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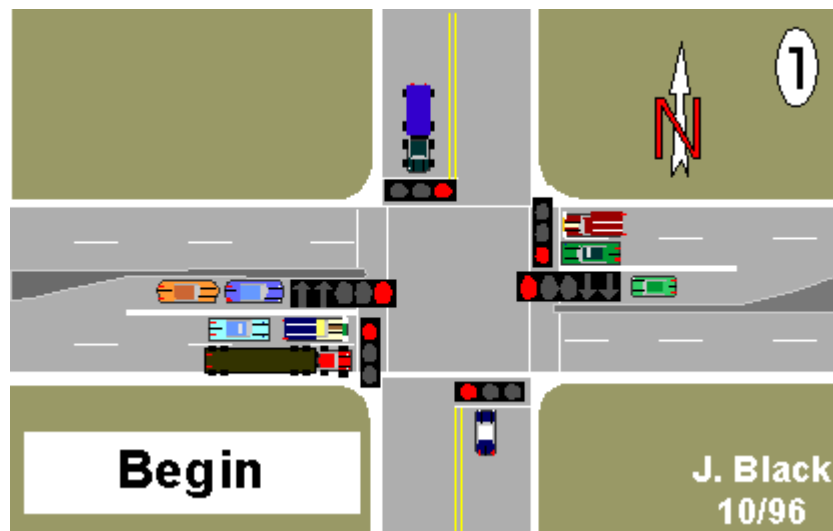
TecNote 1103 - The Permitted Lag Left-Turn Display



Naztec wishes to thank the City of Lewisville, Texas for providing the information contained in this TecNote. We encourage all of our customers to share new applications for our products to improve traffic operations. There are many ways to resolve issues, such as the "Yellow Trap" safety problem and Naztec, Inc. does not endorse any method specifically. The Permitted Lag (PL) left-turn display is provided as an alternative using several unique features in our TS-2 NTCIP based controller. Hopefully, this information will prove useful to other customers trying to resolve the "Yellow Trap" problem with lead/lag left-turn sequences.

Statement of the Problem

Left-turn signal phasing can be used to improve two-way progression and reduce driver delay, stops and fuel consumption. Computer programs like as [Synchro](#), [PASSER 2](#) and [4](#) can optimize lead/lag left-turn sequences to improve the efficiency of the signal as much as 15-25% compared with fixed leading left-turn sequences. However, when lead/lag left-turn phasing is combined with protected/permitted left-turn signal displays, a safety problem called the "Yellow Trap" results for the leading left-turn driver as shown below.



The "Yellow Trap" (Figure 1) occurs when a driver making a permitted left-turn sees *all yellow displays* and assumes that the opposing through drivers are stopping, when in fact, the opposing through direction remains green for the lagging left-turn interval.



Figure 1 - Left-turn Displays During the "Yellow Trap"

The Permitted Lag (PL) left-turn display simply omits the overlap driving the permissive indications in the leading left-turn display. Only the lagging left-turn is permitted during lead/lag left-turn sequences. Drivers in the leading left-turn direction see the following display (Figure 2) when the main street clears in the leading turn direction.



Figure 2 - PL Display During the Same Yellow Clearance

This protected-only display prevents a permitted left-turn from being "trapped" during the yellow clearance before the lagging left-turn is serviced.

[Various left-turn displays](#) have been developed to resolve the "Yellow Trap" issue and the National Signal Committee is currently reviewing research conducted by [NCHRP 3-54](#) on the effectiveness of these displays. Eventually, this research will lead to recommendations for a standard left-turn display in the MUTCD. But until then, traffic engineers must apply other methods to overcome the "Yellow Trap" and gain the progression benefits of lead/lag left-turn sequences.

The Permitted Lag (PL) Left-turn Display

The PL display is accomplished by turning the overlap "Off" for the leading left-turn display. This coordination feature is provided in the Naztec TS-2 controller under the "Alt Tables+" screen - (MM->2->6 -> right screen)

Suppose you wish to run a lead/lag left-turn sequence for pattern 2 and the permissive indications for the left-turn display are driven by overlap 2. The overlap can be disabled for this pattern by turning overlap (Olp.) 2 "Off" for Pat# 2 on the "Alt Tables+" screen as shown below.

<-Pat#	Olp.	Off:	12345678	CIC	CNA	Max2	Dia
1			0	.	.	DFT
2			.X.....	0	.	.	DFT
3			0	.	.	DFT

In this example, the permitted indications remain red for the leading left-turn left-turn display whenever pattern 2 is selected.

