February 7, 2001

DILEMMA ZONE PROTECTION

A driver approaching a green traffic signal indication encounters an area of indecision in advance of the stop line. If, while in this "dilemma zone", the green indication should happen to turn yellow, the driver may hesitate in deciding whether to stop or continue through the intersection. The dilemma zone has been formally defined as: the area in advance of the stop line that begins at a location where 90% of the drivers will stop while 10% of the drivers will continue through the intersection, and ends at a location where only 10% of the drivers will stop while 90% of the drivers will continue through. Figure 1 indicates the dilemma zone for approach speeds between 40 and 55 mph.

Research has revealed that the dilemma zone is longer at higher speeds (about 160 feet long at 55 mph) than at slower speeds (about 140 feet long at 40 mph). Research has also shown that the dilemma zone both begins further away from the intersection at higher speeds (it starts 400 feet from the intersection at 55 mph but only 250 feet from the intersection at 40 mph) and ends further away from the intersection at higher speeds (ending 240 feet from the intersection at 55 mph and 110 feet from the intersection at 40 mph).

A detection design that minimizes the probability that the yellow interval will be displayed while vehicles are in the dilemma zone is of benefit in reducing erratic driver behavior and associated accidents. What might such a detection design look like?

Figure 2 shows a detection scheme that will provide dilemma zone protection for vehicles travelling between 40 mph and 55 mph, and will do so with reasonably efficient initial and passage intervals of 22 seconds and 2.5 seconds, respectively. The combined dilemma zone for vehicles travelling between 40 mph and 55 mph begins at 400 feet from the stop line and ends at 110 feet from the stop line. As the calculations in Figure 2 demonstrate, two small loops (or other detection device) placed at 400 feet and 255 feet from the stop line will pass drivers travelling between 40 mph and 55 mph completely thru the combined dilemma zone.

Figure 3 provides the calculations that show why an initial interval of 22 seconds (or greater) is needed. The initial interval must be long enough to clear out a queue of vehicles stored between the stop line and the closest loop, which is 255 feet away. Assuming a spacing of 25 feet per vehicle, approximately 10 vehicles can store in this 255 foot area. And since it takes about 2.2 seconds per vehicle to clear a long queue of vehicles past the stop line, an initial interval of 10 x 2.2 = 22 seconds is required. Since there is no detection within 255 feet of the intersection, providing less than 22 seconds could result in vehicles at the end of the queue not making it through the intersection on the first green, an undesirable occurrence.

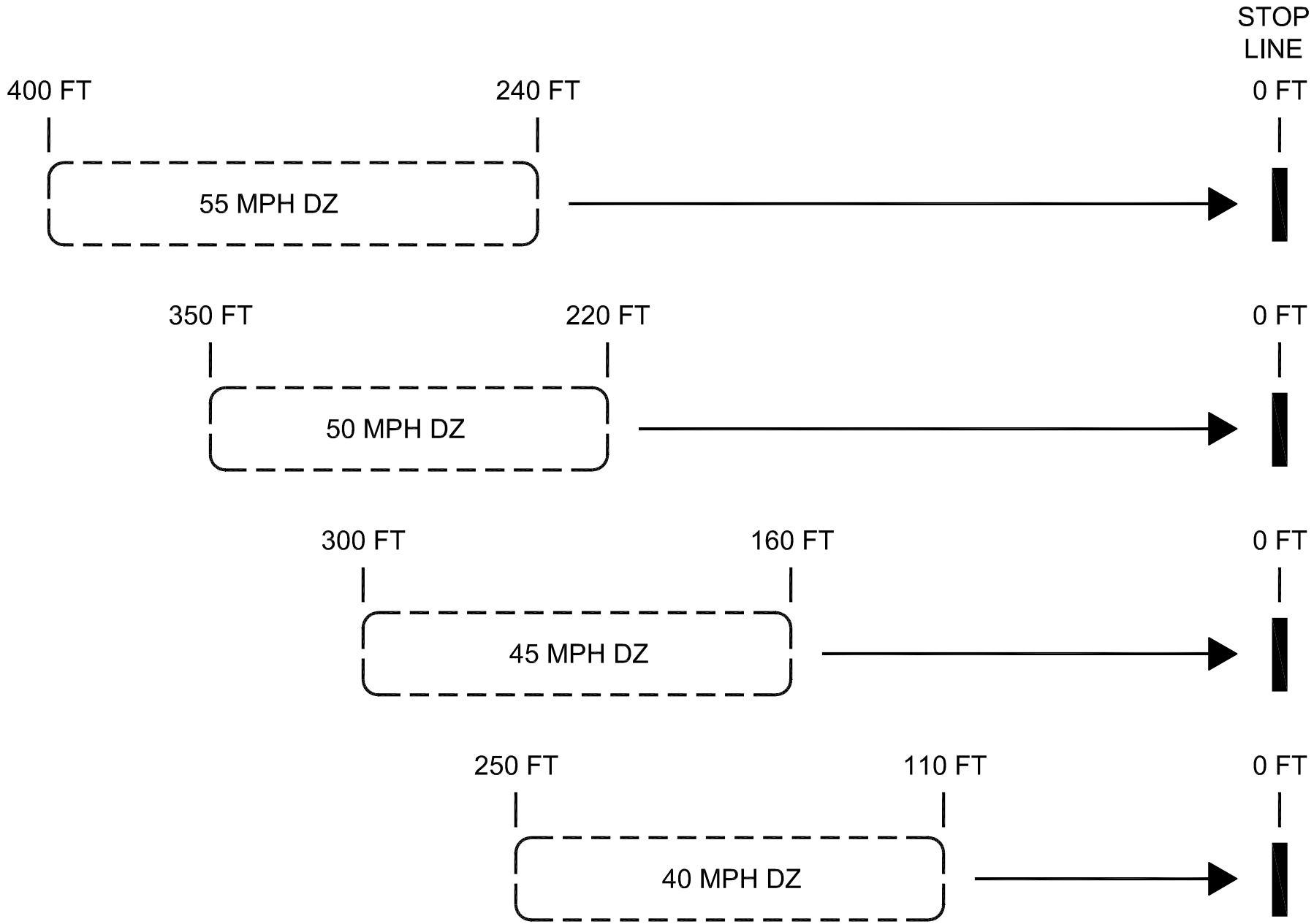
It should be noted that dilemma zone protection only makes sense for **major** street **thru** lanes. Dilemma zone protection does not make sense for **minor** street thru lanes because the high initial interval that is required would produce very inefficient operation for a lower volume movement.

