5 ISSUE BRIEFS

# Traffic Signals

## Purpose of Traffic Signals

Traffic signals are used to assign vehicular and pedestrian right-of-way. They are used to promote the orderly movement of vehicular and pedestrian traffic and to prevent excessive delay to waiting traffic.

Traffic signals should not be installed unless one of the warrants specified by the *Manual on Uniform Traffic Control Devices* (MUTCD) has been satisfied. The satisfaction of a warrant is not in itself justification for a signal. A traffic engineering study must be conducted to determine if the traffic signal should be installed.

The installation of a traffic signal requires sound engineering judgment and must balance the following, sometimes conflicting, goals:

- Moving traffic in an orderly fashion;
- Minimizing delay to vehicles and pedestrians;
- Reducing crash-producing conflicts; and
- Maximizing capacity for each intersection approach.


## Where Should A Signal Be Installed?

The MUTCD lists eight warrants for the placement of traffic signals. Readers are encouraged to review Part 4 of the MUTCD for greater specificity regarding signal warrants. Access management considerations and the spacing of signals on arterial roadways are critical elements of system efficiency and operational safety.

The basic question that must be answered is "Will this intersection operate better with or without a traffic signal?"

## Advantages of Signals

Warranted traffic signals properly located and operated, usually have one or more of the following advantages:

- Provide for orderly movement of traffic;
- Increase traffic capacity of the intersection;
- Reduce the frequency of certain types of crashes, (e.g. right-angle crashes);
- Provide for continuous or nearly continuous movement of traffic along a given route; and
- Interrupt heavy traffic to permit other traffic, vehicular or pedestrian, to cross.

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# Factors to Consider When Installing a Signal

A number of factors should be considered when planning to signalize an intersection. These factors include:

- The need to balance delay. Excessive delay results in significant fuel waste and higher motorist costs and air pollution. Solution: signal timing improvements.
- Potential diversion of arterial traffic neighborhood streets. Solution: signal timing improvements.
- Red-light running violations and associated crashes. Solution: Signal Timing, Adequate Yellow Clearance Interval/All-Red Interval.
- Cost. The cost for a signal ranges from $50,000 to more than $200,000 based on the complexity of the intersection and the characteristics of the traffic using it. In addition, the annual operating cost of each signal ranges from $1,000 to $5,000.

## Signal Improvements That May Decrease Crashes

- Signal retiming;
- Signal phasing and cycle improvements;
- Review and assure adequacy of yellow change interval/all-red clearance interval for safer travel through the intersection;
- Use of longer visors, louvers, backplates and reflective borders;
- Installation of 12 in. signal lenses;
- Install additional signal heads for increased visibility;
- Provide advance detection on the approaches so that vehicles are not in the dilemma zone when the signal turns yellow;
- Repositioning of signals overhead (via mast arm) instead of post mounted;
- Use of double red signal displays; and
- Remove signals from late night early morning programmed flash.

Table 1, Signalization Countermeasures at Signalized Intersections, includes specific categories of countermeasures such as signal operational improvements, signal hardware and combination signal and other improvements. The table provides the effectiveness in terms of the percentage potential crash reductions that might be experienced, if available. This table is also found in Briefing Sheet No.8, which includes a more comprehensive toolbox of countermeasures for consideration at intersections. Traffic engineers and other transportation professionals can use the information in this Briefing Sheet when the public or an elected or appointed official asks a question such as:

> *What is the range of solutions that might be considered at the signalized intersection of "Maple" and "Elm" streets due to the high number of total crashes and left-turn crashes?" What low-cost improvements can be tried first? If these improvements don't give us a higher degree of safety, what else can we try?*

Traffic engineers will need to consider site-specific environmental, geometric and operational conditions before making a judgment regarding those countermeasures that can be applied to a particular intersection.

# Table 1:
## Signalization Countermeasures at Signalized Intersections

**Numbers in [n] indicate references used for Table 1**

**Numbers prior to the [n] represent the range of % crash reduction that might be expected from implementing a given improvement.**

- **Countermeasure/Crash Type identified; however no estimate of effectiveness is provided.**

