



# **Specification of Detector Logic Operation**

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Guidelines for Developing

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**Title:** Specification of Detector Logic Operation – Guidelines for Developing

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**Document no:** TS-TN-020

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**Version:** 1.0

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**Date:** 26 May 2009

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**Approved by:** P. Margison, General Manager Traffic Management

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#### **Revision history**

<b>Version</b>	<b>Date</b>	<b>Details</b>

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# Contents

<b>I Introduction</b> .....	<b>5</b>
1.1 Scope.....	5
1.2 Definitions and abbreviations.....	5
1.3 References .....	5
1.4 Associated Documents .....	6
<b>2 Design Steps</b> .....	<b>7</b>
<b>3 Format and Explanation of Terms</b> .....	<b>8</b>
3.1 Detector Function (FN).....	9
3.2 Signal Group/Phase Status (SG/PS) .....	10
3.3 Demand Status (DS) .....	11
3.4 Part Examples of Detector Specification Schedules .....	13
<b>4 Guide to Approach Numbering</b> .....	<b>14</b>
4.1 Example 1 .....	16
4.2 Example 2.....	17
4.3 Example 3 .....	18
4.4 Example 4.....	19
<b>5 Principles of Detector Logic</b> .....	<b>20</b>
5.1 Introduction .....	20
5.2 Overlap Logic.....	21
5.3 Filter Right Turn in Exclusive Right Turn Lane .....	22
5.4 Shared Right Turn Lane.....	23
5.5 Shared Right turn Lane (Side Street) .....	26
5.6 Exclusive Left turn Lane with Pedestrian Conflict .....	27
<b>6 Preparation of Schedule</b> .....	<b>28</b>
6.1 Example 1 .....	29
6.2 Example 2.....	31
<b>7 Standard Table Format</b> .....	<b>33</b>
7.1 Structure .....	33
7.2 Right Turn Lanes .....	34
7.3 SCATS Signal Pulses .....	34
<b>8 Standard Table Selection</b> .....	<b>34</b>
8.1 Introduction .....	34
8.2 Exclusive Through Lane – Stop Line (Presence) Detector.....	39
8.3 Shared/Exclusive Right Turn Lane Stop Line (Presence) Detector .....	41
8.4 Shared/Exclusive Left Turn Lane Stop Line (Presence) Detector.....	44
8.5 Through Movement - Advance (Passage) Detector .....	50
<b>9 Detector Classes</b> .....	<b>51</b>
9.1 Summary .....	51
9.2 Selection Guide.....	53

## Table of Figures

Figure 1	Preliminary Steps .....	8
Figure 2	A-B2 Detector .....	21
Figure 3	Exclusive Right Turn Lane .....	22
Figure 4	Shared Right Turn .....	24
Figure 5	Filter Right turn Movement on Side Street.....	26
Figure 6	Filter Right turn Movement on Side Street.....	27
Figure 7	Exclusive Through Lane Detector Logic Selection.....	40
Figure 8	Right turn Detector Logic Selection.....	42
Figure 9	Right turn Detector Logic Selection (cont'd).....	43
Figure 10	Left turn Detector Logic Selection.....	46
Figure 11	Left turn Detector Logic Selection (cont'd).....	47
Figure 12	Left turn Detector Logic Selection (cont'd).....	48
Figure 13	Left turn Detector Logic Selection (cont'd).....	49
Figure 14	Through Movement Passage (Advance) Detector Logic Selection .....	50

## Table of Tables

Table 1	Standard Table 6 .....	22
Table 2	Standard Table 5 .....	23
Table 3	Standard Table 4 .....	25
Table 4	Standard Table 20.....	27
Table 5	Standard Table 7 .....	28

# I Introduction

This document provides a description of the method to be adopted in specifying the function of detectors at signalled locations. It replaces the Standard for Detector Specification Schedule [1].

In addition, a set of standard detector logic tables has been established to assist in the selection of the detector function in the preparation of the intersection design plan. The benefits of such a set of standards are significant with regard to design and the adaptive engineering required to translate that design into a controller personality.

The basic functions of a detector are to demand, extend and/or increment the phase(s) appropriate to the traffic in an approach lane. The schedule defines in detail the conditions applying to the function of each detector, or group of detectors.

An abbreviated symbolic language is used to define:

- (a) the period during which the function occurs,
- (b) any other conditions affecting the function.

The schedule is to be initiated at the design stage of an intersection and included on all signal design plans, except simple two phase, standard “Single Diamond” and standard “Double Diamond” overlap designs.

It should be noted that Split Approach Timing is normally specified in this Schedule. However, where separate lane timing is required at any location, a note to this effect should be added to the design plan.

Within the traffic signal controller pushbutton demands are recognised as part of the series of inputs which are termed detectors. Detector operation and specification are described in this document. Pushbutton demands, and hence pedestrian movements, are special types of detectors and are dealt with in Specification of Pedestrian Movement Operation, [10].

## I.1 Scope

This document supports vehicle group labelling of signal groups not phase labelling of signal groups. Detectors are labelled in accordance with Traffic Signals Practice [7].

## I.2 Definitions and abbreviations

Term	Meaning
EPD	Example Personality Data
LM	Library Macro
OD	Operational Description
RTA	Roads and Traffic Authority of NSW
TAE	Typical Application Example
TMB	Traffic Management Branch of RTA

## I.3 References

- [1] VD018-10, Standard for Detector Specification Schedule, 23 December 1988 (*also titled Standard Tables for Detector Logic, RTA Standard Personality, 24 November 1988*)
- [2] VD018-5, Standard for Single Diamond Overlap Design
- [3] VD018-6, Standard for Double Diamond Overlap Design
- [4] VD018-8, Standard for Signal Group Displays
- [5] VD018-14, Standard for Single Diamond Overlap Phasing with Filter Option

- [6] TS-QA-156, Personality Standard Tables Management – Standard Operating Procedure
- [7] Traffic Signals Practice, Design – RTA, February 2008
- [8] RTA-TC-106, Traffic Signal Operation, Version 1.1, October 2000

## **I.4 Associated Documents**

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- [9] TS-TN-019, Specification of Vehicle Group Operation – Guidelines for Developing
- [10] TS-TN-021, Specification of Pedestrian Movements Operation – Guidelines for Developing
- [11] TS-TN-022, Specification of Ancillary Operation – Guidelines for Developing
- [12] TS-TN-023, Layout of Macros for Standard Tables – Guidelines
- [13] TS-TN-026, Standard for Single Diamond Overlap Phasing
- [14] TS-TN-027, Standard for Double Diamond Overlap Phasing
- [15] RTA-TC-185, RTA Standard Personality Reference Manual (Phases)
- [16] RTA-TC-305, RTA Standard Personality User Manual

## 2 Design Steps

1. Prepare a sketch of the intersection including lane markings, pedestrian crossings and detector locations. Make sure to distinguish between shared and exclusive lanes.
2. Prepare a sketch of the movements permitted in each phase (one sketch per phase) with arrows indicating the direction of movement.
3. Determine what signal groups are required in accordance with TS-TN-019 [9], TS-TN-026 [13] or TS-TN-027 [14], as appropriate.
4. Add the primary lanterns for each signal group to the sketch.
5. Add signal group labelling to the lanterns.
6. Label each detector with the phase(s) it demands or extends.
7. To distinguish the approach or where detector functions differ within the same approach (e.g. the detectors are used for different lane movements), a numerical suffix is added to the phase label. The numerical suffix is allocated in a clockwise direction from the controller for each phase label (e.g. A-B1 and A-B2, C1 and C2). Each alpha-numeric is a detector group.
8. Where there is more than one detector with the same alpha-numeric, add a lane position labels (L, C, R – see Figure 1) for each detector in the group.
9. Assign a unique number to each detector based on its alpha-numeric label, and its lane position (left to right).
10. Amend the movement diagrams so that there is one movement arrow for each detector group.
11. Add approach numbers to the movement diagrams for each movement which uses the waste, gap or headway timers (see Figure 1 and section 4).
12. Determine the detector logic for each detector.
13. Draw a detector specification schedule as described in sections 3 and 6.

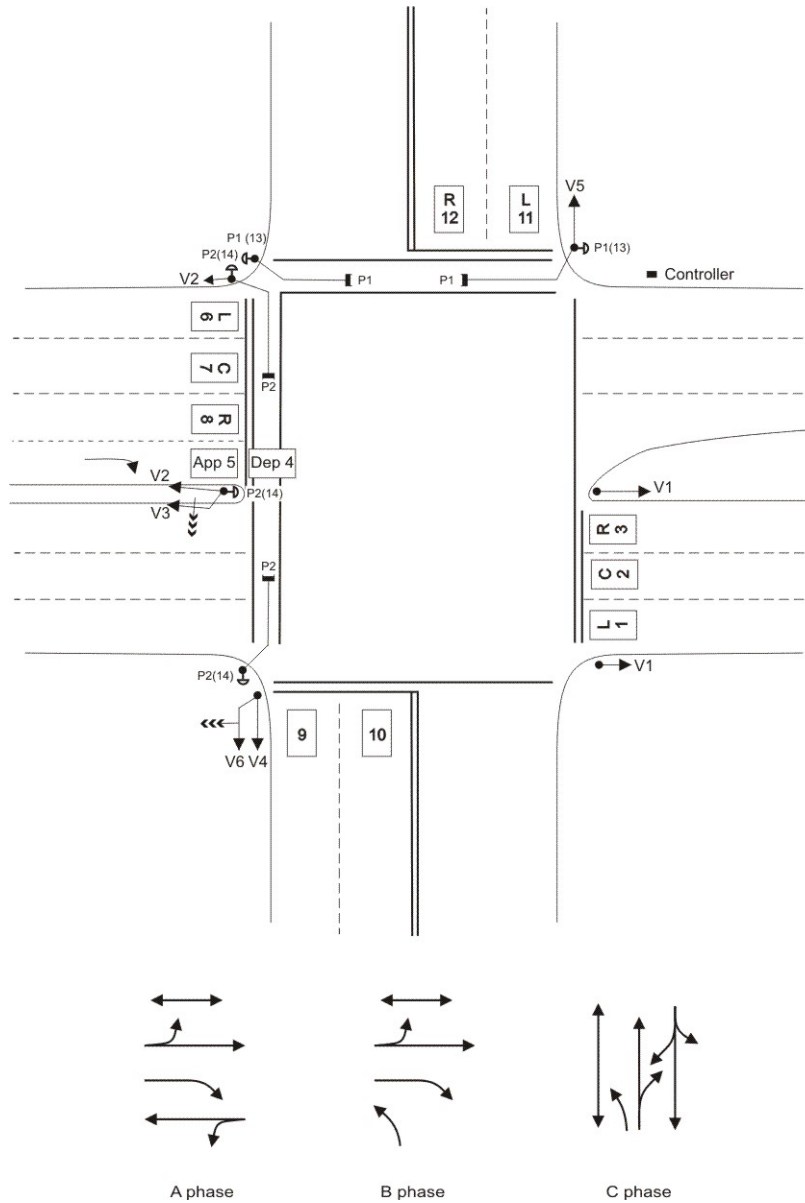


Figure 1 Preliminary Steps

### 3 Format and Explanation of Terms

The specification is to be set out in a schedule as follows:

Detector	Specification			
	FN			
	SG/PS			
	DS			

Where:

Term	Meaning
FN	Is the Detector Function
SG/PS	Is the Signal Group or Phase Status

Term	Meaning
DS	Is the Demand Status or other conditions affecting the function

The detector label is placed in the left box of the schedule and symbols are used in the columns to specify the Detector Function, Signal Group/Phase Status and Demand Status.

Symbol	Meaning
A dot (.)	Placed between symbols means “and”
A plus (+)	Placed between symbols means “or”
A bar (–)	Placed over a symbol means the opposite or inverse of the same symbol without a bar

The following is an outline of the rows to be completed (downwards) in each column.

### 3.1 Detector Function (FN)

The detector function is to be specified as – X(Y), where X is the phase demanded, extended or incremented and Y (in brackets) is the actual function.

e.g. A(L) means actuation of this detector registers a locked demand for A phase.

The following is a list of functions and their meanings. (This is not an exhaustive list and may be expanded as new functions are required.)

#### 3.1.1 Demand Functions

Symbol	Meaning	Function
L	Locked Demand	The Detector places a demand for the specified phase. The demand is not cancelled if the detector is vacated.
NL	Non Locked Demand	The detector places a demand for the specified phase. The demand is cancelled if the detector is vacated.
PR	Presence Timed Demand	The detector places a demand for the specified phase upon expiry of the presence timer associated with the detector. The demand is cancelled if the detector is vacated.
CL	Conditionally Locked Demand	The detector places a conditionally locked demand for the specified phase, upon non expiry of the gap or waste timer for approach n.
CCn	Conditional Demand	The detector places a demand for the specified phase upon expiry of the gap or waste timer for approach n, (and this detector actuated).
PB	Pedestrian Demand	The pedestrian demand places a demand for the specified phase.

In all cases - the demand is cancelled by the conditions specified in the SG/PS and DS entries.

For the sake of brevity, two demand functions can be combined with an “and” symbol in the detector specification schedule if the SG/PS and DS are the same, e.g. A(L).B(L). However, they cannot be combined with an “or” symbol, e.g. A(L)+B(L) is illegal.

#### 3.1.2 Extension Functions

Symbol	Meaning	Function
En	Extend Approach	The detector extends approach n for the specified phase. That is, the detector provides normal gap, headway and waste timing for approach n.
IN	Increments	Provides increment counting for the detector for the specified phase. Used only for approaches with advance detectors and with

Symbol	Meaning	Function
		no stop line detectors on the same approach. Vehicles crossing the detector when the signal group is “not green” are counted as increments.

NOTE: Gn and Wn do not occur in the standard Detector Logic Tables.

Extension functions cannot be combined at all.

### 3.1.3 Examples of commonly used detector functions

Symbol	Meaning (Function)
A(L)	Registers a locked demand for A phase.
A(NL)	Registers a non-locked demand for A phase.
B(PR)	Registers a non-locked demand for B phase subject to expiry of presence timer.
C(PB)	Registers a demand for pedestrian demand for C phase.
C(E2)	Operates extension timers for (i.e. “extends”) approach 2 of C phase.

## 3.2 Signal Group/Phase Status (SG/PS)

This entry specifies the period during which the detector function (FN) may (or may not) occur.

The phase during which the detector function applies is specified by a single letter, e.g. A for A phase, etc. Similarly, a detector function may be qualified by the status of a signal group. In this case the signal group designation is specified in the SG/PS entry, e.g. V2 for a signal group which is green in A and B phase and may overlap.

The above method provides a concise means for specifying the duration for commonly used functions. Brevity has taken precedence over clarity, and the exact meaning of the SG/PS entry should be interpreted in the appropriate manner for each function type and detector type. This is illustrated by the following examples:

### 3.2.1 Demand Functions (Stop Line Presence Detectors)

A	FN	A(L)
	SG/PS	$\bar{A}$
	DS	-

For a single letter SG/PS entry is interpreted as “not during A phase. That is, not during any interval in A phase, including the Yellow and All-Red intervals. The phase demand is cancelled during the entire phase.

A-B1	FN	A(L)
	SG/PS	$\overline{V2}$
	DS	-

For a single group SG/PS entry is interpreted as, “not while the V2 signal group is displaying green or yellow”. That is, the phase demand is cancelled when the signal group is displaying green or yellow.

### 3.2.2 Demand Functions (Advance Detectors)

A	FN	A(L)
	SG/PS	$\bar{A}$
	DS	-

SG/PS entry is interpreted as “not during A phase green intervals”. Thus a detection in the A phase Yellow or All Red intervals would register a locked demand for A phase. That is, the phase demand is cancelled during the phase’s green intervals.

A-BI	FN	A(L)
	SG/PS	$\overline{V2}$
	DS	-

SG/PS entry is interpreted as “not while the V2 signal group is displaying green”. That is, the phase demand is cancelled when the signal group is displaying green.

### 3.2.3 Extension Function (Advance or Stop Line Detectors)

A	FN	A(En)
	SG/PS	A
	DS	-

SG/PS entry is interpreted as “during A phase green intervals” since the phase can only be extended during the phase’s green intervals.

A-BI	FN	A(En)
	SG/PS	V2
	DS	-

SG/PS entry is interpreted as “while V2 signal group is displaying green”.

