approaches, regardless of whether they are inbound or outbound, must have different identification numbers. (Suggestion: number the inbound approaches 1, 2, 3 . . . around the intersection. Continue numbering the outbound approaches around the intersection with the next available number.)

(6) - Total number of approaches = no. inbound + no. outbound

- Length of simulation time - remember that under normal situations, about 2 minutes of start-up time is necessary in order to load the system.
- The minimum headway for vehicles entering the system. If left blank, a one second headway is assumed.
- The pre-processors have pre-programmed 10 vehicle classes (small cars, medium cars, large cars, vans, single-unit trucks, semi-trailer trucks, full trailers, recreational vehicles, buses, and sports cars) and 3 driver classes (aggressive, average, and slow). All necessary information about these classes is defaulted in the pre-processor. Only if these values are to be changed does the user need to input this information. If so, enter the number of vehicle classes and driver classes desired.
- The percent of turning vehicles to enter the correct lane, no lane changes, at queue in time. If a turning bay, right or left, is provided, then all of the turning vehicles enter on the adjacent lane, which limits turning vehicles to one lane changing maneuver on the inbound approach.

B. There are "N" sets (B.1, B.2, B.3 combination) in this section, "N" being the total number of approaches.

B.1. The information required can be found on the following example sketch: (MANDATORY)



- Azimuth is measured clockwise with North as 0°. Standing at the start of the approach (inbound - away from intersection, outbound - in intersection) looking north, turn clockwise until you are looking along the approach, and the angle turned is the azimuth.
- X and Y coordinates of approach. First compute inbound approach lengths required by using the formula:

$$\text{LEN} = \frac{1.4 \times \text{VOL}}{\text{NSTL} + \text{NTBF} - \text{NLTF}} \quad , \quad (400 \leq \text{LEN} \leq 1000).$$

LEN - Approach Length Required (Round to nearest multiple of 50 feet)

VOL - Equivalent Hourly Volume

NSTL - Number of Straight Through Lanes

NTBF - Number of Turning Bays divided by 8
$(0.00 \leq \text{NTBF} \leq 0.25)$

NLTF - Number of Left Turn Fraction times 2
$(0.00 \leq \text{NLTF} \leq 0.30)$

Outbound approach lengths range from 250 feet for light volumes to 400 feet for heavy volumes. After deciding on approach lengths, set up a cartesian coordinate system with the origin located in the bottom left hand corner.

- Speeds on the inbound approaches should be obtained from speed studies.
- The available headway distributions and required parameters are shown in the following table. See Appendix for a more complete discussion of headway distributions.
- In this case, since the angle between approaches 3 and 5 is 22°, the default value of 20° for straight zone will need to be overridden on card B.1 (columns 25-27). Both approaches 1 and 3 will need that value (say, 25°) specified.

Conceptualization of
Default Turn Movements

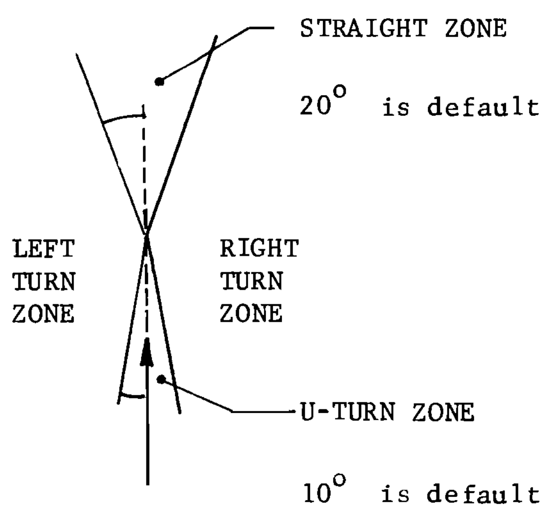


TABLE 1. HEADWAY DISTRIBUTIONS

Distribution	Parameter
U N I F O R M	Standard Deviation
L O G N R M L	Standard Deviation
N E G E X P	-
S N E G E X P	Minimum Headway
G A M M A	Mean^2 /Variance
E R L A N G	Integer Value of Parameter for Gamma (can be rounded up or down)
C O N S T A N	-

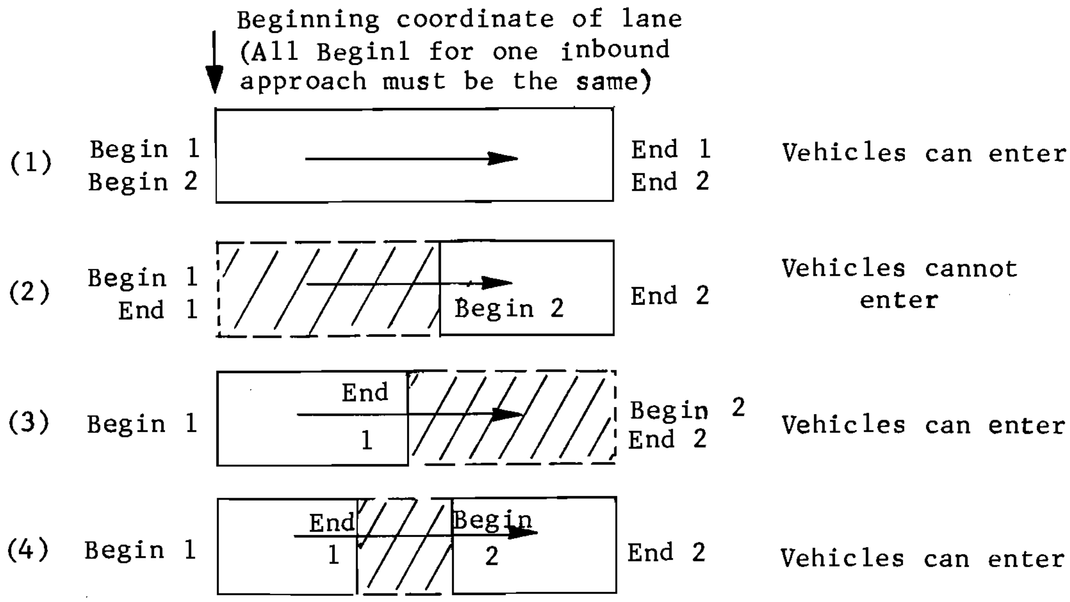
Selection of a headway distribution can be accomplished several ways. Depending on the purpose of the run, an arbitrary choice may be made. Usual practice has been to assume a shifted negative exponential (SNEGEXP) distribution, but there are indications that this is not the best distribution in many cases. Use of a supplemental program (DISFIT), developed for just this purpose, will fit all of the above distributions to a set of headways gathered by field observation and select the "best-fit." The program also gives numerical values of the required parameter for each distribution.

B.2. - One card

- Use this section only if the user wishes to override the pre-programmed values of vehicle mix for this approach.

B.3. Lane geometry - one card for each 2 lanes in the approach.

All possible lane configurations are shown below. (MANDATORY)



Begin 1, Begin 2, End 1, and End 2 are integer values of distance from the "beginning" of the approach.
(Inbound approaches end at the intersection,
outbound approaches begin at the intersection.)
The four conditions are:

(1) clear lane; open at both ends;

(2) a lane which begins at some distance down the approach; e.g., adding a left or right turn bay;

(3) a lane which ends before the end of the approach causes merging traffic flow; dropping a lane;

(4) a lane blocked midway down the approach.

Legal movements from each lane at the intersection are coded on this card also. The percent of approach volume entering each lane at the beginning of the approach is specified here (Inbound only).

B.3. is repeated until all lanes (median lane first) in one particular approach are exhausted; then the (B.1, B.2, B.3) combination is completed for the next approach.

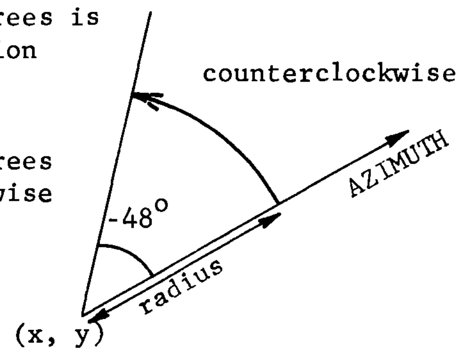
C. The geometry pre-processor plots a plan view of the intersection. Lane lines, curbs, medians, etc. will be shown, but curb returns have to be defined individually.

C.1. The number of curb returns to be plotted. (MANDATORY) (arcs)

C.2. Information required to define an arc:

+ number of degrees is clockwise rotation from beginning azimuth

- number of degrees is counterclockwise rotation from beginning azimuth



D. Any lines not defined by the approaches will be inputted here. (STOP LINES, PED X-WALK . . .)

D.1. = Number of additional lines to be plotted (MANDATORY)

D.2. = X, Y coordinates of end points.

E. Number and location of sight distance restrictions. (E.1 IS MANDATORY)

F. Card 1 - Plotting Instructions: (MANDATORY)

Path Type: PRIMARY = Only legal movements allowed, and no lane changing in the intersection. (PRIMARY is recommended)
OPTION1 = Only legal movements allowed and vehicles may change one lane in the intersection. OPTION1 paths should not be used unless a specific case exists where the lane-change paths are necessary.

Plot Option: NOPLOT = Generate no plot
PLOT = Plot with ball point pen
PLOTI = Plot with ink pen

Plot Type: SAME = Plot all intersection paths on the same frame
SEPARATE = Plot the intersection paths from each inbound approach on a separate frame

Max Radius for Paths - Paths with larger radii than this will be replaced as straight line movements.

Clearance Distance for Conflicts - The distance from all other paths to the path in question is compared to a clearance distance. When this distance is violated, a path conflict is set at that position.

Card 2 - Input/Output Options: (MANDATORY)

Input - Enter YES if the user wishes to override the program supplied values of percent of drivers in each vehicle class, vehicle characteristics, and driver characteristics. The program supplied values are shown in Table 2, page 32.

Output - If the user wishes to have logout summaries (amount of delay, average speed, etc.) for any particular class (of vehicles or drivers), a YES should be entered in the correct columns. "NO" should be coded like this:

N	O	

TABLE 2. DEFAULT VALUES

		Vehicle Class and Type									
		1	2	3	4	5	6	7	8	9	10
		Small Car	Medium Car	Large Car	Vans, Mini-bus	Single-unit	Semi-trailer	Full-trailer	Recreational	Bus	Sports Car
Section H overrides these	Length	15	17	19	25	30	50	55	25	35	14
	Operating Characteristic Factor	100	110	110	100	85	80	75	90	85	115
	Maximum Deceleration	16	16	16	16	12	12	12	12	12	16
	Maximum Acceleration	8	9	11	8	8	7	6	6	5	14
	Maximum Velocity	150	192	200	150	160	160	150	150	125	205
	Minimum Turning Radius	20	22	24	28	42	40	45	28	28	20
Section G overrides these	Percentage Aggressive Drivers	30	35	20	25	40	50	50	20	25	50
	Percentage Average Drivers	40	35	40	50	30	40	40	30	50	40
	Percentage Slow Drivers	30	30	40	25	30	10	10	50	25	10
Sec. B.2 overrides this	Percentage in Traffic Stream	20	32	30	15	.5	.2	.1	.2	.5	1.5

		1	2	3
Section I overrides these	Driver Class and Type	Aggressive	Average	Slow
	Driver Characteristic	110	100	85
	Perception Reaction Time	0.5	1.0	1.5

G. One card for each vehicle class - even if the driver mix will be changed in only one class, all other percentages must be defined again.

H. One card for each section.

- User supplied values of vehicle length
- User supplied values of vehicle operating characteristics
- User supplied values of vehicle deceleration
- User supplied values of vehicle acceleration
- User supplied values of vehicle velocity
- User supplied values of minimum turning radius

I. One card for each section.

- User supplied values of driver operational factor
- User supplied values of perception reaction time.

