ENGINEERING POLICY SPECIAL BALLOT

Effective: **January 18, 2026**

NOTE: EPG articles that are unchanged have been intentionally not shown on the ballot. Some of the intentionally removed articles have been renumbered due to new articles being added, but the content of these articles has not changed.

Supplementary files for the ballot can be found here.

Issue 1: 616 Temporary Traffic Control (MUTCD Part 6)

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Jon Nelson – Highway Safety and Traffic Division

Summary: This revision will bring MoDOT's Temporary Traffic Control policy into compliance with the MUTCD 11th Edition and 23 CFR Part 630 Subpart J & K. New speed feedback plaque for work zones to replace the Radar Speed Advisory System. New guidance for providing pedestrian access and pedestrian channelizing devices through work zones. Updated references to typical applications to more closely follow MUTCD naming conventions. Section on positive protection and temporary traffic barrier requirements and guidance added.

Publication: Engineering Policy Guide: 616

Issue 2: 620 Pavement Marking (MUTCD Part 3)

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Jon Nelson – Highway Safety and Traffic Division

Summary: This revision will bring MoDOT's Pavement Marking policy into compliance with the MUTCD 11th Edition. Clarified naming and layout of dotted lane lines and dotted extension lines. Clarified curb marking policy for edge of roadway, medians, and islands. Includes guidance on the use of chevron markings in gore areas.

Publication: Engineering Policy Guide: 620

Issue 3: 900 TRAFFIC CONTROL

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Jon Nelson – Highway Safety and Traffic Division

Summary: This revision will bring MoDOT's introduction to the Traffic Control section into compliance with the MUTCD 11th Edition.

Publication: Engineering Policy Guide: 900

Issue 4: 902 Signals (MUTCD Part 4)

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Jon Nelson – Highway Safety and Traffic Division

Summary: This revision will bring MoDOT's Traffic Signal policy into compliance with the MUTCD 11th Edition. Signal warrant criteria are changed from standard to guidance statements, adding flexibility to whether a signal is installed for a given location. Additional information included on signal operations and pedestrian and bicycle signals.

Publication: Engineering Policy Guide: 902

Issue 5: 903 Highway Signing (MUTCD Part 2)

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Jon Nelson – Highway Safety and Traffic Division

Summary: This revision will bring MoDOT's Highway Signing policy into compliance with the MUTCD 11th Edition. Sign sizes were modified to meet current MoDOT standards. Certain signs were redesigned for compliance, and new signs were added. Reference location signs or emergency reference markers (ERMs) are now required on all freeways and expressways with reference location sign continuity. Welcome To signing policy and airport signing policy were updated.

Publication: Engineering Policy Guide: 903

Issue 6: 908 Traffic Controls for School Areas (MUTCD Part 7)

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Jon Nelson – Highway Safety and Traffic Division

Summary: This revision will bring MoDOT's Traffic Control for School Areas policy into compliance with the MUTCD 11th Edition. Provided guidance for the use of in-street school crossing signs on medians. Updated policy for school bus stop ahead signs.

Publication: Engineering Policy Guide: 908

Issue 7: 910 Intelligent Transportation Systems

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Jon Nelson – Highway Safety and Traffic Division

Summary: This revision will bring MoDOT's Intelligent Transportation Systems policy into compliance with the MUTCD 11th Edition. Clarifies policy on DMS traffic safety campaign messages. Provides updated guidance on DMS message syntax, font sizes, and graphics.

Publication: Engineering Policy Guide: 910

Issue 8: 911 General (MUTCD Part 1)

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Jon Nelson – Highway Safety and Traffic Division

Summary: This new section will include the general information from Part 1 of the MUTCD 11th Edition to meet the FHWA standard for substantial conformance. Adopted from the MUTCD with minimal changes.

Publication: Engineering Policy Guide: 911

Issue 9: 912 Traffic Control Device Considerations for Automated Vehicles (MUTCD Part 5)

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Jon Nelson – Highway Safety and Traffic Division

Summary: This new section will bring MoDOT's Traffic Control Device Considerations for Automated Vehicles policy into compliance with the MUTCD 11th Edition. All items in this section are support and guidance statements for consideration.

Publication: Engineering Policy Guide: 912

Issue 10: 913 Traffic Control for Railroad and Light Rail Transit Grade Crossings (MUTCD Part 8)

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Jon Nelson – Highway Safety and Traffic Division

Summary: This new section will bring MoDOT's Traffic Control for Railroad and Light Rail Transit Grade Crossings policy into compliance with the MUTCD 11th Edition.

Publication: Engineering Policy Guide: 913

Issue 11: 914 Traffic Control for Bicycle Facilities (MUTCD Part 9)

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Jon Nelson – Highway Safety and Traffic Division

Summary: This new section will bring MoDOT's Traffic Control for Bicycle Facilities policy into compliance with the MUTCD 11th Edition. Revisions to policy on pavement marking, signing, and signal operations as they relate to bicycle facilities.

Publication: Engineering Policy Guide: 914

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Attention to the safety (https://www.modot.org/safety) of travelers is especially important in work zones (https://www.modot.org/work-zone-awareness).

The workspace is the area closed to traffic and set aside for workers, equipment and material. Work zone signing items such as regulatory signs and Type III Movable Barricades and other work zone items such as Changeable Message Signs, flashing arrow panels, channelizing devices, lighting devices and signals are specially designed to minimize risk to workers and travelers. Pavement edge treatment is frequently included in work zones as are practices such as crossovers, temporary connections and detours.

The work zone duration and location of work are discussed in this article. There are many aspects to be considered when inspecting construction quality and this article provides construction inspection guidelines.

Temporary traffic control devices warn motorists of hazards, advise the proper path through the work area, delineate areas where travelers may not operate and separate them from workers and opposing traffic. Whenever worn or damaged devices appear in a work zone, the general quality of the work zone deteriorates. To avoid this, MoDOT has provided quality

EPG articles are not referenced as "sections" but as EPG XXX.X or as "articles" to avoid confusion with MoDOT specs (which are contractually binding).

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standards for temporary traffic control devices.

Work Zone Enhancement Software

- Evaluation of Work Zone Enhancement Software Programs (https://spexternal.modot.mo.gov/sites/cm/CORDT/or10006.pdf)
- **See also:** Research Publications (https://www.modot.org/research-publications)

Work Zone Customer Survey (https://www.modot.org/work-zone-customer-survey)

Traffic has developed the Work Zone Customer Survey (https://www.modot.org/work-zone-customer-survey) to take advantage of travelers viewing MoDOT work zones. The Work Zone Customer Survey has been revised so that reviewing work zones is even easier. You can keep our work zones safe and efficient by submitting your information directly from the survey's website location or by printing, filling out and mailing the report card.

Work Zone Figures

- Listing of Typical Applications (TA) for MoDOT Employees
- Legend for the Design and Construction and Materials Typical Applications

To provide uniform flagging and to train employees how to protect themselves, co-workers and travelers, MoDOT requires flagger control.

Every day MoDOT has many work zones (https://www.modot.org/work-zone-awareness) on Missouri's highways. MoDOT is committed to providing safe and efficient movement of both motorized and non-motorized traffic through or around temporary traffic control work zones and providing protection for workers and equipment located within these work zones. To better educate technicians and those designing and managing temporary traffic control work zones, Work Zone Technician Training, Advanced Work Zone Training, MoDOT Work Zone Guidelines and Work Zone User Training is available.

This article also provides law enforcement services, traffic control for non-motorized traffic and transit considerations.

Traffic Control for Field Operations, contains information on temporary traffic control measures.

Fleet lighting guidelines are also available.

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616.1 General (MUTCD Chapter 6A)

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616.1.4 Crashworthiness of TTC Devices (MUTCD Section 6A.04)
616.1.5 Night Work (MUTCD Section 6A.05)

616.1.1 General (MUTCD Section 6A.01)

Support. Whenever the acronym "TTC" is used in EPG 616, it refers to "temporary traffic control."

Standard. The needs and control of all road users (motorists, bicyclists, and pedestrians within the highway, or on a site roadway open to public travel (see definition in EPG 911 (MUTCD Section 1C.02)), including persons with disabilities) through a TTC zone shall be an essential part of highway construction, utility work, maintenance operations, and the management of traffic incidents.

Support. When the normal function of the roadway, or a site roadway open to public travel, is suspended, TTC planning provides for continuity of the movement of motor vehicle, bicycle, and pedestrian traffic (including accessible passage) (see EPG 616.28); transit operations (see EPG 616.21); and access (and accessibility) to property and utilities.

The primary function of TTC is to facilitate movement of road users through or around TTC zones while protecting road users, workers, responders to traffic incidents, and equipment.

Of equal importance to the public traveling through the TTC zone is the safety of workers performing the many varied tasks within the work space. TTC zones present constantly changing conditions that are unexpected by the road user. This creates an even higher degree of vulnerability for the workers and incident management responders on or near the roadway (see EPG 616.3.4). At the same time, the TTC zone provides for the efficient completion of whatever activity interrupted the normal use of the roadway.

Consideration for road user safety, worker and responder safety, and the efficiency of road user flow is an integral element of every TTC zone, from planning through completion. A concurrent objective of the TTC is the efficient construction and maintenance of the highway and the efficient resolution of traffic incidents.

No one set of TTC devices can satisfy all conditions for a given project or incident. At the same time, defining details that would be adequate to cover all applications is impractical. Instead, EPG 616 displays typical applications that depict common applications of TTC devices. The TTC selected for

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each situation depends on the type of highway, road user conditions, the duration of operation, physical constraints, and the nearness of the work space or incident management activity to road users.

The TTC needs on 400 AADT or lower volume roads will sometimes be minimal, especially for shorter-term durations and for lower-speed roads. The use of maintenance vehicle warning flashers, a limited number of signs, or a single flagger could be adequate for these situations.

Improved road user performance might be realized through a well-prepared public relations effort that covers the nature of the work, the time and duration of its execution, the anticipated effects upon road users, and possible alternate routes and modes of travel. Such programs have been found to result in a significant reduction in the number of road users traveling through the TTC zone, which reduces the possible number of conflicts.

Operational improvements might be realized by using intelligent transportation systems (ITS) in work zones. The use in work zones of ITS technology, such as portable camera systems, highway advisory radio, variable speed limits, ramp metering, traveler information, merge guidance, warning systems for vehicles exiting the work space, and queue detection information, is aimed at increasing safety for both workers and road users and helping to ensure a more efficient traffic flow. The use in work zones of ITS technologies has been found to be effective in providing traffic monitoring and management, data collection, and traveler information. See EPG 910 for additional information regarding ITS.

Standard. TTC plans and devices shall be the responsibility of the public body or official or the owners of site roadways open to public travel having jurisdiction for guiding road users.

Guidance. There should be adequate statutory authority for the implementation and enforcement of needed road user regulations, parking controls, speed zoning, and the management of traffic incidents. Such statutes should provide sufficient flexibility in the application of TTC to meet the needs of changing conditions in the TTC zone.

Support. The provisions of EPG 616 apply to both rural and urban areas. A rural highway is normally characterized by lower volumes, higher speeds, fewer turning conflicts, and less conflict with pedestrians or other vulnerable road users. An urban street is typically characterized by relatively low speeds, wide ranges of road user volumes, narrower roadway lanes, frequent intersections and driveways, significant vulnerable road user activity, and more businesses and houses.

Special plans preparation and coordination with transit (see EPG 616.21), other highway agencies, law enforcement and other emergency units (see EPG 616.22), utilities, schools, trucking associations, and railroad companies might be needed to reduce unexpected and unusual road user operation situations.

616.1.2 Fundamental Principles of Temporary Traffic Control (MUTCD Section 6A.02)

Guidance. Road user and worker safety and accessibility in TTC zones should be an integral and high-priority element of every project from planning through design and construction. Similarly, maintenance and utility work should be planned and conducted with the safety and accessibility of all

motorists, bicyclists, pedestrians (including those with disabilities), and workers being considered at all times. If the TTC zone includes a grade crossing, early coordination with the railroad company or light rail transit agency should take place.

The following are the seven fundamental principles of TTC:

A. General plans or guidelines should be developed to provide safety for motorists, bicyclists, pedestrians, workers, enforcement/emergency officials, and equipment, with the following factors being considered:

1. The basic safety principles governing the design of permanent roadways and roadsides should also govern the design of TTC zones. The goal should be to route road users through such zones using roadway geometrics, roadside features, and TTC devices as nearly as possible comparable to those for normal highway situations.
2. A TTC plan, in detail appropriate to the complexity of the work project or incident, should be prepared and understood by all responsible parties before the site is occupied. Any changes in the TTC plan should be approved by an official who is knowledgeable, trained, and certified in proper TTC practices.

B. Road user movement should be inhibited as little as practical, based on the following considerations:

1. TTC at work and incident sites should be designed on the assumption that drivers will only reduce their speeds if they clearly perceive a need to do so (see EPG 616.2.1).
2. Frequent and abrupt changes in geometrics such as lane narrowing, dropped lanes, or main roadway transitions that require rapid maneuvers, should be avoided.
3. Work should be scheduled in a manner that minimizes the need for lane closures or alternate routes, while still getting the work completed safely and quickly and the lanes or roadway open to traffic as soon as possible.
4. Attempts should be made to reduce the volume of traffic using the roadway or freeway to match the restricted capacity conditions. Road users should be encouraged to use alternative routes. When the roadway capacity is reduced because of lane closures, the demand could exceed the available capacity, which might result in either a lengthy stopped or slow moving queue of vehicles that might extend past the normal location of the signs shown in the typical advance warning area. An assessment of the expected queue length, which should be a part of the TTC plan design process, might result in adjustments to the sign spacing and number of signs as well as the use of more conspicuous devices to increase the distance and conspicuity of the advance warning area. For high-volume roadways and freeways, the closure of selected entrance ramps or other access points and the use of signed diversion routes should be evaluated.
5. Bicyclists and pedestrians, including those with disabilities, should be provided with access and passage through the TTC zone.
6. If work operations permit, lane closures on high-volume streets and highways should be scheduled during off-peak hours. Night work should be considered if the work can be accomplished safely with a series of short-term operations.
7. Early coordination with officials having jurisdiction over the affected cross streets and providing emergency services should occur if significant impacts to roadway operations are anticipated.

C. Motorists, bicyclists, and pedestrians should be guided in a clear and positive manner while approaching and traversing TTC zones and incident sites. The following principles should be applied:

1. Adequate warning, delineation, and channelization should be provided to assist in guiding road users in advance of and through the TTC zone or incident site by using proper

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pavement marking, signing, or other devices that are effective under varying conditions. Information should be provided in usable formats for pedestrians with vision disabilities.

2. TTC devices inconsistent with intended travel paths through TTC zones should be removed or covered. However, in intermediate-term stationary, short-term, and mobile operations, where visible permanent devices are inconsistent with intended travel paths, devices that highlight or emphasize the appropriate path should be used. Traffic control devices should provide information in usable formats for pedestrians with vision disabilities.
3. Flagging procedures, when used, should provide positive guidance to road users traversing the TTC zone.

D. To provide acceptable levels of operations, routine day and night inspections of TTC elements should be performed as follows:

1. Individuals who are knowledgeable, trained, and certified in the principles of proper TTC should be assigned responsibility for safety in TTC zones. The most important duty of these individuals is to ensure that TTC devices on the project are consistent with the TTC plan and are effective for motorists, bicyclists, pedestrians, and workers.
2. As the work progresses, temporary traffic controls and/or working conditions should be modified, as needed, to facilitate road user movement and provide worker safety. The individual responsible for TTC should have the authority to halt work until applicable or remedial safety measures are taken.
3. TTC zones should be carefully monitored under varying conditions of road user volumes, light, and weather to check that applicable TTC devices are effective, clearly visible, clean, and in compliance with the TTC plan.
4. When warranted, an engineering study should be made (in cooperation with law enforcement officials) of reported crashes occurring within the TTC zone. Crash records in TTC zones should be monitored to identify the need for changes in the TTC zone.

E. Attention should be given to the maintenance of roadside safety during the life of the TTC zone by applying the following principles:

1. To accommodate run-off-the-road incidents, disabled vehicles, or emergency situations, unencumbered roadside recovery areas or clear zones should be provided where practical.
2. Channelization of road users should be accomplished by the use of pavement markings, signing, and crashworthy, detectable channelizing devices.
3. Work equipment, workers' private vehicles, materials, and debris should be stored in such a manner to reduce the probability of being impacted by run-off-the-road vehicles.

F. Each person whose actions affect TTC zone safety, from the upper-level management through the field workers, should receive training appropriate to the job decisions each individual is required to make. Only those individuals who are trained and certified in proper TTC practices and have a basic understanding of the principles (established by applicable standards and guidelines, including those of the EPG) should supervise the selection, placement, and maintenance of TTC devices used for TTC zones and for incident management.

G. Good public relations should be maintained by applying the following principles:

1. The needs of all road users should be assessed such that appropriate advance notice is given and clearly defined alternative paths are provided.
2. The cooperation of the various news media should be sought in publicizing the existence of and reasons for TTC zones because news releases can assist in keeping the road users well informed.
3. The needs of abutting property owners, residents, and businesses should be assessed and appropriate accommodations made.
4. The needs of emergency service providers (law enforcement, fire, and medical) should be assessed and appropriate coordination and accommodations made.

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5. The needs of railroads and transit should be assessed and appropriate coordination and accommodations made.
6. The needs of operators of commercial vehicles such as buses and large trucks should be assessed and appropriate accommodations made.
7. Early coordination should occur with school officials to discuss potential impacts on picking up and dropping off schoolchildren, on school bus routing, and on safe routes to school patterns.

616.1.3 TTC Devices (MUTCD Section 6A.03)

Guidance. The design and application of TTC devices used in TTC zones should consider the needs of all road users (motorists, bicyclists, and pedestrians), including those with disabilities.

Standard. Traffic control devices shall be defined as all signs, signals, markings, channelizing devices, or other devices that use colors, shapes, symbols, words, sounds, or tactile information for the primary purpose of communicating a regulatory, warning, or guidance message to road users on a street, highway, pedestrian facility, bikeway, pathway, or site roadway open to public travel.

All traffic control devices used for construction, maintenance, utility, or incident management operations on a street, highway, pedestrian facility, bikeway, pathway, or site roadway open to public travel shall comply with the applicable provisions of the EPG.

All TTC devices shall be removed as soon as practical when they are no longer needed. When work is suspended for short periods of time, TTC devices that are no longer appropriate shall be removed or covered.

616.1.4 Crashworthiness of TTC Devices (MUTCD Section 6A.04)

Support. Various articles of the EPG require certain traffic control devices, their supports, and/or related appurtenances to be crashworthy (see definition in EPG 911 (MUTCD Section 1C.02)). Such MUTCD crashworthiness provisions apply to all streets, highways, and site roadways open to public travel.

Standard. FHWA Category 2 and 3 TTC devices shall be compliant with MASH 2016 Test Level 3 (TL-3) unless a waiver is in place. For contract or permit projects, documentation from the contractor or permittee shall be furnished to the engineer.

Guidance. For maintenance work, all products should be crashworthy based on statewide bids and purchasing documents.

616.1.5 Night Work (MUTCD Section 6A.05)

Support. Conducting highway construction and maintenance activities during night hours could provide an advantage when traditional daytime traffic control strategies cannot achieve an acceptable balance between worker and public safety, traffic and community impact, and constructability. The two basic advantages of working at night are reduced traffic congestion and less involvement with

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business activities. However, the two basic conditions that must normally be met for night work to offer any advantage are reduced traffic volumes and easy set up and removal of the traffic control patterns on a nightly basis.

Shifting work activities to night hours, when traffic volumes are lower and normal business is less active, might offer an advantage in some cases, as long as the necessary work can be completed and the worksite restored to essentially normal operating conditions to carry the higher traffic volume during non-construction hours.

Although working at night might offer advantages, it also includes safety issues. Reduced visibility inherent in night work impacts the performance of both drivers and workers. Because traffic volumes are lower and congestion is minimized, speeds are often higher at night, necessitating greater visibility at a time when visibility is reduced. Finally, the incidence of impaired (alcohol or drugs), fatigued, or drowsy drivers might be higher at night.

Working at night also involves other factors, including construction productivity and quality, social impacts, economics, and environmental issues. A decision to perform construction or maintenance activities at night normally involves some consideration of the advantages to be gained compared to the safety and other issues that might be impacted.

EPG 616.14.18 contains specific provisions on TTC for work during nighttime hours.

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616.2 Temporary Traffic Control Elements (MUTCD Chapter 6B)

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616.2.9 Detours and Diversions (MUTCD Section 6B.09)

616.2.1 Temporary Traffic Control Plans (MUTCD Section 6B.01)

Support. Each TTC zone is different. Many variables, such as location of work, highway type, geometrics, vertical and horizontal alignment, intersections, interchanges, road user volumes, road user mix (motorists, bicyclists, and pedestrians), road vehicle mix (buses, trucks, and cars), and road user speeds affect the needs of each zone. The goal of TTC in work zones is safety with minimum disruption to road users. The key factor in promoting TTC zone safety is proper judgment.

A TTC plan describes TTC measures to be used for facilitating road users through a work zone or an incident area. TTC plans play a vital role in facilitating road user flow when a work zone, incident, or other event temporarily disrupts normal road user flow. Important auxiliary provisions that cannot conveniently be specified on project plans can easily be incorporated into Special Provisions within the TTC plan.

TTC plans range in scope from being very detailed to simply referencing typical drawings contained in the EPG, Missouri Standard Plans for Highway Construction (https://www.modot.org/missouri-standard-plans-highway-construction), or specific drawings contained in the contract documents. The degree of detail in the TTC plan depends entirely on the nature and complexity of the situation.

The TTC plan is an integral part of the planning and design of a project. The scope of the TTC plan is determined by the complexity of the project and is developed by the designer in the district in cooperation with district construction, maintenance, and traffic staff.

Standard. A TTC plan shall be developed for every project. Typical traffic control set-ups shall be shown for each work activity within the work zone. The location of all traffic control devices shall be provided in the TTC plan.

Guidance. When staged construction is used, the stages should be clearly defined in the TTC plan. Each stage should have a description of the type of work being done during that phase. Stationing is to be shown, if applicable.

A preliminary field check with district construction and traffic should be conducted to ensure the TTC plan will be compatible with field conditions.

Option. Traffic count data may be obtained from Transportation Planning to aid in the development of the TTC plan. This is especially the case where traffic capacity is a significant factor in the design of the TTC plan. Intersection traffic count data may also be requested from district traffic personnel. Hourly volumes can assist in determining the type of traffic control used, working hour restrictions and other aspects of the TTC plan. The use of Highway Capacity Software, VISSIM, CORSIM or other computer programs may aid in estimating queue lengths, delays, etc. resulting from the work zone.

Support. For additional information related to traffic flow through work zones, see EPG 616.19.

For additional plan sheet guidance see EPG 237.

During TTC activities, commercial vehicles might need to follow a different route from passenger vehicles because of bridge, weight, clearance, or geometric restrictions. Also, vehicles carrying hazardous materials might need to follow a different route from other vehicles.

Guidance. A TTC plan should be developed for planned activities that will affect road users. A TTC plan should be developed for unplanned and emergency situations where practicable. Consideration should also be given to snow plowing operations in TTC zones.

The TTC plan should start in the planning phase and continue through the design, construction, and restoration phases. The TTC plans and devices should follow the principles set forth in EPG 616. The management of traffic incidents should follow the principles set forth in EPG 616.15.

TTC plans should be prepared by persons knowledgeable (for example, trained and/or certified) about the fundamental principles of TTC and work activities to be performed. The design, selection, and placement of TTC devices for a TTC plan should be based on engineering judgment. Designers should be familiar with the traffic control sheets of the Missouri Standard Plans for Highway Construction (https://www.modot.org/missouri-standard-plans-highway-construction) and the Missouri Standard Specifications for Highway Construction (https://www.modot.org/missouri-standard-specifications-highway-construction).

Coordination should be made between adjacent or overlapping projects to check that duplicate signing is not used and to check compatibility of traffic control between adjacent or overlapping projects.

Traffic control planning should be completed for all highway construction, utility work, maintenance operations, and incident management including minor maintenance and utility projects prior to occupying the TTC zone. Planning for all road users should be included in the process.

For any planned special event that will have an impact on the traffic on any street or highway, a TTC plan should be developed in conjunction with and be approved by MoDOT district staff and/or agencies that have jurisdiction over the affected roadways.

Provisions for effective continuity of accessible circulation paths for pedestrians should be incorporated into the TTC plan.

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Option. Provisions may be incorporated into the project bid documents that enable contractors to develop an alternate TTC plan.

Modifications of TTC plans may be necessary because of changed conditions or a determination of better methods of safely and efficiently handling road users.

Guidance. This alternate or modified plan should have the approval of the responsible highway agency or owner of site roadways open to public travel prior to implementation.

Provisions for effective continuity of transit service should be incorporated into the TTC planning process because often public transit buses cannot efficiently be detoured in the same manner as other vehicles (particularly for short-term maintenance projects). Where applicable, the TTC plan should provide for features such as accessible temporary bus stops, pull-outs, and satisfactory waiting areas for transit patrons, including persons with disabilities (see EPG 913.1.13 for additional light rail transit issues to consider for TTC).

Provisions for effective continuity of railroad service and acceptable access to abutting property owners and businesses should also be incorporated into the TTC planning process.

Reduced speed zoning (lowering the regulatory speed limit) should be avoided as much as practical because drivers will reduce their speeds only if they clearly perceive a need to do so.

If reduced speed limits are used, they should be used only in the specific portion of the TTC zone where conditions or restrictive features are present. However, frequent changes in the speed limit should be avoided.

Support. See EPG 616.18 for additional provisions regarding work zone speed limits.

EPG 616.16 contains typical applications (TAs) of TTC zones that are organized according to duration, location, type of work, and highway type. Table 6P-1 of the MUTCD is an index of these typical applications for contract projects (see EPG 616.16.2). EPG 616.16.3 includes typical applications for internal use by MoDOT employees. These typical applications include the use of various TTC methods, but do not include a layout for every conceivable work situation.

Decisions regarding the selection of the most appropriate typical application to use as a guide for a specific TTC zone require an understanding of each situation. Although there are many ways of categorizing TTC zone applications, the typical applications are characterized by work duration, work location, work type, and highway type.

Guidance. Typical applications should be altered, when necessary, to fit the conditions of a particular TTC zone.

Option. Other devices may be added to supplement the devices shown in the typical applications. The sign spacings and taper lengths may be increased to provide additional time or space for driver response.

Devices labeled as optional in the typical applications may be deleted.

Support. Formulating specific plans for TTC at traffic incidents is difficult because of the variety of situations that can arise.

Well-designed TTC plans for planned special events will likely be developed from a combination of treatments from several of the typical applications.

616.2.2 Temporary Traffic Control Zones (MUTCD Section 6B.02)

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Support. A TTC zone is an area of a highway where road user conditions are changed because of a work zone, an incident zone, or a planned special event through the use of TTC devices, uniformed law enforcement officers, or other authorized personnel.

A work zone is an area of a highway with construction, maintenance, or utility work activities. A work zone is typically marked by signs, channelizing devices, barriers, pavement markings, and/or work vehicles. It extends from the first warning sign or high-intensity rotating, flashing, oscillating, or strobe lights on a vehicle to the END ROAD WORK sign or the last TTC device.

An incident zone is an area of a highway where temporary traffic controls are imposed by authorized officials in response to a traffic incident (see EPG 616.15). It extends from the first warning device (such as a sign, light, or cone) to the last TTC device or to a point where road users return to the original lane alignment and are clear of the incident.

A planned special event often creates the need to establish altered traffic patterns to handle the increased traffic volumes generated by the event. The size of the TTC zone associated with a planned special event can be small, such as closing a street for a festival, or can extend throughout a municipality for larger events. The duration of the TTC zone is determined by the duration of the planned special event.

616.2.3 Components of Temporary Traffic Control Zones (MUTCD Section 6B.03)

Support. A TTC zone is often divided into four areas as needed, based on engineering judgment: the advance warning area, the transition area, the activity area (which includes workspace and buffer spaces), and the termination area. Figure 616.2.3 illustrates the four areas typically included in a TTC zone. These four areas are described in EPG 616.2.4 through EPG 616.2.7.

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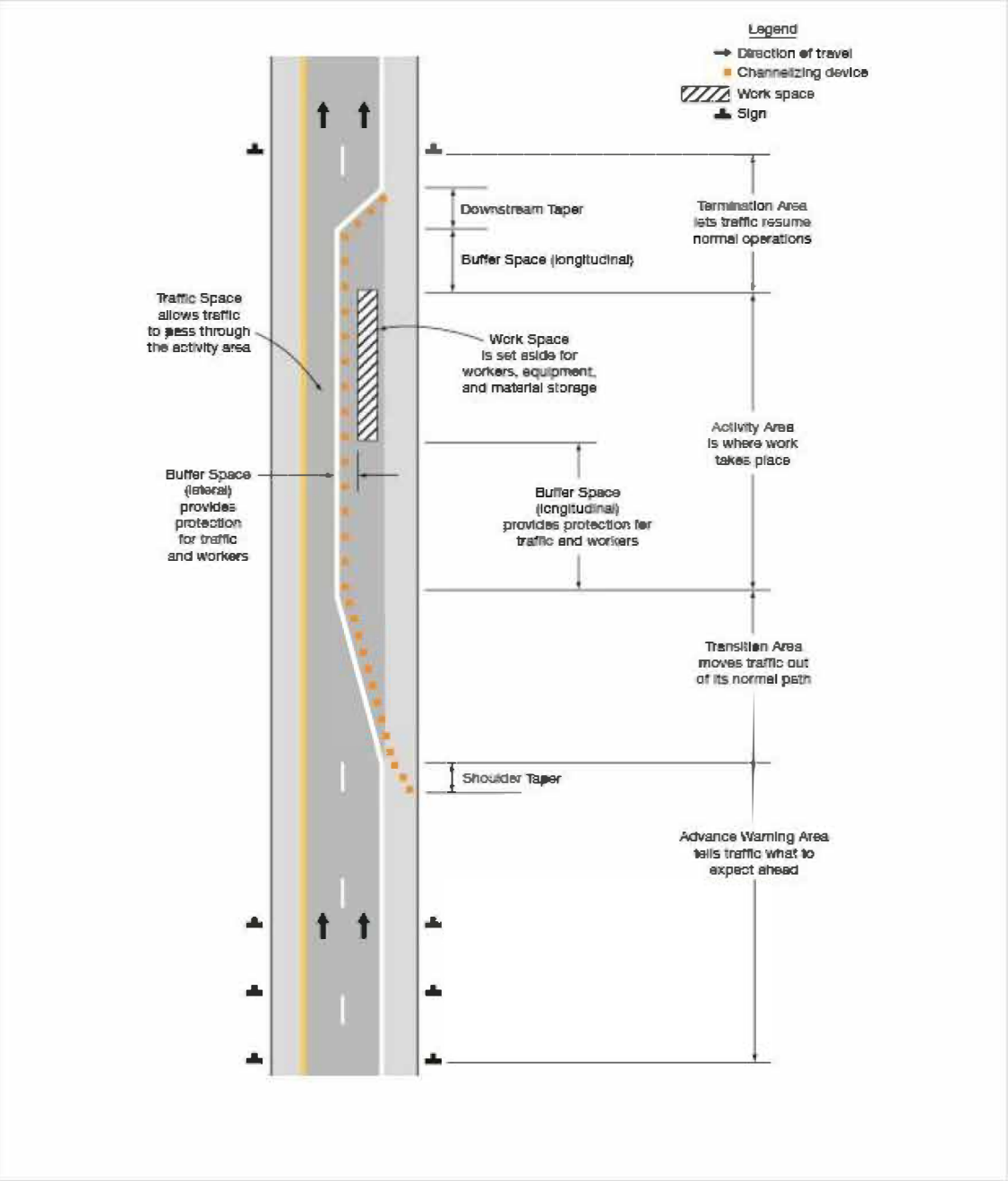


Figure 616.2.3 Component Parts of a Temporary Traffic Control Zone

616.2.4 Advance Warning Area (MUTCD Section 6B.04)

Support. The advance warning area is the section of highway where road users are informed about the upcoming transition and activity areas or incident area.

Option. The advance warning area may vary from a single sign or high-intensity rotating, flashing, oscillating, or strobe lights on a vehicle to a series of signs in advance of the TTC zone activity area.

Guidance. The signs or other warning devices should be positioned to give the driver sufficient time to react to the conditions. Warning devices should not be placed too far in advance, as the warning message will lose effectiveness.

Typical distances for placement of advance warning signs on freeways and expressways should be longer because drivers are conditioned to uninterrupted flow. Therefore, the advance warning sign placement should extend on these facilities as far as ½ mile or more.

On urban streets, the effective placement of the nearest warning sign to the TTC zone, in feet, should range from 4 to 8 times the speed limit in mph, with the high end of the range being used when speeds are relatively high. When two or more advance warning signs are used on higher-speed streets, such as major arterials, the advance warning area should extend a greater distance (see Table 616.2.4).

Option. When a single advance warning sign is used (in cases such as low-speed residential streets), the advance warning area may be as short as 100 feet.

Guidance. Since rural highways are normally characterized by higher speeds, the effective placement of the first warning sign in feet should be substantially longer—from 8 to 12 times the speed limit in mph. Since two or more advance warning signs are normally used for these conditions, the advance warning area should extend 1,500 feet or more for open highway conditions (see Table 616.2.4).

Table 616.2.4 Recommended Advance Warning Sign Minimum Spacing

Road Type	Distance between Signs*		
	A	B	C
Urban (35 mph or less)	100 feet	100 feet	100 feet
Urban (40 mph or more)	350 feet	350 feet	350 feet
Rural	500 feet	500 feet	500 feet
Expressway/Freeway	1,000 feet	1,500 feet	2,640 feet

* The column headings A, B, C are the dimensions shown in MUTCD Figures 6P-1 through 6P-54. The A dimension is the distance from the transition or point of restriction to the first sign. The B dimension is the distance between the first and second signs. The C dimension is the distance between the second and third signs. (The "first sign" is the sign in a three-sign series that is closest to the TC zone. The "third sign" is the sign that is furthest upstream from the TTC zone.)

Note: See Table 616.16.3.3 for MoDOT internal use

The distances contained in Table 616.2.4 are approximate, are intended for guidance purposes only, and should be applied with engineering judgment. These distances should be adjusted for field conditions, if necessary, by increasing or decreasing the recommended distances.

Support. The need to provide additional reaction time for a condition is one example of justification for increasing the sign spacing. Conversely, decreasing the sign spacing might be justified in order to place a sign immediately downstream of an intersection or major driveway such that traffic turning onto the roadway in the direction of the TTC zone will be warned of the upcoming condition.

Option. Advance warning may be eliminated when the activity area is sufficiently removed from the road users' path so that it does not interfere with the normal flow.

In some cases on high volume routes, traffic backups due to the work activity may extend past the normal advance warning area. In this case, additional signing may be required to warn drivers before they reach the backup. For longer-term activities, alternate route signing and interactive devices or changeable message signs may be considered. Computer programs are available to aid in estimating back ups and delays due to work zones.

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In some cases, particularly in urban areas, the advance warning area may extend through an intersection or interchange. Special considerations such as additional advance signs or adjustments to sign spacing may be needed to assure all approaching drivers are informed of the conditions.

616.2.5 Transition Area (MUTCD Section 6B.05)

Support. The transition area is that section of highway where road users are redirected out of their normal path. Transition areas usually involve strategic use of tapers, which because of their importance are discussed separately in detail.

Standard. Except for mobile operations, when redirection of the road users' normal path is required, road users shall be directed from the normal path to a new path with appropriate channelizing devices, traffic control devices, and/or TTC methods.

Option. Because it is impracticable in mobile operations to redirect the road users' normal path with stationary channelization, more dominant vehicle-mounted traffic control devices, such as arrow boards, portable changeable message signs, and high-intensity rotating, flashing, oscillating, or strobe lights, may be used instead of channelizing devices to establish a transition area.

616.2.6 Activity Area (MUTCD Section 6B.06)

Support. The activity area is the section of the highway where the work activity takes place. It is comprised of the work space, the traffic space, and the buffer space.

The work space is that portion of the highway closed to road users and set aside for workers, equipment, material, and a shadow vehicle, if one is used upstream. Work spaces are usually delineated for road users by channelizing devices or, to exclude vehicles and pedestrians, by temporary barriers.

Option. The work space may be stationary or may move as work progresses.

Guidance. Since there might be several work spaces (some even separated by several miles) within the project limits, each work space should be adequately signed to inform road users and reduce confusion.

Option. The workspace may be supplemented by channelizers and/or barricades placed perpendicular to the flow of traffic to deter non-construction related use of closed lanes.

Support. The traffic space is the portion of the highway in which road users are routed through the activity area.

The buffer space is a lateral and/or longitudinal area that separates road user flow from the work space or an unsafe area, and might provide some recovery space for an errant vehicle.

Guidance. Neither work activity nor storage of equipment, vehicles, or material should occur within a buffer space.

Option. Buffer spaces may be positioned either longitudinally or laterally with respect to the direction of road user flow. The activity area may contain one or more lateral or longitudinal buffer spaces.

A longitudinal buffer space may be placed in advance of a work space.

The longitudinal buffer space may also be used to separate opposing road user flows that use portions of the same traffic lane, as shown in Figure 616.2.6.

If a longitudinal buffer space is used, the values shown in Table 616.2.6 may be used to determine the length of the longitudinal buffer space.

Table 616.2.6 Stopping Sight Distance as a Function of Speed

Speed*	Distance
20 mph	115 feet
25 mph	155 feet
30 mph	200 feet
35 mph	250 feet
40 mph	305 feet
45 mph	360 feet
50 mph	425 feet
55 mph	495 feet
60 mph	570 feet
65 mph	645 feet
70 mph	730 feet
* Posted speed, off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed	

Support. Typically, the buffer space is formed as a traffic island and defined by channelizing devices.

When a shadow vehicle, arrow board, or changeable message sign is placed in a closed lane in advance of a work space, only the area upstream of the vehicle, arrow board, or changeable message sign constitutes the buffer space.

Option. The lateral buffer space may be used to separate the traffic space from the work space, as shown in Figures 616.2.3 and 616.2.6, or such areas as excavations or pavement-edge drop-offs. A lateral buffer space also may be used between two travel lanes, especially those carrying opposing flows.

Guidance. The width of a lateral buffer space should be determined by engineering judgment.

Option. When work occurs on a high-volume, highly-congested facility, a vehicle storage or staging space may be provided for incident response and emergency vehicles (for example, tow trucks and fire apparatus) so that these vehicles can respond quickly to road user incidents. This may involve providing storage space at the beginning or end of the activity area or both.

Guidance. Vehicle storage or staging space should not extend into any portion of the buffer space.

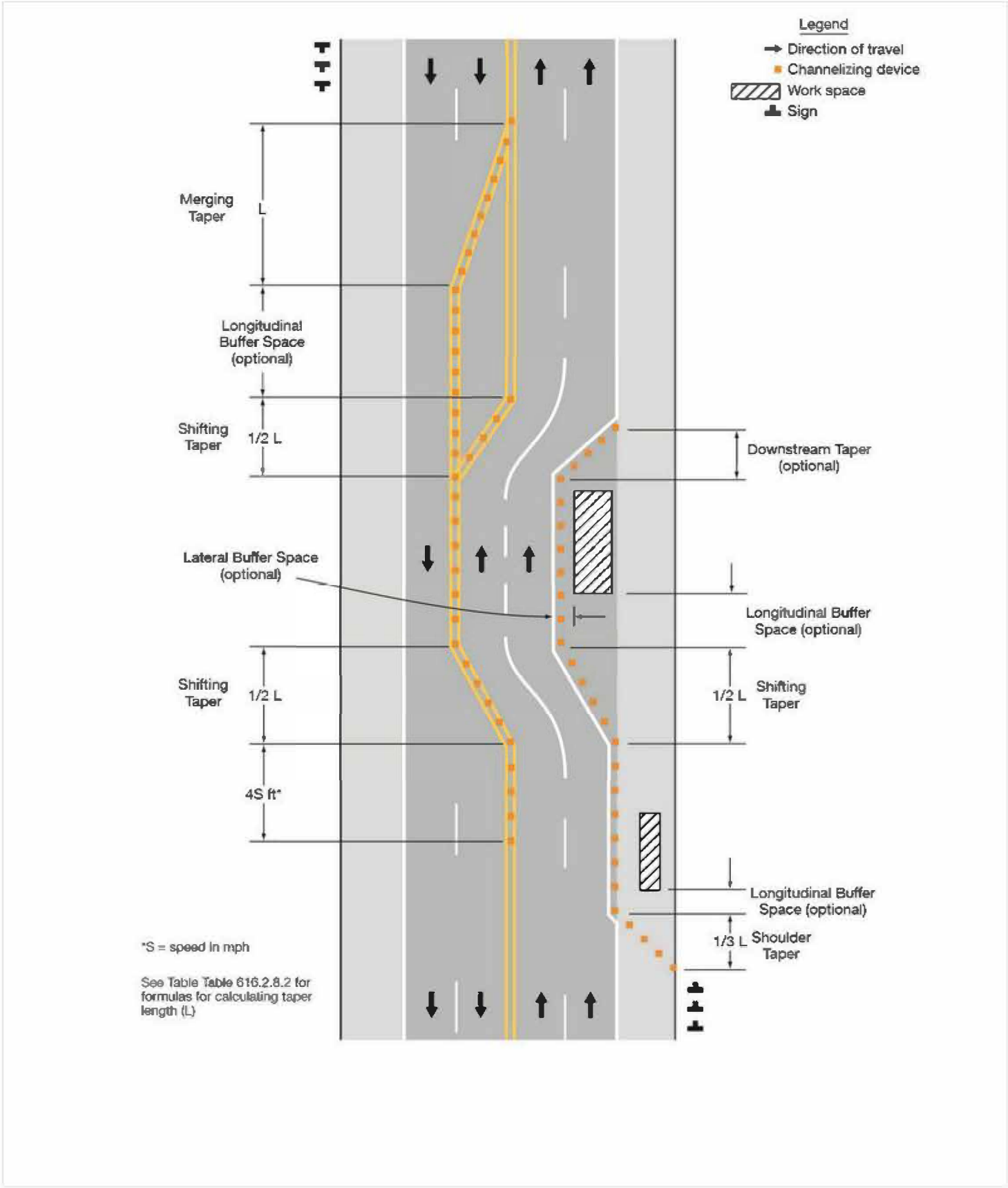


Figure 616.2.6 Types of Tapers and Buffer Spaces

616.2.7 Termination Area (MUTCD Section 6B.07)

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Support. The termination area is the section of the highway where road users are returned to their normal driving path. The termination area extends from the downstream end of the work area to the last TTC device such as END ROAD WORK signs, if posted.

Option. An END ROAD WORK sign, a Speed Limit sign, or other signs may be used to inform road users that they can resume normal operations.

A longitudinal buffer space may be used between the work space and the beginning of the downstream taper.

616.2.8 Tapers (MUTCD Section 6B.08)

Option. Tapers may be used in both the transition and termination areas. Whenever tapers are to be used in close proximity to an interchange ramp, crossroads, curves, or other influencing factors, the length of the tapers may be adjusted.

Support. Tapers are created by using a series of channelizing devices and/or pavement markings to move traffic out of or into the normal path. Types of tapers are shown in Figure 616.2.6.

Longer tapers are not necessarily better than shorter tapers (particularly in urban areas with characteristics such as short block lengths or driveways) because extended tapers tend to encourage sluggish operation and to encourage drivers to delay lane changes unnecessarily. The test concerning adequate lengths of tapers involves observation of driver performance after TTC plans are put into effect.

Guidance. The appropriate taper length (L) should be determined using the criteria shown in Tables 616.2.8.1 and 616.2.8.2.

Table 616.2.8.1 Taper Length Criteria for Temporary Traffic Control Zones

Type of Taper	Taper Length
Merging Taper	at least L
Shifting Taper	at least 0.5 L
Shoulder Taper	at least 0.33 L
One-Lane, Two-Way Traffic Taper	100 feet
Downstream Taper	100 feet

Note:

1. Use Table 616.2.8.2 to calculate L
2. See Table 616.16.3.4 for MoDOT internal use

Table 616.2.8.2 Formulas for Determining Taper Length

Speed (S)	Taper Length (L) in feet
40 mph or less	$L = \frac{WS^2}{60}$
45 mph or more	$L = WS$
Where: L = taper length in feet W = width of offset in feet S = posted speed limit, or off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed in mph Note: See Table 616.16.3.4 for MoDOT internal use	

616.2.8.1 Merging Tapers

Support. A merging taper requires the longest distance because drivers are required to merge into common road space.

Guidance. A merging taper should be long enough to enable merging drivers to have adequate advance warning and sufficient length to adjust their speeds and merge into an adjacent lane before the downstream end of the transition.

Except as provided in the last Guidance paragraph of this article, merging tapers should be used to close a lane or combine traffic lanes on multilane facilities. Full-length tapers L (see Tables 616.2.8.1 and 616.2.8.2) should be used where practical. For long-term operations, lane line markings should be removed through the merging taper and temporary edge lines should be provided to guide drivers through the taper and work area.

616.2.8.2 Shifting Tapers

Support. A shifting taper is used when a lateral shift is needed. When more space is available, a longer than minimum taper distance can be beneficial. Changes in alignment can also be accomplished by using horizontal curves designed for normal highway speeds.

Guidance. A shifting taper should have a length of approximately ½ L (see Tables 616.2.8.1 and 616.2.8.2). Where shifting tapers are used, REVERSE CURVE or REVERSE TURN signs, along with any required advisory speed plaques, are to be posted prior to the shift. For long-term operations, conflicting pavement markings are removed and temporary markings provided to guide drivers through the tapers and work area. For short-term operations where it is not practical to modify pavement markings, devices should be placed at a spacing of approximately 10 feet.

616.2.8.3 Shoulder Tapers

Support. A shoulder taper might be beneficial on a high-speed roadway where shoulders are part of the activity area and are closed, or when improved shoulders might be mistaken as a driving lane. In these instances, the same type, but abbreviated, closure procedures used on a normal portion of the roadway can be used.

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Guidance. If used, shoulder tapers should have a length of approximately ⅓ L (see Tables 616.2.8.1 and 616.2.8.2). If a shoulder is used as a travel lane, either through practice or during a TTC activity, a normal merging or shifting taper should be used.

616.2.8.4 Downstream or Closing Tapers

Support. A downstream (closing) taper might be useful in termination areas to provide a visual cue to the driver that access is available back into the original lane or path that was closed.

Guidance. If used, a downstream (closing) taper should have an approximate length of 100 feet with devices placed at a spacing of approximately 20 feet.

616.2.8.5 One-Lane Two-Way Tapers

Support. The one-lane, two-way taper is used in advance of an activity area that occupies part of a two-way roadway in such a manner that a portion of the road is used alternately by traffic in each direction.

Guidance. A taper having an approximate length of 100 feet with channelizing devices at approximately 20-foot spacing should be used to guide traffic into the one-lane section, and a downstream taper should be used to guide traffic back into their original lane.

Support. An example of a one-lane, two-way traffic taper is shown in Figure 616.2.8.

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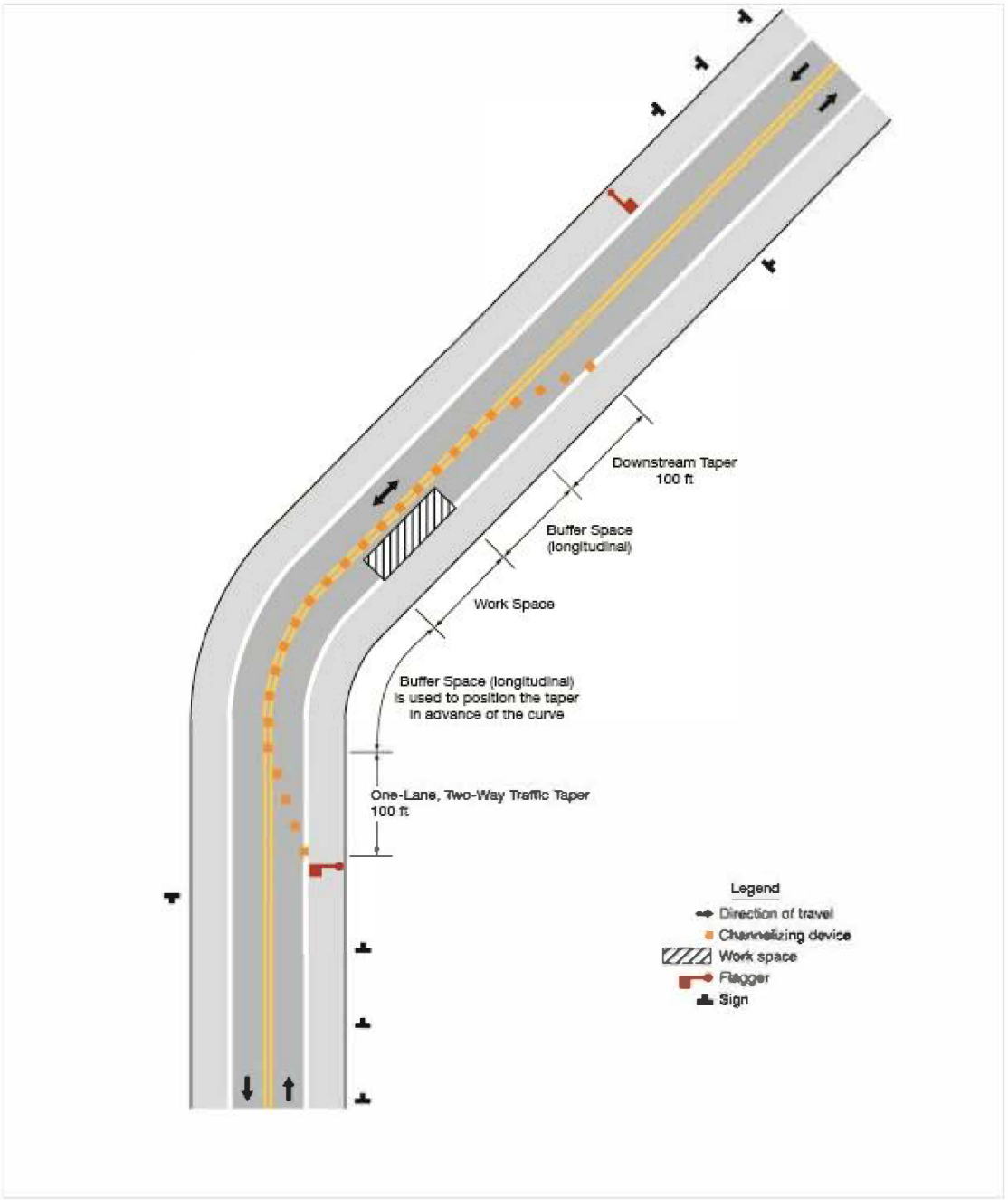


Figure 616.2.8 Example of a One-Lane, Two-Way Traffic Taper

Guidance. Except as provided in the paragraph below, the minimum taper length for the closure of a two-way center turn lane should be ½ L. (See Tables 616.2.8.1 and 616.2.8.2).

Option. A shorter taper length may be used when space is limited.

616.2.9 Detours and Diversions (MUTCD Section 6B.09)

Support. A detour is a temporary rerouting of road users onto an existing highway in order to avoid a TTC zone.

Detours are used when other methods of traffic control such as one-lane, two-way operations, lane closures or temporary bypasses cannot be used. Detours are provided over the shortest possible route around the closure that can sufficiently accommodate the traffic.

Guidance. Detours should be clearly signed over their entire length so that road users can easily use existing highways to return to the original highway.

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Any proposed detour route should be evaluated to determine the condition of the pavement, capacity of the roadway and geometrics. The existing traffic (AADT) on the roadway being closed and the detour route, as well as the facility types should be considered when determining detour routes. State routes should be used for detours.

Option. Based on engineering judgment, projects located on routes with less than 400 AADT may not require signed detour routes.

Outer roadways may be constructed early in the project phasing or enhanced to serve as detours.

Local facilities may be considered for detours based on engineering judgement. City streets or county roads may be improved for use as detour routes

Standard. If other agencies' facilities are used as detour routes, an agreement with the agency having jurisdiction over the roadway shall be required.

Support. A diversion is a temporary rerouting of road users onto a temporary highway or alignment placed around the work area.

Option. Alternate route signing may be used where lane closures or physical height or width restrictions will have a significant effect on traffic and a viable alternate route is available. Alternate route signing may also be used where temporary bridge weight restrictions are imposed during construction.

Support. For information regarding notification of detour routes, see EPG 616.20.3.2.2, EPG 616.20.9, and EPG 616.20.10.

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616.3 Pedestrian and Worker Safety (MUTCD Chapter 6C)

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616.3.1 Pedestrian and Worker Safety – General (MUTCD Section 6C.01)

Standard. The various TTC provisions for pedestrian and worker safety set forth in EPG 616 shall be applied by knowledgeable (for example, trained and/or certified) persons after appropriate evaluation and engineering judgment.

616.3.2 Pedestrian Considerations (MUTCD Section 6C.02)

Support. A wide range of pedestrians might be affected by TTC zones, including the young, elderly, and people with disabilities such as hearing, vision, or mobility. Pedestrians need a clearly delineated and usable travel path. Considerations for pedestrians with disabilities are addressed in EPG 616.3.3.

Guidance. Prior to closing a sidewalk or other pedestrian facility, the maintaining agency should advise users of the future closure.

Standard. If the TTC zone affects the movement of pedestrians, adequate pedestrian access and walkways shall be provided.

Option. If establishing or maintaining an alternate pedestrian route is not feasible during the project, an alternate means of providing for pedestrians may be used, such as adding free bus service around the project or assigning someone the responsibility to assist pedestrians with disabilities through the project limits.

If an existing pedestrian route is impacted by a short duration or a short-term stationary work zone that is attended with project personnel, establishing an alternate pedestrian route may not be necessary if the work can be stopped and pedestrians can navigate the work zone. Pedestrians may be

delayed for a short period of time for project personnel to move equipment and material to facilitate passage. Work zone personnel may also provide assistance to pedestrians as necessary.

Support. Pedestrians are reluctant to retrace their steps to a prior intersection for a crossing or to add distance or out-of-the-way travel to a destination.

Guidance. The following three items should be considered when planning for pedestrians in TTC zones:

A. Pedestrians should not be led into conflicts with vehicles, equipment, and operations.
B. Pedestrians should not be led into conflicts with vehicles moving through or around the worksite.
C. Pedestrians should be provided with a convenient and accessible path that replicates as nearly as practical the most desirable characteristics of the existing sidewalk(s) or footpath(s).

A pedestrian route should not be severed and/or moved for non-construction activities such as parking for vehicles and equipment.

TTC zones should be designed to minimize conflicts between vehicular and pedestrian movements. Consideration should be made to separate pedestrian movements from both worksite activity and vehicular traffic. Unless an acceptable route that does not involve crossing the roadway can be provided, pedestrians should be appropriately directed with advance signing that encourages them to cross to the opposite side of the roadway. In urban and suburban areas with high vehicular traffic volumes, these signs should be placed at intersections (rather than midblock locations) so that pedestrians are not confronted with midblock worksites that will induce them to attempt skirting the worksite or making a midblock crossing.

Support. TA-28 and TA-29 show typical TTC device usage and techniques for pedestrian movement through work zones.

See EPG 616.28 for additional information regarding pedestrian movement through work zones.

Guidance. To accommodate the needs of pedestrians, including those with disabilities, the following considerations should be addressed when temporary pedestrian pathways in TTC zones are designed or modified:

A. Provisions for continuity of accessible paths for pedestrians should be incorporated into the TTC plan.
B. Access to transit stops should be maintained.
C. A smooth, continuous hard surface should be provided throughout the entire length of the temporary pedestrian facility. There should be no curbs or abrupt changes in grade or terrain that could cause tripping or be a barrier to pedestrians with disabilities. The geometry and alignment of the facility should meet the applicable requirements of the “U.S. Department of Justice 2010 ADA Standards for Accessible Design, September 15, 2010, 28 CFR 35 and 36, Americans with Disabilities Act of 1990.”
D. The width of the existing pedestrian facility should be provided for the temporary facility if practical. Traffic control devices and other construction materials and features should not intrude into the usable width of the sidewalk, temporary pathway, or other pedestrian facility. When it is not possible to maintain a minimum width of 60 inches throughout the entire length of the pedestrian pathway, a 60 x 60-inch passing space should be provided at least every 200 feet to allow individuals in wheelchairs to pass.

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E. Blocked routes, alternate crossings, and sign and signal information should be communicated to pedestrians with vision disabilities by providing devices such as audible information devices or barriers and channelizing devices that are detectable to the pedestrians traveling with the aid of a long cane or who have vision disabilities.
F. When channelization is used to delineate a pedestrian pathway, a continuous detectable edging should be provided throughout the length of the facility such that pedestrians using a long cane can follow it. These detectable edgings should comply with the provisions of EPG 616.13.04.
G. Signs and other devices mounted lower than 7 feet above the temporary pedestrian pathway should not project more than 4 inches into accessible pedestrian facilities.

Support. Where pedestrians in TTC zones are routed on temporary pedestrian pathways, providing information in non-visual formats (such as accessible pedestrian signals with audible tones and/or speech messages, and vibrotactile surfaces) aids pedestrians with vision disabilities so they can navigate the temporary pathway. EPG 616.3.3 contains additional information on accessibility considerations in TTC zones. EPG 902.11.1 contains information on accessible pedestrian signals.

Option. Whenever it is feasible, the worksite may be closed off from pedestrian intrusion if doing so is determined to be preferable to channelizing pedestrians along the site with TTC devices.

Guidance. Fencing should not create sight distance restrictions for road users. Fences should not be constructed of materials that would be hazardous if impacted by vehicles. Wooden railing, fencing, and similar systems placed immediately adjacent to motor vehicle traffic should not be used as substitutes for crashworthy temporary traffic barriers.

Ballast for TTC devices should be kept to the minimum amount needed and should be mounted low to prevent penetration of the vehicle windshield.

Movement by work vehicles and equipment across designated pedestrian paths should be minimized and, when necessary, should be controlled by flaggers or other TTC. Staging or stopping of work vehicles or equipment along the side of pedestrian paths should be avoided, since it encourages movement of workers, equipment, and materials across the pedestrian path.

Access to the work space by workers and equipment across pedestrian walkways should be minimized because the access often creates unacceptable changes in grade, and rough or muddy terrain, and pedestrians will tend to avoid these areas by attempting non-intersection crossings where no curb ramps are available.

Option. A canopied walkway may be used to protect pedestrians from falling debris, and to provide a covered passage for pedestrians.

Guidance. Covered walkways should be sturdily constructed and adequately lighted for nighttime use.

When pedestrian and vehicle paths are rerouted to a closer proximity to each other, consideration should be given to separating them by a temporary traffic barrier.

If a temporary traffic barrier is used to shield pedestrians, it should be designed to accommodate site conditions.

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Support. Depending on the possible vehicular speed and angle of impact, temporary traffic barriers might deflect upon impact by an errant vehicle. Guidance for locating and designing temporary traffic barriers can be found in Chapter 9 of the "Roadside Design Guide," 4th Edition, 2011, AASHTO.

Standard. Normal vertical curbing shall not be used as a substitute for temporary traffic barriers when temporary traffic barriers are needed.

Option. Temporary traffic barriers or longitudinal channelizing devices may be used to discourage pedestrians from unauthorized movements into the work space. They may also be used to inhibit conflicts with vehicular traffic by minimizing the possibility of midblock crossings.

Support. A major concern for pedestrians is building construction encroaching onto the contiguous sidewalks, which forces pedestrians off the curb into direct conflict with moving vehicles.

Guidance. If a significant potential exists for vehicle incursions into the pedestrian path, pedestrians should be rerouted or temporary traffic barriers should be installed.

Support. TTC devices, temporary traffic barriers, and wood or chain link fencing with a continuous detectable edging can satisfactorily delineate a pedestrian path.

Guidance. Tape, rope, or plastic chain strung between devices should not be used as a control for pedestrian movements because they are not detectable and are therefore not accessible to and usable by individuals with disabilities.

In general, pedestrian routes should be preserved in urban and commercial suburban areas. Alternative routing should be discouraged.

The highway agency in charge of the TTC zone should regularly inspect the activity area so that effective pedestrian TTC is maintained.

616.3.3 Accessibility Considerations (MUTCD Section 6C.03)

Support. Additional information on the design and construction of accessible temporary facilities is found in the "Guidelines for Accessible Pedestrian Signals (NCHRP Web-Only Document 117B)," 2008 Edition (TRB) and the U.S. Department of Justice 2010 ADA Standards for Accessible Design, September 15, 2010, 28 CFR 35 and 36, Americans with Disabilities Act of 1990.

Where pedestrians are detoured to a temporary traffic control signal, an accessible pedestrian signal (see EPG 902.11) provides information in non-visual formats (such as audible tones and/or speech messages, and vibrating surfaces) so that a pedestrian with vision disabilities can know when to cross the street along the alternate route.

Guidance. Adequate provisions should be made for pedestrians with disabilities. The extent of needs for such provisions should be determined through engineering judgment or by the individual responsible for each TTC zone situation.

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Standard. When existing pedestrian facilities are disrupted, closed, or relocated in a TTC zone, the temporary facilities shall be detectable and include accessibility features consistent with the features present in the existing pedestrian facility. A barrier that is detectable by a person with a vision disability traveling with the aid of a long cane shall be placed across the full width of the closed pedestrian facility.

Support. Maintaining a detectable, channelized pedestrian route is much more useful to pedestrians with vision disabilities than closing a walkway and providing audible directions to an alternate route involving additional crossings and a return to the original route. Braille is not useful in conveying such information because it is difficult to find. Audible instructions might be provided, but the extra distance and additional street crossings might add complexity to a trip.

Guidance. Because printed signs and surface delineation are not usable by pedestrians with vision disabilities, blocked routes, alternate crossings, and sign and signal information should be communicated to pedestrians with vision disabilities by providing audible information devices, tactile and/or vibrating surface devices, and barriers and channelizing devices that are detectable to pedestrians traveling with the aid of a long cane or who have vision disabilities.

Support. The most desirable way to provide information to pedestrians with vision disabilities that is equivalent to visual signing for notification of sidewalk closures is a speech message provided by an audible information device. Devices that provide speech messages in response to passive pedestrian actuation are the most desirable. Other devices that continuously emit a message, or that emit a message in response to use of a pushbutton, are also acceptable. Audible information devices might not be needed if detectable channelizing devices make an alternate route of travel evident to pedestrians with vision disabilities.

Guidance. If a pushbutton is used to provide equivalent TTC information to pedestrians with vision disabilities, the pushbutton should be equipped with a locator tone to notify pedestrians with vision disabilities that a special accommodation is available, and to help them locate the pushbutton.

616.3.4 Worker Safety Considerations (MUTCD Section 6C.04)

Support. Equally as important as the safety of road users traveling through the TTC zone is the safety of workers. TTC zones present temporary and constantly changing conditions that are unexpected by road users. This creates an even higher degree of vulnerability for workers on or near the roadway.

Maintaining TTC zones with road user flow inhibited as little as possible, and using TTC devices that get the road users' attention and provide positive direction are of particular importance. Likewise, equipment and vehicles moving within the activity area create a risk to workers on foot. When possible, the separation of moving equipment and construction vehicles from workers on foot provides the operators of these vehicles with a greater separation clearance and improved sight lines to minimize exposure to the hazards of moving vehicles and equipment.

Guidance. The following are the key elements of worker safety and TTC management that should be considered to improve worker safety:

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A. Training—all workers should be trained on how to work next to motor vehicle traffic in ways that minimize their vulnerability. Workers having specific TTC responsibilities should be trained in TTC techniques, device usage, and placement.
B. Temporary Traffic Barriers—temporary traffic barriers should be placed along the work space depending on factors such as lateral clearance of workers from adjacent traffic, speed of traffic, duration and type of operations, time of day, and volume of traffic.
C. Speed Management—reducing the speed of vehicular traffic, mainly through regulatory speed zoning, funneling, lane reduction, and/or the use of speed safety cameras, uniformed law enforcement officers or flaggers should be considered. See EPG 616.22 for additional information about Law Enforcement Services for work zones.
D. Activity Area—operations entering and departing the work space, and within the work space, should be planned to minimize backing maneuvers by construction vehicles and equipment to minimize the risk of run-over and back-over crashes.
E. Worker Safety Planning—a trained person designated by the employer should conduct a basic hazard assessment for the worksite and job classifications required in the activity area. This safety professional should determine whether engineering, administrative, or personal protection measures should be implemented. This plan should be in accordance with the Occupational Safety and Health Act of 1970, as amended, "General Duty Clause" Section 5(a)(1) - Public Law 91-596, 84 Stat. 1590, December 29, 1970, as amended, and with the requirement to assess worker risk exposures for each job site and job classification, as per 29 CFR 1926.20 (b)(2) of "Occupational Safety and Health Administration Regulations, General Safety and Health Provisions."
F. Safety Apparel (see EPG 616.3.5).

Option. The following are additional elements of TTC management that may be considered to improve worker safety:

A. Shadow Vehicle—in the case of mobile and constantly moving operations, such as pothole patching and striping operations, a shadow vehicle, equipped with appropriate lights and warning signs, may be used to protect the workers from impacts by errant vehicles. The shadow vehicle may be equipped with a rear-mounted impact attenuator.
B. Road Closure—if alternate routes are available to handle road users, the road may be closed temporarily to facilitate project completion and thus further reduce worker vulnerability.
C. Law Enforcement Use—in highly vulnerable work situations, particularly those of relatively short-duration, law enforcement units may be stationed to heighten the awareness of passing vehicular traffic and to improve safety through the TTC zone.
D. Lighting—for nighttime work, the TTC zone and approaches may be lighted.
E. Special Devices—these include rumble strips, changeable message signs, hazard identification beacons, and flags. Intrusion warning devices may be used to alert workers to the approach of errant vehicles.

Support. Judicious use of the special devices described in Item E in the preceding paragraph might be helpful for certain difficult TTC situations, but misuse or overuse of special devices or techniques might lessen their effectiveness.

616.3.5 High-Visibility Safety Apparel (MUTCD Section 6C.05)

Support. MoDOT has unique requirements for safety apparel that exceed MUTCD criteria. MoDOT requirements are included in this article. A graphical representation of personal protective equipment (https://epg.modot.org/files/0/0f/132_8_5_x_11_ROW_PPE.pdf) is available.

Standard. For daytime activity, all workers, including emergency responders, within the right-of-way who are within the TTC zone shall wear high-visibility safety apparel that meets the Performance Class 2 or 3 requirements of the ANSI/ISEA 107–2015 publication entitled "American National Standard for High-Visibility Safety Apparel and Headwear," or equivalent revisions, except as provided in the first Option paragraph below. For daytime activity, all workers shall wear a hard hat, safety glasses, a Performance Class 3 top or a Performance Class 2 top, and safety footwear. A person designated by the employer to be responsible for worker safety shall make the selection of the appropriate class of garment.

For nighttime activity, all workers, including emergency responders, within the right-of-way who are within the TTC zone shall wear high-visibility safety apparel that meets the Performance Class 2 or 3 requirements of the ANSI/ISEA 107–2015 publication entitled "American National Standard for High-Visibility Safety Apparel and Headwear," or equivalent revisions, except as provided in the first Option paragraph below. For nighttime activity, all workers shall wear a hard hat, safety glasses, a Performance Class 3 top OR a Performance Class 2 top and a Class E bottom, and safety footwear. A person designated by the employer to be responsible for worker safety shall make the selection of the appropriate class of garment.

MoDOT employees shall wear personal protective equipment (PPE) appropriate for each hazard. The department will provide required protective equipment for use by the employees. Supervisors shall control the issuance and replacement of this equipment. When PPE is furnished to the employee, it is the responsibility of the employee to use and maintain it as specified by MoDOT and the manufacturer.

The apparel background (outer) material color shall be fluorescent orange-red, fluorescent yellow-green, or a combination of the two as defined in the ANSI standard. The retroreflective material shall be orange, yellow, white, silver, yellow-green, or a fluorescent version of these colors.

When uniformed law enforcement personnel are used to direct traffic, to investigate crashes, or to handle lane closures, obstructed roadways, and disasters, high-visibility safety apparel as described in this article shall be worn by the law enforcement personnel.

Option. Emergency and incident responders and law enforcement personnel within the TTC zone may wear high-visibility safety apparel that meets the performance requirements of the ANSI/ISEA 207-2006 publication entitled "American National Standard for High-Visibility Public Safety Vests," or equivalent revisions, and labeled as ANSI 207-2006, in lieu of ANSI/ISEA 107-2015 apparel.

Standard. Except as provided in the Option paragraph below, firefighters or other emergency responders working within the right-of-way shall wear high-visibility safety apparel as described in this article.

Option. Firefighters or other emergency responders working within the right-of-way and engaged in emergency operations that directly expose them to flame, fire, heat, and/or hazardous materials may wear retroreflective turn-out gear that is specified and regulated by other organizations, such as the National Fire Protection Association.

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Standard. For flagger wear during nighttime activity, high-visibility safety apparel that meets the Performance Class 3 requirements of the ANSI/ISEA 107–2015 publication entitled “American National Standard for High-Visibility Apparel and Headwear,” or equivalent revision, and labeled as meeting the ANSI 107-2015 standard performance for Class 3 risk exposure shall be worn.

For nighttime activity, all flaggers shall also wear a high visibility/reflective hard hat, safety glasses, a Performance Class 3 top, and a Class E bottom or a Performance Class 2 top and a Class E bottom, and safety footwear. Hard hats other than high-visibility/reflective orange or green hard hat shall be covered with a high visibility orange or green covering.

For flagger wear during daytime activity, high-visibility safety apparel that meets the Performance Class 2 or 3 requirements of the ANSI/ISEA 107–2015 publication entitled “American National Standard for High-Visibility Apparel and Headwear,” or equivalent revision, and labeled as meeting the ANSI 107-2015 standard performance for Class 3 risk exposure shall be worn. For daytime activity, all flaggers shall also wear a high-visibility hard hat, safety glasses, a Performance Class 3 top or a Performance Class 2 top, and safety footwear. Hard hats shall be high-visibility/reflective.

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616.4 Flagger Control (MUTCD Chapter 6D)

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616.4.1 Qualifications for Flaggers (MUTCD Section 6D.01)

Standard. Except when performed under emergency conditions, workers engaged in flagging operations on the state highway system shall have successfully completed a recognized flagger training course. Flagger re-certification is required every four years. Contract and permit flaggers shall be certified in accordance with Standard Specifications Section 616.4.3 (https://www.modot.org/missouri-standard-specifications-highway-construction).

Guidance. Because flaggers are responsible for public safety and make the greatest number of contacts with the public of all highway workers, they should be trained in proper traffic control practices and public contact techniques. Flaggers should be able to satisfactorily demonstrate the following abilities:

A. Ability to receive and communicate specific instructions clearly, firmly, and courteously;
B. Ability to move and maneuver quickly in order to avoid danger from errant vehicles;
C. Ability to control signaling devices (such as paddles and flags) in order to provide clear and positive guidance to drivers approaching a TTC zone in frequently changing situations;
D. Ability to understand and apply proper traffic control practices, sometimes in stressful or emergency situations; and
E. Ability to recognize dangerous traffic situations and warn workers in sufficient time to avoid injury.

