TRAFFIC ENGINEERING HANDBOOK

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Third Edition

PREPARED UNDER DIRECTION OF THE
TRAFFIC ENGINEERING HANDBOOK EDITORIAL BOARD

PUBLISHED BY
INSTITUTE OF TRAFFIC ENGINEERS
WASHINGTON, D. C.

1965

If pedestrians are present at the intersection, even in small numbers, good practice requires that their minimum safe crossing needs be accommodated.

The duration of a phase which will be utilized by pedestrians should provide a suitable starting time plus sufficient walking time for the pedestrian to clear the conflict zone prior to the release of opposing vehicles. A minimum starting time of 5 sec and a walking speed of 4 ft per sec are values frequently used. With these values, a minimum green interval would be:

$$G = 5 + \frac{D}{4} - Y$$

where G = minimum green interval in seconds
D = length in feet of the longest crosswalk in use during the phase (or the portion of that distance subject to vehicular conflicts)
Y = duration of the associated yellow interval in seconds.

On wide, divided roadways, it is sometimes advantageous to provide crossing time only sufficient to reach the median island. Pedestrians then cross in two cycles. Pedestrian signals must be installed to effectuate this procedure.

Yellow Interval. The purpose of the yellow interval is twofold: (1) to advise drivers that the green interval is about to end and to permit them to come to a safe stop and, (2) to allow vehicles having entered the intersection legally to clear the point of conflict prior to the release of opposing pedestrians or vehicles.[22]

Thus, the duration of the clearance period is a function of approaching speed. To satisfy the first purpose, the minimum duration of the yellow period is:

$$y_1 = t + \tfrac{1}{2}\frac{v}{a}$$

where y = yellow interval in seconds
t = perception-reaction time of driver in seconds
v = approach speed in feet per second
a = deceleration rate in feet per second per second.

To satisfy both conditions, the minimum clearance interval must be:[23]

$$y_2 = t + \tfrac{1}{2}\frac{v}{a} + \frac{(w + l)}{v}$$

where w = width of intersection
l = length of vehicle.

Using reasonable limiting values of $t = 1$ sec, $a = 15$ ft per sec per sec, and $l = 20$ ft, the values of y_1 and y_2 for various approach speeds are shown in Table 11.4 (see page 408).

The yellow clearance interval used should exceed the values of y_1 for the approach speed selected. On the general assumption that excessively short or long yellow intervals encourage driver disrespect, common practice is to confine the yellow period to values between 3 and 5 seconds. Where y_2 exceeds the value selected for the yellow interval and where hazardous conflict is likely, an all-red clearance interval is frequently used between the yellow interval and the green interval for opposing traffic.

[22] The *Uniform Vehicle Code* requires that a driver not enter the intersection on a red indication. If he has entered on the yellow, however, he legally may proceed through the intersection on the red indication.

[23] D. Gazis, R. Herman, and A. Maradudin, "The Problem of the Amber Signal Light in Traffic Flow," *Traffic Engineering*, Institute of Traffic Engineers, Vol. 30, No. 10 (July, 1960), pp. 19-26, 53.

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Table 11.4—Theoretical Minimum Clearance Intervals For Different Approach Speeds And Crossing Street Widths*

Approach Speed (*mph*)	Minimum Time to Stop (y_1) (*sec*)	Minimum Time to Stop or Clear Intersection (y_2) (*sec*)				
		w= 30†	w = 50†	w = 70†	w = 90†	w = 110†
20	2.0	3.8	4.4	5.6	5.7	6.4
30	2.5	3.6	4.1	4.5	5.0	5.5
40	3.0	3.9	4.2	4.5	4.9	5.2
50	3.4	4.1	4.4	4.7	5.0	5.2
60	3.9	4.5	4.7	4.9	5.1	5.4

* obtained from the formulas:

$y_1 = t + \frac{V}{2a}$ and $y_2 = t + \frac{v}{2a} + \frac{(w + l)}{v}$, when t = 1 sec, a = 15 ft per sec per sec, and l = 20 ft.

† Crossing street width in feet.

Green Interval. Numerous methods are in use for estimating appropriate green intervals. The minimum green interval for each phase may be set by pedestrian requirements or may be set by the practical vehicle operational minimum, usually taken to be 12 seconds. The determination of green intervals above these minimum values is based on the objectives of: (1) proportioning the green time among the approaches so that the ratio of capacity to demand on each of the critical approaches is approximately equal and, (2) having each green interval of sufficient length that most green phases during peak demand periods are long enough to accommodate all traffic arriving during the phase.

These objectives can be accomplished in the following steps:

1. Select a tentative phasing for the intersection.
2. Compute necessary clearance periods for each approach and select the longest required for each phase.
3. Compute the minimum green required for each phase accommodating pedestrians.
4. Compute the capacity of each approach on the basis of a full hour of green time.[21]
5. From traffic counts, determine the average hourly volume on each approach for the period under consideration (usually the peak hour of a typical weekday).
6. Compute the ratio of volume to capacity for each approach and determine the critical (highest) ratio for each phase.
7. Assign to the phase with the lowest critical ratio the green time determined in Step 3 (but not less than 15 sec).
8. Assign to each additional phase a green time in the same proportion as its critical ratio bears to the critical ratio of the first phase, but not less than its minimum green determined in step 3.
9. Sum the clearance intervals determined in step 1, and the green intervals determined in steps 7 and 8. The values of each should then be adjusted so that the sum equals a multiple of five and each interval is an integer percentage of the sum. (This step is required to accommodate the mechanical limitations of existing control equipment.)

The result of these nine steps is the minimum cycle length which meets the first objective for the period under study. It is necessary, however, to determine whether

[21] See *Highway Capacity Manual*, U.S. Department of Commerce, Bureau of Public Roads, Washington, D.C., 1965, and Chapter 8 of this Handbook.

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