J. One card for each specially entered vehicle (chronological order). (OPTIONAL)

A. (MANDATORY)
(3 cards)

TITLE CARD

1 — 80

PARAMETER CARD

Start-up time (minutes) — columns 1–4 (_ . _ _)
(2.00 ≤ STRTIM ≤ 5.00)
(no statistics gathered)

Simulation time (minutes) — columns 6–10 (_ _ . _ _)
(10.00 ≤ SIMTIM ≤ 60.00)
(statistics gathered)

Step increment for simulation time (seconds) — columns 12–15 (_ . _ _)
(0.50 ≤ DT ≤ 1.50)
(Recommended: 1.00 signal, 0.50 non-signal)

Speed below which << delay below XX mph >> is gathered (0 ≤ XX ≤ 40) — columns 16–18

Maximum clear distance for being in a queue — columns 19–21
(4 ≤ XQDIST ≤ 40)
(30 ft recommended)

<u>Traditional Car Follow Equation Parameters</u>

"Lambda" Parameter — columns 23–27 (_ . _ _ _)
(2.300 ≤ CAREQL ≤ 4.000)
(2.800 recommended)

"Mu" Parameter — columns 29–33 (_ . _ _ _)
(0.600 ≤ CAREQM ≤ 1.000)
(0.800 recommended)

"Alpha" Parameter — columns 35–38
(0 ≤ CAREQA ≤ 4000)
(4000 recommended)

(continued)

A. (continued)

PARAMETER CARD (cont)

Type of intersection control
(1 ≤ ICONTR ≤ 7)

40

1 = Uncontrolled
2 = Yield
3 = Less than all-way stop
4 = All-way stop
5 = Pretimed signal
6 = Semi-actuated signal
7 = Full-actuated signal

YES/NO for statistical summary of individual turning movements
Default = "YES"

42 44

YES/NO for statistical summary of each inbound approach
Default = "YES"

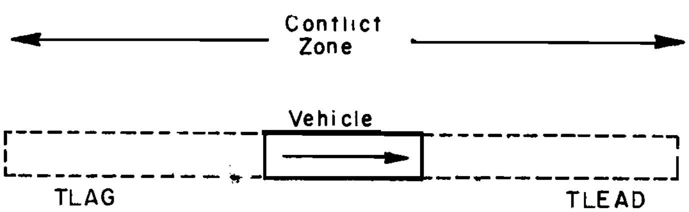
46 48

YES/NO for punched output of statistics
Default = "YES"

50 52

YES/NO for writing pollution tape for dispersion model
Default = "NO"

54 56



Time of lead zone for conflict checking
(1.00 ≤ TLEAD ≤ 3.00)
(1.50 recommended)

58 • 61

Time of lag zone for conflict checking
(1.00 ≤ TLAG ≤ 3.00)
(2.50 recommended)

63 • 66

(continued)

A. (continued)

Lane control for all lanes (lanes ordered
as previously in the geometry processor output)

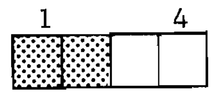
1 = Outbound lane, or an inbound lane which ends before the intersection
2 = Uncontrolled
3 = Yield sign
4 = Stop sign
5 = Signal
6 = Signal with left turn on red
7 = Signal with right turn on red

LANE CONTROL CARD

Lane Number 1	1	14	27	40
Lane Number 2	2	15	28	41
Lane Number 3	3	16	29	42
.	4	17	30	43
.	5	18	31	44
.	6	19	32	45
	7	20	33	46
	8	21	34	47
	9	22	35	48
	10	23	36	49
	11	24	37	50
	12	25	38	
	13	26	39	

B. Cam stack information
(Only if Section A, Parameter Card, Column 40 is a 5, 6, or 7)

CAM STACK CARD 1



B.1. Number of signal controller cam stack positions
$(4 \leq \text{NCAMSP} \leq 72)$

Each new set of signal indications is an additional cam stack position

B.2. One card for each cam stack position

CAM STACK CARD 2

Phase number in which this cam stack position is contained ($1 \leq ICAMPH \leq 8$)	2
Time span of cam stack position (seconds) ($TCAMSP \geq 1$ only if ICONTR = 5)	3 – 5

The three-digit code (see following page) - this defines the signal indication that faces each inbound lane shown

Inbound lanes ordered as in the geometry processor output

Every inbound lane's cam stack position must be coded (including channelized right turns and blocked lanes)

Inbound Lane Number 1	6 – 8	Lane Number 14	45 – 47
Lane Number 2	9 – 11	Lane Number 15	48 – 50
Lane Number 3	12 – 14	Lane Number 16	51 – 53
Lane Number 4	15 – 17	Lane Number 17	54 – 56
Lane Number 5	18 – 20	Lane Number 18	57 – 59
Lane Number 6	21 – 23	Lane Number 19	60 – 62
Lane Number 7	24 – 26	Lane Number 20	63 – 65
Lane Number 8	27 – 29	Lane Number 21	66 – 68
Lane Number 9	30 – 32	Lane Number 22	69 – 71
Lane Number 10	33 – 35	Lane Number 23	72 – 74
Lane Number 11	36 – 38	Lane Number 24	75 – 77
Lane Number 12	39 – 41	Lane Number 25	78 – 80
Lane Number 13	42 – 44		

Three-Digit Signal Codes

Position 1	=	Turn code
Position 2	=	Indication for turn code in Position 1
Position 3	=	Indication for all other allowable movements from this lane

AG	=	All allowable movements green
AA	=	All allowable movements amber
AR	=	All allowable movements red
AP	=	All allowable movements protected green
LGA	=	Left turn green, all other allowable movements amber
LGR	=	Left turn green, all other allowable movements red
LAG	=	Left turn amber, all other allowable movements green
LAR	=	Left turn amber, all other allowable movements red
LRG	=	Left turn red, all other allowable movements green
LRA	=	Left turn red, all other allowable movements amber
LPG	=	Left turn protected green, all other allowable movements green
LPA	=	Left turn protected green, all other allowable movements amber
LPR	=	Left turn protected green, all other allowable movements red
SGA	=	Straight green, all other allowable movements amber
SGR	=	Straight green, all other allowable movements red
SAG	=	Straight amber, all other allowable movements green
SAR	=	Straight amber, all other allowable movements red
SRG	=	Straight red, all other allowable movements green
SRA	=	Straight red, all other allowable movements amber
RGA	=	Right green, all other allowable movements amber
RGR	=	Right green, all other allowable movements red
RAG	=	Right amber, all other allowable movements green
RAR	=	Right amber, all other allowable movements red
RRG	=	Right red, all other allowable movements green
RRA	=	Right red, all other allowable movements amber
UNS	=	Unsignalized lane (channelized right turn, or blocked lane)

Note: In order to reduce the amount of coding needed, it is not necessary to duplicate the code for several cam stack positions if the signal indication remains the same. For example, if Lane 7 has an AR_ code for cam stack positions 2 through 8, then only cam stack position 2 need be coded AR_. The remainder (3,4,5,6,7, and 8) may be left blank for Lane 7.

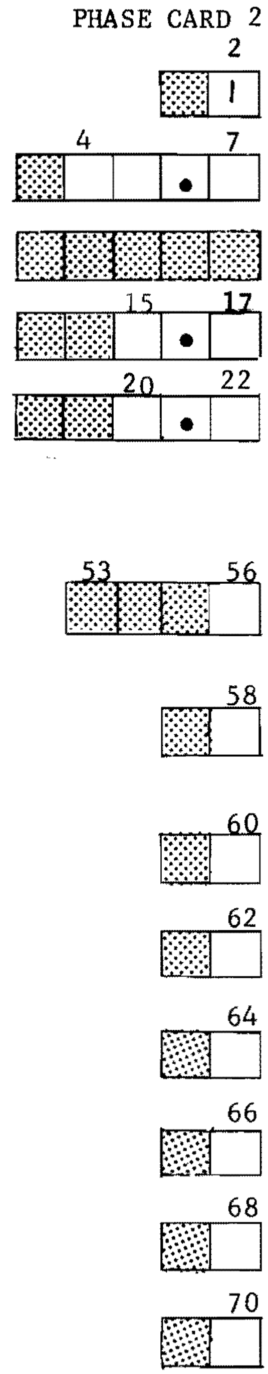
C. Semi-actuated controller information
(Only if Section A, Parameter Card, Column 40 = 6)

PHASE CARD 1

1			4

C.1. Number of controller phases
($2 \leq NPHASE \leq 8$)

C.2. Major street phase information



Phase number

Minimum assured green (sec)

Amber clearance interval (sec)

All-red clearance interval (sec)

Number of phases which can be cleared to directly from this phase
(1 ≤ NPHNXT ≤ 7)

Phase number of the first phase which can be cleared to directly from this phase
(1 ≤ LPHNXT(1) ≤ NPHNXT)

Phase number ... second ...
(1 ≤ LPHNXT(2) ≤ NPHNXT)

third

fourth

fifth

sixth

seventh

C.3. Minor street(s) phase information
(2 cards - one set for each minor phase)

	PHASE CARD 3
Phase number (2 ≤ IPHASE ≤ NPHASE)	2
Initial interval (sec) (TII ≥ DT)	3–7
Vehicle interval (sec) (TVI ≥ DT)	8–12
Amber clearance interval (sec) (TCI ≥ 0.0)	13–17
All-red clearance interval (sec) (TAR ≥ 0.0)	18–22
Maximum extension (sec) (TMX ≥ 0.0)	23–28
ON/OFF for skip phase switch position Default = "OFF"	29–32
ON/OFF for recall switch position Default = "OFF"	33–36
YES/NO is this phase controlled by a minor movement controller attached to a parent phase? Default = "NO"	37–40
YES/NO is this a dual left phase which will be followed on the cam stack by the two corresponding single left phases (i.e., $A_{xy} \rightarrow A_x \rightarrow A_y$) Default = "NO"	41–44
AND/OR for the type of interconnection between the detectors on this phase (AND is a series connection, OR is a parallel connection) Default = "OR"	45–48
See Examples 1 and 2 on pages 51 and 52 for coding detector information.	
Number of detectors attached to this phase (1 ≤ NLD ≤ 10)	49–52
Number of phases which can be cleared to directly from this phase (1 ≤ NPHNXT ≤ 7)	53–56

(continued)

C.3. (continued)

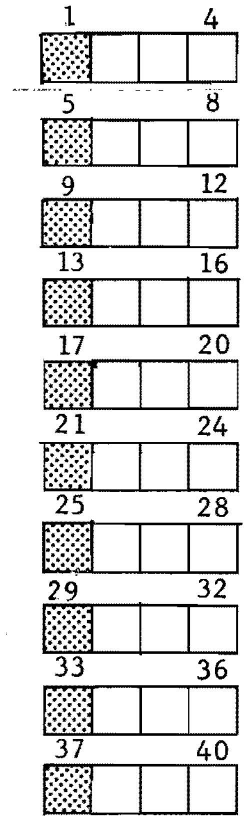
PHASE CARD 3 (cont)

Phase number of the first phase which can be cleared to directly from this phase ($1 \le LPHNXT(1) \le NPHNXT$)	58
Phase number ... second ... ($1 \le LPHNXT(2) \le NPHNXT$)	60
third	62
fourth	64
fifth	66
sixth	68
seventh	70

(continued)

C.3. (continued)

PHASE DETECTOR CARD



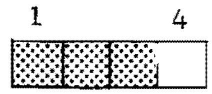
List of detector numbers attached to this phase. A "NOT" connection should be coded with a minus sign (i.e., as a negative number).

If the first detector is negative, a "NOT" connection, then the remainder of the detectors must be negative; which implies an ALL-RED REST Phase. (Note: All positive connected detectors should be coded first, then the negative connected detectors should be coded.)

See Example 2, page 52, for the correct usage of the "NOT" connection.

D. Full-actuated controller information
(Only if Section A, Parameter Card, Column 40 = 7)

PHASE CARD 1



D.1. Number of controller phases
($2 \le NPHASE \le 8$)

D.2. (2 cards - one set for each controller phase)

PHASE CARD 2

Field	Columns
Phase number (1 ≤ IPHASE ≤ NPHASE)	2
Initial interval (sec) (TII ≥ DT)	3–7
Vehicle interval (sec) (TVI ≥ DT)	8–12
Amber clearance interval (sec) (TCI ≥ 0.0)	13–17
All-red clearance interval (sec) (TAR ≥ 0.0)	18–22
Maximum extension (sec) (TMX ≥ 0.0)	23–28
ON/OFF for skip phase switch position Default = "OFF"	29–32
ON/OFF for recall switch position Default = "OFF"	33–36
YES/NO for is this phase controlled by a minor movement controller attached to a parent phase? Default = "NO"	37–40
YES/NO for is this a dual left phase which will be followed on the cam stack by the two corresponding single left phases (i.e., $A_{xy} \rightarrow A_x \rightarrow A_y$) Default = "NO"	41–44
AND/OR for the type of interconnection between the detectors on this phase (AND is a series connection, OR is a parallel connection) See Examples 1 and 2 on pages 51 and 52 for coding detector information. Default = "OR"	45–48
Number of detectors attached to this phase (1 ≤ NLD ≤ 10)	49–52
Number of phases which can be cleared to directly from this phase (1 ≤ NPHNXT ≤ 7)	53–56

(continued)

D.2. (continued)

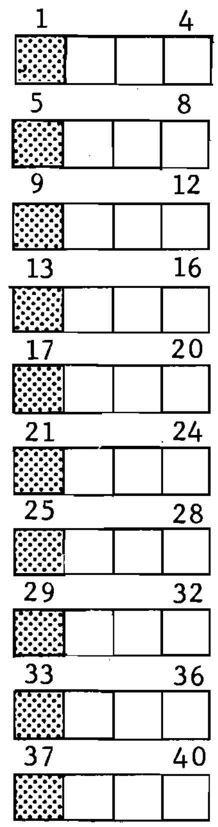
PHASE CARD 2 (cont)

Phase number of the first phase which can be cleared to directly from this phase ($1 \le LPHNXT(1) \le NPHNXT$)	58
Phase number ... second ... ($1 \le LPHNXT(2) \le NPHNXT$)	60
third	62
fourth	64
fifth	66
sixth	68
seventh	70

(continued)

D.2. (continued)

PHASE DETECTOR CARD



List of detector numbers attached to this phase. A "NOT" connection should be coded with a minus sign (i.e., as a negative number).

If the first detector is negative, a "NOT" connection, then the remainder of the detectors must be negative; which implies an ALL-RED REST Phase. (Note: All positive connected detectors should be coded first, then the negative connected detectors should be coded.)

See Example 2, page 52, for the correct usage of the "NOT" connection.

