621 SIGNAL PHASE CHANGE INTERVALS

This guidance shall apply to all calculations of yellow and all-red timing, with the exception of those for protected-only left turn movements. For calculation of yellow and all-red timing for protected-only left-turn movements, see TGP 622.

These formulae shall be utilized for all applicable signal phase change interval calculations performed on or after the date of approval of these guidelines.

621.1 PHASE CHANGE AND CLEARANCE INTERVALS

Vehicle phase change and clearance intervals are intended to provide a uniform and orderly transition between two conflicting phases. It consists of a yellow change interval and a red clearance interval.

The yellow vehicle change interval should be followed by an all-red clearance interval of sufficient duration to permit the intersection to clear before cross traffic is released. **The length of the yellow vehicle change interval and the all-red clearance interval shall be established on the basis of these guidelines and engineering judgment.**

ADOT uses Institute of Transportation Engineers (ITE) formulas for phase change intervals; these formulas are general and should only be used as a guide. Other factors at an intersection (such as approach grades, visibility, truck traffic and local traffic characteristics) should be considered. It is important that approach grades and truck traffic are considered in determining the yellow and red intervals. The yellow change interval must not be too short (causing quick stops and/or red violations) nor too long (encouraging vehicles to enter late in the yellow interval).

An engineering study may be used to determine the approach speed. The posted speed limit may be assumed to be the approach speed when an engineering study is not available.

Yellow Change Interval

The intent of the steady yellow interval is to warn traffic of an impending change in the right-of-way assignment. Yellow vehicle change intervals should have a range of 3 to 6 seconds.

The following formulas may be used to determine the yellow time. This is based on the Institute of Transportation Engineers equation for yellow change interval.

(1) Minimum yellow vehicle change interval = $t_1 + t_2$

Reaction time

$$t_1 = 1\text{sec}$$

$$t_2 = \frac{1.47v}{(2a + 64.4g)}$$

where: g = % grade divided by 100 (downhill is negative grade)
a = deceleration rate of 10 feet per second per second

Experience has shown that a perception-reaction time t_1 of one second (1 sec.) is realistic. Also, deceleration rates of 8 and 12 feet per second per second are the lower and upper limits for establishing vehicle change intervals. Typically, drivers in large urban cities will exhibit higher rates of deceleration than drivers in smaller towns or on rural highways. For typical applications, a deceleration rate (a) of 10 feet per second per second will be used in calculating the yellow vehicle change interval.

Red Clearance Interval

The red clearance interval is an interval at the end of yellow change interval during which the phase has a red-signal display before the display of green for the next phase. The intent of this interval is to allow time for vehicles that entered the intersection during the yellow change interval to clear the intersection prior to the next phase.

The following formulas may be used to determine the red time. This is based on the Institute of Transportation Engineers (ITE) equation for red clearance interval.

(2) All Red Clearance Interval

$$t_3 = \frac{W + L}{1.47V}$$

where: V = Posted Speed in mile per hour
W = Intersection Width (ft), stop bar to the farthest conflicting lane
L = Length of Vehicle (ft), assumed to be 20 feet

Phase Change Interval

Total Phase Change Interval = $t_1 + t_2 + t_3$

621.2 PEDESTRIAN INTERVALS

A. WALK Indication

The WALK indication should be at least 7 seconds in length so that pedestrians will have adequate opportunity to leave the curb or wheelchair ramp before their clearance interval is shown. A WALK interval of more than 7 seconds may be used for moderate to heavy pedestrian volumes.

B. DON'T WALK Indication

A flashing DON'T WALK indication shall always succeed the WALK indication to provide pedestrian clearance. The pedestrian clearance time shall be calculated from the following equation:

Pedestrian Clearance Time = $\frac{P}{w} - Y$ (rounded up to nearest whole second)

where:

P = distance from curb to curb or center of wheelchair ramp to center of wheelchair ramp along center of crosswalk, in feet

w = normal walking speed, assumed to be 3.5 feet per second (ft/s)

Y = yellow vehicle change interval

Research verifies that 1/3 of all pedestrians cross streets at a rate slower than 4.0 fps and 15% walk at or below 3.5 fps. The timing of pedestrian signal indications near facilities that serve segments of the population with slower walking speeds should be calculated based on a slower walking speed. Such populations should be anticipated near shopping centers, convalescent or rest homes, therapy centers, elementary schools, etc. A walking speed of 3.5 fps should be considered if senior citizens or school children are in the majority at a specific crosswalk**.** If proposed, walking speeds of 4.0 fps may be considered by the Traffic Operations Engineer.

On a street which has an island or median of 6 feet or greater width, the pedestrian clearance time may be computed to provide only enough time to clear the crossing from the curb to the median. **In such cases, an additional detector shall be provided on the island.**