In some instances it is necessary to specify the duration of the function in a rigorous manner. In such cases a parameter in brackets is appended to the SG/PS entry to accurately specify the phase intervals or the signal group colours. For example, the duration of the A phase pedestrian walk signal is specified by the entry, A(WALK). The following list of symbols describes those currently in use.

Symbol	Meaning
LS	Late start interval
MIN	Minimum green interval
ECG	Early cut off green interval
Y	Yellow interval
AR	All-red interval
I	Intergreen interval, ie Early cut off Green, Yellow and All Red
WALK	Walk interval
CL	Clearance interval (flashing don’t walk)
W&CL	Walk & Clearance intervals
EXT	Extension green interval
VIG	Variable initial green interval

The function is cancelled when the condition specified in the SG/PS entry is no longer true. The function may also be cancelled by conditions specified in the Demand Status (DS) entry, as described below.

## 3.3 Demand Status (DS)

This entry specifies any extra conditions which apply to the detector function. Boolean logic is used to combine the conditions into a compound entry. The following list of symbols, with associated meanings, details the conditions currently in use. This list may be expanded as new conditions are required.

Symbol	Meaning (Function)
A	Presence of a phase demand, (specified by the phase letter, A phase in this case).
A(NEXT)	The next phase to follow the running phase, (A phase in this case).

Symbol	Meaning (Function)
A (PB)	Presence of a pushbutton demand, (for A phase in this case).
A(PR)	Expiry of presence timer, (for A detector in this case).
A(NG)	No expiry of the gap timer (for A detector in this case).
A(DET)	Demand registered from specified detector (for A detector in this case).
Z-	Masterlink/Flexilink Z- special facility signal.
Z+	Masterlink/Flexilink Z+ special facility signal.
XSF <sub>n</sub>	Masterlink/Flexilink XSF bit n special facility signal.
Z5	Masterlink Z5 special facility signal.
Q-	Masterlink/Flexilink Q- special facility signal.
Q+	Masterlink/Flexilink Q+ special facility signal.
MLINK	Masterlink mode of operation.
FLEXI	Flexilink mode of operation.
ISOL	Isolated mode of operation.
VI (VEH RUN)	Vehicle signal group has run during this cycle.
PI (PED RUN)	Pedestrian movement I has run during this cycle.
A(PHASE RUN)	Phase has run during this cycle.

The complement of a condition is expressed by placing a line above the particular condition. The method of combining conditions is illustrated in the example below.

Note that a dash, “-”, is used for the DS entry if there are no extra conditions.

### 3.3.1 Examples of Demand Status:

Symbol	Meaning
A	A phase demanded.
$\bar{A}$	A phase not demanded.
B+C	B or C phase demanded.
B.C	B and C phase (both) demanded.
$\bar{B}.\bar{C}$	No demand for B phase and no demand for C phase.
$\bar{B}+P2(PB)$	No demand for B phase, or a push-button demand for P2 pedestrian.
B1(NG)	No expiry of gap timer on B1 detector.
Z+	Masterlink/Flexilink Z+ signal is present.

### 3.4 Part Examples of Detector Specification Schedules

A1	FN	A(L)	A1 In the case of an advance detector the detector demands A phase during any period except the A phase green. In the case of a stop line detector the detector demands A phase during any period except A phase.
	SG/PS	$\overline{A}$	
	DS	-	
A2	FN	A(E2)	A2 The detector extends A phase (i.e. operates gap and waste/headway timers) for approach 2 during the A phase green.
	SG/PS	A	
	DS	-	
B1	FN	B(E1)	B1 The detector extends B phase (i.e. operates gap and waste/headway timers) for approach 1 during the B phase green period providing C phase is not the next phase.
	SG/PS	B	
	DS	$\overline{C(NEXT)}$	
D1	FN	D(CC2)	D1 The detector demands D phase during the C phase green period if the gap or waste timers for approach 2 have expired.
	SG/PS	C	
	DS	-	
A-B1	FN	B(PR)	A-B1 The detector demands B phase during A phase if the presence timer has expired.
	SG/PS	A	
	DS	-	
E-F2	FN	F(CL)	E-F2 The detector demands F phase during E phase providing there is no expiry of the gap timer for the E-F2 detector. The demand is cancelled during phases other than E phase.
	SG/PS	E	
	DS	E-F2(NG)	
A-B2	FN	A(L).B(L)	A-B2 The detector (stop line) demands both A and B phases except when the V2 signal group is displaying green or yellow.
	SG/PS	$\overline{V2}$	
	DS	-	
A-B2	FN	A(E2)	A-B2 The detector extends approach 2 during A phase except when B phase is to follow A phase. (Another column is required in this case to specify the extension function during B phase).
	SG/PS	A	
	DS	$\overline{B(NEXT)}$	

B-C	FN	B(E3)
	SG/PS	B
	DS	$\overline{C(NEXT).B-C(PR)}$

B-C The detector extends approach 3 during B phase when C phase is not next and when the presence timer for the B-C detector has not expired. If C phase is next or if the presence timer for the B-C detector has expired, then the detector ceases to extend B phase.

B-D	FN	D(L)
	SG/PS	$\overline{V3}$
	DS	Z+

B-D The detector (stop line) places a locked demand for D phase except when the V3 signal group is displaying green or yellow and the Masterlink/Flexilink Z+ signal is present.

B-D	FN	D(E1)
	SG/PS	D
	DS	$Z+.B(NEXT)$

B-D The detector extends approach 1 during D phase, providing the Masterlink or Flexilink Z+ signal is present and B phase is not the next phase.

P2 (PB)	FN	C(PB)
	SG/PS	$\overline{P2(WALK)}$
	DS	-

C1 The push-button places a demand for C phase except when the P2 pedestrian movement is displaying walk.

## 4 Guide to Approach Numbering

The choice of approach numbering is quite arbitrary, however in practice it is more convenient for the user if a uniform method of numbering is applied. The description below outlines some general principles, followed by examples to illustrate the principles. Refer to the examples in conjunction with these notes.

The principles are related to the Standard Personality and Time settings and the display format for approach timers in current controllers. The following points list the constraints in allocating approach numbers:

1. The Standard Personality allows a maximum of 8 sets of approach timers to be in operation in any particular phase and hence the maximum number of approaches is constrained to 8 or less in any phase.
2. To avoid confusion in the field it has been found essential to number the approaches starting from 1 to the required number, and desirable that no numbers are skipped in the number sequence.
3. The Standard Time settings provide only 4 sets of approach time settings, (i.e. gap, headway and waste time settings) per phase. If more than 4 approaches are required for a phase then there are two options for obtaining the time settings for approaches 5 through 8:
  - (a) The first 4 approaches should be chosen to correspond with approaches which must have different time settings. The remaining approaches (5 through 8) may share the most appropriate of the time settings for the first 4 approaches. For example, approach 5 may be an overlap approach and would probably require the same time settings as a detector in an adjacent lane (which has been prudently chosen as one of the first 4 approaches). (As a general rule, the approaches for detectors which use the shared lane logic for right turn detectors should be numbered in the first 4 approaches.)

- (b) If more than 4 different sets of approach time settings are required for a particular phase, then special tables can be included in the Standard Personality to allow unused approach time settings from another phase to be used for approaches 5 through 8. This method is quite acceptable, but requires very clear documentation to avoid confusion in the field.
- 4. Current controllers display only 2 sets of approach timers (gap, headway and waste timers) at a time, although it is a simple matter to quickly step the display to another pair of approach timers. To assist the field staff it is desirable to maintain the same approach number for a particular detector in all phases in which the detector is controlling the approach. In practice this is not always possible, however it is usually possible to make the approach number always odd or always even in each phase in which the approach is timing. This allows the operator the minimum disorientation at a phase change.

A table technique is used in the examples below to assist in choosing the approach numbers. The steps for the table technique are:

1. List each detector in a column. Detectors with “approach” and “departure” sections require a separate entry for each section. In practice the “departure” section is equivalent to the entire 11 metre loop.
2. Separate columns are required for each of the used phases.

Steps 1 and 2

Phase Detector	A	B	C
A			
B			
A-B			
B-C			
C			

3. For each detector in turn, a cross is marked in each column corresponding to a phase in which the approach is required to time.
4. Optionally a further row can be provided to sum the maximum number of approaches which must time in each phase.

Steps 3 and 4

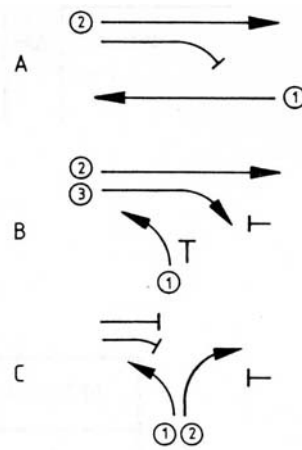
Phase Detector	A	B	C
A	X		
B		X	
A-B	X	X	
B-C		X	X
C			X
TOTAL	2	3	2

5. To achieve the goals outlined in the principles above, the approach numbers should be allocated such that the same approach number is used for all the entries in a particular row. If this is not possible, then the entries in a row should be chosen to be only odd values or only even values. It is recommended that detectors using the shared lane logic should have approach numbers in the range 1 to 4. Numbers should not be skipped in the numbering sequence.

Steps 5

Phase Detector	A	B	C
A	X		
B		X	
A-B	X	X	
B-C		X	X
C			X
TOTAL	2	3	2

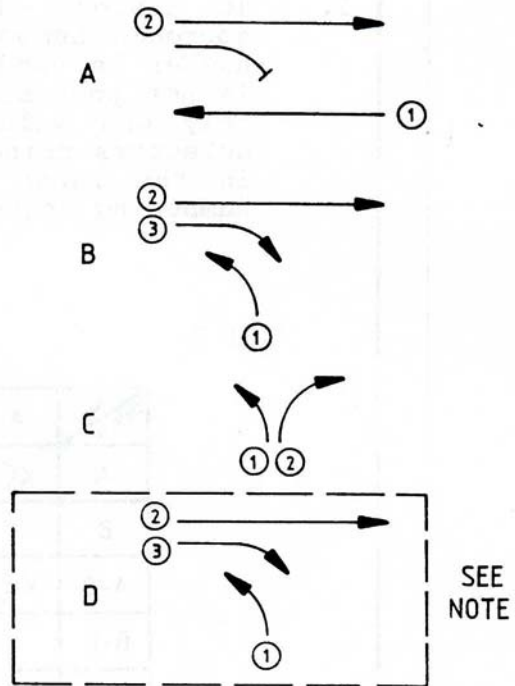
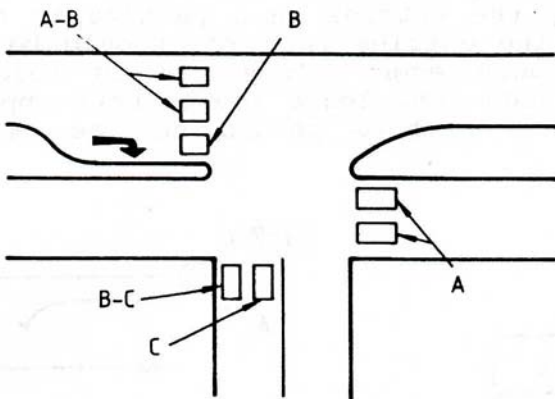
Step 6



- Once the approach numbers have been selected, they should be added to the relevant movement diagrams on the design plan. (It is not necessary to show the selection table on the design plan.)

Note: In most cases, alternative numbering to the following examples is possible using the above method. However if the above principles are retained, approach numbering will remain consistent.

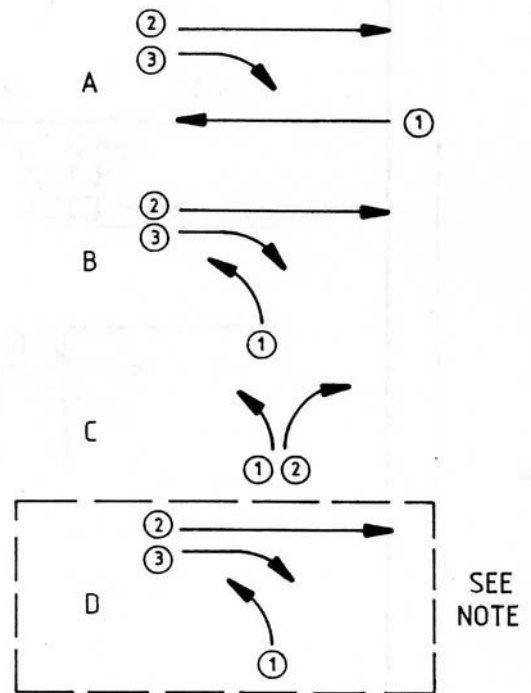
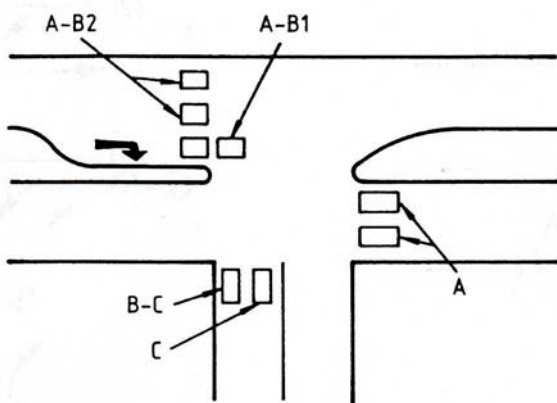
## 4.1 Example I



DETECTOR	A APPROACHES	B APPROACHES	C APPROACHES	D APPROACHES
A	X1			
A-B	X2	X2		X2
B		X3		X3
B-C		X1	X1	X1
C			X2	
TOTAL APPROACHES	2	3	2	3

NOTE: This example illustrates a 3 phase design. For the 4 phase design with a repeat right turn movement, approach numbers for D phase are the same as B phase.

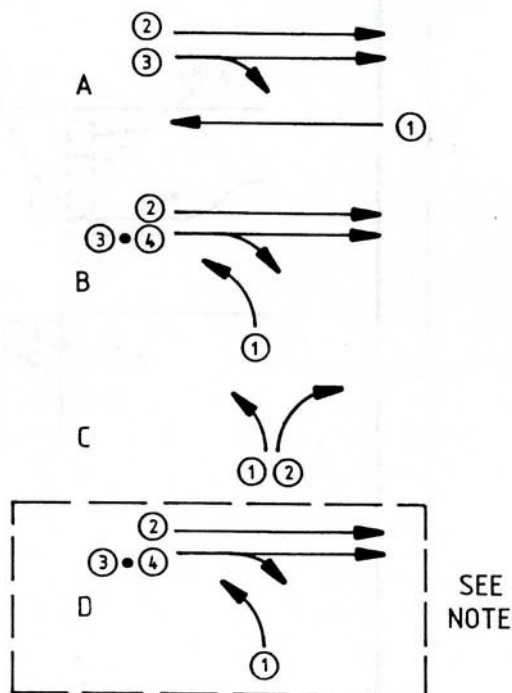
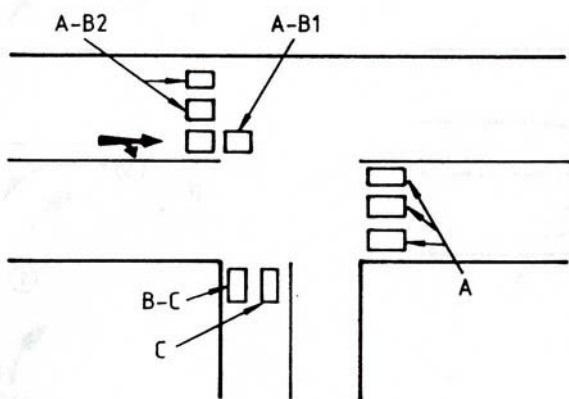
## 4.2 Example 2



DETECTOR	A APPROACHES	B APPROACHES	C APPROACHES	D APPROACHES
A	X1			
A-B1 DEP				
A-B1 APP	X3	X3		X3
A-B2	X2	X2		X2
B-C		X1	X1	X1
C			X2	
TOTAL APPROACHES	3	3	2	3

NOTE: This example illustrates a 3 phase design. For the 4 phase design with a repeat right turn movement, approach numbers for D phase are the same as B phase.