E. Detector location information for actuated signal
(Only if Section A, Parameter Card, Column 40 equals 6 or 7)

DETECTOR CARD 1

1 4

E.1. Total number of detectors
($0 \le$ NLOOPS ≤ 20)

E.2. One card for each detector

DETECTOR CARD 2

Field	Card columns
Detector number ($1 \leq N \leq 20$)	2
Detector type < PULSE > or < PRESENCE > Default = "PRESENCE"	3–11 (P . . S E)
Distance down lane to beginning of detector ($0 \leq STRTLD \leq 1000$)	12–16
Distance down lane to end of detector ($0 \leq STOPLD \leq 1000$)	17–20
Approach number in which the detector is located (as numbered in GEOMETRY PROCESSOR INPUT) ($1 \leq IA \leq NAP \leq 12$)	21–24
Number of lanes covered by this detector ($1 \leq NLDLN \leq 6$)	25–28
List of lanes covered by this detector	29–32, 33–36, 37–40, 41–44, 45–48, 49–52

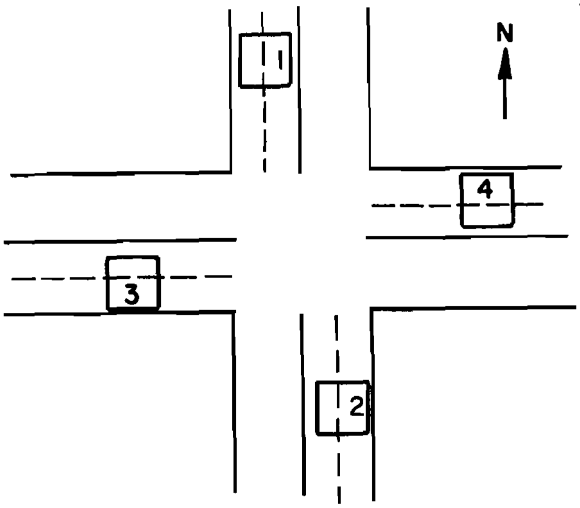
Coding Detector Information

For full-actuated and semi-actuated controllers, vehicle detectors on the approaches allow for a demand to be set on the phase to which each detector is connected. More than one detector may be connected to a phase (the "or" case).

The following example illustrates the coding for detectors required with a 2-phase controller.

Example 1. Full-actuated 2-phase controller

Phase 1 = North / South
Phase 2 = East / West



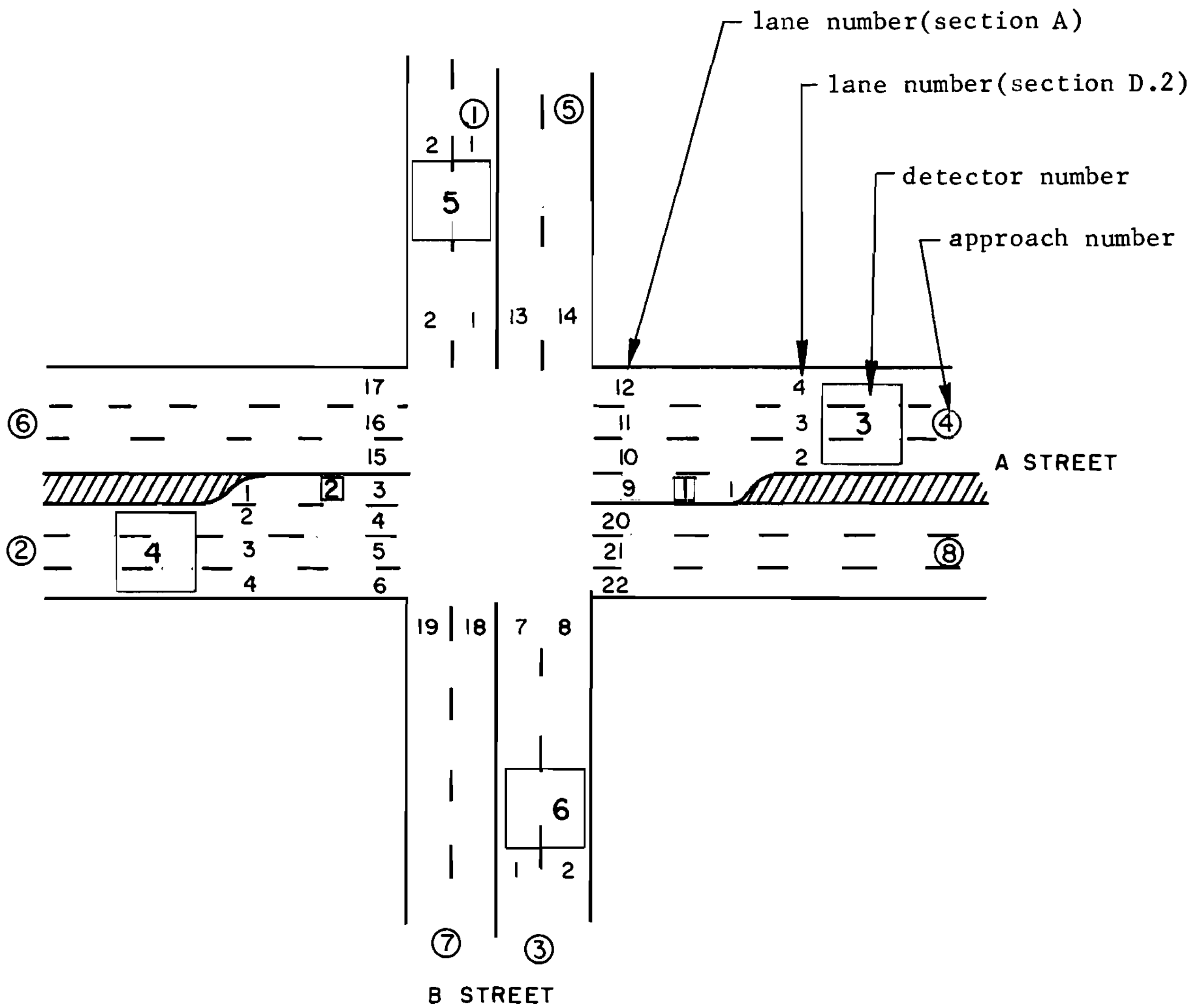
Phase 1 is demanded when either No. 1 or No. 2 is tripped.

Phase 2 is demanded when either No. 3 or No. 4 is tripped.

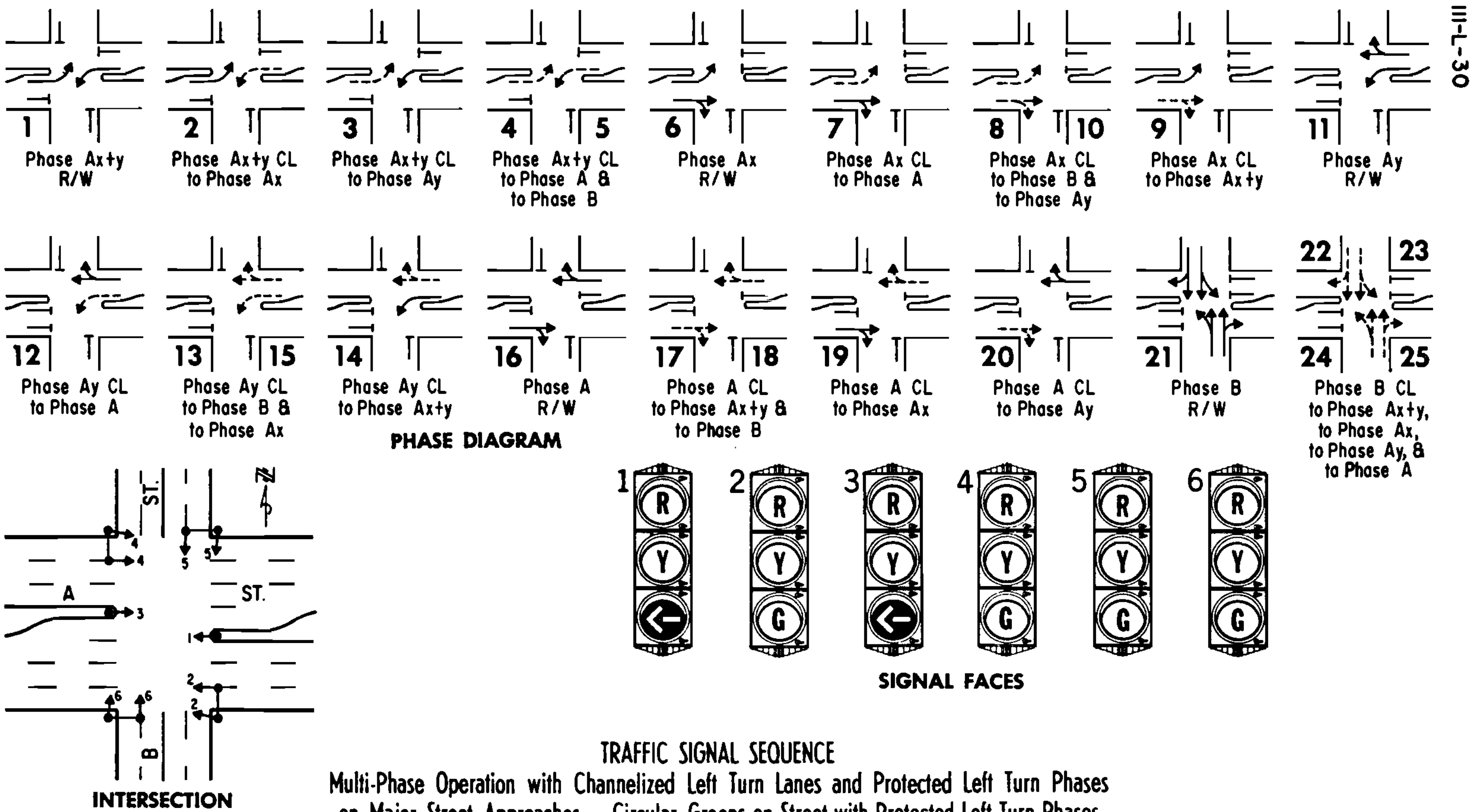
Section D.2 should look like this:

1	5.0	5.0	3.5	0.0	35.0	OFF	OFF	NO	NO	OR	2	1	2
1	2												
2	6.0	3.0	3.0	0.0	25.0	OFF	OFF	NO	NO	OR	2	1	1
3	4												

Example 2. Fully-skippable 5-phase. This example follows the traffic signal sequence example in the SDHPT Manual on Uniform Traffic Control Devices, pages III-L-30, 31 (see next two pages). As diagrammed there, phase A (X + Y) is the overlap of phases A (X) and A (Y). However, this model allows only one phase to be entered at a time; hence, the "extra phase."



Phase 1	=	A (X + Y)	(dual left on A Street)
2	=	A (X)	(single left from East)
3	=	A (Y)	(single left from West)
4	=	A	(East-West)
5	=	B	(North-South)



TRAFFIC SIGNAL SEQUENCE
Multi-Phase Operation with Channelized Left Turn Lanes and Protected Left Turn Phases on Major Street Approaches - Circular Greens on Street with Protected Left Turn Phases

SOURCE: State Department of Highways and Public Transportation, Division of Maintenance Operations, Texas Manual on Uniform Traffic Control Devices for Streets and Highways, vol. 2, (Austin, Texas: 1973), p. III-L-30.

		1					2					SIGNAL SEQUENCE 3					4					5				
SIGNAL		PHASE Ax + y					PHASE Ax					PHASE Ay					PHASE A					PHASE B				
		R / W	CL to Ax	CL to Ay	CL to A	CL to B	R / W	CL to A	CL to B	CL to Ax+y	CL to Ay	R / W	CL to A	CL to B	CL to Ax+y	CL to Ax	R / W	CL to B	CL to Ax+y	CL to Ax	CL to Ay	R / W	CL to Ax+y	CL to Ax	CL to Ay	CL to A
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1.	A ST EB LT	←	←	Y	Y	Y	←	Y	Y	←	Y	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
2.	A ST EB	R	R	R	R	R	G	G	Y	Y	Y	R	R	R	R	R	G	Y	Y	G	Y	R	R	R	R	R
3.	A ST WB LT	←	Y	←	Y	Y	R	R	R	R	R	←	Y	Y	←	Y	R	R	R	R	R	R	R	R	R	R
4.	A ST WB	R	R	R	R	R	R	R	R	R	R	G	G	Y	Y	Y	G	Y	Y	Y	G	R	R	R	R	R
5.	B ST NB	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	G	Y	Y	Y	Y
6.	B ST SB	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	G	Y	Y	Y	Y

NOTES:

1. Right Turn Arrows may be added on B Street.
2. Any face may be Span Wire Mounted, Mast Arm Mounted, or Mast Arm and Post Top or Bracketed as shown.
3. Not all of the changes shown may be possible, depending upon the type of Controller and Detectors, if any.
4. Faces 1 and 3 should be accompanied by sign "LEFT ON ARROW ONLY," and should have Louvers.

TRAFFIC SIGNAL SEQUENCE

Multi-Phase Operation with Channelized Left Turn Lanes and Protected Left Turn Phases on Major Street Approaches - Circular Greens on Street with Protected Left Turn Phases

SOURCE: State Department of Highways and Public Transportation, Division of Maintenance Operations, Texas Manual on Uniform Traffic Control Devices for Streets and Highways, vol. 2, (Austin, Texas: 1973), p. III-L-31.

Phase 1 may be entered only if detectors 1 and 2 have registered a demand on red.

Phase 2 is demanded by detector no. 2 alone. If detector no. 1 is demanded also, there is not demand for this phase; hence, an "AND NOT" connection.

Phase 3 is demanded by detector 1 alone.

Phase 4 is demanded by detectors 3 or 4.

Phase 5 is demanded by detectors 5 or 6.

The entire listing of the simulator processor input for Example 2 is shown on the following page.

For the dual left phase (Phase 1) the value of TII + TVI must be the minimum of TII + TVI for the two separate left turn phases (Phases 2 and 3). The value of TMX for Phase 1 must also be the minimum TMX of Phases 2 and 3. The clearance intervals TCI and TAR for Phase 1 must be the maximum of the like variables of Phases 2 and 3.