Instead, for minor movements, we tend to use long loops situated at the stop line with short extension intervals and short initial intervals so that the right-of-way is quickly returned to the major street once the minor street demand has been satisfied.

Dilemma zone protection is not needed for **turn** lanes because vehicles must slow down to negotiate a turn, and little or no dilemma zone exists when vehicles are going slow.

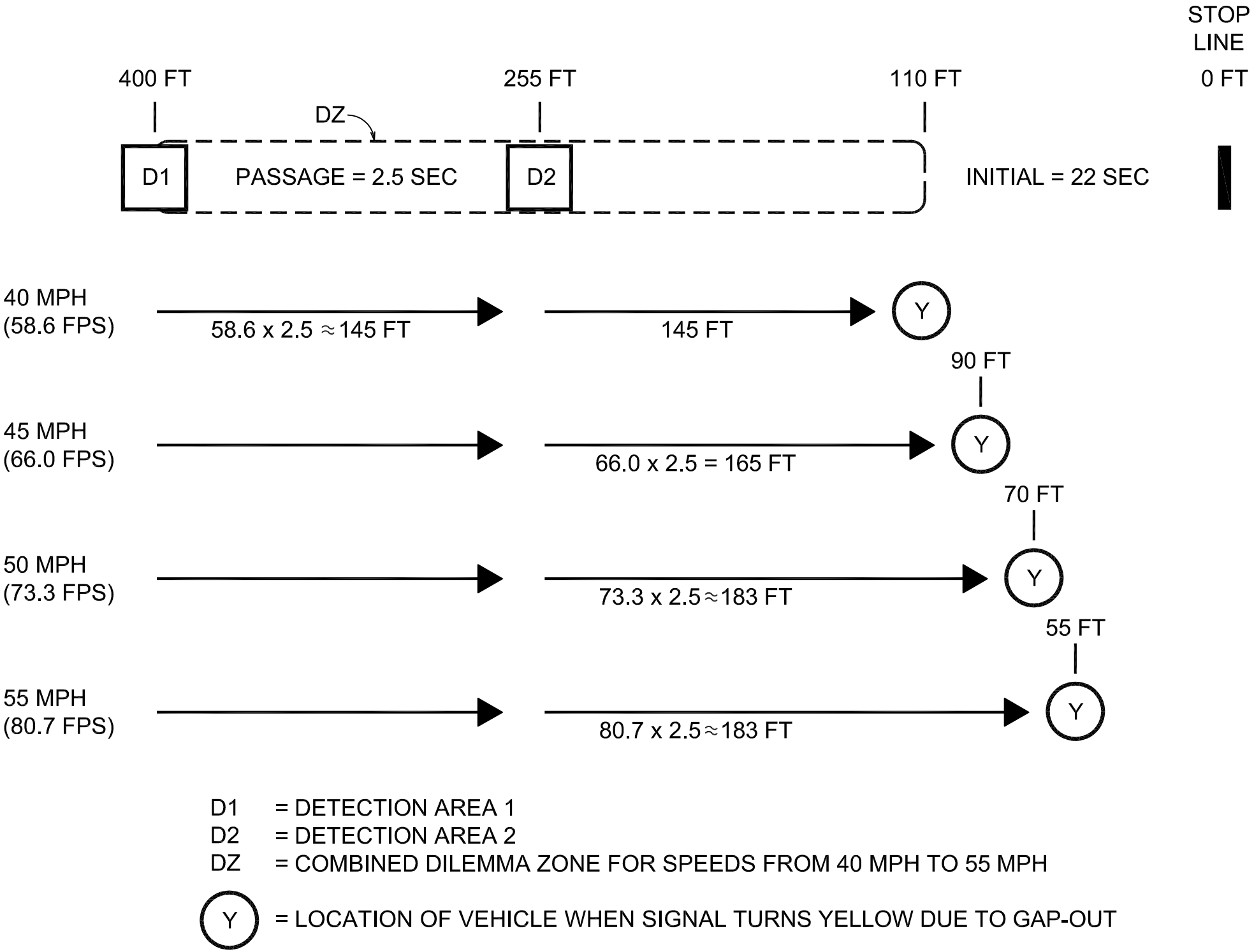
Providing dilemma zone protection for high speed major through movements is a good idea and the design proposed in this article does a nice job of providing efficient dilemma zone protection over a relatively wide range of approach speeds.

