



Traffic Engineering Instructions (TEI)

Distribution: Director of Highway Division, Director of Operations and Safety, Director of Policy, Planning and Intermodal Development, Director of Project Delivery, Director of Municipal Assistance, Highway Safety & Design Project Managers, Municipal Assistance Project Managers, Consultant Designers, Development Review and Permitting Services.

Approved: _____ **Date:** _____
 Derek Lyman, PE
 Traffic Signal & ITS Manager

Subject: **Best Practice for Determining Traffic Signal Clearance Intervals**

Administrative Information:

Effective Date: TEI 20 - 401 shall be effective from the date of approval.

Superseded TEI: Not Applicable

Exceptions: Not Applicable

Disposition of TEI Content: The content of TEI 20 - 401 will be incorporated into future design manuals and other documents as applicable.

Purpose:

The purpose of this document is to provide a uniform guideline for determining traffic signal clearance intervals, primarily for use by VTrans personnel and their consultants/contractors.

Implementation:

The content of TEI 20-401 is to be implemented immediately for projects which include new or revised traffic signal controller timings, and for revised controller timings deployed as part of scheduled retiming or comprehensive timing upgrades of the signal, or corridor as applicable.

These recommendations are not required to be implemented as part of minor field-timing adjustments.

Background:

In 2012, the National Cooperative for Highway Research (NCHRP) published NCHRP Report 731: *Guidelines for Timing Yellow and All-Red Clearance Intervals at Signalized Intersections* which analyzes and recommends engineering calculations for the determination of yellow and red clearance intervals.

VTrans recognizes the safety benefits of the recommendations of this report and wishes to provide clear guidance on its interpretation and implementation for VTrans signals with consideration to consistent application and ease of use for design, operations, and maintenance users.

New guidance released by ITE in 2020 has raised questions with regard to best practices for Vermont. VTrans has reviewed both documents and recommends the below practice be used as it limits subjectivity and increases consistency in application of appropriate clearance intervals.

Scope:

The goal of TEI 20-401 is to provide guidance and recommendations on the implementation and interpretation of the recommendations of NCHRP Report 731 for new signal systems, replaced signal components, and revised timing plans developed as part of scheduled retiming programs.

TEI 20-401 is not intended to replace the application of engineering judgement in the determination of appropriate yellow and red clearance intervals for individual signalized intersections, or unusual signal configurations (e.g. one-lane, two-way temporary bridges).

Technical Information:

NCHRP 731 recommends the following equations be used in the determination of yellow and red clearance intervals:

$$Y = t + (1.47V)/(2a + 64.4g)$$

$$R = \frac{W + L}{1.47V} - 1$$

Y = Yellow clearance interval, in seconds

R = Red clearance interval, in seconds

t = Perception-Reaction Time (PRT) - Use **1.0 seconds**

V = approach speed, in miles per hour - Use **measured 85th percentile speed if available. If not available, use Posted Speed + 7 mph as an approximation. Left turn clearances should use a speed of 20 mph regardless of approach speed.**

a = deceleration rate - Use **10 ft/s/s**

g = approach grade expressed as a decimal (percent grade / 100), downgrade expressed as a negative value - **Should be measured approximately 5 seconds travel time, or a distance of 5*(1.47V) feet, upstream of the stop bar. See Table 1.**

W = intersection width, in feet - **Measured from the stop bar to the far side of the intersection, as defined by the extension of the curb line or outside edge of furthest travel lane. Turning movements should be measured along the approximate travel path.**

L = length of vehicle - Use **20.0'**

The recommended values, listed above in **bold**, are recommended for typical conditions and may be modified based on engineering judgement. For more information refer to NCHRP 731.

For convenience, the distances at which approach grade is measured are tabulated for common approach speeds here. Note that engineering judgment should be applied in cases where the approach grade varies significantly over this distance.

Table 1: Distance in Advance of Stop Bar at which Approach Grade is Measured

Approach Speed (posted)	Approach grade measured at distance (ft)
25 mph	235
30 mph	272
35 mph	309
40 mph	345
45 mph	382
50 mph	419

Rounding: Yellow and Red clearance intervals should be rounded up to the next whole- or half-second interval.

Minimum Values:

Minimum Yellow: VTrans typical minimum value for yellow clearance intervals is 4.0 seconds. In no case should yellow clearance intervals be reduced below the MUTCD minimum value of 3.0 seconds.

Minimum Red: VTrans typical minimum value for red clearance interval is 2.0 seconds.

Maximum values: Ordinary intersection geometries will return reasonable clearance intervals, but in unusual cases large clearance values may be calculated. Engineering judgement should be used in the determination of an appropriate maximum value for clearance intervals. The MUTCD provides guidance that neither yellow nor red clearance time should exceed 6 seconds.

Typical Values:

Recognizing that many intersections are fundamentally similar and appropriate clearances are generally dependent on only a few variables, typical values are presented below. These typical values are not meant to replace proper engineering analysis but provide useful lookup values for common intersection conditions.

Yellow Clearance Intervals: Calculated yellow clearance intervals are primarily dependent on approach speed, and also affected by approach grade. The below table provides typical yellow clearance intervals for common approach speeds, within the specified range of approach grades.

Table 2: Yellow Clearance for Common Approach Speeds and Grades

Approach Speed (posted)	Approach Grade (range)	Yellow Clearance (sec)
25 mph	$g > -6.5\%$	4.0
30 mph	$g > -3\%$	4.0
35 mph	$g > +1\%$	4.0
35 mph	$+1\% > g > -3.5\%$	4.5
40 mph	$+5\% > g > 0\%$	4.5
40 mph	$0\% > g > -4\%$	5.0
45 mph	$+3\% > g > -1\%$	5.0
45 mph	$-1\% > g > -4.5\%$	5.5
50 mph	$+1\% > g > -2\%$	5.5

Red Clearance Intervals: Calculated red clearance intervals are primarily dependent on approach speed and intersection width. The below table provides typical red clearance intervals for common approach speeds, within the specified range of intersection widths.

Table 3: Red Clearance for Common Approach Speeds and Intersection Widths

Approach Speed (posted)	Intersection width (range)	Red Clearance (sec)
25 mph	$W < 120'$	2.0
25 mph	$120' < W < 145'$	2.5
30 mph	$W < 140'$	2.0
35 mph	$W < 165'$	2.0
40 mph	$W < 185'$	2.0
45 mph	$W < 210'$	2.0
50 mph	$W < 230'$	2.0

Reference

Federal Highway Administration. (2009). Manual on Uniform Traffic Control Devices. US Department of Transportation, Federal Highway Administration.

Institute of Transportation Engineers. (2020). Guidelines for Determining Traffic Signal Change and Clearance Intervals. Institute of Transportation Engineers.

Transportation Research Board. (2012). Report 731: Guidelines for Timing Yellow and All-Red Clearance Intervals at Signalized Intersections. NCHRP. Retrieved from <https://www.nationalacademies.org/trb/transportation-research-board>