SECTION

```
        LISTING OF SIMULATION MODEL INPUT FOR EXAMPLE 2

                  1         2         3         4         5         6
        123456789012345678901234567890123456789012345678901234567890123456789012345678
        ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
A.     <SDHPT - MUTCD   EXAMPLE - PAGE III-L-30,31     5 PHASE FULL SKIPPABLE
A.     <2.00 10.00 1.00  10 30 2.800 0.800 4000 7  YES  YES YES NO    1.50 2.50
A.     <5755575755571111111111
B.1    <  25
B.2    <1    AR  AR AP  AR AR  AR AR AR  AP AR  AR AR
B.2    <1                                AA
B.2    <1           AA                   AP
B.2    <1                                AA
B.2    <1
B.2    <2           AP  AG AG  AG        AP
B.2    <2           AA
B.2    <2               AA AA  AA
B.2    <2           AP
B.2    <2           AA
B.2    <3           AR  AR AR  AR        AP AG  AG AG
B.2    <3                                AA
B.2    <3                                   AA  AA AA
B.2    <3                                AP
B.2    <3                                AA
B.2    <4               AG AG  AG        AR AG  AG AG
B.2    <4               AA AA  AA           AA  AA AA
B.2    <4
B.2    <4               AG AG  AG
B.2    <4               AA AA  AA           AG  AG AG
B.2    <5    AG  AG     AR AR  AR AG AG     AR  AR AR
B.2    <5    AA  AA               AA AA
B.2    <5
B.2    <5
B.2    <5
D.1    <   5
D.2    <1   5.0   2.0  3.0   0.0  18.0 ON   OFF NO   YES  AND    2    4 2 3 4 5
D.2    <   1  2
D.2    <2   5.0   2.0  3.0   0.0  18.0 ON   OFF NO   NO   AND    2    4 4 5 1 3
D.2    <   2  -1
D.2    <3   5.0   2.0  3.0   0.0  18.0 ON   OFF NO   NO   AND    2    4 4 5 1 2
D.2    <   1  -2
D.2    <4  14.0   3.0  4.0   0.0  35.0 ON   OFF NO   NO   OR     2    4 5 1 2 3
D.2    <   3  4
D.2    <5  13.0   3.0  3.5   0.0  30.0 ON   OFF NO   NO   OR     2    4 1 2 3 4
D.2    <   5  6
E.1    <   6
E.2    <1 PRESENCE   550 600   4    1    1
E.2    <2 PRESENCE   550 600   2    1    1
E.2    <3 PRESENCE   450 500   4    3    2    3   4
E.2    <4 PRESENCE   450 500   2    3    2    3   4
E.2    <5 PRESENCE   475 500   1    2    1    2
E.2    <6 PRESENCE   475 500   3    2    1    2
        vvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvv
                  1         2         3         4         5         6
        123456789012345678901234567890123456789012345678901234567890123456789012345678
```

Example 3. Full-actuated 2-phase with 2 minor movement controllers. This must be modeled as a 5-phase controller with the restrictions explained below. This example is similar to Example 2 (being the same intersection with the same loop locations).

A minor movement controller leads the parent and therefore can clear only to its parent. However, an A(X + Y) can gap-out to an A(X) or an A(Y) and then from there to its parent phase. Additionally, it must be known if this is a minor movement phase so that demand on red can be effected as soon as the minor phase is entered. This insures that the cam stack will not rest in a minor movement position but will gap-out to its parent phase.

Again, this example is similar to the signal sequence example in the SDHPT Manual on Uniform Traffic Control Devices, pages III-L-30, 31, except that cam stack positions 5, 8, 9, 10, 13, 14, and 15 have been eliminated.

The entire listing of the simulator processor input for Example 3 is shown on the following page.

Phase 1 =	A (X + Y)	Both minors
2 =	A (X)	
3 =	A (Y)	
4 =	A	Parent
5 =	B	

For a minor phase, the last phase on the list of phases which can be cleared to directly should be the parent phase associated with the minor phase.

SECTION

LISTING OF SIMULATION MODEL INPUT FOR EXAMPLE 3

```
                  1         2         3         4         5         6
          123456789012345678901234567890123456789012345678901234567890123456789012345678
          ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
A.    <  SDHPT - MUTCD  EXAMPLE - PAGE III-L-30,31    PARENT-MINOR CONTROL
A.    <2.20 10.00 1.00 10 30 2.800 0.800 4000 7 YES YES YES NO  1.50 2.50
A.    <5755575755571111111111
B.1   <  18
B.2   < 1   AR AR AP AR AR AR AR AR AP AR AR AR
B.2   < 1                           AA
B.2   < 1         AA                AP
B.2   < 1                           AA
B.2   < 2         AP AG AG AG       AR
B.2   < 2         AA
B.2   < 3         AR AR AR AR       AP AG AG AG
B.2   < 3                           AA
B.2   < 4            AG AG AG       AR AG AG AG
B.2   < 4            AA AA AA          AA AA AA
B.2   < 4
B.2   < 4            AG AG AG
B.2   < 4            AA AA AA          AG AG AG
B.2   < 5   AG AG    AR AR AR AG AG    AR AR AR
B.2   < 5   AA AA             AA AA
B.2   < 5
B.2   < 5
B.2   < 5
D.1   <   5
D.2   < 1  5.0  2.0  3.0  0.0  18.0 ON  OFF YES YES AND   2   3 2 3 4
D.2   <   1   2
D.2   < 2  5.0  2.0  3.0  0.0  18.0 ON  OFF YES NO  AND   2   1 4
D.2   <   2  -1
D.2   < 3  5.0  2.0  3.0  0.0  18.0 ON  OFF YES NO  AND   2   1 4
D.2   <   1  -2
D.2   < 4 10.0  3.0  4.0  0.0  35.0 ON  OFF NO  NO  OR    4   4 5 1 2 3
D.2   <   3   4
D.2   < 5 13.0  3.0  3.5  0.0  30.0 ON  OFF NO  NO  OR    2   4 1 2 3 4
D.2   <   5   6
E.1   <   6
E.2   < 1 PRESENCE  550 600   4   1   1
E.2   < 2 PRESENCE  550 600   2   1   1
E.2   < 3 PRESENCE  450 500   4   3   2   3   4
E.2   < 4 PRESENCE  450 500   2   3   2   3   4
E.2   < 5 PRESENCE  475 500   1   2   1   2
E.2   < 6 PRESENCE  475 500   3   2   1   2
          vvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvv
                  1         2         3         4         5         6
          123456789012345678901234567890123456789012345678901234567890123456789012345678
```

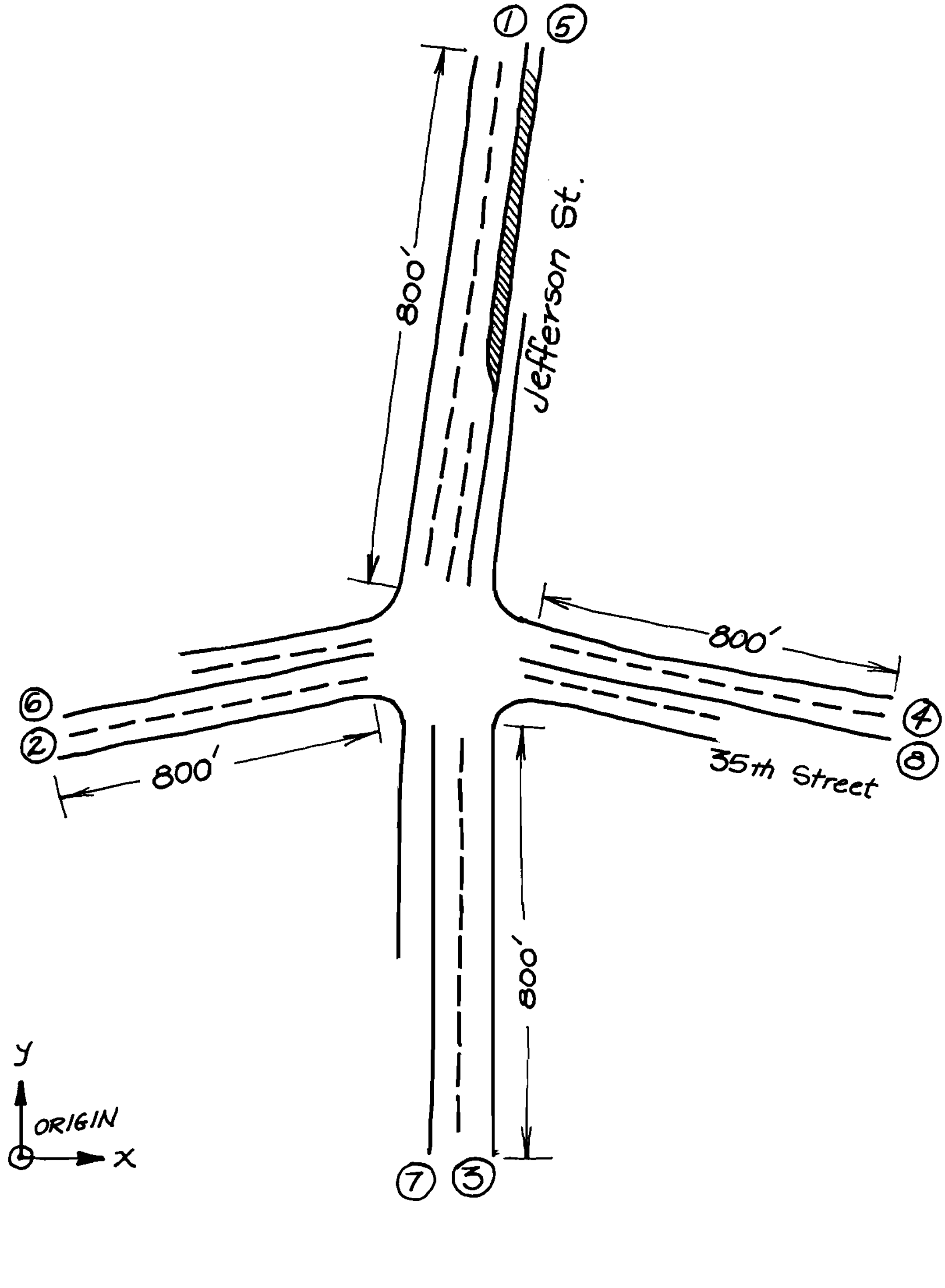
CHAPTER 5. CASE STUDY: 35th AND JEFFERSON STREET INTERSECTION

This intersection is located in suburban Austin at the crossing of an artery and a collector street, both experiencing medium to heavy volumes during peak periods. A pretimed two-phase signal controller is in place at the intersection, running a 60-second cycle normally and extending to an 86-second cycle during peaks.

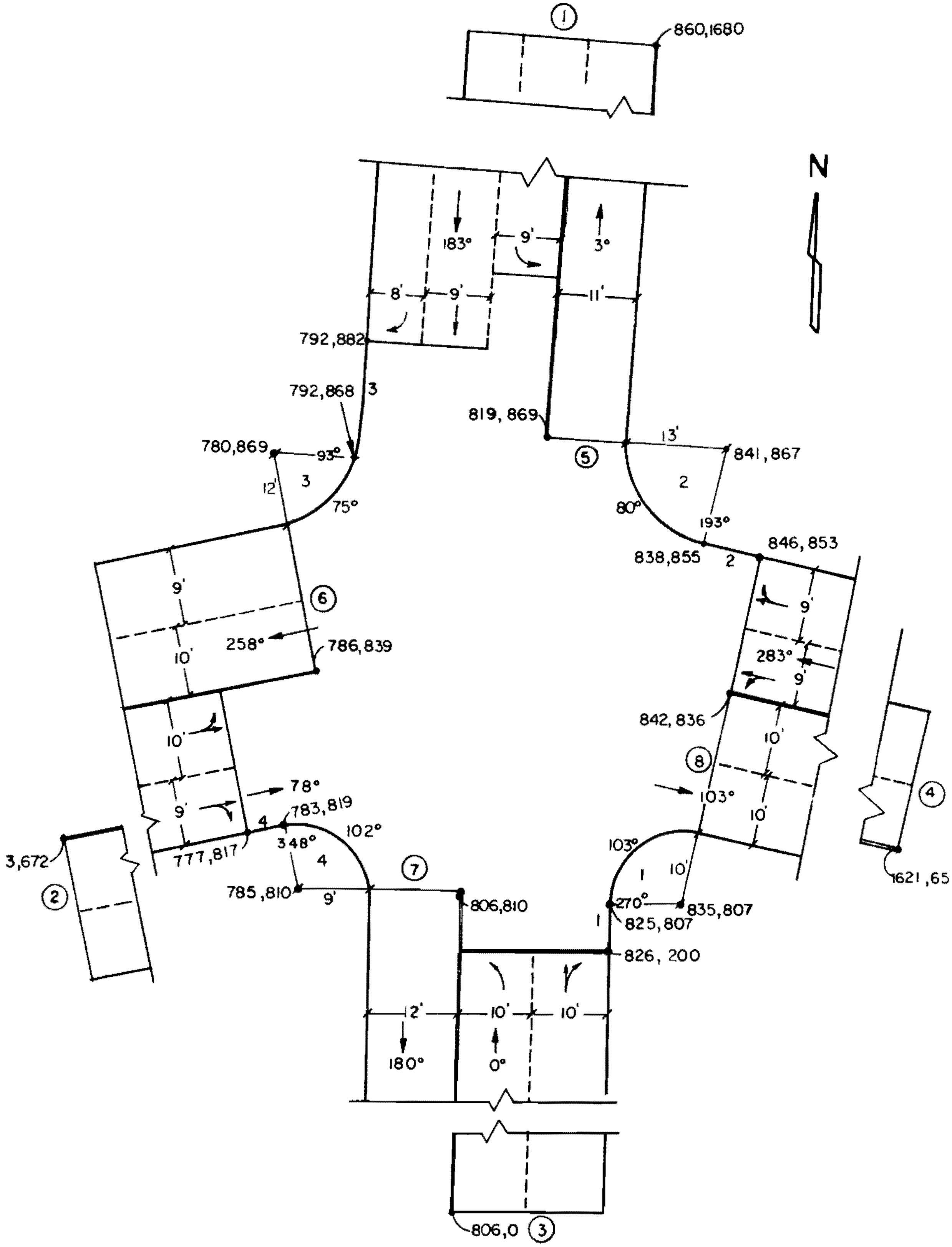
The necessary input for the driver-vehicle processor was gathered by a traffic-survey crew. Volumes in each approach, lane occupancy, and spot speeds were measured. Headway data were gathered for analysis by the distribution fitting program, DISFIT.