616.4.2 STOP/SLOW Paddle for Hand-Signaling (MUTCD Section 6D.02)

Guidance. The STOP/SLOW paddle (see Figure 616.4.2) should be the primary and preferred hand-signaling device because the STOP/SLOW paddle gives road users more positive guidance than red flags.

Standard. The STOP/SLOW paddle (R1-1 and WO20-8) shall have an octagonal shape on a rigid handle. When used at night, the STOP/SLOW paddle shall be retroreflectorized.

Option. A STOP/STOP or a SLOW/SLOW paddle may be used in certain situations (see EPG 616.4.5), provided the device meets the size and shape requirements for the STOP/SLOW paddle.

Guidance. The STOP/SLOW paddle should be fabricated from light semi-rigid material.

Support. The optimum method of displaying a STOP or SLOW message is to place the STOP/SLOW paddle on a rigid staff that is tall enough that when the end of the staff is resting on the ground, the message is high enough to be seen by approaching or stopped traffic.

Option. The STOP/SLOW paddle may be modified to improve conspicuity by incorporating either white or red flashing lights on the STOP face, and either white or yellow flashing lights on the SLOW face. The flashing lights may be arranged in any of the following patterns:

A. Two white or red lights, one centered vertically above and one centered vertically below the STOP legend; and/or two white or yellow lights, one centered vertically above and one centered vertically below the SLOW legend;
B. Two white or red lights, one centered horizontally on each side of the STOP legend; and/or two white or yellow lights, one centered horizontally on each side of the SLOW legend;
C. One white or red light centered below the STOP legend; and/or one white or yellow light centered below the SLOW legend;
D. A series of eight or more small white or red lights no larger than ¼ inch in diameter along the outer edge of the paddle, arranged in an octagonal pattern at the eight corners of the border of the STOP face; and/or a series of eight or more small white or yellow lights no larger than ¼ inch in diameter along the outer edge of the paddle, arranged in a diamond pattern along the border of the SLOW face; or
E. A series of white lights forming the shapes of the letters in the legend.

Standard. If flashing lights are used on the STOP face of the paddle, their colors shall be all white or all red. If flashing lights are used on the SLOW face of the paddle, their colors shall be all white or all yellow.

If more than eight flashing lights are used, the lights shall be arranged such that they clearly convey the octagonal shape of the STOP face of the paddle and/or the diamond shape of the SLOW face of the paddle.

If flashing lights are used on the STOP/SLOW paddle, the flash rate shall be at least 50, but not more than 60, flashes per minute.

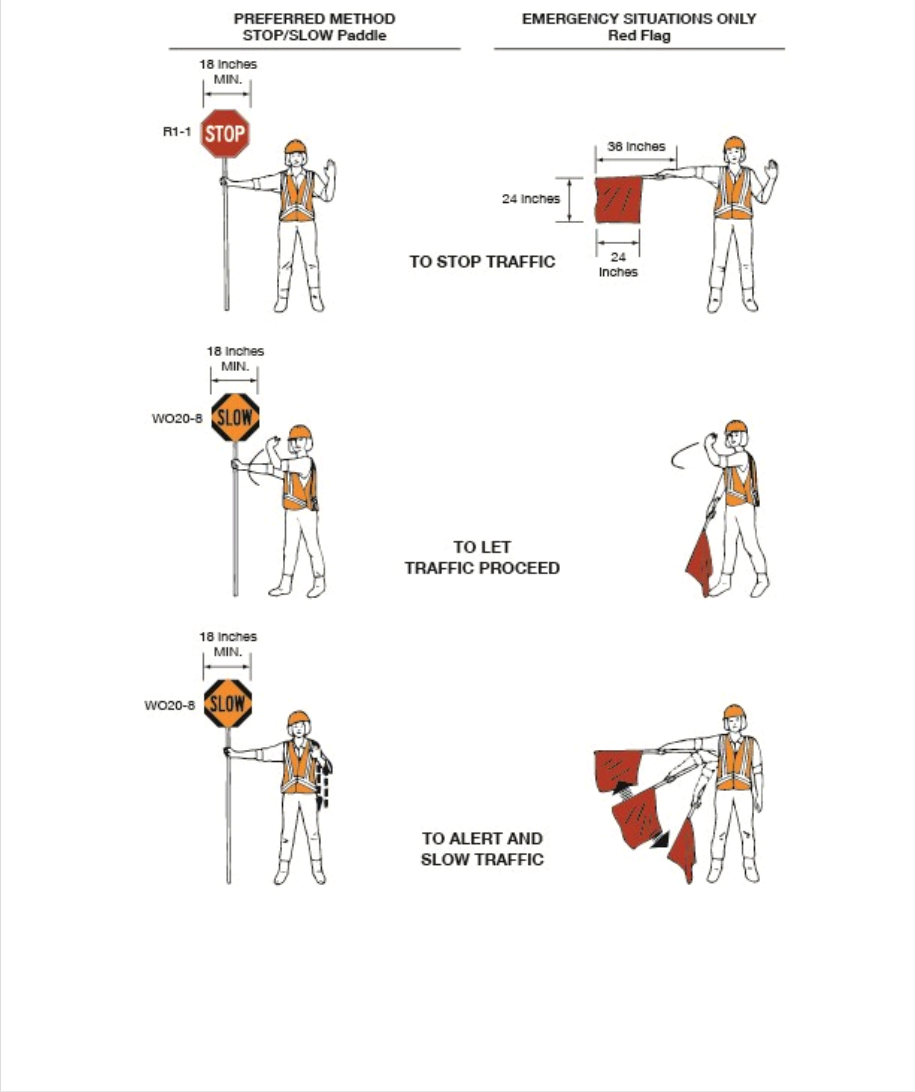


Figure 616.4.2 Use of Hand-Signaling Devices by Flaggers

616.4.3 Flag for Hand-Signaling (MUTCD Section 6D.03)

Guidance. Use of flags should be limited to emergency situations.

Standard. Flags, when used, shall be red or fluorescent orange-red in color, shall be a minimum of 24 inches square, and shall be securely fastened to a staff that is approximately 36 inches in length. Flags shall only be used until a STOP/SLOW paddle is available.

Guidance. The free edge of a flag should be weighted so the flag will hang vertically, even in heavy winds.

Standard. When used at nighttime, flags shall be retroreflectorized.

616.4.4 Flashlight for Hand-Signaling (MUTCD Section 6D.04)

Option. When flagging in an emergency situation at night in a non-illuminated flagger station, a flagger may use a flashlight with a red glow cone to supplement the STOP/SLOW paddle or flag.

Standard. When a flashlight is used for flagging in an emergency situation at night in a non-illuminated flagger station, the flagger shall hold the flashlight in the left hand, shall hold the paddle or flag in the right hand as shown in Figure 616.4.2, and shall use the flashlight in the following manner to control approaching road users:

A. To inform road users to stop, the flagger shall hold the flashlight with the left arm extended and pointed down toward the ground, and then shall slowly wave the flashlight in front of the body in a slow arc from left to right such that the arc reaches no farther than 45 degrees from vertical.
B. To inform road users to proceed, the flagger shall point the flashlight at the vehicle's bumper, slowly aim the flashlight toward the open lane, then hold the flashlight in that position. The flagger shall not wave the flashlight.
C. To alert or slow traffic, the flagger shall point the flashlight toward oncoming traffic and quickly wave the flashlight in a Figure eight motion.

616.4.5 Flagger Procedures (MUTCD Section 6D.05)

Support. The use of paddles and flags by flaggers is illustrated in Figure 616.4.2.

Standard. Flaggers shall use a STOP/SLOW paddle, a flag, or an Automated Flagger Assistance Device (AFAD) (see EPG 616.12.2 through EPG 616.12.4) to control road users approaching a TTC zone. The use of hand movements alone without a paddle, flag, or AFAD to control road users shall be prohibited when controlling traffic in a one-lane two-way operation except when the control is provided by emergency responders at incident scenes as described in EPG 616.15.1 or provided by uniformed law enforcement officers.

The following methods of signaling with a paddle shall be used:

A. To stop road users, the flagger shall stand on the shoulder, face road users and aim the STOP paddle face toward road users in a stationary position with the arm extended horizontally away from the body. The free arm shall be held with the palm of the hand above shoulder level toward approaching traffic.
B. To direct stopped road users to proceed, the flagger shall stand on the shoulder and face road users with the SLOW paddle face aimed toward road users in a stationary position with the arm extended horizontally away from the body. The flagger shall motion with the free hand in a sweeping motion for road users to proceed.
C. To alert or slow traffic, the flagger shall stand on the shoulder, face road users with the SLOW paddle face aimed toward road users in a stationary position with the arm extended horizontally away from the body. The flagger shall motion up and down with the free hand, palm down.

The following methods of signaling with a flag shall be used:

A. To stop road users, the flagger shall stand on the shoulder, face road users and extend the flag staff horizontally across the road users' lane in a stationary position so that the full area of the flag is visibly hanging below the staff. The free arm shall be held with the palm of the hand above shoulder level toward approaching traffic.
B. To direct stopped road users to proceed, the flagger shall stand on the shoulder and face road users with the flag and arm lowered from the view of the road users, and shall motion with the free hand in a sweeping motion for road users to proceed. Flags shall not be used to signal road users to proceed.
C. To alert or slow traffic, the flagger shall stand on shoulder, face road users and slowly wave the flag in a sweeping motion of the extended arm from shoulder level to straight down without raising the arm above a horizontal position. The flagger shall keep the free hand down.

Guidance. The flagger should stand on the shoulder adjacent to the road user being controlled prior to stopping road users. The flagger may walk from the shoulder toward the center line of the roadway after making eye contact with the driver of the first approaching vehicle. A flagger should only stand in the lane being used by moving road users after road users have stopped. The flagger should be clearly visible to the first approaching road user at all times. The flagger also should be visible to other road users. The flagger should be stationed sufficiently in advance of the workers to warn them (for example, with audible warning devices such as horns or whistles) of approaching danger by out-of-control vehicles. The flagger should stand alone, away from other workers, work vehicles, or equipment.

Option. In certain conditions, it may be more appropriate for a flagger to use a STOP/STOP or a SLOW/SLOW paddle to convey the appropriate message to approaching road users and avoid confusing those that are approaching the operation from the opposing direction.

Additional Information for Flaggers

Communication Devices

When required, flaggers shall be equipped with a portable, two-way, FCC approved communication system. The two flaggers must be able to see each other or be equipped with an appropriate communication device. Employees shall not use cell phones, headsets, etc., while engaged in flagging operations.

Flagger Situations

The flagger should stand either on the shoulder adjacent to the traffic being controlled or, in limited circumstances, in the barricaded lane. In rural areas, the flagger position will normally be on the right shoulder of the roadway and in urban areas, on the right curb. The flagger location may differ according to conditions, especially on multilane highways and streets. In some locations, to operate effectively, a position may have to be taken on the shoulder opposite the barricaded section. The flagger should only stand in the lane being used by traffic after traffic has stopped. Stand where oncoming traffic can see the flagger. Make sure the flagger is visible, not standing where the sun or a shadow makes it hard to see the flagger.

Factors That Affect Sight Distances

The flagger should be visible for at least 500 ft. in daytime operations, 1000 ft. for nighttime operations, or more if conditions warrant. What are some items that might hide the flagger from the driver's sight?

Hills

Curves

Obstructions

Shade – hard to see flaggers and workers in shaded area

Color contrast – wearing an orange vest and standing next to a similarly colored truck

Bad weather

Darkness

Note: If it's a minimum value, the flagger can go greater. If it's a maximum value, the flagger can go less. Use no less than the minimum value and no more than the maximum value.

Single Flagger

A single flagger may be used for short duration operations. During the short duration (60-minute) time period, a single flagger is allowed to close one lane of traffic up to a maximum of 15 minutes. Single flagging operation will have a flagger symbol sign, STOP/SLOW paddle, and a protective vehicle. An example would be a truck depositing material off the edge of the roadway. In this situation, a flagger symbol sign will be installed in advanced of the flagger. The flagger will be positioned between the flagger symbol sign and the protective vehicle. The protective vehicle is placed in advance of the work space. The flagger will stop the traffic in this closed lane while the other lane flows free. When the closed lane is opened again, the flagger allows the traffic to proceed. After stopped traffic is allowed to proceed, the flagger should turn the STOP/SLOW paddle parallel to the flagger so that no message is displayed to either direction of traffic.

Note: Single flagging procedures should not be conducted during nighttime work zone operations.

Two Flaggers

When two flaggers are required, lines of communication must be established prior to the start of flagging operations. The two flaggers must be able to see each other or have a communication device designated for proper communication. One flagger should be the lead flagger and coordinate all activities.

Always use appropriate advance warning signs, giving particular attention to sign visibility, legibility and placement.

Remember to always remove signs or completely cover the sign messages when they do not apply to present traffic control conditions.

Advance Flagger

An advance flagger may be used where there is limited sight distance to the activity area or where long lines of traffic form. The decision to use an advance flagger should be made at the work zone supervisor level. As an advance flagger, the flagger should stop each vehicle as it approaches, inform the driver of the situation ahead, and explain the actions required such as: “fresh oil ahead, drive slowly,” “keep to the right and stay in line,” etc. Where there are long lines of stopped traffic waiting to proceed, the advance flagger should move down the line and inform each driver of the reason for the delay and the approximate length of the delay. Be considerate, alert and avoid unnecessary conversation.

Pilot Vehicle

The use of a pilot vehicle is a safe and efficient means of moving traffic when a lane must be shared by traffic going both directions and the work zone area is lengthy or difficult to navigate. Two flaggers are required when a pilot vehicle is used. Flaggers will stop traffic following the standard procedures and hold the vehicles until the pilot vehicle arrives. The pilot vehicle will move to the head of the line of waiting vehicles and flagger will release the vehicles to follow the pilot vehicle back to the other flagger. After the line of cars has passed the flagger station and there is a gap in traffic, the flagger will again stop the oncoming traffic and hold the vehicles until the pilot vehicle returns.

When a pilot vehicle is used, traffic delays should be limited to 15 minutes. If the wait is longer, inform your supervisor and discuss options to keep the delay time within the 15-minute limit.

Prior to use of pilot cars on either Maintenance or Construction projects, a public outreach effort should be made using MoDOT’s “Pilot Car Brochure” (https://www.modot.org/media/20664). Contact Community Relations prior to the anticipated work and they will help with brochure and mailing. The brochure contains basic information about how pilot car operations work and gives the public advanced notification about the upcoming work zone. At a minimum, the brochure should be mailed to every property directly along the affected work area. This is important because the private entrances and driveways along the affected work area are not likely to have flagger control and knowing the proper procedures should increase the public and worker safety. Mailing the brochure to properties along side roads to the work area may also be appropriate. The “Pilot Car Brochure” has two places for project specific information. On the front cover there is a place to put a diagram or map showing the project limits to grab the public’s attention and to help convey exactly where the pilot car will be used. On the inside of the brochure there is a box for contact and project specifics.

Stationary and Mobile Flagging Operations: 3, 2 or 1 Cone Procedures

MoDOT operations shall follow the Stationary & Mobile Flagging Operations: 3, 2 or 1 Cone Procedures as shown in Figure 616.4.5. The cones provide additional target value at the flagger station area, a visual for the driver to stop and not encroach on the flagger and the cone would provide an audible noise if ran over by the driver. The allowed reflectorized channelizers are the following: trim-line, minimum 28-inch cone, or minimum 28-inch collapsible cones.

Stationary & Mobile Flagging Operations
3, 2 or 1 Cone Procedures

Flagger Station Location

- Setup in order to be visible to oncoming traffic (500' Day & 1000' Night)
- Setup a min 500' from Flagger symbol sign & no further than 1 mile
- Setup at least 100' from the traffic control devices that delineate the work space and/or work vehicles
- Flagger stations should be located such that an errant vehicle has additional space to stop without entering the work space, the flagger must identify an escape route

Mobile & Short Duration Operations

- ***When lane width is less than 12 foot, 2 cones is recommended during Short Duration and 1 cone must be used during Mobile Operations***

Long, Intermediate and Short Term Stationary Operations

- ***When lane width is 12 foot, use of 3 cones is recommended***
- ***When lane width is less than 12 foot, 2 or 1 cone(s) may be used***



Step 1: Stopping Traffic

- Setup cone(s) as shown and return to shoulder
- Remain facing traffic, with STOP visible
- Keep visual contact with drivers of stopping vehicles
- Keep left hand raised with palm facing driver, signaling to stop

Reference EPG 616.5.7.1





Step 2: Traffic has Stopped

- Once traffic has stopped, move out towards the center of the lane
- Keep the Stop/Slow Paddle in your right hand and position it out towards the center line, be sure not to cross the line with the Stop/Slow Paddle
- Keep visual contact with drivers of stopped vehicles
- Keep left hand raised with palm facing driver, signaling to stop, until traffic has stopped





Step 3: Preparing to Release Traffic

- Once you have confirmed opposing traffic is clear, make your way back to the shoulder taking the cone (as shown) with you
- Be sure to keep STOP visible to the stopped traffic
- *Based on the type of operation, lane width and number of cones used, you may need to move multiple cones*





Step 4: Releasing Traffic

- Once on the shoulder, rotate the Stop/Slow Paddle to SLOW and release traffic
- Direct traffic by signaling with your arm and waving vehicles through



These photos represent the open lane of the work zone. The flagger at the opposite end controlling traffic of the closed lane (the lane work is actually taking place in) would not move the cone(s). Instead, you would motion traffic to drive around the cone(s). There may be instances when you have to move the cone to allow traffic to pass, such as when traffic has stopped too close to the cone or to accommodate a OWOD load. A minimum of 1 cone or trim-line channelizer must be used. Additional channelizers may be used at the discretion of the District Maintenance Engineer, Safety & Health Manager, Superintendent and/or Supervisor.
Contact your Safety & Health Manager and/or Work Zone Coordinator with any questions.

Figure 616.4.5 Stationary & Mobile Flagging Operations: 3, 2 or 1 Cone Procedures

616.4.6 Flagger Stations (MUTCD Section 6D.06)

Standard. Except as provided in the following Option paragraph, flagger stations shall be located such that approaching road users will have sufficient distance to stop at an intended stopping point.

Option. If sufficient stopping sight distance is not achievable, the location of the flagger station may be modified based on engineering judgment.

The distances shown in Table 616.2.6, which provides information regarding the stopping sight distance as a function of speed, may be used for the location of a flagger station. These distances may be increased for downgrades and other conditions that affect stopping distance.

Guidance. Flagger stations should be located such that an errant vehicle has additional space to stop without entering the work space. The flagger should identify an escape route that can be used to avoid being struck by an errant vehicle.

Standard. Except in emergency situations, flagger stations shall be preceded by an advance warning sign or signs. Except in emergency situations, flagger stations shall be illuminated when flagging is used at night. The minimum required illuminance for flagging operation activity is 5 foot-candles.

Spacing between flagger and flagger symbol sign shall not exceed one mile.

Option. When the maximum allowable work zone length cannot be attained due to this limitation, additional flagger symbol signs may be staged throughout the length of the work zone. In such instances, the flagger symbol signs are set up and removed as work progresses so only one sign is displayed in each direction and that sign is no more than one mile in advance of the flagger.

Additional Information Regarding Flagger Stations

Standard. Flagger stations shall be located in advanced warning area so that approaching road users will have sufficient distance to stop at an intended stopping point.

- Be alert, remain standing at all times.
- Always face oncoming traffic and stand outside the path of an approaching vehicle.
- A flagger's normal station is on the shoulder of the road, minimum of 500 ft. from the flagger symbol sign and minimum of 100 ft. from the workspace.
- Park your vehicle off the road, away from your station.
- Stand alone, do not mingle with the work crew or the public.

Make sure you are visible to oncoming traffic, not standing where the sun is impeding visibility or in a shadow. Stand in a location that allows approaching traffic adequate time to respond.

Prior to the start of flagging operations, all signs should be in place. A good flagger location is one where the sight distance is sufficient and the flagger is clearly visible to approaching motorists, workers and, when practical, the other flagger(s).

In stationary operations, the flagger should be positioned a distance equal to the appropriate sign spacing, typically 500 ft. from the flagger symbol sign. For mobile operations, spacing between flagger and flagger symbol sign shall not exceed one mile. When the maximum allowable work zone length cannot be attained due to this limitation, additional flagger symbol signs may be staged throughout the length of the work zone. In such instances, the flagger symbol signs are set up and knocked down as work progresses so only one sign is displayed in each direction and that sign is no more than one mile in advance of the flagger.

When more than one flagger is being used, all communication procedures should be clear before any flagging begins. If there is a major intersection within the closed area, an additional flagger may be needed to control traffic entering the temporary traffic control zone from the major intersection.

Law enforcement personnel should be secured to perform flagging functions, when needed, at intersections fully-controlled by an active traffic signal or stop signs. Law enforcement personnel are the only ones who can legally assign right of way through an intersection when the assignment is opposed to in place traffic control.

When flagging on a rural undivided highway, the length of the work zone should not exceed three miles. When flagging in an urban area, the length of a work zone should not exceed one mile. When work is completed and flaggers are off the road, remove work zone signs promptly.

Emergency vehicles have right of way priority in a work zone; only allow them to proceed when safe to do so and communications between all flaggers have occurred.

The typical applications will show a distance of the sign spacing, which is greater than the buffer zone.

Guidance. Flagger stations should be located so that an errant vehicle has additional space to stop without entering the work space. The flagger should identify an escape route that can be used to avoid being struck by an errant vehicle.

Standard. Except in emergency situations, flagger stations shall be preceded by an advance warning sign or signs. Except in emergency situations, flagger stations shall be illuminated at night.

Nighttime Flagging



When nighttime work is being performed, lighting should be used to illuminate the work area, equipment crossings and other areas. The amount and location of light provided for the work area is based on the type and detail of work being performed and the degree of difficulty in navigating the work zone. Minimum required intensity for flagging operation activity is 5 foot-candles. (One foot-candle equals the amount of light delivered by a 1-candela light source to a 1 sq. ft. surface 1 ft. away). Work area lighting provides a minimum maintained intensity of 5 foot-candles (54 lux). See EPG 616.3.5 for nighttime high visibility apparel requirements.

Glare

Lighting shall not produce a disabling glare to approaching motorist, flaggers, or workers. Factors impacting glare are:



- Distance between driver and luminaries
- Height of luminaries
- Direction the luminaries are aimed

To minimize glare:

- Locate luminaries so that axis of candlepower is located away from the line of sight of motorists
- Luminaries should be aimed so the center of the beam axis is no greater than 60 degrees above vertical plane.
- Tower-mounted luminaries should be aimed either perpendicular or parallel to the roadway.



Area lighting illuminates specific areas significant to traffic guidance within the temporary traffic control zone during nighttime hours. Lighting of this nature is required at flagger stations and may be considered at gore areas, transitions, ingress and egress areas, equipment crossings, intersections, and temporary signals. A minimum intensity of 5 foot-candles in the specific area is recommended for this type of lighting. Typically, this lighting is provided by a single light on a portable lighting unit or mounted on a temporary pole. As with work lighting, lighting shall be positioned so that it does not cause glare for motorists, spill onto adjacent properties, create shadows or become a safety concern. Flagger stations in operation at night are required to be lit.

Workers Safety Considerations

Protect yourself and co-workers! Once the flagger have been selected or assigned a flagger position by the supervisor, look over the area for one or more methods or routes of escape - a place to get to in order to avoid being injured by oncoming vehicles, regardless of the reason.

Should the flagger observe a vehicle coming in the flagger's direction, the flagger should protect themselves first - THEN warn the crew.

It is a good idea to have an air horn or some type of warning device that can be heard by the crew above construction noise.

Make sure that the crew is aware of the flagger's signals and knows what to do when the flagger sounds the warning.

Remember, the flagger's job is handling traffic. As the flagger, do not assist the work crew, watch construction operations instead of traffic, or engage in any other activity.

If the flagger needs a break, the flagger should tell their supervisor so that another qualified flagger may relieve them.

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616.5 One-Lane, Two-Way Traffic Control (MUTCD Chapter 6E)

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616.5.1 One-Lane, Two-Way Traffic Control – General (MUTCD Section 6E.01)
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616.5.4 Pilot Car Method (MUTCD Section 6E.04)
616.5.5 Temporary Traffic Control Signal Method (MUTCD Section 6E.05)

616.5.1 One-Lane, Two-Way Traffic Control – General (MUTCD Section 6E.01)

Standard. When traffic in both directions must use a single lane for a limited distance, movements from each end shall be coordinated.

Guidance. Temporary one-lane, two-way traffic control operations are considered on a case-by-case basis. One-lane, two-way operations should be avoided when hourly volumes exceed 600 vehicles per hour. When hourly volumes exceed 600 vehicles per hour or conditions in the following articles cannot be met, alternative construction methods should be considered, such as night work, shoulder improvements for maintaining two-way traffic, time restrictions for lane closures, construction during off-peak hours, detours, or diversions.

Provisions should be made for alternate one-way movement through the constricted section via methods such as flagger control, a flag transfer, a pilot car, or traffic control signals.

Control points at each end should be chosen to permit easy passing of opposing lanes of vehicles.

Provisions should be made for the control of movements from intersecting side roads or access points within a one-way, two-lane TTC zone (see TA-10).

Option. Individual residences along the highway within the work area may be personally contacted and informed of the process for entering and exiting their property.

616.5.2 Flagger Method (MUTCD Section 6E.02)

Guidance. Traffic should be controlled by a flagger at each end of a constricted section of roadway. One of the flaggers should be designated as the coordinator. To provide coordination of the control of the traffic, the flaggers should be able to communicate with each other orally, electronically, or with

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manual signals. These manual signals should not be mistaken for flagging signals. When more than one flagger is being used, all communication procedures should be clear before any flagging begins.

Support. Flagger segments are generally not longer than three miles for rural highways and one mile for urban highways. The maximum length is specified on the TTC plan so the contractor can properly stage the work.

616.5.3 Flag Transfer Method (MUTCD Section 6E.03)

Support. The driver of the last vehicle proceeding into the one-lane section is given a red flag (or other token) and instructed to deliver it to the flagger at the other end. The opposite flagger, upon receipt of the flag, then knows that traffic can be permitted to move in the other direction. A variation of this method is to replace the use of a flag with an official pilot car that follows the last road user vehicle proceeding through the section.

Guidance. The flag transfer method should be employed only where the one-way traffic is confined to a relatively short length of a road, usually no more than 1 mile in length.

616.5.4 Pilot Car Method (MUTCD Section 6E.04)

Option. A pilot car may be used to guide a queue of vehicles through the TTC zone or detour.

Pilot vehicles may be specified to supplement flaggers when the length of the one-lane, two-way operation exceeds one-half mile.

Guidance. The pilot car should have the name of the contractor or contracting authority prominently displayed.

Standard. The PILOT CAR FOLLOW ME (GO20-4) sign shall be mounted on the top or on the rear of the pilot vehicle (see EPG 616.8.35).

The pilot car operation shall be coordinated with flagging operations or other methods of control at each end of the one lane section of the work zone.

If an Automated Flagger Assistance Device (AFAD) (see EPG 616.12.2) is used in pilot car operations, the AFAD shall be operated by a flagger positioned near and within the line of sight of the AFAD. The AFAD shall not be left unattended at any time that the AFAD is being used.

Guidance. The access control and signing for each side road located within the work area of the one-lane, two-way operation should be determined as discussed in EPG 616.5.1. Where applicable, the signing sequence for the side road should be supplemented with the PILOT CAR IN USE WAIT & FOLLOW (GO20-4a) sign (see TA-10 for MoDOT internal use).

If temporary traffic control signals are used in pilot car operations and long wait times will be encountered by road users, consideration should be given to using signs to notify drivers of the wait time and/or pilot car operation, based on engineering judgment.

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When a pilot vehicle is used, traffic delays should be limited to 15 minutes.

616.5.5 Temporary Traffic Control Signal Method (MUTCD Section 6E.05)

Option. Traffic control signals may be used to control vehicular traffic movements in one-lane, two-way TTC zones (see TA-12 and EPG 616.15).

Portable Signal Flagger Device (PSFD) Control. PSFDs are portable traffic control systems that may be used by the contractor to replace flagging operations for short-term lane closures on two-lane highways. In a typical flagging operation, a PSFD system requires four units with two units placed on either side of the roadway, in each direction. The primary benefit of the PSFD is the safety enhancement to the flaggers (see TA-10SPSFD).

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616.6 Temporary Traffic Control Zone Signs - General (MUTCD Chapter 6F)

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- EPG 616.6.2.1 Sign Location
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- EPG 616.6.2.3 Sign Supports
- Additional Guidance for Sign Supports

616.6.3 Sign Maintenance (MUTCD Section 6F.03)

616.6.1 General Characteristics of TTC Zone Signs (MUTCD Section 6F.01)

Support. TTC zone signs convey both general and specific messages by means of words, symbols, and/or arrows and have the same three categories as all road user signs: regulatory, warning, and guide.

Guidance. Where the color orange is required, the fluorescent orange color should also be used.

Support. The fluorescent version of orange provides higher conspicuity than standard orange, especially during twilight.

Option. Flashing beacons (see EPG 902.18) may be used in conjunction with signs.

Standard. When flashing beacons are used in conjunction with a sign, they shall not block the sign face.

Support. Work zone warning signs are typically 48 in. x 48 in., diamond-shaped, black on fluorescent orange signs with Type 9 or 11 sheeting. Work zone regulatory signs are identical to permanent regulatory signs with Type 4 sheeting. Work zone guide signs are generally rectangular in shape and have a black legend and border on a fluorescent orange background with Type 9 or 11 sheeting; but can come in different sizes, shapes, colors and sheeting depending on type and purpose of the signing. Sometimes a plate or plaque is affixed to a work zone sign or mounted below it to customize the sign.

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Sign dimensions for contract projects are located in Standard Plan 616.10 (https://www.modot.org/media/16892) and for maintenance projects are located in the MGS-04-01 Roll-up Signs.

EPG 903.1.4 contains additional information regarding the design of signs, including an Option allowing the development of special word message signs if a standard word message or symbol sign is not available to convey the necessary regulatory, warning, or guidance information.

Guidance. Non-standard work zone signs (i.e., legends or sizes not shown on Standard Plan 616.10 (https://www.modot.org/media/16892)) should be designed with the assistance of the Highway Safety and Traffic Division. Correspondence with the Highway Safety and Traffic Division on this design is to indicate these are work zone signs. The non-standard work zone signs should be detailed in the plans and listed under “Miscellaneous Signs” on the D-2BS sheet.

Standard. All signs used at night shall be retroreflective.

Option. Signs may be made of rigid or flexible material.

EPG 616.6.1.1 Flags

Option. Standard orange flags may be used in conjunction with signs during daytime hours. It is allowable to leave flags on signs when daytime work continues into nighttime.

Standard. When standard orange flags are used in conjunction with a sign, they shall not block the sign face.

EPG 616.6.1.2 Existing Sign Use

Option. Existing warning signs that are still applicable may remain in place within a TTC zone.

Guidance. All existing signs within the project limits should be shown on the TTC plan with a descriptive note indicating "UIP" (use in place), "cover" or "remove".

616.6.2 Sign Placement (MUTCD Section 6F.02)

EPG 616.6.2.1 Sign Location

Guidance. Signs should be located on the right-hand side of the roadway unless otherwise provided in the EPG.

To ensure maximum visibility, existing signs and other physical features (trees, sidewalks, billboards, commercial signs, etc.) should be considered when locating work zone signs.

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Option. Where special emphasis is needed, signs may be placed on both the left-hand and right-hand sides of the roadway. Signs mounted on portable supports may be placed within the roadway itself. Signs may also be mounted on or above barricades.

EPG 616.6.2.2 Sign Mounting Height

Support. The provisions of this article regarding mounting height apply unless otherwise provided for a particular sign elsewhere in the EPG.

Standard. Rural Undivided Highways - The minimum height, measured vertically from the bottom of the sign to the elevation of the near edge of the pavement, of signs installed at the side of undivided highways in rural areas shall be 5 feet (see Standard Plan 616.10 (https://www.modot.org/media/16892)).

Urban Highways or Rural Divided Highways - The minimum height, measured vertically from the bottom of the sign to the top of the curb, or in the absence of curb, measured vertically from the bottom of the sign to the elevation of the near edge of the traveled way, of signs installed at the side of the divided highways or highways in business, commercial, or residential areas where parking or pedestrian movements are likely to occur, or where the view of the sign might be obstructed, shall be 7 feet (see Standard Plan 616.10 (https://www.modot.org/media/16892)).

The minimum height, measured vertically from the bottom of the sign to the sidewalk, of signs installed above sidewalks shall be 7 feet.

The bottom of a sign mounted on a barricade, or other portable support, shall be at least 1 foot above the traveled way.

Option. The height to the bottom of a secondary sign mounted below another sign may be 1 foot less than the height provided in the first three Standard paragraphs of EPG 616.6.2.2.

EPG 616.6.2.3 Sign Supports

Guidance. Neither portable nor permanent sign supports should be located on sidewalks, bicycle facilities, or areas designated for pedestrians or bicyclists.

Standard. Signs shall be mounted and placed in accordance with Section 307 of the U.S. Department of Justice 2010 ADA Standards for Accessible Design, September 15, 2010, 28 CFR 35 and 36, Americans with Disabilities Act of 1990.

Guidance. Except as provided in the following option paragraph, signs mounted on portable sign supports that do not meet the minimum mounting heights provided in EPG 903 should not be used for a duration of more than 3 days.

Option. The R9-8 through R9-11a series, R11 series, W1-6 through W1-8 series, M4-10, E5-1, or other similar type signs may be used on portable sign supports that do not meet the minimum mounting heights provided in EPG 903 for longer than 3 days.

Support. Methods of mounting signs other than on posts are illustrated in Figure 616.6.2.3.

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Guidance. Signs mounted on Type 3 Barricades should not cover more than 50 percent of the top two rails or 33 percent of the total area of the three rails.

Standard. Signs and sign supports used together shall be crashworthy (see EPG 616.1.4). Where large signs having an area exceeding 50 square feet are installed on multiple breakaway posts, the clearance from the ground to the bottom of the sign shall be at least 7 feet.

Option. For mobile operations, a sign may be mounted on a work vehicle, a shadow vehicle, or a trailer stationed in advance of the TTC zone or moving along with it.

Support. Standard Plan 616.10 (https://www.modot.org/media/16892) shows sign mounting requirements, post size and quantities requirements, and post installation details. The standard plans show detailed information for use of signs on posts, barrier, vehicles, and barricades.

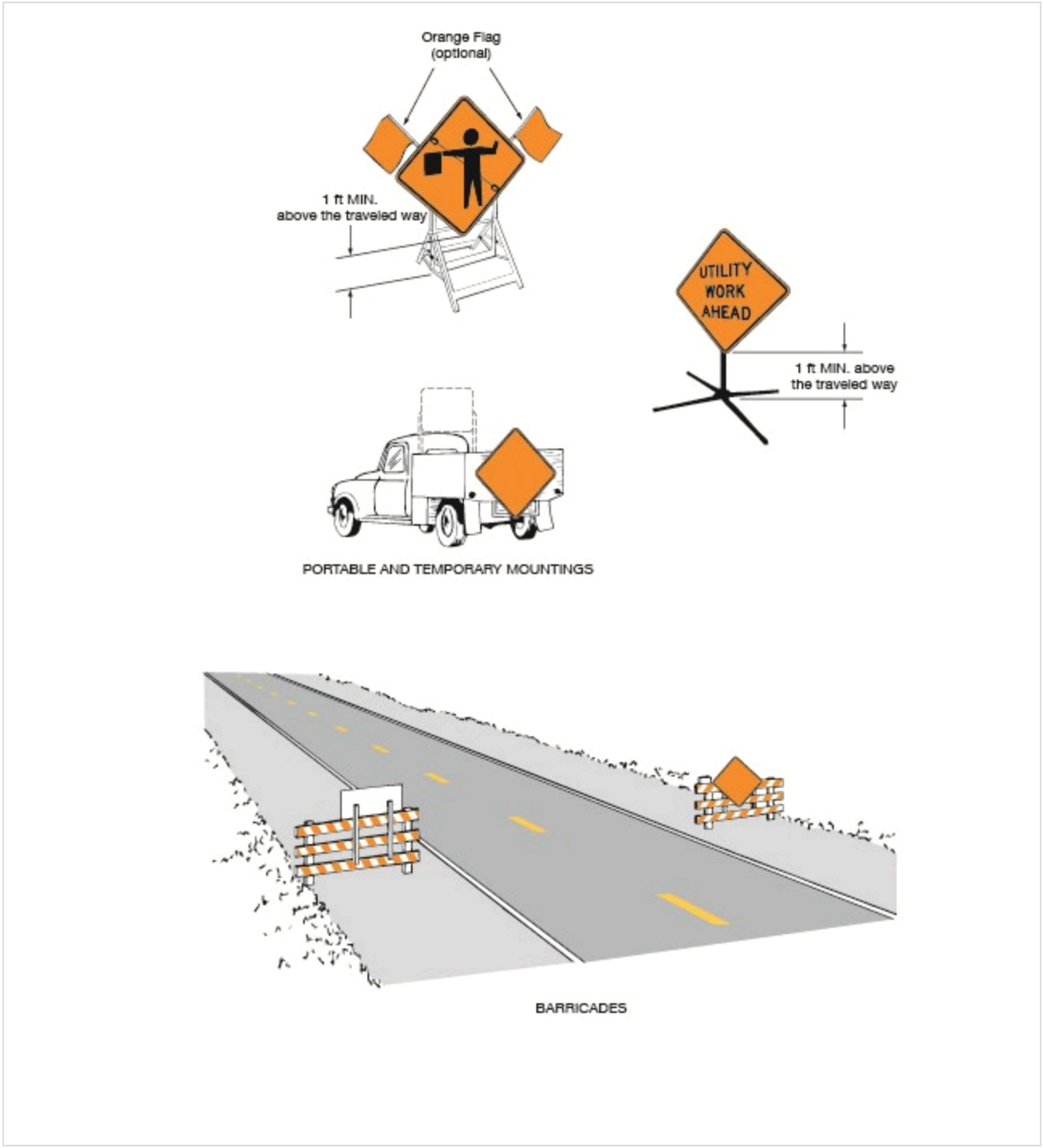


Figure 616.6.2.3 Methods of Mounting Signs Other Than on Posts

Additional Guidance for Sign Supports

For long-term duration projects, post or type 1 portable sign supports should be 5 ft. or 7 ft. depending on rural or urban applications. For short-term duration projects (up to 3 days), signs may be mounted on type 2 portable sign supports and should have a minimum height of 12 inches. Additional mounting heights for signs located on barrier and vehicles are located in Standard Plan 616.10.

The sign mounting method is dependent upon the contractor's operations and is not to be dictated on the plans. See Standard Plan 616.10 for mounting methods and post installation requirements. Sign relocation is only paid for post-mounted signs. MoDOT does not pay for temporary or portable sign relocations. If the designer judges post-mounted signs will be used on a project, a pay item for Relocated Signs (616-10.10) is to be included in the contract documents. Sign quantities are tabulated on the plans and are paid for by the square foot. The tabulation and any notes concerning the signs shall be consistent throughout the traffic control plan.

Signs may be supported in one of four methods: on a portable support, post-mounted, vehicle-mounted or barrier-mounted.

Portable signs are temporary traffic control signs affixed to a portable support such as an easel, fold- up sign stand, self-driving post, skid, barricade, etc.

These signs are to be constructed of either a rigid or flexible substrate, as required, to meet crashworthiness requirements.

A minimum mounting height of one ft., measured vertically from the bottom of the sign to the near edge of the pavement, is recommended. However, higher mounting heights should be considered on higher volume highways, on multi-lane highways, in urban settings, and where the sign is located in line with other traffic control devices to increase visibility of the sign. Mounting heights for regulatory and guide signs are as specified for post-mounted signs.

Portable signs may be located adjacent to or within the roadway itself. However, a minimum lateral clearance of three ft., measured horizontally from the edge of the sign to edge of the designated traveled way, is recommended.

Signs mounted in this manner may be left in place for up to three days. An exception to this duration is any crosswalk/sidewalk closure, any road closure, Horizontal Arrow, Double-Headed Horizontal Arrow, Chevron, DETOUR (within arrow) or Gore Exit sign. These sign may be left in place for over three days.

When not in use, consideration should be given to removing portable signs from the temporary traffic control zone to discourage theft and limit potential hazards within the right of way.



Picture 1: Easel portable sign. Pictures 2 & 3: Fold-up signs at 1-ft. and 5-ft. heights.



Picture 4: Self-driving post. Picture5: Skid-mounted sign

Post-mounted signs are temporary traffic control signs affixed to a breakaway support such as perforated square steel tube, u-channel, wood, etc..

These signs are constructed of a rigid substrate.

A minimum mounting height of seven ft., measured vertically from the bottom of the sign to the near edge of the pavement, is recommended for urban highways and rural divided highways. A minimum mounting height of five ft., measured vertically from the bottom of the sign to the near edge of the pavement, is recommended for rural undivided highways. If a supplemental sign is mounted below another sign, the mounting height of the supplemental sign may be one ft. less than the heights specified.

A minimum lateral clearance of two ft., measured horizontally from the edge of the sign to the edge of the roadway, is recommended for installations on roadways with curbed sections. A minimum lateral clearance of six ft., measured horizontally from the edge of the sign to the edge

of the traveled way, is recommended for installations on roadways without curbed sections.



U-Channel Post-Mounted Sign

Vehicle-mounted signs, when allowed in this manual, are temporary traffic control signs affixed to a protective vehicle or pilot car at a recommended minimum height of four ft., measured vertically from the bottom of the sign to the pavement surface.

For additional information, review Standard Drawing 616.10.



Vehicle-Mounted Signs

Barrier-mounted signs are temporary traffic control signs affixed to the top portion of a temporary or permanent traffic barrier. The method of attachment to the barrier must ensure a positive connection and minimize potential for vehicle snagging. Mounting heights for regulatory and guide signs are as specified for post-mounted signs.

In order to accommodate narrow medians, see EPG 903.1.5.

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Barrier-Mounted Signs

If the sign cannot be mounted by a method specified by EPG 903.1.14, Standard Plan 616.10, or Standard Plan 903.03, the mounting method is also to be specified in the plans.

616.6.3 Sign Maintenance (MUTCD Section 6F.03)

Guidance. Signs should be properly maintained for cleanliness, visibility, retroreflectivity, and correct positioning.

Signs that have lost significant legibility should be promptly replaced.

Support. EPG 616.24 provides examples of sign maintenance.

EPG 903.1.21 contains information regarding the retroreflectivity of signs, including the signs that are used in TTC zones.

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616.7 TTC Zone Regulatory Signs (MUTCD Chapter 6G)

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616.7.4 Road Closed Signs (R11-2 Series) (MUTCD Section 6G.04)
616.7.5 Local Traffic Only Signs (R11-3 Series and R11-4) (MUTCD Section 6G.05)
616.7.6 Weight Limit Signs (R12-1) (MUTCD Section 6G.06)
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616.7.8 PEDESTRIAN CROSSWALK Sign (R9-8) (MUTCD Section 6G.09)
616.7.9 SIDEWALK CLOSED Signs (R9-9, R9-10, R9-11, and R9-11a) (MUTCD Section 6G.10)
616.7.10 TURN OFF 2-WAY RADIO AND CELL PHONE Sign (R22-2) (MUTCD Section 6G.11)
616.7.11 Other Regulatory Signs (MUTCD Section 6G.12)

616.7.1 Regulatory Sign Authority (MUTCD Section 6G.01)

Support. Regulatory signs inform road users of traffic laws or regulations and indicate the applicability of legal requirements that would not otherwise be apparent.

Standard. Regulatory signs shall be authorized by the public agency or official having jurisdiction and shall conform with EPG 903.2.

616.7.2 Regulatory Sign Design and Size (MUTCD Section 6G.02)

Standard. TTC regulatory signs shall comply with the Standards for regulatory signs presented in Part 2 and in the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)).

The sizes for TTC regulatory signs shall be as shown in Standard Plan 616.10 (https://www.modot.org/media/16892).

616.7.3 Regulatory Sign Applications (MUTCD Section 6G.03)

Standard. If a TTC zone requires regulatory measures different from those existing, the existing permanent regulatory devices shall be removed or covered and superseded by the appropriate temporary regulatory signs. This change shall be made in compliance with applicable ordinances or statutes of the jurisdiction.

616.7.4 Road Closed Signs (R11-2 Series) (MUTCD Section 6G.04)



Guidance. The ROAD CLOSED (R11-2) sign should be used when the roadway is closed to all road users except contractors' equipment or officially authorized vehicles. The R11-2 sign should be accompanied by appropriate warning and detour signing (see TA-8 and TA-9).

Guidance. Road Closed signs should be installed at or near the center of the roadway on or above a Type 3 Barricade that closes the roadway (see EPG 616.11.7).

Standard. Road Closed signs shall not be used where road user flow is maintained through the TTC zone with a reduced number of lanes on the existing roadway or where the actual closure is some distance beyond the sign.



The correct use of the Road Closed sign is to either mount it on the barricade or place a sign behind the barricade. If a sign stand and barricades are used separately, the sign and barricades should have a distance of 7 ft. to 10 ft. apart.

616.7.5 Local Traffic Only Signs (R11-3 Series and R11-4) (MUTCD Section 6G.05)

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R11-3a



R11-4

Guidance. The Local Traffic Only signs should be used where road user flow detours to avoid a closure some distance beyond the sign, but where local road users can use the roadway to the point of closure. These signs should be accompanied by appropriate warning and detour signing (see TA-8 and TA-9).

In rural applications, the Local Traffic Only sign should have the legend ROAD CLOSED XX MILES AHEAD, LOCAL TRAFFIC ONLY (R11-3).

In urban areas, a ROAD CLOSED TO THRU TRAFFIC (R11-4) sign should be used.

616.7.6 Weight Limit Signs (R12-1) (MUTCD Section 6G.06)



R12-1

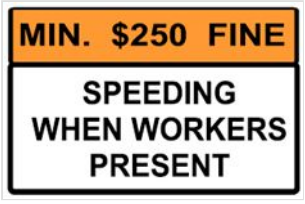
Standard. A Weight Limit sign, which shows the gross weight that is permitted on the roadway or bridge, shall be consistent with State or local regulations and shall not be installed without the approval of the authority having jurisdiction over the highway.

When weight restrictions are imposed because of the activity in a TTC zone, a marked detour shall be provided for vehicles weighing more than the posted limit.

616.7.7 Work Zone and Higher Fines Signs and Plaques (MUTCD Section 6G.08)



G20-5aP WORK ZONE



WORK ZONE FINE



SPEEDING/PASSING

Standard. A WORK ZONE (GO20-5aP) plaque shall be mounted above all SPEED LIMIT signs within a TTC zone, except on the SPEED LIMIT signs at the end of the work zone to return traffic to the normal posted speed. These plaques shall be mounted above all DO NOT PASS signs within a TTC zone. These signs shall be used on the above signs regardless of whether the WORK ZONE FINE sign is used.

WORK ZONE FINE sign and SPEEDING/PASSING (plate) information and guidelines is available in EPG 616.18.

616.7.8 PEDESTRIAN CROSSWALK Sign (R9-8) (MUTCD Section 6G.09)



R9-8

Option. The PEDESTRIAN CROSSWALK (R9-8) sign may be used to indicate where a temporary crosswalk has been established.

Standard. If a temporary crosswalk is established, it shall be accessible to pedestrians with disabilities in accordance with EPG 616.3.3.

616.7.9 SIDEWALK CLOSED Signs (R9-9, R9-10, R9-11, and R9-11a) (MUTCD Section 6G.10)



R9-9



R9-10



R9-11



R9-11a

Guidance. SIDEWALK CLOSED signs should be used where pedestrian flow is restricted. Bicyclist/Pedestrian Detour (MO4-9a) signs or Pedestrian Detour (MO4-9b) signs should be used where pedestrian flow is rerouted (see EPG 616.9.2).

The SIDEWALK CLOSED (R9-9) sign should be installed at the beginning of the closed sidewalk, at the intersections preceding the closed sidewalk, and elsewhere along the closed sidewalk as needed.

The SIDEWALK CLOSED, (ARROW) USE OTHER SIDE (R9-10) sign should be installed at the beginning of the restricted sidewalk when a parallel sidewalk exists on the other side of the roadway.

The SIDEWALK CLOSED AHEAD, (ARROW) CROSS HERE (R9-11) sign should be used to indicate to pedestrians that sidewalks beyond the sign are closed and to direct them to open crosswalks, sidewalks, or other travel paths.

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The SIDEWALK CLOSED, (ARROW) CROSS HERE (R9-11a) sign should be installed just beyond the point to which pedestrians are being redirected.

Support. These signs are typically mounted on a detectable barricade to encourage compliance and to communicate with pedestrians that the sidewalk is closed. Printed signs are not useful to many pedestrians with vision disabilities. A barrier or barricade detectable by a person with a vision disability is sufficient to indicate that a sidewalk is closed. If the barrier is continuous with detectable channelizing devices for an alternate route, accessible signing might not be necessary.

See EPG 616.3 and EPG 616.28 for additional information.

616.7.10 TURN OFF 2-WAY RADIO AND CELL PHONE Sign (R22-2) (MUTCD Section 6G.11)

Support. See EPG 616.8.22 for signage at blasting areas.

616.7.11 Other Regulatory Signs (MUTCD Section 6G.12)

Option. Regulatory word message signs other than those classified and specified in the EPG and the "Standard Highways Signs" publication (see EPG 911 (MUTCD Section 1A.05)) may be developed and used based on engineering judgment to aid the enforcement of other laws or regulations in TTC zones.

Standard. All special regulatory signs shall be designed with the assistance of the Highway Safety and Traffic Division.

Guidance. Special regulatory signs should comply with the general requirements of color, shape, and alphabet size and series. The sign message should be brief, legible, and clear.

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616.8 TTC Zone Warning Signs (MUTCD Chapter 6H)

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616.8.3 ROAD (BRIDGE) (RAMP) WORK Sign (WO20-1) (MUTCD Section 6H.03)

616.8.4 DETOUR Sign (WO20-2) (MUTCD Section 6H.04)

616.8.5 ROAD CLOSED Sign (WO20-3) (MUTCD Section 6H.05)

616.8.6 ONE LANE ROAD Sign (WO20-4) (MUTCD Section 6H.06)

616.8.7 Lane(s) Closed Signs (WO20-5, WO20-5a, and WO9-3) (MUTCD Section 6H.07)

616.8.8 Lane Ends Signs (WO4-2 and WO9-2a) (MUTCD Section 6H.08)

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616.8.10 RAMP NARROWS Sign (WO5-4) (MUTCD Section 6H.10)

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616.8.12 EXIT OPEN and EXIT CLOSED Signs (EO5-2 and EO5-2a) (MUTCD Section 6H.12)

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616.8.14 BE PREPARED TO STOP sign (WO3-4)

616.8.15 Two-Way Traffic Sign (WO6-3) (MUTCD Section 6H.16)

616.8.16 Workers Signs (WO21-1 and WO21-1a) (MUTCD Section 6H.18)

616.8.17 Surface Condition Signs (WO21-2 and WO8-7) (MUTCD Section 6H.19)

616.8.18 Motorized Traffic Signs (WO8-6 and WO8-6c) (MUTCD Section 6H.21)

616.8.19 Shoulder Work Signs (WO21-5, WO21-5a, and WO21-5b)(MUTCD Section 6H.22)

616.8.20 SURVEY CREW Sign (WO21-6) (MUTCD Section 6H.23)

616.8.21 UTILITY WORK Sign (WO21-7) (MUTCD Section 6H.24)

616.8.22 Signs for Blasting Areas

Support. TTC zone warning signs notify road users of specific situations or conditions on or adjacent to a roadway that might not otherwise be apparent.

616.8.23 Shoulder Signs and Plaque (WO8-4, WO8-17, and WO8-17P) (MUTCD Section 6H.26)

616.8.24 UNEVEN LANES Sign (WO8-11) (MUTCD Section 6H.27)

616.8.25 STEEL PLATE AHEAD Sign (WO8-24) (MUTCD Section 6H.28)

616.8.26 NO CENTER LINE Sign (WO8-12) (MUTCD Section 6H.29)

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616.8.28 Large Arrow Signs (WO1-6 and WO1-7)

616.8.29 Double Reverse Curve Signs (WO24-1 Series) (MUTCD Section 6H.31)

616.8.30 Advisory Speed Plaque (WO13-1P) (MUTCD Section 6H.32)

616.8.31 Supplementary Distance Plaque (WO7-3aP) (MUTCD Section 6H.33)

616.8.32 Motorcycle Plaque (WO8-15aP) (MUTCD Section 6H.34)

616.8.33 ROAD WORK NEXT XX MILES Sign (GO20-1) (MUTCD Section 6H.35)

616.8.34 END ROAD WORK Sign (GO20-2) (MUTCD Section 6H.36)

616.8.35 PILOT CAR FOLLOW ME Sign (GO20-4) and PILOT CAR IN USE WAIT & FOLLOW (GO20-4a) (MUTCD Section 6H.37)

616.8.36 Other Warning Signs (MUTCD Section 6H.38)

616.8.37 Reduced Speed Limit Ahead (WO3-5)

616.8.38 GROOVED PAVEMENT (WO8-15)

616.8.39 NARROW LANES (WO5-5)

616.8.40 Vehicle Speed Feedback System (Radar Speed Advisory System)

616.8.41 Object Markers (MUTCD Section 6H.43)

Standard. TTC warning signs shall comply with the Standards for warning signs presented in EPG 903 and in the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)).

Support. The letter "O" is added to the TTC sign designation of WO and GO to represent the color orange, which provides a separate nomenclature from the permanent warning signs.

Standard. The sizes for TTC guide signs shall be as shown in Standard Plan 616.10 (https://www.modot.org/media/16892).

Except as provided in the first option paragraph below, TTC warning signs shall be diamond-shaped with a black legend and border on a fluorescent orange background, except for the Grade Crossing Advance Warning (WO10-1) sign, which shall have a black legend and border on a fluorescent yellow background.

Option. Warning signs that are required or recommended in EPG 903 or EPG 908 to have a fluorescent yellow-green background may have that color background in TTC zones.

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Existing warning signs with a yellow background that are still applicable may remain in place.

Warning signs used for TTC incident management situations may have a black legend and border on a fluorescent pink background.

Mounting or space considerations may justify a change from the standard diamond shape to a rectangular shape.

In emergencies with coordination from district work zone coordinators, available warning signs having yellow backgrounds may be used if signs with orange or fluorescent pink backgrounds are not at hand.

Guidance. Where any part of the roadway is obstructed or closed by work activities or incidents, advance warning signs should be installed to alert road users well in advance of these obstructions or restrictions.

Where road users include pedestrians, the provision of supplemental audible information or detectable barriers or barricades should be provided for people with vision disabilities.

Support. Detectable barriers or barricades communicate very clearly to pedestrians who have vision disabilities that they can no longer proceed in the direction that they are traveling.

Option. Advance warning signs may be used singly or in combination.

Where distances are not displayed on warning signs as part of the message, a supplemental plaque with the distance legend may be mounted immediately below the sign on the same support.

616.8.2 Position of Advance Warning Signs (MUTCD Section 6H.02)

Guidance. Where highway conditions permit, warning signs should be placed in advance of the transition and activity areas at varying distances depending on roadway type, condition, and posted speed. Table 616.2.4 contains information regarding the spacing of advance warning signs.

Where multiple advance warning signs are needed on the approach to a transition and activity area, the ROAD WORK AHEAD (WO20-1) sign should be the first advance warning sign encountered by road users.

Support. Various conditions, such as limited sight distance or obstructions that might require a driver to reduce speed or stop, might require additional advance warning signs.

Option. As an alternative to a specific distance on advance warning signs, the word AHEAD may be used.

Utility work, maintenance, or minor construction can occur within the TTC zone limits of a major construction project, and additional warning signs may be needed.

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Guidance. Utility, maintenance, and minor construction signing and TTC should be coordinated with appropriate authorities so that road users are not confused or misled by the additional TTC devices.

616.8.3 ROAD (BRIDGE) (RAMP) WORK Sign (WO20-1) (MUTCD Section 6H.03)



WO20-1

Guidance. The ROAD (BRIDGE) (RAMP) WORK (WO20-1) sign, which serves as a general warning of obstructions or restrictions, should be located in advance of the work space or any detour, on the road where the work is taking place.

Where traffic can enter a TTC zone from a crossroad or a major (high-volume) driveway, an advance warning sign should be used on the crossroad or major driveway.

Option. The legend BRIDGE or RAMP may be substituted for ROAD and the distance legend may be either XX FEET, XX MILES, or AHEAD.

616.8.4 DETOUR Sign (WO20-2) (MUTCD Section 6H.04)



WO20-2

Guidance. The DETOUR (WO20-2) sign should be used in advance of a road user detour over a different roadway or route.

The DETOUR sign should only be installed on the route being detoured. The DETOUR sign should not be used with temporary bypasses or connections unless part of or the entire route is over other existing roadways.

Option. The distance legend may be either XX FEET, XX MILES, or AHEAD.

Support. See EPG 616.2.9 for additional information regarding detour routes.

See EPG 616.9.2 for additional information regarding detour route signing.

616.8.5 ROAD CLOSED Sign (WO20-3) (MUTCD Section 6H.05)



WO20-3

Guidance. The ROAD CLOSED (WO20-3) sign should be used in advance of the point where a highway is closed to all road users, or to all but local road users.

Option. The distance legend may be either XX FEET, XX MILES, or AHEAD.

616.8.6 ONE LANE ROAD Sign (WO20-4) (MUTCD Section 6H.06)



WO20-4

Standard. The ONE LANE ROAD (WO20-4) sign shall be used only in advance of that point where motor vehicle traffic in both directions must use a common single lane (see EPG 616.5.1).

Option. The distance legend may be either XX FEET, XX MILES, or AHEAD.

616.8.7 Lane(s) Closed Signs (WO20-5, WO20-5a, and WO9-3) (MUTCD Section 6H.07)



WO20-5



WO20-5a



WO9-3

Standard. The Lane(s) Closed sign shall be used in advance of that point where one or more through lanes of a multi-lane roadway are closed.

For a single lane closure, the Lane Closed (WO20-5) sign shall use the legend RIGHT (LEFT) LANE CLOSED. Where two or more adjacent lanes are closed, the WO20-5a sign shall use the legend XX RIGHT (LEFT) LANES CLOSED.

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Option. The distance legend may be either XX FEET, XX MILES, or AHEAD.

Guidance. The Interior Lane Shift (WO9-3) sign should be used in advance of that point where work occupies an interior lane(s) and approaching motor vehicle traffic is directed to the right or left of the work zone in the lane(s) by using a shifting taper to route traffic around the closed interior lane(s).

616.8.8 Lane Ends Signs (WO4-2 and WO9-2a) (MUTCD Section 6H.08)



WO4-2



WO9-2a

Option. The Lane Ends (WO4-2) sign may be used to warn drivers of the reduction in the number of lanes for moving motor vehicle traffic in the direction of travel on a multi-lane roadway.

Guidance. The MERGE HERE TAKE TURNS (WO9-2a) sign should be used to identify the merge point at which vehicles from alternate lanes take turns merging during Late Merge applications (see EPG 616.14.19).

616.8.9 ON RAMP Plaque (WO13-4P) (MUTCD Section 6H.09)



WO13-4P

Guidance. When work is being done on a ramp, but the ramp remains open, the ON RAMP (WO13-4P) plaque should be used to supplement the advance ROAD WORK sign.

Support. It may not be possible to install an ON RAMP plaque on signs mounted for short duration or mobile operations.

616.8.10 RAMP NARROWS Sign (WO5-4) (MUTCD Section 6H.10)



WO5-4

Guidance. The RAMP NARROWS (WO5-4) sign should be used in advance of the point where work on a ramp reduces the normal width of the ramp along a part or all of the ramp.

Support. See EPG 903.3.15 for additional information regarding the ROAD NARROWS (WO5-1) sign.

See EPG 903.3.16 for additional information regarding the NARROW BRIDGE (WO5-2) sign.

616.8.11 EXIT GORE sign (EO5-1)



EO5-1

Guidance. Temporary EXIT GORE (EO5-1) signs should be provided when work in the vicinity of off-ramps shifts the gore point of the ramp.

616.8.12 EXIT OPEN and EXIT CLOSED Signs (EO5-2 and EO5-2a) (MUTCD Section 6H.12)



EO5-2



EO5-2a

Option. An EXIT OPEN (EO5-2) or EXIT CLOSED (EO5-2a) sign may be used to supplement other warning signs where work is being conducted in the vicinity of an exit ramp and where the exit maneuver for vehicular traffic using the ramp is different from the normal condition.

616.8.13 Flagger Sign (WO20-7) (MUTCD Section 6H.15)



WO20-7

Guidance. The Flagger (WO20-7) sign should be used in advance of any point where a flagger is stationed to control road users. These signs should be displayed when a flagger is present and should be covered or removed when the flagger is not present.

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Option. The flagger sign may be used in conjunction with the BE PREPARED TO STOP (WO3-4) sign.

616.8.14 BE PREPARED TO STOP sign (WO3-4)



WO3-4

Option. The BE PREPARED TO STOP (WO3-4) sign may be used where conditions require traffic to stop for flagger-controlled truck/equipment crossings or entrances and temporary road closures where traffic is allowed to proceed unimpeded until access is needed. This sign may also be used in one-lane, two-way flagging operations where no work zone speed limit is established.

616.8.15 Two-Way Traffic Sign (WO6-3) (MUTCD Section 6H.16)



WO6-3

Guidance. When one roadway of a normally-divided highway is closed, with two-way vehicular traffic maintained on the other roadway, the Two-Way Traffic (WO6-3) sign should be used at the beginning of the two-way vehicular traffic section and at intervals to remind road users of opposing vehicular traffic.

616.8.16 Workers Signs (WO21-1 and WO21-1a) (MUTCD Section 6H.18)



WO21-1



WO21-1a

Option. A Workers (WO21-1) sign may be used to alert road users of workers in or near the roadway.

Guidance. In the absence of other warning devices, a Workers sign should be used when workers are in the roadway.

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Option. The WORKERS (WO21-1a) word message sign may be used as an alternate to the Workers (W21-1) symbol sign.

616.8.17 Surface Condition Signs (WO21-2 and WO8-7) (MUTCD Section 6H.19)



WO21-2 WO8-7 WO8-7a

Guidance. The FRESH OIL (WO21-2), LOOSE GRAVEL (WO8-7), and FRESH OIL/LOOSE GRAVEL signs should be used to warn road users of the surface treatment.

616.8.18 Motorized Traffic Signs (WO8-6 and WO8-6c) (MUTCD Section 6H.21)



WO8-6 WO8-6c

Option. TRUCK CROSSING (WO8-6) and TRUCK ENTRANCE (WO8-6c) signs may be used to alert road users to locations where unexpected travel on the roadway or entries into or departures from the roadway by construction vehicles might occur.

Support: These locations might be relatively confined or might occur randomly over a segment of roadway.

616.8.19 Shoulder Work Signs (WO21-5, WO21-5a, and WO21-5b)(MUTCD Section 6H.22)



WO21-5 WO21-5a WO21-5b

Support. Shoulder Work signs warn of maintenance, reconstruction, or utility operations on the highway shoulder where the roadway is unobstructed.

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Standard. The Shoulder Work sign shall have the legend SHOULDER WORK (WO21-5), RIGHT (LEFT) SHOULDER CLOSED (WO21-5a), or RIGHT (LEFT) SHOULDER CLOSED XX FT or AHEAD (WO21-5b).

Option. The Shoulder Work sign may be used in advance of the point on a non-limited access highway where there is shoulder work. It may be used singly or in combination with a ROAD WORK NEXT XX MILES or ROAD WORK AHEAD sign.

Guidance. On freeways and expressways, the RIGHT (LEFT) SHOULDER CLOSED XX FT or AHEAD (WO21-5b) sign followed by RIGHT (LEFT) SHOULDER CLOSED (WO21-5a) sign should be used in advance of the point where the shoulder work occurs and should be preceded by a ROAD WORK AHEAD sign.

616.8.20 SURVEY CREW Sign (WO21-6) (MUTCD Section 6H.23)



WO21-6

Guidance. The SURVEY CREW (WO21-6) sign should be used to warn of surveying crews working in or adjacent to the roadway.

616.8.21 UTILITY WORK Sign (WO21-7) (MUTCD Section 6H.24)



WO21-7

Option. For permit projects, the UTILITY WORK (WO21-7) sign may be used as an alternate to the ROAD (STREET) WORK (WO20-1) sign for utility operations on or adjacent to a highway.

The distance legend may be either XX FEET, XX MILES, or AHEAD.

616.8.22 Signs for Blasting Areas

Support. These signs are not shown on the traffic control plan due to the various methods of detonation and various locations within a project that may require blasting. Reference to Blasting Area requirements are located in the following: Specification Section 616 (https://www.modot.org/missouri-standard-specifications-highway-construction%7C), EPG 203, MUTCD Section 6H.25, and MUTCD TA-2.

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Standard. Road users shall be warned where blasting operations occur. A sequence of signs shall be prominently displayed to warn all road users of blasting operations and to direct operators of mobile radio equipment, including cellular telephones, to turn off transmitters in a blasting area. These signs shall be covered or removed when there are no explosives in the area or the area is otherwise secured.

616.8.23 Shoulder Signs and Plaque (WO8-4, WO8-17, and WO8-17P) (MUTCD Section 6H.26)



WO8-4


WO8-17



WO8-17P

Option. The SOFT SHOULDER (WO8-4) sign may be used to warn of a soft shoulder condition.

Guidance. The Shoulder Drop Off (WO8-17) sign should be used when an unprotected shoulder drop-off, adjacent to the travel lane, exceeds 2 inches in depth for a continuous length along the roadway, based on engineering judgment.

When the SHOULDER DROP-OFF signs are installed for greater than three days, the SHOULDER DROP-OFF (W8-17P) supplemental plaque should be mounted below the W8-17sign.

616.8.24 UNEVEN LANES Sign (WO8-11) (MUTCD Section 6H.27)



WO8-11

Guidance. The UNEVEN LANES (WO8-11) sign should be used during operations that create a difference in elevation between adjacent lanes that are open to travel.

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Support. This sign is to be used as shown in Standard Plans 619.10 (https://www.modot.org/media/16895) and 620.10 (https://www.modot.org/media/16897).

616.8.25 STEEL PLATE AHEAD Sign (WO8-24) (MUTCD Section 6H.28)



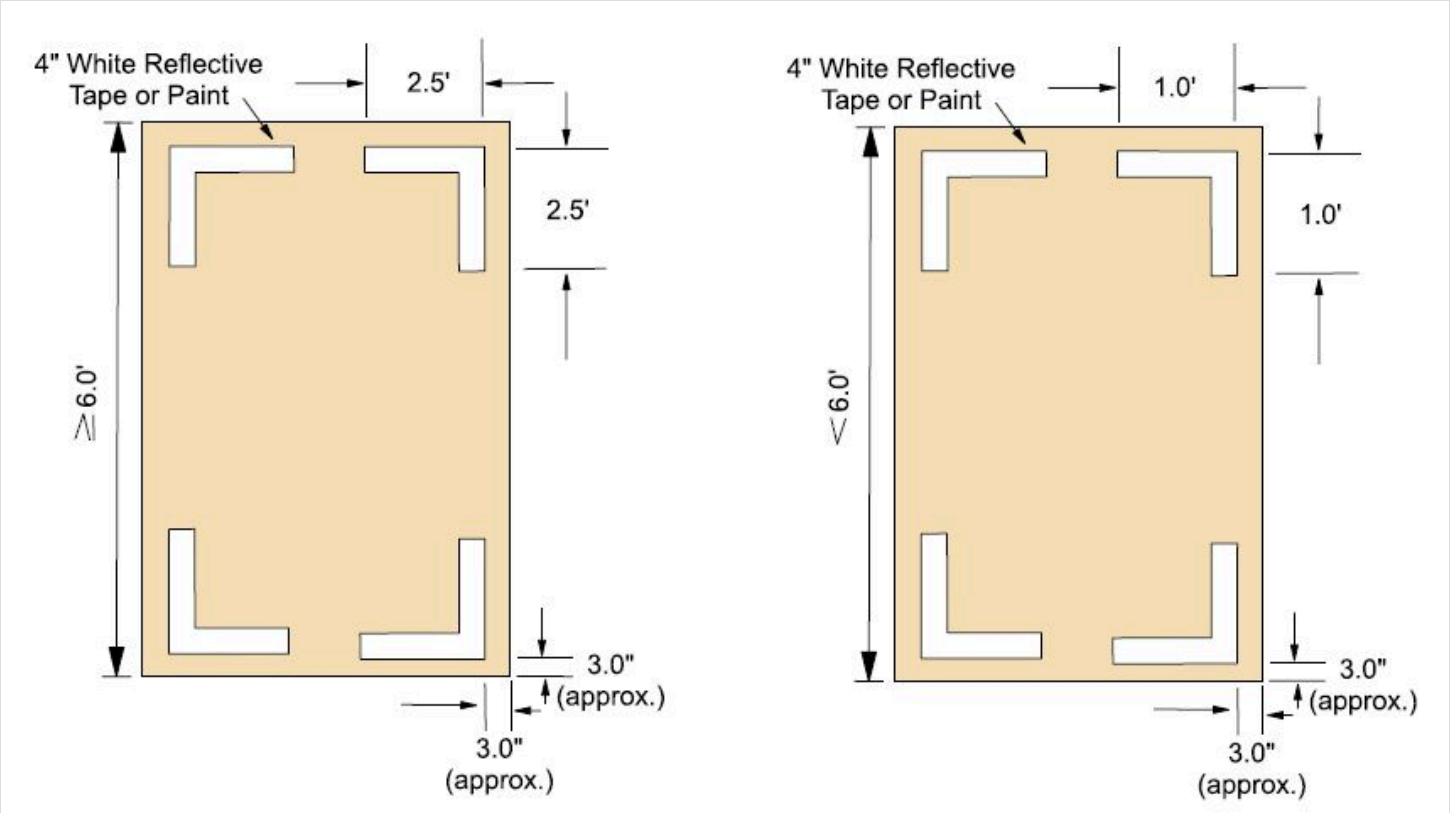
WO8-24

Option. Unprotected excavations or repairs located within a roadway are usually backfilled when workers are not present, but may also be covered with steel plates. While plating is generally used by Maintenance employees on low speed (under 45 mph) roadways, it may also be appropriate within contract and permit work zones. A design exception may be needed to use steel plates in contract and permit work zones.

Guidance. When steel plates are used, STEEL PLATE AHEAD (WO8-24) signs should be used to warn road users that the presence of a temporary steel plate(s) might make the road surface uneven and might create slippery conditions during wet weather (see TA-47).

