Signalization Design

An Online Continuing Education Course for Engineers

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I. Introduction

Traffic signals are electronically controlled traffic control devices that control the movement of traffic at intersections. Traffic signals have been in use since the 1930's when the concept of the three-section signal head (red/yellow/green) was established.

Traffic signals are one of the most restrictive forms of traffic control that can be used at an intersection. To control the placement of traffic signals, the Manual on Uniform Traffic Control Devices (MUTCD) was developed providing a series of warrants to justify the installation of a traffic signal.

Traffic signals are common traffic control devices at major intersections. This is because they can handle high volumes of traffic at complex intersections.

The number of right-angle crashes is generally reduced by the installation of a signal. Left turn crashes are also reduced when there is a separate left turn phase. Pedestrian crossing movements are also safer under signal control. It should be noted that the installation of a signal may increase the number of rear-end crashes. However, generally these crashes are less severe than other types of crashes.

Signal installation is much more costly than other forms of intersection control. A complete signal installation including design, construction and inspection can cost from $100,000 to $250,000 depending on the type of signal design. Signing and pavement marking modifications can be used to improve the function of an intersection and can cost less than $5,000.

It should be noted that the installation of a signal is not a "cure all" for all traffic problems at intersections. Geometric modifications or signing and pavement marking changes may provide suitable results. Less invasive measures should be attempted before installing a signal.

It is important to weigh the advantages and disadvantages of a signal prior to proceeding with the design.

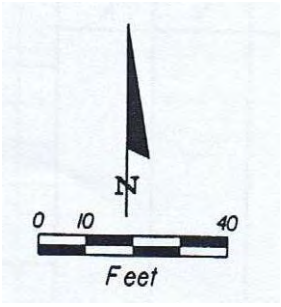
Advantages	Disadvantages
• Provide orderly movement of traffic • Increase traffic-handling capacity of the intersection • Reduction in right-angle and left-turn crashes • Can be coordinated to provide continuous movement of traffic • Used to interrupt heavy traffic at intervals to permit other traffic to cross	• Cost • Aesthetics • Increase in rear-end crashes • Excessive delay • Excessive disobedience of signal indications

Field Survey Information

A signalization plan sheets requires an accurate base plan on which the signalization details are placed. This base must include right-of-way lines since the signalization equipment must be placed within the existing right-of-way. If insufficient right-of-way is available a permanent easement agreement or purchase of right-of-way must be obtained prior to construction. In addition to the right-of-way lines, the survey should include all geometric features of the proposed/existing intersection. These items may include sidewalks, curbs, medians, driveways, etc. Utility locates should also be performed to ensure that there are no conflicts between the signalization equipment and existing utilities. It is important to note that utilities may run overhead or underground, so a thorough survey should be completed. It is also crucial to coordinate with the local power company to establish the locations of the power drop for the electrical service.

Plans Preparation

A signalization plan will need to be plotted "to scale." "To scale" means that a measurement on the plan sheet corresponds to a dimension in the field. For example, a 1:20 scale means 1-inch equals 20 feet. Typical signalization plans can be drawn at 1:20, 1:40 or 1:50 scale. The following illustration shows the North arrow and 1:40 scale that would be placed in a corner of each plan sheet.



Traffic Signal Warrants

The MUTCD states that "an engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at a particular location."

It expanded this requirement to include the investigation of the need for a traffic control signal. The investigation shall include the analysis of factors related to the existing operation and safety at the study location and the potential to improve these conditions.

The MUTCD requires the satisfaction of at least one of the signal warrants. The following are the MUTCD signal warrants.

Warrant 1 – Eight-Hour Vehicular Volume
Warrant 2 – Four-Hour Vehicular Volume
Warrant 3 – Peak Hour
Warrant 4 –Pedestrian Volume
Warrant 5 – School Crossing
Warrant 6 – Coordinated Signal System
Warrant 7 – Crash Experience
Warrant 8 – Roadway Network
Warrant 9 – Intersection Near a Grade Crossing

Traffic Signal Control Type

There are three different signal control types:

Pre-Timed

Pre-timed signals operate with fixed cycle lengths and green split. Most pre-timed controls feature multiple timing plans, with different cycle, split and offset values for different periods of the day.

Semi-Actuated

Semi-actuated signals operate with varied green time for the main street left turn phases and side street phases. These times can vary by time of day or cycle to cycle. The major street thru movement green time can only vary by time of day.

Actuated

Actuated signals vary the amount of green time allocated to each phase based on traffic demand. Actuated control does not rely on a fixed cycle length unless the intersection is in a coordinated system or under adaptive control. It provides variable lengths of green timing for phases that are equipped with detectors. The time for each movement depends on the characteristics of the intersection and timing parameters.

Traffic Signal Heads

Vehicle Displays

The location of signal heads should be evaluated based on visibility requirements and type of signal display. While signal head placement is governed by MUTCD requirements for signal displays, the specific placement of signal heads is typically determined by local policies. When designing the placement of signal heads, the following should be considered in addition to the minimum requirements in the MUTCD:

- Consistency with other intersections in the area
- A geometric design issue that could confuse a driver
- A large percentage of vehicles on one or more approaches that block lines of sight including trucks and vans
- The width of the intersection
- The turning paths of the vehicles.

The MUTCD requires that each signal head have at least 3 but no more than five indications. Indications can either be 8 inches or 12 inches in diameter. Most municipalities require 12 inch indications for increased visibility.

Indications can have incandescent bulbs or LED's (Light Emitting Diodes). Most municipalities require LED indications which us less power and have a longer life. The following illustration shows an aluminum signal head with LED indications.

Signal heads are constructed with aluminum or polycarbonate. Polycarbonate heads weigh less and resist corrosion. However, polycarbonate heads may deteriorate from ultraviolet (UV) radiation. The following illustration shows a polycarbonate head.

A signal head can ha direction of traffic. For example, a signal hea e following illustration shows a 4-way signal

Lateral Positioning of Sig

The MUTCD requires a minimum of 2 signal faces for thru movements. Two faces are required to ensure that motorists always have an indication present, even if one burns out. For turn lanes, only 1 signal face is required. In addition, the MUTCD requires a minimum spacing of 8 feet between 2 signal faces controlling the thru movement.

Longitudinal Positioning of Signals

Signal heads shall be placed no less than 40 feet beyond the stop line and no more than 180 feet beyond the stop line unless a supplemental near-side signal face is provided. The following illustration shows the longitudinal positioning of signals.