This Naztec overlap feature allows you to disable the permitted left-turn displays during a lead/lag left-turn sequence. The permitted turn indications in each left-turn head are driven by separate overlaps, so only the leading permitted display (or overlap) needs to be disabled.

This controller feature allows the lead/lag phase sequence to be reversed by pattern. For example, a PASSER generated pattern may require phase 1 to lead in the AM timing pattern and lag in the PM plan. Many signal systems have resolved the "Yellow Trap" issue by physically changing one signal head to protected-only and leaving the lagging direction protected/permitted. This may benefit one timing plan, but leads to an inflexible system because the lead/lag phase sequence cannot be reversed. The Permitted Lag (PL) left-turn display provides the ability of running any left-turn sequence safely.

Confusing Red Ball and Green Arrow Indications

Protected/permitted left-turn displays often confuse drivers when the following indications are used during a dual left-turn sequence.



Figure 3 - Confusing Red Ball and Arrow Indications

Human factors studies show that a solid red indication and a green arrow in the same signal head appear contradictory to many drivers. This confusion does not pose a safety concern but can increase vehicle delay when drivers hesitate during the initial portion of the protected-only interval.

The Permitted Lag (PL) left-turn display, overcomes this problem using the Naztec "modifier feature" which causes an overlap to go dark whenever a specified phase is timing the green or amber sequence.

For example, assume that the protected arrows in a 5-section left-turn display are driven by phase 1 and the permitted indications are driven by overlap "A" comprised of **included** phases 1 and 6.

Overlap "A" (or overlap 1) is defined using the key sequence MM->1->5->2->1 ENTER 1.

Ovrlp	A	Øs
Included	Øs	1	6	0	0	0	0	0
Modifier	Øs	1	0	0	0	0	0	0
Type:	NORMAL	Grn:	0	Yel:	3.5	Red:	1.5	

Notice that phase 1 is specified as a "modifier phase" for this overlap. Whenever phase 1 is timing green or amber clearance, the output for Overlap "A" will be dark providing the following display that is less confusing to the driver.



Figure 4 - PL Display Overcomes the Confusion

The "modifier phase" also removes the confusion in the Permitted Lag (PL) left-turn display (Figure 4). Without this feature, the lagging left-turn driver would receive a solid red indication with the protected arrow indications in the left-turn display.



Figure 5 - Permitted Lag (PL) Left-turn Display During a Lagging Left-turn Sequence

Notice that the Permitted Lag (PL) left-turn display (Figure 5) does not require louvers to shield the solid green indication as required in the [Dallas PPLT left-turn display](#). The PL display also overcomes the confusion of displaying a solid red with an arrow indication in the same signal head.

Conflict Monitor Considerations

The conflict monitor has to be "smart" enough to disable the "red fail" check on the overlap channel when the "modifier phase" darkens all the outputs. Some monitors also perform a "sequence fail" check that becomes an issue for the PL display when the overlap goes a solid green to a dark indication. The Naztec [Series 500 NEMA Conflict Monitor](#) allows you to disable "red fail" and "sequence fail" by channel to overcome these problems. It might also be possible to monitor the red indication from a separate overlap with the same include phases, but without a "modifier" phase depending on your configuration.

Field Wiring Considerations

The user should also keep in mind that the PL display requires 3 separate signal conductors from the cabinet load bay to each left-turn head to drive the permitted displays using separate overlaps. This requirement can pose a problem if the existing permitted displays are wired to the adjacent through indications and field wiring is not available from the display to the signal cabinet.

Conclusions

The benefits of lead/lag left-turn sequences have been well known for some time. Lead/lag left-turn sequences can be optimized with [Synchro](#), [PASSER 2 and 4](#) to improve progression and minimize delay, stops and fuel consumption. However, the "Yellow Trap" safety problem prevents traffic engineers from using lead/lag left-turn sequences to this advantage when protected/permitted left-turn displays are present.

This TecNote presents the Permitted Lag (PL) left-turn display as one alternative to overcome the "Yellow Trap" problem by converting the leading left-turn display to protected-only. This method prevents the "Yellow Trap" without louvering the solid green indication and also overcomes the problem of a solid red and protected left-turn indication displayed concurrently. Therefore, the PL display can provide several operational benefits whenever lead/lag left-turn sequences are used with protected/permitted left-turn displays.

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