In any case, the plate must be appropriately sized to adequately conduct the vehicular loading and must be delineated according to the diagram below. Only 3/4 in. of the plate's overall thickness may protrude above the roadway surface and the height differential must be transitioned at a rate no steeper than 3H:1V around the entire perimeter. This may be accomplished by beveling the plate, wedging asphalt or mechanically fastening, as approved by the engineer. Care must be taken to ensure that a mechanical fastener is appropriate for the operating speed of the work zone. The surface of the plate must be treated for skid resistance, either by surface deformation or direct application of a friction course.

Support. See Figure 616.8.25 for markings to be used on steel plates.



Steel plates with any side ≥ 6' long

Steel plates with any side < 6' long

Figure 616.8.25 Examples of Markings on Steel Plates

616.8.26 NO CENTER LINE Sign (WO8-12) (MUTCD Section 6H.29)



WO8-12

Support. The NO CENTER LINE (WO8-12) sign is a black-on-orange warning sign used on two-lane and two-lane with auxiliary lane facilities where centerline marking is eliminated for 200 linear ft. or more. These signs are used in combination with temporary pavement marking. These signs are placed in advance of the missing centerline markings area at the recommended sign spacing.

Guidance. For extended areas continuously or intermittently missing centerline marking, NO CENTER LINE signs should also be installed within 150 ft. after the intersection of a state route and at two-mile spacing throughout the affected area.

Option. Upon the discretion of the engineer or supervisor, additional NO CENTER LINE signs may be installed within 150 ft. after other intersections.

When a sign placed at the two-mile interval and another sign placed after an intersection fall within one-eighth mile of each other, the sign placed at the two-mile interval may be eliminated.

Support. Standard Plan 620.10 (https://www.modot.org/media/16897) shows the configuration for these signs and pavement markers on a two-lane roadway. This layout is to also be included in the TCP.

Standard. When temporary pavement markings and/or NO CENTER LINE signs are necessitated by either a change in roadway use or the elimination of permanent pavement markings, the following provisions shall be incorporated into the operation:

A. Those performing the operation shall be responsible for coordinating the procurement, installation, maintenance and removal, as applicable, of pavement markings, temporary or permanent, and any NO CENTER LINE signs.
B. Temporary pavement markings and any NO CENTER LINE signs shall be in place prior to opening a roadway to traffic. On two-lane highways with AADTs less than 1000, when certain material and operations do not allow the practical application of these markings (e.g., seal coat, cold mix curing, fly coating, etc.), installation of temporary pavement markings may be delayed up to 5 working days, initiated by the elimination of the permanent pavement markings, provided the required NO CENTER LINE signs are in place as prescribed previously prior to opening the facility to traffic.
C. For Contract Projects – Permanent pavement marking shall be installed in accordance with Section 620 Pavement Marking (http://www.modot.org/business/standards_and_specs/SpecbookEPG.pdf#page=9).
D. For Maintenance Operations – Permanent pavement markings should be installed no later than 14 calendar days after any operation has been completed. However, delays in installation should be minimized where possible.
E. Removal or obliteration of all pavement markings shall be complete and leave minimal pavement scarring. Concealing any pavement marking with black paint or asphalt is not acceptable.

616.8.27 Reverse Curve Signs (WO1-4 Series) (MUTCD Section 6H.30)



WO1-4 WO1-4b WO1-4c

Guidance. In order to give road users advance notice of a lane shift, a Reverse Curve (WO1-4, WO1-4b, or WO1-4c) sign should be used when a lane (or lanes) is being shifted to the left or right. If the design speed of the curves is 30 mph or less, a Reverse Turn (WO1-3) sign should be used.

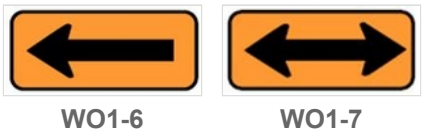
Standard. If a Reverse Curve (or Turn) sign is used, the direction of the reverse curve (or turn) shall be appropriately illustrated. Except as provided in the following option paragraph, the number of lanes illustrated on the sign shall be the same as the number of through lanes available to road users.

Option. Where two or more lanes are being shifted, a WO1-4 (or WO1-3) sign with an ALL LANES (WO24-1cP) plaque may be used instead of a sign that illustrates the number of lanes.

Where more than three lanes are being shifted, the Reverse Curve (or Turn) sign may be rectangular.

Support. See EPG 903.3.7 for information regarding Turn and Curve signs.

616.8.28 Large Arrow Signs (WO1-6 and WO1-7)



WO1-6 WO1-7

Support. The One-Direction Large Arrow (WO1-6) sign and the Two-Direction Large Arrow (WO1-7) sign are used in conjunction with Type 3 barricades. The WO1-6 sign is also used in conjunction with the Turn (WO1-1) sign and the Reverse Turn (WO1-3) sign.

616.8.29 Double Reverse Curve Signs (WO24-1 Series) (MUTCD Section 6H.31)



WO24-1 WO24-1a WO24-1b WO24-1cP

Option. The Double Reverse Curve (WO24-1, WO24-1a, or WO24-1b) sign may be used where the tangent distance between two reverse curves is less than 600 feet, thus making it difficult for a second Reverse Curve (WO1-4 series) sign to be placed between the curves. If the design speed of the curves is 30 mph or less, Double Reverse Turn signs may be used.

Standard. If a Double Reverse Curve (or Turn) sign is used, the direction of the double reverse curve (or turn) shall be appropriately illustrated. Except as provided in the following option paragraph, the number of lanes illustrated on the sign shall be the same as the number of through lanes available to road users.

Option. Where two or more lanes are being shifted, a WO24-1 (or Double Reverse Turn sign showing one lane) sign with an ALL LANES (WO24-1cP) plaque may be used instead of a sign that illustrates the number of lanes.

Where more than three lanes are being shifted, the Double Reverse Curve (or Turn) sign may be rectangular.

616.8.30 Advisory Speed Plaque (WO13-1P) (MUTCD Section 6H.32)



WO13-1P

Option. In combination with a warning sign, an Advisory Speed (WO13-1P) plaque may be used to indicate a recommended speed for a change in horizontal alignment or through a signed condition within a TTC zone.

Standard. The Advisory Speed plaque shall not be used in conjunction with any sign other than a warning sign, nor shall it be used alone. When used with orange TTC zone signs, this plaque shall have a black legend and border on an orange background.

Support. Warning signs with advisory speed plaques (see EPG 903.3.59) inform drivers of the recommended operating speed based on temporary conditions within a TTC zone. Examples include narrow lanes, temporary diversion (reverse curves), lane shifts, sight distance restrictions, rough road surface, bumps, low/no shoulder, workers on foot, work vehicles or equipment close to the open travel lane, or other conditions that indicate the need for reduced speed.

AASHTO and ITE design documents contain established engineering practices for the determination of the recommended advisory speeds for horizontal curves or locations with limited sight distance.

616.8.31 Supplementary Distance Plaque (WO7-3aP) (MUTCD Section 6H.33)



WO7-3aP

Option. In combination with a warning sign, a Supplementary Distance (WO7-3aP) plaque with the legend NEXT XX MILES may be used to indicate the length of highway over which a work activity is being conducted, or over which a condition exists in the TTC zone.

In long TTC zones, Supplementary Distance plaques with the legend NEXT XX MILES may be placed in combination with warning signs at regular intervals within the zone to indicate the remaining length of highway over which the TTC work activity or condition exists.

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Standard. The Supplementary Distance plaque with the legend NEXT XX MILES shall not be used in conjunction with any sign other than a warning sign, nor shall it be used alone. When used with orange TTC zone signs, this plaque shall have a black legend and border on an orange background.

Guidance. When used in TTC zones, the Supplementary Distance plaque with the legend NEXT XX MILES should be placed below the initial warning sign designating that, within the approaching zone, a temporary work activity or condition exists.

616.8.32 Motorcycle Plaque (WO8-15aP) (MUTCD Section 6H.34)



WO8-15aP

Option. A Motorcycle (WO8-15aP) plaque may be mounted below a GROOVED PAVEMENT (WO8-15) sign if the warning is intended to be directed primarily to motorcyclists.

Standard. When the GROOVED PAVEMENT (WO8-15) sign is in place for greater than three days, the Motorcycle (WO8-15Pa) plaque shall be used in addition to the WO8-15 sign.

616.8.33 ROAD WORK NEXT XX MILES Sign (GO20-1) (MUTCD Section 6H.35)



GO20-1

Guidance. The ROAD WORK NEXT XX MILES (GO20-1) sign should be installed in advance of TTC zones that are more than 2 miles in length.

Option. The ROAD WORK NEXT XX MILES (GO20-1) sign may be used to warn road users of a downstream lane addition or head-to-head lane reconstruction. Examples of projects where this sign is not to be installed include new alignment, guardrail replacement, or those with mobile operations.

The ROAD WORK NEXT XX MILES sign may be mounted on a Type 3 Barricade. The sign may also be used for TTC zones of shorter length.

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Standard. The distance displayed on the ROAD WORK NEXT XX MILES sign shall be stated to the nearest whole mile.

616.8.34 END ROAD WORK Sign (GO20-2) (MUTCD Section 6H.36)



GO20-2

Guidance. When used, the END ROAD WORK (G20-2) sign should be placed near the downstream end of the termination area, as determined by engineering judgment when the ROAD WORK NEXT XX MILES sign is used.

Option. The END ROAD WORK sign may be installed on the back of a warning sign facing the opposite direction of road users or on the back of a Type 3 Barricade.

616.8.35 PILOT CAR FOLLOW ME Sign (GO20-4) and PILOT CAR IN USE WAIT & FOLLOW (GO20-4a) (MUTCD Section 6H.37)



GO20-4



GO20-4a

Standard. The PILOT CAR FOLLOW ME (GO20-4) sign shall be mounted in a conspicuous position on the top or on the rear of a vehicle used for guiding one-way vehicular traffic through or around a TTC zone (see EPG 616.5.4).

Standard. The 42 x 30 inch PILOT CAR IN USE WAIT & FOLLOW (GO20-4a) shall be used on all state routes.

Option. The 42 x 30 inch PILOT CAR IN USE WAIT & FOLLOW (GO20-4a) may be used on any non-state routes, as determined by the engineer.

Guidance. The 18 x 12 inch PILOT CAR IN USE WAIT & FOLLOW (GO20-4a) should be used on all other non-state routes (city streets, county roads, etc.).

616.8.36 Other Warning Signs (MUTCD Section 6H.38)

Option. Advance warning signs may be used by themselves or with other advance warning signs.

Besides the warning signs specifically related to TTC zones, several other warning signs in EPG 903 may apply in TTC zones.

Word message warning signs other than those classified and specified in the EPG and the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)) may be developed and used based on engineering judgment to warn of special conditions in TTC zones.

Standard. Except as provided in EPG 616.6.1 and EPG 616.8.1, other warning signs that are used in TTC zones shall have black legends and borders on a fluorescent orange background.

Guidance. Other warning signs should comply with the general requirements of color, shape, and alphabet size and series. The sign message should be brief, legible, and clear.

616.8.37 Reduced Speed Limit Ahead (WO3-5)



WO3-5

Standard. The Reduced Speed Limit Ahead (WO3-5) sign shall be used when the geometrics of the roadway require an approved speed reduction greater than 10 mph below the existing or posted speed limit.

Support. If the geometrics of the roadway require a 10 mph speed reduction at the beginning of the project and construction work requires an additional 5 to 10 mph reduction farther down the road, then the WO3-5 sign is not required.

Standard. The Reduced Speed Limit Ahead (WO3-5) sign shall be followed by a SPEED LIMIT (R2-1) sign. The speed limit indicated on the REDUCDED SPEED LIMIT AHEAD sign shall be identical to the SPEED LIMIT sign (see EPG 616.18).

616.8.38 GROOVED PAVEMENT (WO8-15)



WO8-15

Standard. When cold-milled areas are left opened to traffic, the GROOVED PAVEMENT (WO8-15) sign shall be used in locations described in Specifications Section 622 (https://www.modot.org/missouri-standard-specifications-highway-construction).

Support. Since designers cannot estimate the various times a contractor may leave a milled area opened to traffic, these signs are not shown on the traffic control plan. These signs, if used, are furnished by the contractor at the contractor's expense.

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Standard. When the GROOVED PAVEMENT (WO8-15) sign is in place for greater than three days, the Motorcycle (WO8-15aP) plaque shall be used in addition to the WO8-15 sign.

616.8.39 NARROW LANES (WO5-5)



WO5-5

Option. The NARROW LANES (WO5-5) sign may be used on multilane highways where the lane width is temporarily reduced.

616.8.40 Vehicle Speed Feedback System (Radar Speed Advisory System)

Option. A Vehicle Speed Feedback (WO13-20aP) plaque (see Figure 616.8.40) that displays the speed of an approaching vehicle to the vehicle operator may be used to provide warning to drivers of their speed in relation to a speed limit (R2-1) sign within a TTC zone.

Standard. When used to display the speed of an approaching vehicle in relation to the posted speed limit, the Vehicle Speed Feedback (WO13-20aP) plaque shall be mounted below a Speed Limit (R2-1) sign (see EPG 903.2.20).

The Vehicle Speed Feedback assembly shall not be installed at a location where the posted speed limit on the route changes. Vehicle Speed Feedback assemblies shall be placed anywhere downstream of a speed limit change but shall be a minimum of 200 feet downstream of a speed limit change on conventional routes and a minimum of 400 feet downstream of a speed limit change on expressways of freeways. Vehicle Speed Feedback assemblies shall be installed in accordance with the Vehicle Speed Feedback Assembly Typical Application.

The legend YOUR SPEED shall be a black legend on a fluorescent orange retroreflective background. The changeable legend displaying the speed of the approaching vehicle shall be a yellow or orange luminous legend on a black opaque background. The vehicle speed displayed on the changeable portion of the sign shall be displayed as an integer. The Vehicle Speed Feedback plaque shall not flash, strobe, change color, or use other animated elements integrated into the changeable legend display. When no vehicles are approaching, the changeable display shall not display a legend.

Vehicle Speed Feedback sign equipment shall not have the capability to collect, store or transmit personally identifiable information of any type.

Guidance. The changeable portion of the Vehicle Speed Feedback legend should be approximately the same height, width, and stroke of those on the Speed Limit sign it supplements or is mounted below.

When a WO13-20aP plaque is used with a Speed Limit sign it should be approximately the same width as the Speed Limit sign it is mounted below.

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Support. A nonstandard JSP, NJSP 21-06 (https://epg.modot.org/forms/JSP/NJSP2106.docx), has been created for the Radar Speed Advisory System (RSAS).

See EPG 907.8 for additional information.



Figure 616.8.40 Vehicle Speed Feedback Plaque

616.8.41 Object Markers (MUTCD Section 6H.43)

Support. Object markers are used in work zones to mark temporary obstructions within or adjacent to the roadway (see EPG 903.3.73).

Standard. A Type 1 Object Marker shall be attached to the lead module of sand-filled impact attenuators.

Option. Type 3 Object Markers may be used to supplement other channelizing devices in special situations.

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616.9 TTC Zone Guide Signs (MUTCD Chapter 6I)

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616.9.1 Guide Signs – General (MUTCD Section 6I.01)

616.9.2 Detour Signs and Plaques (MO4-8P, MO4-8a, MO4-9, MO4-9a, MO4-9b, MO4-9c, and MO4-10) (MUTCD Section 6I.02)

616.9.3 EXIT CLOSED Panel (MUTCD Section 6I.03)

616.9.4 WORK ZONE NO PHONE ZONE Sign

616.9.5 Project Information Sign

616.9.1 Guide Signs – General (MUTCD Section 6I.01)

Support. Guide signs along highways provide road users with information to help them along their way through the TTC zone. The design of guide signs is presented in EPG 903.

The letter "O" is added to the TTC sign designation of MO and EO to represent the color orange, which provides a separate nomenclature from the permanent guide signs.

Guidance. The following guide signs should be used in TTC zones as needed:

A. Standard route markings where temporary route changes are necessary,
B. Directional signs and street name signs, and
C. Special guide signs relating to the condition or work being done.

Standard. If additional temporary guide signs are used in TTC zones, they shall have a black legend and border on a fluorescent orange background.

Option. Guide signs used in TTC incident management situations may have a black legend and border on a fluorescent pink background.

When temporary directional signs and temporary street name signs are used in conjunction with detour routing, these signs may have a black legend and border on fluorescent orange background.

When permanent directional signs or permanent street name signs are used in conjunction with detour signing, they may have a white legend on a green background (see EPG 903.4.31 and EPG 903.4.40).

Standard. The sizes for TTC guide signs shall be as shown in Standard Plan 616.10 (https://www.modot.org/media/16892).

616.9.2 Detour Signs and Plaques (MO4-8P, MO4-8a, MO4-9, MO4-9a, MO4-9b, MO4-9c, and MO4-10) (MUTCD Section 6I.02)





Detour Route Assemblies

Standard. Each detour shall be adequately marked with standard temporary route signs and destination signs.

Guidance. Where city streets, county roads and other public roads are detoured due to roadwork, detour signing should be provided showing the name or number of the road being detoured. Detour signing should be provided at each junction through the detour route as well as confirmation signs where there are long detour sections over the same route.

Detour Route Assemblies should only be installed on the route being detoured. Detour signing should be used along the detour route to guide road users through the detour. Detour Route Assemblies should not be used with temporary bypasses or connections unless part of or the entire route is on other existing roadways.

Support. Additional information is located in EPG 616.2.9 Detours and Diversions.

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TA-8 and TA-9 show a typical detour of a road closed beyond the junction.

Option. Detour signs in TTC incident management situations may have a black legend and border on a fluorescent pink background.

The Detour Arrow (MO4-10) sign may be used where a detour route has been established.

The DETOUR (MO4-8P) plaque may be mounted at the top of a route sign assembly to mark a temporary route that detours from a highway, bypasses a section closed by a TTC zone, and rejoins the highway beyond the TTC zone.

Guidance. The Detour Arrow (MO4-10) sign should normally be mounted just below the ROAD CLOSED (R11-2, R11-3a, or R11-4) sign. The Detour Arrow sign should include a horizontal arrow pointed to the right or left as required.

The DETOUR (MO4-9) sign should be used for unnumbered highways, for emergency situations, for periods of short durations, or where, over relatively short distances, road users are guided along the detour and back to the desired highway without route signs.

A Street Name sign should be placed above, or the street name should be incorporated into, a DETOUR (MO4-9) sign to indicate the name of the street being detoured.

Option. The END DETOUR (MO4-8a) sign may be used to indicate that the detour has ended.

Guidance. When the END DETOUR sign is used on a numbered highway, the sign should be mounted above a route sign after the downstream end of the detour.

The Pedestrian/Bicyclist Detour (MO4-9a) sign should be used where a pedestrian/bicyclist detour route has been established because of the closing of a pedestrian/bicycle facility to through traffic.

Standard. If used, the Pedestrian/Bicyclist Detour sign shall have an arrow pointing in the appropriate direction.

Option. The arrow on a Pedestrian/Bicyclist Detour sign may be on the sign face or on a supplemental plaque.

The Pedestrian Detour (MO4-9b) sign or Bicyclist Detour (MO4-9c) sign may be used where a pedestrian or a bicyclist detour route (not both) has been established because of the closing of the pedestrian or bicycle facility to through traffic.

616.9.3 EXIT CLOSED Panel (MUTCD Section 6I.03)

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Guidance. When an exit ramp is closed, an EXIT CLOSED sign panel with a black legend and border on a fluorescent orange background should be placed diagonally across the interchange/intersection guide signs.

616.9.4 WORK ZONE NO PHONE ZONE Sign



WORK ZONE NO PHONE ZONE SIGN

Support. The WORK ZONE NO PHONE ZONE sign is designed to capture the traveling public's expectation that cellular phone and other distracting device usage is not allowed within the project limits.

Guidance. The WORK ZONE NO PHONE ZONE sign should be used on all contract projects unless the roadway is closed to traffic or the construction has no effect on existing roadways. One WORK ZONE NO PHONE ZONE sign should be placed a minimum of 500 ft. before the ROAD WORK AHEAD sign. On two-lane undivided roadways, only one NO PHONE ZONE sign should be used for each direction of traffic affected by the project.

Option. District Engineers have discretion whether to use this sign on mobile and short-term projects, such as contract leveling course.

Support. See Standard Plan 616.10 (https://www.modot.org/media/16892) for sign layout.

616.9.5 Project Information Sign

Support. The Project Information sign provides the traveling public the finished date of the project as promised by MoDOT.

Guidance. The Project Information sign should be used on projects deemed prominent by the district. One sign should be placed in each direction of traffic on state highways. This sign should not be used on roadways that are closed to traffic or where the construction has no effect on existing roadways.

The Project Information sign should be placed in a visible area within the project's limits provided its placement does not disrupt a sequence of signs (e.g., between ROAD WORK AHEAD, RIGHT LANE CLOSED AHEAD and RIGHT LANE CLOSED).

Option. If a visible location within the project is not available, this sign may be placed approximately 500 ft. before the GO20-1 ROAD WORK NEXT XX MILES sign.

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Support. Because of the sign's width, flatter areas are preferable in order to avoid long post lengths in fill sections.

See EPG 903.8.9 for additional information regarding Project Information signs.

Project Information Sign Details

The designer should complete the D-28 form and submit it to the Central Office Highway Safety and Traffic Division where it will be detailed. The finished layout will be returned to the designer for inclusion in the traffic control plans.

The options available to the designer to describe the project are listed below. Any deviations from this list must be approved by the Public Information and Outreach Unit.

- Bridge Improvements
- New Bridge
- Intersection Improvement
- Road Improvements
- Road Resurfacing
- New Signals
- New Intersection
- New Pavement
- Signal Improvements
- Pavement Repair
- Road Widening
- Safety Improvements
- Lane Additions
- New Interchange
- Surface Improvements

The options available for project completion date on the sign are Spring, Summer, Fall, or Winter along with the year.

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616.10 TTC Zone Pavement Markings (MUTCD Chapter 6J)

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616.10.1 Pavement Markings in TTC Zones (MUTCD Section 6J.01)
616.10.2 Temporary Markings (MUTCD Section 6J.02)
616.10.3 Temporary Raised Pavement Markers (MUTCD Section 6J.03)
616.10.4 Delineators (MUTCD Section 6J.04)

616.10.1 Pavement Markings in TTC Zones (MUTCD Section 6J.01)

Support. Pavement markings are installed or existing markings are maintained or enhanced in TTC zones to provide road users with a clearly defined path for travel through the TTC zone in day, night, and twilight periods under both wet and dry pavement conditions.

Guidance. The work should be planned and staged to provide for the placement and removal of the pavement markings in a way that minimizes the disruption to traffic flow approaching and through the TTC zone during the placement and removal process.

Standard. Existing pavement markings shall be maintained in all long-term stationary (see EPG 616.14.1) TTC zones in accordance with EPG 620.1 and EPG 620.2, except as otherwise provided for temporary pavement markings in EPG 616.10.2. Pavement markings shall match the alignment of the markings in place at both ends of the TTC zone. Pavement markings shall be placed along the entire length of any paved detour or temporary roadway prior to the detour or roadway being opened to road users.

Guidance. For long-term stationary operations, pavement markings in the temporary traveled way that are no longer applicable should be removed or obliterated as soon as practical. Pavement marking obliteration should remove the non-applicable pavement marking material, and the obliteration method should minimize pavement scarring.

Standard. Painting over existing pavement markings with black paint or spraying with asphalt shall not be accepted as a substitute for removal or obliteration.

Option. Removable, non-reflective, preformed tape that is approximately the same color as the pavement surface may be used where markings need to be covered temporarily.

616.10.2 Temporary Markings (MUTCD Section 6J.02)

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Support. Temporary markings are those pavement markings or devices that are placed within TTC zones to provide road users with a clearly defined path of travel through the TTC zone when the permanent markings are either removed or obliterated during the work activities. Temporary markings are typically needed during the reconstruction of a road while it is open to traffic, such as overlays or surface treatments or where lanes are temporarily shifted on pavement that is to remain in place.

Guidance. Unless justified based on engineering judgment, temporary pavement markings should not remain in place for more than 14 days after the application of the pavement surface treatment or the construction of the final pavement surface on new roadways or over existing pavements.

The temporary use of edge lines, channelizing lines, lane-reduction transitions, gore markings, and other longitudinal markings, and the various non-longitudinal markings (such as stop lines, railroad crossings, crosswalks, words, symbols, or arrows) should be in accordance with Standard Plan 620.10 (https://www.modot.org/media/16897) and EPG 620.

Short-term pavement marking tape should be used in locations where the marking will be in place no more than two weeks. Short-term pavement marking paint is not typically removed. If removal is required, removable tape should be used.

Standard. Warning signs, channelizing devices, and delineation shall be used to indicate required road user paths in TTC zones where it is not possible to provide a clear path by pavement markings.

Except as otherwise provided in this Section, all temporary pavement markings for no-passing zones shall comply with the requirements of EPG 620.1 and EPG 620.2. All temporary broken (intermittent) line pavement markings shall use the same cycle length as permanent markings and shall have line segments that are at least 4 feet long.

Guidance. All pavement markings and devices used to delineate road user paths should be reviewed during daytime and nighttime periods.

Support. MoDOT does not sign for passing zones.

Guidance. If used, the NO CENTER LINE sign should be placed in accordance with EPG 616.8.26.

616.10.3 Temporary Raised Pavement Markers (MUTCD Section 6J.03)

Option. Retroreflective raised pavement markers may be substituted for markings of other types in TTC zones.

Standard. If used, the color and pattern of the raised pavement markers shall simulate the color and pattern of the markings for which they substitute.

If temporary raised pavement markers are used to substitute for broken (intermittent) line segments, a group of at least three retroreflective markers equally spaced at no greater than 5 feet shall be installed every 40 feet.

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If temporary retroreflective raised pavement markers are used to substitute for solid lines, the markers shall be equally spaced at no greater than 20 feet.

Option. Temporary raised pavement markers may be used to substitute for broken (intermittent) line segments by using at least two retroreflective markers placed at each end of a segment of 2 to 5 feet in length, using the same cycle length as permanent markings.

Standard Plan 620.10 (https://www.modot.org/media/16897) may be used to substitute for the number, spacing, and layout of temporary raised pavement markers in a work zone.

Guidance. Raised pavement markers should be considered for use along surfaced detours or temporary roadways, and other changed or new travel-lane alignments.

Option. Temporary marking tape may be used to establish experimental lanes or intersection markings to determine the markings effectiveness prior to installing the permanent markings. It may also be used to mark temporary centerlines following spot sealing and patching operations.

616.10.4 Delineators (MUTCD Section 6J.04)

Support. MoDOT does not use delineators in work zones.

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616.11 TTC Zone Channelizing Devices (MUTCD Chapter 6K)

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616.11.12 Other Channelizing Devices (MUTCD Section 6K.12)

616.11.1 Channelizing Devices – General (MUTCD Section 6K.01)

Standard. Designs of various channelizing devices shall be as shown in Standard Plan 616.10 (https://www.modot.org/media/16892). All channelizing devices shall be crashworthy (see definition in EPG 911 (MUTCD Section 1C.02)).

Support. The function of channelizing devices is to warn road users of conditions created by work activities in or near the roadway and to guide road users. Channelizing devices include cones, tubular markers, vertical panels, drums, and barricades.

Channelizing devices provide for smooth and gradual vehicular traffic flow from one lane to another, onto a bypass or detour, or into a narrower traveled way. They are also used to channelize traffic away from the work space, pavement drop-offs, pedestrian or shared-use paths, bicycle facilities, or opposing directions of vehicular traffic.

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Guidance. The spacing between cones, tubular markers, vertical panels, drums, and barricades should not exceed a distance in feet equal to 1 times the speed limit in mph when used for taper channelization, and should not exceed a distance in feet equal to 2 times the speed limit in mph when used for tangent channelization.

When channelizing devices have the potential of leading vehicular traffic out of the intended vehicular traffic space as shown in TA-39, the channelizing devices should be extended a distance in feet of 2 times the speed limit in mph beyond the downstream end of the transition area.

Option. A gap not exceeding 2 inches between the bottom rail and the ground surface may be used to facilitate drainage.

A series of sequential flashing warning lights may be placed on channelizing devices that form a merging taper in order to increase driver detection and recognition of the merging taper.

Guidance. Sequential flashing warning lights should be placed on channelizing devices that form a merging taper on interstate highways during nighttime operations.

Option. Sequential flashing warning lights may be used on other multi-lane highways as determined by the districts.

Support. The flashing rates and patterns for warning lights used on channelizing devices are specified in EPG 616.12.7.

Standard. The retroreflective material used on channelizing devices shall display a similar color day or night.

Except as provided in the following Option paragraph, information identifying the owner or manufacturer of the channelizing device shall not be displayed on any portion of the device that can be seen by road users approaching the device.

Option. The name and telephone number of the highway agency, contractor, or supplier may be displayed on the non-retroreflective surface of all types of channelizing devices.

Standard. The area containing the name and telephone number shall be non-retroreflective and not over 2 inches in height.

Guidance. Particular attention should be given to maintaining the channelizing devices to keep them clean, visible, and properly positioned at all times.

Standard. Channelizing devices that are no longer serviceable (see definition in EPG 911 (MUTCD Section 1C.02)) shall be replaced.

616.11.2 Pedestrian Channelizing Devices (MUTCD Section 6K.02)

Support. Pedestrian channelizing devices indicate a suitable path of pedestrian travel around or through the work zone.

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Guidance. Pedestrian channelizing devices should be provided when work activities impact sidewalks or other pedestrian facilities or when the design of the temporary pedestrian facility does not otherwise include accessibility features consistent with the features in the existing pedestrian facility.

The pedestrian channelizing devices should be used both to close sidewalks and to delineate an alternate route.

Support. An example of a pedestrian channelizing device is depicted in Figure 616.11.2.

Standard. Pedestrian channelizing devices shall be crashworthy (see definition in EPG 911 (MUTCD Section 1C.02)) when exposed to vehicular traffic.

Devices used to channelize pedestrians shall be detectable to users of long canes and visible to pedestrians with vision disabilities.

When used as a sidewalk closure, the device shall cover the entire width of the sidewalk.

Pedestrian channelizing devices shall have continuous detection plates and hand-trailing edges. The bottom of the detection plate shall be no higher than 2 inches above the walkway. The top edge of the detection plate shall be at least 8 inches above the walkway. The top of the hand-trailing edge shall be no lower than 32 inches and no higher than 38 inches above the walkway. The top surface of the hand-trailing edge shall be smooth to optimize hand trailing. Both the detection plate and the hand-trailing edge shall share a common vertical plane.

Guidance. When pedestrian channelizing devices are combined in a series, the gap between devices should not exceed 1 inch.

Support. The hand-trailing edge is the upper rail on a pedestrian channelizing device, as shown in Figure 616.11.2. It is provided to allow pedestrians with vision disabilities to follow the pedestrian channelizing device with their hand. The hand-trailing edge is not a weight-bearing railing.

Guidance. There should be at least a 2-inch gap between the hand-trailing edge and its support.

Standard. When visible to vehicular traffic the detection plate and the hand-trailing edge of the pedestrian channelizing device shall have retroreflective sheeting complying with the second Standard paragraph of EPG 616.11.1.

Guidance. When not visible to vehicular traffic, the pedestrian channelizing device should have a contrasting pattern in alternating light and dark colors to provide visual contrast on the upper surface consisting of a minimum of 6 inches of sheeting or other contrasting materials.

Option. Non-retroreflective materials may be used on the pedestrian side of the pedestrian channelizing device.

The sheeting on the pedestrian side of the pedestrian channelizing device may have stripes that are oriented either vertically or at a 45-degree angle.

Support. The contrast of the light and dark stripes on the barricade sheeting assists pedestrians with vision disabilities in following the designated detour.

EPG 616.13.4 also contains information regarding detectable edging for pedestrian channelization.

Option. A continuous wall may be used as a pedestrian channelizing device.

Guidance. When used, a continuous wall should have a lower edge no more than 2 inches above the walkway, should extend a minimum of 32 inches above the walkway, should have a common vertical face, and should have alternating, contrasting sheeting positioned 32 inches above the walkway.

Option. The continuous wall may extend to any height above the 32-inch minimum.

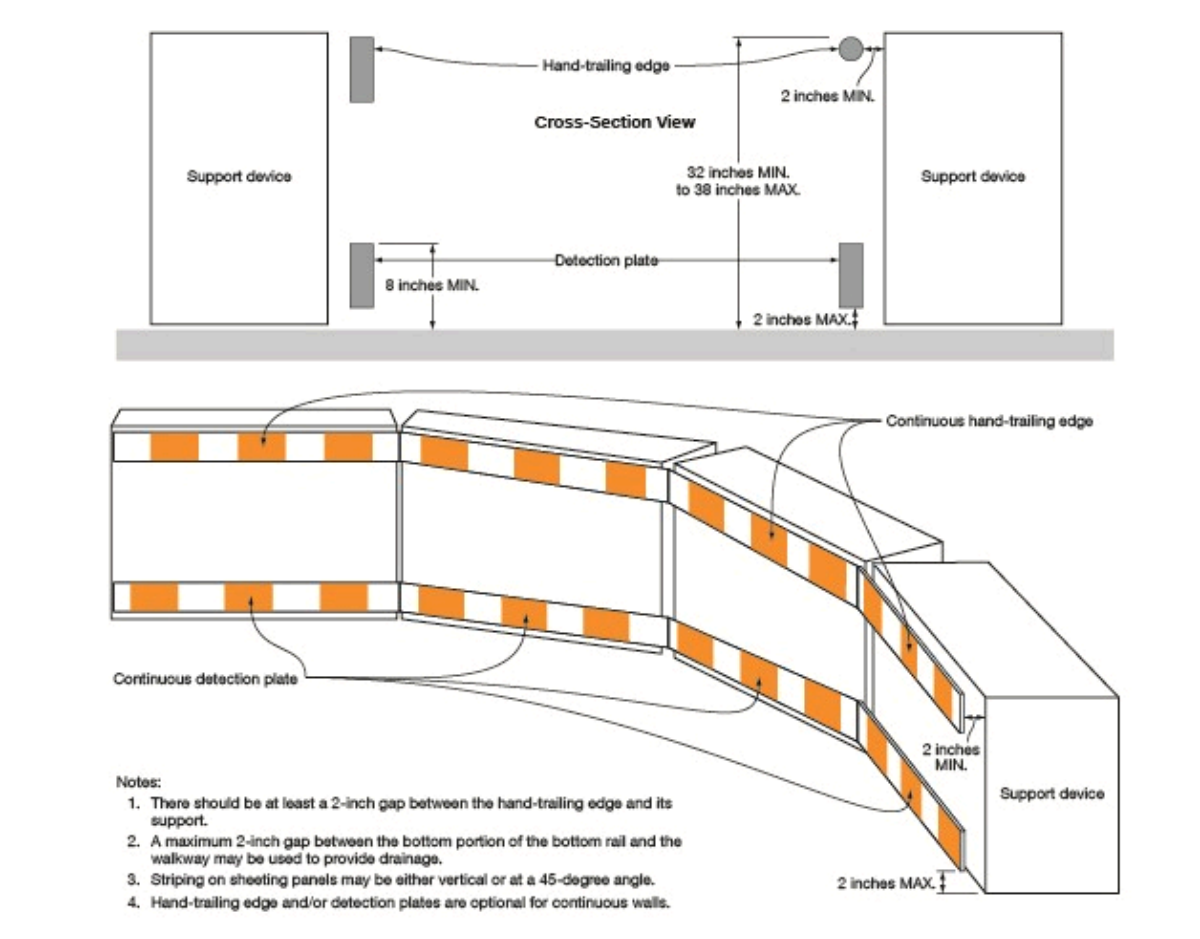


Figure 616.11.2 Pedestrian Channelizing Device

616.11.3 Cones and Trim-line Channelizers (MUTCD Section 6K.03)

616.11.3.1 Cones

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Standard. Cones (see Standard Plan 616.10 (https://www.modot.org/media/16892)) shall be predominantly orange and shall be made of a material that can be struck without causing damage to the impacting vehicle.

Cones shall be retroreflectorized and shall not be less than 28 inches in height.

Retroreflectorization of cones that are 28 to 36 inches in height shall be provided by a 6-inch wide white band located 3 to 4 inches from the top of the cone and an additional 4-inch wide white band located approximately 2 inches below the 6-inch band.

Retroreflectorization of cones that are more than 36 inches in height shall be provided by horizontal, circumferential, alternating orange and white retroreflective stripes that are 4 to 6 inches wide. Each cone shall have a minimum of two orange and two white stripes with the top stripe being orange. Any non-retroreflective spaces between the retroreflective stripes shall not exceed 3 inches in width.

Option. Cones may be used only for daytime operations on minor roads.

Traffic cones may be used to channelize road users, divide opposing vehicular traffic lanes, divide lanes when two or more lanes are kept open in the same direction, and delineate short-duration maintenance and utility work.

616.11.3.2 Trim-line Channelizers

Support. Trim-line channelizing devices are a type of cone that is the preferred channelizing device to be used in work zones for daytime and nighttime applications.

Standard. Trim-line channelizers (see Standard Plan 616.10 (https://www.modot.org/media/16892)) shall be predominantly orange and shall be made of a material that can be struck without causing damage to the impacting vehicle. Trim-line channelizers shall not be less than 42 inches in height.

Trim-line channelizers shall be retroreflectorized. Retroreflectorization of trim-line channelizers shall be provided by horizontal, circumferential, alternating Type 4 fluorescent orange and Type 4 white retroreflective stripes that are 6 in. to 8 in. wide. Each trim-line channelizer shall have a minimum of two orange and two white stripes with the top stripe being orange. Any non-retroreflective spaces between the retroreflective stripes shall not be wider than 3 inches.

Guidance. Trim-line channelizers should be the channelizing devices used in ramp areas, intersections, and areas with limited lateral clearances.

Option. Trim-line channelizers may be used to channelize road users, divide opposing vehicular traffic lanes, divide lanes when two or more lanes are kept open in the same direction, and delineate short duration maintenance and utility work.

Guidance. Steps should be taken to minimize the possibility of trim-line channelizers being blown over or displaced by wind or moving vehicular traffic.

Option. Cones may be doubled up to increase their weight.

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Support. Some cones are constructed with bases that can be filled with ballast. Others have specially weighted bases, or weight such as sandbag rings, that can be dropped over the cones and onto the base to provide added stability.

Guidance. Ballast should be kept to the minimum amount needed.

Option. If additional ballasting is needed, trim-line channelizers and cones are allowed to have one ballast added to the original ballast.

616.11.4 Tubular Markers (MUTCD Section 6K.04)

Support. Tubular markers are typically used to divide traffic in temporary two-lane, two-way traffic situations.

Standard. Tubular markers (see Standard Plan 616.10 (https://www.modot.org/media/16892)) shall be predominantly orange for TTC zone applications and shall be a minimum of 28 inches high and 2 inches wide facing road users. They shall be made of a material that can be struck without causing damage to the impacting vehicle.

Tubular markers shall be retroreflectorized. Retroreflectorization of tubular markers that have a height of less than 42 inches shall be provided by two 3-inch wide Type 4 white bands placed a maximum of 2 inches from the top with a maximum of 6 inches between the bands. Retroreflectorization of tubular markers that have a height of 42 inches or more shall be provided by four 4-inch to 6-inch wide alternating orange and white stripes with the top stripe being orange**.**

Guidance. Tubular markers have less visible area than other devices and should be used only where space restrictions do not allow for the use of other more visible devices.

Tubular markers should be stabilized by affixing them to the pavement, by using weighted bases, or by using weights such as sandbag rings that can be dropped over the tubular markers and onto the base to provide added stability. Ballast should be kept to the minimum amount needed.

Option. Tubular markers may be used effectively to divide opposing lanes of road users and divide vehicular traffic lanes when two or more lanes of moving vehicular traffic are kept open in the same direction.

Standard. A tubular marker shall be attached to the pavement to display the minimum 2-inch width to the approaching road users.

616.11.5 Vertical Panels (MUTCD Section 6K.05)

Option. Vertical panels may be specified instead of trim-line channelizers for longitudinal channelization within the activity area.

Support. The diagonal marking provided by these devices subliminally directs motorists into the traffic space. This effect is beneficial in two-way two-lane operations and work zones within expressways and/or urban areas having many entrances. When specified, quantities are calculated and shown on the plans.

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Standard. Vertical panels (see Standard Plan 616.10 (https://www.modot.org/media/16892)) shall have retroreflective striped material that is 8 to 12 inches in width and at least 24 inches in height. They shall have alternating diagonal Type 4 orange and Type 4 white retroreflective stripes sloping downward at an angle of 45 degrees in the direction vehicular traffic is to pass.

Where the height of the retroreflective material on the vertical panel is 36 inches or more, a stripe width of 6 inches shall be used.

Option. Where the height of the retroreflective material on the vertical panel is less than 36 inches, a stripe width of 4 inches may be used.

Where space is limited, vertical panels may be used to channelize vehicular traffic, divide opposing lanes, or replace barricades.

616.11.6 Drums (MUTCD Section 6K.06)

Standard. Drums (see Standard Plan 616.10 (https://www.modot.org/media/16892)) used for road user warning or channelization shall be constructed of lightweight, deformable materials. They shall be a minimum of 36 inches in height and have at least an 18-inch minimum width regardless of orientation. Metal drums shall not be used. The markings on drums shall be horizontal, circumferential, alternating Type 4 fluorescent orange and Type 4 white retroreflective stripes 4 to 6 inches wide. Each drum shall have a minimum of two orange and two white stripes with the top stripe being orange. Any non-retroreflectorized spaces between the horizontal orange and white stripes shall not exceed 3 inches wide. Drums shall have closed tops that will not allow collection of construction debris or other debris.

Support. Drums are highly visible, have good target value, give the appearance of being formidable obstacles and, therefore, command the respect of road users. They are portable enough to be shifted from place to place within a TTC zone in order to accommodate changing conditions, but are generally used in situations where they will remain in place for a prolonged period of time.

Option. Although drums are most commonly used to channelize or delineate road user flow, they may also be used alone or in groups to mark specific locations.

Drums may be specified in lieu of trim-line channelizers to provide longitudinal channelization within the activity area if their larger size and additional retroreflective area are deemed appropriate.

Guidance. Drums should not be weighted with sand, water, or any material to the extent that would make them hazardous to road users or workers when struck. Drums used in regions susceptible to freezing should have drain holes in the bottom so that water will not accumulate and freeze causing a hazard if struck by a road user. Drums should not be used in ramp areas, intersections or areas with limited lateral clearance.

Standard. Ballast shall not be placed on the top of a drum.

616.11.7 Type 1 or 3 Barricades (MUTCD Section 6K.07)

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Support. A barricade is a portable or fixed device having from one to three rails with appropriate markings and is used to control road users by closing, restricting, or delineating all or a portion of the right-of-way.

Barricades are classified as Type 1 or Type 3 (See Standard Plan 616.10 (https://www.modot.org/media/16892)).

Standard. Stripes on barricade rails shall be alternating orange and white retroreflective stripes sloping downward at an angle of 45 degrees in the direction road users are to pass. Except as provided in the following Option paragraph, the stripes shall be 6 inches wide.

Option. When rail lengths are less than 36 inches, 4-inch wide stripes may be used.

Standard. The minimum length for Type 1 Barricades shall be 24 inches, and the minimum length for Type 3 Barricades shall be 48 inches. Each barricade rail shall be 8 to 12 inches wide. Barricades used on freeways, expressways, and other high-speed roadways shall have a minimum of 270 square inches of retroreflective area facing road users.

Guidance. Where barricades extend entirely across a roadway, the stripes should slope downward in the direction toward which road users must turn.

Where both right and left turns are provided, the barricade stripes should slope downward in both directions from the center of the barricade or barricades.

Where no turns are intended, the stripes should be positioned to slope downward toward the center of the barricade or barricades.

Barricade rails should be supported in a manner that will allow them to be seen by the road user, and in a manner that provides a stable support that is not easily blown over or displaced.

The width of the existing pedestrian facility should be provided for the temporary facility if practical. Traffic control devices and other construction materials and features should not intrude into the usable width of the sidewalk, temporary pathway, or other pedestrian facility. When it is not possible to maintain a minimum width of 60 inches throughout the entire length of the pedestrian pathway, a 60 x 60-inch passing space should be provided at least every 200 feet to allow individuals in wheelchairs to pass.

Barricade rail supports should not project into pedestrian circulation routes more than 4 inches from the support between 27 and 80 inches from the surface as described in Section 307 of the U.S. Department of Justice 2010 ADA Standards for Accessible Design, September 15, 2010, 28 CFR 35 and 36, Americans with Disabilities Act of 1990.

Option. For Type 1 Barricades, the support may include other unstriped horizontal rails necessary to provide stability.

Guidance. On high-speed expressways or in other situations where barricades might be susceptible to overturning in the wind, ballasting should be used.

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Option. Sandbags may be placed on the lower parts of the frame or the stays of barricades to provide the required ballast. Additional ballasting information is located in EPG 616.24.

Guidance. The Type 1 (one rail) Barricade should only be used for non-motorized traffic operations on all highways.

Option. Type 1 Barricades may be used for emergency road closures on two-lane, undivided highways.

Barricades may be used alone or in groups to mark a specific condition or they may be used in a series for channelizing road users.

Guidance. Type 3 Barricades should be used on freeways and expressways or other high-speed roadways. Type 3 Barricades should be used to close or partially close a road.

Two Type 3 Barricades should be used be used to close roadways that are 20 feet or less in width (including any paved shoulders). Three or more Type 3 Barricades should be used to close roadways that are more than 20 feet in width (including any paved shoulders).

Where provision is made for access of authorized equipment and vehicles, the responsibility for Type 3 Barricades should be assigned to a person who will provide proper closure at the end of each work day.

Support. When a highway is legally closed but access must still be allowed for local road users, barricades usually are not extended completely across the roadway.

Standard. A sign shall be installed with the appropriate legend concerning permissible use by local road users (see EPG 616.7.5).

Guidance. Adequate visibility of the barricades from both directions should be provided.

Option. Signs may be installed on barricades (see EPG 616.6.2).

616.11.8 Direction Indicator Barricades (MUTCD Section 6K.08)

Standard. The Direction Indicator Barricade (see Standard Plan 616.10 (https://www.modot.org/media/16892)) shall consist of a One-Direction Large Arrow (WO1-6) sign mounted above a diagonal striped, horizontally-aligned, retroreflective rail.

The One-Direction Large Arrow (WO1-6) sign shall have a black legend and border on a fluorescent orange background. The stripes on the bottom rail shall be alternating Type 4 orange and Type 4 white retroreflective stripes sloping downward at an angle of 45 degrees in the direction road users are to pass. The stripes shall be 4 inches wide. The One-Direction Large Arrow (WO1-6) sign shall be 24 x 12 inches. The bottom rail shall have a length of 24 inches and a height of 8 inches.

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Guidance. For long-term stationary operations, direction indicator barricades should be used instead of trim-lime channelizers in merging tapers because they provide direction and have a larger target area for the motorists.

Option. For shorter duration projects, Direction Indicator Barricades may be used in lieu of other channelizers.

Guidance. If used, Direction Indicator Barricades should be used in a series to direct the driver through the taper and into the intended travel lane.

Direction Indicator Barricades should not be used in shifting tapers.

616.11.9 Temporary Traffic Barriers as Channelizing Devices (MUTCD Section 6K.09)

Support. Temporary traffic barriers (see EPG 616.13.2) are not TTC devices in themselves; however, when placed in a position identical to a line of channelizing devices and marked and/or equipped with appropriate channelization features to provide guidance and warning both day and night, they serve as TTC devices (see EPG 617.1).

Standard. Temporary traffic barriers serving as TTC devices shall comply with requirements for such devices as set forth throughout EPG 616.

Temporary traffic barriers (see EPG 616.13.2) shall not be used solely to channelize road users, but also to protect the work space. If used to channelize vehicular traffic, the temporary traffic barrier shall be supplemented with delineation, pavement markings, or channelizing devices for improved daytime and nighttime visibility.

Guidance. Temporary traffic barriers should not be used for a merging taper except in low-speed urban areas.

When it is necessary to use a temporary traffic barrier for a merging taper in low-speed urban areas or for a constricted/restricted TTC zone, the taper length should be designed to optimize road user operations considering the available geometric conditions.

Standard. When it is necessary to use a temporary traffic barrier for a merging taper in low-speed urban areas or for a constricted/restricted TTC zone, the taper shall be delineated using channelizing devices, and/or an edge line, and delineators on the barrier.

Guidance. When used for channelization, temporary traffic barriers should be of a light color for increased visibility.

616.11.10 Longitudinal Channelizing Devices (MUTCD Section 6K.10)

Support. Longitudinal channelizing devices are lightweight, deformable devices that are highly visible, have good target value, and can be connected together.

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Standard. If used singly as Type 1, 2, or 3 barricades, longitudinal channelizing devices shall comply with the general size, color, stripe pattern, retroreflectivity, and placement characteristics established for the devices described in EPG 616.11.

Guidance. If used to channelize vehicular traffic at night, longitudinal channelizing devices should be supplemented with retroreflective material or delineation for improved nighttime visibility.

Option. Longitudinal channelizing devices may be used instead of a line of cones, drums, or barricades.

Longitudinal channelizing devices may be hollow and filled with water as a ballast.

Longitudinal channelizing devices may be used for pedestrian traffic control.

Standard. If used for pedestrian traffic control, longitudinal channelizing devices shall be interlocked to delineate or channelize flow. The interlocking devices shall not have gaps that allow pedestrians to stray from the channelizing path.

Guidance. Longitudinal channelizing devices have not met the crashworthy requirements for temporary traffic barriers and should not be used to shield obstacles or provide positive protection for pedestrians or workers.

616.11.11 Temporary Lane Separators (MUTCD Section 6K.11)

Option. Temporary lane separators may be used to channelize road users, to divide opposing vehicular traffic lanes, and to divide lanes when two or more lanes are open in the same direction.

Standard. Temporary lane separators shall consist of a longitudinal base component with a maximum height of 4 inches and a maximum width of 1 foot. The longitudinal base shall have sloping sides in order to facilitate crossover by emergency vehicles. One or more types of channelizing devices, such as tubular markers, vertical panels, or a Narrow Two-Way Traffic (WO6-4) sign (see EPG 616.8.15) mounted on flexible supports, shall be affixed to the longitudinal base.

Channelizing devices affixed to the longitudinal base of a temporary lane separator shall be retroreflectorized to provide nighttime visibility.

Guidance. A temporary lane separator should be stabilized by affixing it to the pavement in a manner suitable to its design, while allowing the unit to be intentionally moved from place to place within the TTC zone in order to accommodate changing conditions.

Temporary Lane Separators should not be used to shield obstacles or provide positive protection for pedestrians or workers because these devices have not met the crashworthy requirements for temporary traffic barriers.

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Standard. At pedestrian crossing locations, temporary lane separators shall have an opening or be shortened to provide a pathway that is at least 60 inches wide for crossing pedestrians.

616.11.12 Other Channelizing Devices (MUTCD Section 6K.12)

Guidance. Channelizing devices other than those described in Standard Plan 616.10 (https://www.modot.org/media/16892) should only be used with the approval of the Highway Safety and Traffic Division.

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616.12 Other TTC Zone Traffic Control Devices (MUTCD Chapter 6L)

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616.12.1 Temporary Traffic Control Signals (MUTCD Section 6L.01)

Standard. Temporary traffic control signals (see EPG 902.4.11) used to control road user movements through TTC zones and in other TTC situations shall comply with the applicable provisions of EPG 902.

Support. Temporary traffic control signals are typically used in TTC zones such as temporary haul road crossings; temporary one-way operations along a one-lane, two-way highway; temporary one-way operations on bridges, and intersections.

Standard. A temporary traffic control signal that is used to control traffic through a one-lane, two-way section of roadway shall comply with the provisions of EPG 902.15.2.

Guidance. When temporary traffic control signals are used, conflict monitors typical of traditional traffic control signal operations should be used.

Support. Where pedestrians are detoured to a temporary traffic control signal, an accessible pedestrian signal (see EPG 902.11) provides information in non-visual formats (such as audible tones and/or speech messages, and vibrating surfaces) so that a pedestrian with vision disabilities can know when to cross the street along the alternate route.

Option. Temporary traffic control signals may be portable or temporarily mounted on fixed supports.

Support. Wood pole span wire signals are typically used for temporary signals. Temporary lighting is typically provided on the wood poles (silhouette discernment lighting as described in EPG 901).

Guidance. Temporary traffic control signals should only be used in situations where temporary traffic control signals are preferable to other means of traffic control, such as changing the work staging or work zone size to eliminate one-way vehicular traffic movements, using flaggers to control one-way or crossing movements, using STOP or YIELD signs, and using warning devices alone.

Support. Factors related to the design and application of temporary traffic control signals include the following:

A. Safety and road user needs;
B. Work staging and operations;
C. The feasibility of using other TTC strategies (for example, flaggers, providing space for two lanes, or detouring road users, including bicyclists and pedestrians);
D. Sight distance restrictions;

E. Human factors considerations (for example, lack of driver familiarity with temporary traffic control signals);
F. Road-user volumes including roadway and intersection capacity;
G. Affected side streets and driveways;
H. Vehicle speeds;
I. The placement of other TTC devices;
J. Parking;
K. Turning restrictions;
L. Pedestrians;
M. The nature of adjacent land uses (such as residential or commercial);
N. Legal authority;
O. Signal phasing and timing requirements;
P. Full-time or part-time operation;
Q. Actuated, fixed-time, or manual operation;
R. Power failures or other emergencies;
S. Inspection and maintenance needs;
T. Need for detailed placement, timing, and operation records; and
U. Operation by contractors or by others.

Although temporary traffic control signals can be mounted on trailers or lightweight portable supports, fixed supports offer superior resistance to displacement or damage by severe weather, vehicle impact, and vandalism.

Guidance. Other TTC devices should be used to supplement temporary traffic control signals, including warning and regulatory signs, pavement markings, and channelizing devices.

Temporary traffic control signals not in use should be covered or removed.

If a temporary traffic control signal is located within ½ mile of an adjacent traffic control signal, consideration should be given to interconnected operation.

Standard. Temporary traffic control signals shall not be located within 200 feet of a grade crossing unless the temporary traffic control signal is provided with preemption in accordance with EPG 902.6.18, EPG 902.6.19, and EPG 913.4.9, or unless a uniformed officer or flagger is provided at the crossing to prevent vehicles from stopping within the crossing.

616.12.2 Automated Flagger Assistance Devices – General (MUTCD Section 6L.02)

Support. Automated Flagger Assistance Devices (AFADs) enable a flagger(s) to be positioned out of the lane of traffic and are used to control road users through TTC zones. These devices are designed to be remotely operated either by a single flagger at one end of the TTC zone or at a central location, or by separate flaggers near each device's location.

There are two types of AFADs:

A. An AFAD (see EPG 616.12.3) that uses a remotely controlled STOP/SLOW sign on either a trailer or a movable cart system to alternately control right-of-way.
B. An AFAD (see EPG 616.12.4) that uses remotely controlled red and yellow lenses and a gate arm to alternately control right-of-way.

AFADs might be appropriate for short-term and intermediate-term activities (see EPG 616.14.1). Typical applications include TTC activities such as, but not limited to:

A. Bridge maintenance,
B. Haul road crossings, and
C. Pavement patching.

Standard. AFADs shall only be used in situations where there is only one lane of approaching traffic in the direction to be controlled.

When used at night, the AFAD location shall be illuminated in accordance with EPG 616.4.6.

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Guidance. AFADs should not be used for long-term stationary work (see EPG 616.14.1).

Standard. Because AFADs are not traffic control signals, they shall not be used as a substitute for or a replacement for a continuously operating temporary traffic control signal as described in EPG 616.12.1.

AFADs shall meet the crashworthy (see definition in EPG 911 (MUTCD Section 1C.02)) performance criteria contained in EPG 616.1.4.

Guidance. If used, AFADs should be located in advance of one-lane, two-way tapers and downstream from the point where approaching traffic is to stop in response to the device.

Standard. If used, AFADs shall be placed so that all of the signs and other items controlling traffic movement are readily visible to the driver of the initial approaching vehicle with advance warning signs alerting other approaching traffic to be prepared to stop.

If used, an AFAD shall be operated only by a flagger (see EPG 616.4.1) who has been trained on the operation of the AFAD. The flagger(s) operating the AFAD(s) shall not leave the AFAD(s) unattended at any time while the AFAD(s) is being used.

The use of AFADs shall conform to one of the following methods:

A. An AFAD at each end of the TTC zone (Method 1), or
B. An AFAD at one end of the TTC zone and a flagger at the opposite end (Method 2).

Except as provided in the following Option paragraph, two flaggers shall be used when using either Method 1 or Method 2.

Option. A single flagger may simultaneously operate two AFADs (Method 1) or may operate a single AFAD on one end of the TTC zone while being the flagger at the opposite end of the TTC zone (Method 2) if both of the following conditions are present:

A. The flagger has an unobstructed view of the AFAD(s), and
B. The flagger has an unobstructed view of approaching traffic in both directions.

Guidance. When an AFAD is used, the advance warning signing should include a ROAD WORK AHEAD (WO20-1) sign, a ONE LANE ROAD (WO20-4) sign, and a BE PREPARED TO STOP (WO3-4) sign.

Standard. When the AFAD is not in use, the signs associated with the AFAD, both at the AFAD location and in advance, shall be removed or covered.

Guidance. A State or local agency that elects to use AFADs should adopt a policy, based on engineering judgment, governing AFAD applications. The policy should also consider more detailed and/or more restrictive requirements for AFAD use, such as the following:

A. Conditions applicable for the use of Method 1 and Method 2 AFAD operation,
B. Volume criteria,
C. Maximum distance between AFADs,
D. Conflicting lenses/indications monitoring requirements,
E. Fail-safe procedures,
F. Additional signing and pavement markings,
G. Application consistency,
H. Larger signs or lenses to increase visibility, and
I. Use of backplates.

616.12.3 STOP/SLOW Automated Flagger Assistance Devices (MUTCD Section 6L.03)

Standard. A STOP/SLOW Automated Flagger Assistance Device (AFAD) shall include a STOP/SLOW sign that alternately displays the STOP (R1-1) face and the SLOW (WO20-8) face of a STOP/SLOW paddle (see Figure 616.12.3).

The AFAD's STOP/SLOW sign shall have an octagonal shape, shall be fabricated of rigid material, and shall be mounted with the bottom of the sign a minimum of 6 feet above the pavement on an appropriate support. The size of the STOP/SLOW sign shall be at least 24 x 24 inches with letters at least 8 inches high. The background of the STOP face shall be red with white letters and border. The background of the SLOW face shall be diamond-shaped and orange with black letters and border. Both faces of the STOP/SLOW sign shall be retroreflectorized.

The AFAD's STOP/SLOW sign shall have a means to positively lock, engage, or otherwise maintain the sign assembly in a stable condition when set in the STOP or SLOW position.

The AFAD's STOP/SLOW sign shall be supplemented with active conspicuity devices by incorporating either:

A. White or red flashing lights within the STOP face and white or yellow flashing lights within the SLOW face meeting the provisions contained in EPG 616.4.2; or
B. A Stop Beacon (see EPG 902.18.5) mounted a maximum of 24 inches above the STOP face and a Warning Beacon (see EPG 902.18.3) mounted a maximum of 24 inches above, below, or to the side of the SLOW face. The Stop Beacon shall not be flashed or illuminated when the SLOW face is displayed, and the Warning Beacon shall not be flashed or illuminated when the STOP face is displayed. Except for the mounting locations, the beacons shall comply with the provisions of EPG 902.18.

Option. Type B warning light(s) (see EPG 616.12.7) may be used in lieu of the Warning Beacon during the display of the SLOW face of the AFAD's STOP/SLOW sign.

Standard. If Type B warning lights are used in lieu of a Warning Beacon, they shall flash continuously when the SLOW face is displayed and shall not be flashed or illuminated when the STOP face is displayed.

Option. The faces of the AFAD's STOP/SLOW sign may include louvers to improve the stability of the device in windy or other adverse environmental conditions.

Standard. If louvers are used, the louvers shall be designed such that the full sign face is visible to approaching traffic at a distance of 50 feet or greater.

Guidance. The STOP/SLOW AFAD should include a gate arm that descends to a down position across the approach lane of traffic when the STOP face is displayed and then ascends to an upright position when the SLOW face is displayed.

Option. In lieu of a stationary STOP/SLOW sign with a separate gate arm, the STOP/SLOW sign may be attached to a mast arm that physically blocks the approach lane of traffic when the STOP face is displayed and then moves to a position that does not block the approach lane when the SLOW face is displayed.

Standard. Gate arms, if used, shall be fully retroreflectorized on both sides, and shall have vertical alternating red and white stripes at 16-inch intervals measured horizontally as shown in Figure 913.4.1. When the arm is in the down position blocking the approach lane:

A. The minimum vertical aspect of the arm and sheeting shall be 2 inches, and
B. The end of the arm shall reach at least to the center of the lane being controlled.

A WAIT ON STOP (R1-7) sign (see Figure 616.12.3) shall be displayed to road users approaching the AFAD.

Option: A GO ON SLOW (R1-8) sign (see Figure 616.12.3) may also be displayed to road users approaching the AFAD.

The WAIT ON STOP/ GO ON SLOW (R1-7a) sign (see Figure 616.12.3) may also be used to display both messages to approaching road users.

Standard. The GO ON SLOW sign, if used, and the WAIT ON STOP sign shall be positioned on the same support structure as the AFAD or immediately adjacent to the AFAD such that they are in the same direct line of view of approaching traffic as the sign faces of the AFAD.

To inform road users to stop, the AFAD shall display the STOP face and the red or white lights, if used, within the STOP face shall flash or the Stop Beacon shall flash. To inform road users to proceed, the AFAD shall display the SLOW face and the yellow or white lights, if used, within the SLOW face shall flash or the Warning Beacon or the Type B warning lights shall flash.

If STOP/SLOW AFADs are used to control traffic in a one-lane, two-way TTC zone, safeguards shall be incorporated to prevent the flagger(s) from simultaneously displaying the SLOW face at each end of the TTC zone. Additionally, the flagger(s) shall not display the AFAD's SLOW face until all oncoming vehicles have cleared the one-lane portion of the TTC zone.

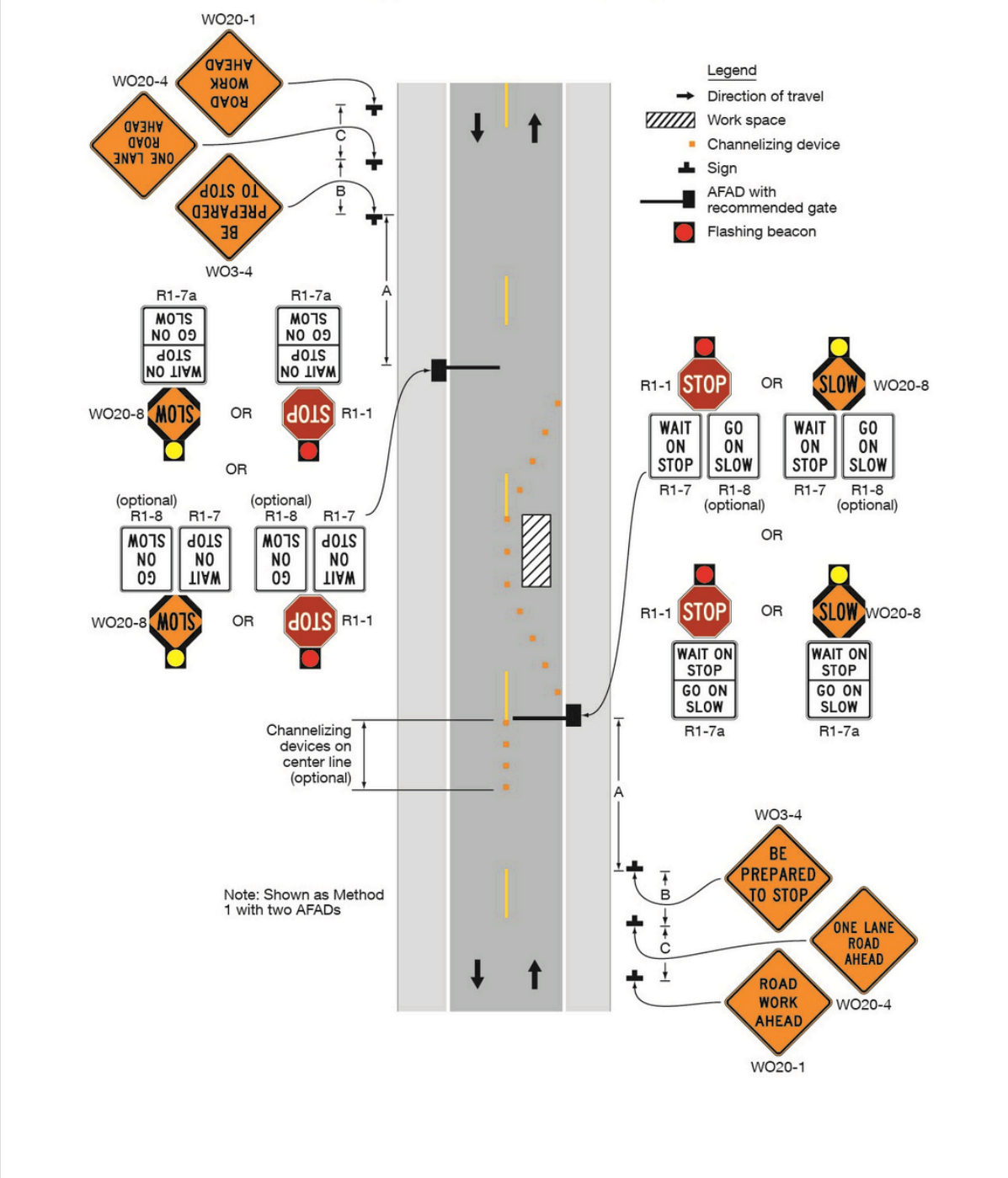


Figure 616.12.3 Example of the Use of a STOP/SLOW Automated Flagger Assistance Device (AFAD)

616.12.4 Red/Yellow Lens Automated Flagger Assistance Devices (MUTCD Section 6L.04)

Standard. A Red/Yellow Lens Automated Flagger Assistance Device (AFAD) shall alternately display a steadily illuminated CIRCULAR RED lens and a flashing CIRCULAR YELLOW lens to control traffic without the need for a flagger in the immediate vicinity of the AFAD or on the roadway (see Figure 616.12.4).

Red/Yellow Lens AFADs shall have at least one set of CIRCULAR RED and CIRCULAR YELLOW lenses that are 12 inches in diameter. Unless otherwise provided in this Section, the lenses and their arrangement, CIRCULAR RED on top and CIRCULAR YELLOW below, shall comply with the applicable provisions for traffic signal indications in EPG

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902. If the set of lenses is post-mounted, the bottom of the housing (including brackets) shall be at least 7 feet above the pavement. If the set of lenses is located over any portion of the highway that can be used by motor vehicles, the bottom of the housing (including brackets) shall be at least 15 feet above the pavement.

Option. Additional sets of CIRCULAR RED and CIRCULAR YELLOW lenses, located over the roadway or on the left-hand side of the approach and operated in unison with the primary set, may be used to improve visibility and/or conspicuity of the AFAD.

Standard. A Red/Yellow Lens AFAD shall include a gate arm that descends to a down position across the approach lane of traffic when the steady CIRCULAR RED lens is illuminated and then ascends to an upright position when the flashing CIRCULAR YELLOW lens is illuminated. The gate arm shall be fully retroreflectorized on both sides, and shall have vertical alternating red and white stripes at 16-inch intervals measured horizontally as shown in Figure 913.4.1. When the arm is in the down position blocking the approach lane:

A. The minimum vertical aspect of the arm and sheeting shall be 2 inches, and
B. The end of the arm shall reach at least to the center of the lane being controlled.

A Stop Here On Red (R10-6 or R10-6a) sign (see EPG 903.2.48) shall be installed on the right-hand side of the approach at the point at which drivers are expected to stop when the steady CIRCULAR RED lens is illuminated (see Figure 616.12.4).

To inform road users to stop, the AFAD shall display a steadily illuminated CIRCULAR RED lens and the gate arm shall be in the down position. To inform road users to proceed, the AFAD shall display a flashing CIRCULAR YELLOW lens and the gate arm shall be in the upright position.

If Red/Yellow Lens AFADs are used to control traffic in a one-lane, two-way TTC zone, safeguards shall be incorporated to prevent the flagger(s) from actuating a simultaneous display of a flashing CIRCULAR YELLOW lens at each end of the TTC zone. Additionally, the flagger shall not actuate the AFAD's display of the flashing CIRCULAR YELLOW lens until all oncoming vehicles have cleared the one-lane portion of the TTC zone.

A change interval shall be provided as the transition between the display of the flashing CIRCULAR YELLOW indication and the display of the steady CIRCULAR RED indication. During the change interval, the CIRCULAR YELLOW lens shall be steadily illuminated. The gate arm shall remain in the upright position during the display of the steadily illuminated CIRCULAR YELLOW change interval.

A change interval shall not be provided between the display of the steady CIRCULAR RED indication and the display of the flashing CIRCULAR YELLOW indication.

Guidance. The steadily illuminated CIRCULAR YELLOW change interval should have a duration of at least 5 seconds, unless a different duration, within the range of durations recommended by EPG 902.6.17, is justified by engineering judgment.