Some time was spent also at the intersection gathering geometric data for the other pre-simulation processor; the geometry processor. Lane widths, azimuths of approaches, and locations of left turn bays were noted. A sketch of the intersection is shown on the following page with each approach numbered. Eight hundred feet was chosen as the length for each inbound approach, and four hundred feet for the outbound approaches. A plan view of the intersection is shown on the next page after the sketch giving the cartesian coordinates of required points. Lane widths and azimuths are also shown for each approach.

Following the photographs of the intersection, the coding form containing the input to the pre-processors is shown; then, two CalComp plots of the intersection produced by the geometry processor; then, the coding form for the card input to the simulation model. Finally, there appear some selected output from an actual simulation run.



Sketch of the intersection.

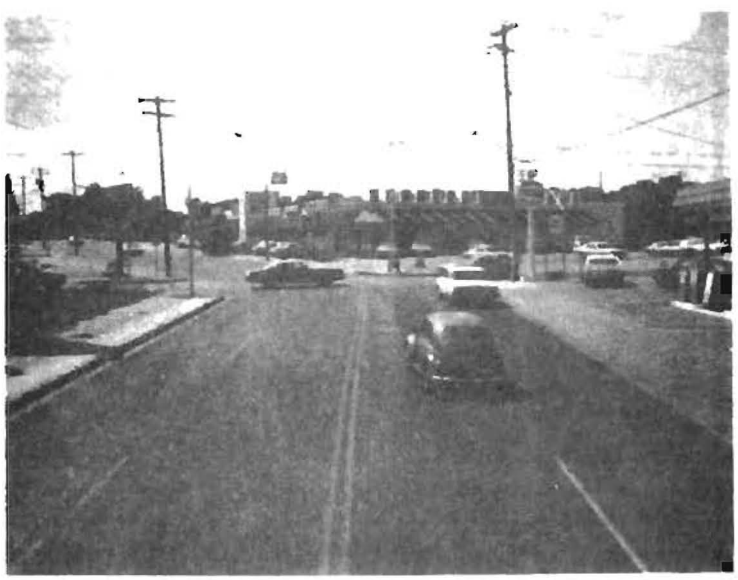


Plan view of the intersection.

Jefferson Street Southbound (1)

35th Street Eastbound (2)

Jefferson Street Northbound (3)



35th Street Westbound (4)

IDENTIFICATION CASE STUDY INPUT 1 (SHORT FORM) CODED BY ______ DATE ______ PAGE 1 OF 3

SECTION	Card (columns 1–80)
A	***** 35TH AND JEFFERSON: PRE-SIMULATION PROCESSOR INPUT *****
	4
	1 2 3 4
	4
	5 6 7 8
	8 12
B.1	1 183 860 1680 35 3 20 10 LOGNRML 500 11.06 19.0 25.7 0 11 71 18 NO
B.3	9 0 0 690 790 L 0 9 0 800 0 800 S 55
B.3	8 0 800 0 800 R 45
B.1	2 78 3 612 35 2 25 10 SNEGEXP 550 1.18 33.6 38.7 3 0 13 84 NO
B.3	10 0 787 0 787 LS 41 9 0 787 0 787 SR 59
B.1	3 0 806 0 35 2 20 10 LOGNRML 750 5.43 30.0 34.3 63 16 0 21 NO
B.3	10 0 0 600 800 L 0 10 0 800 0 800 SR 100
B.1	4 283 1621 656 35 2 25 10 LOGNRML 600 4.99 23.9 28.6 13 70 17 0 NO
B.3	9 0 800 0 800 LS 36 9 0 800 0 800 SR 64
B.1	5 3 817 869 35 1

IDENTIFICATION CASE STUDY INPUT 1 (SHORT FORM) CODED BY ______ DATE ______ PAGE 2 OF 3

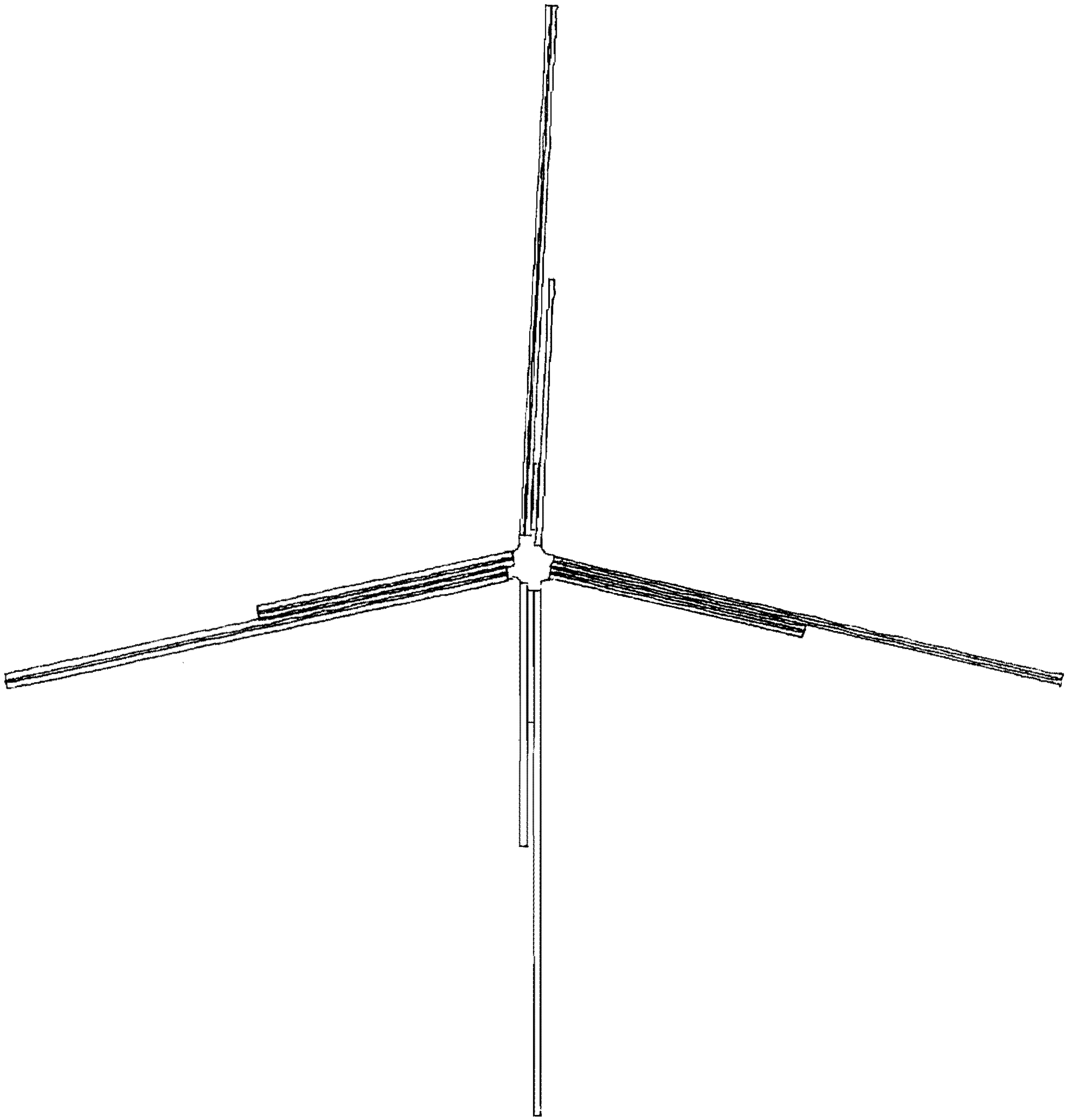
SECTION	1–4	5–8	9–12	13–16	17–20	21–25	41–44	45–48	49–52	53–56	57–60	61–65
B.3	11	0	400	0	400	LSR						
B.1	6	258	786	839	35	2						
B.3	10	0	400	0	400	LS	9	0	400	0	400	SR
B.1	7	180	806	810	35	1						
B.3	12	0	400	0	400	LSR						
B.1	8	103	842	836	35	2						
B.3	10	0	400	0	400	LS	10	0	400	0	400	SR
C.1	4											
C.2	1	835	807	270	103	10						
C.2	2	841	867	193	80	13						
C.2	3	780	869	93	75	12						
C.2	4	785	810	348	102	9						
D.1	4											
D.2	1	826	800	825	807							
D.2	2	846	853	838	855							
D.2	3	792	882	792	868							

SECTION

IDENTIFICATION CASE STUDY INPUT 1 (SHORT FORM) CODED BY ______ DATE ______ PAGE 3 OF 3

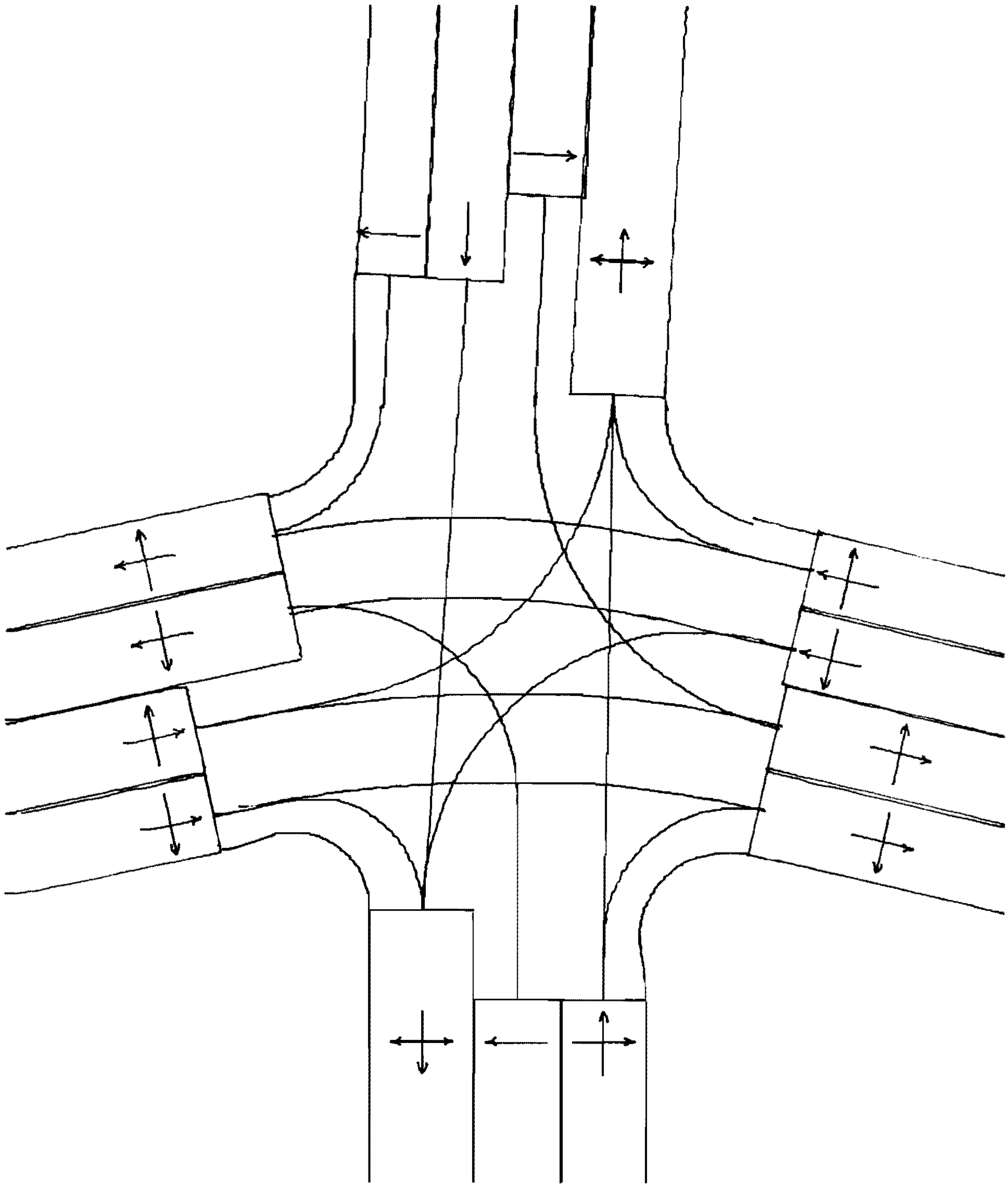
SECTION	1–80
D.2	4 777 817 783 819
E.1	4
E.2	1 864 638
E.2	2 727 751
E.2	3 703 874
E.2	4 890 896
F	PRIMARY FLOTI SAME 250.00 18.00
	NO NO NO NO NO NO NO NO NO NO NO NO NO NO NO NO
J	123.45 3 3 15 7 1 2 1
J	130.50 3 1 75 6 1 2 1

***** 35TH AND JEFFERSON: PRE-SIMULATION PROCESSOR INPUT *****



SCALE FACTOR IS 250.0 FEET PER INCH

***** 35TH AND JEFFERSON, PRE-SIMULATION PROCESSOR INPUT *****



SCALE FACTOR IS 18.0 FEET PER INCH

IDENTIFICATION CASE STUDY INPUT 2 CODED BY ______ DATE ______ PAGE 1 OF 1

```
A    *****         SIMPRO TITLE - JEFFERSON STREET AT 35TH STREET                           *****
A    2.00 10.00 1.00 10 30 2.800 0.800 4000 5 YES YES NO  NO  1.50 2.50
A    557575757111111
B.1     4
B.2   1 44AG AG AG AR AR AG AG AR AR
B.2   1  3AA AA AA       AA AA
B.2   2 30AR AR AR AG AG AR AR AG AG
B.2   2  3         AA AA       AA AA
```

