Yellow and Red Intervals—It’s Just a Matter of Time

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Presentation Content

- Background on Timing Methodology
- Findings and Recommendations from NCHRP project
- Alabama DOT Guideline
- ITE Recommended Practice
Yellow and Red Signal Timing Intervals

- Intended to provide safe and efficient transition between conflicting vehicular movements.

- Yellow **change** interval warns vehicle traffic that green signal indication is being terminated and that red signal indication will be exhibited immediately thereafter.

- Red **clearance** interval displays red signal indication to all potentially conflicting vehicle traffic movements, providing additional time as safety measure.
ITE Proposed Recommended Practice 1985

- Kinematic equation for calculating “vehicle clearance interval” or “change period”

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

- Never formally adopted
- Existing resources use this equation as basis for calculation
Several national publications serve as references:

- FHWA Yellow Change Intervals Memorandum (2008)
Research Team

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Reason for Project

- No single national standard, recommended practice, or set of guidelines for calculating duration
- Parameters involved in calculating yellow and red intervals studied 25+ years ago
- Red-light running is one of most common causes of intersection crashes, often related to adequacy of yellow and red intervals
- Controversy over RLR Automated Enforcement
Project Objective

Develop comprehensive and uniform set of recommended guidelines for determining safe and operationally efficient yellow and red intervals at signalized intersections
Guidelines for Timing Yellow and Red Intervals at Signalized Intersections

Study Scope and Methodology

- Survey of State and Local Practices – in concert with ITE – 60% did not have a timing policy
- Literature Review
- Field Studies:
  - Data on parameters used in kinematic equation: PRT, Deceleration rates, Approach speed
  - 80 intersection approaches in 5 states yielded 7500 data points
Major Findings

- PRT (t) confirmed to be 1.0 s
- Deceleration rate confirmed to be 10 fpsps
- 85\textsuperscript{th} %tile approach speed for thru vehicles is closely approximated by adding 7 mph to speed limit.
- 85\textsuperscript{th} %tile approach speed for left-turn vehicles is closely approximated by subtracting 5 mph from speed limit.
- Start-up delay after onset of green is 1.1 s; conflict time is 4.1 s
Recommended Guideline – Yellow Change Interval

- Perception-reaction time (t)
  - Use 1.0 s

- Deceleration rate (a)
  - Use 10 ft/s²

- Approach speed (V)
  - Use 85th percentile approach speed
  - Use approach speed limit +7 mph

- Grade (g)

\[
Y = t + \frac{1.47V}{2a + 64.4g}
\]
Guideline – Red Clearance Interval

- Is it necessary?
  - *MUTCD* Section 4D.04: Vehicular traffic presented with green must yield to other vehicular traffic and pedestrians lawfully within intersection
  - *MUTCD* Section 4D.26: Red is recommended, but not required
  - Studies have not consistently or definitively demonstrated long-term crash reductions

- We concluded that red clearance interval is appropriate
Guideline – Red Clearance Interval

- **Approach speed (V)**
  - Use same as yellow change interval

- **Vehicle length (L)**
  - Use 20 ft

- **Intersection width (W)**
  - Measure from back/upstream edge of approaching movement stop line to far side of intersection as defined by extension of curb line or outside edge of farthest travel lane

- **Reduction**
  - Subtract 1 s to account for vehicle start-up delay

\[
R = \frac{W + L}{1.47V} - 1
\]
Guideline – Intersection Width
Guideline – Left Turns

- **Yellow Change Interval**
  - Approach speed (V)
    - Use approach speed limit -5 mph

- **Red Clearance Interval**
  - Approach speed (V)
    - Use 20 mph
  - Intersection width (W)
    - Measure from back/upstream edge of approaching movement stop line to far side of intersection as defined by extension of curb line or outside edge of farthest travel lane along vehicle turning path
Guideline – Left Turns

- **Protected only**
  - Yellow and red calculated for each approach and implemented as calculated
  - Intervals for opposing approaches need not be same duration

- **Permissive only**
  - Yellow and red calculated for opposing approaches (including through movements) and implemented as longest values
  - Intervals for opposing approaches need to be same duration

- **Protected/permissive**
  - Yellow and red calculated and implemented respective to protected and permissive portions of phase
Guideline – Considerations

- Minimum and maximum values
  - Yellow Change Interval
    - No min or max
  - Red Clearance Interval
    - 1 s min
    - No max
- Rounding
  - Not necessary with modern controller technology
Project Conclusions

- Discovered widely varied approach in timing practices
- Confirmed accepted values for perception-reaction time and deceleration rate
- Provided basis for 85\textsuperscript{th} percentile speed estimations
- Justified accounting for start-up delay
- Formed a succinct guideline based on kinematic equation, encouraging uniform practical application
Alabama DOT Guidance

- Generic ‘Rule of Thumb’ should not be used
- Adopts same ITE Kinematic Equation with:
  - \( V = 85^{th} \) %tile, or SL but ‘verify’ that not different
  - \( D = 10 \) fpsps
  - \( T = 1.4 \) S
  - \( G = \) consider
- Yellow
  - Not less than 3 s and need approval for > 6 s
- All- Red
  - Width—same measurement
  - Vehicle length – 20 ft, but can increase if high truck %
  - For Left-turning: \( V = 25 \) mph; 15 if skewed
New ITE Recommended Practice

- Issuing Proposed RP this month
- Essentially accepts the recommendations of the NCHRP Report with some minor changes and more flexibility for changes based on Engineering Judgment and Studies
- Comment period
- Will provide RP after addressing comments and acceptance by ITE Board—several months away!
So... In conclusion:

- Fundamentally, all traffic control devices should be applied uniformly so that drivers experience same device and operation regardless of location.

- Guideline– from ITE presumably-- strives to achieve national acceptance for uniform practical application.

- Guideline-- based on typical roadway conditions, but allowance provided for “engineering judgment”– We don’t want to take the engineer out of the equation.