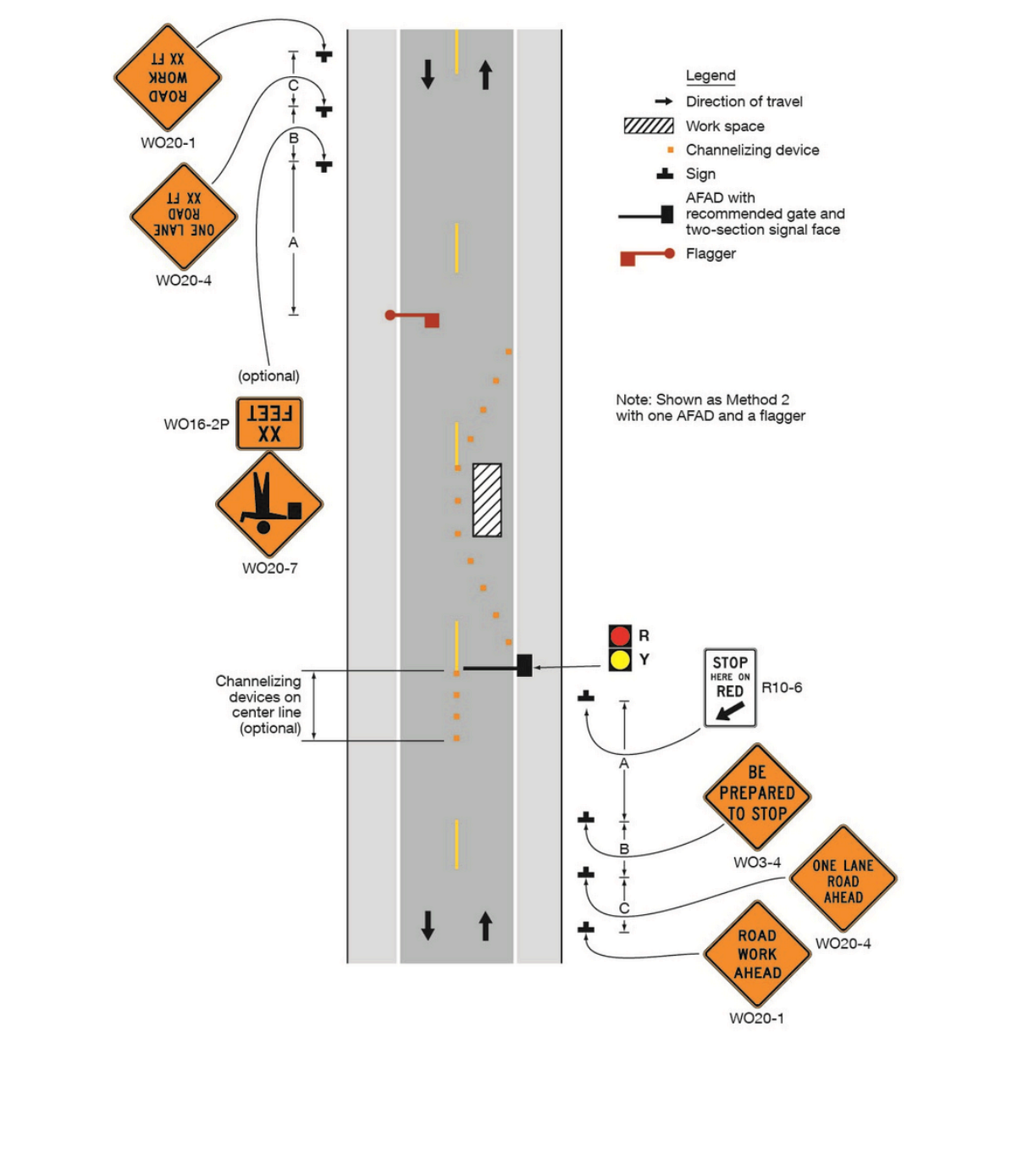


Figure 616.12.4 Example of the Use of a Red Yellow Lens Automated Flagger Assistance Device (AFAD)

616.12.5 Portable Changeable Message Signs (MUTCD Section 6L.05)

Support. Portable changeable message signs (PCMS) are TTC devices installed for temporary use with the flexibility to display a variety of messages. In most cases, portable changeable message signs follow the same provisions for design and application as those given for changeable message signs in EPG 903.11. The information in this article describes situations where the provisions for portable changeable message signs differ from those given in EPG 903.11.

Portable changeable message signs are used most frequently on high-density urban freeways, but have applications on all types of highways where highway alignment, road user routing problems, or other pertinent conditions require advance warning and information.

Portable changeable message signs have a wide variety of applications in TTC zones including: roadway, lane, or ramp closures; incident management; width restriction information; speed control or reductions; advisories on work scheduling; road user management and diversion; warning of adverse conditions or special events; and other operational control.

The primary purpose of portable changeable message signs in TTC zones is to advise the road user of unexpected situations. Portable changeable message signs are particularly useful as they are capable of:

A. Conveying complex messages,
B. Displaying real time information about conditions ahead, and
C. Providing information to assist road users in making decisions prior to the point where actions must be taken.

Some typical applications include the following:

A. Where the speed of vehicular traffic is expected to drop substantially;
B. Where significant queuing and delays are expected;
C. Where adverse environmental conditions are present;
D. Where there are changes in alignment or surface conditions;
E. Where advance notice of ramp, lane, or roadway closures is needed;
F. Where crash or incident management is needed; and/or
G. Where changes in the road user pattern occur.

Guidance. The components of a portable changeable message sign should include: a message sign, control systems, a power source, and mounting and transporting equipment. The front face of the sign should be covered with a protective material.

Standard. Portable changeable message signs shall comply with the applicable design and application principles established in EPG 903.1. Portable changeable message signs shall display only traffic operational, regulatory, warning, and guidance information, and shall not be used for advertising messages.

CMSs shall not be used to replace static sign messages.

Support. EPG 903.12.2 contains information regarding overly simplistic or vague messages that is also applicable to portable changeable message signs.

Standard. The colors used for legends on portable changeable message signs shall comply with those shown in Table 903.1.6.

Support. EPG 903.12.4 contains information regarding the luminance, luminance contrast, and contrast orientation that is also applicable to portable changeable message signs.

Guidance. Portable changeable message signs should be visible from ½ mile under both day and night conditions.

Support. EPG 903.2.20 contains information regarding the design of portable changeable message signs that are used to display speed limits that change based on operational conditions, or are used to display the speed at which approaching drivers are traveling.

Guidance. A portable changeable message sign should be limited to three lines of eight characters per line or should consist of a full matrix display.

Except as provided in the following paragraph, the letter height used for portable changeable message sign messages should be a minimum of 18 inches.

Option. For portable changeable message signs mounted on service patrol trucks or other incident response vehicles, a letter height as short as 10 inches may be used. Shorter letter sizes may also be used on a portable changeable message sign used on low speed facilities provided that the message is legible from at least 650 feet.

The portable changeable message sign may vary in size.

Guidance. Messages on a portable changeable message sign should consist of no more than two phases, and a phase should consist of no more than three lines of text. Each phase should be capable of being understood by itself, regardless of the order in which it is read. Messages should be centered within each line of legend. If more than one portable changeable message sign is simultaneously legible to road users, then only one of the signs should display a sequential message at any given time.

Support. Road users have difficulties in reading messages displayed in more than two phases on a typical three-line portable changeable message sign.

Standard. Except when being used to simulate an Arrow Board display (see EPG 903.12.6), techniques of message display such as animation, rapid flashing, dissolving, exploding, scrolling, traveling horizontally or vertically across the face of the sign, or other dynamic elements shall not be used.

Guidance. When a message is divided into two phases, the display time for each phase should be at least 2 seconds, and the sum of the display times for both of the phases should be a maximum of 8 seconds.

All messages should be designed with consideration given to the principles provided in this article and also taking into account the following:

A. The message should be as brief as possible and should contain three thoughts (with each thought preferably shown on its own line) that convey:

1. The problem or situation that the road user will encounter ahead,
2. The location of or distance to the problem or situation, and
3. The recommended driver action.

B. If more than two phases are needed to display a message, additional portable changeable message signs should be used. When multiple portable changeable message signs are needed, they should be placed on the same side of the roadway and they should be separated from each other by a distance of at least 1,000 feet.

Standard. When the word messages shown in MUTCD Table 1D-1 or Table 1D-2 need to be abbreviated on a portable changeable message sign, the provisions described in EPG 911 (MUTCD Section 1D.08) shall be followed.

In order to maintain legibility, portable changeable message signs shall automatically adjust their brightness under varying light conditions.

The control system shall include a display screen upon which messages can be reviewed before being displayed on the message sign. The control system shall be capable of maintaining memory when power is unavailable.

Portable changeable message signs shall be equipped with a power source and a battery back-up to provide continuous operation when failure of the primary power source occurs.

The mounting of portable changeable message signs on a trailer, a large truck, or a service patrol truck shall be such that the bottom of the message sign shall be a minimum of 7 feet above the roadway in urban areas and 5 feet above the roadway in rural areas when it is in the operating mode.

Guidance. Portable changeable message signs should be used as a supplement to and not as a substitute for conventional signs and pavement markings.

When portable changeable message signs are used for route diversion, they should be placed far enough in advance of the diversion to allow road users ample opportunity to perform necessary lane changes, to adjust their speed, or to exit the affected highway.

Portable changeable message signs should be sited and aligned to provide maximum legibility and to allow time for road users to respond appropriately to the portable changeable message sign message.

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Portable changeable message signs should be placed off the shoulder of the roadway and behind a traffic barrier, if practicable. Where a traffic barrier is not available to shield the portable changeable message sign, it should be placed off the shoulder and outside of the clear zone. If a portable changeable message sign has to be placed on the shoulder of the roadway or within the clear zone, it should be delineated with retroreflective TTC devices (see Standard Plan 616.10 (https://www.modot.org/media/16892)).

When portable changeable message signs are used in TTC zones, they should display only TTC messages.

When portable changeable message signs are not being used to display TTC messages, they should be relocated such that they are outside of the clear zone or shielded behind a traffic barrier and turned away from traffic. If relocation or shielding is impracticable, they should be delineated with retroreflective TTC devices.

Portable changeable message sign trailers should be delineated on a permanent basis by affixing retroreflective material, known as conspicuity material, in a continuous line on the face of the trailer as seen by oncoming road users.

616.12.6 Arrow Boards (MUTCD Section 6L.06)

Standard. An arrow board shall be a sign with a matrix of elements capable of either flashing or sequential displays. This sign shall provide additional warning and directional information to assist in merging and controlling road users through or around a TTC zone.

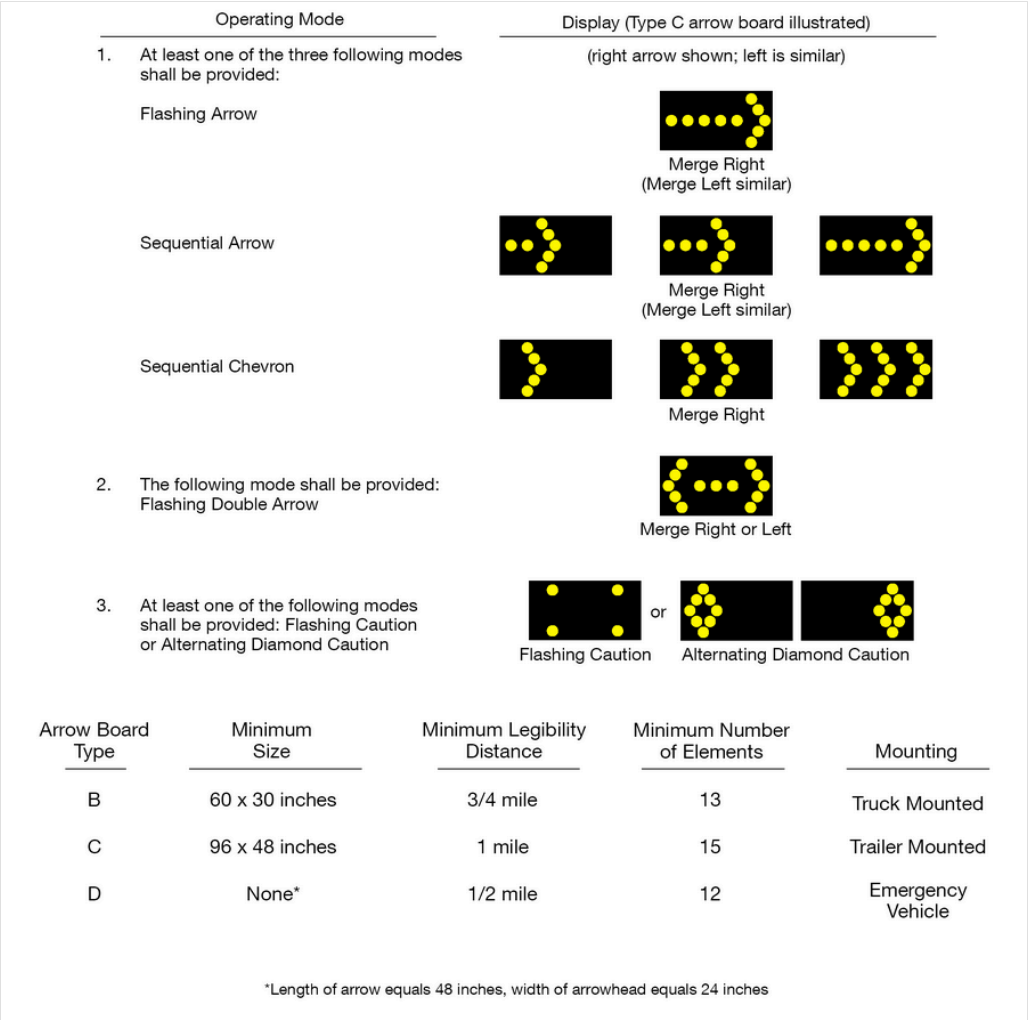
Guidance. An arrow board in the arrow or chevron mode should be used to advise approaching traffic of a lane closure along major multi-lane roadways in situations involving heavy traffic volumes, high speeds, and/or limited sight distances, or at other locations and under other conditions where road users are less likely to expect such lane closures.

If used, an arrow board should be used in combination with appropriate signs, channelizing devices, or other TTC devices.

An arrow board should be placed on the shoulder of the roadway or, if practicable, farther from the traveled lane. It should be delineated with retroreflective TTC devices. When an arrow board is not being used, it should be removed; if not removed, it should be shielded; or if the previous two options are not feasible, it should be delineated with retroreflective TTC devices.

Standard. Arrow boards shall meet the minimum size, legibility distance, number of elements, and other specifications shown in Figure 616.12.6.

Support. Type B arrow boards are truck-mounted units, appropriate for maintenance or mobile operations. Type C arrow boards are trailer-mounted units, intended to be used on high-speed, high-volume motor vehicle traffic control projects. Type D arrow boards are intended for use on vehicles authorized by the State or local agency.



Arrow Board Type	Minimum Size	Minimum Legibility Distance	Minimum Number of Elements	Mounting
B	60 x 30 inches	3/4 mile	13	Truck Mounted
C	96 x 48 inches	1 mile	15	Trailer Mounted
D	None*	1/2 mile	12	Emergency Vehicle

*Length of arrow equals 48 inches, width of arrowhead equals 24 inches

Figure 616.12.6 Advance Warning Arrow Board Specifications

Standard. Type B and C arrow boards shall have solid rectangular appearances. A Type D arrow board shall conform to the shape of the arrow.

All arrow boards shall be finished in non-reflective black. The arrow board shall be mounted on a vehicle, a trailer, or other suitable support.

Guidance. The minimum mounting height, measured vertically from the bottom of the board to the roadway below it or to the elevation of the near edge of the roadway, of an arrow board should be 7 feet, except on vehicle-mounted arrow boards, which should be as high as practicable.

A vehicle-mounted arrow board should be provided with remote controls.

Standard. Arrow board elements shall be capable of at least a 50 percent dimming from full brilliance. The dimmed mode shall be used for nighttime operation of arrow boards.

Guidance. Full brilliance should be used for daytime operation of arrow boards.

Standard. The arrow board shall have suitable elements capable of the various operating modes. The color presented by the elements shall be yellow.

Guidance. If an arrow board consisting of a bulb matrix is used, the elements should be recess-mounted or equipped with an upper hood of not less than 180 degrees.

Standard. The minimum element on-time shall be 50 percent for the flashing mode, with equal intervals of 25 percent for each sequential phase. The flashing rate shall be not less than 25 or more than 40 flashes per minute.

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An arrow board shall have the following three mode selections:

A. A Flashing Arrow, Sequential Arrow, or Sequential Chevron mode;
B. A flashing Double Arrow mode; and
C. A flashing Caution or Alternating Diamond Caution mode.

An arrow board in the arrow or chevron mode shall be used only for stationary or moving lane closures on multi-lane roadways.

For shoulder work, for blocking the shoulder, for roadside work near the shoulder, or for temporarily closing one lane on a two-lane, two-way roadway, an arrow board shall be used only in the caution mode.

Guidance. For a stationary lane closure, the arrow board should be located on the shoulder at the beginning of the merging taper.

Where the shoulder is narrow, the arrow board should be located in the closed lane.

Standard. When arrow boards are used to close multiple lanes, a separate arrow board shall be used for each closed lane.

Guidance. When arrow boards are used to close multiple lanes, if the first arrow board is placed on the shoulder, the second arrow board should be placed in the first closed lane at the upstream end of the second merging taper (see TA-37). When the first arrow board is placed in the first closed lane, the second arrow board should be placed in the second closed lane at the downstream end of the second merging taper.

For mobile operations where a lane is closed, the arrow board should be located to provide adequate separation from the work operation to allow for appropriate reaction by approaching drivers.

Standard. A vehicle displaying an arrow board shall be equipped with high-intensity rotating, flashing, oscillating, or strobe lights.

Arrow boards shall only be used to indicate a lane closure. Arrow boards shall not be used to indicate a lane shift.

Option. A portable changeable message sign may be used to simulate an arrow board display.

616.12.7 Flashing Beacons and Warning Lights (MUTCD Section 6L.07)

Option. Flashing beacons (see EPG 902.18) and/or warning lights may be used to supplement certain retroreflectorized signs and channelizing devices as described in this article.

Support. Type A and Type B warning lights are portable, powered, yellow, lens-directed, enclosed lights.

Standard. Warning lights shall comply with the provisions in Chapter 13 of the publication entitled, “Equipment and Materials Standards of the Institute of Transportation Engineers,” 1998, Institute of Transportation Engineers.

When warning lights are used, they shall be mounted on signs or channelizing devices in a manner that, if hit by an errant vehicle, they will not be likely to penetrate the windshield.

Guidance. The maximum spacing for warning lights should be identical to the channelizing device spacing requirements.

Standard. Except for the sequential flashing warning lights that are described in the following paragraph, flashing warning lights shall not be used for delineation, as a series of flashers fails to identify the desired vehicle path.

If a series of sequential flashing warning lights is used on channelizing devices that form a merging taper, the successive flashing of the lights shall occur from the upstream end of the merging taper to the downstream end of the merging taper in order to identify the desired vehicle path. Each flashing warning light in the sequence shall be flashed at a rate

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of not less than 55 or more than 75 times per minute.

Guidance. Sequential flashing warning lights should be used for merging tapers on interstate highways during nighttime operations.

Option. Sequential flashing warning lights may be used for merging tapers on other multi-lane highways as determined by the district.

Standard. Type A Low-Intensity Flashing warning lights for sequential flashing shall be maintained so as to be capable of being visible on a clear night from a distance of 3,000 feet. Type B High-Intensity Flashing warning lights for AFADs shall be maintained so as to be capable of being visible on a sunny day when viewed without the sun directly on or behind the device from a distance of 1,000 feet.

Warning lights shall have a minimum mounting height of 30 inches to the bottom of the lens.

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Sequential Flashing Warning Light

SPEED	SIGN SPACING (ft.)	TAPER LENGTH (ft.)		RECOMMENDED	CHANNELIZER SPACING (ft.)	
Permanent Posted (mph)	Multi-Lane (S)	Shoulder (1) (T1)	Lane (2) (T2)	BUFFER LENGTH (ft.) (B)	Tapers	Buffer/ Work Areas
0-35	200	70	245	250	35	40
40-45	500	150	540	360	40	80
50-55	1000	185	660	495	50	80
60-70	SA - 1000, SB - 1500, and SC - 2640	235	840	730	60	120

1. Shoulder taper length based on 10 ft. (standard shoulder width) offset. 2. Lane taper length based on 12 ft. (standard lane width) offset.

This Sequential Flashing Warning Light sheet provides guidance on the placement of lights within shoulder and merge taper and operational information. Review appropriate typical applications for signs, sign spacing, taper length, buffer length, channelizer spacing, TMAs, channelizers, etc.

The sequential lights should be self-contained and placed within the merging taper and still communicate with any light within the sequence. The lights should be capable to be spaced at least 60' and may have a offset capability of at least 6'.

Pay item description: The number of sequential lights used in the merge taper will be dependent on the above table criteria based on posted speed limit. Depending on project location and intesity of lighting, the number of lights may be reduce to a minimum of 10 lights within the merge taper. Contract cost of light would be based on purchase, installing and maintaining per light.

Battery Recommendation:
6-Volt Battery: Sequential lights with one 6-volt battery were used on several projects and the lights were getting about 3 weeks of battery life. Several different types of batteries (6-volt) were used on the projects. This is based on continuous use of the light (24/7).

4 D-cell Batteries: Sequential lights with 4 D-Cell batteries with converter were used on several projects and were getting about 3 weeks of battery life. This is based on continuous use of the light (24/7).



6-Volt Batteries



4 D-Cell Batteries



Attachment of Light

Number of Batteries Used on Channelizers:

Due to weight and consistency, a 6-volt battery and 4 D-cell batteries with converter will be considered as equal. All sequential lights must be securely mounted to all channelizers.

If sequential lights are used on Drum-like channelizers, two batteries can be installed.

If they are mounted on a Trimline, only one battery may be installed. An extra ballast ring may be necessary to keep the trimline from tipping over.

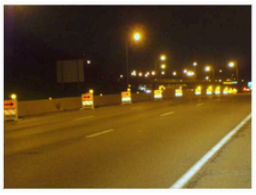
If they are mounted on a Directional Indicator Board, only one battery may be installed.



Two Batteries



One Battery



One Battery

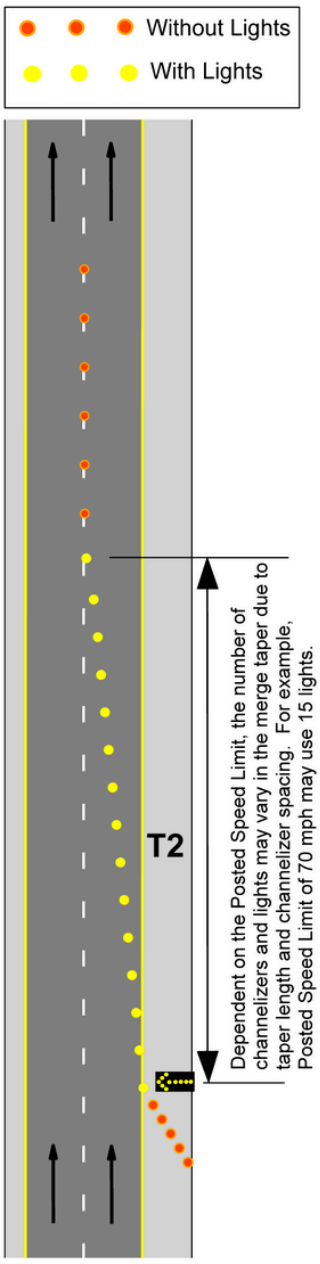


Figure 616.12.7 Sequential Flashing Warning Light

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616.12.8 High-Level Warning Devices (Flag Trees) (MUTCD Section 6L.08)

Support. MoDOT does not use the High-Level Warning Devices.

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616.13 Other TTC Zone Design Features and Safety Devices (MUTCD Chapter 6M)

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616.13.1 General (MUTCD Section 6M.01)

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616.13.5 Crash Cushions (Section 6M.05)

616.13.6 Temporary Transverse Rumble Strips (Section 6M.06)

- 616.13.6.1 Temporary Rumble Strips for Work Zones
- 616.13.6.2 Placement of Temporary Rumble Strips for Work Zones

616.13.7 Screens (Section 6M.07)

616.13.8 Lighting for Night Work (Section 6M.08)

- 616.13.8.1 Fleet Lighting

616.13.1 General (MUTCD Section 6M.01)

Support. Although certain devices and design features, such as lighting, barriers, dividers, crash cushions, and screens, are sometimes used in TTC zones to supplement traffic control devices or enhance traffic operations or safety for road users, they are not considered to be traffic control devices. The following Sections describe the most commonly used devices and design features. EPG 911 (MUTCD Section 1D.04) contains additional information about these devices and design features.

616.13.2 Positive Protection and Temporary Traffic Barriers (MUTCD Section 6M.02)

Support. Temporary traffic barriers, including portable or movable barriers, are devices designed to help prevent penetration by vehicles while minimizing injuries to vehicle occupants, and to protect workers, bicyclists, and pedestrians.

Positive protection devices means devices that contain or redirect vehicles and meet applicable industry crashworthiness evaluation criteria.

Additional information for temporary traffic barriers is located in EPG 617, Specifications Section 617 (https://www.modot.org/missouri-standard-specifications-highway-construction), Standard Plan 617.20 (https://www.modot.org/media/16894), and Standard Plan 619.10 (https://www.modot.org/media/16895).

Standard. At a minimum, agencies shall use positive protection devices in work zones with high anticipated operating speeds that provide workers no means of escape from motorized traffic intruding into the workspace unless an engineering study determines otherwise. An engineering study shall include at a minimum the information as approved by the Highway Safety and Traffic Division.

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Positive protection devices shall be considered in other situations that place workers at increased risk from motorized traffic, and where positive protection devices offer the highest potential for increased safety for workers and road users.

Considerations for positive protection shall include, but are not limited to, the following circumstances:

A. Work zones that provide workers no means of escape from motorized traffic such as tunnels or bridges;
B. Long-term stationary work zones of two weeks or more resulting in substantial worker exposure to motorized traffic;
C. Projects with anticipated operating speeds of 45 mph or greater, especially when combined with high traffic volumes;
D. Work operations that place workers, pedestrians, or bicyclists close to travel lanes open to traffic; and
E. Roadside hazards, such as drop-offs or unfinished bridge decks, that will remain in place overnight or longer.

Temporary traffic barrier shall be required on the following:

A. Roadway excavation edge drop-offs (refer to Standard Plan 619.10 (https://www.modot.org/media/16895)), and
B. Bridge rehabilitation jobs with bridge rail replacement and/or full depth repair.

Guidance. Temporary traffic barrier should be considered for long-term bridge repair work.

Support. When specified, quantities are calculated and shown on the plans. Delineators for temporary concrete traffic barriers are provided at no direct pay as shown on Standard Plan 617.20 (https://www.modot.org/media/16894) and stated in Specifications Section 617 (https://www.modot.org/missouri-standard-specifications-highway-construction). Delineators pay items are used only to retrofit existing permanent concrete traffic barrier.

Work zone setups vary depending on the nature of the positive protection used.

23 CFR Part 630.1108(a) contains additional requirements for certain projects.

Option. Temporary traffic barriers may be used to separate two-way vehicular traffic.

Standard. Temporary traffic barriers shall be supplemented with standard delineation, pavement markings, or channelizing devices for improved daytime and nighttime visibility if they are used to channelize vehicular traffic. The delineation color shall match the applicable pavement marking color.

Temporary traffic barriers, including their end treatments, shall be crashworthy (see definition in EPG 911 (MUTCD Section 1C.02)).

Short intermittent segments of temporary traffic barrier shall not be used because they nullify the containment and redirective capabilities of the temporary traffic barrier, increase the potential for serious injury both to vehicle occupants and pedestrians, and encourage the presence of blunt leading ends. Adjacent temporary traffic barrier segments shall be properly connected in order to provide the overall strength required for the temporary traffic barrier to perform properly.

Guidance. Appropriate channelizing devices and pavement marking should always be used in front of barrier tapers for lane closures, shoulder closures or transition areas for temporary bypasses or connections. Wherever practical, a lateral shy distance should be provided between the edge of the driving lane and the barrier. A longitudinal buffer area should be provided between the channelizer taper and the barrier taper.

Support. Temporary traffic barrier includes portable concrete, portable steel, or movable barrier which can all be moved laterally and/or longitudinally when needed and/or from site to site. More specific information on the use of temporary traffic barriers is contained in Chapters 8 and 9 of “Roadside Design Guide,” 4th Edition, 2011,

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AASHTO and EPG 617.1.

616.13.3 Temporary Raised Islands (MUTCD Section 6M.03)

Standard. Temporary raised islands shall be used only in combination with pavement striping and other suitable channelizing devices**.**

Option. A temporary raised island may be used to separate vehicular traffic flows in two-lane, two-way operations on roadways having a vehicular traffic volume range of 4,000 to 15,000 average daily traffic (ADT) and on freeways having a vehicular traffic volume range of 22,000 ADT to 60,000 ADT.

Temporary raised islands also may be used in other than two-lane, two-way operations where physical separation of vehicular traffic from the TTC zone is not required.

Guidance. Temporary raised islands should have the basic dimensions of 4 inches high by at least 12 inches wide and have rounded or chamfered corners.

The temporary raised islands should not be designed in such a manner that they would cause a motorist to lose control of the vehicle if the vehicle inadvertently strikes the temporary raised island. If struck, pieces of the island should not be dislodged to the extent that they could penetrate the occupant compartment or involve other vehicles.

Standard. At pedestrian crossing locations, temporary raised islands shall have an opening or be shortened to provide at least a 60-inch wide passageway for the crossing pedestrian.

616.13.4 Detectable Edging for Pedestrians (Section 6M.04)

Support. Individual channelizing devices, tape or rope used to connect individual devices, other discontinuous barriers and devices, and pavement markings are not detectable by persons with vision disabilities and are incapable of providing detectable path guidance on temporary or realigned sidewalks or other pedestrian facilities.

Guidance. A continuously-detectable edging should be provided throughout the length of a temporary pedestrian facility such that it can be followed by pedestrians using long canes for guidance. This edging should extend at least 8 inches above the surface of the sidewalk or pathway, with the bottom of the edging a maximum of 2 inches above the surface. This edging should be continuous throughout the length of the facility except for gaps at locations where pedestrians or vehicles will be turning or crossing. This edging should consist of a prefabricated or formed-in-place curbing or other continuous device that is placed along the edge of the sidewalk or walkway. This edging should be firmly attached to the ground or to other devices. Adjacent sections of this edging should be interconnected such that the edging is not displaced by pedestrian or vehicular traffic or work operations, and such that it does not constitute a hazard to pedestrians, workers, or other road users.

Support. Examples of detectable edging for pedestrians include:

A. Prefabricated lightweight sections of plastic, metal, or other suitable materials that are interconnected and fixed in place to form a continuous edge.
B. Prefabricated lightweight sections of plastic, metal, or other suitable materials that are interconnected, fixed in place, and placed at ground level to provide a continuous connection between channelizing devices located at intervals along the edge of the sidewalk or walkway.
C. Sections of lumber interconnected and fixed in place to form a continuous edge.
D. Formed-in-place asphalt or concrete curb.
E. Prefabricated concrete curb sections that are interconnected and fixed in place to form a continuous edge.

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F. Continuous temporary traffic barrier or longitudinal channelizing barricades placed along the edge of the sidewalk or walkway that provides a pedestrian edging at ground level.
G. Chain link or other fencing equipped with a continuous bottom rail.

Guidance. Detectable pedestrian edging should be orange, white, or yellow and should match the color of the adjacent channelizing devices or traffic control devices, if any are present.

616.13.5 Crash Cushions (Section 6M.05)

Support. Crash cushions are systems that mitigate the effects of errant vehicles that strike obstacles, either by smoothly decelerating the vehicle to a stop when hit head-on, or by redirecting the errant vehicle. The two types of crash cushions that are used in TTC zones are stationary crash cushions and truck-mounted attenuators. Crash cushions in TTC zones help protect the drivers from the exposed ends of barriers, fixed objects, shadow vehicles, and other obstacles. Specific information on the use of crash cushions can be found in "Roadside Design Guide," 4th Edition, 2011, AASHTO.

See EPG 617.1 and EPG 612.1.

Standard. Crash cushions shall be crashworthy (see definition in EPG 911 (MUTCD Section 1C.02)). They shall also be designed for each application to stop or redirect errant vehicles under prescribed conditions. Crash cushions shall be periodically inspected to verify that they have not been hit or damaged. Damaged crash cushions shall be promptly repaired or replaced to maintain their crashworthiness.

Support. Stationary crash cushions are used in the same manner as permanent highway installations to protect drivers from the exposed ends of barriers, fixed objects, and other obstacles.

Standard. Stationary crash cushions shall be designed for the specific application intended.

An approved crash cushion shall be installed on the exposed end of the barrier where the posted speed prior to construction on an existing facility or the anticipated posted speed of a temporary facility is greater than 35 mph. A crash cushion shall be installed on the upstream end for divided facilities, and on both ends for all two-way facilities.

Truck- or trailer-mounted attenuators shall be energy-absorbing devices attached to the rear of shadow trucks and shall be used in accordance with the manufacturer's specifications. If used, the shadow vehicle with the attenuator shall be located in advance of the work area, workers, or equipment to reduce the severity of rear-end crashes from errant vehicles.

Support. See EPG 612 for the use of protective vehicle and truck/trailer-mounted attenuators.

Trucks or trailers are often used as shadow vehicles to protect workers or work equipment from errant vehicles. These shadow vehicles are normally equipped with flashing arrows, changeable message signs, and/or high-intensity rotating, flashing, oscillating, or strobe lights and are located properly in advance of the workers and/or equipment that they are protecting. However, these shadow vehicles might themselves cause injuries to occupants of the errant vehicles if they are not equipped with truck-mounted attenuators.

Guidance. The shadow truck should be positioned a sufficient distance in advance of the workers or equipment being protected so that there will be sufficient distance, but not so much so that errant vehicles will travel around the shadow truck and strike the protected workers and/or equipment.

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Support. Chapter 9 of "Roadside Design Guide," 4th Edition, 2011, AASHTO contains additional information regarding the use of shadow vehicles.

616.13.6 Temporary Transverse Rumble Strips (Section 6M.06)

Support. Temporary rumble strips are a strategy for reducing distracted driving and achieving MoDOT's work zone safety goals. Temporary rumble strips are used in construction or maintenance work zones (planned and unplanned) and consist of temporary long-term rumble strips.

Temporary rumble strips (see JSP-13-04C (https://epg.modot.org/forms/JSP/JSP1304.docx)) are comprised of a series of elongated strips installed laterally within the travel lane of the roadway to provide an audible and vibratory alert to drivers of the upcoming work zone.

Temporary long-term rumble strips are installed using adhesive backing on each strip to prevent movement of the strips in the travel lane.

Standard. If the color of a transverse rumble strip used within a travel lane is not the color of the pavement, the color of the rumble strip shall be orange.

When temporary long-term rumble strips are used, installation shall consist of a minimum of 1 set (5 strips per set) per open lane, spaced in accordance with Figure 616.13.6.1 on center with the RUMBLE STRIPS AHEAD sign.

If temporary rumble strips are used in work zones, any damage done to pavement shall be restored to the existing condition.

616.13.6.1 Temporary Rumble Strips for Work Zones

Standard. Temporary long-term rumble strips shall be used in long-term stationary daytime or night-time work zones with a duration of 3 days or more when a lane(s) is impacted.

Guidance. If the project is a long-term stationary project with intermediate construction activities impacting traffic, such as lane restrictions, additional temporary rumble strips should be evaluated for use.

Support. When temporary long-term rumble strips are included in projects performed by contractors, Job Special Provisions (JSPs) for temporary rumble strip used is required. Additional information, including maintenance, repair, and monitoring of temporary rumble strips, can be found in JSP-13-04C (https://epg.modot.org/forms/JSP/JSP1304.docx).

616.13.6.2 Placement of Temporary Rumble Strips for Work Zones

Support. Generally, temporary rumble strips are placed before the feature requiring attention (e.g., merge, lane shift, reduced speed) giving the motorist enough time to act safely. The recommended distance before the feature should be referenced or shown on the plans or figures. The location should be adjusted when needed to comply with the guidance below or based on performance observations.

Standard. Temporary rumble strips shall be placed perpendicular to traffic.

Guidance. The following information is applicable to temporary long-term rumble strips, except where noted.

A. Temporary rumble strip placement should be reviewed, and consideration given to geometric conditions prior to placement.
B. Temporary rumble strips should be place on tangent roadway segments. Placement at or just beyond a vertical curve crest should be avoided.

C. Temporary rumble strips work best when in complete contact with the roadway surface and therefore should not be used on heavily rutted roadways or on roadways with loose material.
D. Temporary rumble strips should not be placed through marked pedestrian crossings, marked pedestrian paths, or on marked bicycle routes. Engineering judgment should be used to avoid placement in these areas.
E. Temporary rumble strips should not be placed where routine braking is expected on the rumble strip. Routine braking on the strips may cause the strips to come loose and require additional maintenance than otherwise would be needed to keep them in place. Relocating the rumble strips should be considered if constant maintenance is required.
F. Additional sets of temporary long-term rumble strips should be used to get the attention of drivers.

Standard. Temporary rumble strips shall be checked, as necessary, for proper adhesion and corrected when needed. If temporary rumble strips are omitted as directed by this standard or field conditions, the decision with explanation of why, shall be documented accordingly.

Temporary Rumble Strip (TRS) Placement

SPEED	SIGN SPACING (ft.)		TAPER LENGTH (ft.)		OPTIONAL	CHANNELIZER SPACING (ft.)	
Permanent Posted (mph)	Undivided (S)	Divided (S)	Shoulder (T1)	Lane (T2)	BUFFER LENGTH (ft.) (B)	Tapers	Buffer/ Work Areas
0-35	200	200	Review appropriate typical applications for signs, sign spacing, taper length, buffer length, channelizer spacing, TMAs, etc.				
40-45	350	500					
50-55	500	1000					
60-70	1000	SA - 1000 SB - 1500 SC - 2640					

NOTES:

See EPG 616.13.6 Temporary Transverse Rumble Strips (Section 6M.06) for rumble strip guidance and locations.

Flagging operation can include human flaggers, automated flagger assistance devices, portable signal flagging devices and traffic control signals operations.

Temporary rumble strips shall be orange in color.

(1) Rumble set distance from a sign (flagger symbol sign, signal ahead, merge, etc. signs) as shown in the following figures.

(2) A set of temporary long-term rumble strips shall consist of 5 strips separated at 10-12 ft. on center.

If the project is a long-term stationary project with intermediate construction activities impacting traffic, such as lane restrictions, additional temporary rumble strips should be evaluated for use.

Temporary Long-term Rumble Strips		
Permanent Posted Speed (MPH)	Distance (ft.) (1)	Spacing (ft.) (2)
0 - 45 (Optional)	120	10 - 12
50 - 55	160	10 - 12
60 - 70	200	10 - 12

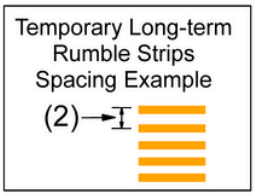


Figure 616.13.6.1 Temporary Rumble Strip Placement

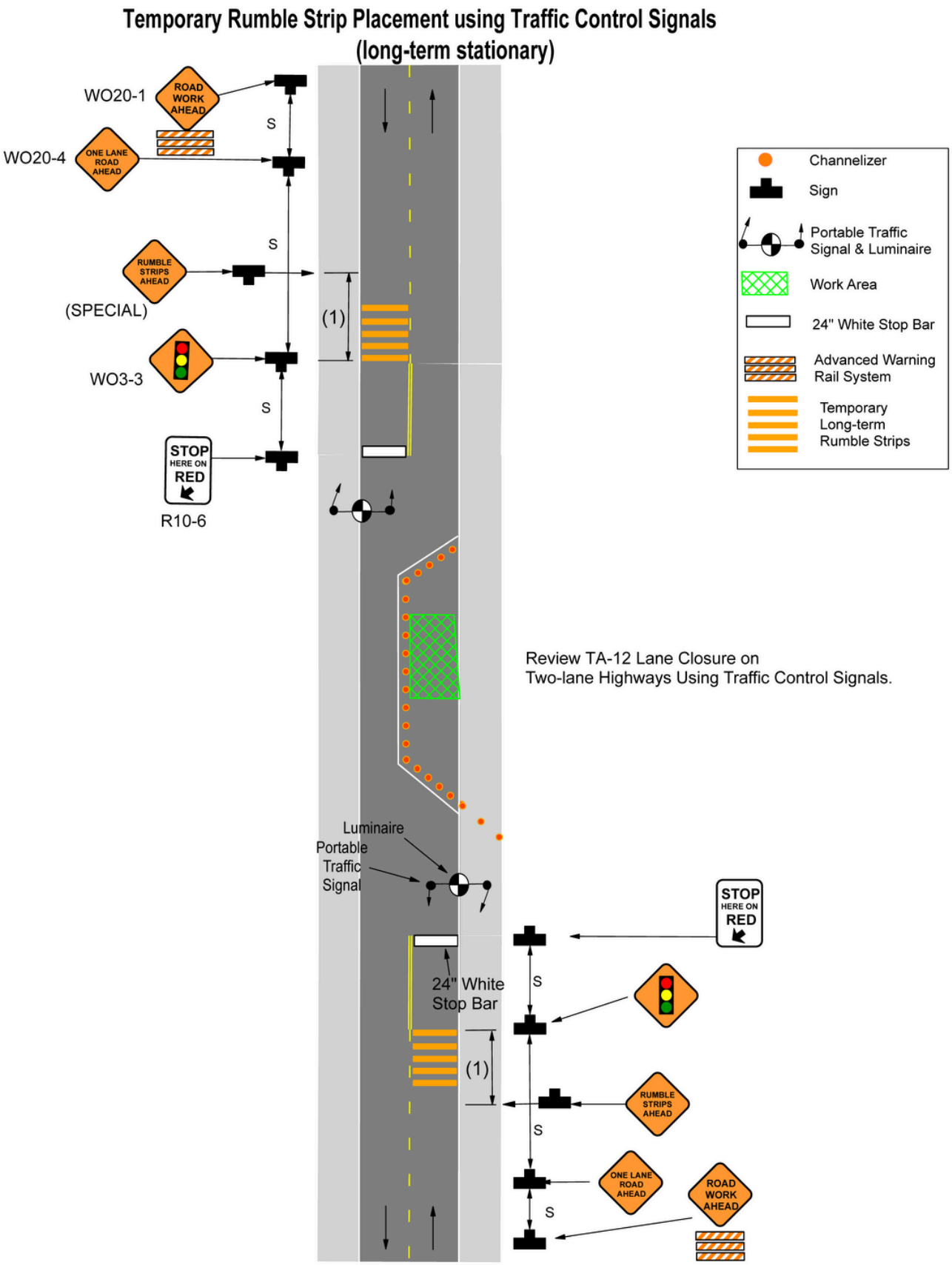


Figure 616.13.6.2 Temporary Rumble Strip Placement using Traffic Control Signals

Rumble Strip Placement on a Divided Highway

(long-term stationary)

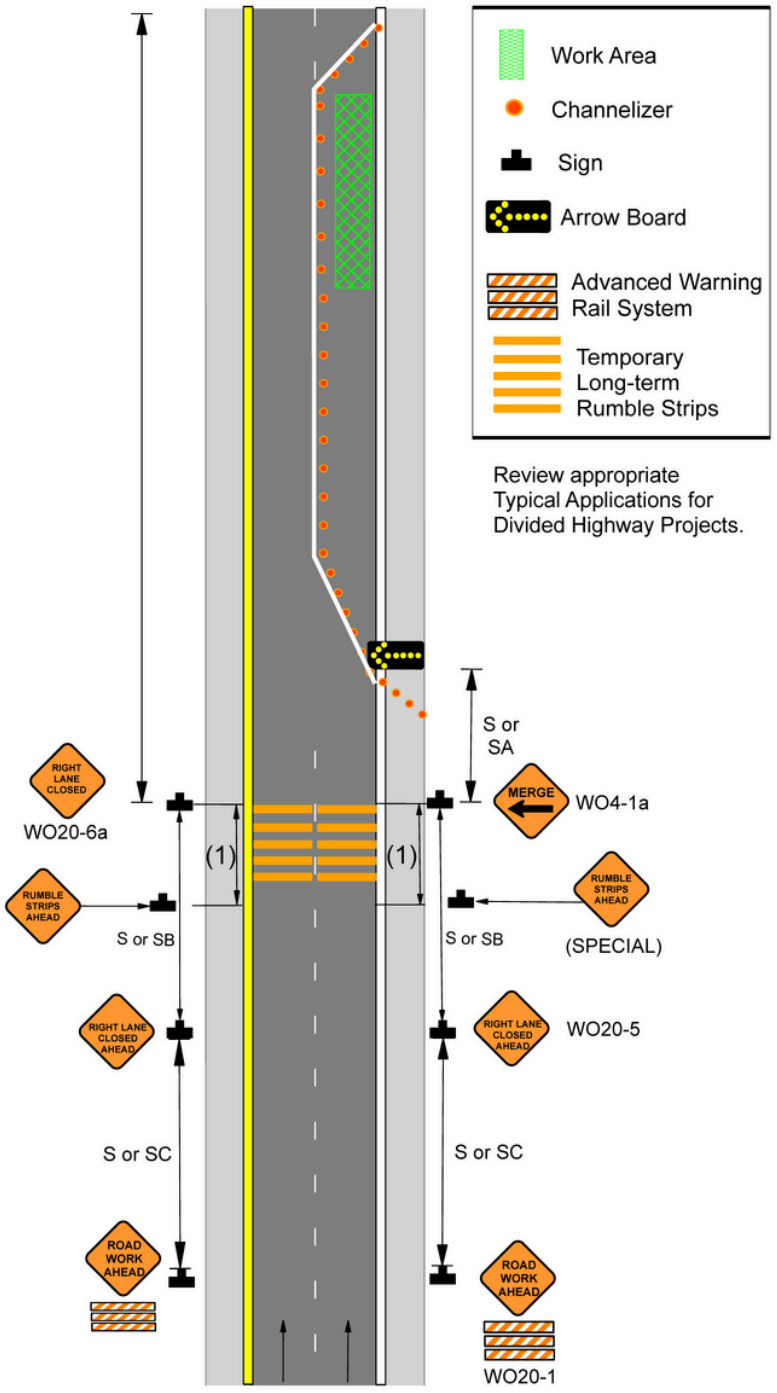


Figure 616.13.6.3 Rumble Strip Placement on a Divided Highway

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616.13.7 Screens (Section 6M.07)

Support. Screens are used to block the road users' view of activities that can be distracting. Screens might improve safety and motor vehicle traffic flow where volumes approach the roadway capacity because they discourage gawking and reduce headlight glare from oncoming motor vehicle traffic.

See EPG 617.1 for additional information.

Guidance. Screens should not be mounted where they could adversely restrict road user visibility and sight distance and adversely affect the operation of vehicles.

Option. Screens may be mounted on the top of temporary traffic barriers that separate two-way motor vehicle traffic.

Guidance. Design of screens should be in accordance with Chapter 9 of "Roadside Design Guide," 4th Edition, 2011, AASHTO.

616.13.8 Lighting for Night Work (Section 6M.08)

Support. Utility, maintenance, or construction activities on highways are frequently conducted during nighttime periods when vehicular traffic volumes are lower. Large construction projects are sometimes operated on a double-shift basis requiring night work (see EPG 616.14.18).

Guidance. When nighttime work is being performed, floodlights should be used to illuminate the work area, equipment crossings, and other areas.

When used, floodlighting should be installed in a manner that minimizes glare to approaching road users, flaggers, or workers.

The adequacy of the floodlight placement and elimination of potential glare should be determined by driving through and observing the floodlighted area from each direction on all approaching roadways after the initial floodlight setup, at night, and periodically. Lighting should be sufficient so as to give road users the capability to identify a worker as a person. Care should be taken to minimize the potential for shadows to conceal workers within the work area.

Support. Desired work area illumination levels vary depending upon the nature of the task involved. An average horizontal luminance of 5 foot candles can be adequate for general activities. Tasks requiring high levels of precision and extreme care can require an average horizontal luminance of 20 foot candles.

Option. Typical work area lighting installations may include dirigible lighting, portable light towers, balloon lighting, lights attached to equipment or post-mounted lights. In some cases, existing lighting or ambient lighting may meet lighting level requirements and negate the need for including work zone lighting.

Support. Temporary fixed lighting illuminates specific areas of significance to guide road users within the TTC zone during nighttime hours.

Option. Temporary fixed lighting may be considered at gore areas, transitions, ingress and egress areas, equipment crossings, intersections, temporary signals, islands temporary bypasses, and crossovers. Temporary fixed lighting may also be considered for areas of potential conflict, such as temporary ramps, intersections, and one-lane, two-way traffic operations that are in place for more than 15 consecutive days. These conditions may require lighting even though the work may not be conducted at night. This type of lighting, while more difficult to design and install, provides more uniform light distribution thereby enabling the motorist to better navigate the work zone at night.

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Guidance. When stationary operations exceed 15 consecutive days, such as a bridge replacement, interchange or intersection work that occurs at night, temporary fixed lighting should be considered in lieu of work zone lighting.

Standard. If temporary fixed lighting is used, it shall be designed and shown in the plans.

Support. Refer to Specifications Section 901 (https://www.modot.org/missouri-standard-specifications-highway-construction) for roadway lighting requirements and EPG 901 for lighting design.

Standard. Except in emergency situations, flagger stations shall be illuminated at night.

616.13.8.1 Fleet Lighting

Support. Fleet lighting increases the visibility of work or incident response vehicles and equipment while in the temporary traffic control zone.

Standard. Except as provided in the following paragraph, all work vehicles and equipment shall be equipped with an acceptable warning light system, per example USDOT-approved warning lights. These lights shall be activated whenever a vehicle or piece of equipment is engaged in a work zone or incident response operation within the temporary traffic control zone.

Option. Vehicles and pieces of equipment may operate without warning lights activated if the vehicles and equipment are located within a workspace delineated by channelizers or protected by a temporary traffic barrier. For this situation, activation of the lights is not required.

Support. For Maintenance lighting requirements, see EPG 616.31. For construction projects see EPG 616.23.

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616.14 Types of Temporary Traffic Control Zone Activities (MUTCD Chapter

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616.14.1 Work Duration (Section 6N.01)

Support. Work duration is a major factor in determining the number and types of devices used in TTC zones. The duration of a TTC zone is defined relative to the length of time a work operation occupies a spot location.

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Standard. The categories of work duration and their time at a location shall be defined as follows:

A. Long-term stationary is work that occupies a location more than 3 days.
B. Intermediate-term stationary is work that occupies a location more than one daylight period up to 3 days, or nighttime work lasting more than 1 hour.
C. Short-term stationary is daytime work that occupies a location for more than 1 hour within a single daylight period.
D. Short duration is work that occupies a location up to 1 hour.
E. Mobile is work that moves intermittently or continuously.
F. Emergency operations include unplanned work. Within MoDOT, these operations consist of the initial response to and repair/removal of safety concerns including Response Priority 1 items (refer to MoDOT's Incident Response Plan).

616.14.1.1 Long-term Stationary

Support. At long-term stationary TTC zones, there is ample time to install and realize benefits from the full range of TTC procedures and devices that are available for use. Larger channelizing devices, temporary roadways, and temporary traffic barriers are frequently used.

Standard. Since long-term operations extend into nighttime, retroreflective and/or illuminated devices shall be used in long-term stationary TTC zones.

616.14.1.2 Intermediate-term Stationary

Support. In intermediate-term stationary TTC zones, it might not be feasible or practical to use procedures or devices that would be desirable for long-term stationary TTC zones, such as altered pavement markings, temporary traffic barriers, and temporary roadways. The increased time to place and remove these devices in some cases could significantly lengthen the project, thus increasing exposure time.

Standard. Since intermediate-term operations extend into nighttime, retroreflective and/or illuminated devices shall be used in intermediate-term stationary TTC zones.

616.14.1.3 Short-term Stationary

Support. Most maintenance and utility operations are short-term stationary work.

In these operations, procedures and devices are usually simplified when compared to intermediate and long-term stationary operations because workers are present to maintain and monitor the temporary traffic control zone, the zone is only set up during daylight hours and it is only in place for a relatively short period of time. Portable signs, arrow boards, channelizers, fleet lighting, protective vehicles, and truck-mounted attenuators are devices generally incorporated into the temporary traffic control plan for these operations.

Several operations where workers and equipment move along the road without stopping, usually at slow speeds, are set up with short-term stationary guidance with the ability to reduce or eliminate channelizers. With the constant movement, advance warning area must be maintained within the work area.

616.14.1.4 Short duration

As compared to stationary operations, short-duration operations are activities that might involve different treatments. Devices having greater mobility might be necessary such as signs mounted on trucks. Devices that are larger, more imposing, or more visible can be used effectively and economically. Short duration operations involve workers who are outside of vehicles making individual short stops for work activities such as litter cleanup, isolated pothole patching isolated crack sealing, utility operations or signal repair.

Guidance. Safety in short-duration operations should not be compromised by using fewer devices simply because the operation will have a short duration.

Guidance. When short-duration operations are being performed, a shadow vehicle equipped with an arrow board or a sign should follow the work vehicle, especially when vehicular traffic speeds or volumes are high. Where feasible, warning signs should be placed along the roadway and moved periodically as work progresses.

To avoid high-volume conditions, consideration should be given to scheduling short-duration operations work during off-peak hours.

If there are short-duration operations on a high-speed travel lane of a multi-lane divided highway, arrow boards should be used."

Standard. Short-duration operations shall have appropriate devices on the equipment (that is, high-intensity rotating, flashing, oscillating, or strobe lights, signs, or special lighting), or shall use a separate vehicle with appropriate warning devices. Although vehicle hazard warning lights are permitted to be used to supplement high-intensity rotating, flashing, oscillating, or strobe lights, they shall not be used instead of these devices.

Option. For short-duration operations that move at speeds of less than 3 mph, mobile signs or stationary signing that is periodically retrieved and repositioned in the advance warning area may be used.

Support. During short-duration work, it often takes longer to set up and remove the TTC zone than to perform the work. Workers face hazards in setting up and taking down the TTC zone. Also, since the work time is short, delays affecting road users are significantly increased when additional devices are installed and removed.

Knowledge of historical traffic conditions are considered when selecting the amount of temporary traffic control to be used on short-duration projects. Traffic conditions need to be monitored throughout the work operation to determine if adjustments are needed to address traffic impacts.

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Option. Considering these factors, simplified control procedures may be warranted for short-duration work. A reduction in the number of devices may be offset by the use of other more dominant devices such as high-intensity rotating, flashing, oscillating, or strobe lights on work vehicles.

Flaggers may be used for short-duration operations that often involve frequent short stops on two-lane two-way roads.

Flags and/or channelizing devices may be used and moved periodically to keep them near the work area.

Appropriately colored or marked vehicles augmented with signs, arrow boards, and with high-intensity rotating, flashing, oscillating, or strobe lights may be used in place of signs and channelizing devices for short-duration operations.

Support. Short-duration operations also include work activities where workers and equipment move along the road without stopping, usually at slow speeds. The advance warning area moves with the work area.

616.14.1.5 Mobile Operations

Support. As compared to stationary and short duration operations, mobile operations are activities which workers rarely exit their vehicles during the operation, such as retrieving large debris during sweeping, quick adjustment while striping, and mowing. Devices having greater mobility might be necessary such as signs mounted on trucks. Devices that are larger, more imposing, or more visible can be used effectively and economically. The mobility of the TTC zone is important.

Guidance. Safety in mobile operations should not be compromised by using fewer devices simply because the operation will frequently change its location.

When mobile operations are being performed, a shadow vehicle equipped with an arrow board or a sign should follow the work vehicle, especially when vehicular traffic speeds or volumes are high. Where feasible, warning signs should be placed along the roadway and moved periodically as work progresses.

To avoid high-volume conditions, consideration should be given to scheduling mobile operations work during off-peak hours.

If there are mobile operations on a high-speed travel lane of a multi-lane divided highway, arrow boards should be used.

Standard. Mobile operations shall have appropriate devices on the equipment (that is, high-intensity rotating, flashing, oscillating, or strobe lights, signs, or special lighting), or shall use a separate vehicle with appropriate warning devices. Although vehicle hazard warning lights are permitted to be used to supplement high-intensity rotating, flashing, oscillating, or strobe lights, they shall not be used instead of these devices.

Option. For mobile operations that move at speeds of less than 3 mph, mobile signs or stationary signing that is periodically retrieved and repositioned in the advance warning area may be used.

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Support. A rolling roadblock is a method of TTC used to slow or stop traffic as a means of temporarily removing traffic from a roadway segment downstream of the road block. The rolling roadblock closes all lanes of traffic by using pacing vehicles to create a gap so that construction activities can be performed. Rolling roadblocks are used where long-term road closures using TTC devices are not needed. A rolling roadblock consists of one blocking/pacing vehicle per lane of traffic, a clearing vehicle, and an advance warning vehicle. The rolling roadblock is normally performed by law enforcement officers during off-peak hours.

See EPG 616.19.7 for information regarding Traffic Pacing.

616.14.1.6 Emergency Operations

Support. Emergency operations include unplanned work. Within MoDOT, these operations consist of the initial response to and repair/removal of safety concerns including Response Priority 1 items (see MoDOT's Incident Response Plan (https://epg.modot.org/index.php?title=Category:948_Incident_Response_Plan_and_Emergency_Response_Management)).

Short-duration operation guidelines and appropriate typical applications should be followed when performing Emergency Operations.

616.14.2 Location of Work (MUTCD Section 6N.02)

Support. EPG 616.3, EPG 616.13.4 and EPG 616.14.4 contain additional information regarding the steps to follow when pedestrian or bicycle facilities are affected by the worksite.

The choice of TTC needed for a TTC zone depends upon where the work is located. As a general rule, the closer the work is to road users (including bicyclists and pedestrians), the greater the number of TTC devices that are needed. Procedures are described later in EPG 616.14 for establishing TTC zones in the following locations:

A. Outside the shoulder,
B. On the shoulder with no encroachment,
C. On the shoulder with minor encroachment,
D. Within the median, and
E. Within the traveled way.

Standard. When the work space is within the traveled way, except for short-duration and mobile operations, advance warning shall provide a general message that work is taking place and shall supply information about highway conditions. TTC devices shall clearly delineate the path roadway users are to follow through the TTC zone.

616.14.3 Modifications To Fulfill Special Needs (MUTCD Section 6N.03)

Support. The typical applications in EPG 616.16 illustrate commonly encountered situations in which TTC devices are employed.

Option. Other devices may be added to supplement the devices provided in the typical applications, and device spacing may be adjusted to provide additional reaction time. When conditions are less complex than those depicted in the typical applications, fewer devices may be needed.

Guidance. When conditions are more complex, typical applications should be modified by giving particular attention to the provisions set forth in EPG 616.1 and by incorporating appropriate devices and practices from the following list:

A. Additional devices:

1. Signs
2. Arrow boards
3. More channelizing devices at closer spacing (see EPG 616.13.4 for information regarding detectable edging for pedestrians)
4. Temporary raised pavement markers
5. Portable changeable message signs
6. Temporary traffic control signals (including accessible pedestrian signals where not otherwise required)
7. Temporary traffic barriers
8. Crash cushions
9. Screens
10. Rumble strips
11. . More delineation

B. Upgrading of devices:

1. A full complement of standard pavement markings
2. Brighter and/or wider pavement markings
3. Larger and/or brighter signs
4. Channelizing devices with greater conspicuity
5. Temporary traffic barriers in place of channelizing devices

C. Improved geometrics at detours or crossovers
D. Increased distances:

1. Longer advance warning area
2. Longer tapers

E. Lighting:

1. Temporary roadway lighting
2. Floodlights

F. Pedestrian routes and temporary facilities
G. Bicycle diversions and temporary facilities

616.14.4 Work Affecting Pedestrian and Bicycle Facilities (MUTCD Section 6N.04)

Support. It is not uncommon, particularly in urban areas, that road work and the associated TTC will affect existing pedestrian or bicycle facilities. It is essential that the needs of all road users, including pedestrians with disabilities, are considered in TTC zones.

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In addition to specific provisions identified in EPG 616.14.5 through EPG 616.14.13, there are a number of provisions that might be applicable for all of the types of activities identified in EPG 616.

Guidance. Where pedestrian or bicyclist usage is high, the typical applications should be modified by giving particular attention to the provisions set forth in EPG 616.3, EPG 616.15, EPG 616.11.2 and EPG 616.13.4, and in other articles of EPG 616 related to accessibility and detectability provisions in TTC zones.

Pedestrians should be separated from the worksite by appropriate devices that maintain the accessibility and detectability for pedestrians with disabilities.

Bicyclists and pedestrians should not be exposed to unprotected excavations, open utility access, overhanging equipment, or other such conditions.

Except for short-duration and mobile operations, when a highway shoulder is occupied, a SHOULDER WORK (WO21-5) sign should be placed in advance of the activity area. When work is performed on a paved shoulder 8 feet or more in width, channelizing devices should be placed on a taper having a length that conforms to the requirements of a shoulder taper. Signs should be placed such that they do not narrow any existing pedestrian passages to less than 48 inches.

Pedestrian detours should be avoided since pedestrians rarely observe them and the cost of providing accessibility and detectability might outweigh the cost of maintaining a continuous route. Whenever possible, work should be done in a manner that does not create a need to detour pedestrians from existing routes or crossings.

Standard. Where pedestrian routes are closed, alternate pedestrian routes shall be provided.

When existing pedestrian facilities are disrupted, closed, or relocated in a TTC zone, the temporary facilities shall be detectable and shall include accessibility features consistent with the features present in the existing pedestrian facility.

Guidance. The continuity of a bikeway should be maintained through the TTC zone if practical.

Support. The continuity of a bikeway through the TTC zone is particularly important where bicyclists have been traveling on a shoulder, bicycle lane, or shared-use path adjacent to a general-purpose lane (having a speed limit greater than or equal to 35 miles per hour) and there would be a significant safety concern if bicyclists were to share that general-purpose lane through the TTC zone.

On roadways which are not bikeways but where bicyclists (when present) typically share lanes with motor vehicle traffic, the TTC plan and Typical Applications for general traffic will usually be adequate for bicyclists as well.

In order to maintain room for bicycle lanes through the TTC zone on a multi-lane roadway, one or more travel lanes could be closed.

Guidance. If a bikeway detour is unavoidable, it should be as short and direct as practical.

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On-road bicyclists should not be directed onto a path or sidewalk intended for pedestrian use except where such a path or sidewalk is a shared-use path, or where no practical alternative is available (such as might be the case on a bridge in the course of a rehabilitation project).

If a portion of a bikeway is to be closed due to construction activities and the detoured bikeway follows a complex path not in the original bikeway corridor, then a full detour plan should be developed and implemented. The TTC for the detour of the bikeway should include all necessary advance warning (WO21 series) signs, detour (WO4-9 series) signs, and any other TTC devices necessary to guide bicyclists along the detour route.

Support. TA-47 through TA-51 provide examples and contain additional information for accommodating bicycles through or around typical TTC zones.

Option. If an on-street bikeway had a wide travel lane or lanes in which bicyclists traveled side by side with motor vehicles prior to construction, and construction activities reduce the lane width(s) to less than 14 feet through the TTC zone, then the BICYCLISTS ALLOWED USE OF FULL LANE (R9-20) sign may be used.

Standard. The minimum TTC sign and plaque sizes for shared-use paths shall conform to those shown in Table 914.1.2. The minimum TTC sign and plaque sizes for on-street bikeways shall conform to EPG 616.7, EPG 616.8, and EPG 616.9.

616.14.5 Work Outside of the Shoulder (MUTCD Section 6N.05)

Support. When work is being performed beyond the shoulders, but within the right-of-way, little or no TTC might be needed. TTC generally is not needed where work is confined to an area 15 feet or more from the edge of the traveled way. However, TTC is appropriate where distracting situations exist, such as vehicles parked on the shoulder, vehicles accessing the worksite via the highway, and equipment traveling on or crossing the roadway to perform the work operations (for example, mowing). A typical application for work beyond the shoulder is shown in TA-1.

Guidance. Where the situations described in the preceding paragraph exist, a single warning sign, such as ROAD WORK AHEAD (WO20-1), should be used. If the equipment travels on the roadway, the equipment should be equipped with appropriate flags, high-intensity rotating, flashing, oscillating, or strobe lights, and/or a SLOW MOVING VEHICLE (WO21-4) sign.

If work vehicles are on the shoulder, a SHOULDER WORK (WO21-5) sign should be used.

Option. For mowing operations, the sign MOWING AHEAD (WO21-8) may be used.

Where the activity is spread out over a distance of more than 2 miles, the SHOULDER WORK (WO21-5) sign may be repeated every 1 mile.

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A supplementary plaque with the message NEXT XX MILES (WO7-3aP) may be used.

616.14.6 Work on the Shoulder with No Encroachment (MUTCD Section 6N.06)

Support. The provisions of this article apply to short-term through long-term stationary operations.

Standard. When paved shoulders having a width of 8 feet or more are closed, at least one advance warning sign shall be used. In addition, channelizing devices shall be used to close the shoulder in advance to delineate the beginning of the work space and direct motor vehicle traffic to remain within the traveled way.

Guidance. When paved shoulders having a width of 8 feet or more are closed on freeways and expressways, road users should be warned about potential disabled vehicles that cannot get off the traveled way. An initial general warning sign, such as ROAD WORK AHEAD (WO20-1), should be used, followed by a RIGHT or LEFT SHOULDER CLOSED (WO21-5a) sign. Where the downstream end of the shoulder closure extends beyond the distance that can be perceived by road users, a supplementary plaque bearing the message NEXT XX FEET (WO16-4P) or MILES (WO7-3aP) should be placed below the SHOULDER CLOSED (WO21-5a) sign. On multi-lane, divided highways, signs advising of shoulder work or the condition of the shoulder should be placed only on the side of the affected shoulder.

When an improved shoulder is closed on a high-speed roadway, it should be treated as a closure of a portion of the road system because road users expect to be able to use it in emergencies. Road users should be given ample advance warning that shoulders are closed for use as refuge areas throughout a specified length of the approaching TTC zone. The sign(s) should read SHOULDER CLOSED (WO21-5a) with distances indicated. The work space on the shoulder should be closed off by a taper or channelizing devices with a length of ⅓ L using the formulas in Tables 616.2.8.1 and 616.2.8.2.

When the shoulder is not occupied but work has adversely affected its condition, the SOFT SHOULDER (WO8-4) sign should be used, as appropriate.

Where the condition extends over a distance in excess of 1 mile, the sign should be repeated at 1-mile intervals.

Option. In addition, a supplementary plaque bearing the message NEXT XX MILES (WO7-3aP) may be used.

Support. Temporary traffic barriers might be needed to inhibit encroachment of errant vehicles into the work space and to protect workers.

Standard. When used for shoulder work, arrow boards shall operate only in the caution mode.

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Support. A typical application for stationary work operations on shoulders is shown in TA-3. A typical application for short-duration or mobile work on shoulders is shown in TA-4. A typical application for work on freeway shoulders is shown in TA-5.

616.14.7 Work on the Shoulder with Minor Encroachment (MUTCD Section 6N.07)

Support. EPG 616.3, EPG 616.13.4, and EPG 616.14.4 contain additional information regarding the steps to follow when pedestrian or bicycle facilities are affected by the worksite.

Guidance. When work takes up part of a lane, vehicular traffic volumes, vehicle mix (buses, trucks, cars, and bicycles), speed, and capacity should be analyzed to determine whether the affected lane should be closed. Unless the lane encroachment permits a remaining lane width of 10 feet, the lane should be closed.

Truck off-tracking should be considered when determining whether the minimum lane width of 10 feet is adequate.

Support. TA-6 illustrates a method for handling vehicular traffic where the stationary or short-duration work space encroaches slightly into the traveled way.

616.14.8 Work Within the Median (MUTCD Section 6N.08)

Support. EPG 616.3, EPG 616.13.4, and EPG 616.14.4 contain additional information regarding the steps to follow when pedestrian or bicycle facilities are affected by the worksite.

Guidance. If work in the median of a divided highway is within 15 feet from the edge of the traveled way for either direction of travel, TTC should be used through the use of advance warning signs and channelizing devices.

616.14.9 Work Within the Traveled Way of a Two-Lane Highway (MUTCD Section 6N.09)

Support. EPG 616.3, EPG 616.13.4, and EPG 616.14.4 contain additional information regarding the steps to follow when pedestrian or bicycle facilities are affected by the worksite.

Detour signs are used to direct road users onto another roadway. At diversions, road users are directed onto a temporary roadway or alignment placed within or adjacent to the right-of-way. Typical applications for detouring or diverting road users on two-lane highways are shown in TA-7, TA-8, and TA-9. TA-7 illustrates the controls around an area where a section of roadway has been closed and a diversion has been constructed. Channelizing devices and pavement markings are used to indicate the transition to the temporary roadway.

Guidance. When a detour is long, Detour (MO4-8, MO4-9) signs should be installed to remind and reassure road users periodically that they are still successfully following the detour.

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When an entire roadway is closed, as illustrated in TA-8, a detour should be provided and road users should be warned in advance of the closure, which in this example is a closure 10 miles from the intersection. If local road users are allowed to use the roadway up to the closure, the ROAD CLOSED AHEAD, LOCAL TRAFFIC ONLY (R11-3a) sign should be used. The portion of the road open to local road users should have adequate signing, marking, and delineation.

Detours should be signed so that road users will be able to traverse the entire detour route and back to the original roadway as shown in TA-9.

Support. Techniques for controlling vehicular traffic under one-lane, two-way conditions are described in EPG 616.5.1.

Option. Flaggers may be used as shown in TA-10.

A temporary traffic control signal may be used as shown in TA-12.

616.14.10 Work Within the Traveled Way of an Urban Street (MUTCD Section 6N.10)

Support. EPG 616.3, EPG 616.13.4, and EPG 616.14.4 contain additional information regarding the steps to follow when pedestrian or bicycle facilities are affected by the worksite.

In urban TTC zones, decisions are needed on how to control vehicular traffic, such as how many lanes are required, whether any turns need to be prohibited at intersections, and how to maintain access to business, industrial, and residential areas.

Pedestrian traffic needs separate attention. EPG 616.3 contains information regarding pedestrian movements near TTC zones.

Standard. If the TTC zone affects the movement of bicyclists, adequate access to the roadway or shared-use paths shall be provided (see EPG 914 and EPG 641).

Where transit stops are affected or relocated because of work activity, both pedestrian and vehicular access to the affected or relocated transit stops shall be provided.

Guidance. If a designated bicycle route is closed because of the work being done, a signed alternate route should be provided. Bicyclists should not be directed onto the path used by pedestrians.

Worksites within the intersection should be protected against inadvertent pedestrian incursion by providing detectable channelizing devices.

Support. Utility work takes place both within and outside the roadway to construct and maintain services such as power, gas, light, water, or telecommunications. Operations often involve intersections, since that is where many of the network junctions occur. The work force is usually small, only a few vehicles are involved, and the number and types of TTC devices placed in the TTC zone is usually minimal.

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Guidance. As discussed under short-duration projects, however, the reduced number of devices in utility TTC zones should be offset by the use of high-visibility devices, such as high-intensity rotating, flashing, oscillating, or strobe lights on work vehicles or high-level warning devices.

Support. TA-6, TA-10, TA-18, TA-21, TA-22, TA-23, TA-26, and TA-33 are examples of typical applications for utility operations. Other typical applications might apply as well.

616.14.11 Work Within the Traveled Way of a Multi-Lane, Non-Access Controlled Highway (MUTCD Section 6N.11)

Support. EPG 616.3, EPG 616.13.4, and EPG 616.14.4 contain additional information regarding the steps to follow when pedestrian or bicycle facilities are affected by the worksite.

Work on multi-lane (two or more lanes of moving motor vehicle traffic in one direction) highways is divided into right-lane closures, left-lane closures, interior-lane closures, multiple-lane closures, and closures on five-lane roadways.

Standard. When a lane is closed on a multi-lane road for other than a mobile operation, a transition area containing a merging taper shall be used.

Guidance. When justified by an engineering study, temporary traffic barriers (see EPG 616.11.9) should be used to prevent incursions of errant vehicles into hazardous areas or work space.

Support. TA-34 illustrates a lane closure in which temporary traffic barriers are used.

Option. When the right-hand lane is closed, TTC similar to that shown in TA-33 may be used for undivided or divided four-lane roads.

Guidance. If morning and evening peak hour vehicular traffic volumes in the two directions are uneven and the greater volume is on the side where the work is being done in the right-hand lane, consideration should be given to closing the inside lane for opposing vehicular traffic and making the lane available to the side with heavier vehicular traffic, as shown in TA-31.