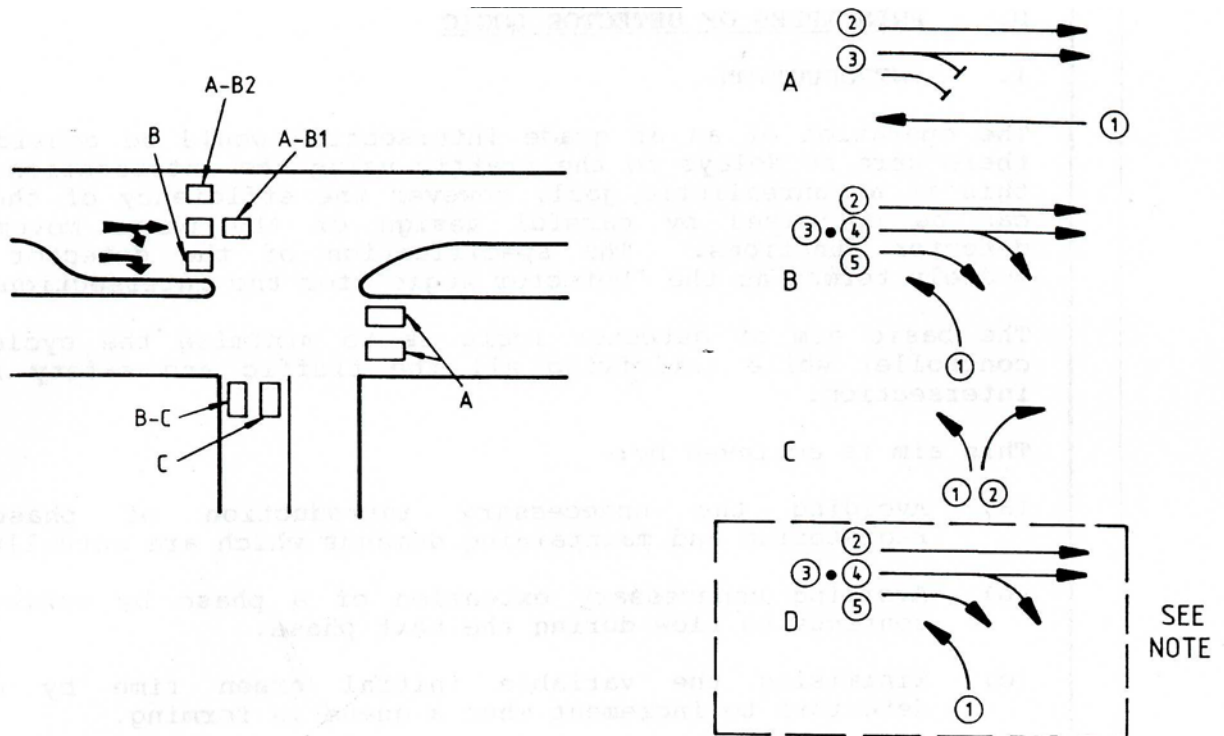
### 4.3 Example 3



DETECTOR	A APPROACHES	B APPROACHES	C APPROACHES	D APPROACHES
A	X1			
A-B1 DEP		X4		X4
A-B1 APP	X3	X3		X3
A-B2	X2	X2		X2
B-C		X1	X1	X1
C			X2	
TOTAL APPROACHES	3	4	2	4

NOTE: This example illustrates a 3 phase design. For the 4 phase design with a repeat right turn movement, approach numbers for D phase are the same as B phase.

### 4.4 Example 4



DETECTOR	A APPROACHES	B APPROACHES	C APPROACHES	D APPROACHES
A	X1			
A-B1 DEP		X4		X4
A-B1 APP	X3	X3		X3
A-B2	X2	X2		X2
B		X5		X5
B-C		X1	X1	X1
C			X2	
TOTAL APPROACHES	3	5	2	5

NOTE: This example illustrates a 3 phase design. For the 4 phase design with a repeat right turn movement, approach numbers for D phase are the same as B phase.

## 5 Principles of Detector Logic

### 5.1 Introduction

The operation of an at-grade intersection would be considered ideal if there were no delays to the traffic using the intersection. In practice this is an unrealistic goal, however the efficiency of the intersection can be optimised by careful design of the phase movements and the detector functions. The specification of the detector functions is loosely termed as the “Detector Logic” for the intersection.

The basic aim of detector logic is to minimise the cycle time of the controller while satisfying all the traffic and safety needs for the intersection.

The aim is achieved by:

- (a) avoiding the unnecessary introduction of phases, by only registering and maintaining demands which are actually required,
- (b) avoiding unnecessary extension of a phase by vehicles which may continue to flow during the next phase,
- (c) minimising the variable initial green time by only allowing detectors to increment when a queue is forming.

The detector logic should be designed to provide efficient operation regardless of the phase sequence. This is particularly important for SCATS controlled intersections since, under Masterlink operation, the phase sequence is determined by the plan data stored in the SCATS master. Also, in Flexilink operation, it is common to have a normal and an alternate phase sequence. Undemanded phases are skipped over in the phase sequence, regardless of the controller operating mode. Thus it is imperative that the detector logic is designed to provide efficient operation for any sequence of phases at the intersection.

The following sections provide an introduction to the detector logic currently used in the standard detector logic tables. (Refer to Sections 7 and 9.)

## 5.2 Overlap Logic

If a movement is permitted in more than one phase then the detector logic for the detectors on that movement can be designed for optimum efficiency.

Consider the case of the A-B2 detector in Figure 2 below.

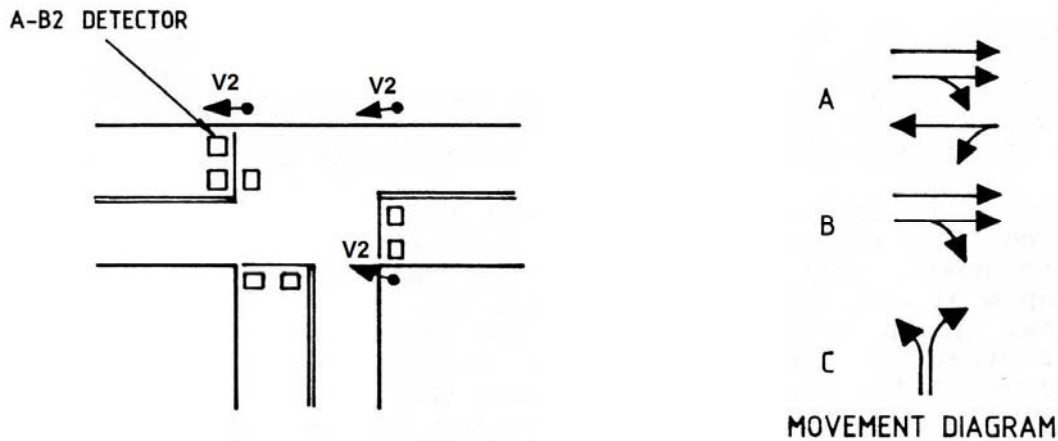


Figure 2 A-B2 Detector

### 5.2.1 Demand Function

Since the V2 overlap signal group is green in both A and B phases, the A-B2 detector should demand either A or B phases (or both) to satisfy traffic waiting at the red signal during C phase. It is apparent that this detector should not place a demand for any phase when the V2 signal group is displaying green, otherwise moving traffic would place an unnecessary demand for another phase.

The matter that needs consideration is which phase, or phases, should be demanded by the A-B2 detector to provide efficient operation for all phase sequences. The most appropriate choice is for the A-B2 “overlap” detector to place a demand for the “through” phase rather than the “right turn” phase. If the overlap detector placed a demand for the right turn phase then, for the sequences B-A-C, the leading right turn would be demanded in every cycle whether it was required or not. The addition of the unnecessary phase would thus reduce the operating efficiency of the intersection. Therefore the overlap detector only demands green for the “through” phase.

The above reasoning relies on the assumption that there is a reasonable traffic flow for the overlap movement and for the flow in the reverse direction. If in fact the traffic volume for the right turn movement is large, and the volume for the opposing A movement is almost negligible, then it would be more appropriate for the overlap detector to demand B phase rather than A phase. In this (rare) case it is probable that A phase would not be required in the cycle, since the A movement has a very low volume.

Note that the phase demand is cleared when the V2 signal group is displaying green, that is during A or B phase.

### 5.2.2 Extension Function

When the V2 signal group is displaying green, the traffic crossing the A-B2 detector should extend the duration of the green signal. Since the signal display is green for both A and B phases it is appropriate to use some form of detector logic to avoid extending either phase unnecessarily if the signal group will continue to display green in the next phase.

Generally, it is inappropriate to make the extension function for a detector in an overlap approach conditional on phase demands since the logic fails if a different phase sequence is used. That is, different detector logic would be required for the sequences A-B-C and A-C-B if the logic used phase demands for controlling the extension function.

However, it is possible to provide logic which is always appropriate by making the extension function conditional on the next phase to be introduced. The A-B2 detector on the overlap approach in the above example is not required to extend the running phase unless the overlap signal group will be red in the next

phase. (Note that when the controller is operating in the isolated mode, the available maximum green time for the overlap movement may now be less than the sum of the maximum green times for the overlap phases since the traffic on the overlap approach effectively does not extend the first phase of the overlap. If the volume for the overlap approach is much greater than the volumes for the right turn and the opposing movement (e.g. tidal flow), then it is essential to specify transfer of unused maximum time between the overlap phases.)

### 5.2.3 Detector Logic Specification

The complete detector logic specification for the A-B2 detector in Figure 2 is expressed symbolically in Table 1.

A-B2	FN	A(L)	A(En)	B(En)
	SG/PS	$\overline{V2}$	A	B
	DS	-	$\overline{B(NEXT)}$	$\overline{A(NEXT)}$

Table 1 Standard Table 6

## 5.3 Filter Right Turn in Exclusive Right Turn Lane

For the case of a filter right turn movement there is a need to avoid demanding the right turn phase unnecessarily if the right turn vehicles are able to filter through the opposing flow. The particular case of an exclusive right turn lane is considered in Figure 3.

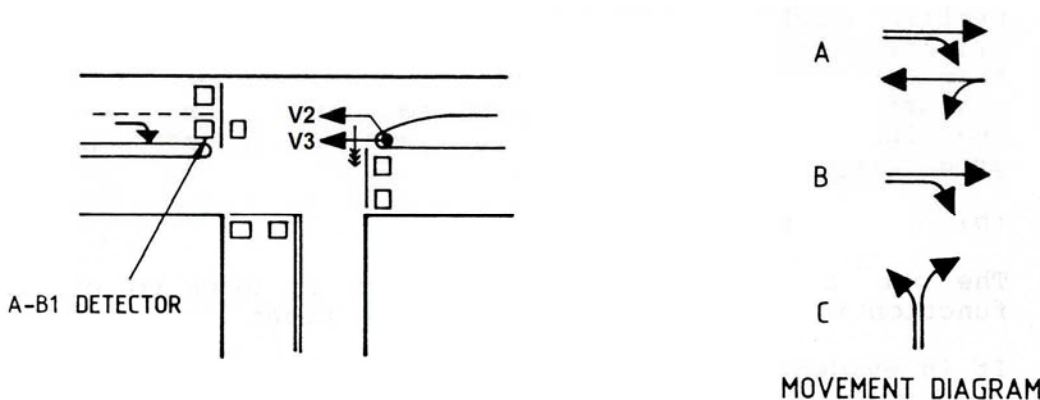


Figure 3 Exclusive Right Turn Lane

### 5.3.1 Demand Function

During A phase, right turn vehicles are permitted to filter. It is apparent that the demand for the right turn phase should be cancelled if all the right turn vehicles are able to filter. A single vehicle which is able to filter without delay must cross the detector loop, but it is undesirable for the vehicle to place a demand for the right turn phase. To prevent unwanted demands for the right turn phase, it is necessary to distinguish between waiting vehicles and vehicles passing over the detection zone. This is achieved by using a presence timer. The timer commences timing when a vehicle is present in the detection zone, but a demand is not registered for the right turn phase until the presence timer has expired. The presence timer setting would typically be set in the range 2 to 3 seconds.

It is necessary to maintain a continuous demand for the right turn phase when there is a queue of vehicles, regardless of whether vehicles are able to filter or not. This requires that a vehicle must always be in the detection zone while the vehicles are filtering. It is possible to calculate the length of the detection zone for a given speed of filtering traffic to ensure that there is always occupancy in the detection zone while there are right turning vehicles. In practice, a standard loop length of 11 metres has been adopted for the right turn detector, rather than treating each case individually. Once the detection zone has been vacated, further vehicles do not register a demand until the presence timer has expired.

In practice the 11 metre detection zone is achieved by two loop sections, each with its own detector. The loop sections are known as the “approach” (APP) and “departure” (DEP) sections, and the outputs of the two detectors are combined by internal software or a diode to provide a single output for the 11 metre loop (APP & DEP). The output of the approach detector only is available as a separate output for providing extension functions and additional demand functions.

When right turn vehicles arrive at a red signal there is no need for the demand to be subject to the presence delay time. For normal traffic conditions the right turn detector should demand the right turn phase, (B phase in the above example), for the case where the right turn phase precedes the “through” phase in the sequence. In light traffic conditions there is more benefit in demanding the “through” phase, for the case where the “through” phase precedes the right turn phase. In light traffic conditions right turn vehicles would have no difficulty in filtering, so it is preferable to introduce the “through” phase rather than the right turn vehicle phase. Thus, when the overlap signal group is red, a right turn vehicle places an immediate demand for both the “through” and right turn phases. Both demands are cleared when the overlap signal group displays green.

### 5.3.2 Extension Function

The output of the approach detector is used to provide the extension function for the case of an exclusive right turn lane.

It is evident that right turn vehicles should unconditionally extend the right turn phase.

Since right turn vehicles may filter in the “through” phase, it is appropriate that right turn vehicles extend the through phase. If vehicles are not able to filter then the extension function for the through phase should be cancelled. This condition is detected by expiry of the presence timer for the right turn detector.

Also, right turn vehicles should not extend the “through” phase if the right turn phase will be the next phase to follow.

### 5.3.3 Detector Logic Specification

The complete detector logic specification for the A-BI detector in Figure 3 is expressed symbolically in Table 2.

A-BI	FN	B(PR)		
DEPARTURE & APPROACH	SG/PS	A		
	DS	-		
A-BI  APPROACH	FN	A(L).B(L)	A(En)	B(En)
	SG/PS	$\overline{V2}$	A	B
	DS	-	$\overline{A-BI(PR)} \cdot \overline{B(NEXT)}$	-

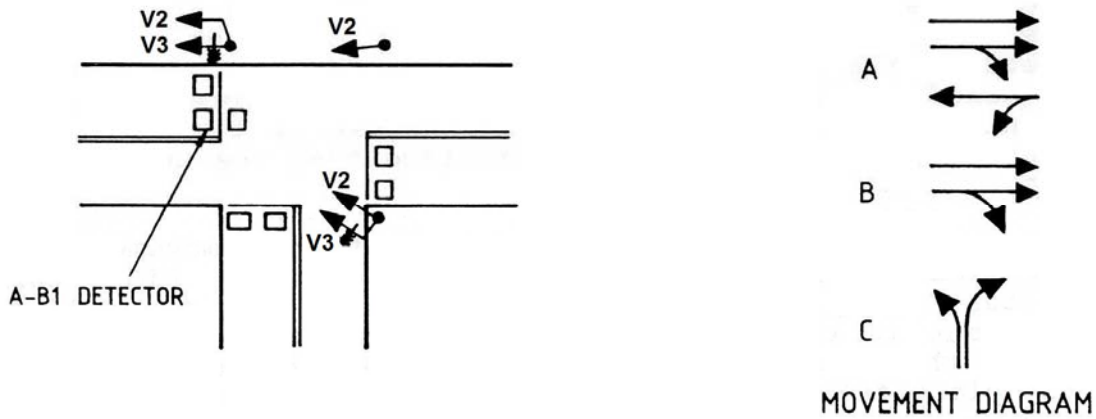
Table 2 Standard Table 5

## 5.4 Shared Right Turn Lane

A right turn lane which is shared with through traffic presents difficulties when the right turn phase precedes the through phase. In particular, there is a need to distinguish between right turn vehicles and through vehicles using the shared lane, otherwise through vehicles would unnecessarily extend the right turn phase.

The particular case of a shared right turn lane is considered in Figure 4.

Note that the logic described applies regardless of whether right turn vehicles are permitted to filter or not.



**Figure 4 Shared Right Turn**

**5.4.1 Demand Function**

The combined outputs for the A-B1 APPROACH and A-B1 DEPARTURE detectors (i.e. the 11 metre loop) provide a presence timed demand for B phase during A phase. That is, the presence timed demand for the right turn phase is placed only while the through phase is running.