| | | Potential Effectiveness (Percentage Reduction) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Improvement Type(s)** | **Cost** | **Total Crashes** | **Right Angle Crashes** | **Left Turn Crashes** | **Rear-end Crashes** | **Sideswipe** | **Pedestrian** | **Red-Light Running** | **Older Driver** |
| **SIGNAL OPERATIONS IMPROVEMENTS** | | | | | | | | | |
| Interconnect/Coordinate Traffic Signals; Optimization | Medium | 15-17 [1] | 25-38 [12] | | ● | | | ● [2] | |
| Increase/Modify Clearance Intervals | Low | 4-31 [1,9,10] | 1-30 [1,9] | | ● | | | ● [2] | |
| Improve Signal Timing (General) | Low | 10-15 [1] | ● | ● | | ● | | ● | |
| Add Protected/Permissive LT Phase | Medium | 4-10 [1,9] | | 40-64 [1,9] | | | | | |
| Use Green Arrow/ Protected Left Turns/Movement Signal Phasing | Low | 3 [9] | | 98 [9] | | | | | ● |
| Use Split Phases | Low | 25 [11] | | ● | ● | ● | | | |
| Use Leading Pedestrian Interval | Low | | | | | | 5 [8] | | |
| Add Pedestrian Phase | Medium | 23-25 [1] | | | | | 7-60 [1,8] | | |
| Add Left-Turn Phasing to an Existing Signal | Medium | 23-48 [6, 12] | | 63-70 [1] | | | 5 [8] | | |
| Provide Green Extension (Advance Detection) | Variable | | | | ● | | | ● | |
| Install Signal Actuation | Variable | | | | ● | ● | | | |
| Assume Slower Walking Speeds for Pedestrian Signal Timing | Low | | | | | | ● | | ● |
| Provide Advance Warning of Signal Changes at Rural Signalized Intersections | Medium | ● | ● | | ● | | | ● | |
| Remove Signals from Late Night/Early Morning Flash | Low | 29[9] | 80 [9] | | | | | | |
| Consider Restricting Right-Turns-on-Red | Low | | | | | | ● | | |
| Consider Installation of Pedestrian Countdown Signals (incremental cost) | Low | | | | | | ● | | |
| Consider Installation of Animated Eye Signals (Incremental cost) | Low | | | | | | ● | | |
| **SIGNAL HARDWARE** | | | | | | | | | |
| Install Larger (12-Inch) Signal Lenses | Low | 10-12 [1,9] | 48 [9] | | ● | ● | | ● | ● |
| Install Flashing Beacon at Intersection | Medium | 30-38 [1] | | | | | | | |
| Install Flashing Beacon at Advance of Intersection | Medium | 25-28 [1] | | | | | | ● [2] | |
| Replace Pedestal Mounted Signal with Mast Arm | High | 28-43 [12] | ● | | | | | | |
| Install Backplates on Existing Signals | Low | 2-24 [1,9] | 7-93 [1,5,9] | | ● | ● | | ● [2] | ● |
| Optically Programmed Signal Lenses | | 15-18 [1] | | | | | | ● | |
| Provide Louvers, Visors, Special Lenses so Drivers are able to View Signals only for their Approach | Low | | | | ● | ● | | ● | |
| Upgrade Signal Controller | Medium | 20-22 [1 8, 11] | | ● | ● | ● | | | |
| Relocate/Shield Signal Hardware in Clear Zone. Signal Hardware Should Not Obstruct Sight Lines. | Medium | [6] | ● | | ● | ● | | | |
| Install Additional Signal Heads | Medium | 10 [9] | 42 [9] | | ● | ● | | ● | ● |
| Install More Overhead Traffic Signals | High | ● | ● | | ● | | | ● | ● |
| Provide Two Red-Signal Displays within each Signal Head to Increase Conspicuity of the Red Display | Medium | | | | | | | ●[2] | |
| Use LED Traffic Signal Module. | Medium | | | | | | | ● [2] | |
| Stripe for Left-Turn Lane within Existing Roadway | Low | 26 [9] | | 66 [9] | | | | | |
| Red T-Display | Medium | 9 [9] | 36 [9] | | | | | | |

## Table 1 (continued)
## Signalization Countermeasures at Signalized Intersections

| | | Potential Effectiveness (Percentage Reduction) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Improvement Type(s)** | **Cost** | **Total Crashes** | **Right Angle Crashes** | **Left Turn Crashes** | **Rear-end Crashes** | **Sideswipe** | **Pedestrian** | **Red-Light Running** | **Older Driver** |
| **COMBINATION SIGNAL AND OTHER IMPROVEMENTS** | | | | | | | | | |
| Construct Left-Turn Lanes with Signal Upgrades | High | ● | | ● | ● | | | | |
| Left-Turn Lane, Signal and NO Turn Phase | High | 21-25 [1] | | 46-54 [1] | ● | | | | |
| Left-Turn Lane, Signal PLUS Turn Phase | High | 25-36 [1] | | 43-45 [1] | ● | | | | |
| Add Left-Turn Phasing AND Turn Lanes to an Existing Signal | High | 46-69 [12] | ● | ● | ● | | | | |
| Removal Signal, Develop a Program to Identify and Remove Unwarranted Signals. | Low | 50-53 [1] | | | ● | ● | | | |
| Install 12" Signal Heads and SIGNAL | Low | 11 [9] | 36 [9] | | | | | | |

# References for Table 1


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