If the larger vehicular traffic volume changes to the opposite direction at a different time of the day, the TTC should be changed to allow two lanes for opposing vehicular traffic by moving the devices from the opposing lane to the center line. When it is necessary to create a temporary center line that is not consistent with the pavement markings, channelizing devices should be used and closely spaced.

Option. When closing a left-hand lane on a multi-lane undivided road, as vehicular traffic flow permits, the two interior lanes may be closed, as shown in TA-30, to provide drivers and workers additional lateral clearance and to provide access to the work space.

Standard. When only the left-hand lane is closed on undivided roads, channelizing devices shall be placed along the center line as well as along the adjacent lane.

Guidance. When an interior lane is closed, an adjacent lane should also be considered for closure to provide additional space for vehicles and materials and to facilitate the movement of equipment within the work space.

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When multiple lanes in one direction are closed, a capacity analysis should be made to determine the number of lanes needed to accommodate motor vehicle traffic needs. Vehicular traffic should be moved over one lane at a time. As shown in TA-37, the tapers should be separated by a distance of 2L, with L being determined by the formulas in Tables 616.2.8.1 and 616.2.8.2.

Option. If operating speeds are 40 mph or less and the space approaching the work area does not permit moving traffic over one lane at a time, a single continuous taper may be used.

Standard. When a directional roadway is closed, inapplicable WRONG WAY signs and markings, and other existing traffic control devices at intersections within the temporary two-lane, two-way operations section shall be covered, removed, or obliterated.

Option. When half the road is closed on an undivided highway, both directions of vehicular traffic may be accommodated as shown in TA-32. When both interior lanes are closed, temporary traffic controls may be used as provided in TA-30. When a roadway must be closed on a divided highway, a median crossover may be used (see EPG 616.14.15).

Support. TTC for lane closures on five-lane roads is similar to other multi-lane undivided roads. TA-32 can be adapted for use on five-lane roads. TA-35 can be used on a five-lane road for short duration and mobile operations.

616.14.12 Work Within the Traveled Way at an Intersection (MUTCD Section 6N.12)

Support. EPG 616.3, EPG 616.13.4, and EPG 616.14.4 contain additional information regarding the steps to follow when pedestrian or bicycle facilities are affected by the worksite.

The typical applications for intersections are classified according to the location of the work space with respect to the intersection area (as defined by the extension of the curb or edge lines). The three classifications are near side, far side, and in-the-intersection. Work spaces often extend into more than one portion of the intersection. For example, work in one quadrant often creates a near-side work space on one street and a far-side work space on the cross street. In such instances, an appropriate TTC plan is obtained by combining features shown in two or more of the intersection and pedestrian typical applications.

TTC zones in the vicinity of intersections might block movements and interfere with normal road user flows. Such conflicts frequently occur at more complex signalized intersections having such features as traffic signal heads over particular lanes, lanes allocated to specific movements, multiple signal phases, signal detectors for actuated control, and accessible pedestrian signals and detectors.

Guidance. The effect of the work upon signal operation should be considered, and temporary corrective actions should be taken, if necessary, such as revising signal phasing and/or timing to provide adequate capacity, maintaining or adjusting signal detectors, and relocating signal heads to provide adequate visibility as described in EPG 902.

Standard. When work will occur near an intersection where operational, capacity, or pedestrian accessibility problems are anticipated, the highway agency having jurisdiction shall be contacted.

Guidance. For work at an intersection, advance warning signs, devices, and markings should be used on all cross streets, as appropriate. The typical applications depict urban intersections on arterial streets. Where the posted speed limit, the off-peak 85th-percentile speed prior to the work starting, or the anticipated speed exceeds 40 mph, additional warning signs should be used in the advance warning area.

Pedestrian crossings near TTC sites should be separated from the worksite by appropriate barriers that maintain the accessibility and detectability for pedestrians with disabilities.

Support. Near-side work spaces, as depicted in TA-21, are simply handled as a midblock lane closure. A problem that might occur with near-side lane closure is a reduction in capacity, which during certain hours of operation could result in congestion and back-ups.

Option. When near-side work spaces are used, a mandatory turn lane may be used for through vehicular traffic.

Where space is restricted in advance of near-side work spaces, as with short block spacings, two warning signs may be used in the advance warning area, and a third action-type warning or a regulatory sign (such as Keep Left) may be placed within the transition area.

Support. Far-side work spaces, as depicted in TA-22 through TA-25, involve additional treatment because road users typically enter the activity area by straight-through and left-turn or right-turn movements.

Guidance. When a lane through an intersection must be closed on the far side, it should also be closed on the near-side approach to preclude merging movements within the intersection.

Option. If there are a significant number of vehicles turning from a near-side lane that is closed on the far side, the near-side lane may be converted to a mandatory turn lane.

Support. TA-26 and TA-27 provide guidance on applicable procedures for work performed within the intersection.

Option. If the work is within the intersection, any of the following strategies may be used:

A. A small work space so that road users can move around it, as shown in TA-26;
B. Flaggers or uniformed law enforcement officers to direct road users, as shown in TA-27;
C. Work in stages so the work space is kept to a minimum; and
D. Road closures or upstream diversions to reduce road user volumes.

Guidance. Depending on road user conditions, a flagger(s) and/or a uniformed law enforcement officer(s) should be used to control road users.

Support. TA-52 through TA-54 provide guidance on applicable procedures for work performed within a circular intersection.

616.14.13 Work Within the Traveled Way of a Freeway or Expressway (MUTCD Section 6N.13)

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Support. Special conditions encountered where vehicular traffic must be moved through or around TTC zones on high-speed, high-volume roadways can pose challenges to the TTC. Although the general principles outlined in other articles of the EPG are applicable to all types of highways, high-speed, access-controlled highways need special planning and attention in order to accommodate vehicular traffic while also protecting road users and workers. The traffic volumes, vehicle mix (buses, trucks, cars, and bicycles, if permitted), and speed of vehicles on these facilities require that careful TTC procedures be implemented, for example, to induce critical merging maneuvers well in advance of work spaces and in a manner that creates minimum turbulence and delay in the vehicular traffic stream.

When the roadway capacity is reduced as a result of lane closures, the demand might exceed the available capacity and result in either a lengthy stopped or slow moving queue of vehicles that might extend past the normal signs used in the typical advance warning area.

Guidance. An assessment of the expected queue length should be a part of the TTC plan design process and adjustments to the sign spacing and number of signs as well as the possibility of using more conspicuous devices should be considered to increase the distance and conspicuity of the advance warning area.

Support. One strategy often employed to mitigate the extended queue issue is to work during off peak hours or at night. When the work is limited to night hours, increased use of warning lights, illumination of work spaces, and intelligent advance warning systems might be necessary.

TTC for a typical lane closure where a queue is not anticipated to accumulate on a divided highway is shown in TA-33 and TA-34. Temporary traffic controls for short duration and mobile operations on freeways are shown in TA-35. A typical application for shifting vehicular traffic lanes around a work space is shown in TA-36. TTC for multiple and interior lane closures on a freeway is shown in TA-37 and TA-38.

Guidance. The method for closing an interior lane when the open lanes have the capacity to carry vehicular traffic should be as shown in TA-37. When the capacity of the other lanes is needed, the method shown in TA-38 should be used.

616.14.14 Two-Lane, Two-Way Traffic on One Roadway of a Normally Divided Highway (MUTCD Section 6N.14)

Support. Two-lane, two-way operation on one roadway of a normally divided highway (head-to-head traffic) is a typical procedure that requires special consideration in the planning, design, and work phases, because unique operational problems (for example, increasing the risk of head-on crashes) can arise with the two-lane, two-way operation. Head-to-head traffic is generally limited to rural locations.

Guidance. When head-to-head traffic is being considered, MoDOT Design staff should be contacted for concurrence.

Two-lane, two-way operation on one roadway of a normally divided highway should be used only after the following criteria are addressed and documented:

A. The benefit/cost of the two-lane, two-way operation compares favorably to the benefit/cost of other potential traffic control options (e.g., alternate routes, temporary lanes, construction staging, use of shoulders, etc.). The analysis is to include both construction and road user costs associated with each option.
B. A capacity analysis of the two-lane, two-way operation confirms this type of traffic management can reasonably accommodate the traffic volumes without detrimental delay to travelers.
C. The median shoulder width must be adequate for emergency stopping.

Standard. When two-lane, two-way traffic control must be maintained on one roadway of a normally divided highway, opposing vehicular traffic shall be separated with either temporary traffic barriers (see EPG 617.1) (concrete safety-shape or approved alternate), or channelizing devices and temporary pavement markings throughout the length of the two-way operation, as shown on Standard Plans 617.20 (https://www.modot.org/media/16894), 616.10 (https://www.modot.org/media/16892) and 620.10 (https://www.modot.org/media/16897), respectively. The use of markings and complementary signing, by themselves, shall not be used.

When two-lane, two-way traffic control must be maintained on one roadway of a normally divided highway, all obstructions or fixed objects shall have protection provided for both directions of travel.

Option. This may require providing temporary installations of impact attenuators or crash cushions for guardrail, bridge ends, barrier walls, etc. on what would normally be the downstream side of the obstruction.

Support. TA-39 shows the procedure for two-lane, two-way operation. Treatments for entrance and exit ramps within the two-way roadway segment of this type of work are shown in TA-40 and TA-41.

616.14.15 Crossovers (MUTCD Section 6N.15)

Support. Crossovers constructed to facilitate two-lane, two-way. Crossovers are located where horizontal and vertical alignments provide sufficient sight distance.

Guidance. The following are considered good guiding principles for the design of crossovers:

A. Tapers for lane drops should be separated from the crossovers, as shown in TA-39.
B. Crossovers should be designed for the work zone speed limit according to EPG 616.18.
C. A good array of channelizing devices, delineators, and full-length, properly placed pavement markings should be used to provide drivers with a clearly defined travel path.
D. The design of the crossover should accommodate all vehicular traffic, including trucks and buses.

Support. Temporary traffic barriers and the excessive use of TTC devices cannot compensate for poor geometric and roadway cross-section design of crossovers.

614.14.16 Interchanges (MUTCD Section 6N.16)

Guidance. Access to interchange ramps on limited-access highways should be maintained even if the work space is in the lane adjacent to the ramps. Access to exit ramps should be clearly marked and delineated with channelizing devices. For long-term projects, conflicting pavement markings should

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be removed and new ones placed. Early coordination with officials having jurisdiction over the affected cross streets and providing emergency services should occur before ramp closings.

Option. If access is not possible, ramps may be closed by using signs and Type 3 Barricades. As the work space changes, the access area may be changed, as shown in TA-42. A TTC zone in the exit ramp may be handled as shown in TA-43.

When a work space interferes with an entrance ramp, a lane may need to be closed on the freeway (see TA-44). A TTC zone in the entrance ramp may require shifting ramp vehicular traffic (see TA-44).

616.14.17 Work in the Vicinity of a Grade Crossing (MUTCD Section 6N.17)

Standard. When grade crossings exist either within or in the vicinity of a TTC zone, lane restrictions, flagging, or other operations shall not create conditions where vehicles can be queued across the tracks. If the queuing of vehicles across the tracks cannot be avoided, a uniformed law enforcement officer or flagger shall be provided at the crossing to prevent vehicles from stopping on the tracks, even if automatic warning devices are in place.

Support. TA-46 shows work in the vicinity of a grade crossing.

EPG 913.1.13 contains additional information regarding TTC zones in the vicinity of grade crossings.

Guidance. Early coordination with the railroad company or transit agency should occur before work starts.

616.14.18 Work During Nighttime Hours (MUTCD Section 6N.18)

Support. EPG 616.1.5 contains additional information regarding considerations for conducting work operations during nighttime hours.

Guidance. Considering the safety issues inherent to night work, consideration should be given to enhancing traffic controls (see EPG 616.14.3) to provide added visibility and driver guidance, and increased protection for workers.

In addition to the enhancements listed in EPG 616.14.3, consideration should be given to providing additional lights and retroreflective markings to workers, work vehicles, and equipment.

Option. Where reduced traffic volumes at night make it feasible, the entire roadway may be closed by detouring traffic to alternate facilities, thus removing the traffic risk from the activity area.

Guidance. Consideration should be given to stationing uniformed law enforcement officers and lighted patrol cars at night work locations where there is a concern that high speeds or impaired drivers might result in undue risks for workers or other drivers.

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Standard. Except in emergencies, temporary lighting shall be provided at all flagger stations used during nighttime work.

Support. Desired illumination levels vary depending upon the nature of the task involved. An average horizontal luminance of 5 foot candles can be adequate for general activities. An average horizontal luminance of 10 foot candles can be adequate for activities around equipment. Tasks requiring high levels of precision and extreme care can require an average horizontal luminance of 20 foot candles.

616.14.19 Late Merge (MUTCD Section 6N.19)

Support. The Late Merge is designed to use all available lanes until the merge point is reached at the lane closure taper rather than merging as soon as possible into the open lane. The Late Merge addresses many of the challenges that are associated with traffic operations in advance of lane closures at TTC zones such as queue length, capacity, and driver satisfaction.

Option. Late Merge systems may consist of static or portable changeable message signs.

Guidance. Static Late Merge signing should consist of the STAY IN LANE TO MERGE POINT (R4-9a) sign and the MERGE HERE TAKE TURNS (WO9-2a) sign (see Figure 616.14.19).

Option. The following messages may be used on changeable message signs at an upstream location during the Late Merge application:

A. “STAY IN YOUR LANE/MERGE AHEAD”
B. “STAY IN YOUR LANE/MERGE AHEAD XX MILES”
C. “USE BOTH LANES/TO MERGE POINT”
D. “USE BOTH LANES/STOPPED TRAFFIC AHEAD
E. “SLOW TRAFFIC AHEAD/USE BOTH LANES”

The following messages are typically used on changeable message signs at the merge point during the Late Merge application:

A. “TAKE YOUR TURN/MERGE HERE”
B. “MERGE HERE/TAKE TURNS”

Support. EPG 616.19.6.3 includes additional provisions for Smart Work Zone (SWZ) Strategy Selection.

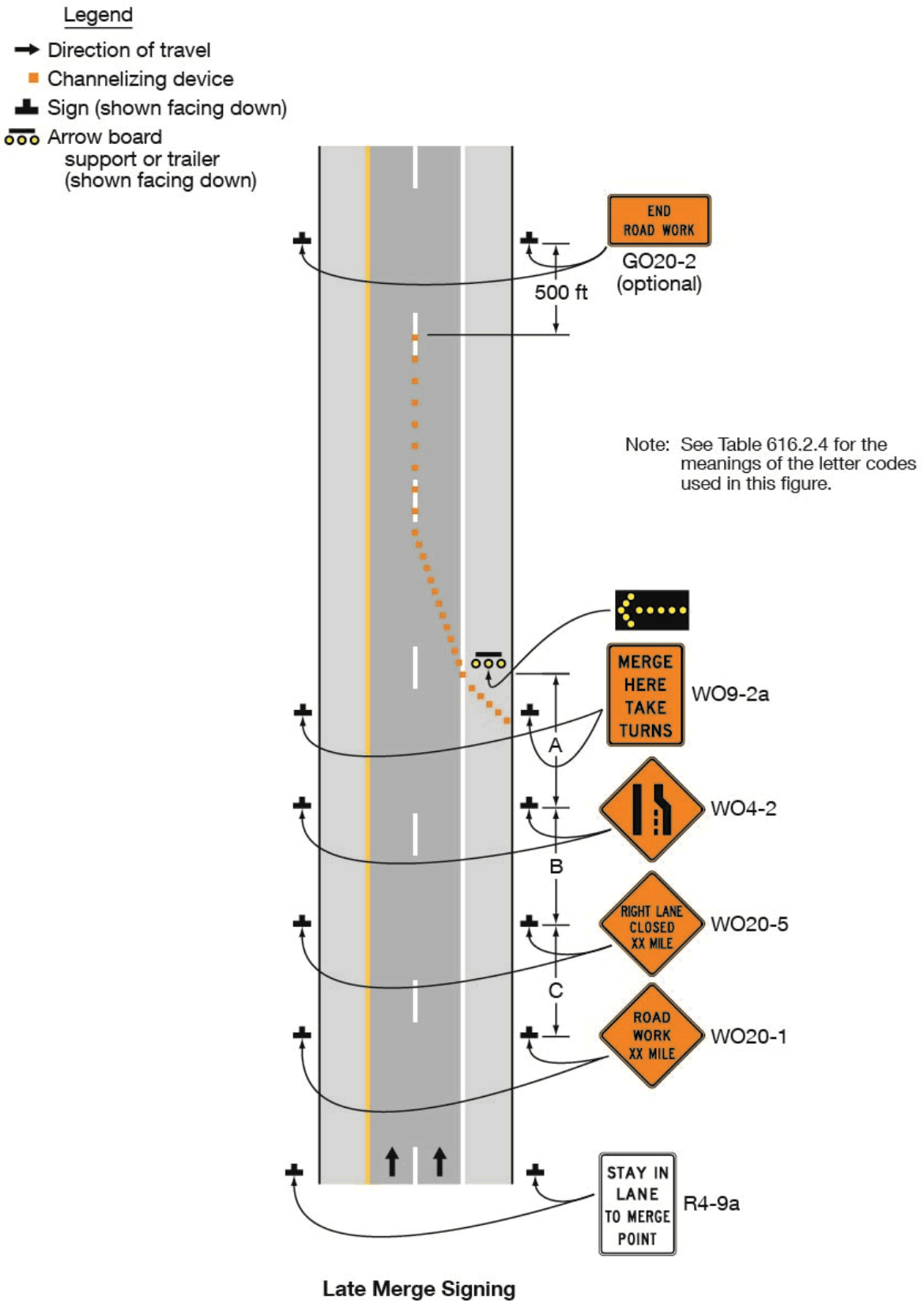


Figure 616.14.19 Late Merge

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616.15 Control of Traffic Through Traffic Incident Management Areas (MUTCD Chapter 6O)

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616.15.1 General (MUTCD Section 6O.01)

Support. The National Incident Management System (NIMS) requires the use of the Incident Command System (ICS) at traffic incident management scenes.

A traffic incident is an emergency road user occurrence, a natural disaster, or other unplanned event that affects or impedes the normal flow of traffic.

A traffic incident management area is an area of a highway where temporary traffic controls are installed, as authorized by a public authority or the official having jurisdiction of the roadway, in response to a road user incident, natural disaster, hazardous material spill, or other unplanned incident. It is a type of TTC zone and extends from the first warning device (such as a sign, light, or cone) to the last TTC device or to a point where vehicles return to the original lane alignment and are clear of the incident.

Traffic incidents can be divided into three general classes of duration, each of which has unique traffic control characteristics and needs. These classes are:

A. Major—expected duration of more than 2 hours,
B. Intermediate—expected duration of 30 minutes to 2 hours, and
C. Minor—expected duration under 30 minutes.

The primary functions of TTC at a traffic incident management area are to inform road users of the incident and to provide guidance information on the path to follow through the incident area. Alerting road users and establishing a well-defined path to guide road users through the incident area will serve to protect the incident responders and those involved in working at the incident scene and will aid in moving road users expeditiously past or around the traffic incident, will reduce the likelihood of secondary traffic crashes, and will preclude unnecessary use of the surrounding local road system.

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Examples include a stalled vehicle blocking a lane, a traffic crash blocking the traveled way, a hazardous material spill along a highway, and natural disasters such as floods and severe storm damage.

For additional information see EPG 616.14.1.6.

Guidance. In order to reduce response time for traffic incidents, highway agencies, appropriate public safety agencies (law enforcement, fire and rescue, emergency communications, emergency medical, and other emergency management), and private sector responders (towing and recovery and hazardous materials contractors) should mutually plan for occurrences of traffic incidents along the major and heavily traveled highway and street system.

On-scene responder organizations should train their personnel in TTC practices for accomplishing their tasks in and near traffic and in the requirements for traffic incident management contained in the EPG. On-scene responders should take measures to move the incident off the traveled roadway or to provide for appropriate warning. All on-scene responders and news media personnel should constantly be aware of their visibility to oncoming traffic and wear high-visibility apparel. Planning and training should include incorporation of estimated time durations to clear the event as part of their initial incident estimate. When events are deemed as probable Major Traffic Incidents that could generate prolonged lane or road closures, notification of all affected agencies should be initiated as part of the initial incident report that is provided to the emergency communications center who would then be responsible for making notifications to appropriate state, regional, and local agencies and resources for the purpose of ramping up and responding as quickly as possible thus facilitating a more rapid transition from emergency TTC to an MUTCD-compliant TTC zone when warranted.

Emergency vehicles arriving at an incident should be positioned in a manner that attempts to protect both the responders performing their duties and road users traveling through the incident scene, while minimizing, to the extent practical, disruption of the adjacent traffic flow. Emergency vehicle positions should optimize traffic flow through the incident scene. All emergency vehicles that subsequently arrive should be positioned in a manner that does not interfere with the established temporary traffic flow.

Responders arriving at a traffic incident should estimate the magnitude of the traffic incident, the expected time duration of the traffic incident, and the expected vehicle queue length, and then should set up the appropriate temporary traffic controls for these estimates.

Option. Warning and guide signs used for TTC traffic incident management situations may have a black legend and border on a fluorescent pink background (see EPG 616.8 and EPG 616.9 for proper wording and symbols).

Support. For MoDOT forces, incident management signing examples are located in MGS-04-01 Roll-up Signs and may be purchase through a statewide bid.

While some traffic incidents might be anticipated and planned for, emergencies and disasters might pose more severe and unpredictable problems. The ability to quickly install proper temporary traffic controls might greatly reduce the effects of an incident, such as secondary crashes or excessive traffic delays. An essential part of fire, rescue, spill clean-up, highway agency, and enforcement activities is

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the proper control of road users through the traffic incident management area in order to protect responders, victims, and other personnel at the site. These operations might need corroborating legislative authority for the implementation and enforcement of appropriate road user regulations, parking controls, and speed zoning. It is desirable for these statutes to provide sufficient flexibility in the authority for, and implementation of, TTC to respond to the needs of changing conditions found in traffic incident management areas.

Option. For traffic incidents, particularly those of an emergency nature, TTC devices on hand may be used for the initial response as long as they do not themselves create unnecessary additional hazards.

Support. The establishment, maintenance, and prompt removal of lane diversions can be effectively managed by interagency planning that includes representatives of highway and public safety agencies.

Guidance. All traffic control devices needed to set up the TTC at a traffic incident should be available so that they can be readily deployed for all major traffic incidents. The TTC should include the proper traffic diversions, tapered lane closures, and upstream warning devices to alert traffic approaching the queue and to encourage early diversion to an appropriate alternative route.

Attention should be paid to the upstream end of the traffic queue such that warning is given to road users approaching the back of the queue.

If manual traffic control is needed, it should be provided by qualified flaggers or uniformed law enforcement officers.

Option. If flaggers are used to provide traffic control for an incident management situation, the flaggers may use appropriate traffic control devices that are readily available or that can be brought to the traffic incident scene on short notice.

Guidance. When light sticks or flares are used to establish the initial traffic control at incident scenes, channelizing devices (see EPG 616.11.1) should be installed as soon thereafter as practical.

Option. The light sticks or flares may remain in place if they are being used to supplement the channelizing devices.

Guidance. The light sticks, flares, and channelizing devices should be removed after the incident is terminated.

616.15.2 Major Traffic Incidents (MUTCD Section 6O.02)

Support. Major traffic incidents are typically traffic incidents involving hazardous materials, fatal traffic crashes involving numerous vehicles, and other natural or man-made disasters. These traffic incidents typically involve closing all or part of a roadway facility for a period exceeding 2 hours.

Guidance. If the traffic incident is anticipated to last more than 24 hours, applicable procedures and devices set forth in EPG 616 should be used.

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Support. A road closure can be caused by a traffic incident such as a road user crash that blocks the traveled way. Road users are usually diverted through lane shifts or detoured around the traffic incident and back to the original roadway. A combination of traffic engineering and enforcement preparations is needed to determine the detour route, and to install, maintain, or operate, and then to remove the necessary traffic control devices when the detour is terminated. Large trucks are a significant concern in such a detour, especially when detouring them from a controlled-access roadway onto local or arterial streets.

During traffic incidents, large trucks might need to follow a route separate from that of automobiles because of bridge, weight, clearance, or geometric restrictions. Also, vehicles carrying hazardous material might need to follow a different route from other vehicles.

Some traffic incidents such as hazardous material spills might require closure of an entire highway. Through road users must have adequate guidance around the traffic incident. Maintaining good public relations is desirable. The cooperation of the news media in publicizing the existence of, and reasons for, traffic incident management areas and their TTC can be of great assistance in keeping road users and the general public well informed.

616.15.3 Intermediate Traffic Incidents (MUTCD Section 6O.03)

Support. Intermediate traffic incidents typically affect travel lanes for a time period of 30 minutes to 2 hours, and usually require traffic control on the scene to divert road users past the blockage. Full roadway closures might be needed for short periods during traffic incident clearance to allow traffic incident responders to accomplish their tasks.

616.15.4 Minor Traffic Incidents (MUTCD Section 6O.04)

Support. Minor traffic incidents are typically disabled vehicles and minor crashes that result in lane closures of less than 30 minutes. On-scene responders are typically law enforcement and towing companies, and occasionally highway agency service patrol vehicles.

Diversion of traffic into other lanes is often not needed or is needed only briefly. It is not generally possible or practical to set up a lane closure with traffic control devices for a minor traffic incident. Traffic control is the responsibility of on-scene responders.

Guidance. When a minor traffic incident blocks a travel lane, the vehicles involved in the incident should be moved from the blocked lane to the shoulder as quickly as possible.

616.15.5 Use of Emergency-Vehicle Lighting (MUTCD Section 6O.05)

Support. The use of emergency-vehicle lighting (such as high-intensity rotating, flashing, oscillating, or strobe lights) is essential, especially in the initial stages of a traffic incident, for the safety of emergency responders and persons involved in the traffic incident, as well as road users approaching the traffic incident. Emergency-vehicle lighting, however, provides warning only and provides no

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effective traffic control. The use of too many lights at an incident scene can be distracting and can create confusion for approaching road users, especially at night. Road users approaching the traffic incident from the opposite direction on a divided facility are often distracted by emergency-vehicle lighting and slow their vehicles to look at the traffic incident posing a hazard to themselves and others traveling in their direction.

The use of emergency-vehicle lighting can be reduced if good traffic control has been established at a traffic incident scene. This is especially true for major traffic incidents that might involve a number of emergency vehicles. If good traffic control is established through placement of advance warning signs and traffic control devices to divert or detour traffic, then public safety agencies can perform their tasks on scene with minimal emergency-vehicle lighting.

Guidance. Public safety agencies should examine their policies on the use of emergency-vehicle lighting, especially after a traffic incident scene is secured, with the intent of reducing the use of this lighting as much as possible while not endangering those at the scene. Special consideration should be given to reducing or extinguishing forward facing emergency-vehicle lighting, especially on divided roadways, to reduce distractions to oncoming road users.

Because the glare from floodlights or vehicle headlights can impair the nighttime vision of approaching road users, any floodlights or vehicle headlights that are not needed for illumination, or to provide notice to other road users of an incident response vehicle being in an unexpected location, should be turned off at night.

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616.16 Typical Applications (MUTCD Chapter 6P)

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- 616.16.3.3 Recommended Advance Warning Sign Minimum Spacing
- 616.16.3.4 Recommended Taper Length and Spacing



616.16.1 Typical Applications (MUTCD Section 6P.01)

Support. EPG 616.14 contains discussions of typical TTC activities. EPG 616.1.2 contains discussions on development of TTC plans for the various activities. This article presents typical applications for a variety of situations commonly encountered. While not every situation is addressed, the information illustrated can generally be adapted to a broad range of conditions. In many instances, an appropriate TTC plan is achieved by combining features from various typical applications. For example, work at an intersection might present a near-side TTC zone for one street and a far-side TTC zone for the other street. These treatments are found in two different typical applications in the MUTCD, while a third typical application shows how to handle pedestrian crosswalk closures.

In general, the procedures illustrated represent minimum solutions for the situations depicted. Except for the notes (which are clearly classified using headings as being Standard, Guidance, Option, or Support), the information presented in the MUTCD typical applications can generally be regarded as Guidance.

Option. TTC plans may deviate from the typical applications described in this article to allow for conditions and requirements of a particular site or jurisdiction.

Other devices may be added to supplement the devices and device spacing may be adjusted to provide additional reaction time or delineation. Fewer devices may be used based on field conditions.

Support. Figures and tables found throughout EPG 616 provide information for the development of TTC plans.

616.16.2 Typical Applications for Contract Projects

Guidance. For contract projects, the typical applications in Chapter 6P of the MUTCD (https://mutcd.fhwa.dot.gov/kno_11th_Edition.htm) should be the basis for preparing TTC plans. The MUTCD typical applications themselves are not provided in the EPG, but are included in the EPG by reference.

Support. Table 6P-1 of the MUTCD is an index of the 54 typical applications. In the printed version of the MUTCD, the typical applications are shown on the right-hand page with notes on the facing page to the left. In the electronic version, the notes are shown on the page preceding the figure. The legend for the symbols used in the typical applications is provided in Table 6P-2 of the MUTCD. In many of the typical applications, sign spacings and other dimensions are indicated by letters using the criteria provided in Table 616.2.4. The formulas for determining taper lengths are provided in Table 616.2.8.2.

Most of the typical applications show TTC devices for only one direction.

616.16.3 Typical Applications for MoDOT Internal Use

If you have questions about a Typical Application, please email WZTAQuestions@modot.mo.gov (mailto:WZTAQuestions@modot.mo.gov?Subject=Question%20about%20TA)

Support. MoDOT has developed the following typical applications are intended for the use of MoDOT employees. Before each work shift, all employees are required to participate in a pre-shift safety briefing. During the briefing, the applicable typical applications should be printed out and then discussed to know the procedures to follow for the day's work. This should include the risk-based assessment (RBA). The typical applications shown in the EPG are considered current.

[+/-] Emergency Traffic Control

[+/-] Work Beyond the Shoulder

[+/-] Work on the Shoulder

[+/-] Work Within the Traveled Way of a Two-Lane Highway

[+/-] Work Within the Traveled Way at an Intersection and on Sidewalks

[+/-] Work Within the Traveled Way of a Multi-Lane Highway

[+/-] Work at Railroad Crossing

[+/-] Excavations with Steel Plates

Complex Intersection Guidance (MoDOT access only) (https://modotgov.sharepoint.com/sites/cm)

616.16.3.1 Legend for Typical Applications

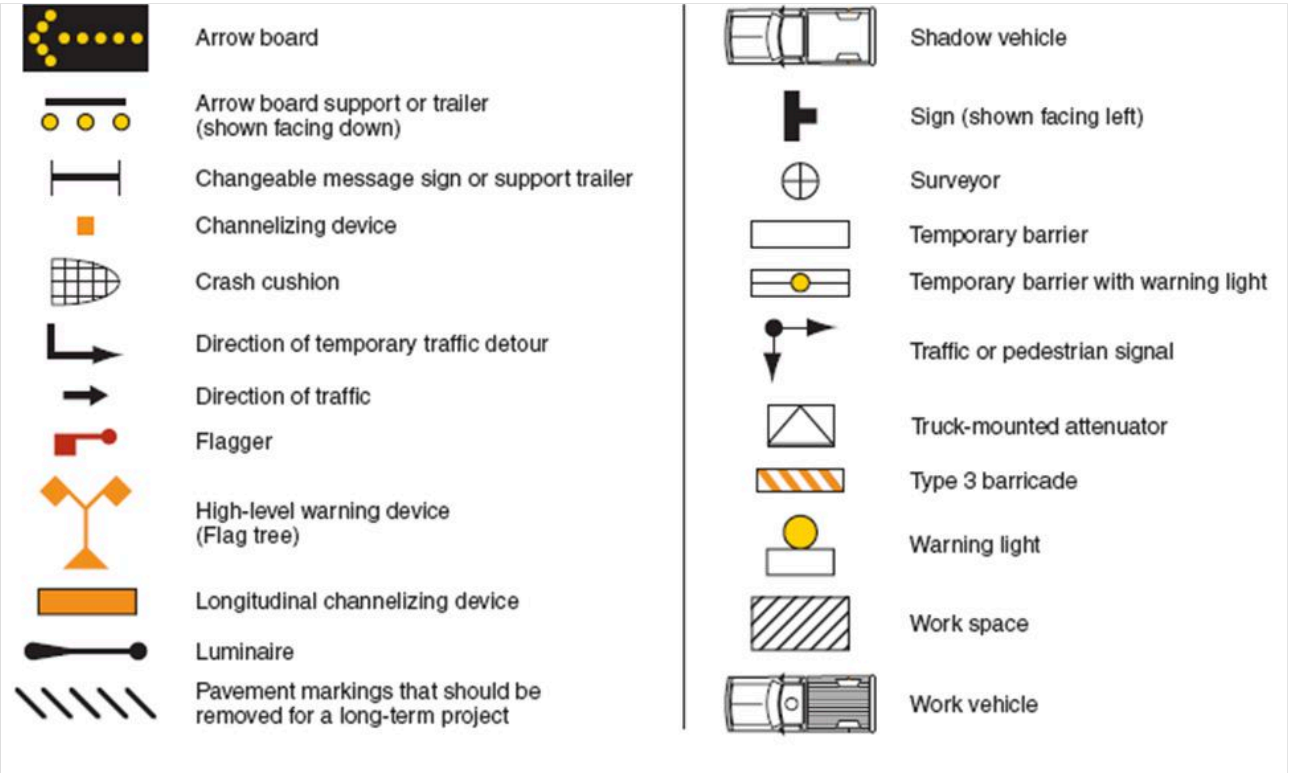


Figure 616.8.2 Meaning of Symbols on Typical Application Diagrams

616.16.3.2 Examples of Highways

Divided Highway: Highway with physical separation of traffic in the opposite direction.



Median Separation



Median Separation with Guard Cable



Barrier Wall Separation

Undivided Highway: Highway with no physical separation of traffic in the opposite direction.



Undivided Highway



Multi-lane Undivided Highway



Multi-lane with Turning Lane



Multi-lane with Raised Median



Multi-lane with Paved Narrow Median

616.16.3.3 Recommended Advance Warning Sign Minimum Spacing

Table 616.16.3.3 Recommended Advance Warning Sign Minimum Spacing

Speed Limit[1], mph	Sign Spacing[2], ft.	
	Undivided Highway	Divided Highway
up to 35	200[3]	200[3]
40 to 45	350	500
50 to 55	500	1000
60 to 70	1000	SA-1000 SB-1500 SC-2640
[1] Speed limit is based on posted speed limit.		
[2] Sign spacing may be adjusted, normally by increasing it, to accommodate field conditions and visibility.		
[3] For urban low speed, minimum recommended spacing in MUTCD is 100 ft.		

616.16.3.4 Recommended Taper Length and Spacing

Table 616.16.3.4 Recommended Taper Length and Spacing

Speed Limit[1], mph	Taper Length[2], ft.		Channelizing Spacing [3], ft.	
	Shoulder[4] (T1)	Lane[5] (T2)	Tapers	Buffer/Work Areas
up to 35	70	245	35[6]	40[6]
40 to 45	150	540	40[6]	80[6]
50 to 55	185	660	50[7]	80[7]
60 to 70	235	840	60[7]	120[7]

[1] Speed limit is based on posted speed limit.
[2] Taper lengths may be adjusted to accommodate crossroads, curves, intersections, ramps or other geometric features.
[3] Channelizer spacing may be reduced to discourage traffic encroachment.
[4] Based on 10 ft. shoulder width.
[5] Based on 12 ft. lane width.
[6] Spacing reduced to 1/2 at intersections.
[7] Spacing may be reduced to 1/2 at intersections.

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616.18 Work Zone Speed Limits

MoDOT has the authority to set speed limits on the state highway system. This power extends to establishing speed limits in temporary traffic control zones, where the speed limit may be reduced from the normal speed limit for safety purposes. Work zones shall be designed to the normal posted speed limit.

A reduced speed limit should be carefully considered before it is imposed, as motorists will only reduce their speed if they perceive a need to do so. Any decision to reduce the speed limit based on an arbitrary, "across the board" or other inappropriate rationale may result in non-compliance with the reduced speed limit by motorists and a false sense of security for workers.

Should a reduced speed limit be deemed appropriate, the following table shows the recommended maximum speed reductions that may be imposed in temporary traffic control zones.

Contents

Table 616.18 Recommended Maximum Speed Reductions
616.18.1 WORK ZONE FINE Sign (CONST-3A)
616.18.2 Sign Descriptions and Applications
616.18.3 Work Zone SPEED LIMIT Figures

Table 616.18 Recommended Maximum Speed Reductions

Activity (i.e. Workers, Equipment or Material) Location	Recommended Work Zone Maximum Speed Reduction (When Applicable)
10 ft. beyond edge of travelway to edge of right of way	No speed reduction
In traffic lane or within 10 ft. of the traffic lane	10 mph
Head-to-head on multilane	10 mph
Special circumstances within a temporary traffic control work zone may warrant a lower speed limit than recommend above. All speed limit reductions greater than 10 mph shall be documented, submitted to and approved by the District Work Zone Coordinator.	

After selecting a reduced speed limit based upon the table above, the following guidelines will assist in the proper installation and application of that reduced speed limit in the temporary traffic control zone.

- On divided highways, the reduced speed is applicable to the affected direction of travel only.
- Existing SPEED LIMIT signs within the temporary traffic control zone shall be covered or removed.
- SPEED LIMIT signs indicating the normal speed limit should be installed at the end of the reduced area provided no other reduction is imposed within the next one-half mile or no existing SPEED LIMIT sign is located within the next one-half mile.
- Reduced speed limit signing shall be removed, covered or turned from traffic when conditions requiring the reduced speed no longer exist.
- For two-lane roadways, normal SPEED LIMIT signs are typically installed opposite the work zone SPEED LIMIT sign on the opposite approach facing traffic leaving the work zone.
- Reduced SPEED LIMIT signs are not to be installed on side street approaches or ramps for work limited to main line only. Reduced SPEED LIMIT signs may be installed downstream from the ramp or side street to inform drivers of the work zone speed limit. If the work is on the ramp, or affects the ramp, reduced SPEED LIMIT signs are to be used.

- Posted work zone speed limit shall not be below 35 mph, except when local ordinance provides for a lower speed. The lower speed shall be used when applicable.
- Appropriate warning signs with advisory speed plaques should be used to advise of any specialized situations (i.e., temporary bypass, narrow lanes, etc.).
- For approved speed reductions greater than 10 mph, additional notification should be provided through the use of the SPEED LIMIT XX AHEAD sign. Refer to EPG 616.18.3 Work Zone SPEED LIMIT Figures.
- For approved speed reductions greater than 20 mph, the speed limit should be reduced in two stages. Refer to EPG 616.18.3 Work Zone SPEED LIMIT Figures.

616.18.1 WORK ZONE FINE Sign (CONST-3A)

The WORK ZONE FINE sign shall be specified on projects where all the following criteria are met:

Additional Info
About Signs Required for Assessing Fines
RSMo 304.582.1 (https://revisor.mo.gov/main/OneSection.aspx?section=304.582)

- Duration of the work zone is longer than 4 hours.
- Reduced speed limits are in effect.
- Normal posted speed limit is 60 mph or greater.
- Workers will be present without positive protection (concrete barrier or guardrail).

If a lane closure is used on a roadway with two lanes in the direction of travel, two DO NOT PASS and two PASS WITH CARE signs and two CONST-3X, (SPEEDING/PASSING) plates shall be specified. WORK ZONE plaques shall be specified for all DO NOT PASS signs being used as part of the work zone signing sequence. If a lane closure is used on a roadway with three or more lanes in the direction of travel, the DO NOT PASS and PASS WITH CARE signs and SPEEDING/PASSING plates shall not be specified.

616.18.2 Sign Descriptions and Applications

Sign descriptions and applications are located in EPG 616.6 Temporary Traffic Control Zone Devices.

616.18.3 Work Zone SPEED LIMIT Figures

Fig. 616.18.3.1, Work Zone SPEED LIMIT Locations within Advance Warning Area
Fig. 616.18.3.2, Work Zone SPEED LIMIT Locations within Activity Area
Fig. 616.18.3.3, Work Zone FINE Sign and SPEED LIMIT Locations within Advance Warning Area
Fig. 616.18.3.4, Work Zone SPEED LIMIT Locations for Reductions Greater than 20 mph and Reduction in Two Locations
Fig. 616.18.3.5, Work Speed Limit Locations within a Lane Closure on Two-Lane Road Using Flaggers

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Category:620 Pavement Marking (MUTCD Part 3)



Guidance for the Selection and Use of Durable Intersection Markings

Pavement Marking Guidelines and Material Decision Tree

Articles in "620 Pavement Marking (MUTCD Part 3)"

The following 16 pages are in this category, out of 16 total.

6

- 620.1 General (MUTCD Chapter 3A)
- 620.2 Pavement and Curb Markings (MUTCD Chapter 3B)
- 620.3 Crosswalk Markings (MUTCD Chapter 3C)
- 620.4 Circular Intersection Markings (MUTCD Chapter 3D)
- 620.5 Preferential Lane Markings for Motor Vehicles (MUTCD Chapter 3E)
- 620.6 Delineators (MUTCD Chapter 3G)
- 620.7 Colored Pavement (MUTCD Chapter 3H)
- 620.8 Channelizing Devices used for Emphasis of Pavement Marking Patterns (MUTCD Chapter 3I)
- 620.9 Marking and Delineation of Islands and Sidewalk Extensions (MUTCD Chapter 3J)

- 620.10 Rumble Strip Markings (MUTCD Chapter 3K)
- 620.11 MoDOT Pavement Marking Materials
- 620.12 Operational Procedures and Safety
- 620.13 Guidelines for Using Water-Borne Traffic Paint
- 620.14 Pavement Marking Maintenance
- 620.15 Construction Inspection for Sec 620
- 620.16 Measurement of Retroreflectivity by Handheld Retroreflectometers

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620.1 General (MUTCD Chapter 3A)

Contents

620.1.1 Standardization of Application (MUTCD Section 3A.01)

620.1.2 Materials (MUTCD Section 3A.02)

620.1.3 Colors (MUTCD Section 3A.03)

620.1.4 Functions, Widths, and Patterns of Longitudinal Pavement Markings (MUTCD Section 3A.04)

620.1.5 Maintaining Minimum Pavement Marking Retroreflectivity (MUTCD Section 3A.05)

620.1.1 Standardization of Application (MUTCD Section 3A.01)

Support. Markings are used to supplement other traffic control devices such as signs, signals, and other markings. In other instances, markings are used alone to effectively convey regulations, warnings, or guidance in ways not obtainable by the use of other devices.

Markings can take many forms including road surface markings, curb markings, delineators, colored pavements, and channelizing devices.

Standard. Each standard marking shall be used only to convey the meaning prescribed for that marking in the EPG, including when used for applications not described in the EPG.

Except as provided in EPG 620.7, all markings on MoDOT highways shall be retroreflective.

Markings that are no longer applicable for roadway conditions or restrictions and that might cause confusion for the road user shall be removed or obliterated to be unidentifiable as a marking as soon as practicable.

620.1.2 Materials (MUTCD Section 3A.02)

Guidance. The materials used for markings should provide the specified color throughout their useful life.

Consideration should be given to selecting pavement marking materials that will minimize tripping or loss of traction for road users, including pedestrians, bicyclists, and motorcyclists.

Support. See EPG 620.11 for additional information regarding MoDOT pavement marking materials.

620.1.3 Colors (MUTCD Section 3A.03)

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Standard. Markings shall be yellow, white, red, or blue. The colors for markings shall conform to the standard highway colors.

Option. Black markings may be used in combination with the colors mentioned in the previous paragraph to enhance the contrast with a light-colored pavement.

Standard. When used, yellow markings for longitudinal lines shall delineate:

A. The separation of traffic traveling in opposite directions,
B. The left-hand edge of the roadways of divided highways and one-way streets or ramps, or
C. The separation of two-way left-turn lanes from other lanes.

When used, white markings for longitudinal lines shall delineate:

A. The separation of traffic flows in the same direction, or
B. The right-hand edge of the roadway

When used, red inlaid pavement markers or delineators shall delineate:

A. Truck escape ramps, or
B. One-way roadways, ramps, or travel lanes that shall not be entered or used in the direction from which the markers are visible.

When used, blue markings shall supplement white markings for parking spaces for persons with disabilities.

When pavement markings that simulate route signs are used (see EPG 620.2.21), the colors shall be the same as those that are used for the route signs (see EPG 903.4.11).

Support. Provisions regarding colored pavements are contained in EPG 620.7.

620.1.4 Functions, Widths, and Patterns of Longitudinal Pavement Markings (MUTCD Section 3A.04)

Standard. The general functions of longitudinal lines shall be as follows:

A. A double line indicates maximum or special restrictions.
B. A solid line discourages or prohibits crossing (depending on the specific application).
C. A broken (intermittent) line indicates a permissive condition.
D. A dotted lane line provides warning of a downstream change in lane function.
E. A dotted line used as a lane line or edge line extension guides vehicles through an intersection, a taper area, or an interchange ramp area.

The widths and patterns of longitudinal lines shall be as follows:

A. Normal line shall be as indicated in Table 620.1.4:

Table 620.1.4 Normal Longitudinal Line Widths

Roadway Classification	White Lines	Yellow Lines	Center Lines *
Major Route	6 inch	6 inch	4 inch
Minor Route	4 inch	4 inch	4 inch
* Includes No Passing Zone markings			

B. Wide line—twice the width of a normal line.
C. Double line—two 4-inch parallel lines separated by a 4-inch gap. The pavement surface shall be visible between the lines in the same way that it is visible outside the lines, except where contrast markings are used in combination with the double line (see EPG 620.1.3).
D. Broken (intermittent) line—10-foot normal width line segments separated by 30-foot gaps.
E. Dotted lane line—3-foot line segments separated by 9-foot gaps where a dotted line is used as a lane line (see EPG 620.2.8).
F. Dotted line extension—2-foot line segments separated by 4-foot gaps within an intersection, taper area, or interchange ramp area (see EPG 620.2.13). The width of a dotted line extension shall be at least the same as the width of the line it extends.

Support. EPG 912 (MUTCD Section 5B.02) contains information on pavement marking considerations for driving automation systems.

See EPG 626.1 and EPG 626.2 for information on edge line and center line rumble strips.

620.1.5 Maintaining Minimum Pavement Marking Retroreflectivity (MUTCD Section 3A.05)

Standard. MoDOT shall use an assessment method that is designed to maintain pavement marking retroreflectivity above the minimum standards of the MUTCD. See EPG 620.16 for test procedures and minimum retroreflectivity requirements.

Local jurisdictions who maintain sections of state routes and the pavement markings on those sections under maintenance agreements shall maintain those markings in accordance with one of the MUTCD assessment methods.

Support. The provisions of this Article do not apply to non-longitudinal pavement markings including, but not limited to, the following:

A. Transverse markings;
B. Word, symbol, and arrow markings;
C. Crosswalk markings; and
D. Chevron, diagonal, and crosshatch markings.

Special circumstances will periodically cause pavement marking retroreflectivity to be below the minimum levels. These circumstances include, but are not limited to, the following:

A. Isolated locations of abnormal degradation;
B. Periods preceding imminent resurfacing or reconstruction;
C. Unanticipated events such as equipment breakdowns, material shortages, and contracting problems; and
D. Loss of retroreflectivity resulting from snow maintenance operations.

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When such circumstances occur, compliance with the first standard paragraph of this Article is still considered to be achieved if a reasonable course of action is taken to resume maintenance of minimum retroreflectivity in a timely manner according to MoDOT's method(s), policies, and procedures.

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620.2 Pavement and Curb Markings (MUTCD Chapter 3B)

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620.2.1 Yellow Center Line Pavement Markings (MUTCD Section 3B.01)
620.2.2 Warrants for Yellow Center Lines (MUTCD Section 3B.02)
620.2.3 No-Passing Zone Pavement Markings (MUTCD Section 3B.03)
620.2.4 Establishing and Recording No Passing Zones
620.2.5 Center Line Markings on Bridges
620.2.6 Pavement Markings for Two-Way Left-Turn Lanes (MUTCD Section 3B.05)
620.2.7 White Lane Line Pavement Markings (MUTCD Section 3B.06)
620.2.8 White Lane Line Markings for Non-Continuing Lanes (Section 3B.07)
620.2.9 Channelizing Lines (MUTCD Section 3B.08)
620.2.10 Edge Line Pavement Markings (MUTCD Section 3B.09)
620.2.11 Warrants for Use of Edge Lines (MUTCD Section 3B.10)
620.2.12 Bridge Edge Lines
620.2.13 Application of Pavement Markings Through Intersections or Interchanges (MUTCD Section 3B.11)
620.2.14 Lane-Reduction Transitions (MUTCD Section 3B.12)
620.2.15 Approach Markings for Obstructions (MUTCD Section 3B.13)
620.2.16 Inlaid Pavement Markers – General (MUTCD Section 3B.14)
620.2.17 Curb Markings for Delineation (MUTCD Section 3B.18)
620.2.18 Stop and Yield Lines (MUTCD Section 3B.19)
620.2.19 Word, Symbol, and Arrow Pavement Markings – General (MUTCD Section 3B.20)
620.2.20 Word Pavement Markings (MUTCD Section 3B.21)
620.2.21 Symbol Pavement Markings (MUTCD Section 3B.22)
620.2.22 Lane-Use Arrows (MUTCD Section 3B.23)
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620.2.24 Chevron and Diagonal Markings (MUTCD Section 3B.25)
620.2.25 Do Not Block Intersection Markings (MUTCD Section 3B.26)
620.2.26 Parking Space Markings (MUTCD Section 3B.27)
620.2.27 Speed Hump and Speed Table Markings (MUTCD Section 3B.29)
620.2.28 Advance Speed Hump and Speed Table Markings (MUTCD Section 3B.30)
620.2.29 Aircraft Speed Measurement Markings
620.2.30 Markings for a Diverging Diamond Interchange with a Transposed Alignment Crossroad (MUTCD Section 3B.31)

620.2.1 Yellow Center Line Pavement Markings (MUTCD Section 3B.01)

Standard. Center line pavement markings, when used, shall be the pavement markings used to delineate the separation of traffic lanes that have opposite directions of travel on a roadway and shall be yellow.

The center line markings on two-lane, two-way roadways shall be one of the following as shown in Figure 620.2.1.1:

A. Two-direction passing zone markings consisting of a normal width broken (intermittent) yellow line where crossing the center line markings for passing with care is permitted for traffic traveling in either direction;

B. One-direction no-passing zone markings consisting of a double yellow line, one of which is a normal width broken (intermittent) yellow line and the other is a normal width solid yellow line, where crossing the center line markings for passing with care is permitted for the traffic traveling adjacent to the broken (intermittent) line, but is prohibited for traffic traveling adjacent to the solid line; or
C. Two-direction no-passing zone markings consisting of two normal width solid yellow lines where crossing the center line markings for passing is prohibited for traffic traveling in either direction.

A single solid yellow line shall not be used as a center line marking on a two-way roadway.

Except where a two-way left-turn lane (see EPG 620.2.6) is present, the center line markings on undivided two-way roadways with four or more lanes for moving motor vehicle traffic always available shall be the two-direction no-passing zone markings consisting of normal width double solid yellow lines separated by 4 in. as shown in Figure 620.2.1.2.

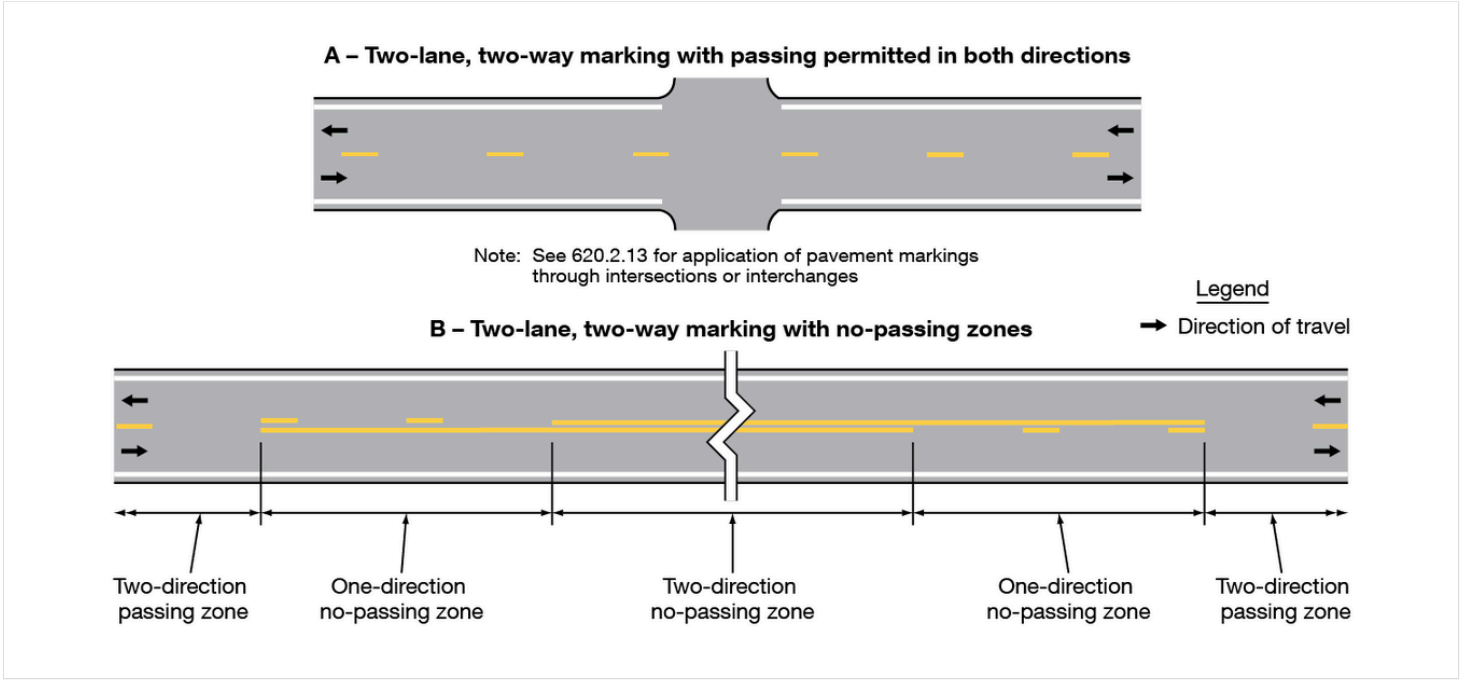


Figure 620.2.1.1 Yellow Center Lines for Two-Lane, Two-Way Applications

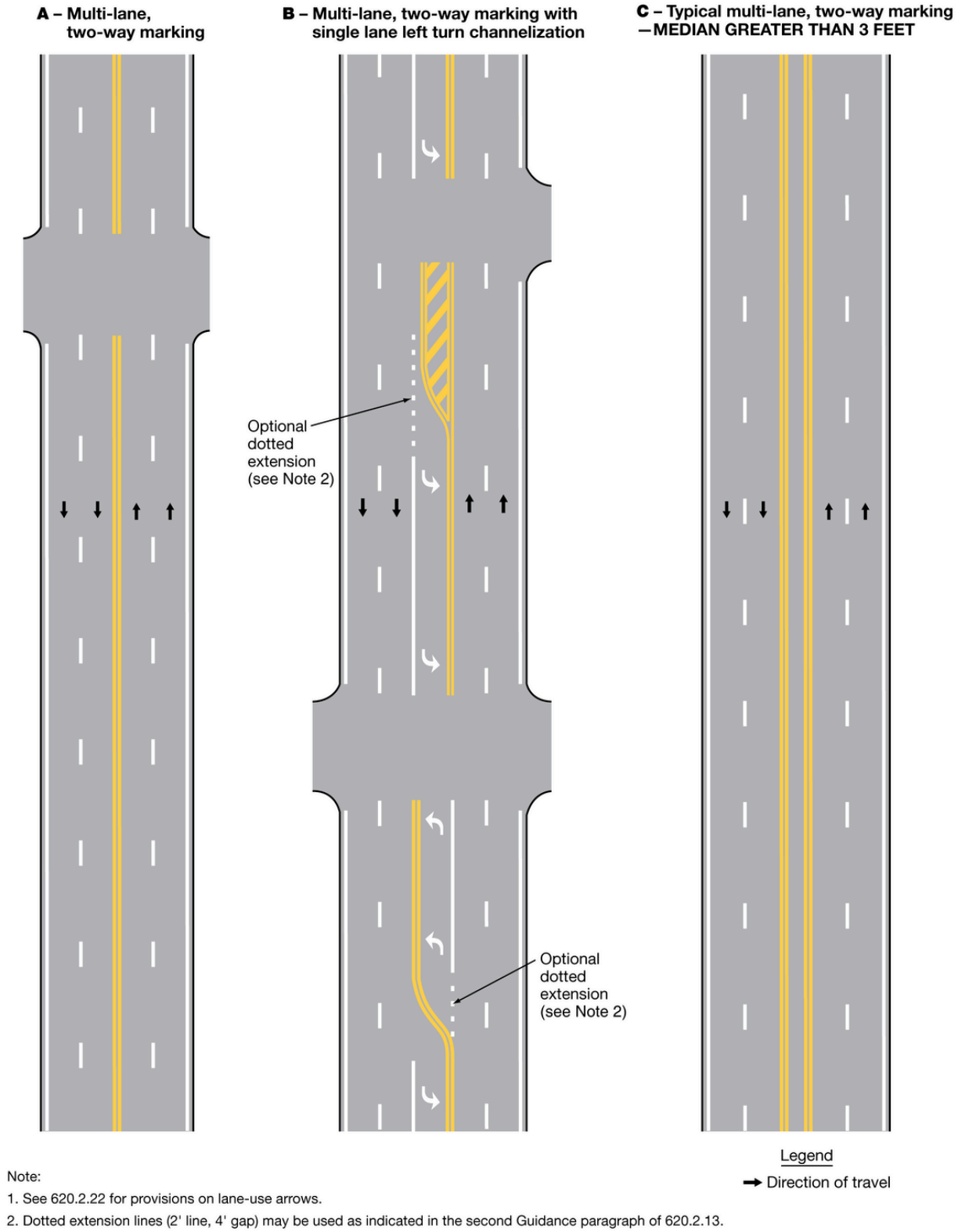


Figure 620.2.1.2 Yellow Center Lines for Four-or-More Lane, Two-Way Applications

Support. MoDOT previously marked center lines using a 2-line or 3-line system. The 3-line system is no longer used by MoDOT.

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Standard. Highways that are currently marked using a 3-line center line marking system shall be maintained using the 3-line system until the center line markings are obliterated.

After a 3-line center line is obliterated from the entire route or a significant portion of the highway, the center line shall be replaced using the 2-line system.

EPG 620.2.13 contains information for application of pavement markings through intersections or interchanges.

Guidance. On two-way roadways with an additional climbing/truck lane in the upgrade direction, the opposing directions of traffic should be separated by using one-direction or two-direction no-passing zone markings.

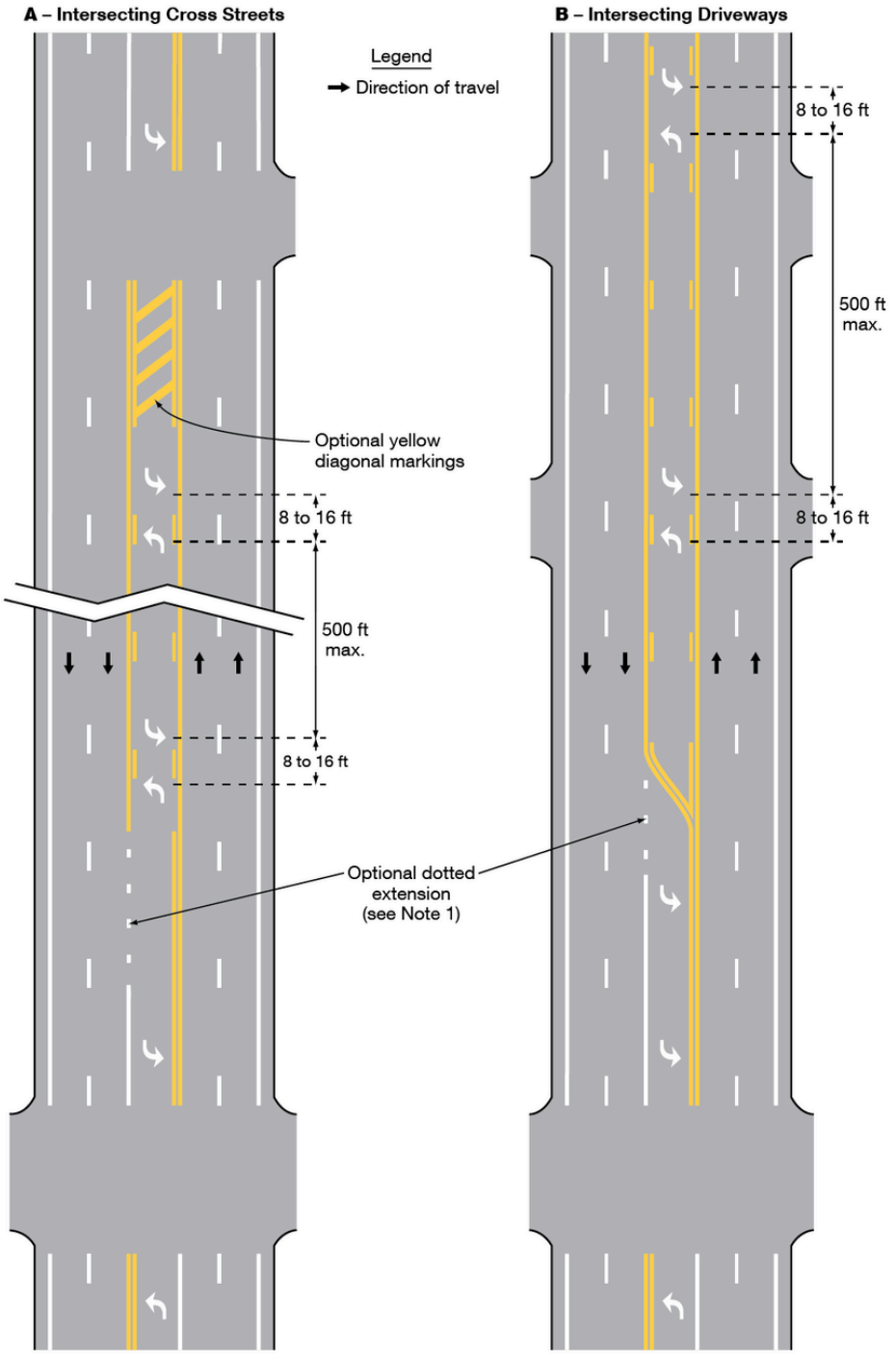
Standard. On two-way roadways with alternating passing lanes, the opposing directions of traffic shall be separated by using two-direction no-passing zone markings (See Standard Plan 620 (https://www.modot.org/media/16896#page=2)).

Support. Examples of markings for alternating passing lanes are shown in Standard Plan 620 (https://www.modot.org/media/16896#page=2).

620.2.2 Warrants for Yellow Center Lines (MUTCD Section 3B.02)

Standard. Center line markings shall be placed on all paved undivided two-way streets or highways that have a traveled way of 18 feet or more in width. Center line markings shall also be placed on all paved undivided two-way streets or highways that have three or more lanes for moving motor vehicle traffic.

Guidance. Engineering judgment should be used in determining whether to place center line markings on traveled ways that are less than 18 feet wide because of the potential for traffic encroaching on the pavement edges, traffic being affected by parked vehicles, and traffic encroaching into the opposing traffic lane. Engineering judgment should also be used to determine if the pavement can support center line markings.



Note:
1. Dotted extension lines (2' line, 4' gap) may be used as indicated in the second Guidance paragraph of 620.2.13.

Figure 620.2.2 Example of Two-Way, Left-Turn Marking Applications

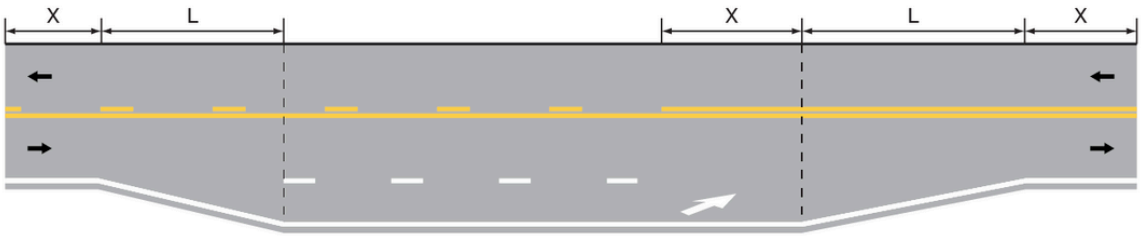
620.2.3 No-Passing Zone Pavement Markings (MUTCD Section 3B.03)

Standard. No-passing zones shall be marked by either the one-direction no-passing zone pavement markings or the two-direction no-passing zone pavement markings described in EPG 620.2.1 and shown in Figure 620.2.1.1.

No-passing zone markings shall be used on:

A. Two-way roadways at lane-reduction transitions (see EPG 620.2.14),
B. Approaches to obstructions that must be passed on the right (see EPG 620.2.15),
C. Approaches to grade crossings (see EPG 913.3.2), and
D. Approaches to crosswalks.
E. Approaches to added uphill truck or passing lanes,
F. Approaches to controlled intersections, and
G. Approaches to lane transitions.

No-passing zone marking shall be installed a minimum of 500 feet in advance of conditions as described in the previous paragraph.



Note:
1. X = Minimum length of 500' or 1/2L, whichever is greater.
2. See Section 620.2.14 for Lane-Reduction Transitions.

Figure 620.2.3.1 Marking Uphill Truck Lane

Option. The length of passing zone markings may be increased for sight distance limitations or based on engineering judgement.

Standard. On two-way, two-lane or non-continuous three-lane roadways, such as uphill truck or passing lanes, where center line markings are installed, no-passing zones shall be established at vertical and horizontal curves and other locations where an engineering study indicates that passing must be prohibited because of inadequate sight distances or other special conditions.

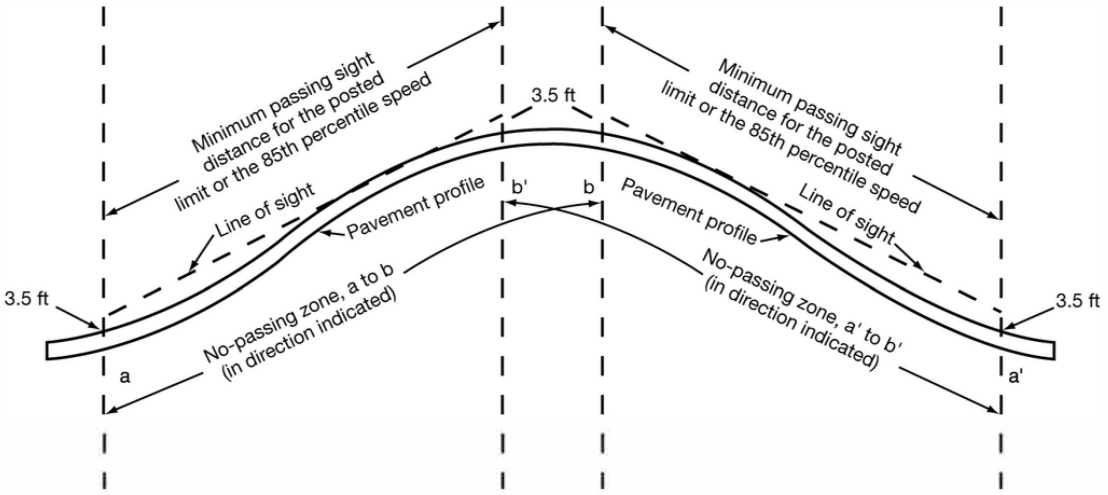
On roadways with center line markings, no-passing zone markings shall be used at horizontal or vertical curves where the passing sight distance is less than the minimum shown in Table 620.2.3 for the posted speed limit or the 85th-percentile speed.

Table 620.2.3 Minimum Passing Sight Distances for No-Passing Zone Markings

85th-Percentile or Speed Limit	Minimum Passing Sight Distance
25 mph	500 feet
30 mph	500 feet
35 mph	550 feet
40 mph	600 feet
45 mph	700 feet
50 mph	800 feet
55 mph	900 feet
60 mph	1,000 feet
65 mph	1,100 feet
70 mph	1,200 feet

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A – No-passing zone at VERTICAL CURVE



a, a' Begin no-passing zone
Sight distance becomes less than minimum measured between points 3.5 feet above pavement

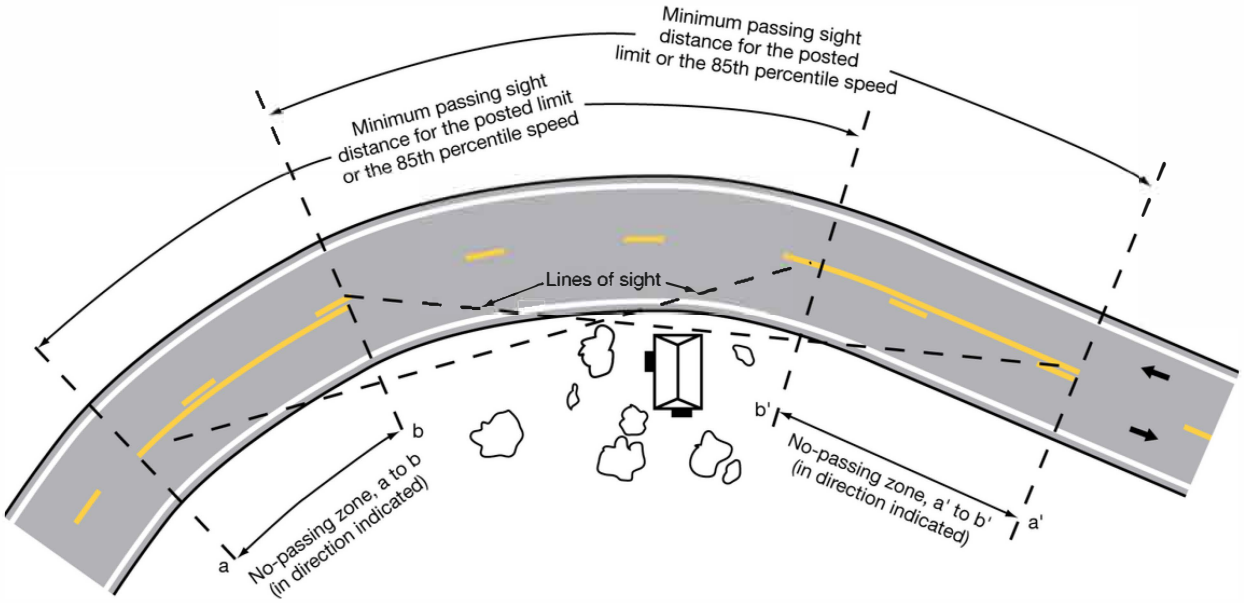
b, b' End no-passing zone
Sight distance again exceeds minimum

Legend
➡ Direction of travel

Profile View

Note: No-passing zones in opposite directions might or might not overlap, depending on alignment

B – No-passing zone at HORIZONTAL CURVE



a, a' Begin no-passing zone
Sight distance becomes less than minimum measured between points 3.5 feet above pavement

b, b' End no-passing zone
Sight distance again exceeds minimum

Plan View

Note: No-passing zones in opposite directions might or might not overlap, depending on alignment

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Figure 620.2.3.2 Method of Locating and Determining the Limits of No-Passing Zones at Curves

Support. The values of the minimum passing sight distance that are shown in Table 620.2.3 are for operational use in marking no-passing zones and are less than the values that are suggested for geometric design in the "AASHTO Green Book – A Policy On Geometric Design Of Highways And Streets".