The A-B1 APPROACH detector places a locked demand for both A and B phase provided the V2 overlap signal group is displaying red. Note that the demand for B phase is not subject to the presence timer in this case. The locked demands for both phases are cleared when the V2 overlap signal displays green.

The above detector logic caters for operation in both the trailing and the leading turn sequences. In particular, when the right turn movement precedes the through phase, an approaching right turn vehicle is not required to wait the presence delay time before placing a demand for the turning phase. A vehicle which arrives at the red signal late in the running phase will thus be guaranteed that the turning movement will be included in the current cycle.

The presence timed demand for the right turn movement is in fact only required to operate during the through phase. Right turn vehicles are permitted to filter during the through phase, the demand for the turning movement is cancelled if the 11 metre loop is vacated. The presence delay thus ensures that through vehicles crossing the 11 metre loop do not place false demands for the right turn movement.

**5.4.2 Extension Function**

The A-B1 APPROACH detector:

1. Extends A phase (the through phase) except when:
  - (a) B phase is next (i.e. B phase is the next demanded phase in the sequence); or
  - (b) the presence timer for the 11 metre loop is expired, i.e. a vehicle is stationary on the loop and is unable to filter, causing the lane to be blocked to through traffic.
2. Extends B phase (the right turn phase) except when A phase is next (i.e. A phase is the next demanded phase in the sequence).

The combined A-B1 APPROACH and A-B1 DEPARTURE detectors (i.e. the 11 metre loop) extend B phase when A phase is next (i.e. A phase is the next demanded phase in the sequence). These combined detectors thus extend the (leading) right turn phase when the through phase is to follow. The approach timing is set up in an unusual manner in this case, with time settings as follows:

- (a) Gap Timer: typically 3.0 seconds
- (b) Headway Timer: typically 0.1 seconds or as small as possible
- (c) Waste Timer: typically 3-4 seconds

For this special approach, the 3 second Gap Timer setting caters for the case in which there is a long space between vehicles in the shared right turn lane. The phase would normally be terminated by the Waste Timer when there are through vehicles using the lane since these would accumulate Waste time. The Gap

and Waste settings are approximately the same and so a long space would in most cases allow the Waste Timer to expire before the Gap Timer.

The Headway Timer is set to expire whenever there is a momentary break in the occupancy of the 11 metre loop. If the vehicles in the shared lane are all turning right, then these vehicles would normally be closely spaced, prevent expiry of the Headway Timer and thus inhibiting Waste timing. This will also be true for the case where there is an occasional through vehicle interposed in the queue, since the right turn vehicles are slower moving vehicles and will thus govern the speed of the queue. The spacing (distance) between vehicles is such that the 11 metre loop is still occupied in this case also. When the vehicles in the shared lane are predominantly through traffic, then the vehicle speeds are greater with greater headways between vehicles. In this case the Headway Timer expires, enabling Waste timing. Since the Waste time is set at 3-4 seconds, the right turn phase is terminated efficiently when the shared lane is not being used by turning vehicles.

### 5.4.3 Detector Logic Specification

The complete detector logic specification for the A-BI detector in Figure 4 is expressed symbolically in Table 3.

A-BI	FN	B(PR)	B(Em)	
DEPARTURE + APPROACH	SG/PS	A	B	
	DS	-	A(NEXT)	
A-BI  APPROACH	FN	A(L).B(L)	A(En)	B(En)
	SG/PS	$\overline{V2}$	A	B
	DS	-	$\overline{A-BI(PR)} \cdot \overline{B(NEXT)}$	$\overline{A(NEXT)}$

Table 3 Standard Table 4

### 5.4.4 Theory of Operation

The efficient termination of a leading right turn phase (which has a shared right turn lane) requires a means of differentiating between the utilisation of the shared lane by right turn vehicles and by through vehicles. Usually this means some form of speed detection by the loop detectors in the shared lane and various techniques have been used with small success.

Another method has been to use a loop positioned in the intersection which is actuated by right turn vehicles but not by through vehicles. This technique presents problems in selecting appropriate Gap time settings to cater for a mixture of through and turning vehicles in the shared lane. Typically the Gap time setting must be set at 8-9 seconds which does not produce efficient operation.

The present method is in fact a speed detection technique, which relies on the empirical relationship between vehicle speed and the spaces between vehicles. For right turn vehicles, the speed is normally sufficiently low that the space between vehicles does not exceed 11 metres. That is, a queue of right turning vehicles provides continuous occupancy over an 11 metre loop in the right turn lane.

Together with this is the recognition that the speed of a queue of vehicles (measured over a loop at the stop line) is determined by the slowest vehicle in the queue, which in this case is the right turn vehicle. The queue speed can thus be used as the criterion for establishing the presence of right turn vehicles, and hence the continuing requirement for the right turn phase.

When the right turn vehicles have been cleared from the front of the queue then the queue speed will increase. This is detected by the increase in spaces between vehicles crossing the 11 meter loop at the stop line. The right turn phase can thus be efficiently terminated by the Waste Timer when the queue speed increases by selecting a very small Headway time setting.

Note that every vehicle in the shared lane extends the turn phase. The turn phase is thus terminated by the Waste Timer not the Gap Timer, except under light traffic conditions.

## 5.5 Shared Right turn Lane (Side Street)

The following logic is a special case which applies only to a filter right turn movement on the side street. Note that the logic below was one of the early attempts for a leading right turn movement with filtering. This method, although included in the standard tables, is now superseded by the logic described above in Section 5.4 (Standard Table 4). The logic is described for the particular example in Figure 5.

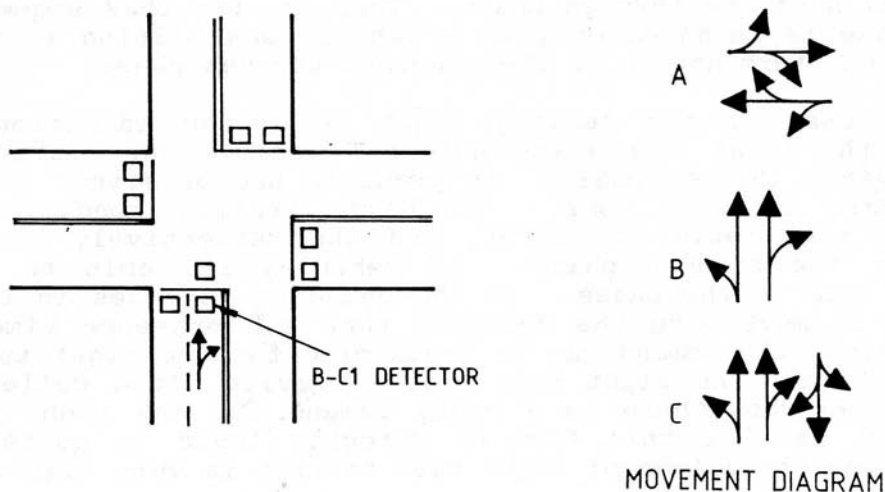


Figure 5 Filter Right turn Movement on Side Street

### 5.5.1 Demand Function

The output of the departure detector (i.e. 11 metre loop) is subject to a presence timer. During the through phase (C phase in the above example), the departure detector places a demand for the right turn phase upon expiry of the presence timer. If the right turn phase follows the through phase (sequence A-C-B), then the demand for the right turn phase is the normal demand subject to presence timer. If, however, the right turn phase precedes the through phase (sequence A-B-C), then the demand for the right turn phase is locked at the termination of the through phase. That is, for this sequence, the right turn phase is demanded only if a vehicle was waiting to make the right turn at the termination of the previous through phase.

For the case of the leading right turn, the intention is to avoid demanding the right turn phase unless a vehicle was unable to filter on the previous through phase. In practice, the on-street performance from this logic is very poor. In heavy traffic conditions right turn vehicles are unable to filter and thus effectively block the shared lane for the through phase. If vehicles are able to filter, it is usually late in the phase. If the queue of vehicles in the shared lane is slow to move onto the detector then the presence timer must expire again before the demand can be registered for the right turn phase. The result is that the right turn phase is quite often demanded on alternate cycles even when there is a heavy demand for the right turn movement. The conclusion is that this form of detector logic is quite inappropriate except when the volume of right turn traffic is very light.

Vehicles in the shared lane arriving at a red signal place a locked demand for the through phase, not subject to a presence timer. The demand is cancelled when the overlap signal group displays green.

### 5.5.2 Extension Function

The approach detector extends the right turn phase unconditionally. Hence the sequence A-B-C (leading right turn) is particularly inefficient since through vehicles in the shared lane extend the right turn phase. Since the logic described above is only suitable for low volumes of right turn traffic, it is appropriate to use a very small maximum time for the right turn phase, thus minimising the inefficiency.

The approach detector also extends the through phase except when the right turn phase is the next phase to follow. If the right turn phase follows the through phase then it may be appropriate to transfer unused maximum time from the through phase to the right turn phase.

### 5.5.3 Detector Logic Specification

The complete detector logic specification for the B-CI detector in Figure 5 is expressed symbolically in Table 4.

B-CI	FN	B(CL)		
DEPARTURE & APPROACH	SG/PS	C		
	DS	-		
B-CI  APPROACH	FN	C(L)	C(En)	B(En)
	SG/PS	$\overline{V6}$	C	B
	DS	-	$\overline{B(NEXT)}$	-

Table 4 Standard Table 20

## 5.6 Exclusive Left turn Lane with Pedestrian Conflict

There is a variety of different detector logic for left turn movements according to the differing conditions on site. An example is given below for the particular case of an exclusive left turn lane, with a heavy left turn movement and a conflicting pedestrian movement with either heavy pedestrian volumes or full red arrow protection for the pedestrian movement. (Note that the example given below is for a T junction, but the same logic applies generally to all intersections with the same conditions.)

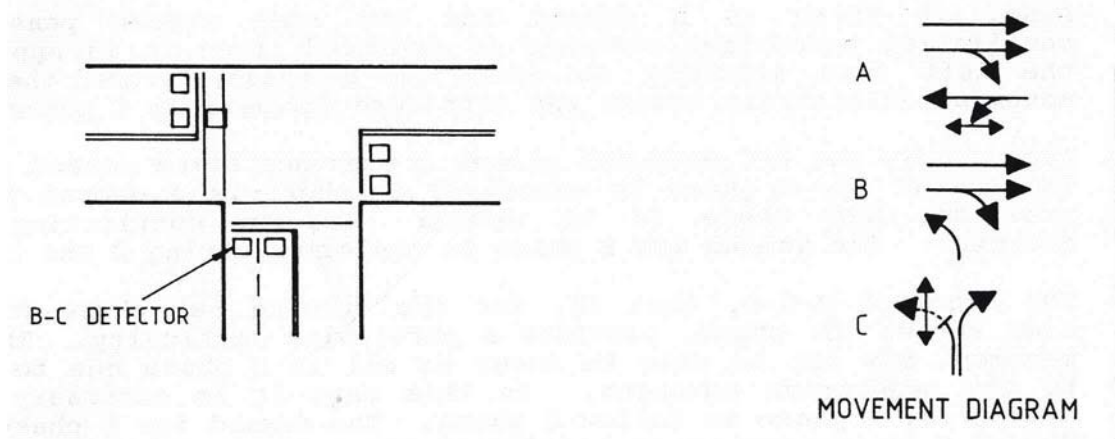


Figure 6 Filter Right turn Movement on Side Street

### 5.6.1 Demand Function

Consider the example above for the sequence A-B-C, that is for the turning (B) phase preceding the side street (C) phase. The assumption is that the left turn volume is large and also that there is a severe degree of conflict between the vehicles and the pedestrian movement in C phase. If there is no demand for the conflicting pedestrian movement in C phase then it is appropriate for the left turn movement to occur in C phase simultaneously with the side street movement. If, however, there is no other demand for the side street phase, then it is more appropriate for the left turn movement to occur in B phase, since this stops traffic on only one approach on the main street.

Also, if there is a demand for the side street phase and the conflicting pedestrian movement is demanded, then it is appropriate for the left turn movement to occur in B phase, since the pedestrian movement effectively blocks the left turn movement in C phase.

Accordingly the B-C detector places a presence timed demand for B phase. The demand for B phase is cancelled if there is a demand for C phase, provided that there is no demand for the conflicting pedestrian movement. The demand for B phase is cancelled during B and C phases.

The sequence A-C-B, that is, for the turning (B) phase following the side street (C) phase, provides a particular difficulty. The left turn movement may not be able to occur at all in C phase due to obstruction by the pedestrian movement. In this case it is necessary to place a demand for B phase to follow C phase. The demand for B phase is cleared during C phase and so an artificial means is required for restoring the demand. This is achieved by monitoring the gap timer for the B-C detector. If the gap timer is expired in C phase then it is unnecessary to demand B phase. If the gap timer is unexpired at the termination of C phase then it is certain that there is a requirement for B phase. Thus, during C phase, the condition for demanding B phase is that there is “NO GAP” on the B-C detector.

### 5.6.2 Extension Function

The B-C detector extends B phase (the turning phase) unless C phase is the next phase to follow. If there is a demand for the conflicting C phase pedestrian movement, then the B-C detector extends B phase regardless of whether C phase is the next phase to follow or not.

The B-C detector extends C phase unless B phase is the next phase to follow.

### 5.6.3 Detector Logic Specification

The complete detector logic specification for the B-C detector in Figure 6 is expressed symbolically in Table 5.

	FN	B(PR)	B(CL)	B(En)	C(En)
B-C	SG/PS	$\bar{B}.\bar{C}$	C	B	C
	DS	$\bar{C} + P2(PB)$	B-C(NG)	$\overline{C(NEXT)}+P2(PB)$	$\overline{B(NEXT)}$

Table 5 Standard Table 7

## 6 Preparation of Schedule

1. Consider each detector in sequence (A, B, C, etc.) and determine specification as follows.
2. Each detector class (i.e. group of detectors which have exactly the same function) is to be separately listed.

Note The two detectors forming an 11 metre detector are treated as a single detector class, but require separate entries in the detector specification schedule for the approach detector and the combined approach & departure detectors.

3. Demand Functions
  - (a) On the “FN” line specify, in correct order which phase is demanded and the type of demand (L, NL etc.). One vertical column is to be used for each function, except “demand and cancel” function [e.g. A(L).B(L)] which may be included together in one column for detectors on an overlap approach.
  - (b) On the “SG/PS” line, specify the period(s) during which the above function may or may not occur.
  - (c) On the “DS” line, specify any demand status or other condition which affects the above demand function of the detector.

#### 4. Extension Functions

- (a) On the “FN” line, specify which phase(s) is extended and by what means. List type of timer (E) and approach numbers. One column is to be used for each function.
- (b) On the “SG/PS” line, specify the period during which the above extension function occurs (or does not occur).
- (c) On the “DS” line, specify any demand status or other condition which affects the above extension function.

Following are two complete examples of the Detector Specification Schedule format. This does not need to be shown on simple two phase signal design plans. For more complex intersections with single and double diamond turns with alternative overlaps, refer to the Standard for Single Diamond Overlap Phasing [13] and the Standard for Double Diamond Overlap Phasing [14] respectively.

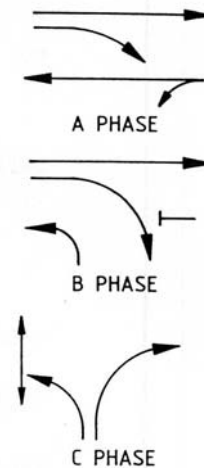
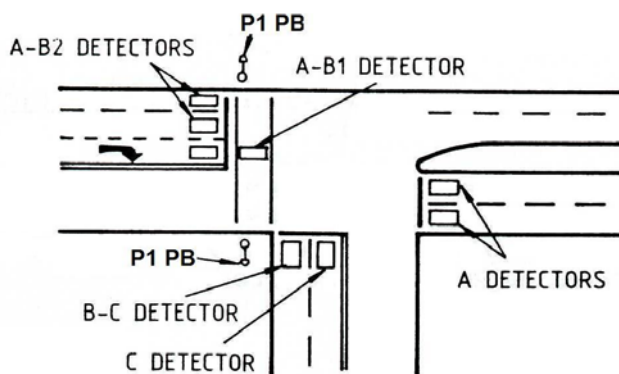
The logic shown applies to either A-B-C or A-C-B sequence and should be specified unless there is documented evidence that different detector logic would be more efficient.

