Spack SOLUTIONS

Engineering Guide

Control Devices: Traffic Signals

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This guide provides background, benefits, limitations, design guidelines, and further resources for designing traffic signal installations.

Key features

Traffic signals have several common names: stoplights, semaphores, stop-and-go lights, or just plain signals. Traffic signals are one device that impacts almost every person, every day. Whether driving to work, to and from the store or even just walking across the street, nearly everyone deals with traffic signals on a near daily basis.

Officially, a traffic signal is "a power-operated traffic control device by which traffic is warned or directed to take some specific action."[1] There are several types of traffic signals in use today. The intersection traffic signal is the most common, which controls vehicle and pedestrian movements at an intersection. Red, yellow, green and white lights indicate which drivers or pedestrians have the right-of-way. Freeway ramp meters and pedestrian HAWK signals (High-intensity Activated crosswalk, generally located at mid-block locations) are also traffic signals, but this guide focuses on the intersection variety.

A traffic signal is not considered a safety device and will not solve all the traffic issues at a given intersection. A dirty little secret in the industry is that the number of crashes at an intersection typically goes up after a signal is installed. However, the increased crashes are usually minor fender benders/rear ends, while more severe right angle/t-bone crashes go down.

Recognizing that traffic signals impact people's lives every day, the timing of a traffic signal becomes extremely important. In fact, traffic engineers keeping traffic signal timing current is one of the highest benefit/cost activities in our industry. Agencies should be in the habit of examining traffic signal timing at least every three to five years, as recommended by the Institute of Transportation Engineers, and sooner if an adjacent development significantly changes traffic patterns at a signalized intersection.

Traffic signals should also be monitored to ensure all of the detectors are working properly, push buttons to bring up the walk phase, and all lights are functioning. The Minnesota Department of Transportation (DOT) recommends public works staff or their contractors inspect their traffic signals annually.

[1] SFHWA Manual on Uniform Traffic Control Devices, May 2012, Section 1A.13

When to install traffic signals

The industry has developed a series of criteria, called “warrants,” to help determine when a signal is needed. Detailed in the Manual on Uniform Traffic Control Devices, these warrants include thresholds for car and pedestrian volumes, driver delays, and the crash history. The exact threshold depends on the number of lanes, urban/rural setting and speed limits. The warrants can be analyzed by hand or through any number of software programs.

An intersection can meet a warrant and not need a traffic signal. Conversely, traffic engineers have installed signals at intersections that do not meet a warrant. Sometimes local and political pressure can trump an engineer’s technical analysis. Ideally, the engineer’s analysis confirms the intersection does meet at least one warrant, and traffic will operate better with the signal. This conclusion is called justifying the traffic signals installation, not just warranting the installation.

Design guidelines for traffic signals

PLANNING FOR AND DESIGNING A TRAFFIC SIGNAL TYPICALLY INVOLVES:

Physical improvement considerations, such as building exclusive turn lanes and making ADA improvements

Operational considerations, such as left turn phasing, overall signal timing, and the location of pedestrian crossings

System considerations, such as interconnection to adjacent signals and advanced warning flashers

TYPICAL DESIGN GUIDELINES FOR NEW SIGNALS INCLUDES:

A minimum of two signal faces per approach: one on the far right side of the intersection and one preferably over each approach through lane

Install each signal face between 40 feet and 180 feet from the stop line

LIMITATIONS OF TRAFFIC SIGNALS

- Potential increase in some types of crashes, such as rear end
- Increase delay for mainline drivers, who may now have to stop when before they did not
- Increase delay for all drivers during off-peak times
- Increase driver frustration if the traffic signal is poorly timed
- Turn lanes often installed in conjunction with traffic signals make longer crosswalks and increase the vehicle exposure time for pedestrians crossing the road

Each signal face shall be visible within a 40-degree cone of visibility, 20 degrees to each side of center

Vehicle detection, such as inductive loops, cameras, or microwave emitters, should detect vehicles at the stop bar of the minor street approaches

Vehicle detectors should detect vehicles 120 to 625 feet from the stop line on all approaches

Push buttons for the crosswalk should be located within five feet of the outside edge and between 1-1/2 and 10 feet from the back of curb/edge of the roadway

It's imperative that traffic engineers check with the local agencies when planning and designing traffic signals for the local design standards. Even adjacent cities can have different standards. Luckily, most agencies have developed detailed manuals for designing and operating traffic signals, or they refer to the agency whose standards they follow. Below is a list of references, including the FHWA Manual on Uniform Traffic Control Devices and great references from the Minnesota DOT.

Resources

- Manual on Uniform Traffic Control Devices
- MnDOT Signals Fundamentals
- MnDOT Signal Design Manual
- MnDOT Signal Optimization and Timing Manual
- MnDOT Traffic Engineering Manual (Chapter 9, Signals)

About Spack Solutions

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