The passing sight distance on a vertical curve is the distance at which an object 3.5 feet above the pavement surface can be seen from a point 3.5 feet above the pavement (see Figure 620.2.3.2). Similarly, the passing sight distance on a horizontal curve is the distance measured along the center line (or right-hand lane line of a three-lane roadway) between two points 3.5 feet above the pavement on a line tangent to the embankment or other obstruction that cuts off the view on the inside of the curve (see Figure 620.2.3.2).

The upstream end of a no-passing zone at point "a" in Figure 620.2.3.2 is that point where the sight distance first becomes less than that specified in Table 620.2.3. The downstream end of the no-passing zone at point "b" in Figure 620.2.3.2 is that point at which the sight distance again becomes greater than the minimum specified.

Standard. Where the distance between successive no-passing zones is less than 500 feet, no-passing zone markings shall connect the zones. If the calculated no passing zone is less than 500 feet, an additional length of marking shall be added to the leading end of the zone to lengthen it to the full 500 feet.

Guidance. No-Passing Zone signs (see EPG 903.3.43) should not be installed without prior approval from the State Highway Safety and Traffic Engineer.

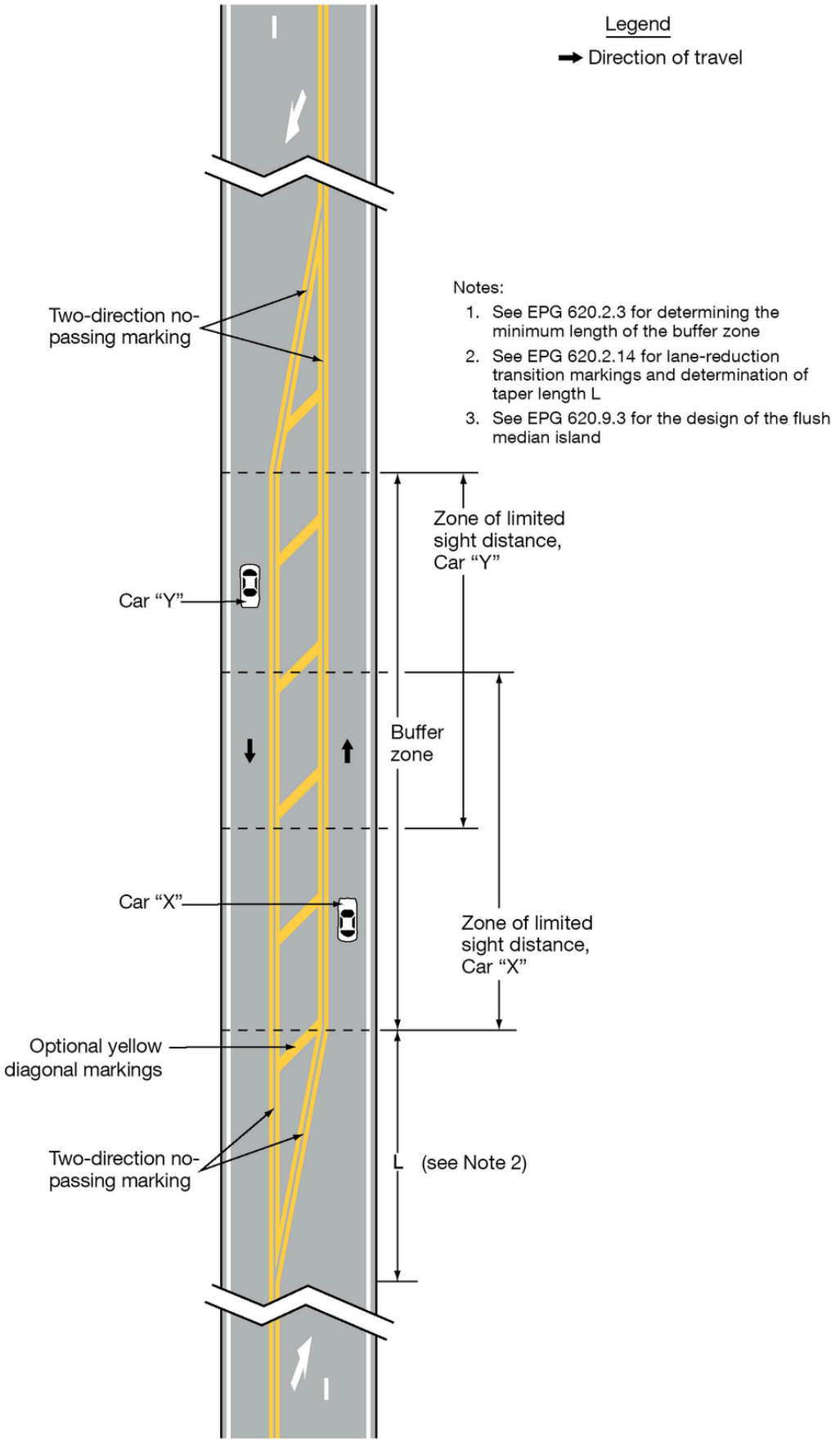


Figure 620.2.3.3 Application of Three-Lane, Two-Way Markings for Changing the Direction of the Center Lane

Standard. On three-lane roadways where the direction of travel in the center lane transitions from one direction to the other, a no-passing buffer zone, consisting of a flush median island (see EPG 620.9.3) at least 50 feet in length, shall be provided in the center lane as shown in Figure 620.2.3.3. A lane-reduction transition (see EPG 620.2.14) shall be provided approaching each end of the buffer zone.

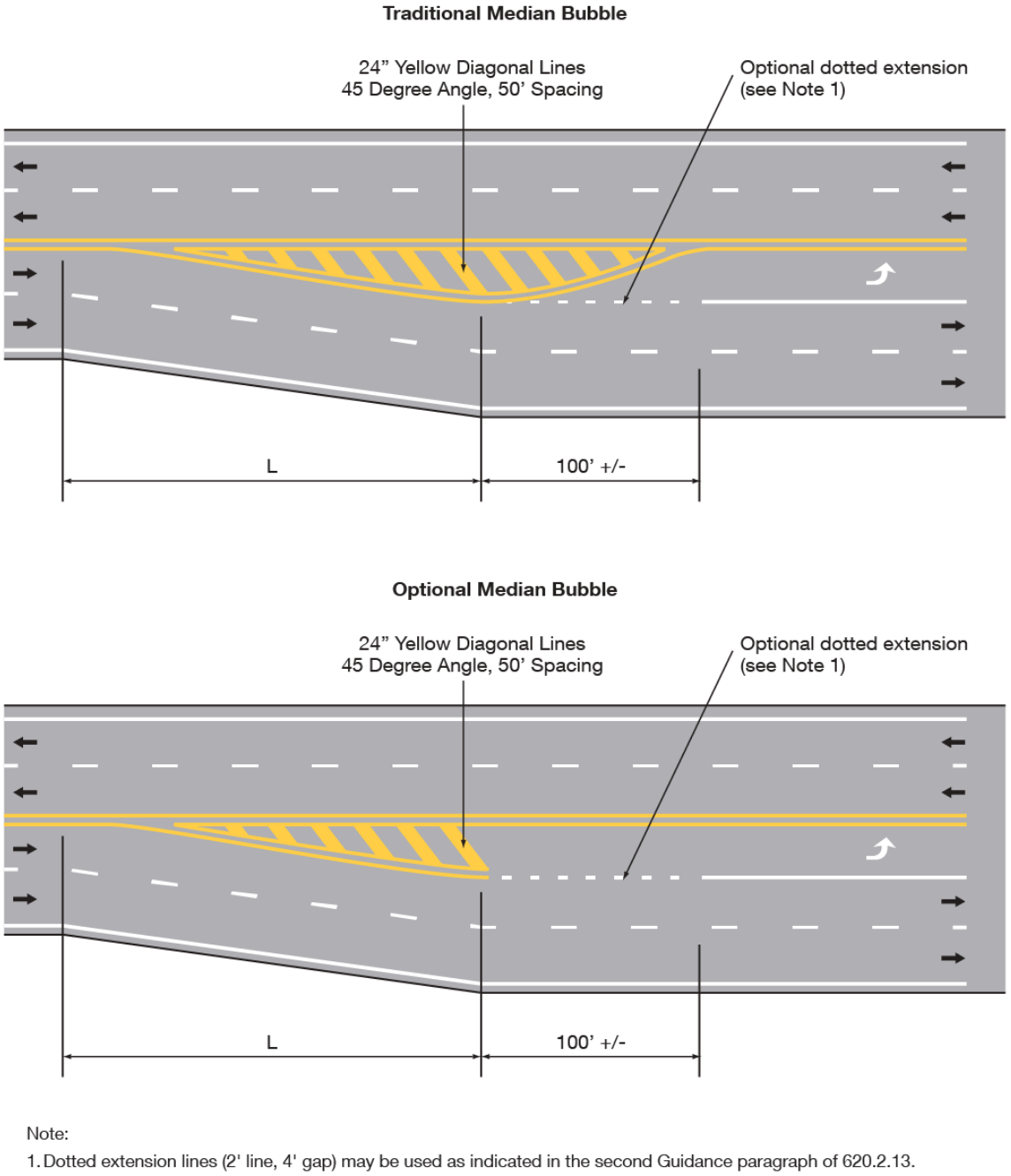
On multi-lane, undivided roadways with two or more lanes in each direction, a minimum of one double yellow center line shall be used to separate the opposing directions of travel. If pavement width is available, the preferred center line marking would provide a painted median formed by two double yellow center lines separated by a minimum of 12 inches to provide greater separation between opposing lanes of travel.

On continuous three-lane (passing lane) sections of roadway, the center line markings shall consist of two double yellow center lines separated by a minimum of 12 inches to separate the opposing directions of travel. See Figure 903.15.24 and EPG 232.2 for additional guidance on passing lanes.

On added uphill truck lanes, a no-passing zone marking shall be provided for the entire length of the ascending direction of travel.

For the descending direction of travel, no-passing zone markings shall be provided for a minimum length of 500 feet or ½ the taper length (L), whichever is greater, in advance of and beyond the location where the uphill truck lane becomes full width (see Figure 620.2.3.3). The length of any no-passing zone related to an uphill truck lane segment shall be increased to address sight distance limitations or based on engineering judgement.

Option. A passing zone may be provided in the descending direction of travel within the uphill truck lane full-width segment being based on available sight distance and engineering judgement.



Note:
1. Dotted extension lines (2' line, 4' gap) may be used as indicated in the second Guidance paragraph of 620.2.13.

Figure 620.2.3.4 Marking for Median Islands for Left Turn Bays

Standard. Median bubbles shall be marked using double yellow center lines to form both sides of the bubble at the beginning of a left turn bay where the bubble separates travel in opposite directions. Each installation of these markings will require individual treatment; therefore, no set dimensions have been established for their placement. Additional markings, such as diagonal lines inside the bubble, if used, shall also be yellow in color (See Figure 620.2.3.4).

Guidance. The taper length of transition zones should not be less than the taper length calculated using the equations L = WS or L = $WS^2/60$ as defined in EPG 620.2.14. Installation of these markings should conform to the established general patterns.

620.2.4 Establishing and Recording No Passing Zones

Standard. The establishment of no passing zones shall be accomplished using two vehicles maintaining a predetermined distance. This distance will mark the beginning and end of the no passing zone section where a target 3.5 ft. above the road surface on the lead vehicle is just out of sight of the driver of the trailing vehicle, whose eye level is 3.5 ft. above the road surface. The use of a highly visible target, such as a flashing amber light, is recommended.

The line of sight used by the trailing vehicle observer shall remain within the limits of the pavement and/or shoulder. Due to current mowing practices, sight distance viewed across any other right of way can be obscured at various times of the year due to seasonal vegetation and right of way which has not been mowed (see Figure 620.2.3.2).

Guidance. The distance between the vehicles should be maintained constant and equal to the minimum passing sight distance value being used. A printed log of the no passing zone should be kept by the district office and copies given to the regional maintenance superintendents so no passing zones can be relocated after maintenance operations.

Support. The most effective way to maintain spacing between vehicles is to space the two vehicles apart the required sight distance and zero out the distance measuring equipment (DME). As the two vehicles move forward, the lead vehicle broadcasts the distance displayed on their DME to the trailing vehicle who works to match the distance on their DME device.

This method of determining no passing zones can be challenging and requires two vehicles, multiple people, and slower travel speeds to be accomplished safely. For longer road segments, on-call contractor-based measurement and reporting systems could be used.

620.2.5 Center Line Markings on Bridges

Standard. The center line markings on bridges, having a clear roadway width of 16 ft. or greater, shall be the same as that marked on the adjoining roadway.

Center line markings shall not be placed on one lane bridges. When dealing with this type of bridge, the center line markings shall stop a distance of 500 ft. from each edge of the bridge deck. Therefore, the length of surface not receiving center line marking shall be 1,000 ft. plus the length of the bridge deck. These bridges will, however, receive the appropriate one-lane bridge markings (see EPG 620.2.12).

620.2.6 Pavement Markings for Two-Way Left-Turn Lanes (MUTCD Section 3B.05)

Support. Two-way left turn lanes may be established by the district if the roadway meets all of the guidelines listed in EPG 232.3.

Standard. If a two-way left-turn lane is used, the lane line pavement markings on each side of the two-way left-turn lane shall consist of a normal width broken (intermittent) yellow line and a normal width solid yellow line to delineate the edges of a lane that can be used by traffic in either direction as part of a left-turn maneuver. These markings shall be placed with the broken (intermittent) line toward the two-way left-turn lane and the solid line toward the adjacent traffic lane as shown in Figure 620.2.2.

Standard. White two-way left-turn lane-use arrows shall be used at or just downstream from the beginning of a two-way left-turn lane to indicate the proper use of these lanes. The left-turn arrows shall be installed in pairs, one arrow per direction.

Guidance. The pairs of arrows should be installed a maximum of 500 ft. apart, with the two arrows in the pair being 8 to 16 ft. apart (see Figure 620.2.2) along a two-way left-turn lane.

Standard. A single-direction lane-use arrow shall not be used in a lane bordered on both sides by yellow two-way left-turn lane longitudinal markings.

Guidance. Signs should be used in conjunction with the two-way left-turn markings (see EPG 903.2.29).

Two-way left-turn lane markings should not extend to intersections (see definition in EPG 911 (MUTCD Section 1C.02)).

Option. Two-way left-turn lanes may be transitioned to mandatory left-turn lanes as shown in Figure 620.2.2 or painted median islands where they approach an intersection.

Support. EPG 913.1.6 contains guidance information for discontinuing a two-way left-turn lane in the immediate vicinity of a highway-rail or highway-LRT grade crossing.

620.2.7 White Lane Line Pavement Markings (MUTCD Section 3B.06)

Standard. When used, lane line pavement markings delineating the separation of traffic lanes that have the same direction of travel shall be white.

Lane line markings shall be used on all freeways and Interstate highways. Lane line markings shall be used on all roadways that are intended to operate with two or more adjacent traffic lanes in the same direction of travel.

Guidance. Lane lines should be offset approximately 2 in. from the longitudinal pavement joint. The 2 in. offset should be the space between the longitudinal joint and the edge of the lane line. See Standard Plan 620 (https://www.modot.org/media/16896)

Lane line markings should be used at congested locations where the roadway will accommodate more traffic lanes with lane line markings than without the markings.

The lane width delineated by lane line pavement markings should not be less than 10 feet.

Support. Examples of lane line markings are shown in Figure 620.2.1.2, and 620.2.2 through 620.2.7.2.

Standard. Except as provided in the first paragraph of EPG 620.2.8, where crossing the lane line markings with care is not discouraged or prohibited, the lane line markings shall consist of a normal width broken (intermittent) white line.

Broken (intermittent) white lane line pavement markings and dotted lane line markings on new concrete pavements shall be enhanced by the use of contrast markings (see EPG 620.1.3).

Where crossing the lane line markings is discouraged, the lane line markings shall consist of a normal width solid white line.

Guidance. A solid white lane line marking should be used on approaches to:

A. Intersections to separate a through lane from a mandatory turn lane.
B. Intersections to separate contiguous mandatory turn lanes from each other.
C. Channelized movements or obstructions.

Option. Solid white lane line markings may be used:

A. On approaches to intersections to separate contiguous through lanes.
B. To separate through traffic lanes from auxiliary lanes, such as an added uphill truck lane.
C. On approaches to crosswalks across multi-lane roadways.

Wide solid lane line markings may be used for greater emphasis.

A curved transition may be used where an edge line, channelizing line, or dotted extension line changes direction.

Support. Examples of locations where a curved transition can have value include freeway exit and entrance ramps, and turn lanes.

Standard. Where crossing the lane line markings is prohibited, the lane line markings shall consist of a solid double white line (DWL).

The State Highway Safety and Traffic Engineer must approve the use of a solid DWL.

Guidance. A solid DWL should be used to address an identifiable need.

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Use signs in advance of the area delineated by a solid DWL to provide motorists an opportunity to adjust to the condition.

620.2.8 White Lane Line Markings for Non-Continuing Lanes (Section 3B.07)

Standard. A normal width dotted white line marking shall be used as the lane line to separate a through lane that continues beyond the interchange or intersection from an adjacent deceleration or acceleration lane.

For exit ramps with a parallel deceleration lane, a normal width dotted white lane line shall be installed from the upstream end of the taper to the theoretical gore or to the upstream end of a solid white lane line, if used, that extends upstream from the theoretical gore as shown in Drawings A and C in Figure 620.2.8.1 and 620.2.8.2.

For an exit ramp with a tapered deceleration lane, a normal width dotted white line extension shall be installed from the theoretical gore through the taper area such that it meets the edge line at the upstream end of the taper as shown in Drawing B in Figure 620.2.8.1.

For entrance ramps with a parallel acceleration lane, a normal width dotted white lane line shall be installed from the downstream end of a solid white lane line, if used, that extends downstream from the theoretical gore, to the upstream end of the acceleration taper, as shown in Drawing A in Figure 620.2.8.3.

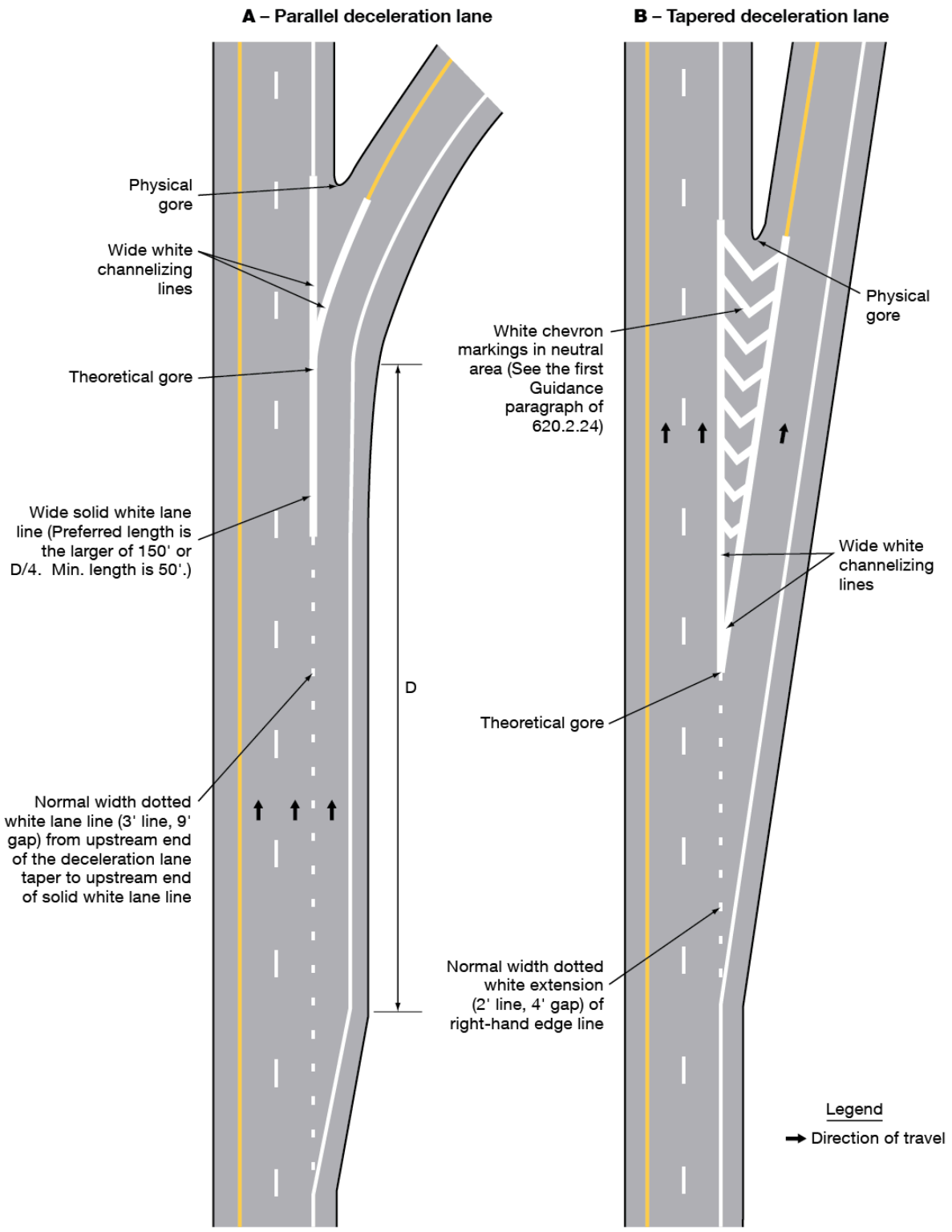


Figure 620.2.8.1 Examples of Dotted Line and Channelizing Line Applications for Exit Ramp Markings *(Sheet 1 of 2)*

C – Parallel deceleration lane at a multi-lane exit ramp having an optional exit lane that also carries the through route

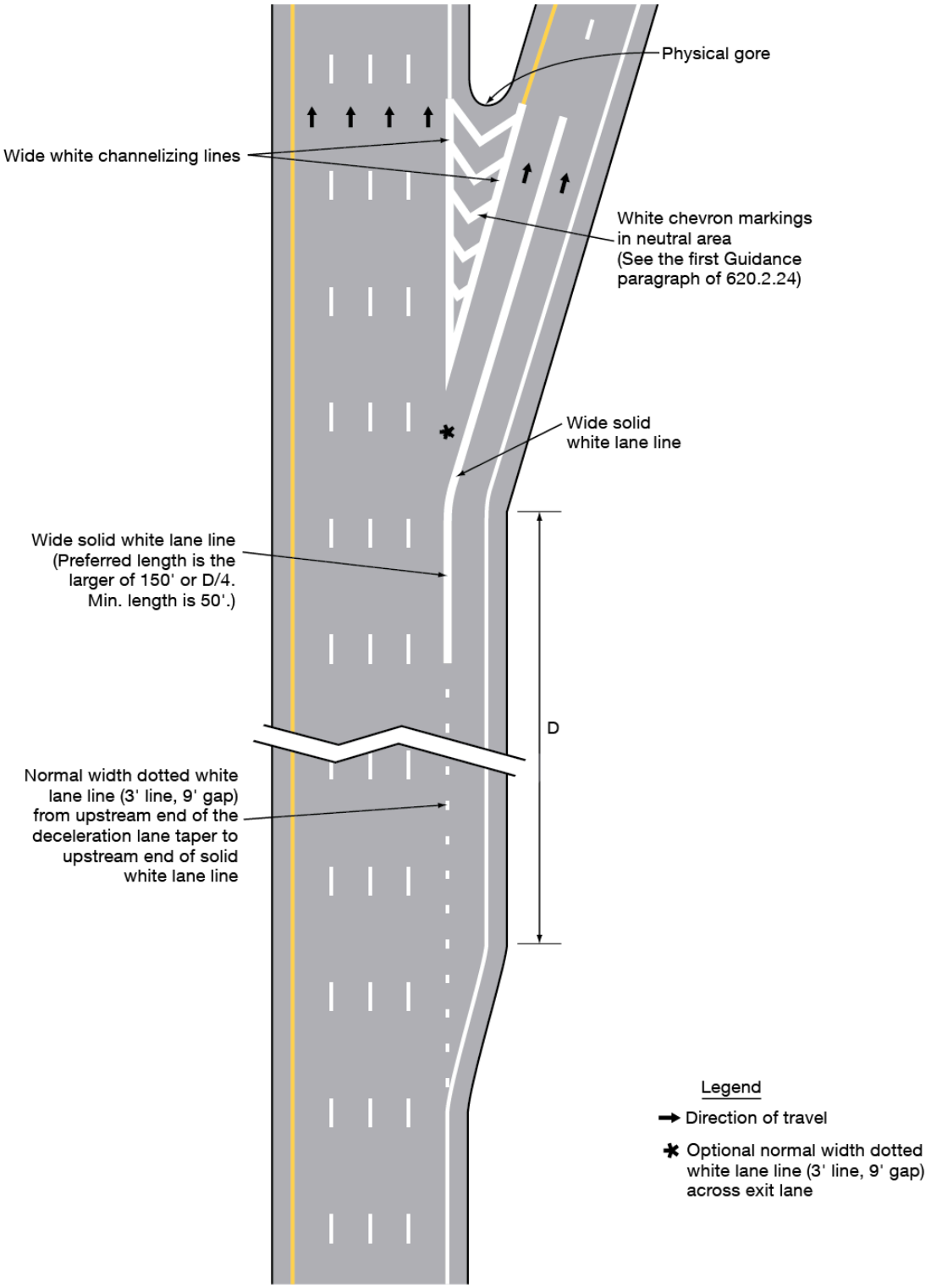


Figure 620.2.8.2 Examples of Dotted Line and Channelizing Line Applications for Exit Ramp Markings *(Sheet 2 of 2)*

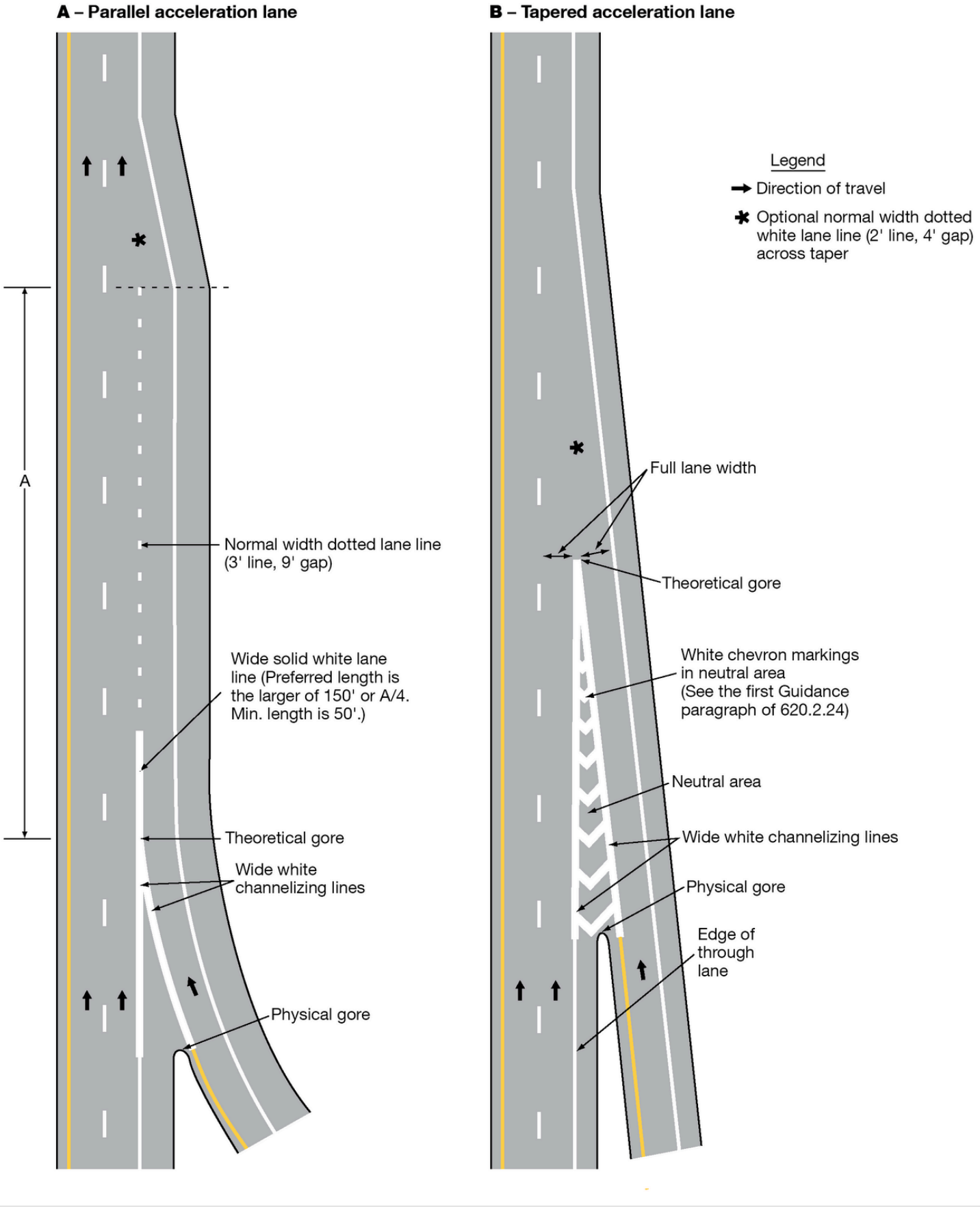


Figure 620.2.8.3 Examples of Dotted Line and Channelizing Line Applications for Entrance Ramp Markings

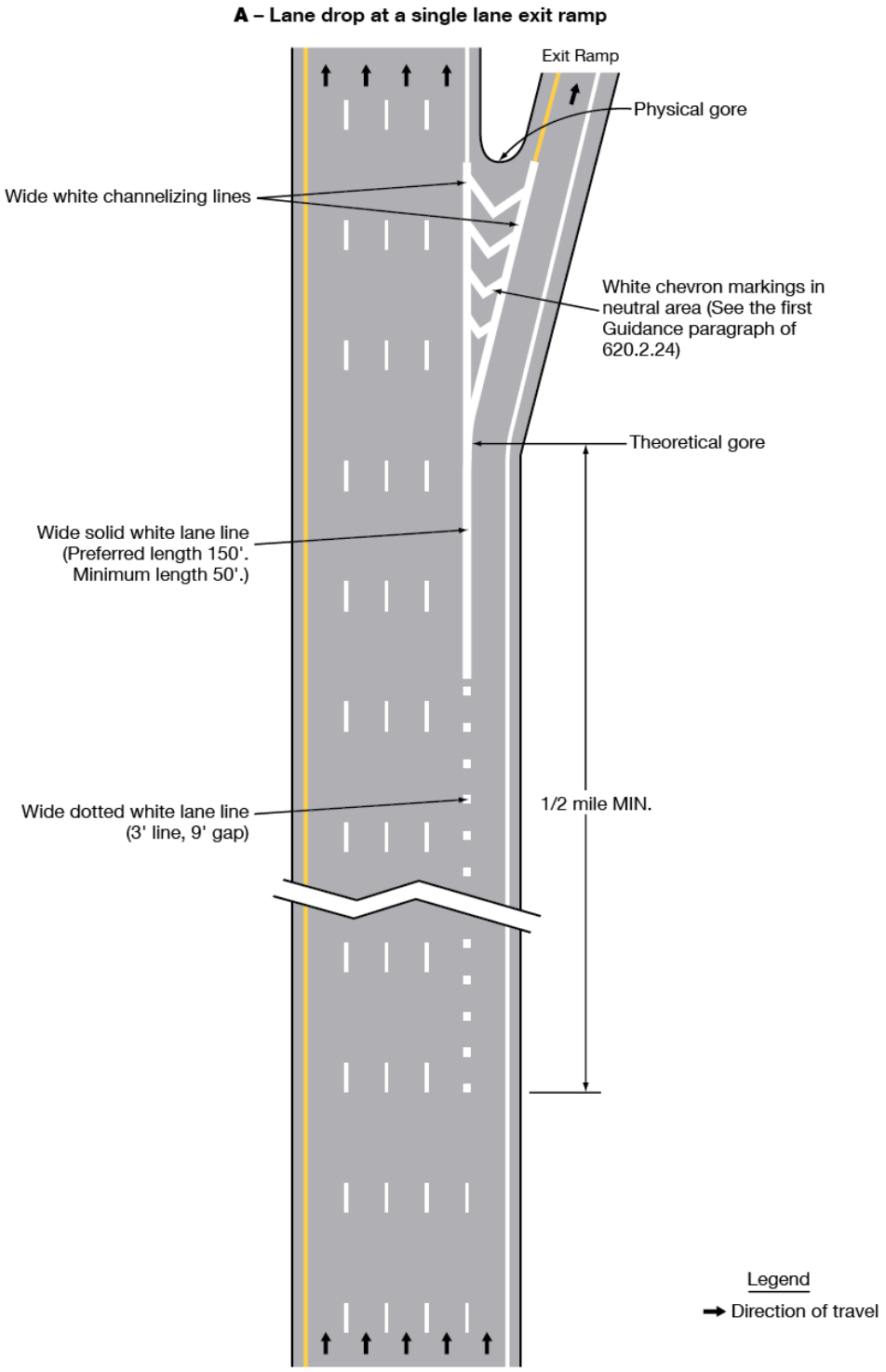


Figure 620.2.8.4 Examples of Applications of Freeway and Expressway Lane-Drop Markings *(Sheet 1 of 6)*

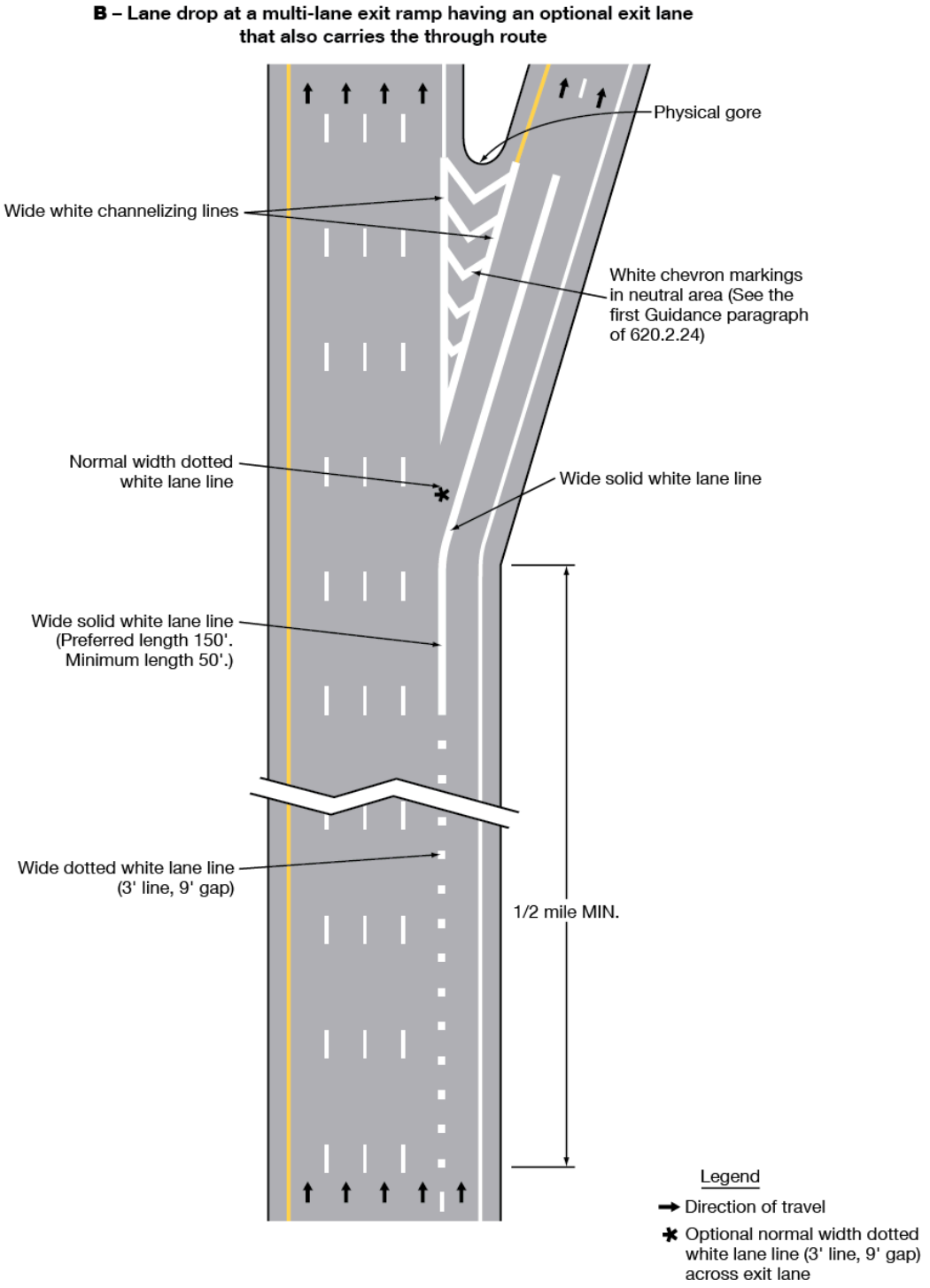


Figure 620.2.8.5 Examples of Applications of Freeway and Expressway Lane-Drop Markings *(Sheet 2 of 6)*

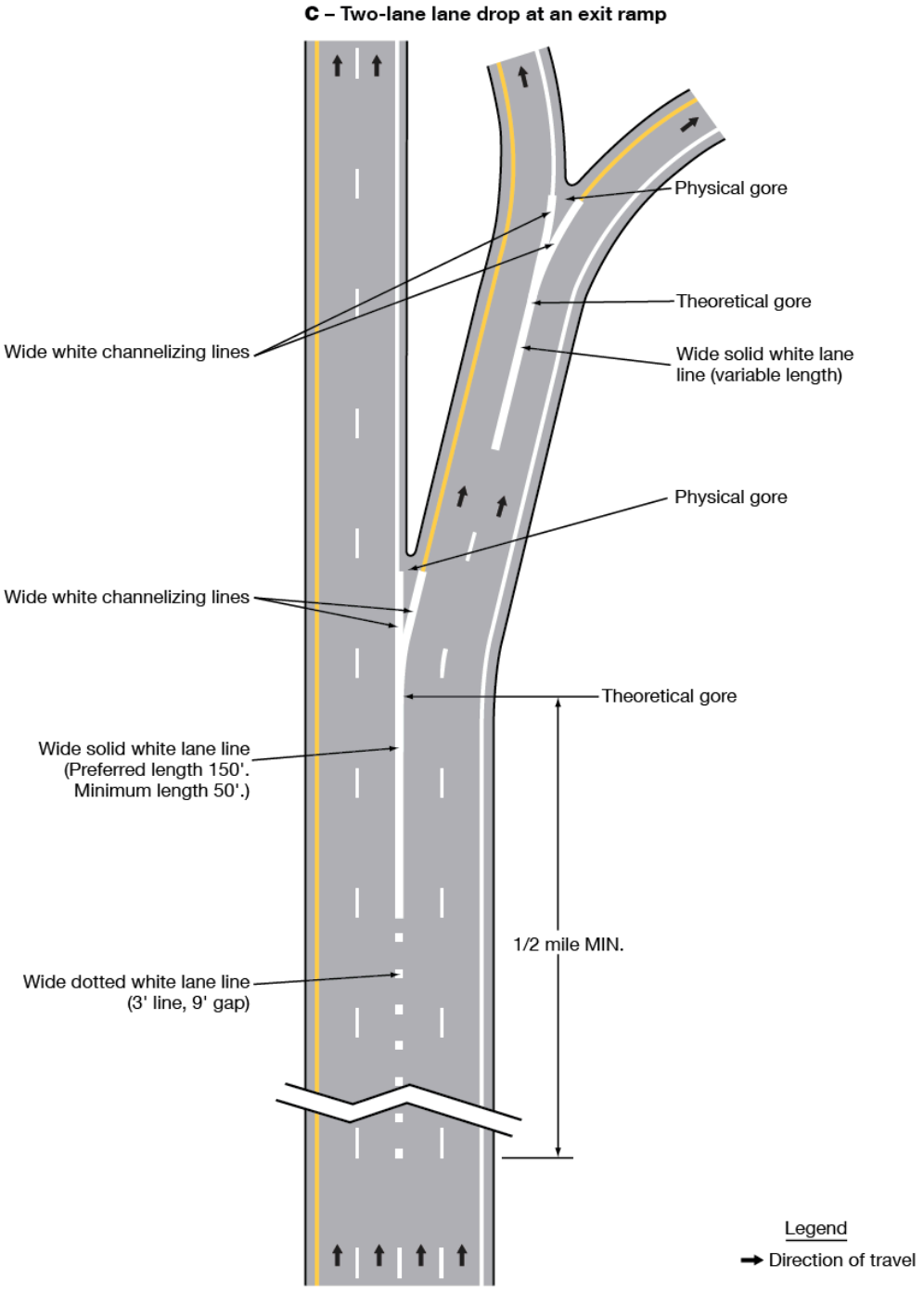


Figure 620.2.8.6 Examples of Applications of Freeway and Expressway Lane-Drop Markings *(Sheet 3 of 6)*

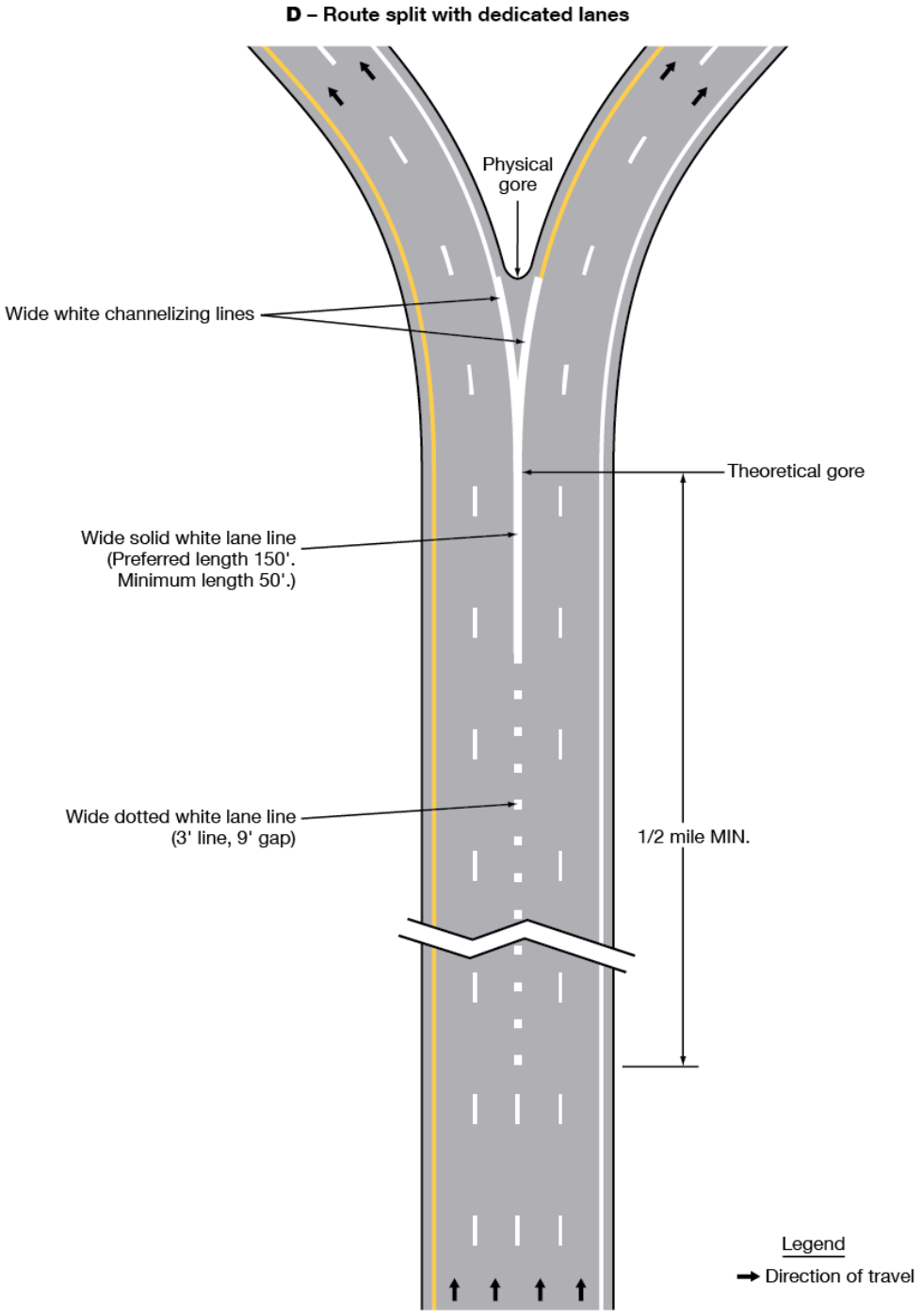


Figure 620.2.8.7 Examples of Applications of Freeway and Expressway Lane-Drop Markings *(Sheet 4 of 6)*

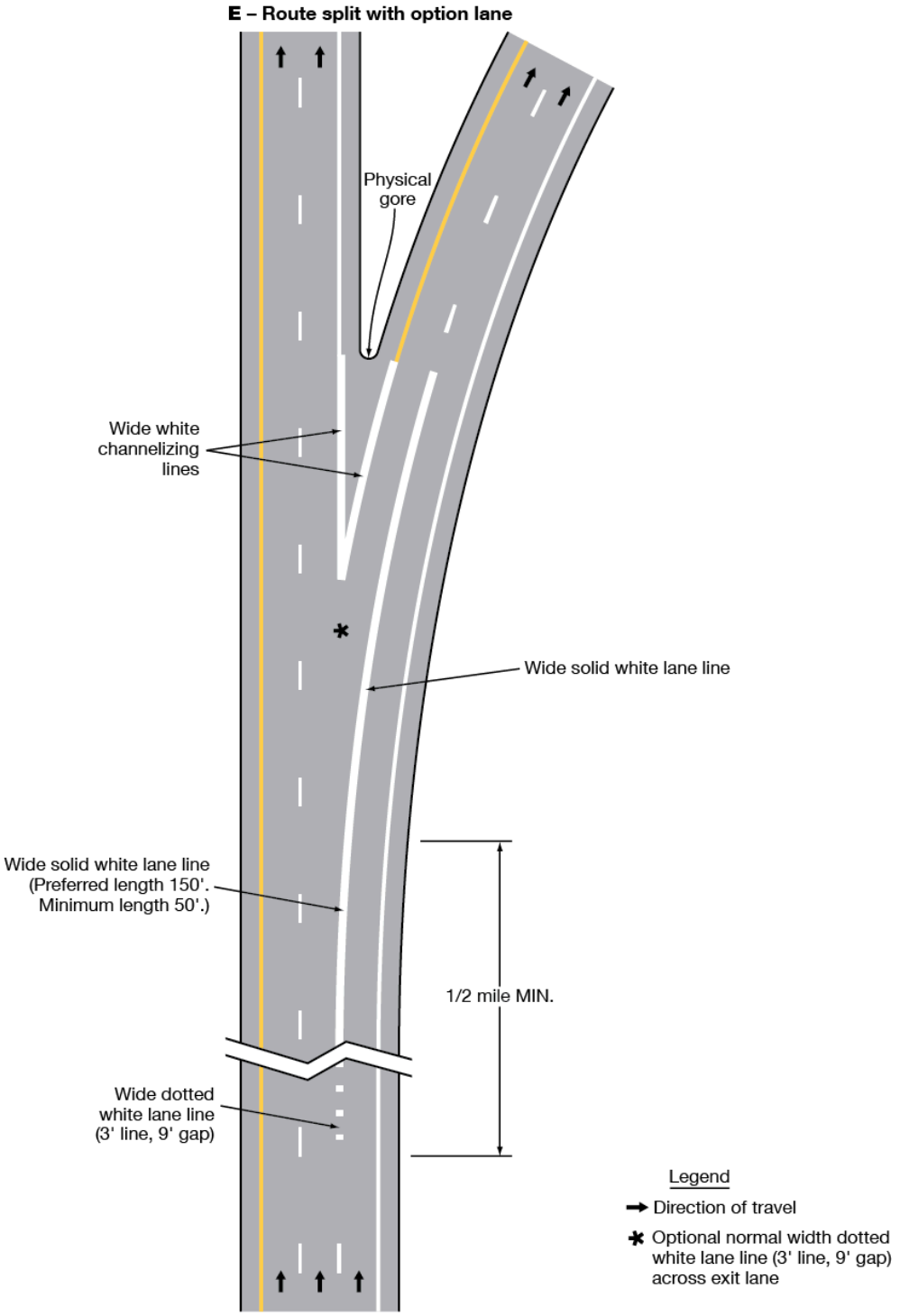


Figure 620.2.8.8 Examples of Applications of Freeway and Expressway Lane-Drop Markings *(Sheet 5 of 6)*

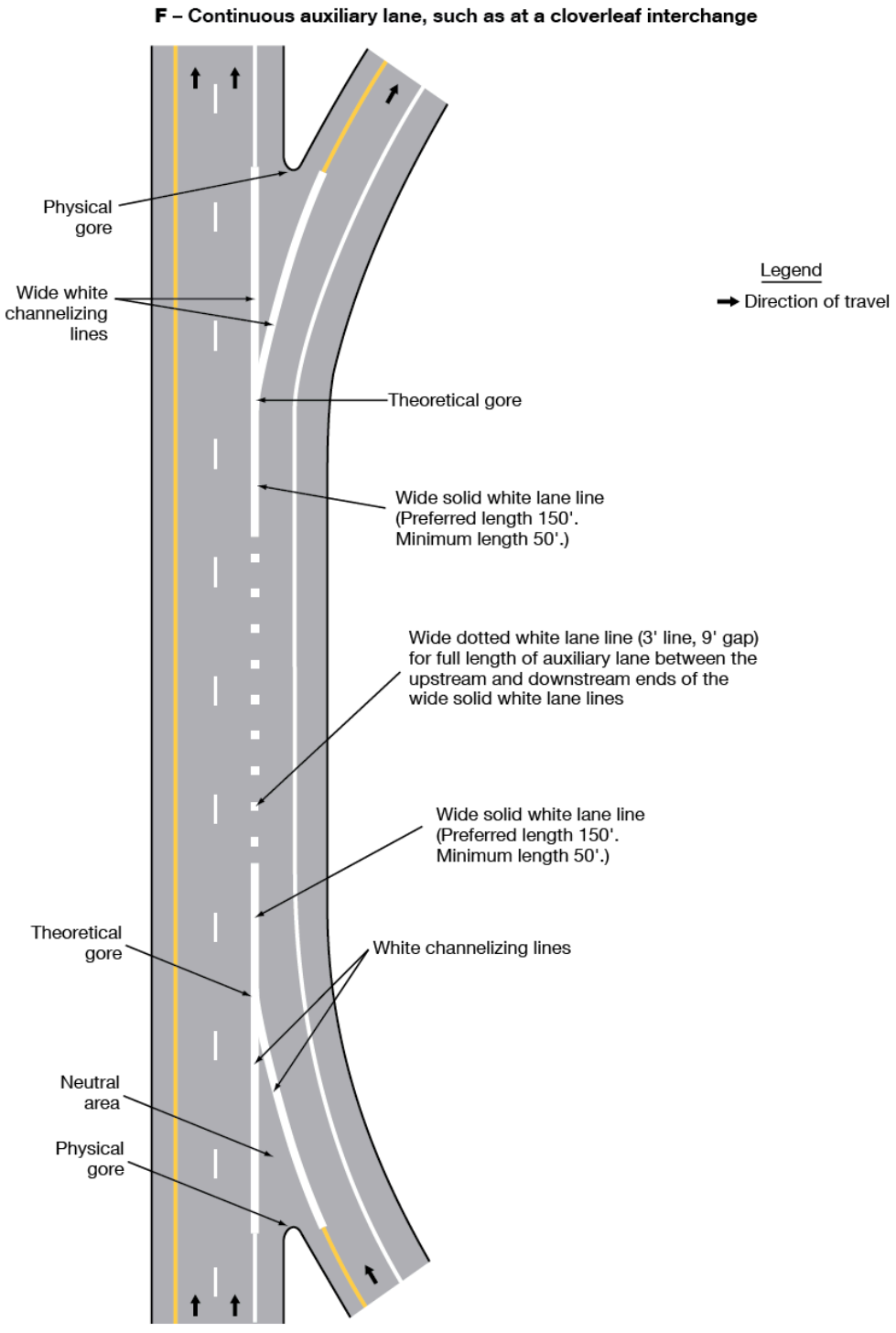


Figure 620.2.8.9 Examples of Applications of Freeway and Expressway Lane-Drop Markings *(Sheet 6 of 6)*

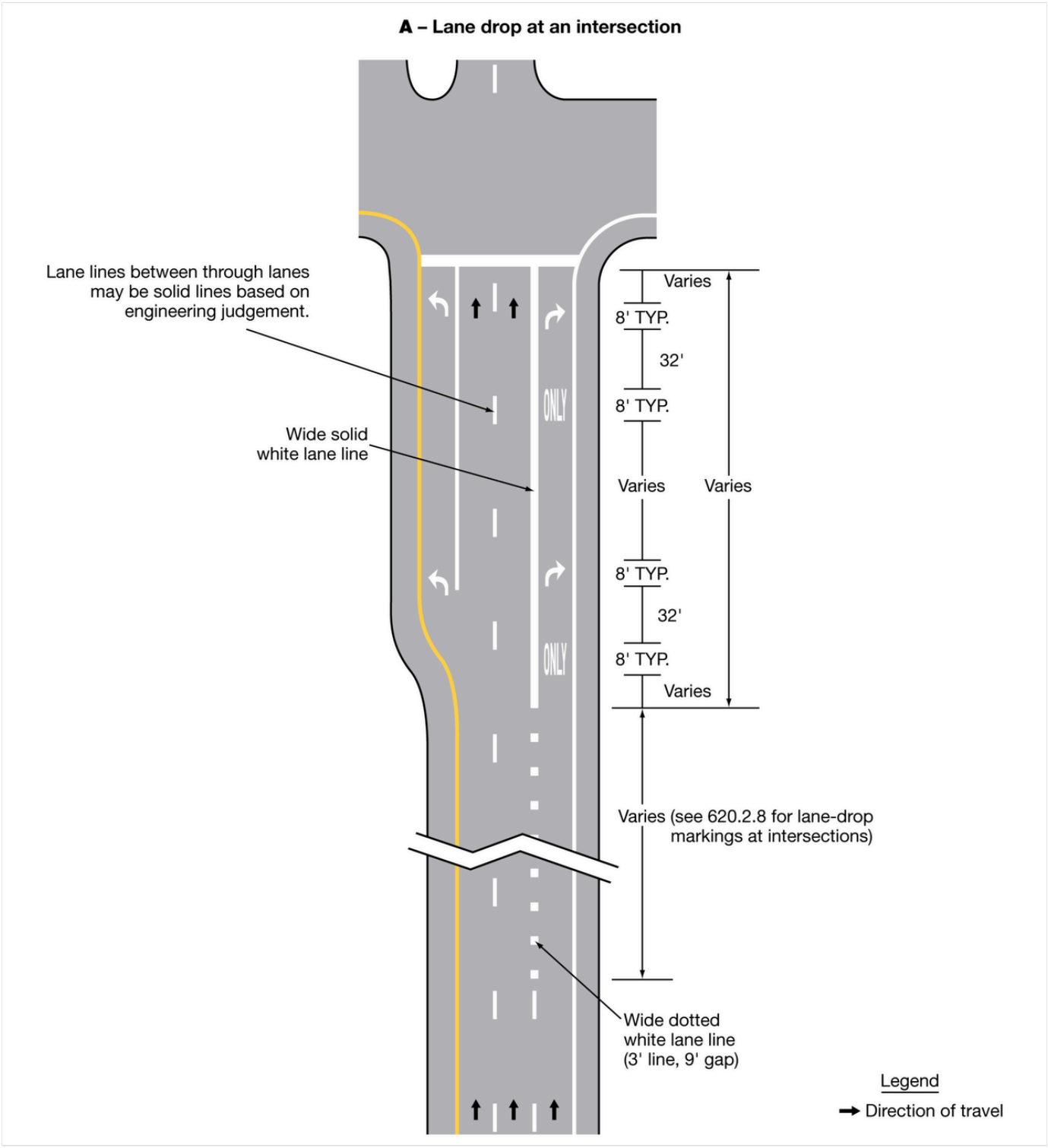


Figure 620.2.8.10 Examples of Applications of Conventional Road Lane-Drop Markings *(Sheet 1 of 2)*

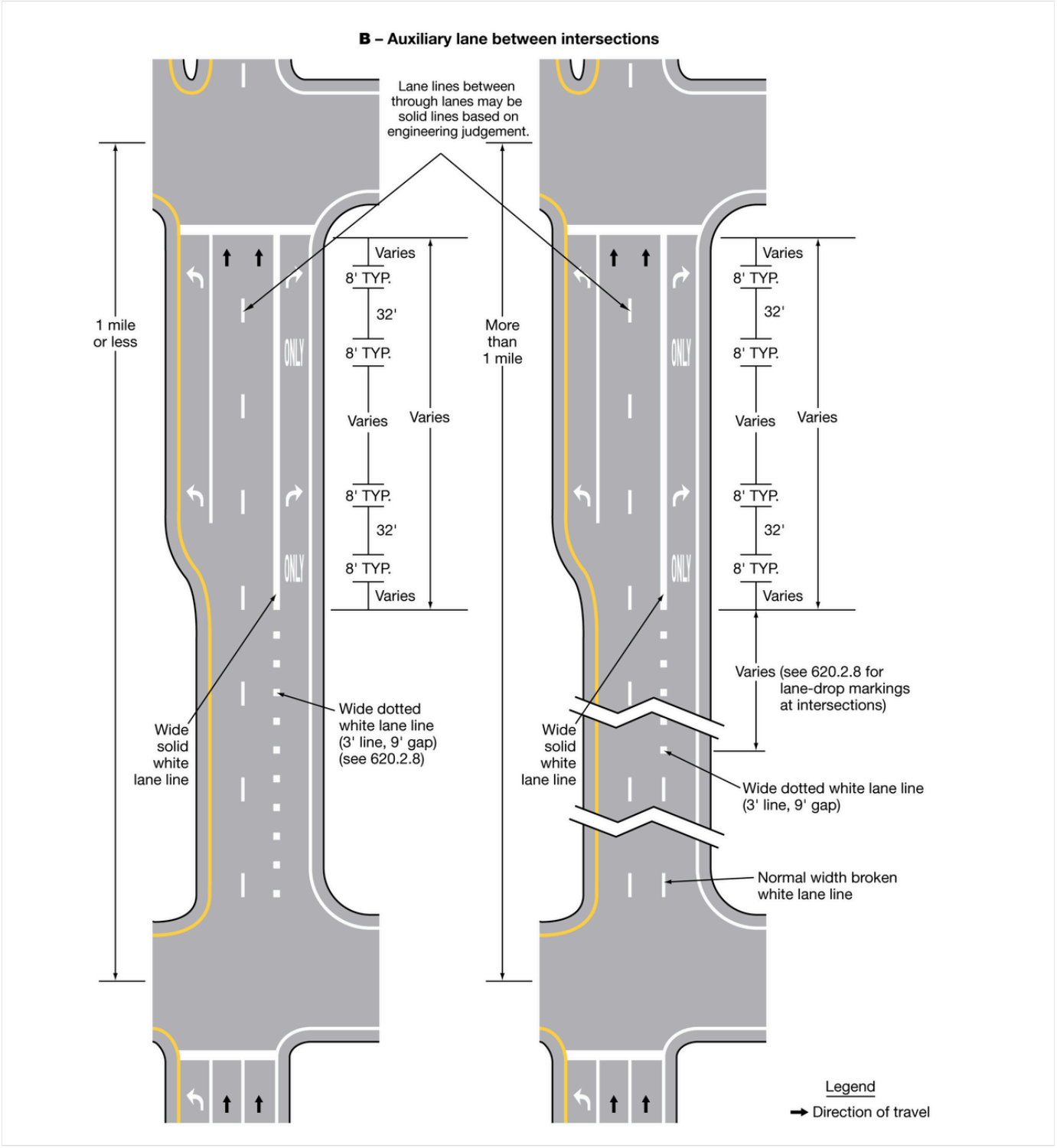


Figure 620.2.8.11 Examples of Applications of Conventional Road Lane-Drop Markings *(Sheet 2 of 2)*

Option. For entrance ramps with a parallel acceleration lane, a normal width dotted white line extension may be installed from the upstream end of the acceleration taper to the downstream end of the acceleration taper, as shown in Drawing A in Figure 620.2.8.3.

For entrance ramps with a tapered acceleration lane, a normal width dotted white line extension may be installed from the downstream end of the channelizing line adjacent to the through lane to the downstream end of the acceleration taper, as shown in Drawing B in Figure 620.2.8.3.

Standard. A wide dotted white lane line shall be used:

A. As a lane drop marking in advance of lane drops at exit ramps to distinguish a lane drop from a normal exit ramp (see Drawings A, B, and C in Figures 620.2.8.4 through 620.2.8.6),

B. In advance of freeway route splits with dedicated lanes (see Drawing D in Figure 620.2.8.7),
C. In advance of freeway route splits with an option lane (see Drawing E in Figure 620.2.8.8),
D. To separate a through lane that continues beyond an interchange from an adjacent continuous auxiliary lane between an entrance ramp and an exit ramp (see Drawing F in Figure 620.2.8.9),
E. As a lane drop marking in advance of lane drops at intersections to distinguish a lane drop from an intersection through lane (see Drawing A in Figure 620.2.8.10), and
F. To separate a through lane that continues beyond an intersection from an adjacent auxiliary lane between two intersections (see Drawing B in Figure 620.2.8.11).

The dotted white lane lines that are used for lane drop markings and that are used as a lane line separating through lanes from auxiliary lanes shall consist of line segments that are 3 feet in length separated by 9-foot gaps.

Guidance. Lane drop markings used in advance of lane drops at freeway and expressway exit ramps should begin at least ½ mile in advance of the theoretical gore.

Option. On the approach to a multi-lane exit ramp having an optional exit lane that also carries through traffic, lane line markings may be used as illustrated in Drawing B in Figure 620.2.8.5.

Guidance. Lane drop markings used in advance of lane drops at intersections should begin a distance in advance of the intersection that is determined by engineering judgment as suitable to enable drivers who do not desire to make the mandatory turn to move out of the lane being dropped prior to reaching the queue of vehicles that are waiting to make the turn. The lane drop markings should begin no closer to the intersection than the most upstream regulatory or warning sign associated with the lane drop.

Support. EPG 620.2.20 and 620.2.22 contain information regarding other markings that are associated with lane drops, such as ONLY word pavement markings and lane-use arrows.

EPG 620.2.14 contains information about the lane line markings that are to be used for transition areas where the number of through lanes is reduced at a location that is not at an interchange or intersection.

Option. In the case of a lane drop at an exit ramp or intersection, a solid white line may replace a portion, but not all of the length, of the wide dotted white lane line (See Figures 620.2.8.4 through 620.2.8.9).

620.2.9 Channelizing Lines (MUTCD Section 3B.08)

Support. Channelizing lines are used to form neutral areas where traffic traveling in the same general direction is permitted on both sides including entrance and exit ramps, access and egress points to and from managed lanes, and left-turn lanes separated from through lanes. Channelizing lines are also sometimes used to alter travel paths for speed management or other purposes.

EPG 620.9 contains information for the application of channelizing lines used in conjunction with islands.

Standard. Except as provided in the third Option paragraph of EPG 620.9.5, a channelizing line shall be a solid wide white line.

Channelizing lines used to mark gores shall be wide solid white lines.

Support. Examples of channelizing line applications are shown in Figures 620.2.8.2, 620.2.8.3, 620.2.8.4, Drawing C in Figure 620.2.15.2, Figures 620.9.2 through 620.9.4.4, and Figure 620.9.7.

Standard. For all exit ramps and for entrance ramps with parallel acceleration lanes, channelizing lines shall be placed on both sides of the neutral area (see Figure 620.2.8.1, Figure 620.2.8.2, Drawing A in Figure 620.2.8.3, and Figures 620.2.8.4 through 620.2.8.9).

For entrance ramps with tapered acceleration lanes, the channelizing lines shall extend to the theoretical gore as shown in Drawing B in Figure 620.2.8.3.

Other pavement markings in the neutral area shall be white.

Support. Pavement markings within the neutral area include chevron markings (see EPG 620.2.24).

620.2.10 Edge Line Pavement Markings (MUTCD Section 3B.09)

Standard. If used, edge line pavement markings shall delineate the right or left edges of a roadway.

Except as provided in EPG 620.5.4, right edge line pavement markings, if used, shall consist of a normal width solid white line to delineate the right-hand edge of the roadway.

If used on the roadways of divided highways or one-way streets, or on any ramp in the direction of travel, left edge line pavement markings shall consist of a normal width solid yellow line to delineate the left-hand edge of a roadway or to indicate driving or passing restrictions left of these markings, except as provided in EPG 620.5.4.

Guidance. When solid wide lines are used at entrance or exit ramps, the additional width of the wide line should encroach on the through lane of the highway (see Figure 620.2.10).

Support. Edge line markings provide visual references to guide road users during adverse weather and visibility conditions.

Guidance. Edge line markings should not be continued through intersections, except for the following situations:

A. Dotted edge line extensions (see EPG 620.2.13), or
B. Through that part of an intersection with no intersection approach (such as the far side of a T-intersection).

Support. EPG 620.2.13 contains information on the use and application of edge lines through intersections, interchanges, and driveways.

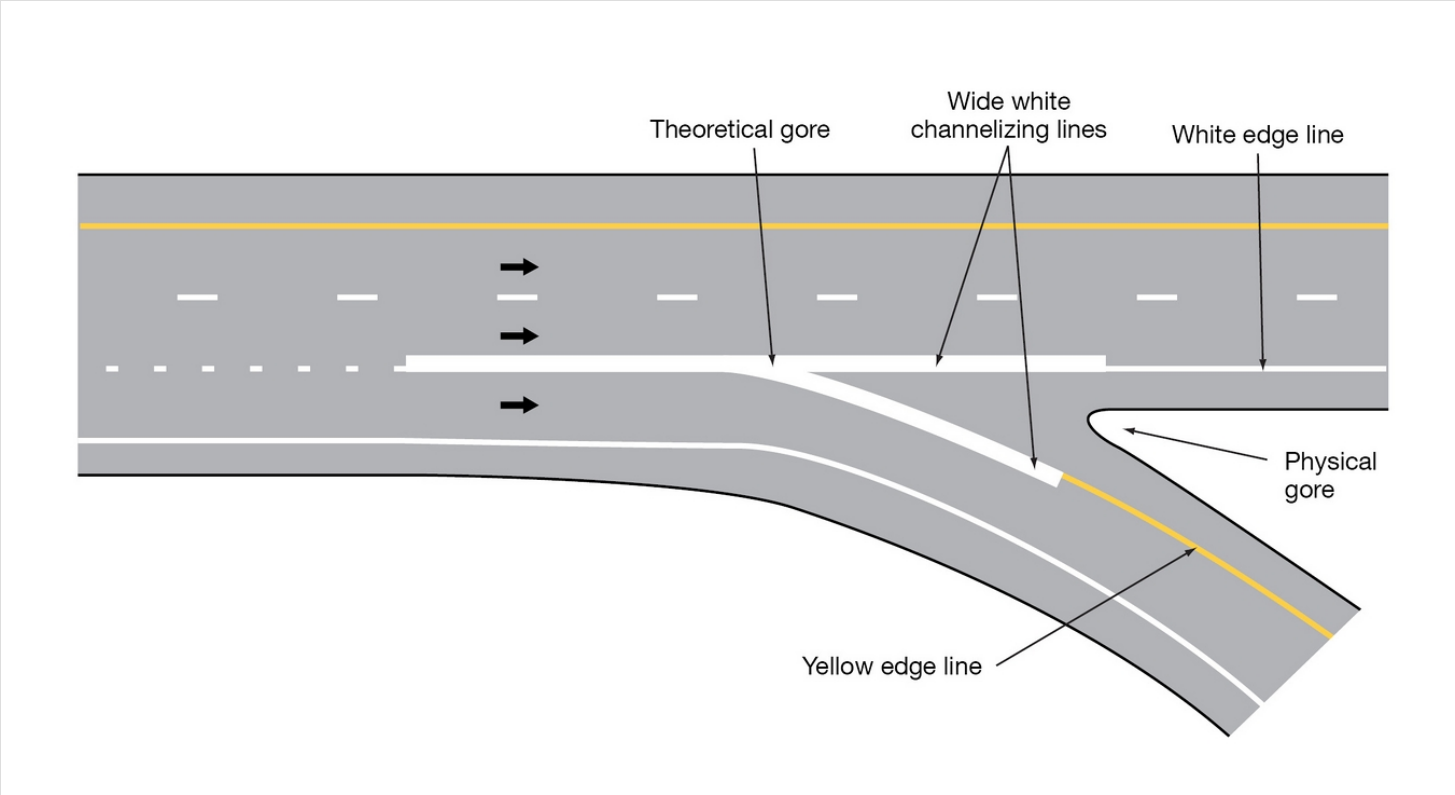


Figure 620.2.10 Example of Channelizing Line Markings at Ramp Gores

620.2.11 Warrants for Use of Edge Lines (MUTCD Section 3B.10)

Standard. Edge line markings shall be placed on paved streets or highways with the following characteristics:

A. Freeways,
B. Expressways, and
C. Routes with a traveled way of 20 feet or more in width and an ADT of 400 vehicles per day or greater.

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Option. Edge line markings may be excluded, based on engineering judgment, for reasons such as if the traveled way edges are delineated by curbs, parking, or other markings.

If a bicycle lane is marked on the outside portion of the traveled way, the edge line that would mark the outside edge of the bicycle lane may be omitted.

Edge line markings may be used where edge delineation is desirable to minimize unnecessary driving on paved shoulders or on refuge areas that have lesser structural pavement strength than the adjacent roadway.