## 6.1 Example I

THREE PHASE (Adaptable to either sequence A-B-C or A-C-B)

Exclusive lane and filtering right turn

Short Red Arrow Protection for P1 Pedestrian movement.



#### A DETECTOR

- (i) Demands A phase during B phase and C phase.
- (ii) Extends A phase.

#### A-B1 DETECTOR

- (i) Demands A phase and B phase during C phase.
- (ii) Demands B phase during A phase if the presence timer has expired.
- (iii) Extends A phase during A phase if the presence timer on the A-B1 detector has not expired and B phase is not next.
- (iv) Extends B phase during B phase.

#### A-B2 DETECTOR

- (i) Demands A phase during C phase.
- (ii) Extends A phase during A phase when B phase is not next.
- (iii) Extends B phase during B phase when A phase is not next.

#### B-C DETECTOR

Where the left turn is heavy and there is a heavy pedestrian flow for the PI pedestrian movement.

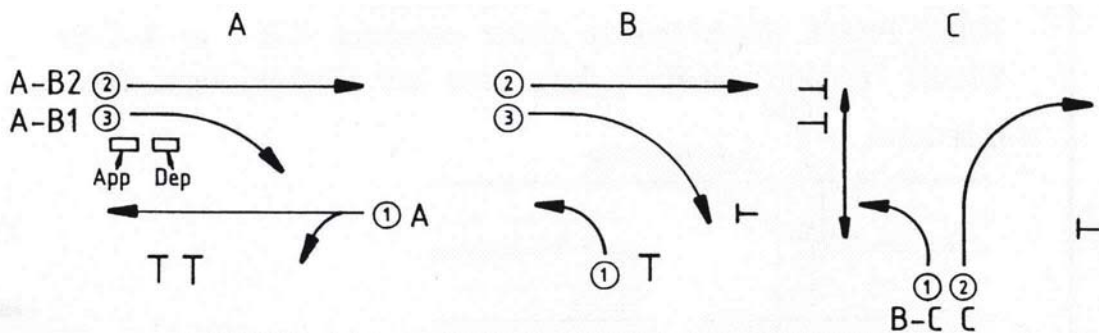
- (i) Demands B phase during A phase if the presence timer has expired and if there is no C phase vehicle demand or if there is a PI pedestrian demand.
- (ii) Demands B phase during C phase if there is no gap on the B-C detector.
- (iii) Extends B phase during B phase when C phase is not next or there is a PI pedestrian demand.
- (iv) Extends C phase during C phase when B phase is not next.

C DETECTOR

- (i) Demands C phase during A phase and B phase.
- (ii) Extends C phase during C phase.

PI(PB) DETECTOR

- (i) Demands C phase when the PI WALK is not green.
- (ii) Demands A phase during C phase when the PI WALK is not green and there is no demand for A phase or B phase.



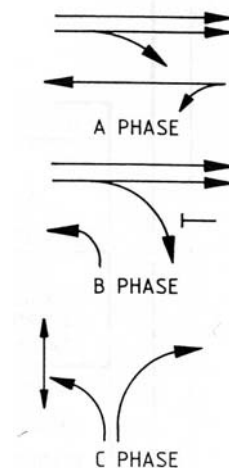
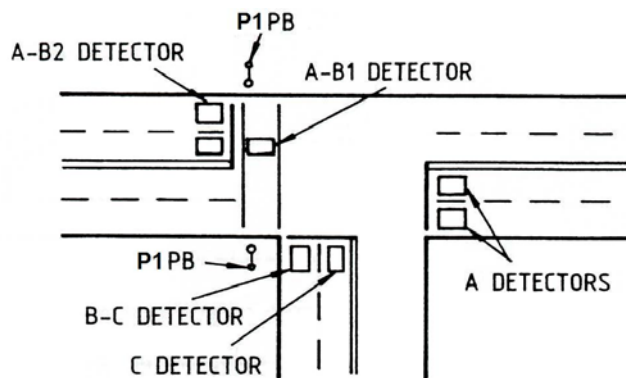
DETECTOR	SPECIFICATION					
A (TABLE 1)	FN	A(L)	A(E1)			
	SG/PS	$\bar{A}$	A			
	DS	-	-			
A-B1 APPROACH & DEPARTURE (TABLE 5)	FN	B(PR)				
	SG/PS	A				
	DS	-				
A-B1 APPROACH (TABLE 5)	FN	A(L).B(L)	A(E3)	B(E3)		
	SG/PS	$\overline{V2}$	A	B		
	DS	-	$\overline{A-B1(PR).B(NEXT)}$	-		
A-B2 (TABLE 6)	FN	A(L)	A(E2)	B(E2)		
	SG/PS	$\overline{V2}$	A	B		
	DS	-	$\overline{B(NEXT)}$	$\overline{A(NEXT)}$		
B-C (TABLE 7)	FN	B(PR)	B(CL)	B(E1)	C(E1)	

	SG/PS	$\bar{B}.C$	C	B	C	
	DS	$\bar{C}+PI(PB)$	B-C(NG)	$\overline{C(NEXT)}+PI(PB)$	$\overline{B(NEXT)}$	
C (TABLE I)	FN	C(L)	C(E2)			
	SG/PS	$\bar{C}$	C			
	DS	-	-			
PI(PB) (TABLE PD2)	FN	C(PB)	A(L)			
	SG/PS	$\overline{PI(WALK)}$	$C.\overline{PI(WALK)}$			
	DS	-	$\bar{A}.B$			

## 6.2 Example 2

THREE PHASE (Adaptable to either sequence A-B-C or A-C-B)

Shared through and right turn lane and filtering right turn.



### A DETECTOR

- (i) Demands A phase during B phase and C phase.
- (ii) Extends A phase during A phase.

### A-B1 DETECTOR

- (i) Demands A phase and B phase during C phase.
- (ii) Demands B phase during A phase if the presence timer has expired.
- (iii) Extends A phase during A phase if the presence timer has not expired and B phase is not next.
- (iv) Extends B phase during B phase (with one set of approach timers if A phase is not next and a different set of approach timers if A phase is next).

### A-B2 DETECTOR

- (i) Demands A phase during C phase.
- (ii) Extends A phase during A phase when B phase is not next.
- (iii) Extends B phase during B phase when A phase is not next.

### B-C DETECTOR

Where left turn is light and there is a light PI pedestrian volume.

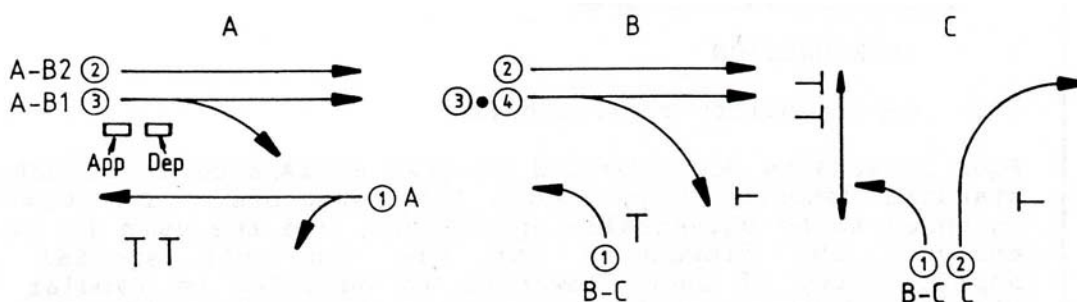
- (i) Demands B phase during A phase if the presence timer has expired and there is no C phase demand.
- (ii) Extends B phase during B phase when C phase is not next.
- (iii) Extends C phase during C phase when B phase is not next.

C DETECTOR

- (i) Demands C phase during A phase and B phase.
- (ii) Extends C phase during C phase.

PI(PB) DETECTOR

- (i) Demands C phase WALK when the PI WALK is not green.
- (ii) Demands A phase during C phase when the PI WALK is not green and there is no demand for A phase or B phase.



DETECTOR	SPECIFICATION					
A (TABLE 1)	FN	A(L)	A(E1)			
	SG/PS	$\bar{A}$	A			
	DS	-	-			
A-B1 APPROACH & DEPARTURE (TABLE 4)	FN	B(PR)	B(E4)			
	SG/PS	A	B			
	DS	-	A(NEXT)			
A-B1 APPROACH (TABLE 4)	FN	A(L).B(L)	A(E3)	B(E3)		
	SG/PS	$\bar{V}2$	A	B		
	DS	-	$\overline{A-B1(PR).B(NEXT)}$	$\overline{A(NEXT)}$		
A-B2 (TABLE 6)	FN	A(L)	A(E2)	B(E2)		
	SG/PS	$\bar{V}2$	A	B		
	DS	-	$\overline{B(NEXT)}$	$\overline{A(NEXT)}$		
B-C (TABLE 8)	FN	B(PR)	B(E1)	C(E1)		
	SG/PS	$\bar{B}.C$	B	C		
	DS	$\bar{C}$	$\overline{C(NEXT)}$	$\overline{B(NEXT)}$		
C	FN	C(L)	C(E2)			

(TABLE 1)	SG/PS	$\bar{C}$	C			
	DS	-	-			
PI(PB) (TABLE PD2)	FN	C(PB)	A(L)			
	SG/PS	$\overline{PIC(WALK)}$	$C.PI(WALK)$			
	DS	-	$\overline{A.B}$			

## 7 Standard Table Format

The following sub-sections describe conventions within the standard tables which might not be self evident to the inexperienced reader.

### 7.1 Structure

Each table has five sections:

- Operational Description – provides a brief, human readable, layman description of how the table operates. This will allow intersection designers to confirm that they have made the correct choice in table request for the Personality development.
- Typical Application Example – provides a layman generic situation, in diagrammatic form, where it might be used and the specification that would reflect the example.
- Example Personality Data – provides the code that would be generated, with specific situation values for a specific situation. Explanation of the terms used in this section can be found in the Standard Personality Reference Manual, [15] and the Standard Personality User Manual [16]. Note: the code given may not match the generic situation given in the Typical Application Example.
- Library Macro – provides the code which is used to generate the standard table code based on the answers given by the user to the questions asked by RGEN. Explanation of the terms used in this section can be found in guidelines for Layout of Macros for Standard Tables, [12].
- Revision History – provides a history of the changes to the table, including a brief summary of changes made before the tables were under formal change control procedures. OD, TAE, EPD and LM refer to the sections (identified above) of the table changed/affected.

Changes to the standard Detector Logic tables are controlled using the Standard Operating Procedure for Personality Standard Tables Management, [6]. The operational description, typical application example and example personality data can be extracted and used to form the notes file used in RGEN to aid the Personality developers. The Library Macro can be extracted to form the macro used in RGEN.

#### 7.1.1 Definitions and Abbreviations

The following definitions and abbreviations are used within the layman sections of the standard tables:

Term	Meaning
A-B	Implies a detector which affects operation in A and B phases.
V7	The signal group which is labelled V7 on the design plan.
EPD	Example Personality Data
LM	Library Macro
LTOR	Left Turn On Red
OD	Operational Description

Term	Meaning
TAE	Typical Application Example
(n)	Implies the approach marked by n in the phase diagrams.

## 7.2 Right Turn Lanes

In section 5, Principles of Detector Logic, right turn lanes make use of an 11 metre loop comprising an “approach” (APP) and “departure” (DEP) section, and within the standard tables the loop detectors and their operation are referred to as the:

- long detector – the combination of the departure and approach sections; and
- approach detector – the approach section.

## 7.3 SCATS Signal Pulses

The Personality can be structured as to provide different modes of operation dependent on the presence, or not, of a signal from SCATS. In the Detector Logic standard tables use is made of the Z- (ZNEG), Z+ (ZPOS) and XSF signals.

Generally, the presence of the:

- Z- signal is used to allow filtering at intersections where it can be useful to stop filtering at certain times of the day, and
- Z+ is used to include a repeat phase in the operation of the intersection.

An XSF signal can be used for either of the above, or to introduce a special facility or phase.

# 8 Standard Table Selection

## 8.1 Introduction

### 8.1.1 Applicability of Flowcharts

Four flowcharts are provided to give assistance in selecting the correct standard table for detector logic. The flowcharts are not intended to be universally applicable and the user is cautioned against applying the flowcharts for any “one-off special cases”. The applicability of each flowchart is detailed in tabular form preceding the flowchart. Particular cases for which the flow chart is not applicable are also detailed.

In some cases, the flowcharts do not lead the user to a table number, but rather to the statement “NO STANDARD TABLE”. In such cases the user must derive the appropriate detector logic from first principles. (Refer to Sections D and E.) In many cases, reference to the standard tables for similar situations may yield some insight in deriving the required detector logic.

The flow charts for stop line (presence) detectors cover the following lane disciplines:

- Through Lanes - Vehicles may only proceed straight ahead (i.e. vehicles may not turn either left or right from these lanes).
- Right Turn Lanes - Vehicles may only turn right (i.e. exclusive right turn lane); or Vehicles may proceed straight ahead or turn right (i.e. shared right turn lane).  
Note that in the stem of a T-junction vehicles, may turn left or right from a shared lane. This case is covered by the flowchart for Left Turn lanes, not the flowchart for Right Turn lanes.
- Left Turn Lanes - Vehicles may only turn left (i.e. exclusive left turn lane); or Vehicles may proceed straight ahead or turn left (i.e. shared left turn lane); or Vehicles may turn either left or right (i.e. shared left turn lane).

One flow chart is provided for advance (passage) detectors. It is of limited application, and is included only as a guide for simple cases.

## 8.1.2 Glossary of Questions on Flowcharts

A glossary of the questions on the flowcharts is provided below together with an explanation of the meaning of each question. This has been provided to avoid any confusion or misunderstanding since the questions must, of necessity be brief in the limited space available on the flowcharts

### 8.1.2.1 Flowchart for Stop Line (Presence) Detector in an Exclusive Through Lane

- (a) "Movement permitted in more than one phase?"

A through movement may only proceed on a green signal. Thus the movement is permitted in more than one phase only if the controlling signal group displays green in more than one phase.

Example: At a 3 phase intersection, the V2 signal group displays green in A and B phases and red in C phase. The controlled through movement is thus permitted in more than one phase.

- (b) "Movement permitted in two phases only?"

This is similar to (i) above, but in this case the movement must be permitted in exactly two phases to produce a "YES" answer.

- (c) "Movement permitted in three phases only?"

This is similar to (i) above, but in this case the movement must be permitted in exactly three phases to produce a "YES" answer.

- (d) "Conditional on pedestrian movement?"

The signal group controlling the through movement may be conditional upon a pedestrian movement. That is, the signal group displays red during the pedestrian walk and clearance, but displays green following the termination of the pedestrian movement. The signal group also displays green if the pedestrian movement was not demanded. In such a case, the through movement is conditional on a pedestrian movement.

- (e) "Repeat phase?"

The purpose of this question is to differentiate between whether the controlling signal group is an overlap signal group or a signal group which displays green more than once in a cycle by virtue of a "repeat" phase.

An overlap signal displays green in two or more phases, with the characteristic that once the green signal has been introduced, it is maintained through the subsequent phase(s). (It is sufficient for the detector logic to place a demand for only one of the overlap phases.)

The signal group displays green more than once in the cycle if there is a "repeat" phase. A "repeat" phase usually means that the movements in one phase are repeated again in another phase in the cycle (e.g. D phase may be a repeat of B phase). In some cases, the repeat phase may not provide a repeat of a pedestrian movement, and thus the movements may differ in the repeat phase. (In the case of repeat phases, it is necessary for the detector logic to place demands for both phases, since the movements do not provide an overlap in normal operation.)

### 8.1.2.2 Flowchart for Stop Line (Presence) Detector in a Right Turn Lane

- (a) "R.T. movement permitted in more than one phase?"

The movement may be permitted in one or more phases by a green arrow or may be permitted as a filter movement by a full green signal.

Example: A right turn movement is permitted in A phase by a full green signal and in B phase by a green arrow and not permitted in any other phase. The movement is thus permitted in more than one phase.

- (b) "R.T. green arrow?"

The answer is “YES” if there is a right turn green arrow controlling the right turn movement in any phase.

(c) “Shared R.T. lane?”

The lane is a shared lane if vehicles may proceed straight ahead or turn right from the lane.

(Note that in the stem of a T-junction, vehicles may turn left or right from a shared lane. This case is covered by the flowchart for Left turn lanes, not the flowchart for Right turn lanes.)

(d) “Non-filter R.T. movement only?”

The right turn movement is a non-filter movement if the right turn vehicles are held by a red arrow in phases other than the right turn green arrow phase(s).