SECTION

```
          SIMULATION PROCESSOR FOR THE TEXAS TRAFFIC SIMULATION PACKAGE

ECHO-PRINT OF TITLE FROM GEOMETRY PROCESSOR
     *****     35TH AND JEFFERSON: PRE-SIMULATION PROCESSOR INPUT     *****

ECHO-PRINT OF TITLE FROM DRIVER-VEHICLE PROCESSOR
     *****     35TH AND JEFFERSON: PRE-SIMULATION PROCESSOR INPUT     *****

ECHO-PRINT OF TITLE FROM SIMULATION PROCESSOR INPUT
      *****      SIMPRO TITLE - JEFFERSON STREET AT 35TH STREET      *****


START-UP TIME (MINUTES) -------------------------- =      2.00
SIMULATION TIME (MINUTES) ------------------------ =     10.00
STEP INCREMENT FOR SIMULATION TIME (SECONDS) ------ =      1.00

SPEED FOR DELAY BELOW XX MPH (MPH) --------------- =     10.00

MAXIMUM CLEAR DISTANCE FOR BEING IN A QUEUE (FT) -- =     30.00

CAR FOLLOWING EQUATION LAMBDA -------------------- =      2.80000
CAR FOLLOWING EQUATION MU ------------------------ =       .80000
CAR FOLLOWING EQUATION ALPHA --------------------- =   4000.00000

SUMMARY STATISTICS PRINTED BY TURNING MOVEMENTS --- =    YES
SUMMARY STATISTICS PRINTED BY INBOUND APPROACH ---- =    YES

PUNCHED OUTPUT OF STATISTICS --------------------- =    NO

WRITE TAPE FOR POLLUTION DISPERSION MODEL --------- =    NO

LEAD TIME GAP FOR CONFLICT CHECKING (SECONDS) ----- =      1.50
LAG TIME GAP FOR CONFLICT CHECKING (SECONDS) ------ =      2.50

INTERSECTION TRAFFIC CONTROL --------------------- =      5  (PRE-TIMED SIGNAL)


LANE CONTROL FOR THE 15 LANES = 5 5 7 5 7 5 7 5 7 1 1 1 1 1 1

     WHERE  1 = OUTBOUND (OR BLOCKED INBOUND) LANE
            2 = UNCONTROLLED
            3 = YIELD SIGN
            4 = STOP SIGN
            5 = SIGNAL
            6 = SIGNAL WITH LEFT TURN ON RED
            7 = SIGNAL WITH RIGHT TURN ON RED


A TOTAL OF  4 CAM STACK ENTRIES

ENTRY  1 PHASE  1 TIME =  44  AG  AG  AG  AR  AR  AG  AG  AR  AR
ENTRY  2 PHASE  1 TIME =   3  AA  AA  AA          AA  AA
ENTRY  3 PHASE  2 TIME =  30  AR  AR  AR  AG  AG  AR  AR  AG  AG
ENTRY  4 PHASE  2 TIME =   3              AA  AA          AA  AA
```

SIMULATION PROCESSOR FOR THE TEXAS TRAFFIC SIMULATION PACKAGE

***** SIMPRO TITLE - JEFFERSON STREET AT 35TH STREET *****

SUMMARY STATISTICS FOR INBOUND APPROACH 4 FOR TURN CODE = U AND LEFT

```
TOTAL DELAY*(VEHICLE-SECONDS) --------------------- =   2110.8
NUMBER OF VEHICLES INCURRING TOTAL DELAY ---------- =     17
PERCENT OF VEHICLES INCURRING TOTAL DELAY --------- =    100.0
AVERAGE TOTAL DELAY (SECONDS) --------------------- =    124.2
AVERAGE TOTAL DELAY/AVERAGE TRAVEL TIME ----------- =     76.0 PERCENT

QUEUE DELAY*(VEHICLE-SECONDS) --------------------- =   1986.0
NUMBER OF VEHICLES INCURRING QUEUE DELAY ---------- =     17
PERCENT OF VEHICLES INCURRING QUEUE DELAY --------- =    100.0
AVERAGE QUEUE DELAY (SECONDS) --------------------- =    116.8
AVERAGE QUEUE DELAY/AVERAGE TRAVEL TIME ----------- =     71.5 PERCENT

STOPPED DELAY*(VEHICLE-SECONDS) ------------------- =   1755.0
NUMBER OF VEHICLES INCURRING STOPPED DELAY -------- =     17
PERCENT OF VEHICLES INCURRING STOPPED DELAY ------- =    100.0
AVERAGE STOPPED DELAY (SECONDS) ------------------- =    103.2
AVERAGE STOPPED DELAY/AVERAGE TRAVEL TIME --------- =     63.2 PERCENT

DELAY BELOW 10.0 MPH*(VEHICLE-SECONDS) ------------ =   2143.0
NUMBER OF VEHICLES INCURRING DELAY BELOW 10.0 MPH - =     17
PERCENT OF VEHICLES INCURRING DELAY BELOW 10.0 MPH  =    100.0
AVERAGE DELAY BELOW 10.0 MPH (SECONDS) ------------ =    126.1
AVERAGE DELAY BELOW 10.0 MPH/AVERAGE TRAVEL TIME -- =     77.1 PERCENT

VEHICLE-MILES OF TRAVEL --------------------------- =      4.171
AVERAGE VEHICLE-MILES OF TRAVEL ------------------- =       .245
TRAVEL TIME (VEHICLE-SECONDS) ---------------------=   2778.7
AVERAGE TRAVEL TIME (SECONDS) --------------------- =    163.5
NUMBER OF VEHICLES PROCESSED ---------------------- =    17
VOLUME PROCESSED (VEHICLES/HOUR) ------------------ =    102.0
TIME MEAN SPEED (MPH) = MEAN OF ALL VEHICLE SPEEDS  =      6.4
SPACE MEAN SPEED (MPH) = TOT DIST / TOT TRAVEL TIME =      5.4
AVERAGE DESIRED SPEED (MPH) ----------------------- =     22.8
AVERAGE MAXIMUM ACCELERATION (FT/SEC/SEC) --------- =      3.8
AVERAGE MAXIMUM DECELERATION (FT/SEC/SEC) --------- =      4.3

OVERALL AVERAGE TOTAL DELAY (SECONDS) ------------- =    124.2
OVERALL AVERAGE QUEUE DELAY (SECONDS) ------------- =    116.8
OVERALL AVERAGE STOPPED DELAY (SECONDS) ----------- =    103.2
OVERALL AVERAGE DELAY BELOW 10.0 MPH (SECONDS) ---- =    126.1

PERCENT OF APPROACH VEHICLES MAKING MOVEMENT ------ =     16.3
```

*See Chapter 6 for an explanation of statistics.

```
SIMULATION PROCESSOR FOR THE TEXAS TRAFFIC SIMULATION PACKAGE

*****      SIMPRO TITLE - JEFFERSON STREET AT 35TH STREET      *****

SUMMARY STATISTICS FOR INBOUND APPROACH  4


TOTAL DELAY (VEHICLE-SECONDS) --------------------- =   5847.2
NUMBER OF VEHICLES INCURRING TOTAL DELAY ---------- =    104
PERCENT OF VEHICLES INCURRING TOTAL DELAY --------- =    100.0
AVERAGE TOTAL DELAY (SECONDS) --------------------- =     56.2
AVERAGE TOTAL DELAY/AVERAGE TRAVEL TIME ----------- =     59.5 PERCENT

QUEUE DELAY (VEHICLE-SECONDS) --------------------- =   4823.0
NUMBER OF VEHICLES INCURRING QUEUE DELAY ---------- =     90
PERCENT OF VEHICLES INCURRING QUEUE DELAY --------- =     86.5
AVERAGE QUEUE DELAY (SECONDS) --------------------- =     53.6
AVERAGE QUEUE DELAY/AVERAGE TRAVEL TIME ----------- =     56.7 PERCENT

STOPPED DELAY (VEHICLE-SECONDS) ------------------- =   3800.0
NUMBER OF VEHICLES INCURRING STOPPED DELAY -------- =     90
PERCENT OF VEHICLES INCURRING STOPPED DELAY ------- =     86.5
AVERAGE STOPPED DELAY (SECONDS) ------------------- =     42.2
AVERAGE STOPPED DELAY/AVERAGE TRAVEL TIME --------- =     44.7 PERCENT

DELAY BELOW 10.0 MPH (VEHICLE-SECONDS) ------------ =   5600.0
NUMBER OF VEHICLES INCURRING DELAY BELOW 10.0 MPH - =    103
PERCENT OF VEHICLES INCURRING DELAY BELOW 10.0 MPH  =     99.0
AVERAGE DELAY BELOW 10.0 MPH (SECONDS) ------------ =     54.4
AVERAGE DELAY BELOW 10.0 MPH/AVERAGE TRAVEL TIME -- =     57.5 PERCENT

VEHICLE-MILES OF TRAVEL --------------------------- =     25.502
AVERAGE VEHICLE-MILES OF TRAVEL ------------------- =       .245
TRAVEL TIME (VEHICLE-SECONDS) ---------------------=   9831.8
AVERAGE TRAVEL TIME (SECONDS) --------------------- =     94.5
NUMBER OF VEHICLES PROCESSED ---------------------- =    104
VOLUME PROCESSED (VEHICLES/HOUR) ------------------ =    624.0
TIME MEAN SPEED (MPH) = MEAN OF ALL VEHICLE SPEEDS  =     10.9
SPACE MEAN SPEED (MPH) = TOT DIST / TOT TRAVEL TIME =      9.3
AVERAGE DESIRED SPEED (MPH) ----------------------- =     23.5
AVERAGE MAXIMUM ACCELERATION (FT/SEC/SEC) --------- =      3.6
AVERAGE MAXIMUM DECELERATION (FT/SEC/SEC) --------- =      3.3

OVERALL AVERAGE TOTAL DELAY (SECONDS) ------------- =     56.2
OVERALL AVERAGE QUEUE DELAY (SECONDS) ------------- =     46.4
OVERALL AVERAGE STOPPED DELAY (SECONDS) ----------- =     36.5
OVERALL AVERAGE DELAY BELOW 10.0 MPH (SECONDS) ---- =     53.8

PERCENT OF VEHICLES MAKING A U-TURN OR A LEFT TURN  =     16.3
PERCENT OF VEHICLES GOING STRAIGHT ---------------- =     75.0
PERCENT OF VEHICLES MAKING A RIGHT TURN ----------- =      8.7

AVERAGE QUEUE LENGTH FOR LANE 1 ------------------- =      5.6   MAX = 10
AVERAGE QUEUE LENGTH FOR LANE 2 ------------------- =      3.1   MAX = 10

NUMBER OF COLLISIONS ------------------------------ =      1
AVERAGE OF LOGIN SPEED/DESIRED SPEED (PERCENT) ---- =     99.4
```

SIMULATION PROCESSOR FOR THE TEXAS TRAFFIC SIMULATION PACKAGE

***** SIMPRO TITLE - JEFFERSON STREET AT 35TH STREET *****

SUMMARY STATISTICS FOR ALL APPROACHES

```
TOTAL DELAY (VEHICLE-SECONDS) --------------------- =  14005.2
NUMBER OF VEHICLES INCURRING TOTAL DELAY ---------- =    378
PERCENT OF VEHICLES INCURRING TOTAL DELAY --------- =     97.9
AVERAGE TOTAL DELAY (SECONDS) --------------------- =     37.1
AVERAGE TOTAL DELAY/AVERAGE TRAVEL TIME ----------- =     51.6 PERCENT

QUEUE DELAY (VEHICLE-SECONDS) --------------------- =   9452.0
NUMBER OF VEHICLES INCURRING QUEUE DELAY ---------- =    258
PERCENT OF VEHICLES INCURRING QUEUE DELAY --------- =     66.8
AVERAGE QUEUE DELAY (SECONDS) --------------------- =     36.6
AVERAGE QUEUE DELAY/AVERAGE TRAVEL TIME ----------- =     51.0 PERCENT

STOPPED DELAY (VEHICLE-SECONDS) ------------------- =   7483.0
NUMBER OF VEHICLES INCURRING STOPPED DELAY -------- =    258
PERCENT OF VEHICLES INCURRING STOPPED DELAY ------- =     66.8
AVERAGE STOPPED DELAY (SECONDS) ------------------- =     29.0
AVERAGE STOPPED DELAY/AVERAGE TRAVEL TIME --------- =     40.4 PERCENT

DELAY BELOW 10.0 MPH (VEHICLE-SECONDS) ------------ =  13025.0
NUMBER OF VEHICLES INCURRING DELAY BELOW 10.0 MPH - =    336
PERCENT OF VEHICLES INCURRING DELAY BELOW 10.0 MPH  =     87.0
AVERAGE DELAY BELOW 10.0 MPH (SECONDS) ------------ =     38.8
AVERAGE DELAY BELOW 10.0 MPH/AVERAGE TRAVEL TIME -- =     54.0 PERCENT

VEHICLE-MILES OF TRAVEL --------------------------- =     94.828
AVERAGE VEHICLE-MILES OF TRAVEL ------------------- =       .246
TRAVEL TIME (VEHICLE-SECONDS) ---------------------=  27729.9
AVERAGE TRAVEL TIME (SECONDS) --------------------- =     71.8
NUMBER OF VEHICLES PROCESSED ---------------------- =    386
VOLUME PROCESSED (VEHICLES/HOUR) ------------------ =   2316.0
TIME MEAN SPEED (MPH) = MEAN OF ALL VEHICLE SPEEDS  =     14.9
SPACE MEAN SPEED (MPH) = TOT DIST / TOT TRAVEL TIME =     12.3
AVERAGE DESIRED SPEED (MPH) ----------------------- =     26.7
AVERAGE MAXIMUM ACCELERATION (FT/SEC/SEC) --------- =      3.6
AVERAGE MAXIMUM DECELERATION (FT/SEC/SEC) --------- =      3.4

OVERALL AVERAGE TOTAL DELAY (SECONDS) ------------- =     36.3
OVERALL AVERAGE QUEUE DELAY (SECONDS) ------------- =     24.5
OVERALL AVERAGE STOPPED DELAY (SECONDS) ----------- =     19.4
OVERALL AVERAGE DELAY BELOW 10.0 MPH (SECONDS) ---- =     33.7

NUMBER OF COLLISIONS ------------------------------ =      4
AVERAGE OF LOGIN SPEED/DESIRED SPEED (PERCENT) ---- =     99.5
```