FIGURE 1



DZ = DILEMA ZONE

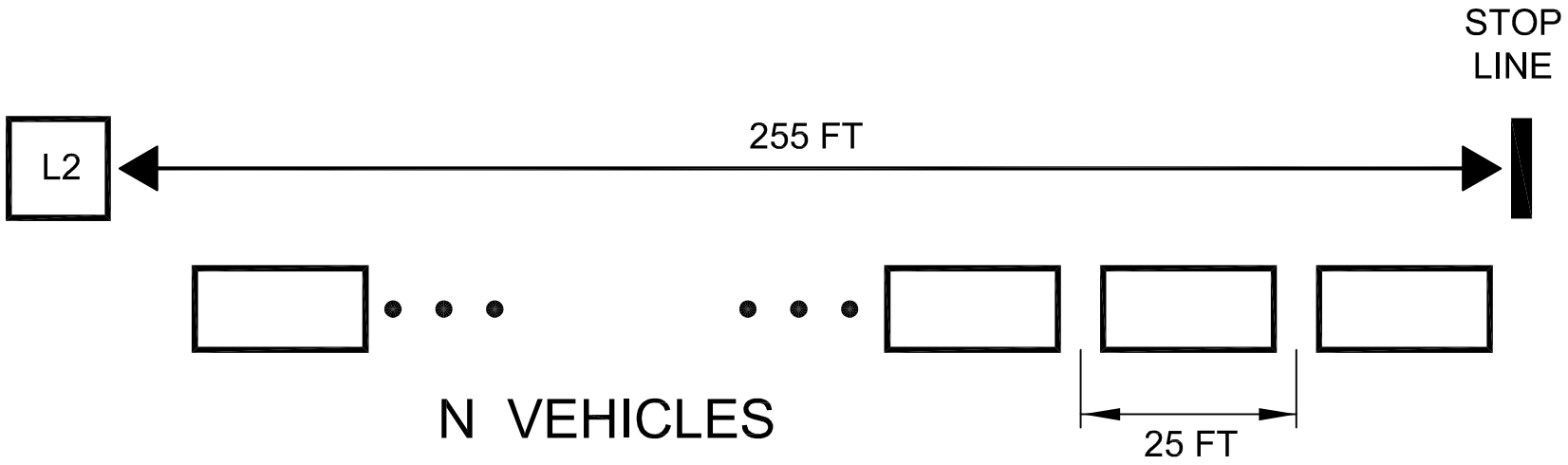
FIGURE 2



D1 = DETECTION AREA 1
D2 = DETECTION AREA 2
DZ = COMBINED DILEMMA ZONE FOR SPEEDS FROM 40 MPH TO 55 MPH

Y = LOCATION OF VEHICLE WHEN SIGNAL TURNS YELLOW DUE TO GAP-OUT

FIGURE 3



$$N = \frac{255\ \text{FT}}{25\ \text{FT/VEH}} \approx 10\ \text{VEHICLES}$$

I = 10 VEHICLES x 2.2 SEC/VEHICLE = **22 SEC**