(e) “R.T. filter by special facility?”

The right turn movement is permitted to filter by the presence of a Masterlink or Flexilink special facility signal (usually Z-). If the special facility signal is not present or if the controller is operating in the isolated mode, the right turn movement is not permitted to filter, that is, the right turn movement is held by a red arrow in phases other than the right turn green arrow phase(s).

(f) “Repeat or overlap R.T. phase(s)?”

The purpose of this question is to determine whether the right turn green arrow is displayed in more than one phase. If this is the case, then the answer to the question is “YES”.

(g) “Repeat R.T. phase?”

The purpose of this question is to differentiate between whether the controlling signal group is an overlap signal or a signal which displays green more than once in the cycle by virtue of a “repeat” phase.

An overlap signal displays green in two or more phases with the characteristic that once the green signal has been introduced, it is maintained through the subsequent phase(s). (It is sufficient for the detector logic to place a demand for only one of the overlap phases.)

The signal group displays green more than once in the cycle if there is a “repeat” phase. A “repeat” phase usually means that the movements in one phase repeated again in another phase in the cycle (e.g. D phase may be a repeat of B phase). In some cases, the repeat phase may not provide a repeat of a pedestrian movement and thus the movements may differ in the repeat phase. (In the case of repeat phases, it is necessary for the detector logic to place demands for both phases, since the movements do not provide an overlap in normal operation.)

(h) “Repeat R.T. phase by special facility?”

The repeat phase may be conditionally included in the cycle by the presence of a Masterlink or Flexilink special facility signal (Z+). If the special facility signal is not present or if the controller is operating in isolated mode, the repeat phase is not included in the cycle.

**8.1.2.3 Flowchart for Stop Line (Presence) Detector in a Left turn Lane**

(a) “L.T.O.R?”

Is Left turn on Red permitted after stopping?

(b) “Controlled slip lane?”

Is the left turn lane a slip lane controlled by a signal group?

(c) “L.T.G.A?”

Is there a left turn green arrow controlling the left turn movement?

(d) “L.T. on green signal in one phase only?”

The left turn is permitted by a full green signal only. Is the green roundel displayed in more than one phase?

(e) “L.T. from side street to main street?”

Is traffic permitted to turn left onto the main street from the side street by Left turn on Red?

- (f) “Green signal in one phase only?”

Does the signal group controlling the left turn display green in only one phase?

- (g) “Repeat phase?”

The purpose of this question is to differentiate between whether the controlling signal group is an overlap signal or a signal which displays green more than once in the cycle by virtue of a “repeat” phase.

An overlap signal displays green in two or more phases with the characteristic that once the green signal has been introduced, it is maintained through the subsequent phase(s). (It is sufficient for the detector logic to place a demand for only one of the overlap phases.)

The signal group displays green more than once in the cycle if there is a “repeat” phase. A “repeat” phase usually means that the movements in one phase are repeated again in another phase in the cycle (e.g. D phase may be a repeat of B phase). In some cases, the repeat phase may not provide a repeat of a pedestrian movement and thus the movements may differ in the repeat phase. (In the case of repeat phases, it is necessary for the detector logic to place demands for both phases, since the movements do not provide an overlap in normal operation.)

- (h) “Overlap movement in 2 phases only?”

The controlling signal group is an overlap signal. Does the signal display green in 2 phases only and overlap the green between phases?

- (i) “Overlap movement in 3 phases only?”

The controlling signal group is an overlap signal. Does the signal display green in 3 phases only and overlap the green between phases?

- (j) Exclusive left turn lane?”

Is traffic only permitted to turn left from this lane?

- (k) “Repeat L.T.G.A. phase?”

Is the left turn green arrow displayed more than once in the cycle by virtue of a “repeat” phase? (Refer to “Repeat Phase” above).

- (l) “Repeat L.T.G.A. phase by special facility?”

Is the repeat left turn green arrow phase conditional on a Masterlink or Flexilink special facility signal (Z+)?

- (m) “Pedestrian conflict with left turn?”

Is there a pedestrian movement in conflict with the left turn movement?

- (n) “Full pedestrian protection?”

Is the left turn movement held by a red arrow during the walk and clearance of the conflicting pedestrian movement?

- (o) “Very light left turn demand?”

Is the left turn flow always less than (typically) 100 vehicles per hour?

- (p) “Heavy pedestrian flow?”

Are there sufficient pedestrians to prevent the left turn traffic from filtering through the pedestrian movement?

- (q) “High proportion of left turn vehicles?”

Does a high proportion of vehicles in the shared lane turn left? (The proportion of left turn vehicles should not be less than 50% of the total approach flow for the lane.)

#### **8.1.2.4 Flowchart for Advance (Passage) Detector**

(a) “Green in more than one phase?”

Does the controlling signal group display green in more than one phase?

(b) “Associated stop line detector?”

Is there a stop line presence detector on the same approach?

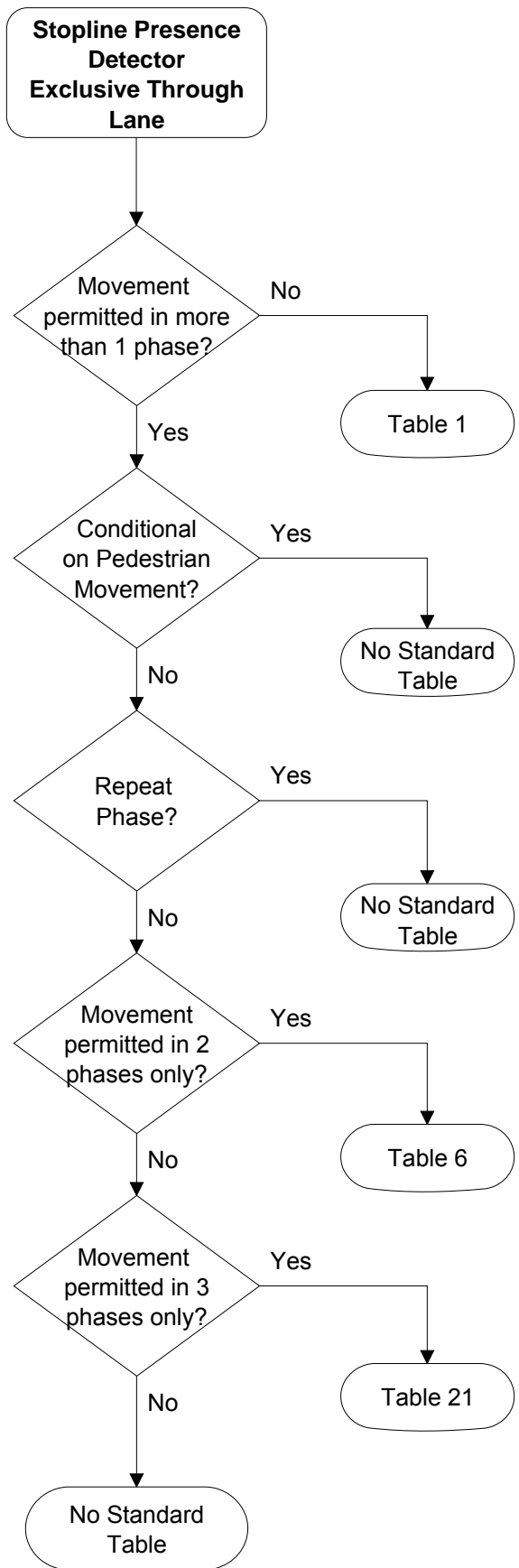
## 8.2 Exclusive Through Lane – Stop Line (Presence) Detector

### Cases for Consideration

- |     |   |
|-----|---|
| (a) | Movement permitted in one phase only.                         |
| (b) | Repeat phase by special facility signal Z+.                   |
| (c) | Repeat phase conditional on pedestrian movement in one phase. |
| (d) | Overlap in two phases only.                                   |
| (e) | Overlap in three phases only.                                 |

### Cases where Flowchart does not apply

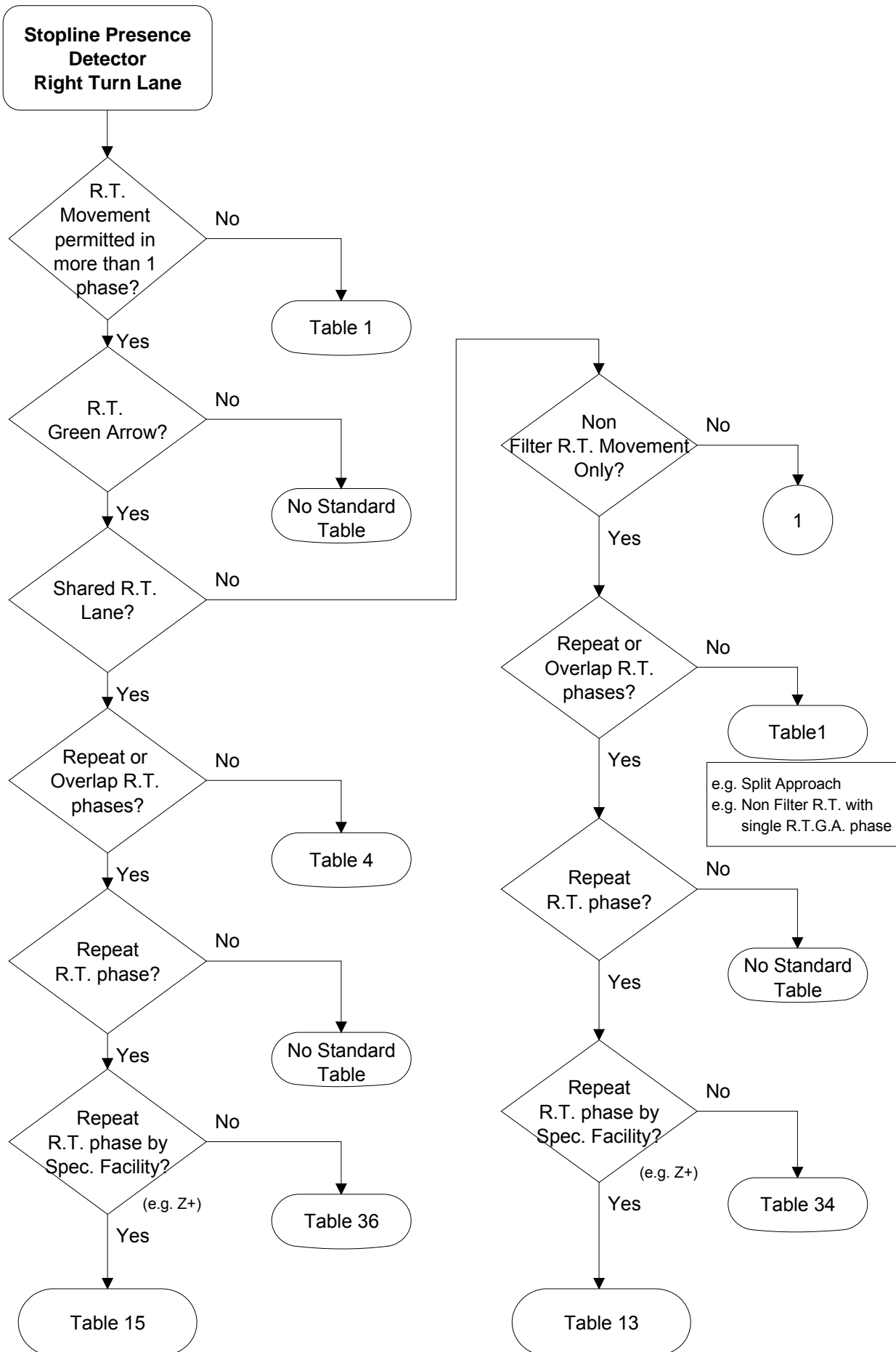
- |     |                                |
|-----|--------------------------------|
| (a) | Single diamond overlap design. |
| (b) | Double diamond overlap design. |



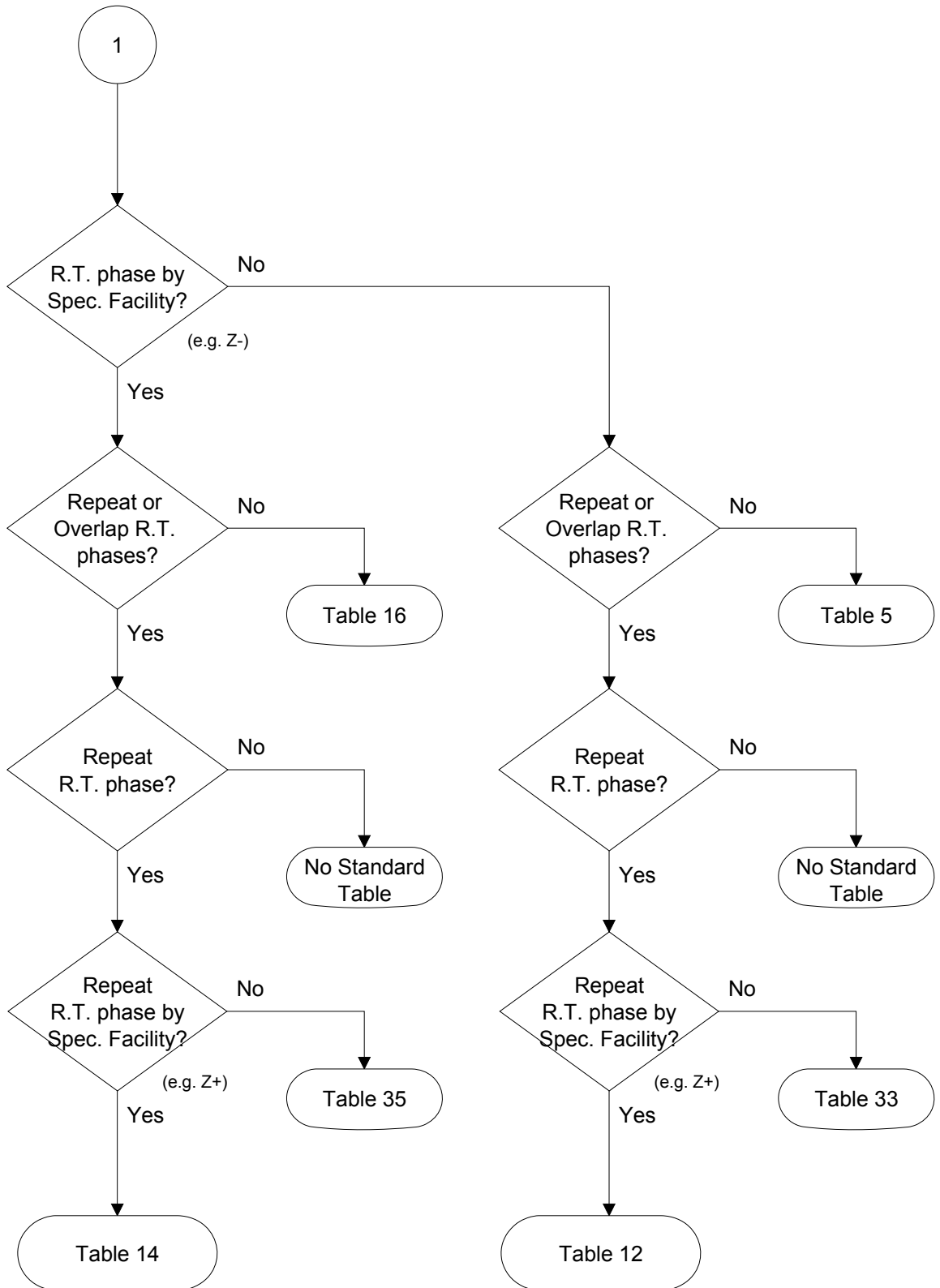
**Figure 7 Exclusive Through Lane Detector Logic Selection**

## 8.3 Shared/Exclusive Right Turn Lane Stop Line (Presence) Detector

Cases for Consideration	
(a)	R.T. on full green only (i.e. R.T. by filter only) e.g. 2 phase.
(b)	R.T. on full green only with repeat by special facility signal Z+ e.g. 2 phase double cycled.
(c)	Split approach.
(d)	Non filter R.T. with single R.T.G.A. phase.
(e)	Non filter R.T. with overlap R.T.G.A. phases.
(f)	Non filter R.T. with repeat R.T.G.A. phase by special facility signal Z+
(g)	Non filter R.T. with repeat R.T.G.A. phase independent of special facility signal Z+.
(h)	Filter R.T. with single R.T.G.A. phase.
(i)	Filter R.T. with overlap R.T.G.A. phases
(j)	Filter R.T. with repeat R.T.G.A. phase by special facility signal Z+.
(k)	Filter R.T. with repeat R.T.G.A. phase independent of special facility signal Z+.
(l)	Non filter R.T. with single R.T.G.A. phase and filter by special facility signal Z-.
(m)	Non filter R.T. with overlap R.T.G.A. phase and filter by special facility signal Z-.
(n)	Non filter R.T. with repeat by Z+ and filter by special facility signal Z-.
(o)	Non filter R.T. with repeat and filter independent of special facility signal.
Cases where Flowchart does not apply	
(a)	Single diamond overlap design.
(b)	Double diamond overlap design.