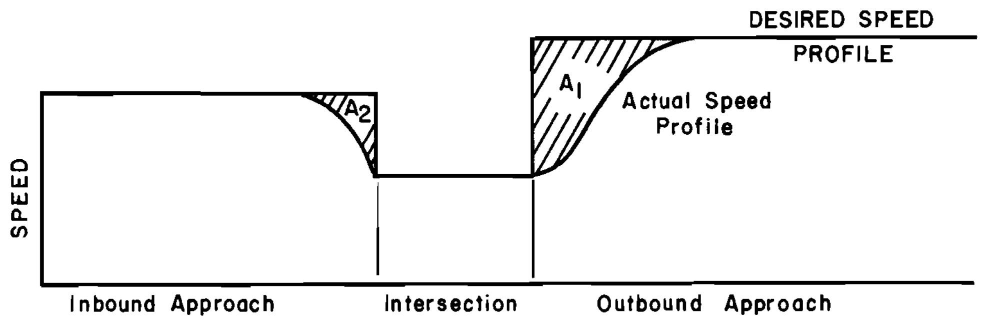
```
    SIMULATION PROCESSOR FOR THE TEXAS TRAFFIC SIMULATION PACKAGE

 *****       SIMPRO TITLE - JEFFERSON STREET AT 35TH STREET       *****

START-UP TIME    =  120.000 SECONDS       NUMBER OF VEHICLES PROCESSED =    35

SIMULATION TIME =  600.000 SECONDS       NUMBER OF VEHICLES PROCESSED =   386

NUMBER OF VEHICLES IN THE SYSTEM AT SUMMARY =    35
AVERAGE NUMBER OF VEHICLES IN THE SYSTEM -- =    46.8


INITIAL     TM TIME =      .535 SECONDS    COST = $    .03

START-UP    TM TIME =    14.175 SECONDS    COST = $    .91
            REAL/TM =     8.466

SIMULATION  TM TIME =   115.867 SECONDS    COST = $   7.40
            REAL/TM =     5.178

SUMMARY     TM TIME =     1.299 SECONDS    COST = $    .08

TOTAL       TM TIME =   131.876 SECONDS    COST = $   8.43

VEHICLE-SECONDS OF SIMULATION PER TM TIME =  239.325

VEHICLE UPDATES PER TM TIME =  239.325
```

CHAPTER 6. EXPLANATION OF SIMULATION RUN STATISTICS

The model reports statistics as instructed by the user at the completion of a run. Several pages of output are generated and this chapter is presented to define some of these statistics.

Total Delay

This is the difference between a vehicle's actual travel time through the system and the time it would have taken at the vehicle's desired speed. This type of delay cannot be measured effectively in the field and is therefore included in the output for comparison between subsequent runs.



Total Delay = Area 1 + Area 2 $(A_1 + A_2)$

In the model, a queue of vehicles at the intersection is recognized. In order to join a queue (or begin one), three factors must be satisfied.

(1) The vehicle velocity must be less than 3 feet per second;

(2) The vehicle must be less than XQDIST feet away from the vehicle ahead (or the stop line if first in lane); and

(3) The vehicle ahead must be in a queue.

XQDIST is a variable on card 2 of the simulation input and is recommended at 30 feet (1-1/2 to 2 car lengths).

Queue Delay

This delay counter is merely a count of how long a vehicle is in a queue. Once a vehicle enters a queue, it continues to accrue queue delay until it enters the intersection.

Stopped Delay

This delay is accrued only while a vehicle is in a queue. Additionally, it is incremented only when the speed of the vehicle falls below 3 feet per second.

Delay Below XX mph

For each time step in simulation that a vehicle in the system is travelling at a speed less than or equal to XX mph, a counter for this delay for that vehicle is incremented. This delay may be accrued anywhere on the inbound or outbound approach and in the intersection.

Two delay statistics appear to have about the same wording for each of the four delays, that is, AVERAGE ____ DELAY and OVERALL ____ DELAY. For example, on page 72, AVERAGE STOPPED DELAY is reported as 42.2 seconds, and OVERALL AVERAGE STOPPED DELAY is 36.5 seconds. In this case, 90 vehicles stopped for an average of 42.2 seconds each. But 3800.0 seconds ÷ 104 vehicles (total number of vehicles processed on approach 4) equals 36.5 seconds. Therefore:

AVERAGE STOPPED DELAY = AVERAGE STOPPED DELAY PER STOPPED VEHICLE

OVERALL AVERAGE STOPPED DELAY = AVERAGE STOPPED DELAY PER VEHICLE (COUNTING ALL VEHICLES)

Login Speed/Desired Speed and Number of Vehicles Eliminated

These two statistics are gathered for each inbound approach and represent the ratio of actual vehicle login (entering the simulation) speed to the vehicle's desired login speed generated by DVPRO. If this ratio is not fairly high then the queue is most likely backing up to the beginning of the approach which could cause vehicles to be eliminated from the system. If either of these conditions occur, the approach lengths should be made longer and the simulation should be rerun.

APPENDIX

HEADWAY DISTRIBUTIONS

APPENDIX. HEADWAY DISTRIBUTIONS

HEADWAY DISTRIBUTION ANALYSIS PROCESSOR INPUT FORM

A. (MANDATORY)

1

60

B. Headway (sec)

1 8

•

(Repeat B for each observed headway)

HEADWAY DISTRIBUTIONS DISCUSSION

Traditionally, when traffic simulation models have utilized a theoretical distribution of vehicle headways in traffic flow, a negative exponential, or a shifted negative exponential distribution has been specified. However, the TEXAS model allows the user to call any of seven distributions. The seven distributions which are available are (1) log normal, (2) gamma, (3) Erlang, (4) shifted negative exponential, (5) negative exponential, (6) constant, and (7) uniform.

To use distributions (1) through (4) and (7) both traffic volume information and a measure of dispersion in headways must be provided. Distributions (5) and (6) require only volume.

The following graphs illustrate the relationship between three values of the parameter (if required) for each distribution using the probability of occurrence given a mean headway of six seconds (or a traffic volume of 600 vehicles per hour). Since the "constant" distribution is really not a distribution at all, every headway will be exactly equal to the value of mean time spacing between vehicles.

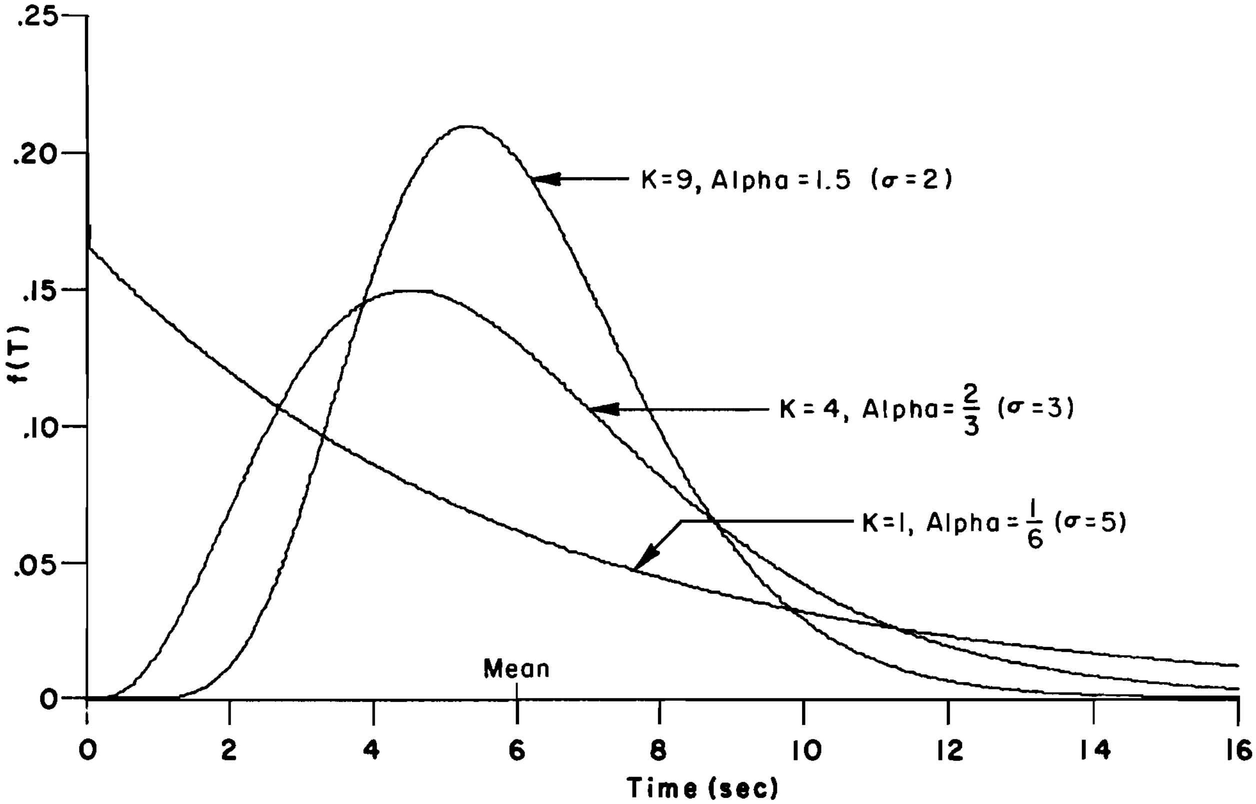
If the traffic engineer has observed headway data for an intersection, the computer program DISFIT can be used as an aid in fitting the observed data with one of the distributions available in the TEXAS model. A chi-square goodness-of-fit test and a Kolmogorov-Smirnov maximum cumulative difference test provide a basis for choice of the most suitable distribution.

Based on current experience in using the TEXAS model, tenative recommendations for headway distributions follow. These are to be used only if no better information is available.

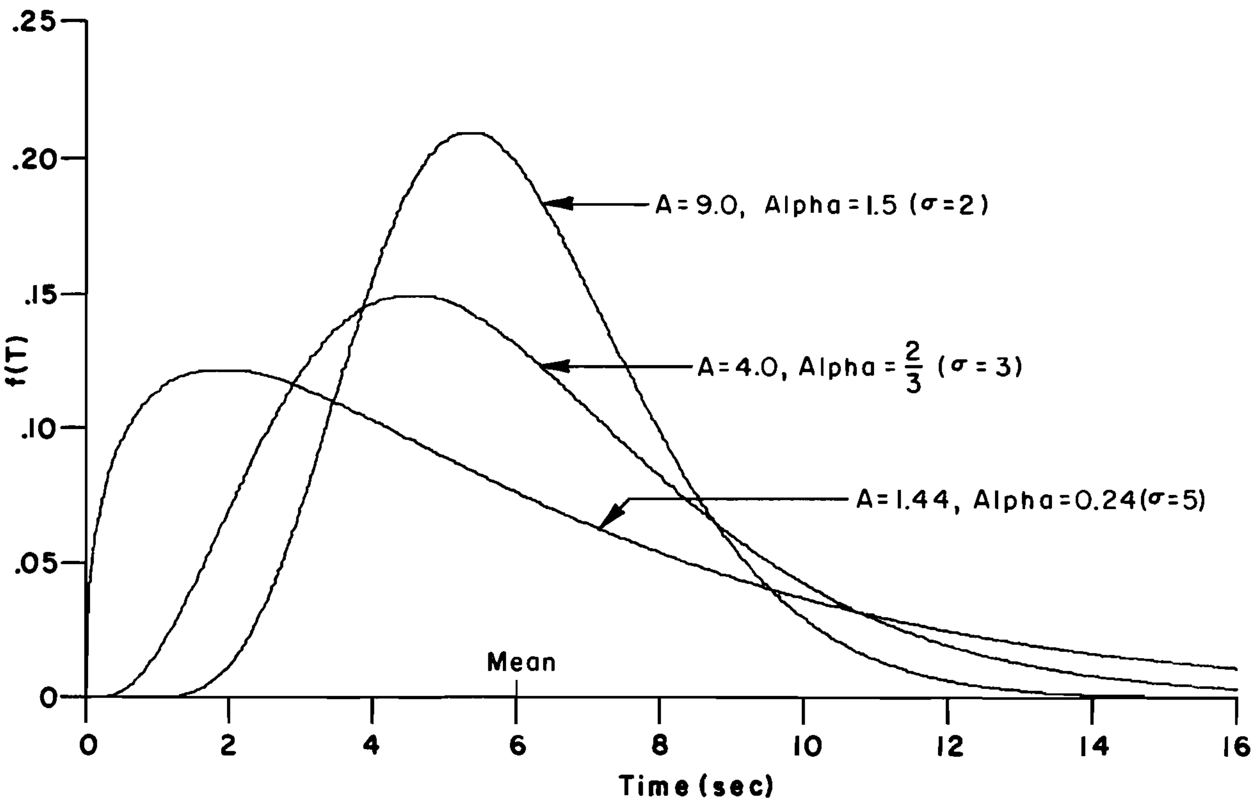
Light flow (less than 200 vph per lane): Negative exponential