620.2.12 Bridge Edge Lines

Standard. Bridges that are located on routes authorized for edge lines shall be striped in accordance with the following classifications (see Figure 620.2.12.1 and Figure 620.2.12.2):

A. Non-shoulder width bridges that have been constructed with a deck less than 2 ft. wider than the adjacent roadway on each side of the pavement shall not have the edge line placed on the bridge deck. The edge line shall end on the adjacent roadway 50 ft. from the bridge deck.
B. Bridges wider than the roadway pavement by more than 2 ft. on each side shall receive edge line that will be continuous with that of the adjoining roadway.
C. Three lane bridges designed and constructed with an additional lane for future use shall be marked as a two lane bridge. The edge line in these cases shall not be offset to provide for the usage of the third lane and the edge line will be continuous across the bridge.
D. One lane, weight restricted bridges have a reduced driving surface due to an inability to carry the weight of two lanes of traffic. These bridges shall be marked using a wide white edge line that forms a 12 ft. travel lane on the bridge deck. These edge lines shall then taper from the edge of the bridge deck 200 ft. to the edge of the roadway pavement. The center line marking, if applicable, shall end 500 ft. from the end of the bridge deck.
E. One lane bridges with width restrictions, having a clear traveling surface 16 ft. or less shall be marked using a wide white edge line that forms a 12 ft. travel lane on the bridge deck. These edge lines shall then taper from the edge of the bridge deck 200 ft. to the edge of the roadway pavement. The center line marking, if applicable, shall end 500 ft. from the end of the bridge deck.

Guidance. Special attention should be given to all bridges whose shoulders are 2 ft. or wider than the shoulders of the adjacent roadway.

Standard. If bridges whose shoulders are 2 ft. or wider than the shoulders of the adjacent roadway are on routes authorized for center line marking, but not edge line marking, a segment of edge line shall be marked to delineate the travel way of the bridge. The edge line marking for these bridges shall begin 500 ft. ahead of, and end 500 ft. beyond, the bridge deck. These markings are intended to guide vehicles from the wider bridge deck to the narrower adjacent roadway (see Figure 620.2.12.1 and Figure 620.2.12.2.)

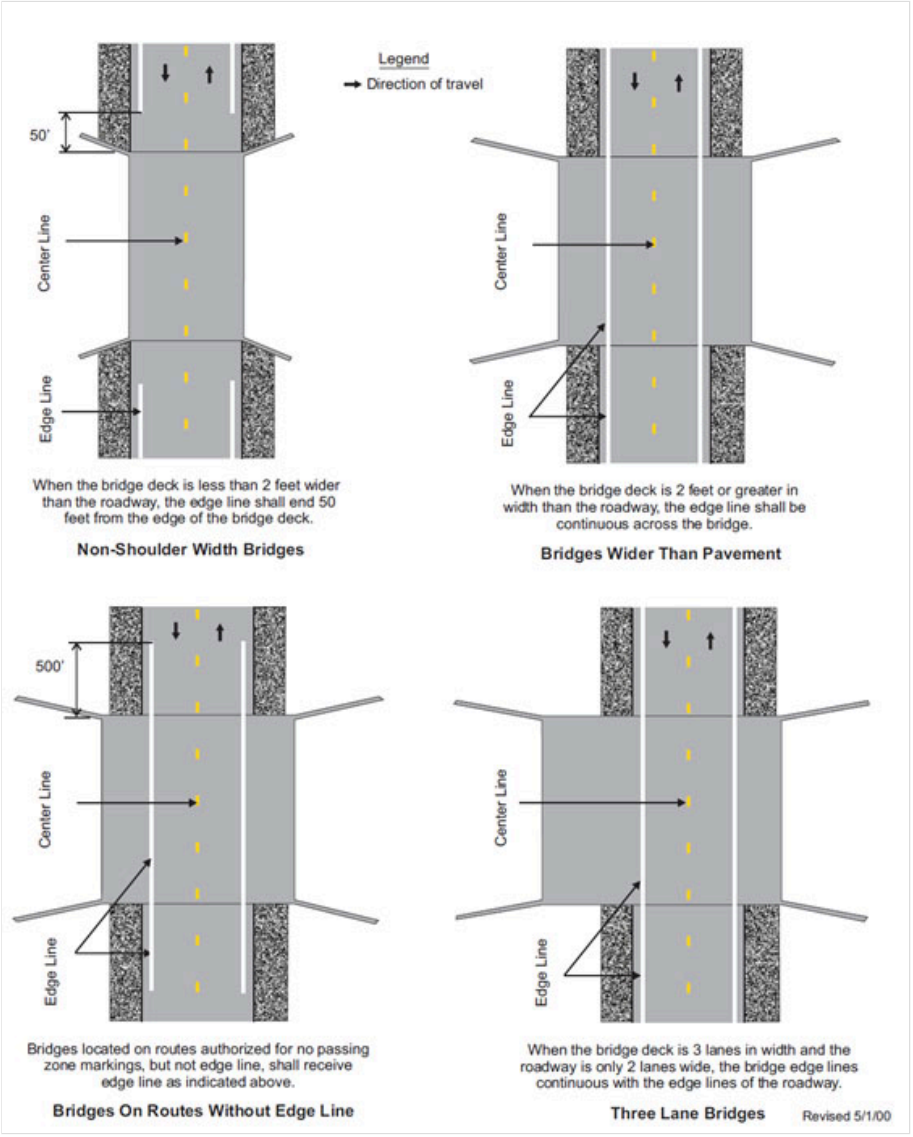


Figure 620.2.12.1 Edge Line Striping for Two-Lane, Two-Way Bridges

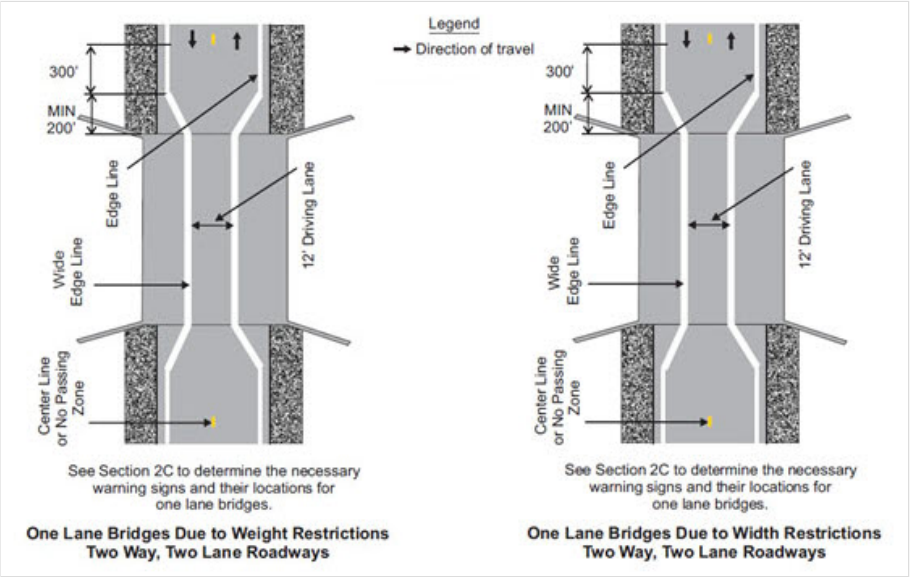


Figure 620.2.12.2 Edge Line Striping for Single Lane Bridges

620.2.13 Application of Pavement Markings Through Intersections or Interchanges (MUTCD Section 3B.11)

Standard. Pavement markings extended into or continued through an intersection or interchange area shall be the same color as the line markings they extend (see Figure 620.2.13.1 and Figure 620.2.13.2).

Intersections that provide more than one turn lane per movement shall have dotted extension lines for traffic to follow through the intersection, except as provided in the following Option paragraph. These lines shall be marked with dotted extension lines (2-foot line segments separated by 4-foot gaps), and shall follow the appropriate turning radius of the intersection. This line shall begin at the solid white lane line of the left turn bay and end at the lane line delineating the lanes the traffic is being channelized to. Dotted extension lines shall not be marked within crosswalks.

Option. Exceptions will be allowed when the dotted extension lines for opposing dual left-turn movements overlap in a manner that may cause driver confusion.

Guidance. Pavement markings extended into or continued through an intersection or interchange area should be at least the same width as the line markings they extend.

Where highway design or reduced visibility conditions make it desirable to provide control or to guide vehicles through an intersection or interchange, such as at offset, skewed, complex, or multi-leg intersections, on curved roadways, where multiple turn lanes are used, or where offset left-turn lanes might cause driver confusion, dotted lane line extension markings consisting of 2-foot line segments and 4-foot gaps should be used to extend longitudinal line markings through an intersection or interchange area.

In areas of limited sight distance due to vertical and/or horizontal curves, an edge line extension may be used to delineate acceleration and deceleration lanes.

Standard. Extensions of center lines through intersections shall be dotted lines.

Guidance. Where a double line is extended through an intersection, a single line of equal width to one of the lines of the double line should be used.

Standard. Solid lines shall not be used to extend edge lines into or through intersections except through that part of an intersection with no intersecting approach (such as at the far side of a T-intersection).

Guidance. Edge line markings should be discontinued across intersecting approaches at intersections or interchanges.

Driveways that do not meet the definition of an intersection (see EPG 911 (MUTCD Section 1C.02)) should have edge line markings maintained across the intersecting approach of the driveway.

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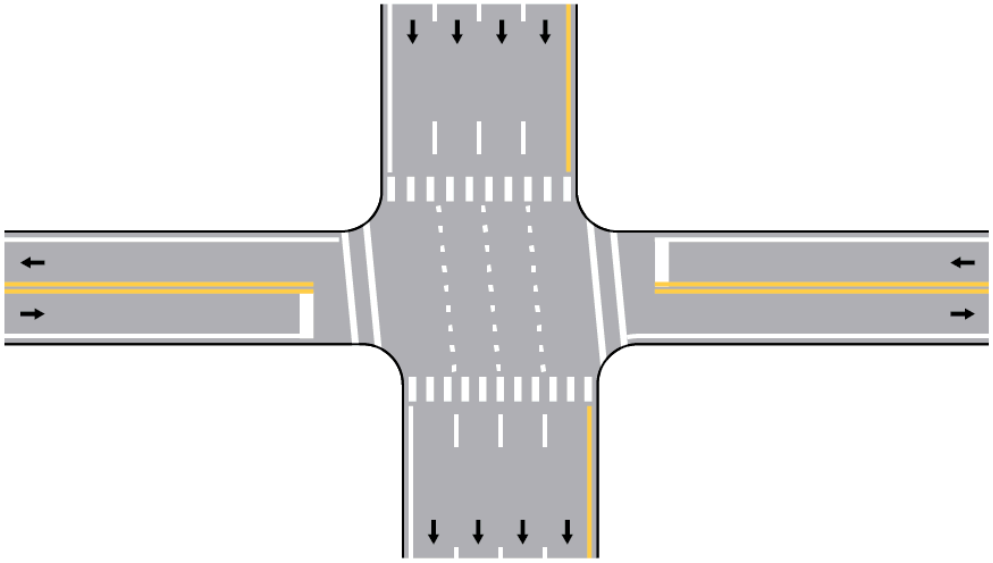
Option. Dotted edge line extensions may be placed through intersections.

Edge line extension lines may be used at the district's discretion.

Guidance. Durable pavement markings should be used for edge line extensions. An attempt should be made to keep the painted portion of this line out of the wheel tracks to promote longer life.

For a divided highway, the edge line at an intersection should begin and end at the taper points when the intersection has no deceleration lanes. Where deceleration lanes are present, the edge line should continue along the outside of the deceleration lane to the beginning of the turn radius (see Figure 620.2.13.3).

A – Typical pavement markings with offset lane lines continued through the intersection



B – Typical pavement markings with line extensions into intersection for double turns

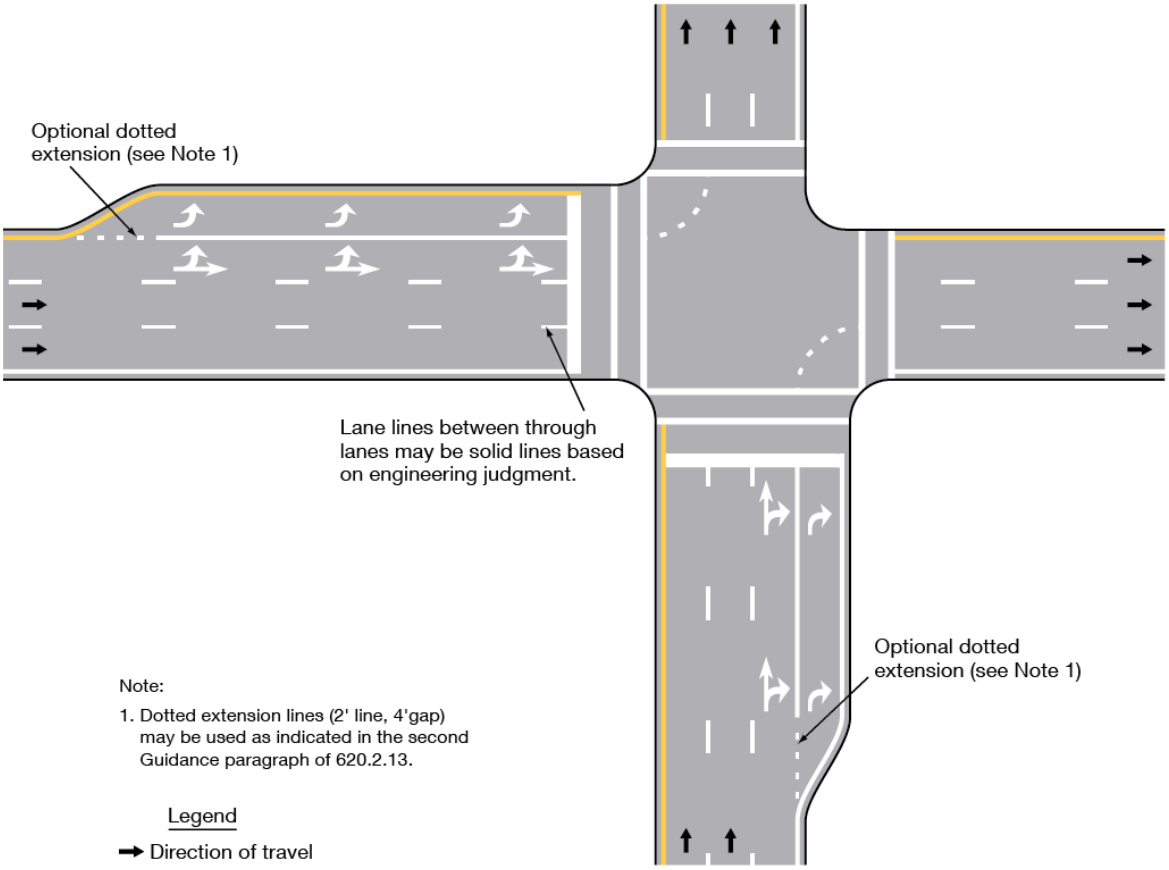


Figure 620.2.13.1 Examples of Line Extensions through Intersections *(Sheet 1 of 2)*

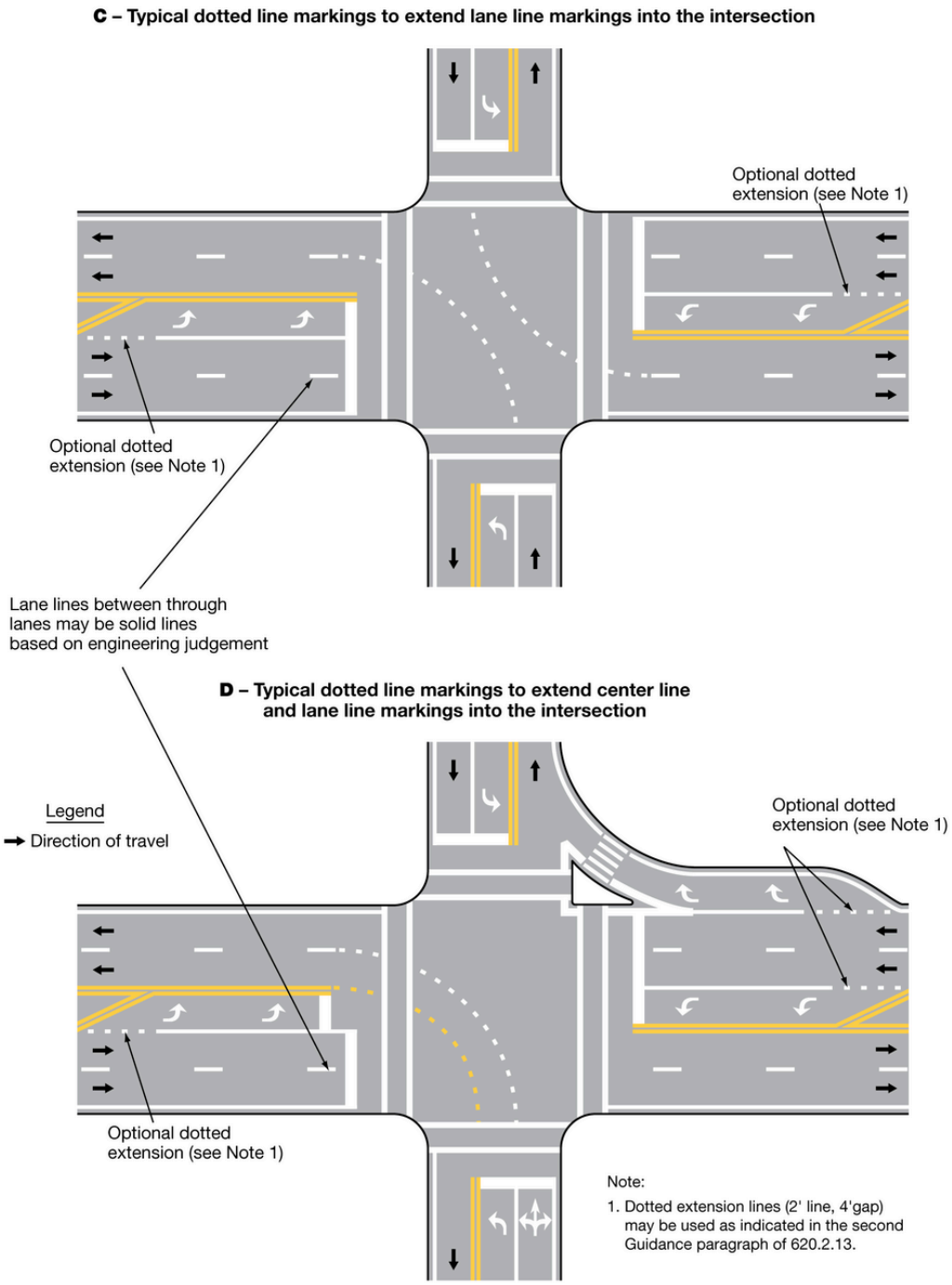


Figure 620.2.13.2 Examples of Line Extensions through Intersections *(Sheet 2 of 2)*

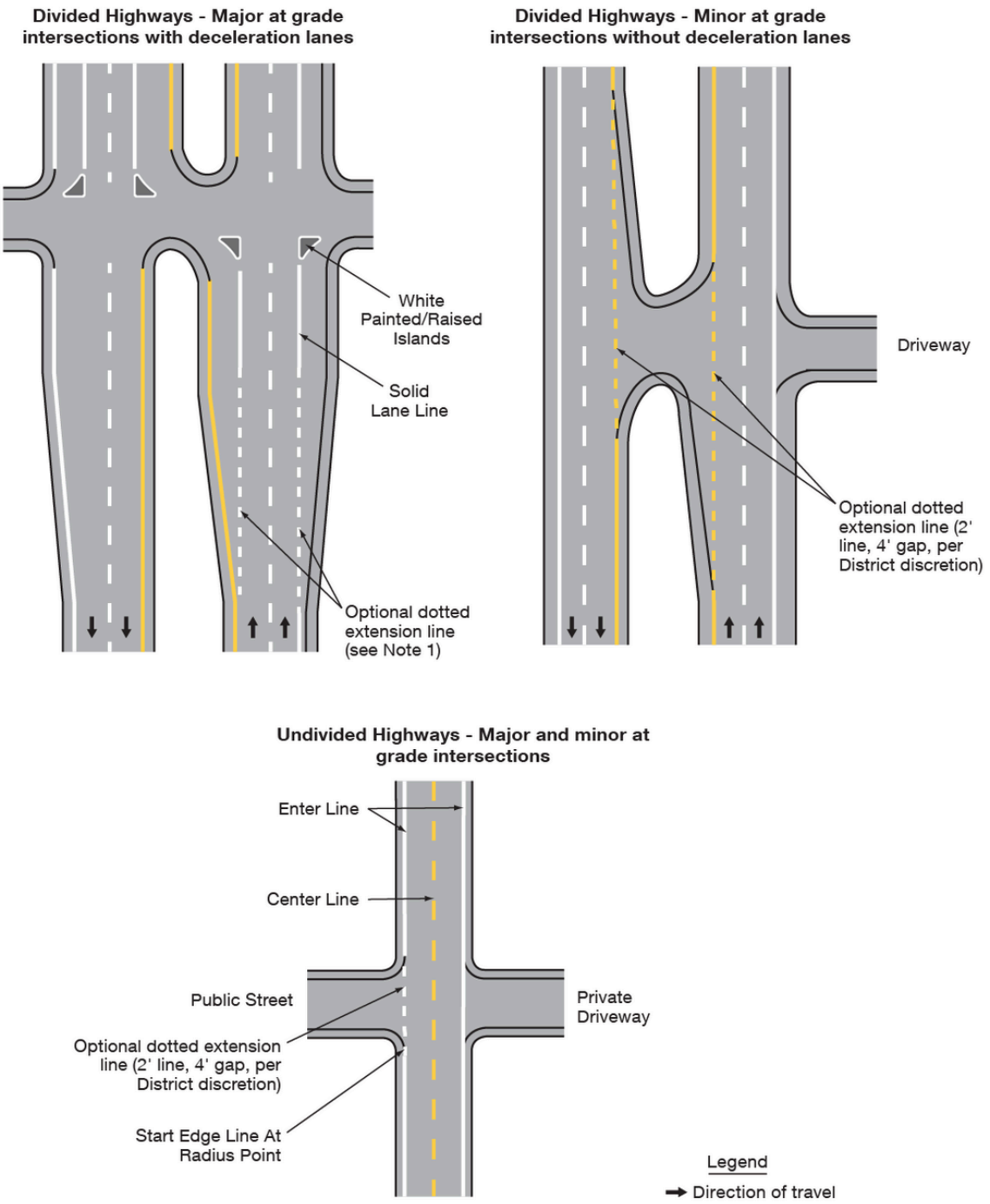


Figure 620.2.13.3 Edge Line Striping for At Grade Intersections

Support. EPG 620.2.30 contains information about edge lines through diverging diamond interchanges with a transposed alignment crossroad.

EPG 620.4.3 provides information for edge lines through roundabouts.

EPG 912 (MUTCD Section 5B.02) contains information on edge line extensions for driving automation system considerations.

EPG 913.3.5 contains information about the extension of edge lines through grade crossing areas.

EPG 914.5.3 contains information for the extensions of bicycle lanes through intersections.

620.2.14 Lane-Reduction Transitions (MUTCD Section 3B.12)

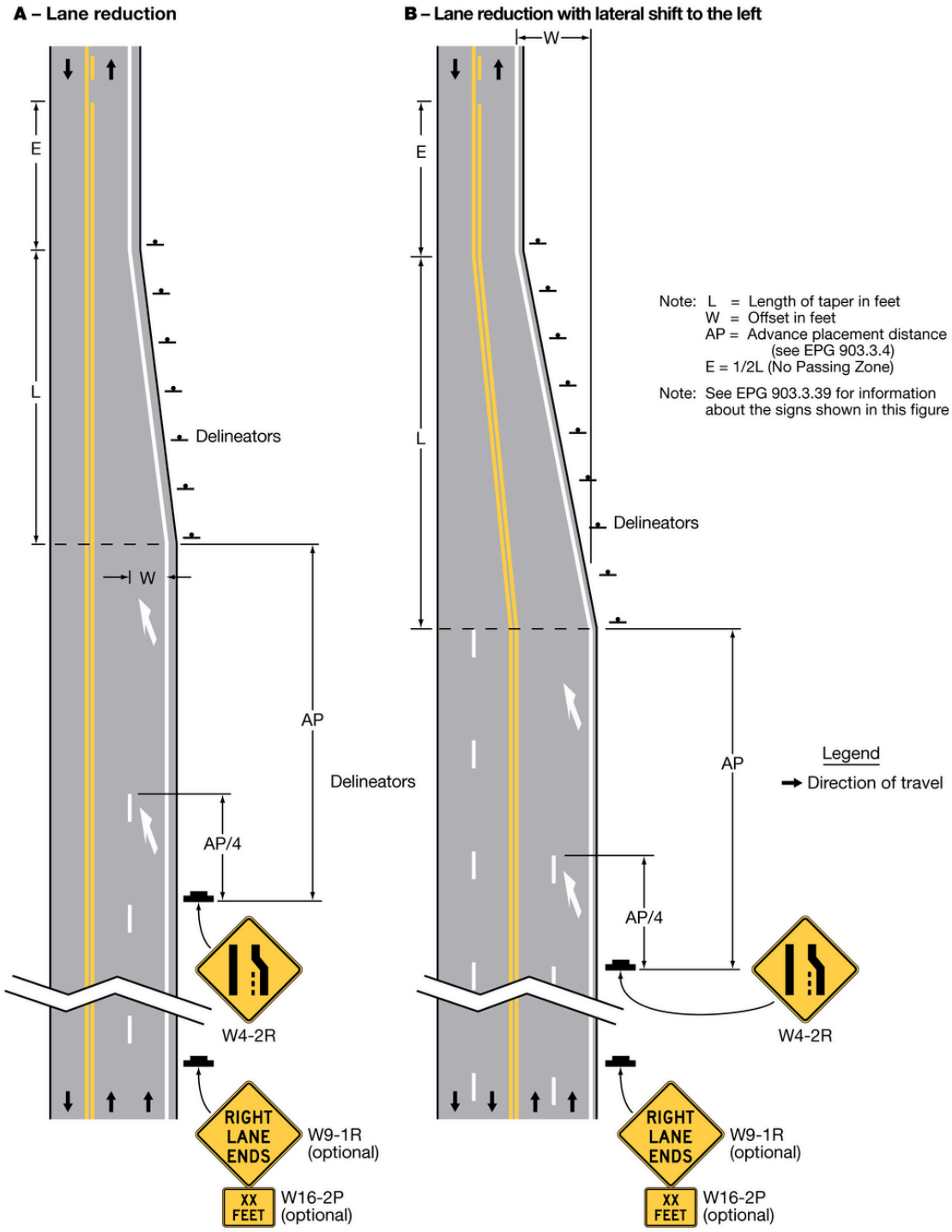


Figure 620.2.14 Examples of Applications of Lane-Reduction Transition Markings

Support. A lane-reduction is where the number of through lanes is reduced at a location that is not at an interchange, ramp, or intersection because of narrowing of the roadway or because of a section of on-street parking in what would otherwise be a through lane.

EPG 620.2.8 contains information on pavement markings for lane drops and splits.

EPG 903.3.39 contains information for warning signing used for lane reductions.

Standard. Lane-reduction transitions (see Figure 620.2.14) shall include the following elements:

A. A no-passing zone (see EPG 620.2.3) to prohibit passing in the direction of the convergence and through the transition area except where not applicable such as one-way streets, expressways, and freeways; and
B. An edge line (see EPG 620.2.10) in the direction of the convergence and through the transition area, except as provided in the first Option paragraph below.

Guidance. Except as provided in the following Option paragraph, the edge line marking should be installed from the location of the Lane Ends warning sign to beyond the beginning of the narrower roadway.

Option. On roadways with operating speeds less than 25 mph where curbs clearly define the roadway edge in the lane-reduction transition, or where a through lane becomes a parking lane, the edge line may be omitted as determined by engineering judgment.

Guidance. Lane-reduction transitions should include the following elements:

A. Delineators installed adjacent to the lane or lanes reduced for the full length of the transition and should be so placed and spaced (see EPG 620.6.4) to show the reduction except as provided in the third Option paragraph below and except as provided in the second paragraph of EPG 620.6.3 for freeways and expressways,
B. Lane-reduction arrow markings (see Drawing H in Figure 620.2.22.1) on the roadway with a speed limit of 45 mph or more, and
C. A termination of the broken (intermittent) white lane line at a point that is ¼ of the advance placement distance (see EPG 903.3.4) between the Lane Ends sign (see EPG 903.3.39) and the point where the transition taper begins.

For roadways having a speed limit of 45 mph or greater, the transition taper length for a lane-reduction transition should be computed by the formula L = WS, where L equals the taper length in feet, W equals the width of the offset distance in feet, and S equals the 85th-percentile speed or the speed limit in mph, whichever is higher. For roadways where the speed limit is less than 45 mph, the formula $L = WS^2/60$ should be used to compute the taper length.

The minimum lane reduction transition taper length should be 100 feet in urban areas and 200 feet in rural areas.

Where observed speeds exceed speed limits, longer tapers should be used.

Option. The minimum taper length may be less than 100 feet on roadways where the operating speed is less than 25 mph.

On new construction, where no speed limit has been established, the design speed may be used in the transition taper length formula.

On low-speed urban roadways where curbs clearly define the roadway edge in the lane-reduction transition, or where a through lane becomes a parking lane, delineators may be omitted as determined by engineering judgment.

Where a lane-reduction transition occurs on a roadway with a speed limit of less than 45 mph, lane-reduction arrow markings may be used.

Lane-reduction arrow markings may be used in long acceleration lanes based on engineering judgment.

620.2.15 Approach Markings for Obstructions (MUTCD Section 3B.13)

Standard. Pavement markings shall be used to guide traffic away from fixed obstructions within a paved roadway. Approach markings for bridge supports, refuge islands, median islands, and raised channelization islands shall consist of a tapered line or lines extending from the center line or the lane line to a point 1 to 2 feet to the right-hand side, or to both sides, of the approach end of the obstruction (see Figure 620.2.15.1 and Figure 620.2.15.2).

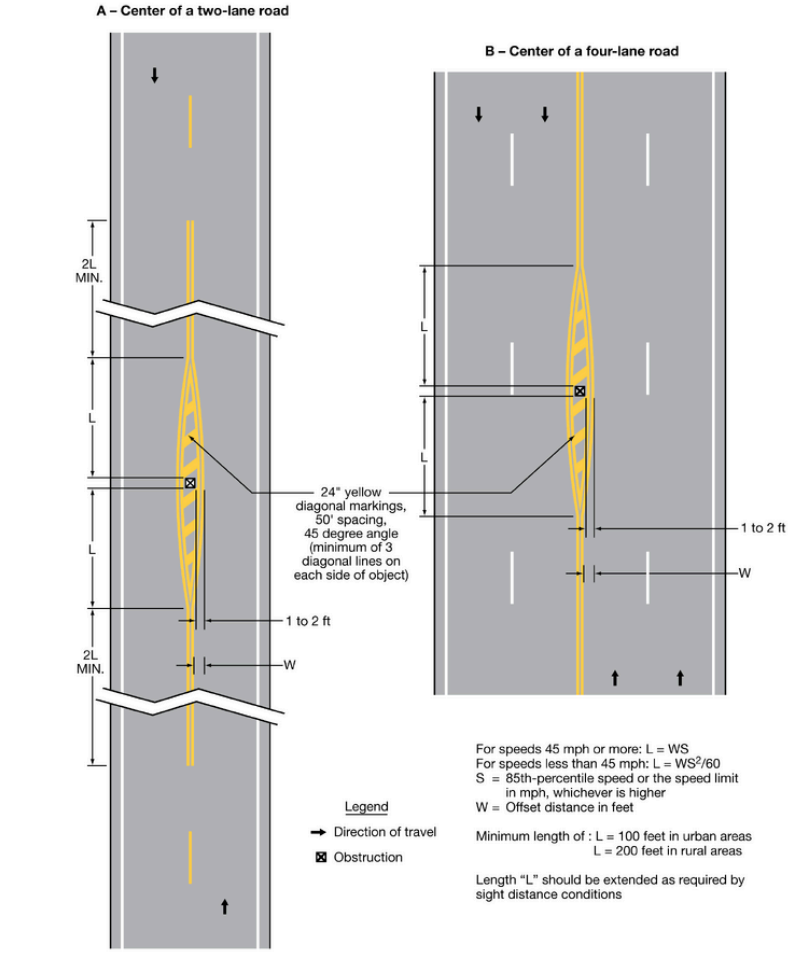


Figure 620.2.15.1 Examples of Applications of Markings for Obstructions in the Roadway
(Sheet 1 of 2)

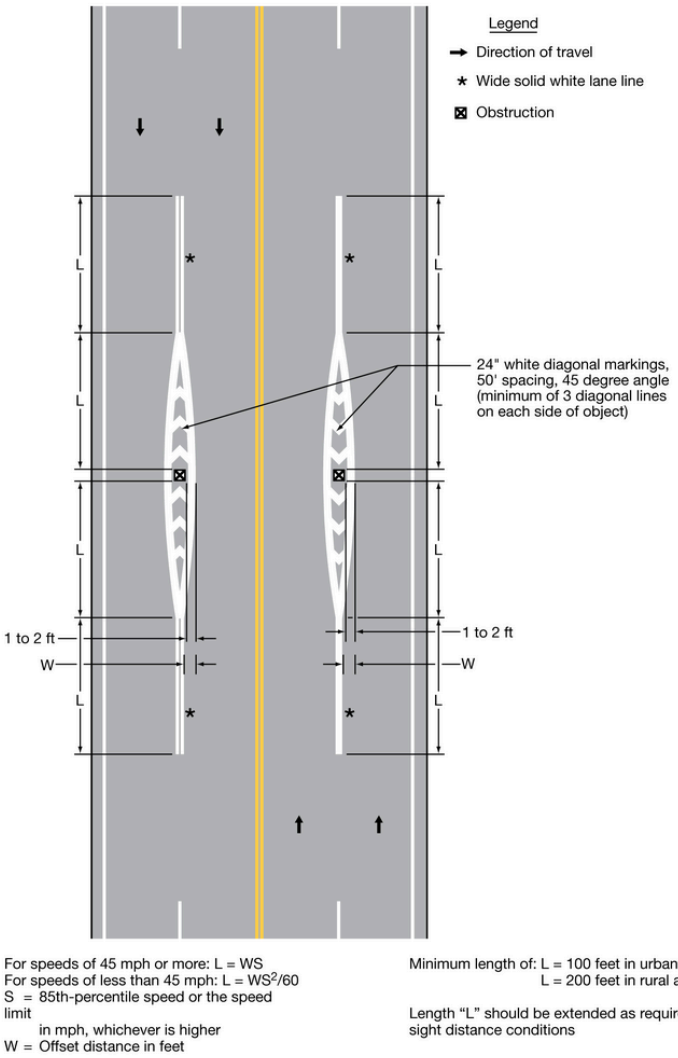


Figure 620.2.15.2 Examples of Applications of Markings for Obstructions in the Roadway
(Sheet 2 of 2)

Guidance. For roadways having a speed limit of 45 mph or greater, the taper length of the tapered line markings should be computed by the formula L = WS, where L equals the taper length in feet, W equals the width of the offset distance in feet, and S equals the 85th-percentile speed or the speed limit, whichever is higher. For roadways where the speed limit is less than 45 mph, the formula $L = WS^2/60$ should be used to compute the taper length.

The minimum taper length should be 100 feet in urban areas and 200 feet in rural areas.

Option. The minimum taper length may be less than 100 feet on roadways where the operating speed is less than 25 mph.

Observed speeds may be used to determine the taper length when the observed speed exceeds the posted or statutory speed limits.

Unique situations may require special markings or warning devices.

Standard. If traffic is required to pass only to the right of the obstruction, the markings shall consist of a two-direction no-passing zone marking at least twice the length of the diagonal portion as determined by the appropriate taper formula (see Drawing A in Figure 620.2.15.1).

Option. If traffic is required to pass only to the right of the obstruction, yellow diagonal markings (see EPG 620.2.24) may be placed in the flush median islands (see EPG 620.9.3) between the no-passing zone markings as shown in Drawings A and B in Figure 620.2.15.1.

Standard. If traffic can pass either to the right or left of the obstruction, the markings shall consist of two channelizing lines diverging from the lane line, one to each side of the obstruction. In advance of the point of divergence, a wide solid white line shall be extended in place of the broken (intermittent) lane line for a distance equal to the length of the diverging lines (see Drawing C in Figure 620.2.15.2).

Option. If traffic can pass either to the right or left of the obstruction, additional white chevron markings (see EPG 620.2.24) may be placed in the flush neutral area between the channelizing lines as shown in Drawing C in Figure 620.2.15.2. Other markings, such as white delineators, white channelizing devices, and white crosswalk markings may also be placed in the flush neutral area.

The obstruction and marking may, if possible, be illuminated by overhead lighting that will adequately light the object without directing glare toward road users approaching from either direction.

Support. EPG 903.3.71 contains information regarding object markers for obstructions within the roadway.

620.2.16 Inlaid Pavement Markers – General (MUTCD Section 3B.14)

Support. MoDOT has utilized a series of various pavement marking systems to enhance wet night visibility over the decades, including snow plowable raised pavement markers, rumble stripe edge lines, grooved in durable markings with wet reflective elements, grooved in waterborne markings with wet elements and the current marking system using an enhanced ASTM Type III glass bead (MoDOT Type L) on all pavement markings on major roads. The MoDOT Type L / high build waterborne pavement marking and edge line rumble stripes are the predominate wet nighttime marking system, with inlaid pavement markers being an optional supplement to this system.



An example of ambient light obscuring pavement markings, but also an example of ILPMs also not working due to the flat grade of the highway not allowing the grooves the ILPMs are installed in to drain, resulting in the markers becoming submerged and rendered ineffective.

Inlaid pavement markers (ILPMs) offer benefits over traditional pavement markings in heavy rain conditions, and in conditions where ambient light creates a sheen on the wet pavement at night making it more difficult to see traditional pavement markings. However, ILPMs are only a supplement to traditional pavement markings, which must be maintained at the highest standards possible. ILPMs only serve as a supplement as they provide no guidance during daylight hours, and pavement markers provide no guidance to the machine vision systems that are being deployed in today's vehicle fleet.

ILPMs can provide a safety benefit during wet-night conditions where they are warranted. However, research indicates ILPMs can have a negative safety impact if applied in areas where they are not warranted, providing too much guidance resulting in drivers overdriving the wet-night conditions. The research found the markers to offer the greatest safety impact in urban areas on divided highways with three or more lanes in one direction and areas where ambient light creates a sheen on the pavement obscuring normal pavement markings. With MoDOT's direction to use rumble stripes for all its major roadways, roads with only two lanes in each direction offer the enhanced edge line guidance to all lanes of traffic compared to a three-lane section where the middle lane has no edge line rumble stripe to reference.

Installations are being limited to the cradle system of ILPMs at this time as they have proven to provide the longest service life compared to other systems which have been evaluated. The reflectors are installed in pairs to provide redundancy and increase the service life of the installation.

ILPMs are not without limitations, these devices are recessed below the pavement surface to protect the reflectors from snowplow damage. On roadway segments with a grade or super elevation in a curve, the grooves the markers are installed in will typically drain keeping the reflectors visible. However, on roadway segments which have a flat grade these grooves can fill up with water covering the reflectors rendering them ineffective in heavier rain events.

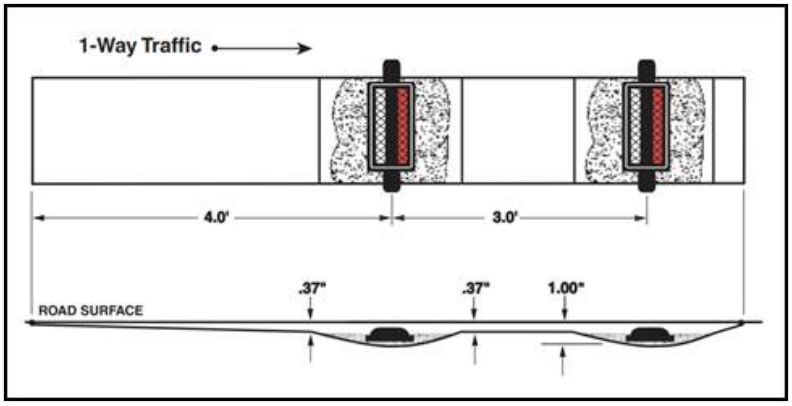
MoDOT's Implementation of ILPMs

Standard. If used, ILPMs shall be installed according to the following conditions:

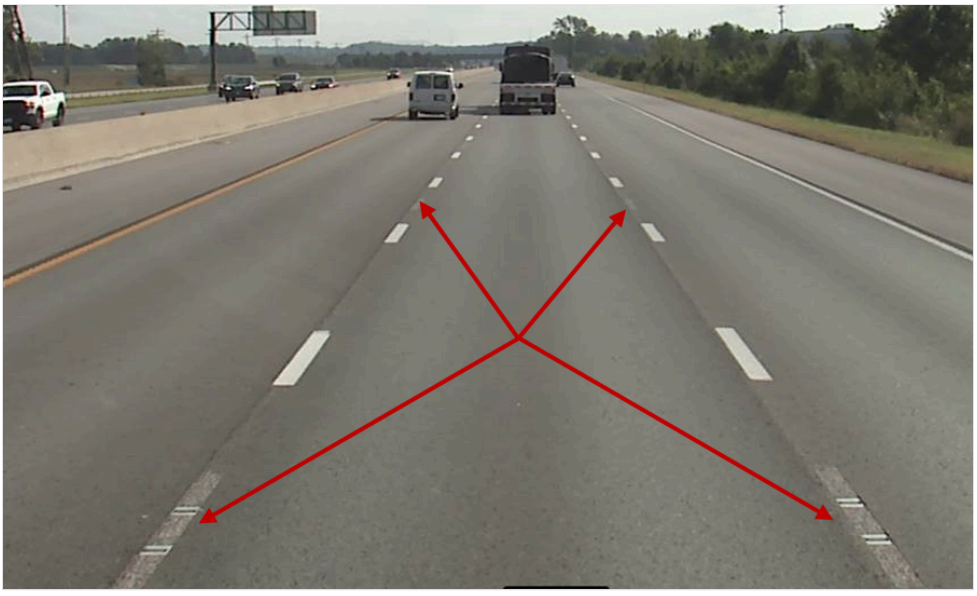
A. ILPMs are limited to freeways with three or more through lanes in one direction.
B. The cradle system of ILPMs shall be the marker style used. ILPMs shall comply with the current approved vendor list.
C. ILPMs shall be installed in pairs, placed in every other gap between the skips of broken (intermittent) lane line markings only when:

1. Installed in accordance with manufactures' installation guidance.
2. Special attention needs to be given to installations on concrete as ILPM installations in concrete have historically had high failure rates. The selected manufacturer must demonstrate they have corrected this issue with an appropriate installation procedure.

D. The ILPMs shall contain a white reflector visible to oncoming traffic and a red reflector on the reverse side of the marker, providing a wrong way deterrent. The color of the ILPMs shall conform to the color of the marking they supplement, under both daylight and nighttime conditions. When used, ILPMs shall require approval from the State Highway Safety and Traffic Engineer.



ILPM installation in pavement groove



Paired ILPM installation and spacing



Newly installed cradle ILPM, cradle tabs still in place which hold the marker at the proper elevation until the epoxy cures



Paired ILPM installation and spacing

Support. ILPMs do have a limited life expectancy, when installed in accordance with the guidance above, the service life is approximately 4 to 5 years or roughly half the life of a typical asphalt overlay. Failure modes can include damage / missing reflector lenses from the cradle, or the loss of the entire reflector installation from the pavement. Loss of the entire marker installation results in a cavity in the pavement which could accelerate pavement deterioration.

Guidance. Maintenance and impacts to pavement should be taken into account when considering the installation of ILPMs. A maintenance program should be implemented to maintain the marker's performance. This maintenance should take place approximately halfway through the asphalt's overlay cycle, assuming an 8 to 10 year cycle.

Support. Concrete installation maintenance requirements can be significantly different due to the service life of a concrete surface. Based on maintenance cycles from other states, this would typically result in maintenance beginning 4 years after the initial installation, a second maintenance cycle 2-3 years later and then annually from that point forward. This cycle accounts for the varying ages of markers that results from the lack of an overlay replacement. The actual maintenance cycle may vary based on inspections. The use of MoDOT's mobile retroreflectivity contract could also be used to measure ILPM performance to determine the maintenance needs.

Option. Maintenance of ILPMs in asphalt may be accomplished in two typical fashions:

A. Install new ILPMs in the gaps between lane lines which did not receive markers initially, allowing the original markers to fade out of service. This is the more efficient and cost effective method, however, milling new markers into a midlife asphalt could accelerating the asphalt joint failure depending on pavement condition.
B. Inspection and replace ILMPs individually in their original locations. This method is more labor intensive and costly; however, it could reduce the risk of accelerated pavement failure by eliminating new milling operations. Reinstalling markers in the cavities left by old, dislodged markers could also help seal and preserve the pavement.

Guidance. When districts consider the use of ILPMs, they should answer the following questions:

A. Does the route in question have a documented wet-night crash history that is tied to visibility and not surface condition to warrant the installation?
B. Will the installations be planned to be maintained or will the initial installation be allowed to fade out of service?
C. If the installation will be allowed to fade out of service, what ramifications would a district expect in terms of failing to meet customer expectations for the presence of the markers and/or increases in wet-night crashes as markers fade away?
D. Will the benefits of installing ILPMs offset the impacts to the pavement and its long term maintenance?



Missing reflector from cradle, new reflector can be reinstalled to maintain



Complete loss of marker installation, these sites need to be patched with asphalt or new markers installed in the same location

620.2.17 Curb Markings for Delineation (MUTCD Section 3B.18)

Option. Barrier curbs on the outside shoulder with a minimum height of 6 inches may be marked for the purpose of delineation.

Guidance. Barrier curbs which are located in the line of traffic flow where the curb serves to channel traffic should be marked, even in cases in which they otherwise would not be marked as indicated in the following paragraph.

Curbs should not be marked in the following cases:

A. Where the posted speed limit is 40 mph or less.
B. Curbs that diverge from the normal traffic flow for commercial and private entrances.
C. Curbs that are mountable (see Standard Plan 609 (https://www.modot.org/media/16880)).

Option. The first 200 ft. of a barrier curb may also be painted in the above cases to mark the beginning of these barriers (See Figure 620.2.17).

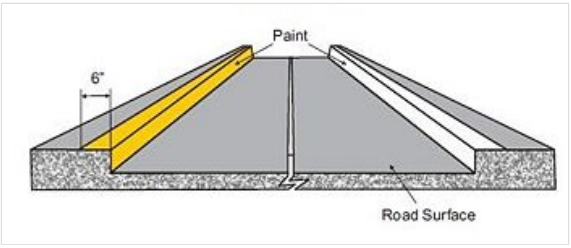


Figure 620.2.17 Painted Curb Marking for Barrier Curbs

Guidance. Since yellow and white curb markings are used for curb delineation and visibility, parking regulations should be established through the installation of standard signs (see EPG 903.2.43 and EPG 903.2.44).

620.2.18 Stop and Yield Lines (MUTCD Section 3B.19)

Option. Stop lines may be used to indicate the point behind which vehicles are required to stop in compliance with a STOP (R1-1) sign or some other traffic control device that requires vehicles to stop, except YIELD signs that are not associated with passive grade crossings.

Standard. Stop lines shall consist of solid white lines extending across approach lanes to indicate the point at which the stop is intended or required to be made.

Except as provided in EPG 913.3.3, stop lines shall not be used at locations where drivers are required to yield in compliance with a YIELD (R1-2) sign, a Yield Here to Pedestrians (R1-5) sign, a Yield Here to School Crossings (R1-5a) sign, a Yield Here to Trail Crossings (R1-5d) sign, or at locations on uncontrolled approaches where drivers or bicyclists are required by State law to yield to pedestrians.

Guidance. Stop lines should be used to indicate the point behind which vehicles are required to stop in compliance with a traffic control signal (see EPG 902.4.8).

Standard. Stop lines shall be 24 inches wide.

Option. Stop lines may be omitted at ramp control signals.

Support. EPG 902.10.2 contains information regarding the use and application of stop lines in conjunction with a pedestrian hybrid beacon.

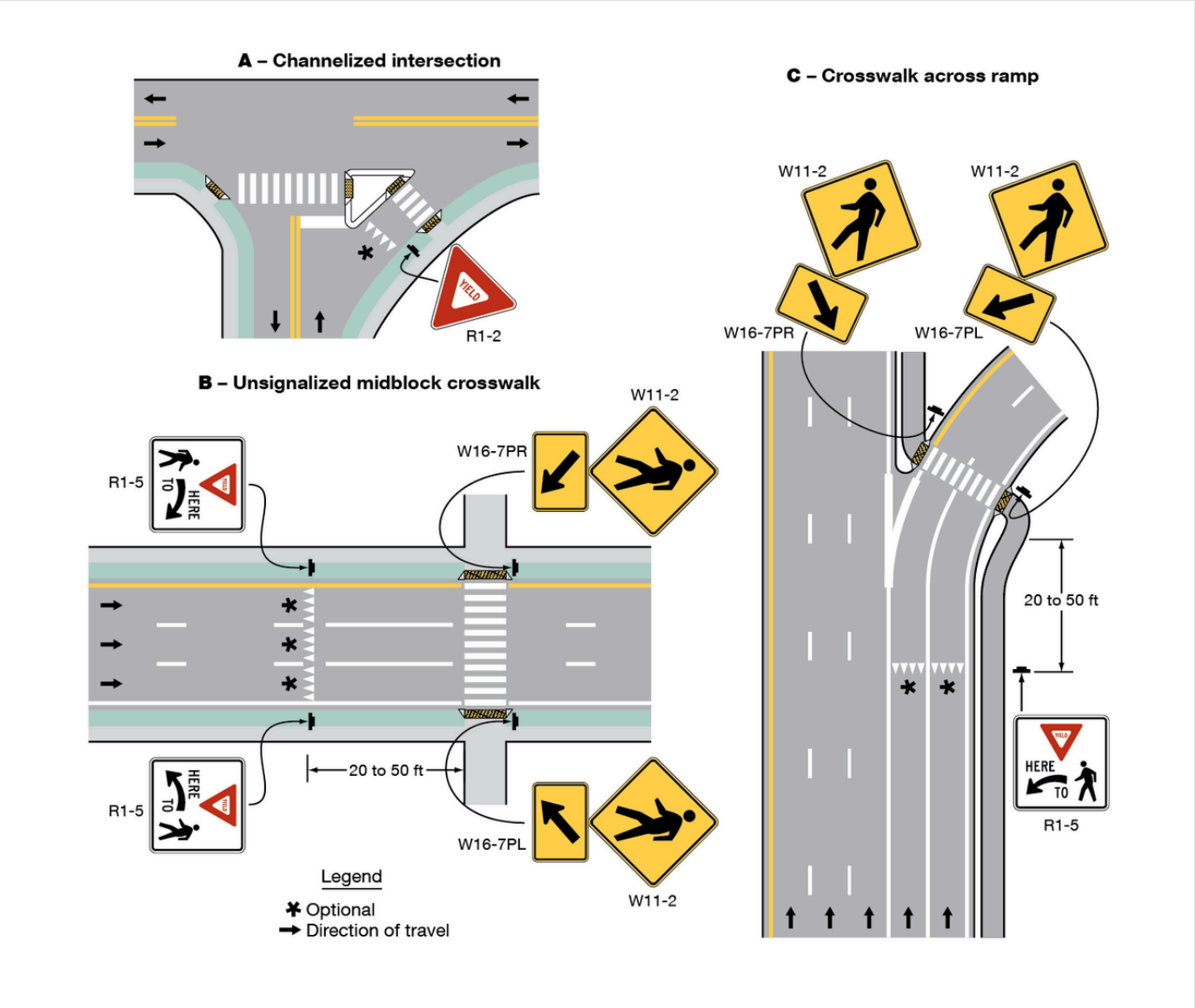


Figure 620.2.18 Examples of Yield Line Applications

Standard. If used, a yield line pavement marking shall not be installed without a Yield (R1-2) sign, a Yield Here to Pedestrians (R1-5) sign, a Yield Here to School Crossings (R1-5a) sign, a Yield Here to Trail Crossings (R1-5d) sign, or some other traffic control device that requires vehicles to yield (see Figure 620.2.18).

Yield lines shall not be used at locations where drivers are required to stop in compliance with a STOP (R1-1) sign, a traffic control signal, or some other traffic control device.

Yield lines shall consist of a row of solid white isosceles triangles pointing toward approaching vehicles extending across approach lanes to indicate the point at which the yield is intended or required to be made.

The individual triangles comprising the yield line shall have a base of 24 inches wide and a height of 36 inches. The space between the triangles shall be 8 to 12 inches. The spacing of triangles in a yield line shall be consistent for that marking. See Standard Plan 620 (https://www.modot.org/media/16896).

Option. Yield lines may be considered for those locations where a channelized right turn lane is developed but there is not an acceleration lane on the intersecting road.

Yield lines may also be used where engineering judgment indicates a need.

Guidance. If used, stop and yield lines should be placed a minimum of 4 feet in advance of the nearest crosswalk line at controlled intersections, except for yield lines at roundabouts as provided for in EPG 620.4.4 and at midblock crosswalks. Stop lines can be adjusted using engineering judgement to accommodate pedestrian facilities or improve safety, but the stop line in the lane closest to the right-hand edge of the roadway should be placed a maximum of 10 feet in advance of the nearest crosswalk. In the absence of a marked crosswalk, the stop line or yield line should be placed at the desired stopping or yielding point, but should not be placed more than 30 feet or less than 4 feet from the nearest edge of the intersecting traveled way.

Stop lines should be placed to allow sufficient sight distance to all other approaches to an intersection.

When a stop line is used in conjunction with the STOP sign it should be placed adjacent to, or in line with, the STOP sign.

When a yield line is used in conjunction with the YIELD sign it should be placed adjacent to, or in line with, the YIELD sign.

Standard. If yield lines are used at a crosswalk that crosses an uncontrolled multi-lane approach, Yield Here to Pedestrians (R1-5 series) signs (see EPG 903.2.18) shall be used.

Guidance. If yield lines are used at a crosswalk that crosses an uncontrolled multi-lane approach, the yield line should be placed 20 to 50 feet in advance of the nearest crosswalk line (see Drawing B in Figure 620.2.18).

If yield lines are used in advance of a crosswalk that crosses an uncontrolled multi-lane approach, parking should be prohibited in the area between the yield line and the crosswalk.

Guidance. Yield lines and Yield Here to Pedestrians signs should not be used in advance of crosswalks that cross an approach to or departure from a circular intersection.

Support. EPG 913.3.3 contains information regarding the use of stop lines and yield lines at grade crossings.

Option. Stop and yield lines may be staggered longitudinally on a lane-by-lane basis (see Drawing D in Figure 620.2.13.2).

Support. Staggered stop lines and staggered yield lines can improve the driver's view of pedestrians, provide better sight distance for turning vehicles, and increase the turning radius for left-turning vehicles.

620.2.19 Word, Symbol, and Arrow Pavement Markings – General (MUTCD Section 3B.20)

Support. Word, symbol, and arrow markings on the pavement are used for the purpose of regulating, warning, or guiding traffic. These pavement markings can be helpful to road users in some locations by supplementing signs and providing additional emphasis for important regulatory, warning, or guidance messages, because the markings do not require diversion of the road user's attention from the roadway surface. Symbol messages are preferable to word messages. Examples of standard word and arrow pavement markings are shown in Figure 620.2.20 and Figure 620.2.22.1, respectively. See Standard Plan 620 (https://www.modot.org/media/16896).

Option. Word, symbol, and arrow pavement markings may be used as determined by engineering judgment to supplement signs and/or to provide additional emphasis for regulatory, warning, or guidance messages provided by other devices.

Support. EPG 913.3.4 contains information for arrow pavement markings in the vicinity of grade crossings.

Standard. Word, symbol, and arrow markings shall be white and retroreflective, except as otherwise provided in EPG 620.2.19.

Option. Black contrast markings may be used in combination with white pavement markings on light-colored pavements, such as concrete, to enhance visibility.

Standard. Pavement marking letters, numerals, symbols, and arrows shall be installed in accordance with the design details in the Pavement Markings chapter of the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)).

Guidance. Word, symbol, and/or arrow markings that are grouped together to formulate one interrelated message should not exceed three lines of information.

Except for the two opposing white arrows of a two-way left-turn lane marking (see Figure 620.2.2), the longitudinal space between word, symbol, and/or arrow markings that are used together to formulate one interrelated message should be four times the height of the characters.

When conveying mandatory messages, these markings should only be used as supplementary devices to the standard signs.

Pavement word, symbol, and arrow markings should be no more than one lane in width.

Pavement word, symbol, and arrow markings should be proportionally scaled to fit within the width of the facility upon which they are applied.

Option. On narrow, low-speed shared-use paths, the pavement words, symbols, and arrows may be smaller than suggested, but to the relative scale.

620.2.20 Word Pavement Markings (MUTCD Section 3B.21)

Guidance. Letters and numerals should be 6 feet or more in height, except as provided in EPG 914.5.1 for the BIKE LANE word pavement marking.

The spacing between pavement word and symbol markings is approximate and should be adjusted as field conditions warrant.

If a pavement marking word message consists of more than one line of information, it should read in the direction of travel. The first word of the message should be nearest to the road user.

Standard. The word STOP shall not be placed on the pavement in advance of a stop line, unless every vehicle is required to stop at all times.

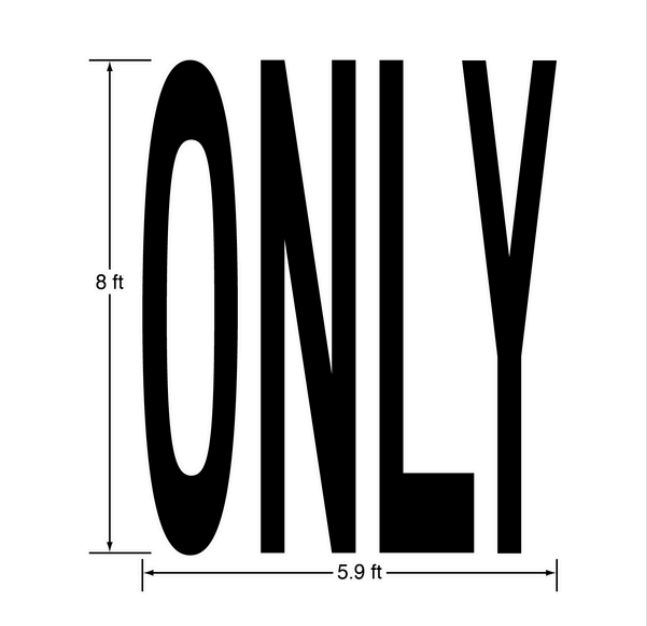


Figure 620.2.20 Example ONLY word pavement marking

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Guidance. Where through lanes approaching an intersection become mandatory turn lanes, ONLY word pavement markings (see Figure 620.2.20) should be used in addition to signs (see EPG 903.2.25 and 903.2.26) and the required lane-use arrow markings (see EPG 620.2.22).

Option. The ONLY word marking may be used to supplement the lane-use arrow markings in lanes that are designated for the exclusive use of a single movement such as turn bays.

The ONLY word marking may be used to supplement a preferential lane word or symbol marking (see EPG 620.5.3).

Standard. The ONLY word marking shall not be used in a lane that is shared by more than one movement.

620.2.21 Symbol Pavement Markings (MUTCD Section 3B.22)

Support. EPG 914.5 contains information on symbol markings that can be used for bicycle lanes.

Option. Pavement markings simulating Interstate, U.S., State, and other official highway route signs with appropriate route numbers, but elongated for proper proportioning when viewed as a marking, may be used to guide road users to their destinations (see Figure 620.2.21.1).

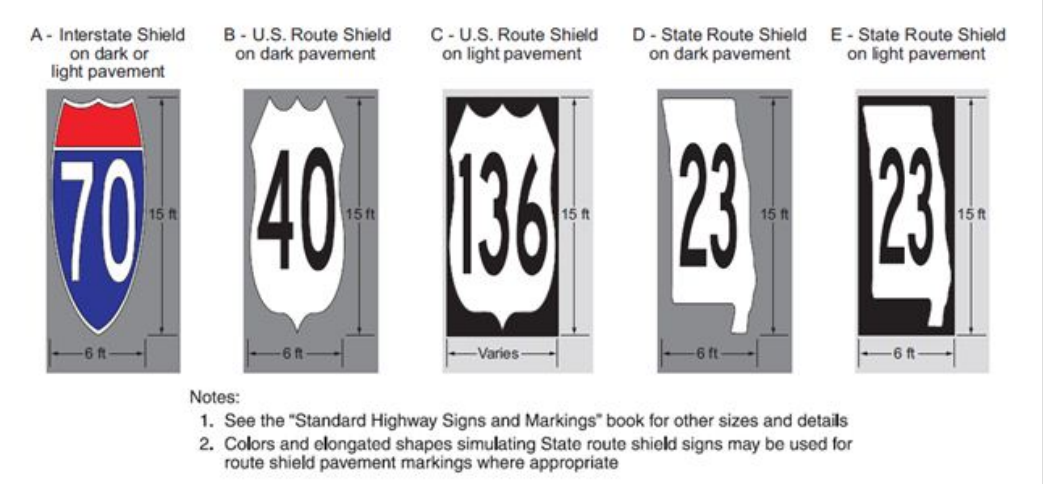


Figure 620.2.21.1 Elongated Route Shields



Figure 620.2.21.2 International Symbol of Accessibility Parking Space Marker

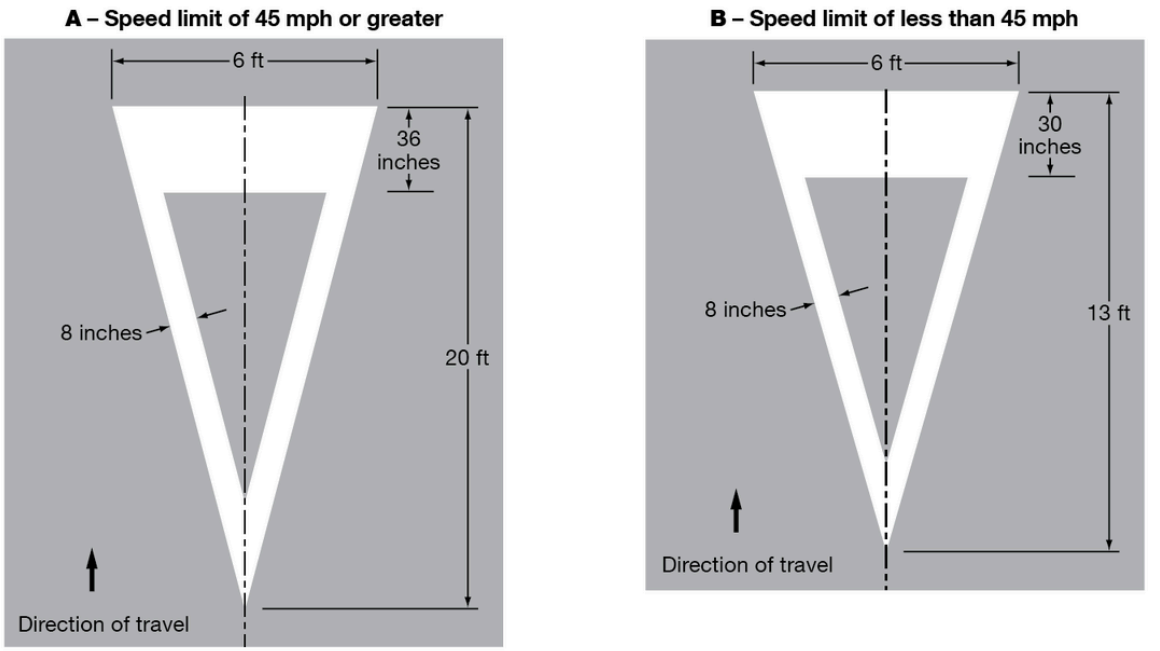


Figure 620.2.21.3 Yield Ahead Triangle Symbols

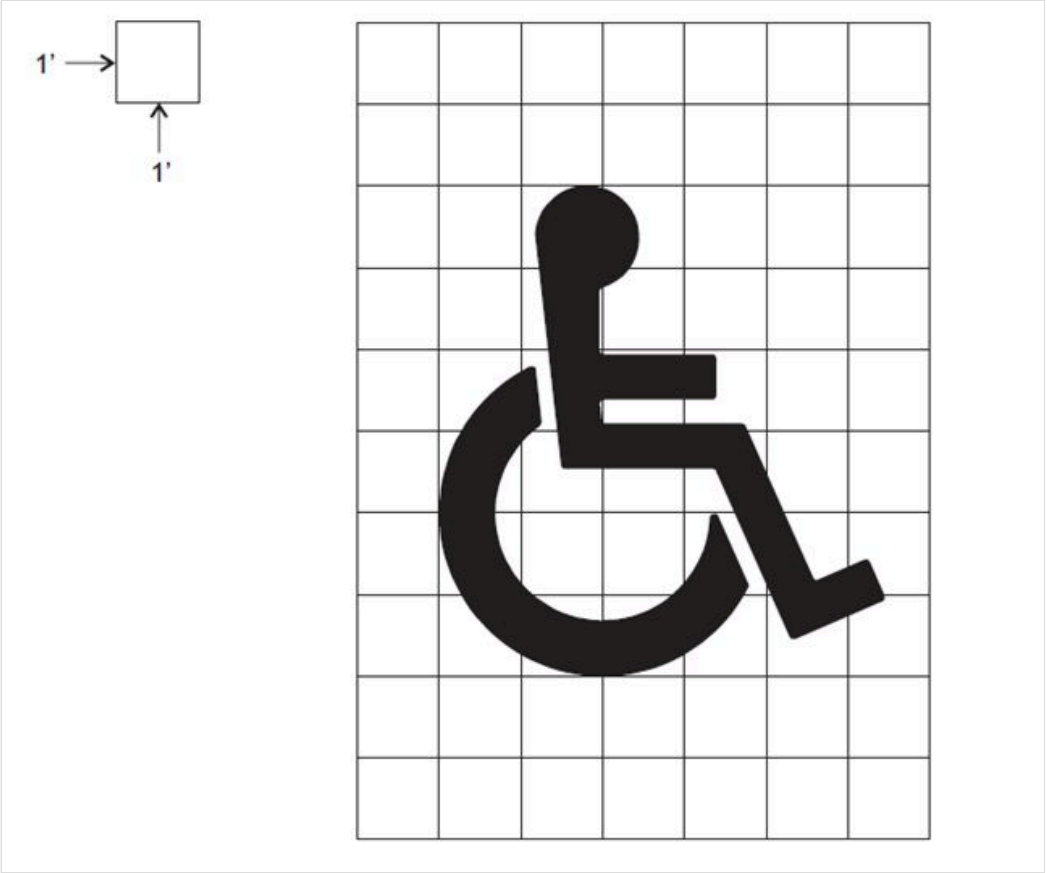


Figure 620.2.21.4 Disabled Symbol Detail

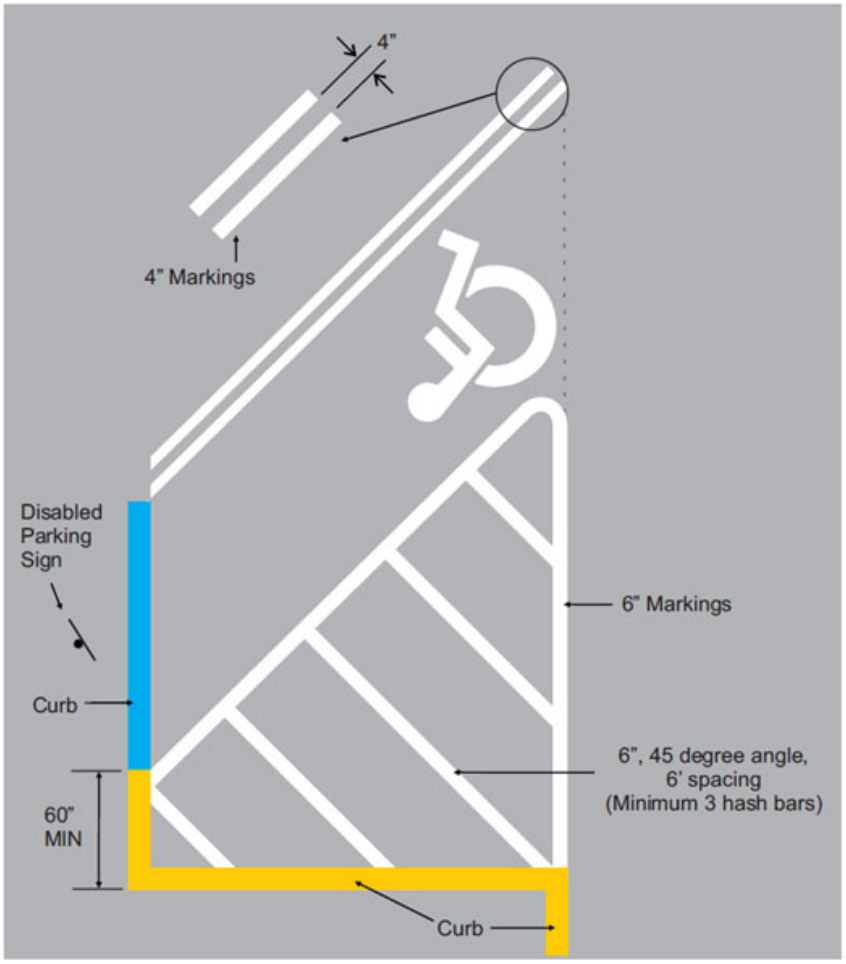


Figure 620.2.21.5 Disabled Parking Area

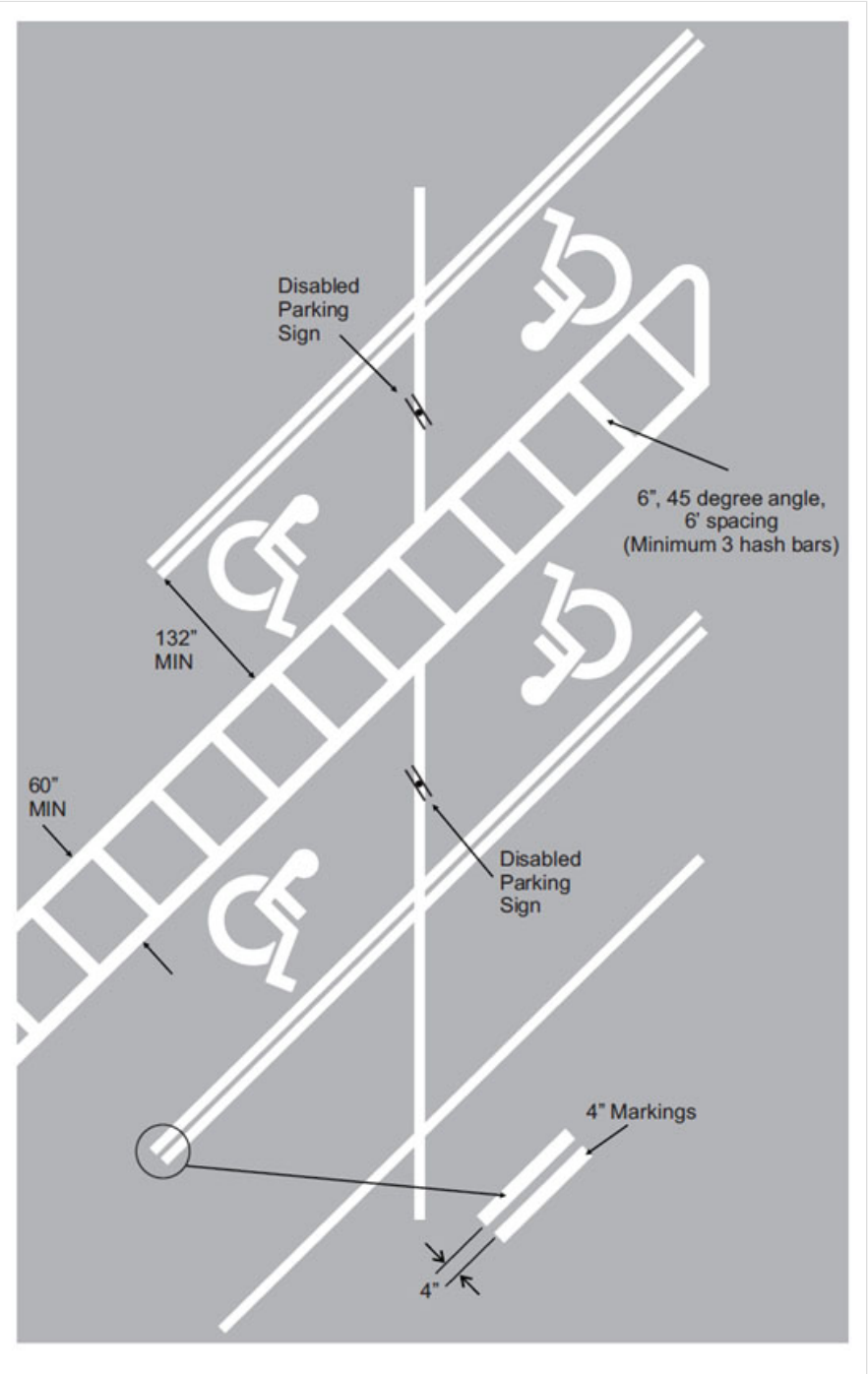


Figure 620.2.21.6 Disabled Parking Area Multiple

Guidance. If route sign markings are provided to guide road users, those route sign markings should be provided in option lanes if markings are provided in any lanes.

