

CHAPTER 2

TRAFFIC SIGNAL DESIGN – GENERAL INFORMATION

2.1 General Information

Highway traffic signal is a generic term that applies to intersection stop-and-go signals, flashing beacons, lane use control signals, ramp entrance signals, and other types of devices. A traffic control signal (traffic signal) shall be defined as any highway traffic signal by which traffic is alternately directed to stop and permitted to proceed. Traffic is defined as vehicles, pedestrians, bicyclists, streetcars, and other conveyances using any highway or private road open to the public for purposes of travel. This chapter presents the design of traffic control signals. In this manual, the term traffic signal applies to a traffic control signal unless otherwise noted. Standards for traffic control signals are important because they need to attract the attention of a variety of road users, including those who are older, those with impaired vision, as well as those who are fatigued or distracted, or who are not expecting to encounter a signal at a particular location. The designer responsible for any type of traffic signal design project, including traffic control signals, should be aware that the design must comply with various standards. In addition to TDOT Standard Specifications, the following standards shall be consulted:

- **MUTCD:** The MUTCD defines the standards used by road managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways, and private roads open to public travel. The MUTCD is published by FHWA under 23 CFR, Part 655, Subpart F. As a minimum, the requirements of the MUTCD must be met on all roads in Tennessee.
- **Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals:** These specifications are published by AASHTO to provide structural design criteria.
- **NEC:** The NEC contains provisions that are considered necessary for the practical safeguarding of persons and property from hazards arising from the use of electricity. The NEC is published by the NFPA.
- **NEMA Standards:** This publication describes the physical and functional requirements of TS-1 and TS-2 signal controllers.
- **ATC Standards:** This publication by AASHTO, ITE, and NEMA is intended to provide an open architecture hardware and software platform that can support a wide variety of ITS applications, including traffic management, safety, security, and other applications.
- **TDOT Design Standards (www.tn.gov/tdot):** These standards are composed of a number of standard drawings that address specific situations that occur on a large majority of construction projects.

This chapter is structured to document the recommended concepts of traffic signal design as they apply to traffic signal timing and to traffic signal infrastructure in the State of Tennessee. The first few sections will introduce basic concepts related to traffic signal design elements, followed by a discussion of traffic signal modes of operation. Next, guidelines to the selection of traffic signal phasing will be presented leading into traffic signal detection design. The following sections will explore traffic signal timing parameters for different modes of operation and preemption guidelines, concluding with several traffic signal infrastructure requirements.

2.2 Site Reviews

A very necessary, but sometimes overlooked, part of a complete traffic signal design is the need for site reviews. The number of site reviews will be dependent on the complexity of the project. It is prudent that the designer have at least one site review during the right-of-way design phase, preferably before the right-of way field review plans are submitted for review. The following benefits may be obtained through site reviews:

- Site reviews can provide information that is not always visible from the survey, such as drainage structures, clusters of trees, ditches and steep slopes. The designer should be aware of the location of these obstacles to avoid pole placement in their vicinity. Removal of vegetation and trees should be considered only as a last resort;
- Site reviews clearly show the roadway configuration and can provide the designer with a better idea of the magnitude and proximity of overhead obstructions, hazards or structures to the roadway;
- Site reviews will enable the designer to select potential service point locations by identifying power sources within the project area;
- Site reviews will enable the designer to verify that the locations of proposed poles are not in conflict with existing or proposed utilities including at-grade and aerial roadway structures.

Sign-in sheets are required during site reviews to document those in attendance. Typical site review attendees include the maintaining agency, local officials, utility companies (especially the power company), railroad (if applicable), TDOT project manager, TDOT HQ project manager (if different), TDOT Region traffic engineer, and consultant engineers/designers. After the site review has concluded, a summary of the meeting minutes shall be prepared by the designer to document the discussions in the field and to identify action items required along with who is responsible for those action items. Site review guidance information is contained in Appendix B.

2.3 Proprietary Equipment for Traffic Signal Systems

Proprietary, as part of a traffic signal installation project, means that a particular piece of equipment (i.e. brand, manufacture, model number, etc.) can be specified in the construction plans (i.e. sole source). Typically, the proprietary item is the predominate piece of equipment installed or being installed by the local maintaining agency. For TDOT consideration and approval of proprietary items, the local maintaining agency (i.e. city, county, etc.) shall make a formal written request to TDOT and justify the need for the proprietary item based on the reasons given in the CFR 23, Part 635.411. The requested item shall also be included in a traffic signal specifications document that is posted on the local maintaining agency's website. Typically, traffic signal proprietary items that are requested include traffic signal controllers, traffic signal monitors, Ethernet switches, radar/video detection, decorative traffic signal poles, and emergency preemption equipment. The specification of proprietary items will not be allowed except in special pre-approved cases by the Director of the Traffic Operations Division. The following are considered during TDOT's review for certification of proprietary items:

2.3.1 Necessary for Synchronization with Existing Facilities

The local maintaining agency shall provide written documentation that the required proprietary item is needed for synchronization with existing facilities. Synchronization means that a product matches specific current or desired characteristics of a project and shall be based on the following or a combination of the following factors:

- **Function:** The proprietary product is necessary for the satisfactory operation of the existing facility;
- **Aesthetics:** The proprietary product is necessary to match the visual appearance of existing facilities; and
- **Logistics:** The proprietary product is interchangeable with products in an agency's maintenance inventory.

Other factors as they relate to synchronization include:

- **Lifecycle:** The relative age of existing systems that will be expanded and the remaining projected life of the proposed proprietary element in relation to the remaining life of the existing elements; and
- **Size/Extent of Products and Systems to be Synchronized To/With:** The relative cost of the proprietary elements compared with replacing the elements requiring synchronization

2.3.2 Unique Product for which there is No Equally Suitable Alternative

The local maintaining agency shall provide written documentation that the required proprietary item does not have an equivalent. The documentation may also include the submission of specific material(s) or product(s) to evaluate in TDOT's review of the proprietary item.

2.3.3 Experimental Products

The local maintaining agency shall provide written documentation that the required proprietary item is for research or for a distinctive type of construction at an intersection for experimental purposes. The documentation shall include an experimental product work plan for review and approval. The work plan should provide for the evaluation of the proprietary product, and where appropriate, a comparison with current technology. Products which have been approved under special funding/evaluation programs do not require additional certification for the use of patented or proprietary products.