Medium volumes (200 - 600 vph per lane): Log normal and shifted negative exponential appear to give approximately the same results

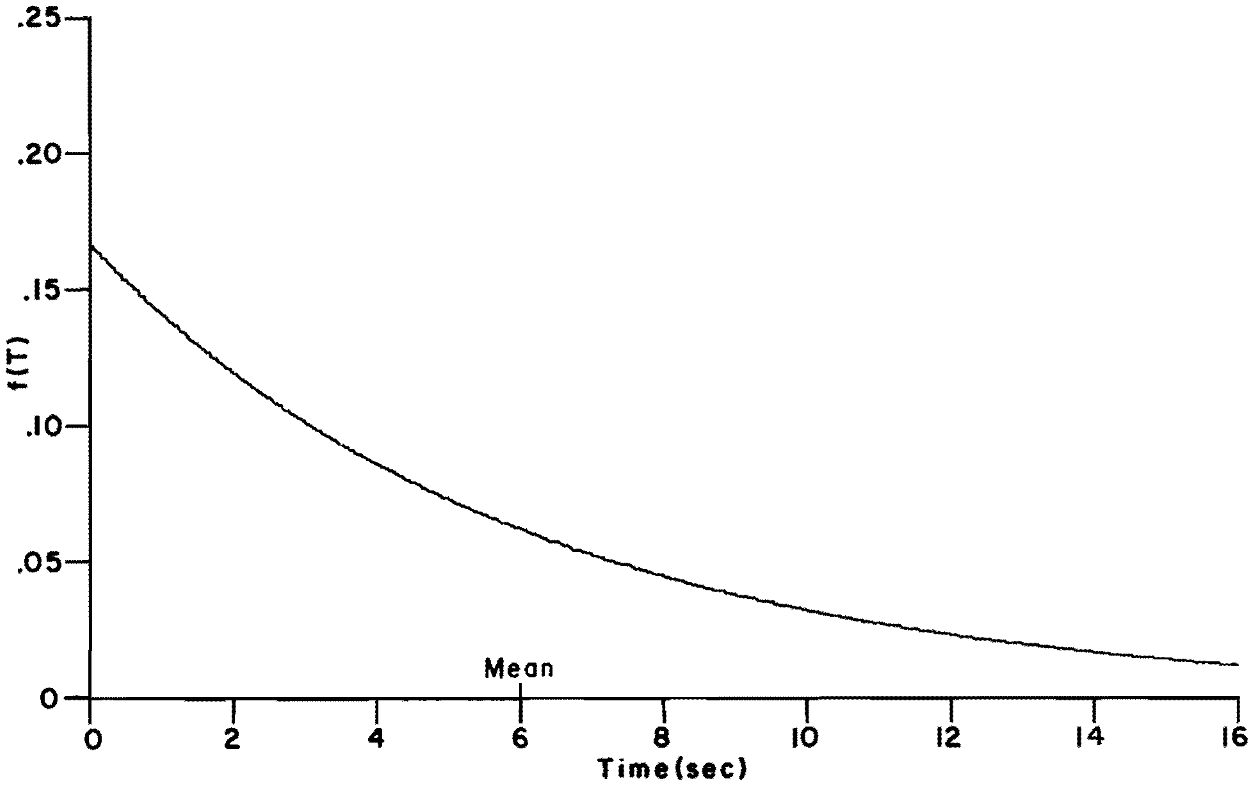
High volumes (more than 600 vph per lane): Shifted negative exponential



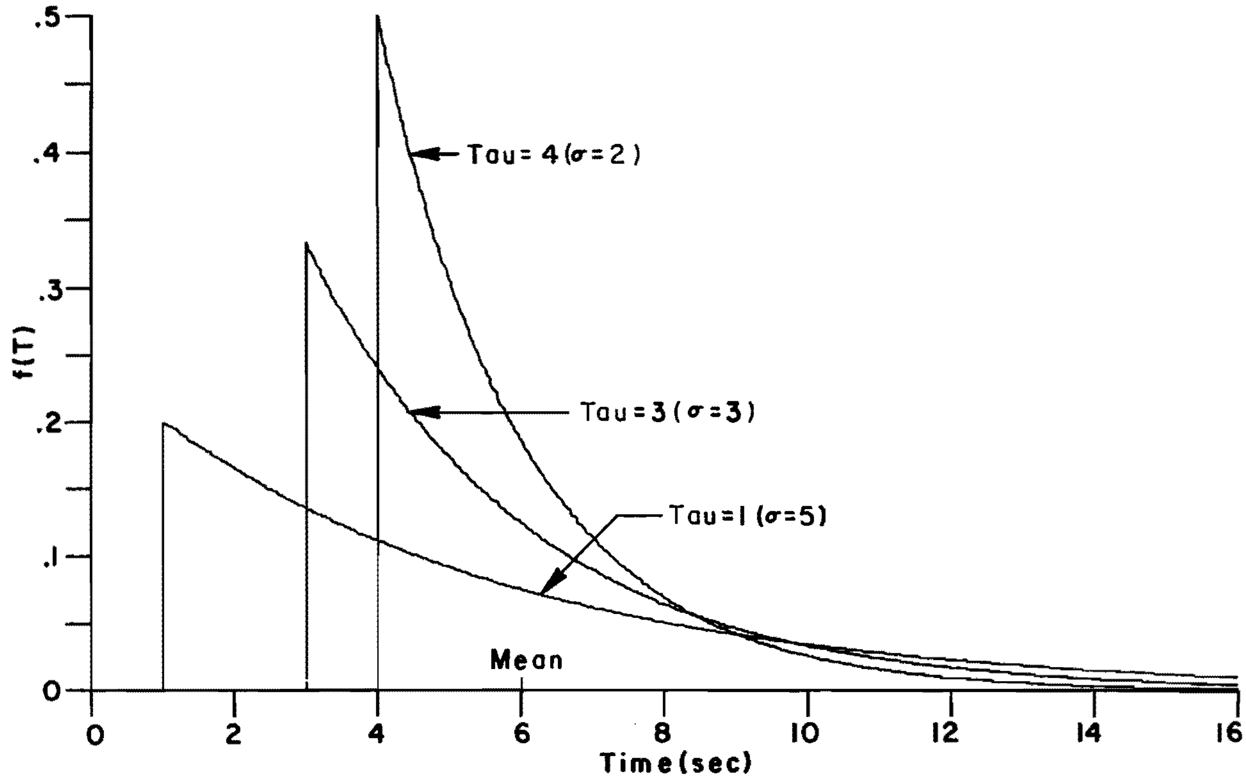
Erlang probability density function.



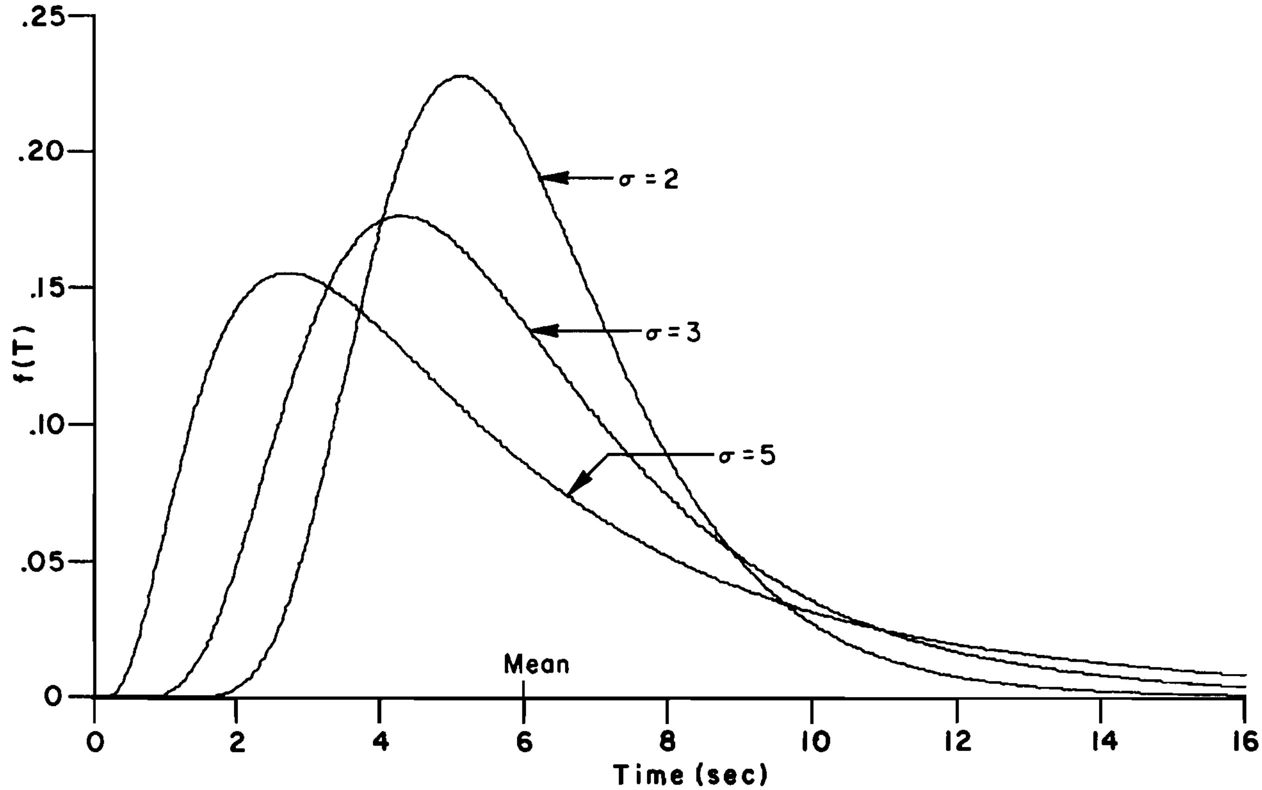
Gamma probability density function.



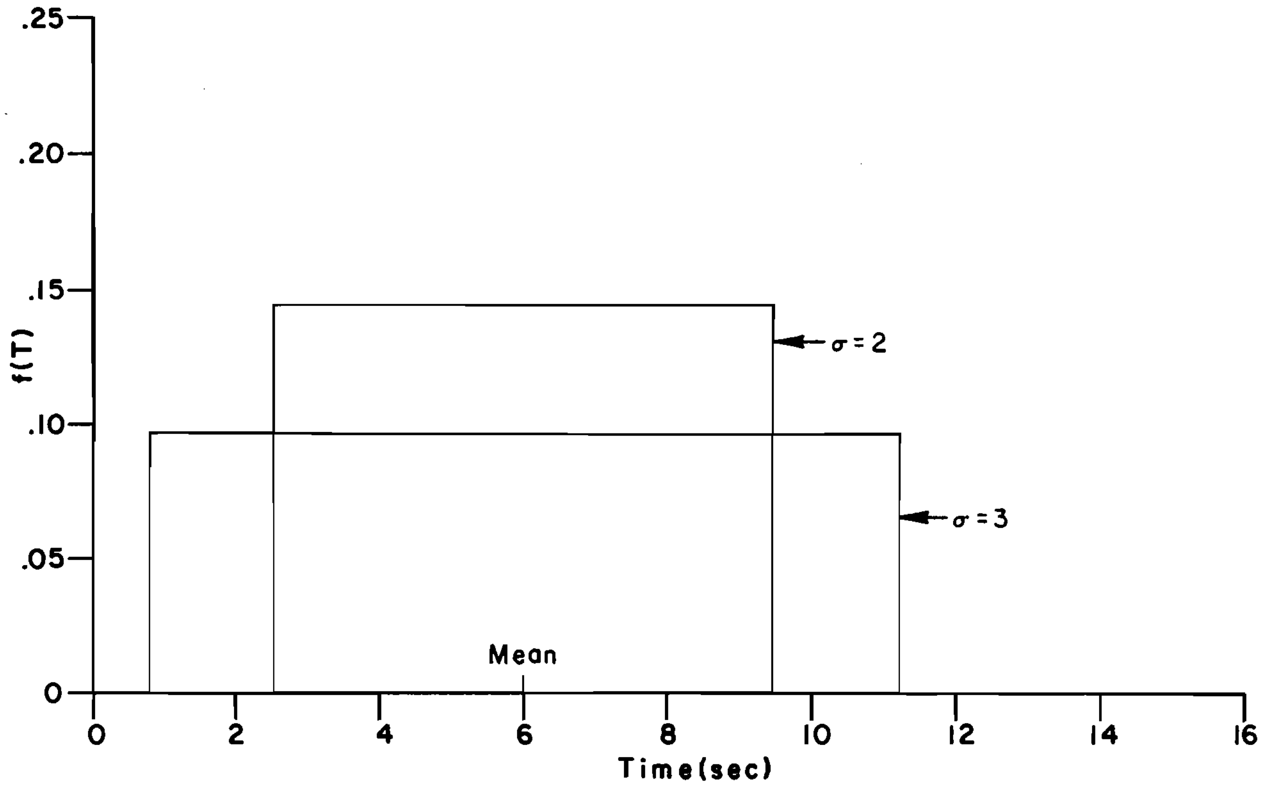
Negative exponential probability density function.



Shifted negative exponential probability density function.



Lognormal probability density function.



Uniform probability density function.