**Figure 8 Right turn Detector Logic Selection**



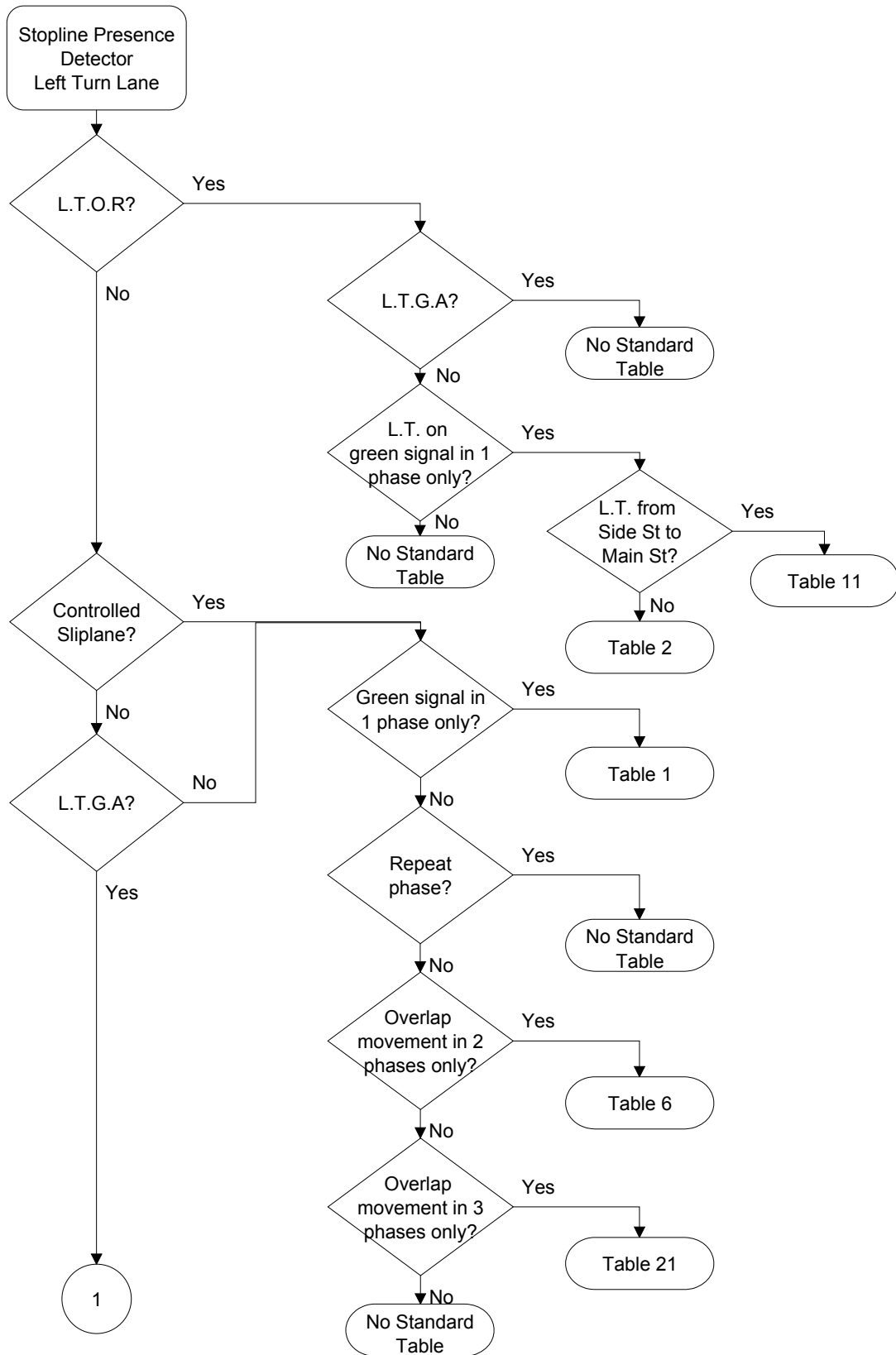
**Figure 9 Right turn Detector Logic Selection (cont'd)**

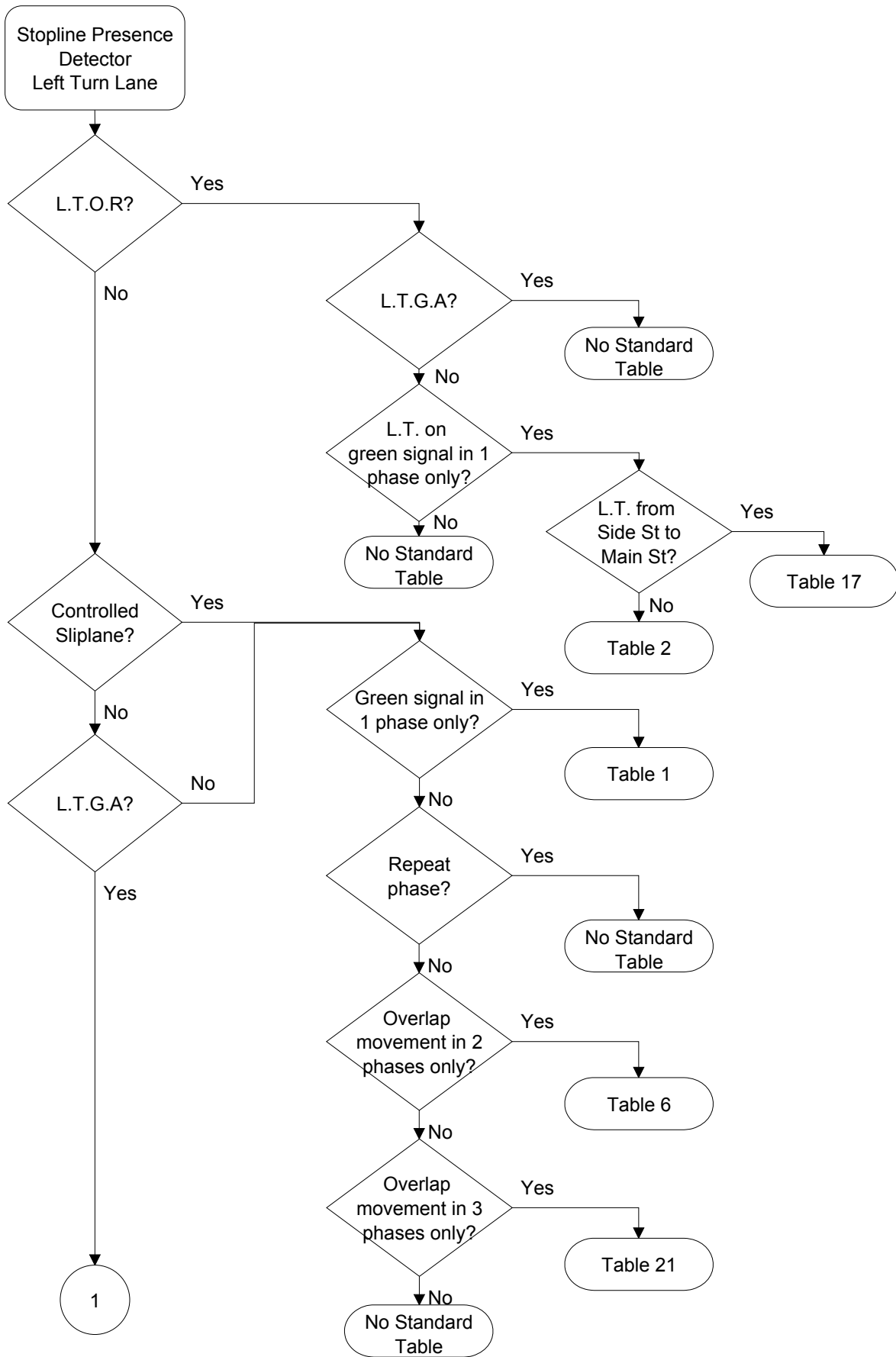
## 8.4 Shared/Exclusive Left Turn Lane Stop Line (Presence) Detector

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Cases for Consideration	
(a)	Left turn on Red.
(b)	Filter left turn only on green roundel.
(c)	Controlled slip lane.
(d)	Left turn with no conflicting pedestrian movement.
(e)	Left turn with short protection for conflicting pedestrian movement.
(f)	Left turn with full protection for conflicting pedestrian movement.
(g)	Repeat left turn green arrow phase.
(h)	Overlap left turn green arrow phases.

Cases where Flowchart does not apply	
(a)	Single diamond overlap design.
(b)	Double diamond overlap design.





**Figure 10 Left turn Detector Logic Selection**

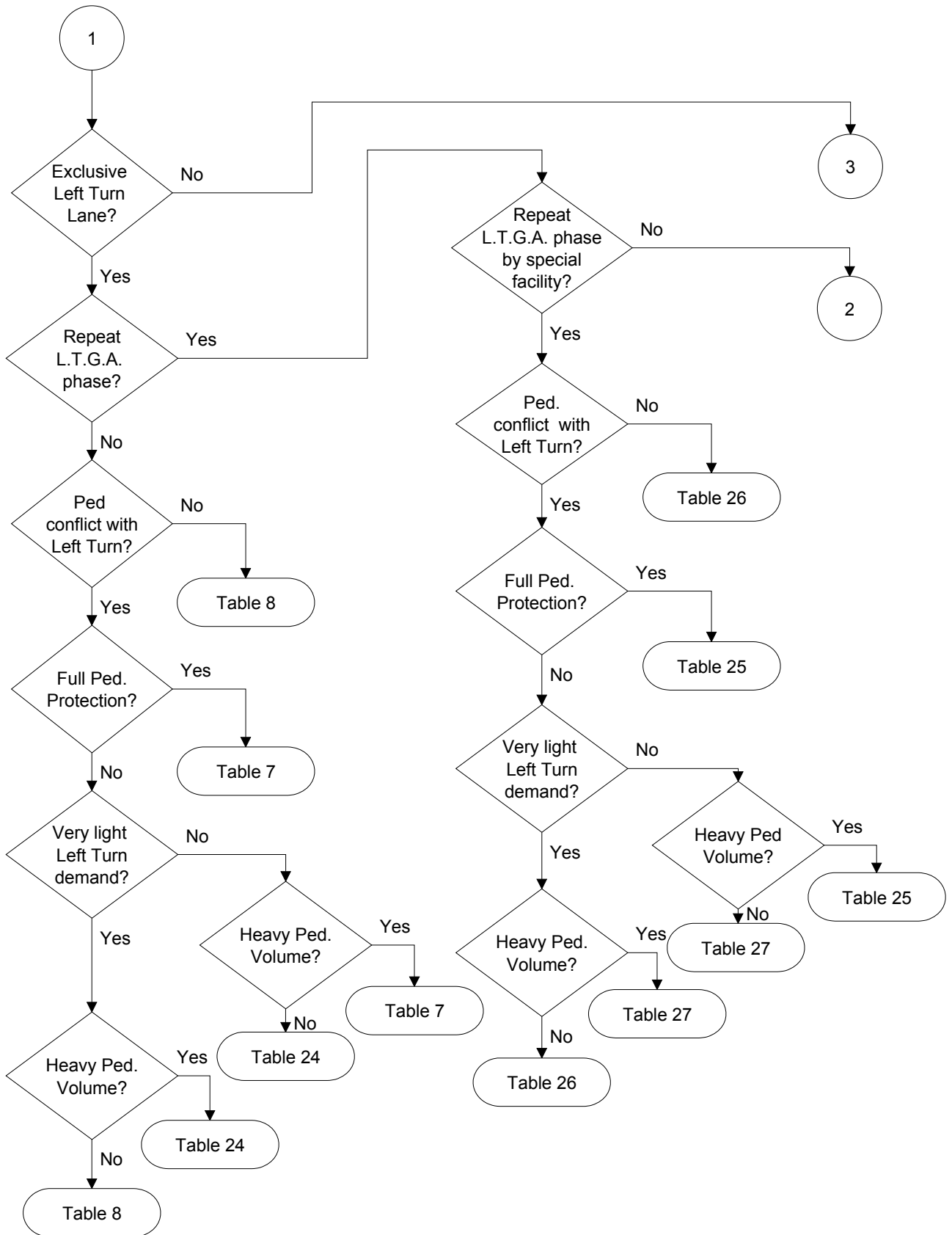


Figure 11 Left turn Detector Logic Selection (cont'd)

