TRAFFIC ENGINEERING HANDBOOK

Fifth Edition

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Local Intersection Timing

Controller Phase Timing

In the 1950s, the controller phase timing of a typical actuated controller was performed using four knobs, Initial Interval, Vehicle Interval, Maximum Green Interval, and Yellow Interval. Today, 14 entries are typical just for timing each phase. A vast array of other inputs permits the tailoring of controller operation to the specific intersection.

For NEMA controllers, the intervals are defined. For the Type 170 family, the software designer has the freedom to define the intervals as desired. The technical data for either must be consulted for details.

Green Interval

Ideally, the length of the green display on each approach to an intersection will be sufficient to serve all the vehicles and pedestrians queued during the red interval, but will not be excessive to that need. Several PC-based computer programs are available to assist in determining the green interval timing.

Actuation of the signal controller is a method of measuring the queue either as it accumulates or as it is served or both, and of beginning and terminating the green display on the basis of real-time information. Current signal controllers measure several parameters against predetermined levels when starting and ending the green display.

For pre-timed signal controllers, the length of the green display is based upon average needs as determined from traffic and pedestrian counts for a specific period of time.

Yellow Change Interval

The purpose of the yellow change interval, which is required to be the first interval following every circular green or green arrow indication, is to warn approaching traffic of the imminent change in the assignment of right-of-way (see Dilemma Zone section under Vehicle Detector Placement).

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Yellow change intervals normally have a duration of 3 to 6 sec. Since long yellow change intervals may encourage drivers to use it as a part of the green interval, a maximum of about 5 sec is typical. If the interval is too short, rear end collisions may result. When the calculation for Yellow Change Interval time indicates a time longer than 5 sec, a red clearance interval typically provides the additional time.

Some jurisdictions time the Yellow Change Interval to enable a vehicle to clear the intersection before the onset of a conflicting green display. Other jurisdictions allow a conflicting green display to be shown before the intersection is cleared and still others allow a conflicting green display to be shown after the vehicles have cleared the center line of the conflicting approach.

Prior to signal controllers based upon digital computers, the length of the Yellow Change Interval was not always stable. In electromechanical pre-timed controllers where the timing dial was divided into 100 discrete increments, the available timing resolution was 100th of the controller cycle length. For a controller cycle length of 50 sec, the interval resolution was 0.5 sec; for 80 sec, the resolution was 0.8 sec. If the calculated Yellow Change Interval was 4.6 sec, it could be set 4.5 or 5.0 sec (50-sec cycle) or 4.0 sec or 4.8 sec (80-sec cycle), but it could not be set at 4.6 sec.

In multi-dial systems, where three different controller cycle lengths were used, the Yellow Change Interval might have been different for each controller cycle length.

The equation shown in Table 13–2 may be used to calculate the Yellow Change Interval time + Red Clearance Interval time. It includes a reaction time, a deceleration element, and an intersection clearing time. In view of the operational history of the Yellow Change Interval, and of the assumptions that are used in the formula, application of the formula requires the exercise of engineering judgment.

Some jurisdictions use the Interval Time column of Table 13–3 as the value for the Yellow Change Interval and the Roadway Width Column as the value for the Red Clearance Interval.

Table 13–2 Formula to Calculate Change + Clearance Interval Time

Metric Values
English Values in [ ]

$$CP = t + \frac{V}{2a} + \frac{V}{20\,[64.4]g} + \frac{W+L}{V}$$

where:
- CP = non-dilemma change period (Change + Clearance Intervals)
- t = perception-reaction time (nominally 1 sec)
- V = approach speed, m/s [ft/s]
- g = percent grade (positive for upgrade, negative for downgrade)
- a = deceleration rate, m/s^2 (typical 3.1 m/s^2) [ft/s^2 (typical 10 ft/s^2)]
- W = width of intersection, curb to curb, m [ft]
- L = length of vehicle, (typical 6 m) [ft (typical 20 ft)]

Source: *Determining Vehicle Signal Change and Clearance Intervals*, Publication IR-073, Washington, D.C.: Institute of Transportation Engineers, 1994.

Table 13–3 Nominal Value for Change + Clearance Interval Time

Level Grade 40-ft Roadway

85th-Percentile Speed Kph	85th-Percentile Speed Mph	Interval Time in Seconds*	Roadway Width Adjustment** in Seconds
30	20	1.4	2.0
40	25	2.8	1.6
50	30	3.2	1.4
60	35	3.6	1.2
	40	3.9	1.0
70	45	4.3	0.9
80	50	4.7	0.8
90	55	5.0***	0.7
100	60	5.4***	0.7
	65	5.8***	0.6

*Values from 1+V/2a

**Values from (W+L)/V

***Usually set at 5 sec with a Red Change Interval providing the rest of the needed time.

As can be seen from Table 13–3, slower speeds result in higher values in the Roadway Width column. When calculating the needed time, consideration should be given to the values for the 15th percentile speed particularly at wider intersections.

For relatively level approaches, some jurisdictions use the formula:

Yellow Change Time in seconds = operating speed in mph / 10

Red Clearance Time in seconds = 1 or 2 sec.

The calculations for steep downgrades will yield values which drivers may consider excessive. Simply reducing the interval times may create dangerous operating conditions. The engineer should consider lowering the approach speeds by reducing the speed limit or by the use of a warning signal or other such measures.

Red Clearance Interval

The Red Clearance Interval is an optional interval that follows a Yellow Change Interval and precedes the next conflicting green interval. The Red Clearance Interval is used to provide additional time following the Yellow Change Interval before conflicting traffic is released. The duration of the Red Clearance Interval is typically on the order of 2 sec but longer intervals may be used.

Please see Yellow Change Interval above for a method of determining the time of the Red Clearance Interval.

The decision as to the use of a Red Clearance Interval is determined by intersection geometrics, collision experience, pedestrian activity, approach speeds, local practices, and engineering judgment.

[17] MUTCD, (1988) Section 4B–17, (2000) Section 4D.14.

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