TRAFFIC ENGINEERING HANDBOOK

6TH EDITION

Institute of Transportation Engineers

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B. Overview

1. Advantages and Disadvantages of Traffic Signals

When properly used, traffic signals are valuable devices for the control of vehicular and pedestrian traffic. They assign the right of way to various traffic movements and thereby influence traffic flow.

Traffic signals that are properly designed, located, operated and maintained will have one or more of the following advantages:

- provision for orderly movement of traffic;
- reduction of conflicts between vehicular movements and between vehicular and pedestrian movements, if proper physical layouts and control measures are used;
- reduction of the frequency of certain types of crashes, especially right-angle crashes;
- coordination to provide for continuous or nearly continuous movement of traffic at a definite speed along a given route under favorable conditions; and
- interruption of heavy traffic flows at intervals to permit other traffic—vehicular or pedestrian—to enter or cross a roadway.

The popular misconception that traffic signals solve all traffic problems at intersections has led to their installation at locations where no justification or warrant exists. Even when justified and/or warranted by traffic and roadway conditions, traffic signals can be poorly designed, ineffectively placed, improperly operated, or poorly maintained. Improper or unjustified traffic signals can result in one or more of the following conditions:

- excessive delay;
- disobedience of signal indications;
- increased use of less adequate routes as road users attempt to avoid the traffic signals;
- increases in the frequency of crashes (especially rear-end crashes);
- reduction of gaps, especially on undivided highways;
- reduced intersection capacity; and
- increased congestion.

Traffic control signal equipment is now almost exclusively microprocessor based. Both software and firmware are used for intersection control, small arterial systems and large, area-wide systems. The rapid expansion of technology and knowledge, innovation, flexibility and capability requires that a practitioner obtain the latest technical documents from the standards-setting agencies and the latest technical data from manufacturers and suppliers before selecting hardware, software and communications systems and methods for a specific project.

2. Human Factors

When determining the human factors involved in the installation of a traffic control signal, the designer must consider what different groups use traffic signals, how the human factors are related to design issues and how human factors relate to the change over time in signal design.

Motorists, pedestrians, bicyclists, trucks, transit users and special-needs pedestrians can all benefit from a properly designed, installed and maintained traffic control signal. To address these user groups, the designer must consider vision, perception-reaction time, ability to process information, walking speed and a user's ability to read and comprehend English. See Chapter 2 for more detail on road user characteristics.

The majority of driver input at a traffic control signal is visual. Minimum design guidelines typically consider a driver's field of vision to be 20 degrees on either side of center; however, vision is most acute within 3 degrees of either side. Perception-reaction time can range from less than 1 second to 2.5 seconds, depending on the expectation of the incident. For example, a driver may expect to see a yellow signal at an intersection but may

not expect a pedestrian in the crosswalk. Depending on the surrounding distractions, the perception-reaction time may need to be increased. The ability for a driver to process information is typically limited to three pieces of information at once.

Pedestrian walking speed also affects the operation of the traffic control signal. The 2003 edition of MUTCD recommends using a walking speed of 4 feet per second (ft./sec.).[3] However, due to concerns about accommodating older pedestrians and pedestrians with disabilities or special needs, a slower walking speed may be considered for the next edition of MUTCD. The American Association of State Highway and Transportation Officials recommends the use of 2.8 ft./sec. in areas with school children and/or elderly pedestrians.

Based on the diversity of the United States, it is no longer correct to assume that all users can read English; therefore, the use of graphic symbols is preferred.

Another important consideration is the effect of an aging population on the average driver's human factors. As drivers age, there is a deterioration of several abilities, including perception-reaction time, information processing, peripheral vision, turning head from side to side and vision (particularly night vision).

3. Legal Authority

The authority to install and maintain traffic signals, when granted to a jurisdiction, is set forth in the law that defines the duties and responsibilities of the jurisdiction. The legal authority for a signal is the state law adopting MUTCD, then MUTCD itself, which requires a traffic engineering study that must be accepted and approved by the governing jurisdiction. A traffic control signal installation must be supported by an engineering study justifying the need for the signal, and the study must be signed and sealed by an engineer who is licensed in the state and is prepared to defend his/her study in court.

4. Other Remedial Measures

Because vehicular delay and crash frequency are sometimes greater and installation and maintenance costs are higher under traffic signal control than under STOP sign control, consideration should be given to other remedial measures even if one or more of the warrants for traffic signals has been met. These other remedial measures include but are not limited to the following:

- installing warning signs along the major roadway to warn road users approaching the intersection;
- relocating the stop line(s) and making other changes to improve the sight distance at the intersection;
- installing edge and channelizing lines along the major roadway approaches to narrow the lane width by tapering, which may encourage reduced speeds on the approaches;
- installing a flashing beacon at the intersection to supplement STOP-sign control;
- installing flashing beacons on warning signs in advance of a STOP-sign-controlled intersection on the major and/or minor roadway approaches;
- adding a lane on a minor roadway approach to allow right turns to operate independently of left and through movements, reducing overall cross-street delay;
- revising the geometrics at the intersection by channelizing vehicular movements and reducing the time required for a road user to complete a movement, which also could assist pedestrians;
- installing roadway lighting if a disproportionate number of crashes occur during hours of darkness;
- restricting one or more turning movements, perhaps on a time-of-day basis, if alternate routes are available;
- installing a roundabout intersection; and
- installing all-way STOP-sign control when justified by a study.