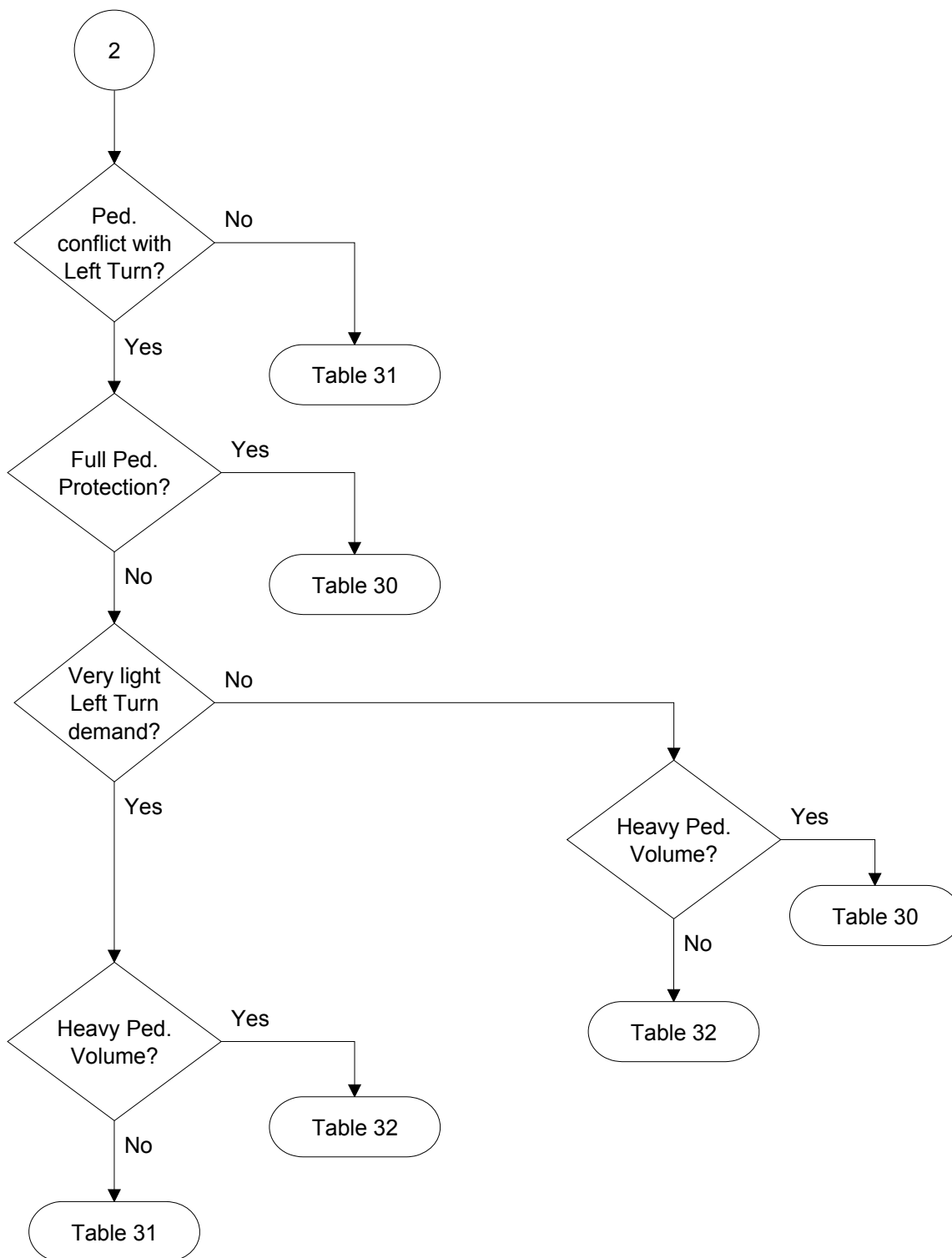
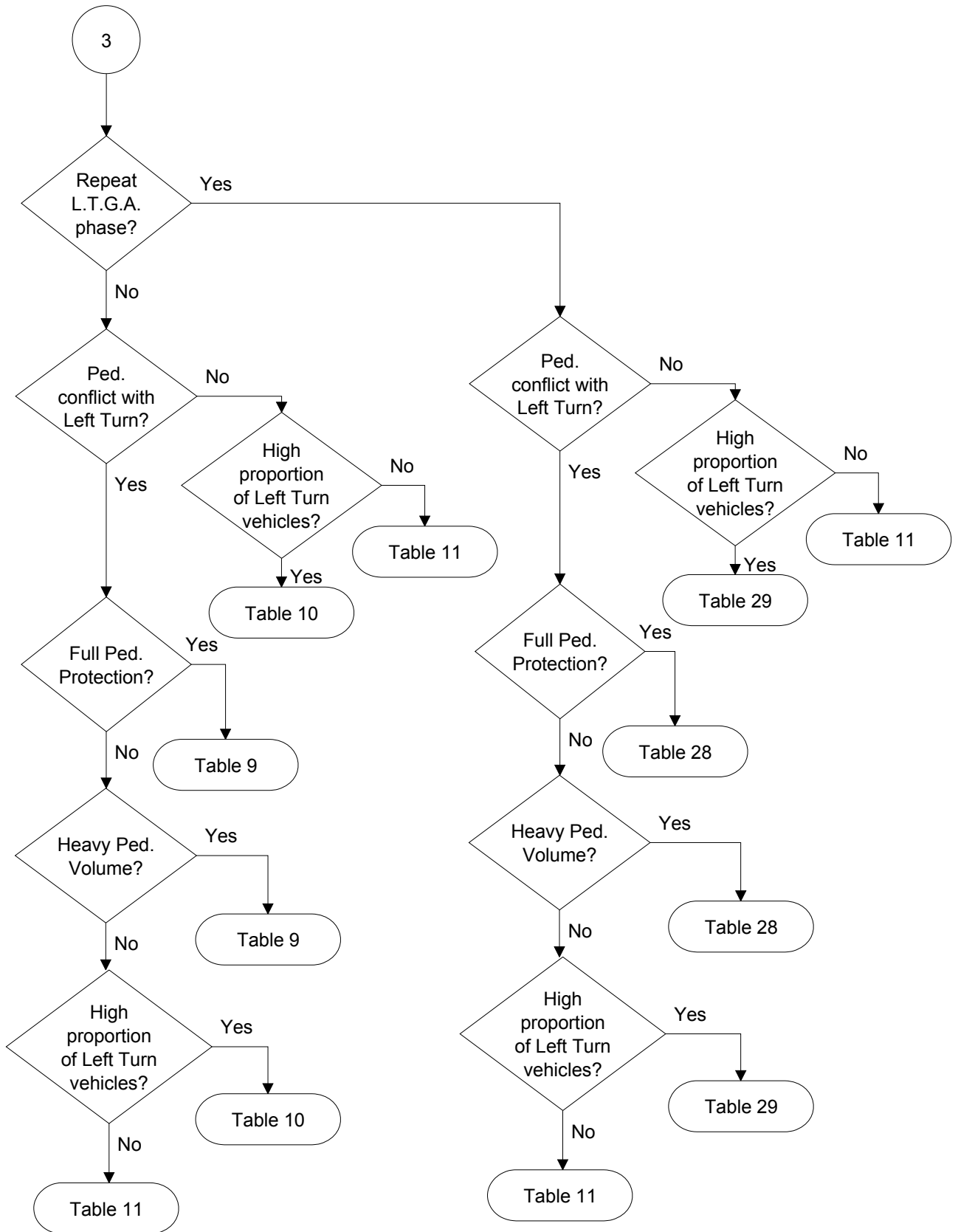


Figure 12 Left turn Detector Logic Selection (cont'd)



**Figure 13 Left turn Detector Logic Selection (cont'd)**

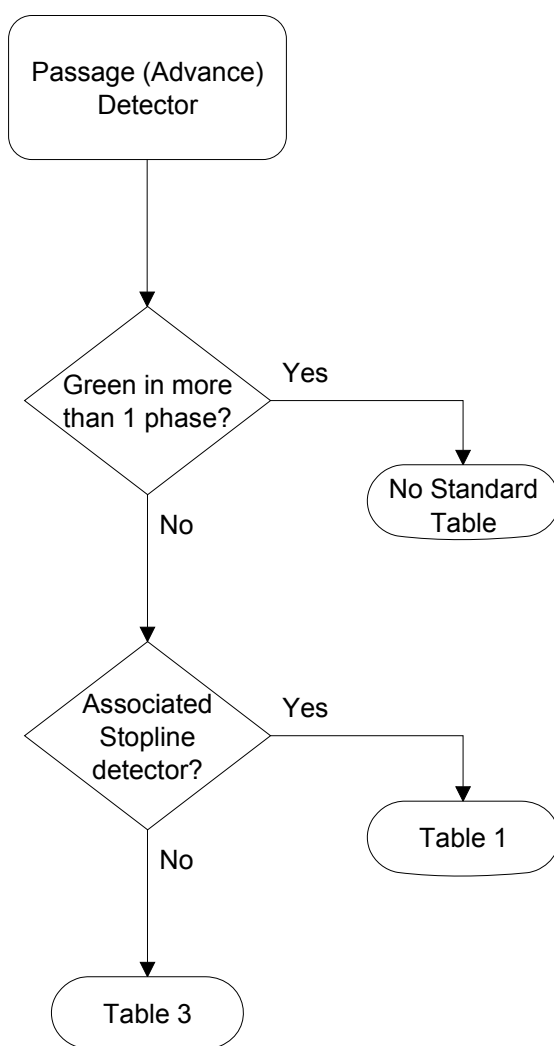
## 8.5 Through Movement - Advance (Passage) Detector

### Cases for Consideration

- (a) Associated Presence (Stop Line) Detector.
- (b) No Associated Presence (Stop Line) Detector.

### Cases where Flowchart does not apply

- (a) Single diamond overlap design.
- (b) Double diamond overlap design.
- (c) Movements which can occur in more than one phase.



**Figure 14 Through Movement Passage (Advance) Detector Logic Selection**

## 9 Detector Classes

Detectors are handled in terms of detector classes. Each class corresponds, (usually), to a single row of a detector specification schedule. A vehicle detector can only be in one class. Dummy classes having no detectors are also possible. Use these where demand functions are used which do not have related detectors, for example in Diamond Overlap designs.

A class consists of all the detectors having the same basic name, (for example, "A-B2"), and also the same, or strongly interrelated logic. If the class has more than one detector then each detector within the class also has a position name, such as "L", "CL", "C", "CR" or "R".

### 9.1 Summary

The presently defined Standard Detector Tables are:

Table 1	Stop Line Presence Detector	Locked Demand
Table 2	Stop Line Presence Detector	Non-locked Demand
Table 3	Advanced Passage Detector	No stop line detector
Table 4	Shared Right turn Lane	
Table 5	Exclusive Right turn Lane	Filtering permitted
Table 6	Stop Line Presence Detector	Overlap Approach, Locked Demand
Table 7	Exclusive Left turn Lane	Heavy Left turn, Full Pedestrian Protection or Heavy Pedestrian Volume
Table 8	Exclusive Left turn Lane	No Conflicting Pedestrian, or Short Protection
Table 9	Shared Left turn Lane	Heavy Pedestrian Volume, or Full Pedestrian Protection
Table 10	Shared Left turn Lane	High Proportion Left turn, No Conflicting Pedestrian, or Short Protection
Table 11	Shared Left turn Lane	Low Proportion of Left turn Vehicles
Table 12	Exclusive Right turn Lane	Repeat Turn by Z+, Filtering permitted
Table 13	Exclusive Right turn Lane	Repeat Turn by Z+, Non-Filter
Table 14	Exclusive Right turn Lane	Repeat Turn by Z+, Filter/Non-Filter with Z-
Table 15	Shared Right turn Lane	Repeat Turn by Z+
Table 16	Exclusive Right turn Lane	Filter/Non-Filter option with Z-
Table 17	Stop Line Presence Detector	Presence Timed Demand
Table 18	Stop Line Presence Detector	Overlap Approach, Non-locked Demand
Table 19	Stop Line Presence Detector	Overlap Approach, Presence Timed Demand
Table 20	Shared Right turn Lane	Filter, with special Conditional-Locked Demand
Table 21	Stop Line Presence Detector	Repeat Phase, Overlap Approach, Locked Demand
Table 22	Stop Line Presence Detector	Repeat Phase, Overlap Approach, Non-locked Demand
Table 23	Stop Line Presence Detector	Repeat Phase Overlap Approach, Presence Timed Demand
Table 24	Exclusive Left turn Lane	Heavy Left turn, Short Pedestrian Protection

Table 25	Exclusive Left turn Lane	Repeat Turn by Z+, Heavy Left turn, Full Pedestrian Protection or Heavy Pedestrian Volume
Table 26	Exclusive Left turn Lane	Repeat Turn by Z+, No Conflicting Pedestrian, or Short Protection
Table 27	Exclusive Left turn Lane	Repeat Turn by Z+, Heavy Left turn, Short Pedestrian Protection
Table 28	Shared Left turn Lane	Repeat Turn, Heavy Pedestrian Volume, or Full Pedestrian Protection
Table 29	Shared Left turn Lane	Repeat Turn, High Proportion Left turn, No Conflicting Pedestrian, or Short Protection
Table 30	Exclusive Left turn Lane	Repeat Turn (Not by Z+), Heavy Left turn, Full Pedestrian Protection or Heavy Pedestrian Volume
Table 31	Exclusive Left turn Lane	Repeat Turn (Not by Z+), No Conflicting Pedestrian, or Short Protection
Table 32	Exclusive Left turn Lane	Repeat Turn (Not by Z+), Heavy Left turn, Short Pedestrian Protection
Table 33	Exclusive Right turn Lane	Repeat Turn (Not by Z+), Filtering permitted
Table 34	Exclusive Right turn Lane	Repeat Turn (Not by Z+), Non-Filter
Table 35	Exclusive Right turn Lane	Repeat Turn (Not by Z+), Filter/Non-Filter with Z-
Table 36	Shared Right turn Lane	Repeat Turn (Not by Z+)

## 9.2 Selection Guide

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1. Left turn On Red	<p>(a) Single Phase Stop Line Presence Detector</p> <ul style="list-style-type: none"> <li>- Table 2 Non-locked Demand</li> <li>- Table 11 Presence Timed Demand</li> </ul> <p>(b) Overlap Approach Stop Line Presence Detector</p> <p>(1) Normal Overlap Approach</p> <ul style="list-style-type: none"> <li>- Table 18 Non-locked Demand</li> <li>- Table 19 Presence Timed Demand</li> </ul> <p>(2) Overlap Approach with Repeat Phase</p> <ul style="list-style-type: none"> <li>- Table 22 Non-locked Demand</li> <li>- Table 23 Presence Timed Demand</li> </ul>
2. Exclusive Left turn Lane	<p>(a) Single turn phase</p> <p>(1) No conflicting pedestrian movement</p> <ul style="list-style-type: none"> <li>- Table 8 Light or heavy left turn</li> </ul> <p>(2) Conflicting pedestrian movement with full protection</p> <ul style="list-style-type: none"> <li>- Table 7 Light or heavy left turn</li> </ul> <p>(3) Short protection with heavy pedestrian volumes</p> <ul style="list-style-type: none"> <li>- Table 7 Heavy left turn</li> <li>- Table 24 Light left turn</li> </ul> <p>(4) Short protection with light pedestrian volumes</p> <ul style="list-style-type: none"> <li>- Table 24 Heavy left turn</li> <li>- Table 8 Light left turn</li> </ul> <p>(b) Repeat turn phase by Z+</p> <p>(1) No conflicting pedestrian movement</p> <ul style="list-style-type: none"> <li>- Table 26 Light or heavy left turn</li> </ul> <p>(2) Conflicting pedestrian movement with full protection</p> <ul style="list-style-type: none"> <li>- Table 25 Light or heavy left turn</li> </ul> <p>(3) Short protection with heavy pedestrian volumes</p> <ul style="list-style-type: none"> <li>- Table 25 Heavy left turn</li> <li>- Table 27 Light left turn</li> </ul> <p>(4) Short protection with light pedestrian volumes</p> <ul style="list-style-type: none"> <li>- Table 27 Heavy left turn</li> <li>- Table 26 Light left turn</li> </ul> <p>(c) Repeat turn phase (Not by Z+)</p> <p>(1) No conflicting pedestrian movement</p> <ul style="list-style-type: none"> <li>- Table 31 Light or heavy left turn</li> </ul> <p>(2) Conflicting pedestrian movement with full protection</p> <ul style="list-style-type: none"> <li>- Table 30 Light or heavy left turn</li> </ul> <p>(3) Short protection with heavy pedestrian volumes</p> <ul style="list-style-type: none"> <li>- Table 30 Heavy left turn</li> <li>- Table 32 Light left turn</li> </ul> <p>(4) Short protection with light pedestrian volumes</p> <ul style="list-style-type: none"> <li>- Table 32 Heavy left turn</li> <li>- Table 31 Light left turn</li> </ul>
3. Shared Left turn Lane	<p>(a) Single turn phase</p> <p>(1) No conflicting pedestrian movement</p> <ul style="list-style-type: none"> <li>- Table 10 High proportion of left turn vehicles</li> <li>- Table 11 Low proportion of left turn vehicles</li> </ul> <p>(2) Conflicting pedestrian movement with full protection</p>

		-	Table 9	High proportion of left turn vehicles
		-	Table 9	Low proportion of left turn vehicles
	(3)	Short protection with heavy pedestrian volumes		
		-	Table 9	High proportion of left turn vehicles
		-	Table 9	Low proportion of left turn vehicles
	(4)	Short protection with light pedestrian volumes		
		-	Table 10	High proportion of left turn vehicles
		-	Table 11	Low proportion of left turn vehicles
	(b)	Repeat turn phase		
	(1)	No conflicting pedestrian movement		
		-	Table 29	High proportion of left turn vehicles
		-	Table 11	Low proportion of left turn vehicles
	(2)	Conflicting pedestrian movement with full protection		
		-	Table 28	High proportion of left turn vehicles
		-	Table 28	Low proportion of left turn vehicles
	(3)	Short protection with heavy pedestrian volumes		
		-	Table 28	High proportion of left turn vehicles
		-	Table 28	Low proportion of left turn vehicles
	(4)	Short protection with light pedestrian volumes		
		-	Table 29	High proportion of left turn vehicles
		-	Table 11	Low proportion of left turn vehicles
4. Exclusive Right turn Lane	(a)	Single right turn phase		
		-	Table 1	Non-filter
		-	Table 5	Filter
		-	Table 16	Filter/Non-filter option by Z-
	(b)	Repeat right turn phase by Z+		
		-	Table 13	Non-filter
		-	Table 12	Filter
		-	Table 14	Filter/Non-filter option by Z-
	(c)	Repeat right turn phase (Not by Z+)		
		-	Table 34	Non-filter
		-	Table 33	Filter
		-	Table 35	Filter/Non-filter option by Z-
5. Shared Right turn Lane	(a)	Single right turn phase		
		-	Table 4	
	(b)	Repeat right turn phase by Z+		
		-	Table 15	
	(c)	Repeat right turn phase (Not by Z+)		
		-	Table 36	
6. Through Movement Stop Line Presence Detectors	(a)	Single Phase Stop Line Presence Detector		
		-	Table 1	Locked Demand cleared by phase
	(b)	Overlap Approach Stop Line Presence Detector		
	(1)	Normal Overlap Approach		
		-	Table 6	Locked Demand cleared by signal group
	(2)	Overlap Approach with Repeat Phase		
		-	Table 21	Locked Demand cleared by signal group
7. Through Movement Advanced Detectors	(a)	With no stop line presence detectors		
		-	Table 3	Incrementing detectors
	(b)	With stop line presence detectors		
		-	Table 1	Non-Incrementing detectors

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For further enquiries  
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Roads and Traffic Authority

July 2009