If two route sign markings are provided in an option lane, they should be placed in sequence and not divided around an optional lane arrow.

Support. EPG 620.1.3 provides information on route sign colors.

Guidance. The International Symbol of Accessibility parking space marking (see Figure 620.2.21.2) should be placed in each parking space designated for use by persons with disabilities.

Option. A blue background with white border may supplement the wheelchair symbol as shown in Figure 620.2.21.2.

A yield-ahead triangle symbol or YIELD AHEAD word pavement marking may be used on approaches to intersections where the approaching traffic will encounter a YIELD sign at the intersection.

Standard. The yield-ahead triangle symbol or YIELD AHEAD word pavement marking shall not be used unless a YIELD sign (see EPG 903.2.5) is in place at the intersection. The yield-ahead triangle symbol marking shall be as shown in Figure 620.2.21.3.

Option. A pedestrian symbol pavement marking may be used on portions of facilities that are reserved exclusively for pedestrian use, such as where a shared-use path transitions to become separate facilities for different types of users.

620.2.22 Lane-Use Arrows (MUTCD Section 3B.23)

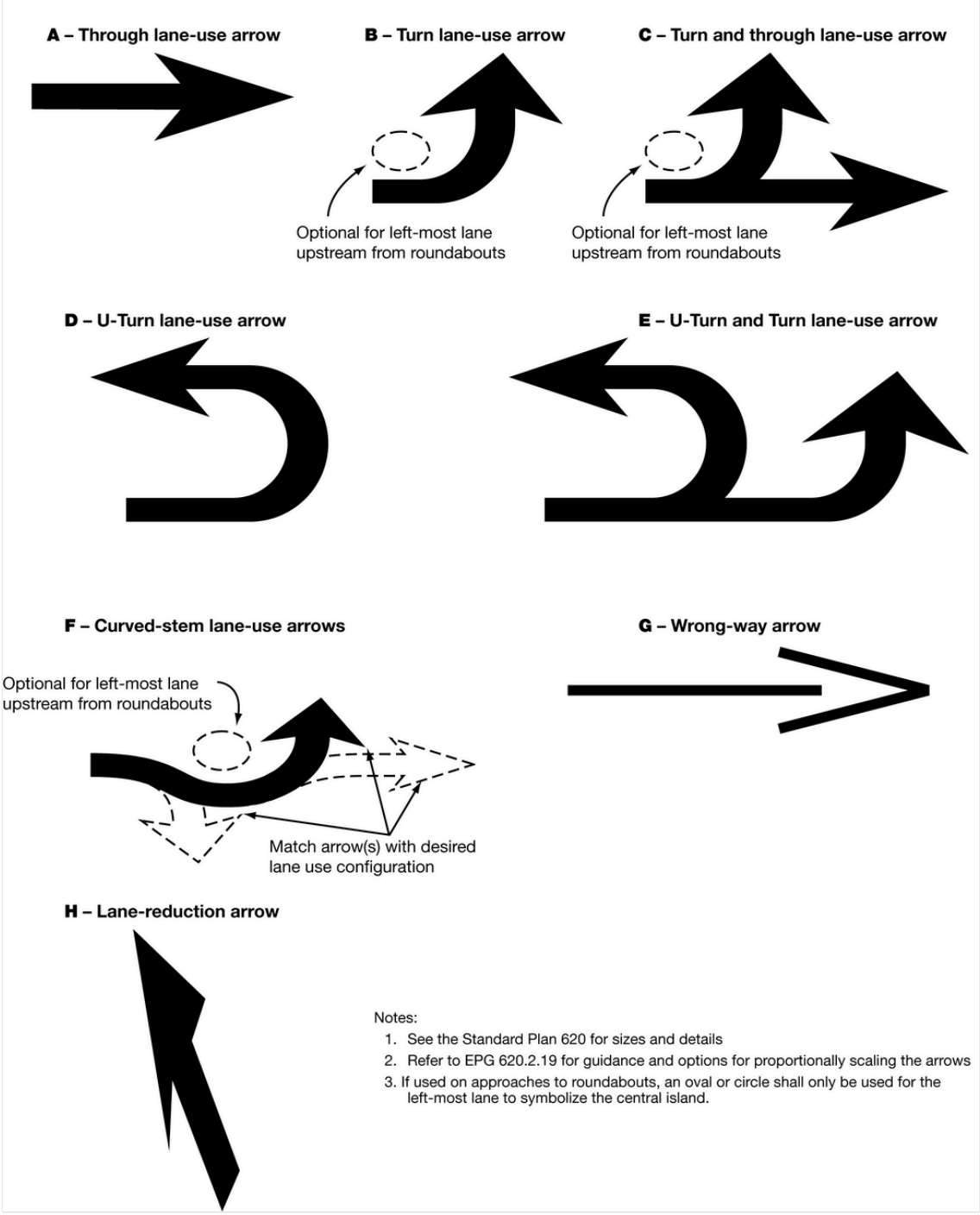


Figure 620.2.22.1 Examples of Arrows for Pavement Markings

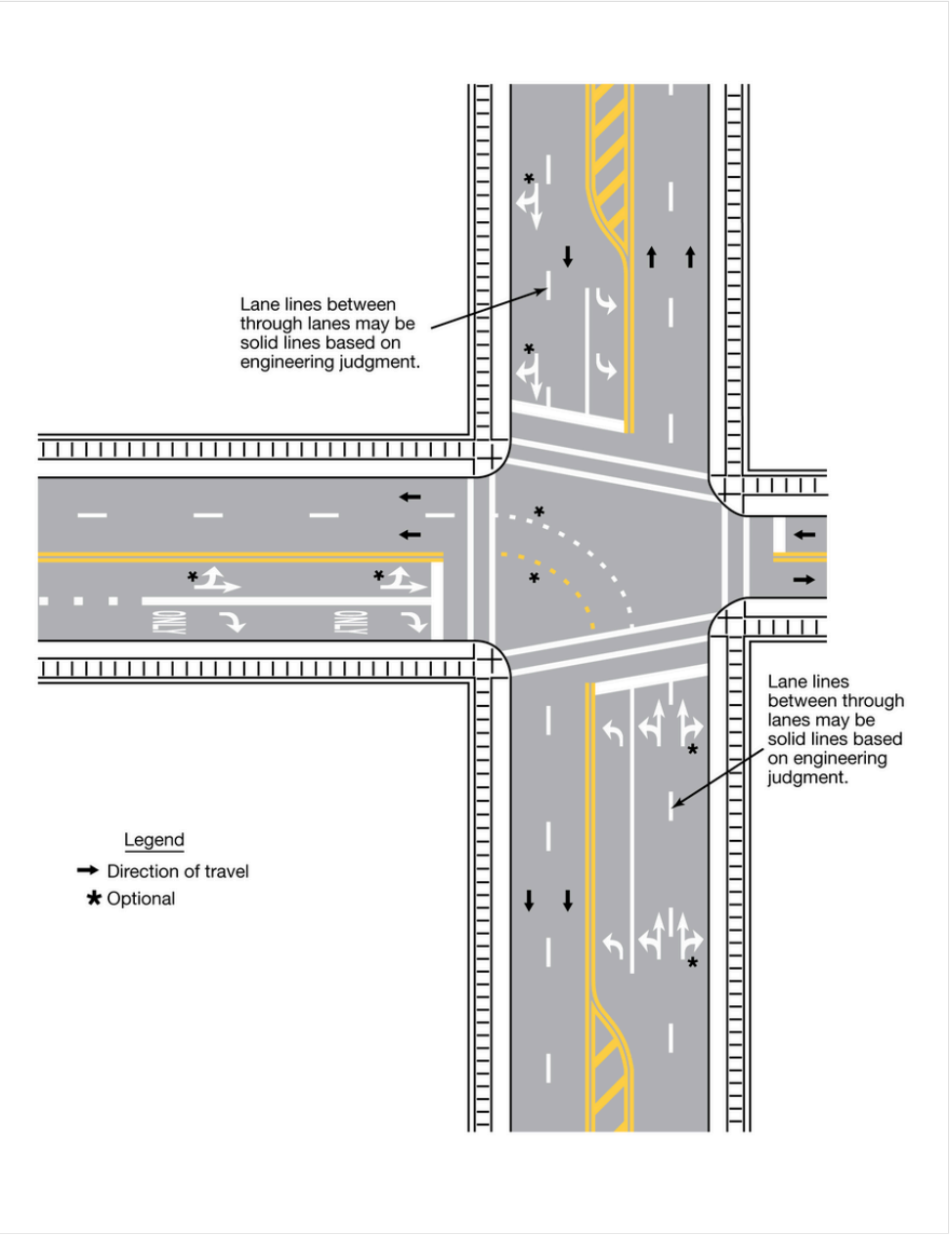


Figure 620.2.22.2 Examples of Lane-Use Control Word and Arrow Pavement Markings

Support. Lane-use arrow markings (see Figure 620.2.22.1) are used to indicate the mandatory or permissible movements in certain lanes (see Figure 620.2.22.2) and in two-way left-turn lanes (see Figure 620.2.20).

EPG 913.3.4 contains information about the placement of lane-use arrow markings in the vicinity of grade crossings.

Guidance. Lane-use arrow markings should be used in lanes and turn bays designated for the exclusive use of a turning movement, except where engineering judgment determines that physical conditions or other markings (such as a dotted extension of the lane line through the taper into the turn bay) clearly discourage unintentional use of a turn bay by through vehicles. Lane-use arrow markings should also be used in lanes from which movements are allowed that are contrary to the normal rules of the road (see Drawing B in Figure 620.2.13.1).

The placement of arrows in channelizing lanes should be determined by the length of the lane and the following criteria (see Figure 620.2.22.3):

A. The first arrow should be placed 75 ft. in advance of the stop line.
B. The second arrow should be placed 200 ft. in advance of the stop line.
C. Any additional arrows should be placed in 200 ft. increments.

The distances between arrows may be adjusted if there are special circumstances that warrant the change.

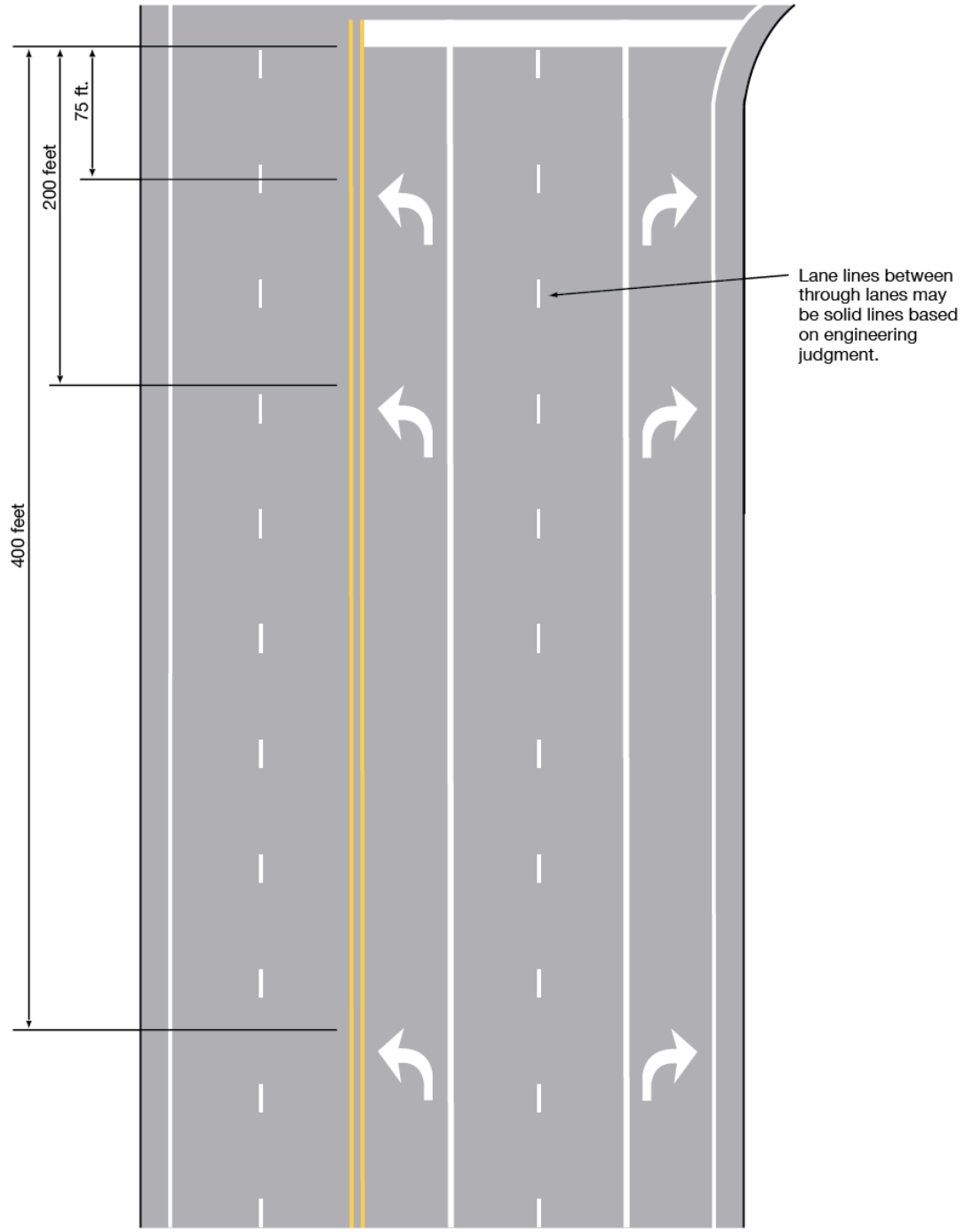


Figure 620.2.22.3 Spacing of Arrow in Left-Turn and Right-Turn Lanes

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Support. An arrow at the downstream end of a turn lane can help to prevent wrong-way movements.

Standard. Where through lanes approaching an intersection become mandatory turn lanes, turn lane-use arrow markings (see Drawing A in Figure 620.2.8.10 and Figure 620.2.22.1) shall be used and shall be accompanied by standard signs (see EPG 903.2.33) and the required ONLY word pavement markings (see EPG 620.2.20).

If used, the ONLY word pavement marking shall be placed in advance of each lane-use arrow for mandatory turn lanes or in advance of a preferential lane word or symbol marking.

Guidance. Where through lanes approaching an intersection become mandatory turn lanes, the required ONLY word markings (see Figure 620.2.20), signs (see EPG 903.2.25 and 903.2.26), and turn lane-use arrow markings should be placed well in advance of the turn and should be repeated as necessary to provide the through motorist advance notification to vacate the lane prior to reaching a point where roadway geometrics or a queue of waiting vehicles forces the motorist to make an unintended turn.

Spacing between the arrow and the ONLY should be four times the height of the ONLY. The use of ONLY should not apply to exit ramps.

Option. On freeways or expressways where a through lane becomes a mandatory exit lane, lane-use arrow markings may be used on the approach to the exit in the dropped lane and in an adjacent optional through-or-exit lane if one exists.

Guidance. The use of straight arrows should be reserved for special cases, such as, locations where crashes have occurred as a result of vehicles making turns from the through lanes.

620.2.23 Wrong-Way Arrows (MUTCD Section 3B.24)

Guidance. Where crossroad channelization or ramp geometrics do not make wrong-way movements difficult, the appropriate lane-use arrow should be placed in each lane of an exit ramp near the crossroad terminal where it will be clearly visible to a potential wrong-way road user (see Figure 903.2.39.1).

Option. The wrong-way arrow markings shown in Drawing G in Figure 620.2.22.1 may be placed near the downstream terminus of a ramp as shown in Figure 903.2.39.1, or at other locations where lane-use arrows are not appropriate, to indicate the correct direction of traffic flow and to discourage drivers from traveling in the wrong direction.

Directional pavement arrows may be used as a substitute for the wrong-way arrows when wrong-way arrows are required.

A maximum of two wrong-way arrows may be provided on a ramp, the placement of the second arrow is dependent upon the design and length of the ramp. Exit ramps that do not contain islands at the intersection of the exit ramp and the crossroad may receive one wrong-way pavement arrow at the top of the ramp. Ramps constructed with islands at the intersection of the exit ramp and the crossroad may receive two wrong-way arrows at the top of the ramp, one arrow on each side of the island.

Wrong-way pavement arrows may be placed on one way outer roads to further indicate the proper direction to travel.

Standard. In the case of two lane ramps where wrong-way pavement arrows are used, one arrow shall be provided for each lane.

Guidance. If used, the point of the wrong-way arrow should be located a distance of 25 ft. from the end of the ramp and the intersecting crossroad. When wrong-way arrows are used on one-way outer roads, the arrows should be installed 25 ft. in advance of the point where the edge of the crossroad and the outer road meet. Where a stop line has been provided, the arrow should be placed 25 ft. in advance of this marking.

On ramps where directional pavement arrows have been provided to aid the motorist in proper lane usage, the wrong-way pavement arrows should not be used.

620.2.24 Chevron and Diagonal Markings (MUTCD Section 3B.25)

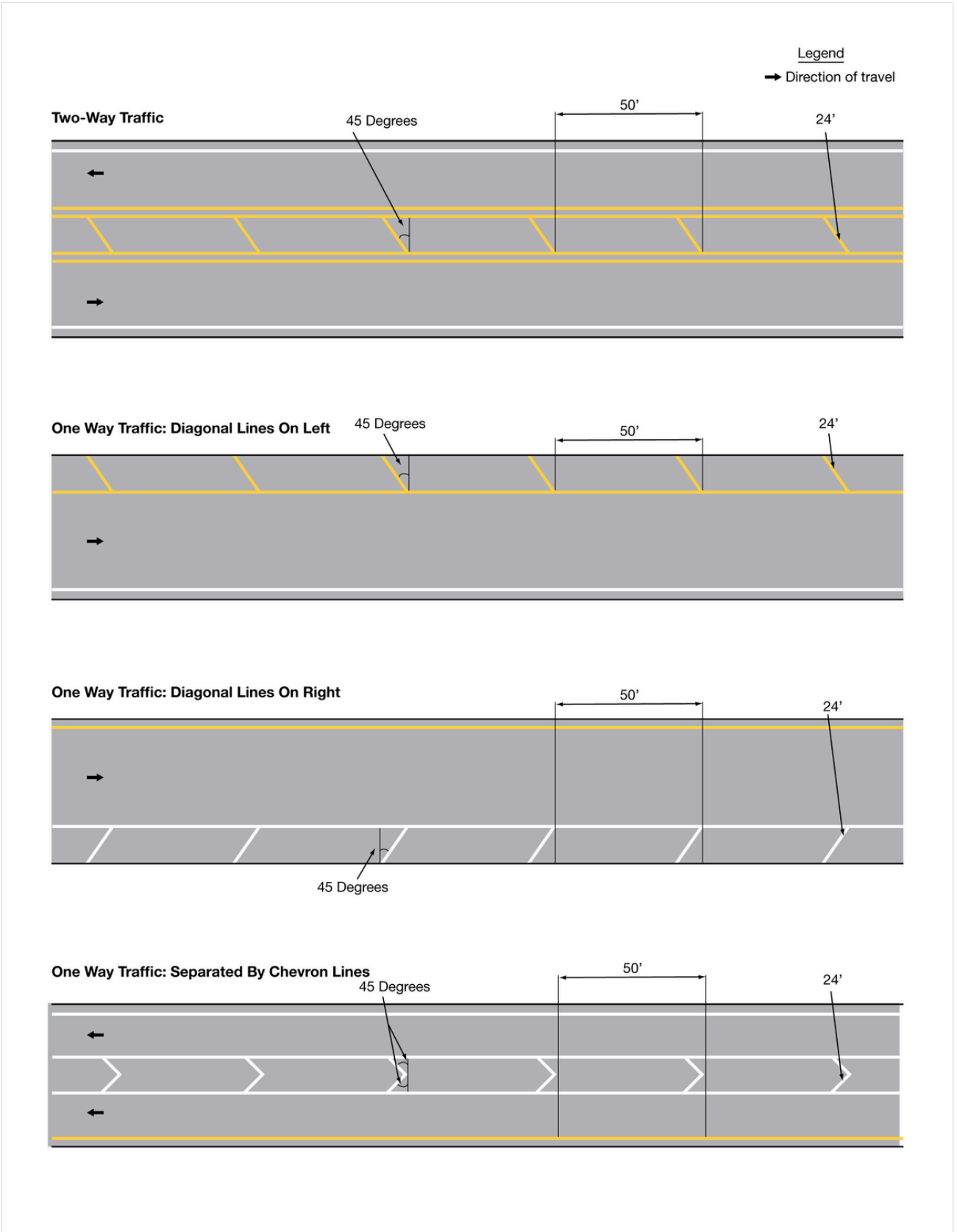


Figure 620.2.24 Typical Chevron and Diagonal Markings

Support. Chevron or diagonal markings are used to discourage travel on certain paved areas, such as shoulders, neutral areas, and flush median islands.

Guidance. Chevrons should be installed in the neutral area of gores when the following conditions are present:

A. A gore length of 250 ft or greater; and

B. Exit lanes depart from through lanes at a low angle leaving a long distance between the theoretical and physical gore (See Drawing B in Figure 620.2.8.1).

Chevrons installed in the neutral area of gores should include a minimum of 3 chevron lines with 50 ft spacing consistent with the note on sheet 1 of Standard Plan 620 (https://www.modot.org/media/16896#page=1).

Chevrons should not be used when there is less than 6 feet of distance between channelizing lines to avoid markings that are not identifiable as a chevron.

Option. Chevron and diagonal markings may be used:

A. On approaches to obstructions in the roadway (see Figure 620.2.15.2),
B. For channelized travel paths on approaches to intersections,
C. In buffer spaces between preferential lanes and general-purpose lanes (see Drawing A in Figure 620.5.2.2), and
D. In the neutral areas of islands.

Support. EPG 912 (MUTCD Section 5B.02) contains information on chevron markings for driving automation system considerations.

Standard. Chevron markings shall be white, with the point of each chevron facing toward approaching traffic, as shown in Figures 620.2.8.1 through 620.2.8.3, Figures 620.2.8.4 through 6202.8.3.6, and Drawing C in Figure 620.2.15.2.

Option. Diagonal markings for opposing directions of traffic may be used:

A. On approaches to obstructions in the roadway (see Drawings A and B in Figure 620.2.15.1),
B. In flush median islands between double solid yellow center line markings (see Figure 620.2.3.3), and
C. In buffer spaces between preferential lanes and general-purpose lanes (see Drawing D in Figure 620.5.2.5).

Diagonal markings may be used on paved shoulders or in no-parking zones, or other locations for special emphasis.

Standard. When diagonal markings are used between opposing directions of traffic or on the left shoulder of a one-way or divided roadway, they shall be yellow and slant away from traffic in the adjacent travel lanes, as shown in Figure 620.2.1.2 and Figure 620.2.3.3, and Drawings A and B in Figure 620.2.15.1.

When diagonal markings are used on the right shoulder or in no-parking zones (see Figure 620.2.26), they shall be white and slant away from traffic in the adjacent travel lane.

Except as provided in the second Option paragraph below, chevrons and diagonal markings shall be 24 inches. The longitudinal spacing of the chevrons or diagonal lines shall be 50 feet, with a minimum of three chevron or diagonal markings being used per application. The chevrons and diagonal lines shall form an angle of approximately 45 degrees with the longitudinal lines that they intersect.

Option. If there is insufficient space to install a minimum of three chevron or diagonal markings at 50 foot longitudinal spacing, the longitudinal spacing may be reduced.

Diagonal markings used in no-parking zones or on roadways with operating speeds of less than 25 mph may be 4 inches wide (see Figure 620.2.26).

620.2.25 Do Not Block Intersection Markings (MUTCD Section 3B.26)

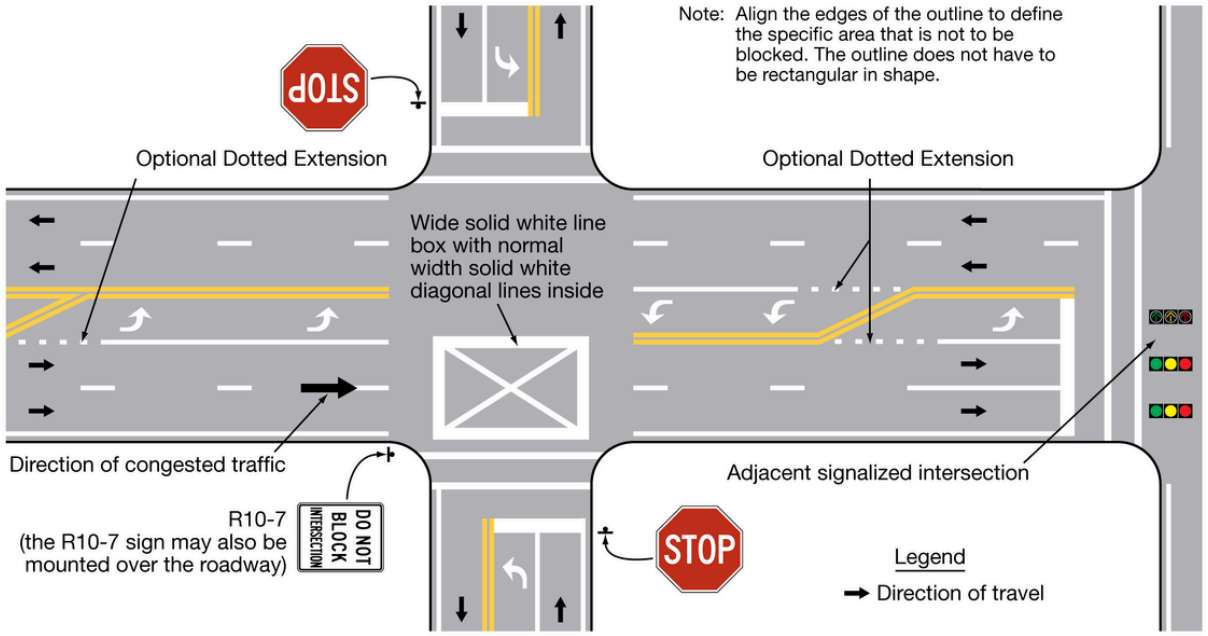


Figure 620.2.25 Do Not Block Intersection Markings

Option. Do Not Block Intersection markings may be used to mark the edges of an intersection area that is in close proximity to a signalized intersection, railroad crossing, or other nearby traffic control that might cause vehicles to stop within the intersection and impede other traffic entering the intersection. If authorized by law, Do Not Block Intersection markings with appropriate signs may also be used at other locations.

Standard. If used, Do Not Block Intersection markings (see Figure 620.2.25) shall consist of wide solid white lines 8 to 12 inches wide that outline the intersection area that vehicles must not block and white cross-hatching 4 in. to 6 in. wide within the intersection area.

Do Not Block Intersection markings shall be accompanied by one or more DO NOT BLOCK INTERSECTION (DRIVEWAY) (CROSSING) (R10-7) signs (see EPG 903.2.48), one or more Do Not Stop On Tracks (R8-8) signs (see EPG 913.2.7), or one or more similar signs.

620.2.26 Parking Space Markings (MUTCD Section 3B.27)

Standard. On-street parking space markings shall be white.

Support. Examples of on-street parking space markings are shown in Figure 620.2.26.

Support. Additional parking space markings for the purpose of designating spaces for use only by persons with disabilities are discussed in EPG 620.2.21 and illustrated in Figure 620.2.21.2.

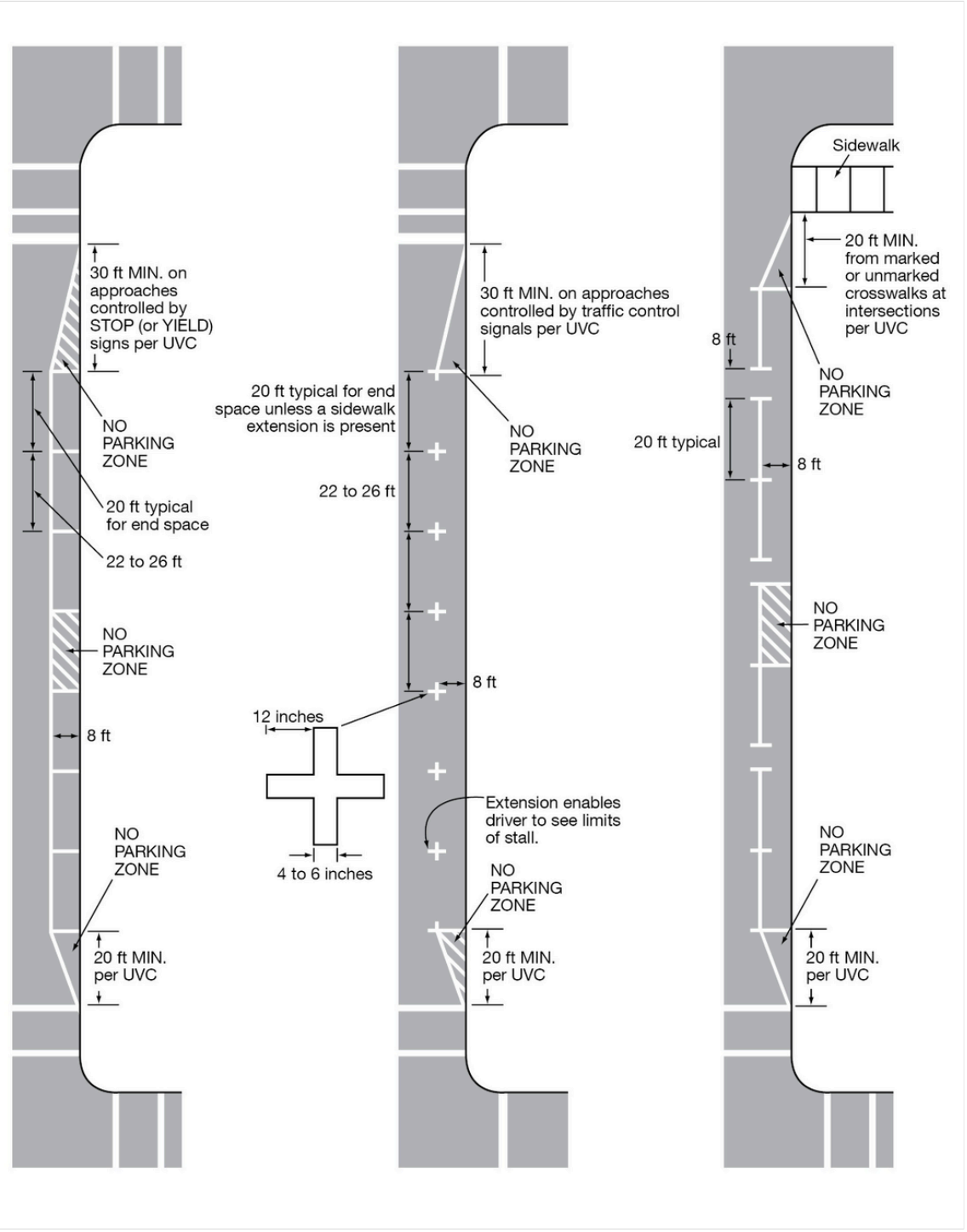


Figure 620.2.26 Example of Parking Space Markings

620.2.27 Speed Hump and Speed Table Markings (MUTCD Section 3B.29)

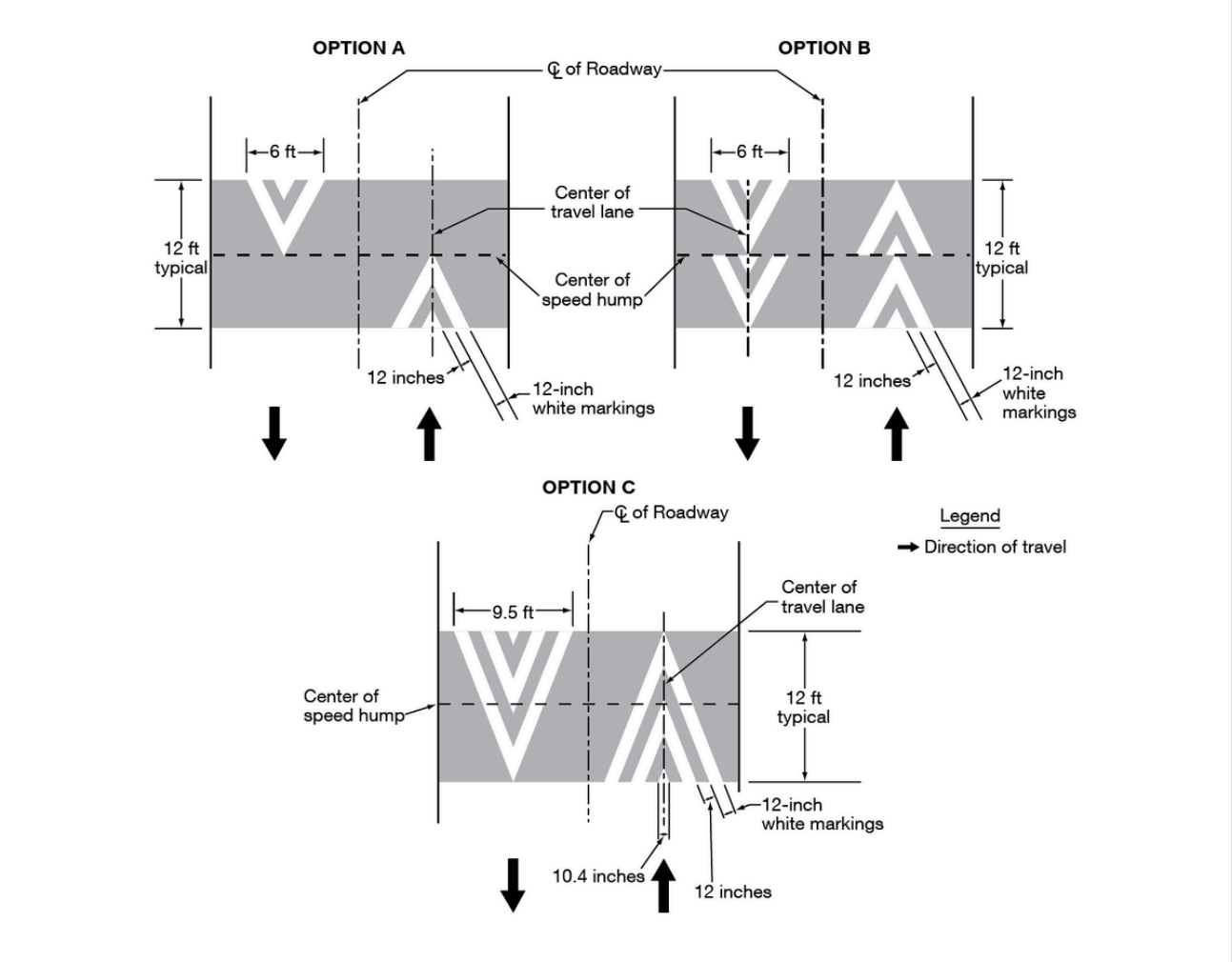


Figure 620.2.27.1 Pavement Markings for Speed Humps without Crosswalks

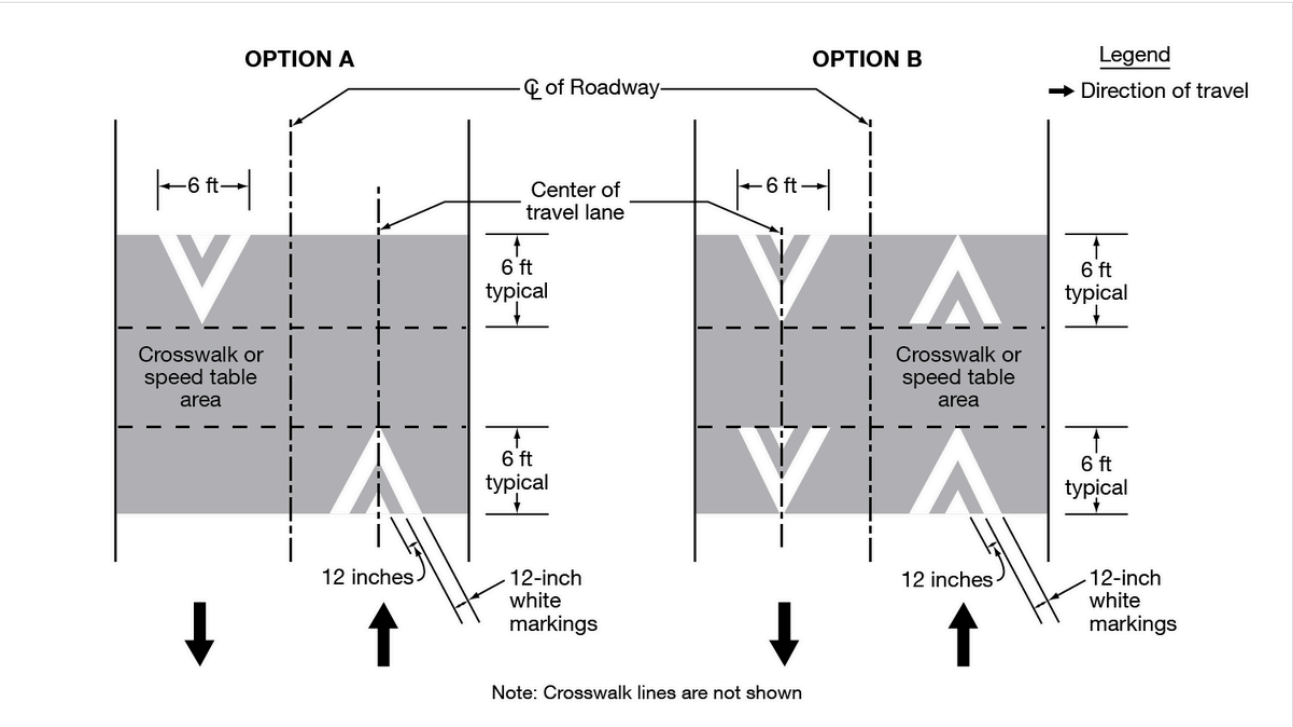


Figure 620.2.27.2 Pavement Markings for Speed Tables or Speed Humps with Crosswalks

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Guidance. Speed humps and speed tables are generally not used on MoDOT-maintained facilities. Districts should contact the State Highway Safety and Traffic Engineer for approval prior to installation.

Standard. If speed hump markings are used, they shall be a series of white markings placed on a speed hump to identify its location. If markings are used for a speed hump that does not also function as a crosswalk or speed table, the markings shall comply with Option A, B, or C shown in Figure 620.2.27.1. If markings are used for a speed hump that also functions as a crosswalk or speed table, the markings shall comply with Option A or B shown in Figure 620.2.27.2.

Option. Where used, center line markings, lane line markings, and edge lines may be discontinued on the profile of the speed hump.

Standard. Where a speed hump or a speed table specifically incorporates a crossing movement for pedestrians, bicyclists, or equestrians, and functions as a raised crosswalk, crosswalk markings (see EPG 620.3) shall be provided.

620.2.28 Advance Speed Hump and Speed Table Markings (MUTCD Section 3B.30)

Guidance. Advance speed hump markings are generally not used on MoDOT-maintained facilities. Districts should contact the State Highway Safety and Traffic Engineer for approval prior to installation.

Option. Advance speed hump markings may be used in advance of speed humps or other engineered vertical roadway deflections such as dips where added visibility is desired or where such deflection is not expected.

Advance word pavement markings such as BUMP or HUMP may be used on the approach to a speed hump either alone or in conjunction with advance speed hump markings. Appropriate advance warning signs may be used in compliance with EPG 903.6.22.

Standard. If advance speed hump or speed table markings are used, they shall be a series of eight white 12-inch transverse lines that become longer and are spaced closer together as the vehicle approaches the speed hump or other deflection.

Guidance. If used, advance speed hump markings should be installed in each approach lane.

620.2.29 Aircraft Speed Measurement Markings

Support. An aircraft speed measurement marking is a transverse marking placed on the roadway to assist the enforcement of speed regulations.

Standard. Aircraft speed check markings shall only be installed after the District Engineer or the District Engineer's representative receives a request from the Missouri State Highway Patrol. A member of the Highway Patrol shall be present when these stations are placed to verify their location and spacing for legal purposes.

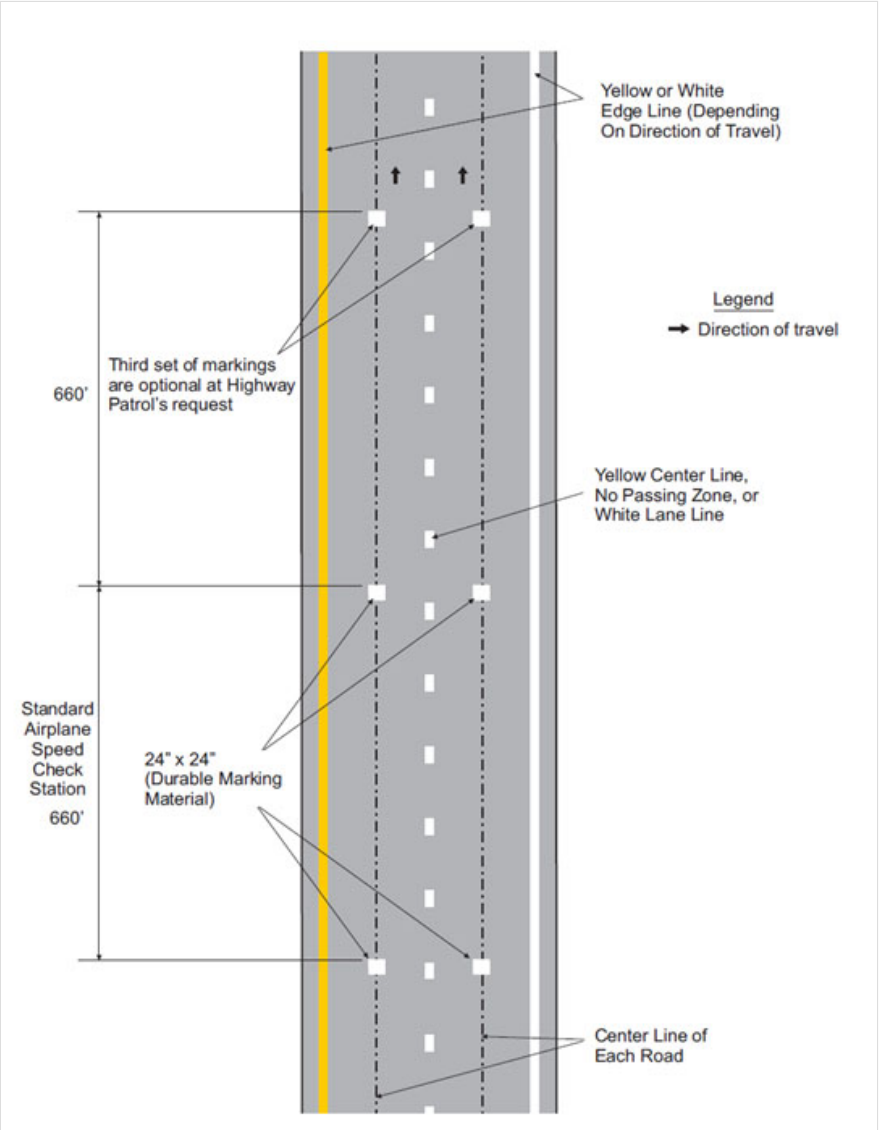


Figure 620.2.29 Pavement Marking for Aircraft Speed Check Stations

Speed measurement markings, if used, shall be white, and shall be 24 in. x 24 in. and the distance between the blocks shall be 660 ft., measured from the leading edge of the first block to the leading edge of the second block. This distance shall be measured on the actual pavement surface and is the same for all posted speeds (See Figure 620.2.29).

The markings shall be reflective, and are to be placed on the center of each driving lane.

Those markings, which have been improperly installed shall be removed by one of the methods noted in EPG 620.11.4.

Option. A third block may be installed at the special request of the Highway Patrol.

If the Highway Patrol wishes to only check traffic flowing in one direction, these markings may be omitted from the opposing lanes.

Guidance. Aircraft speed check markings should receive periodic inspection to ensure they are maintained in an acceptable and functional manner. Existing aircraft speed check markings that are no longer in use should be allowed to deteriorate.

The application of any material should be done following the manufacturer's recommendations for installation.

Option. On concrete surfaces, black may be used to provide contrast of the speed blocks.

620.2.30 Markings for a Diverging Diamond Interchange with a Transposed Alignment Crossroad (MUTCD Section 3B.31)

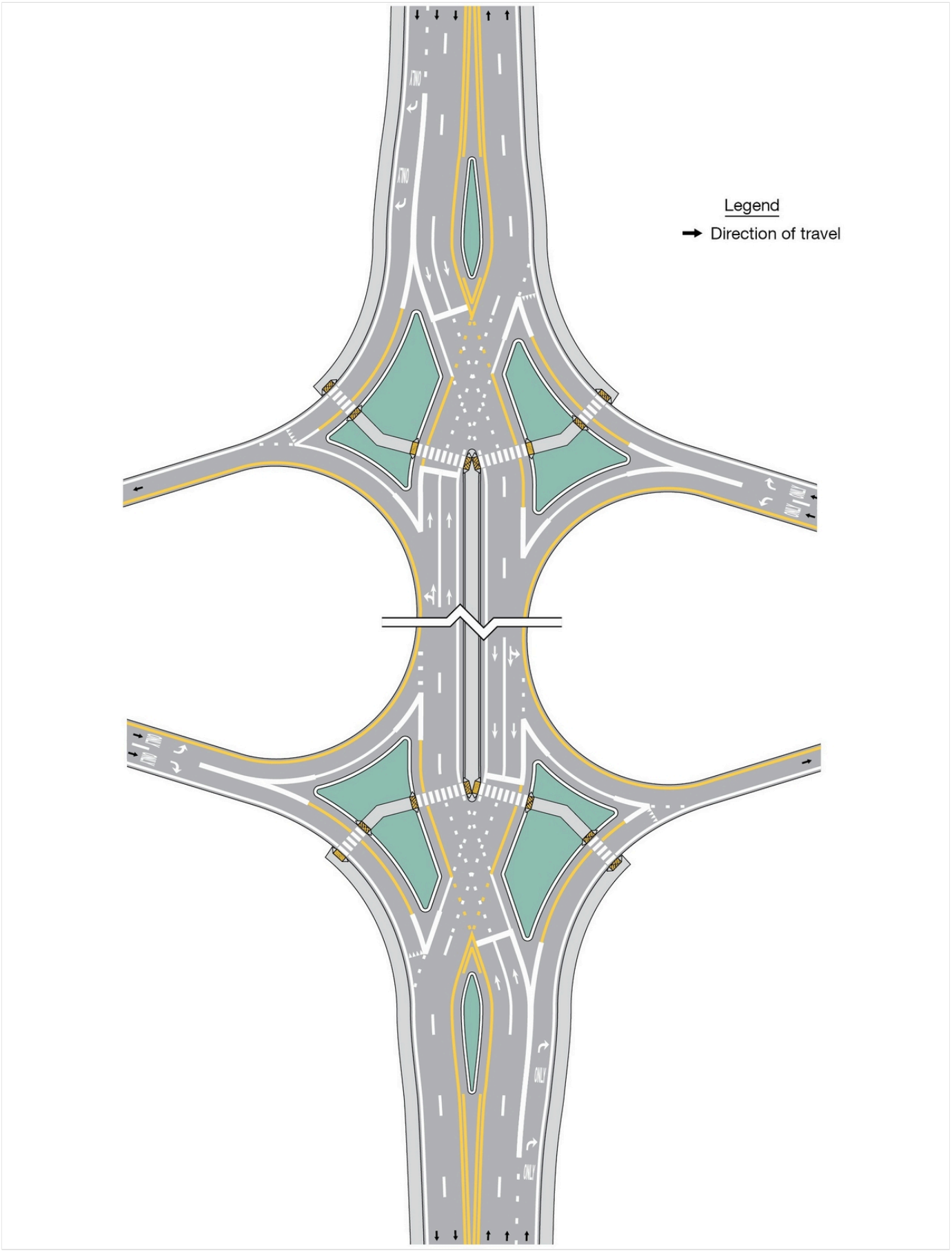


Figure 620.2.30 Example of Pavement Markings for a Diverging Diamond Interchange with a Transposed Alignment Crossroad

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Support. Markings used in a diverging diamond interchange with a transposed alignment crossroad can be advantageous for minimizing wrong-way movements. The potential for wrong-way movements is greatest at the crossover intersections where the alignment becomes transposed.

Standard. On the transposed alignment, each direction shall be considered a one-way roadway whereas the edge line convention shall be in accordance with EPG 620.2.10. Both yellow and white edge lines shall be used.

A lane-use arrow (see EPG 620.2.22) shall be used in each approach lane at the crossover intersection.

Support. EPG 620.3.9 contains information on crosswalks and pedestrian movements for diverging diamond interchanges with a transposed alignment crossroad.

Standard. Flush median islands (see EPG 620.9.3) shall not be used to divide the inverted flow of traffic.

Guidance. Edge line and lane line extensions (see EPG 620.2.13) should be provided through the crossing points.

Support. Figure 620.2.30 illustrates an example of pavement markings for a diverging diamond interchange with a transposed alignment crossroad.

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620.3 Crosswalk Markings (MUTCD Chapter 3C)

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620.3.1 General (MUTCD Section 3C.01)

Support. Crosswalk markings provide guidance for pedestrians who are crossing roadways by defining and delineating paths on approaches to and within signalized intersections, and on approaches to other intersections where traffic stops.

In conjunction with signs and other measures, crosswalk markings help to alert road users of a designated pedestrian crossing point across roadways at locations that are not controlled by traffic control signals or STOP or YIELD signs.

At non-intersection locations, crosswalk markings legally establish the crosswalk.

Detectable warning surfaces mark boundaries between pedestrian and vehicular ways where there is no raised curb. Detectable warning surfaces are typically installed where curb ramps are constructed at the junction of sidewalks and the roadway or shoulder, for marked and unmarked crosswalks. Detectable warning surfaces contrast visually with adjacent walking surfaces, either light-on-dark, or

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dark-on-light. The U.S. Department of Justice 2010 ADA Standards for Accessible Design, September 15, 2010, 28 CFR 35 and 36, Americans with Disabilities Act of 1990 contains specifications for the design of detectable warning surfaces.

620.3.2 Application of Crosswalk Markings (MUTCD Section 3C.02)

Guidance. At locations controlled by traffic control signals, crosswalk markings should be installed.

Option. Crosswalk markings may be omitted if engineering judgment indicates they are not needed to direct pedestrians to the proper crossing path(s).

Guidance. On approaches controlled by STOP or YIELD signs, crosswalk markings should be installed where engineering judgment indicates they are needed to direct pedestrians to the proper crossing path(s).

At uncontrolled approaches, an engineering study should be performed before a marked crosswalk is installed. The following criteria should be considered:

A. Total number of approach lanes,

B. The presence of a median,

C. The distance from adjacent signalized intersections or other controlled crossings,

D. Projected pedestrian and bicyclist volumes,

E. Pedestrian and bicyclist paths of travel,

F. Pedestrian ages and abilities,

G. Pedestrian and bicyclist delays,

H. Location or frequency of public transit stops,

I. Average daily traffic (ADT),

J. Speed limit or the 85th-percentile speed,

K. The horizontal and vertical geometry of the crossing location,

L. The possible consolidation of multiple crossing points,

M. The availability of street lighting, and

N. Other appropriate factors.

Standard. Crosswalk markings shall be provided at legally established crosswalks at non-intersection locations.

Where a shared-use path crossed a roadway, crosswalk markings shall be used.

Guidance. The installation of other traffic control devices and other measures designed to reduce traffic speeds, shorten crossing distances, enhance driver awareness of the crossing, and/or provide active warning of pedestrian presence, should be considered in addition to a new marked crosswalk and signs across an uncontrolled roadway where any of the following conditions exist:

A. The roadway has four or more lanes of travel without a raised median or pedestrian refuge island and an ADT of 12,000 vehicles per day or greater, or

B. The roadway has four or more lanes of travel with a raised median or pedestrian refuge island and an ADT of 15,000 vehicles per day or greater, or

C. The posted speed limit is 40 mph or greater, or

D. A crash study reveals that multiple-threat crashes are the predominant crash type on a multi-lane approach, or

E. When adequate visibility cannot be provided by parking prohibitions.

Support. EPG 902.10 contains information on pedestrian hybrid beacons.

EPG 902.12 contains information on rectangular rapid flashing beacons.

EPG 902.18.3 contains information regarding Warning Beacons to provide active warning of a pedestrian's presence.

EPG 902.20.2 contains information regarding In-Roadway Warning Lights at crosswalks.

EPG 908.3 contains information on school crosswalks.

EPG 908.4 contains information regarding school crossing supervision.

620.3.3 Design of Crosswalk Markings (MUTCD Section 3C.03)

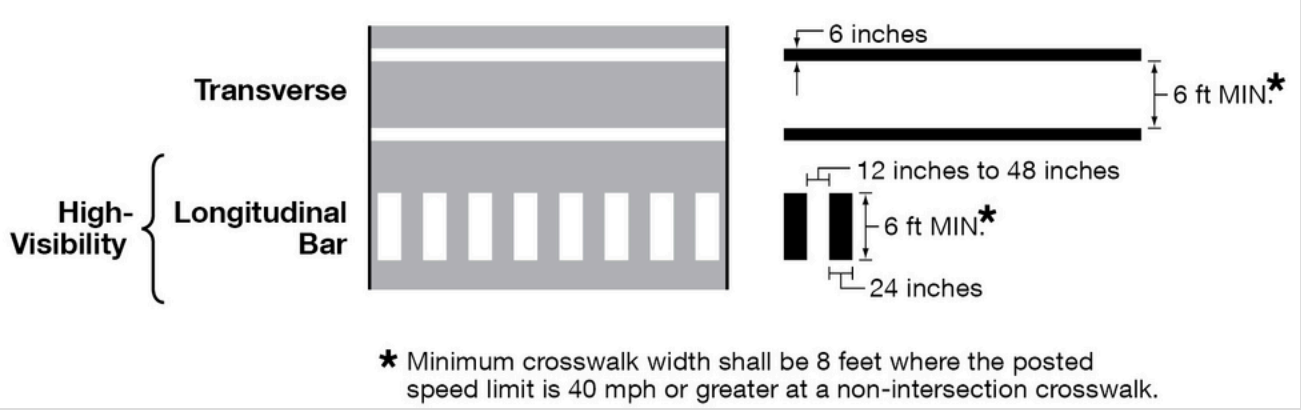


Figure 620.3.3 Crosswalk Markings

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Support. EPG 620.2.19 contains information regarding placement of stop line markings and yield line markings near crosswalk markings.

Crosswalk markings are classified as either transverse line or high-visibility. Transverse crosswalk markings consist of two transverse lines. High-visibility markings consist of longitudinal lines parallel to traffic flow without transverse lines. Figure 620.3.3 presents crosswalk marking designs.

Standard. Crosswalk markings shall be white. When used, transverse lines shall be 6 inches in width.

Except as provided in the following paragraph, the minimum width of a marked crosswalk shall be 6 feet.

At a non-intersection crosswalk where the posted speed limit is 40 mph or greater, the minimum width of the crosswalk shall be 8 feet.

Guidance. High-visibility crosswalk markings (such as shown in Figure 620.3.3) and warning signs (see 903.6.41) should be installed for all crosswalks at non-intersection locations.

Added visibility should be provided by parking prohibitions on the approach to marked crosswalks at non-intersection locations.

Standard. Where curb ramps are provided, crosswalk markings shall be located so that the curb ramps are within the extension of the crosswalk markings.

Guidance. Transverse line crosswalk markings should extend across the full width of pavement or to the edge of the intersecting crosswalk to discourage diagonal walking between crosswalks.

Support. Provisions for aesthetic treatments for the interior portion of a legally-established crosswalk are contained in EPG 620.7.3.

620.3.4 Transverse Line Crosswalks (MUTCD Section 3C.04)

Guidance. Transverse line crosswalk markings should be limited to locations controlled by traffic control signals or on approaches controlled by STOP or YIELD signs.

Support. Transverse line crosswalk marking design consists of two parallel transverse lines (see Figure 620.3.3).

Transverse line crosswalk markings can provide benefits to crosswalk operations including:

A. Define where the channelization of pedestrians or other non-motorized users is necessary to facilitate crossing the roadway.

B. Alert motorists to the location of where pedestrians and other non-motorized users might be expected when crossing the roadway.

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C. Emphasize a crosswalk at a controlled intersection.

D. Fulfill a legal need to mark the crosswalk.

620.3.5 High-Visibility Crosswalks (Section 3C.05)

Option. High-visibility crosswalk markings may be used where additional conspicuity is desired for a crosswalk over transverse line crosswalk markings.

Support. High-visibility crosswalk markings include the longitudinal bar design (see Figure 620.3.3).

High-visibility crosswalk markings can provide benefits to crosswalk operations including:

A. Providing greater detection distances for the approaching motorist.

B. Emphasizing a crosswalk where substantial numbers of pedestrians cross without any other traffic control device.

C. Emphasizing a crosswalk at an uncontrolled approach.

D. Emphasizing the location where a high number of conflicts between turning motorists and users of the crosswalk are expected.

E. Improving visibility of the crosswalk location for otherwise difficult to detect pedestrians or other non-motorized users of the crosswalk.

F. Emphasizing a school crossing.

Standard. The minimum number of individual longitudinal elements to establish a high-visibility crosswalk shall be three.

Guidance. The dimensions of the individual longitudinal element and the lateral spacing between subsequent individual longitudinal elements for a high-visibility crosswalk should be uniform when establishing the crosswalk.

The dimensions of the individual longitudinal element and the lateral spacing between subsequent individual longitudinal elements for a high-visibility crosswalk should be uniform when establishing separate crosswalks on multiple approaches to the same intersection and on both sides of a median refuge if one is present.

The individual longitudinal elements of a high-visibility crosswalk should be angled such that they are parallel to the travel path of approaching traffic.

Option. The lateral spacing between longitudinal elements may be staggered to avoid wheel paths, center lines, and lane lines.

620.3.6 Longitudinal Bar Crosswalks (Section 3C.06)

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Support. The longitudinal bar crosswalk marking design (see Figure 620.3.3) provides for improved detection and recognition over the transverse line crosswalk for people with low vision and cognitive impairments.

Standard. The width of an individual longitudinal bar shall be 24 inches.

The lateral spacing between subsequent longitudinal bars shall not be less than 12 inches or greater than 48 inches.

620.3.7 Crosswalk Markings at Circular Intersections (MUTCD Section 3C.09)

Standard. Crosswalk markings shall not be provided to or from the central island of a roundabout.

Guidance. If pedestrian facilities are provided, crosswalks should be marked across roundabout entrances and exits to indicate where pedestrians are intended to cross.

On an approach to a circular intersection controlled by a YIELD sign and at uncontrolled exits, crosswalks should be a minimum of 20 feet from the edge of the circulatory roadway.

Support. EPG 620.4 Circular Intersection Markings provides figures that illustrate examples of crosswalk markings for roundabouts.

620.3.8 Crosswalks for Exclusive Pedestrian Phases that Permit Diagonal Crossings (MUTCD Section 3C.10)

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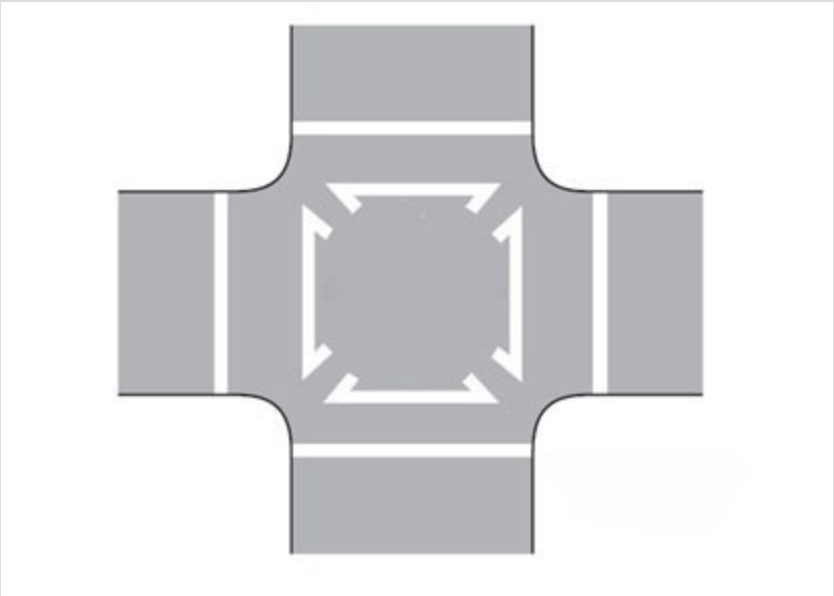


Figure 620.3.8 Example of Crosswalk Markings for an Exclusive Pedestrian Phase that Permits Diagonal Crossings

Note:
High-visibility crosswalks can be used for the crosswalks around the perimeter of the intersection.

Option. When an exclusive pedestrian phase that permits diagonal crossing of an intersection is provided at a traffic control signal, a marking as shown in Figure 620.3.8 may be used for the crosswalk.

Guidance. The segments of the crosswalk marking that facilitate the diagonal crossing should not use high-visibility crosswalk markings.

620.3.9 Crosswalks at Diverging Diamond Interchanges with a Transposed Alignment Crossroad (Section 3C.11)

Support. Diverging diamond interchanges, also known as double-crossover diamond interchanges, include directional crossovers on either side of the interchange that transpose the crossroad which results in vehicles traveling on the left-hand side of the street or highway between the crossover intersections. The potential for altered travel paths for pedestrians and the associated, unique, operational aspects such as traffic approaching from unexpected directions and unfamiliar signal phasing schemes are important considerations.

Guidance. If pedestrian facilities are provided, pedestrian crossing movements of the crossroads at a diverging diamond interchange should be marked at the crossover intersections where motor vehicle traffic becomes transposed.

If pedestrian facilities are provided, crosswalks should be marked across ramp terminals at diverging diamond interchanges to indicate where pedestrians are intended to cross.

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Crosswalks across diverging diamond interchange ramps with yield controlled vehicle movements should be located a minimum of 20 feet from the edge of an intersecting ramp. This is similar to crosswalks on the approaches to circular intersections (see EPG 620.3.7).

Support. EPG 620.2.30 contains information on markings, such as edge lines, lane lines, and lane-use arrows, for diverging diamond interchanges.

Figure 620.2.30 shows an example of pedestrian crossing locations at a diverging diamond interchange.

620.3.10 Pedestrian Islands and Medians (Section 3C.12)

Support. Raised islands or raised medians of sufficient width that are placed in the center area of a street or highway can serve as a place of refuge for pedestrians who are attempting to cross at a midblock or intersection location. Center islands or medians allow pedestrians to find an adequate gap in one direction of traffic at a time, as the pedestrians are able to stop, if necessary, in the center island or median area and wait for an adequate gap in the other direction of traffic before crossing the second half of the street or highway. The U.S. Department of Justice 2010 ADA Standards for Accessible Design, September 15, 2010, 28 CFR 35 and 36, Americans with Disabilities Act of 1990 contains specifications for the design of detectable warning surfaces and provides technical requirements that can be used to determine the minimum width for accessible refuge islands.

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620.4 Circular Intersection Markings (MUTCD Chapter 3D)

Contents

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620.4.5 Word and Symbol Pavement Markings for Roundabouts (MUTCD Section 3D.05)
620.4.6 Arrow Pavement Markings for Roundabouts (MUTCD Section 3D.06)
620.4.7 Markings for Other Circular Intersections (MUTCD Section 3D.07)

620.4.1 General (MUTCD Section 3D.01)

Guidance. Pavement markings and signing for a circular intersection should be integrally designed to correspond to the geometric design and intended lane use of a circular intersection.

Markings on the approaches to a circular intersection and on the circulatory roadway should be compatible with each other to provide a consistent message to road users. The markings should supplement the signing, both conveying the optional and mandatory movements such that road users will know to choose the proper lane in the approach to the circular intersection and remain in that lane throughout departure from the circulatory roadway.

Support. Common circular intersection types include roundabouts, rotaries, and traffic circles (see definitions in EPG 911 (MUTCD Section 1C.02)). Traffic circles and rotaries are often much larger than roundabouts. Modern roundabouts feature channelized, curved approaches that reduce vehicle speed. Traffic calming circles are smaller and are typically used on urban or suburban neighborhood streets.

Figure 620.4.1.1 provides an example of the pavement markings for approach and circulatory roadways at a roundabout. Figures 620.4.2 through 620.4.1.9 illustrate examples of markings for roundabouts of various geometric and lane-use configurations.

Actuated LED pedestrian warning signs (see EPG 903.1.12), traffic control signals, pedestrian hybrid beacons, and rectangular rapid flashing beacons (see EPG 902) are sometimes used at roundabouts to facilitate the crossing of pedestrians or to meter traffic.

EPG 913.1.12 provides information about circular intersections that contain or are in close proximity to grade crossings.

EPG 914.5.5 contains information regarding bicycle lane markings at circular intersections.

EPG 620.3.7 contains information regarding crosswalks at circular intersections.

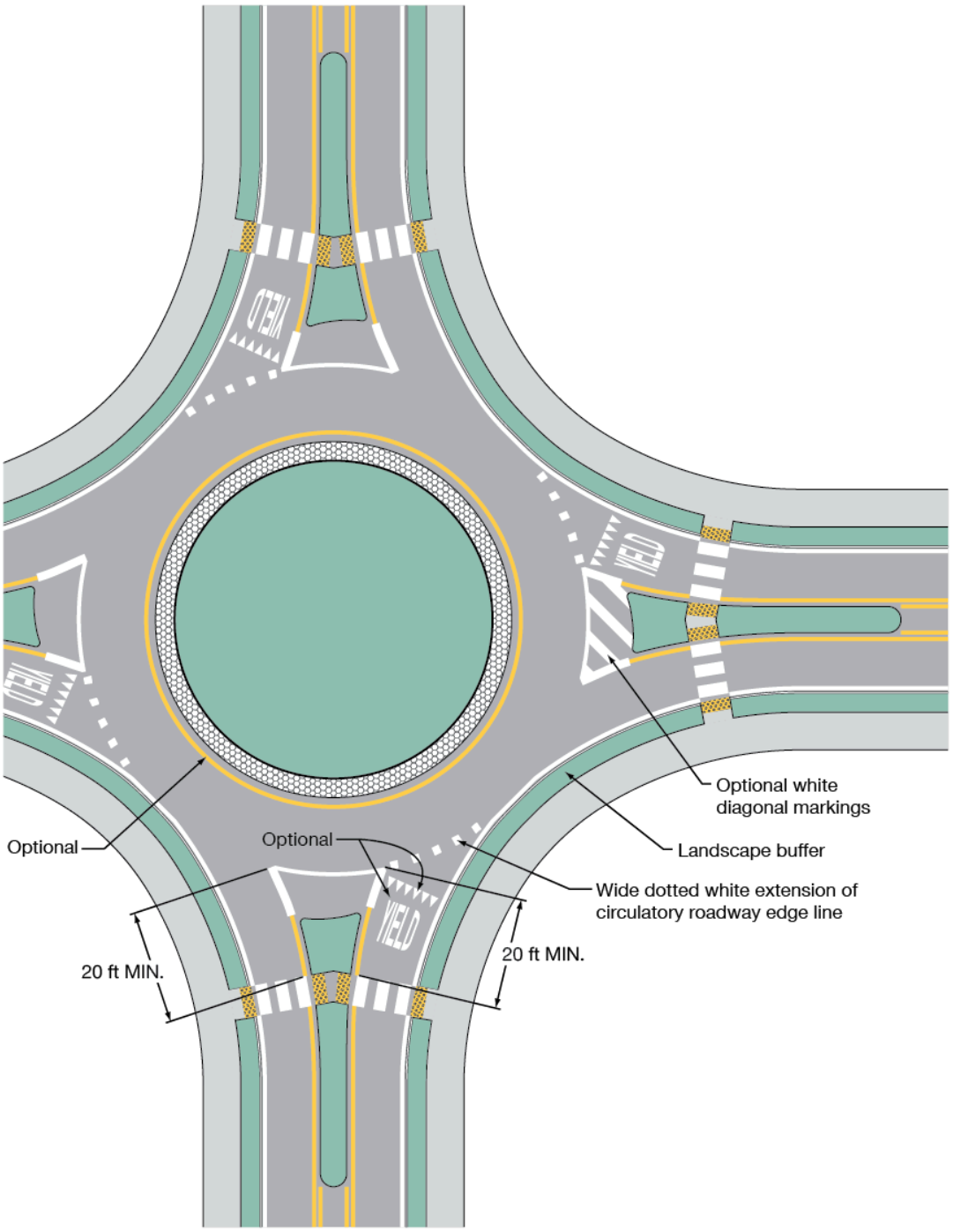


Figure 620.4.1.1 Example of Markings for Approach and Circulatory Roadway at a Roundabout

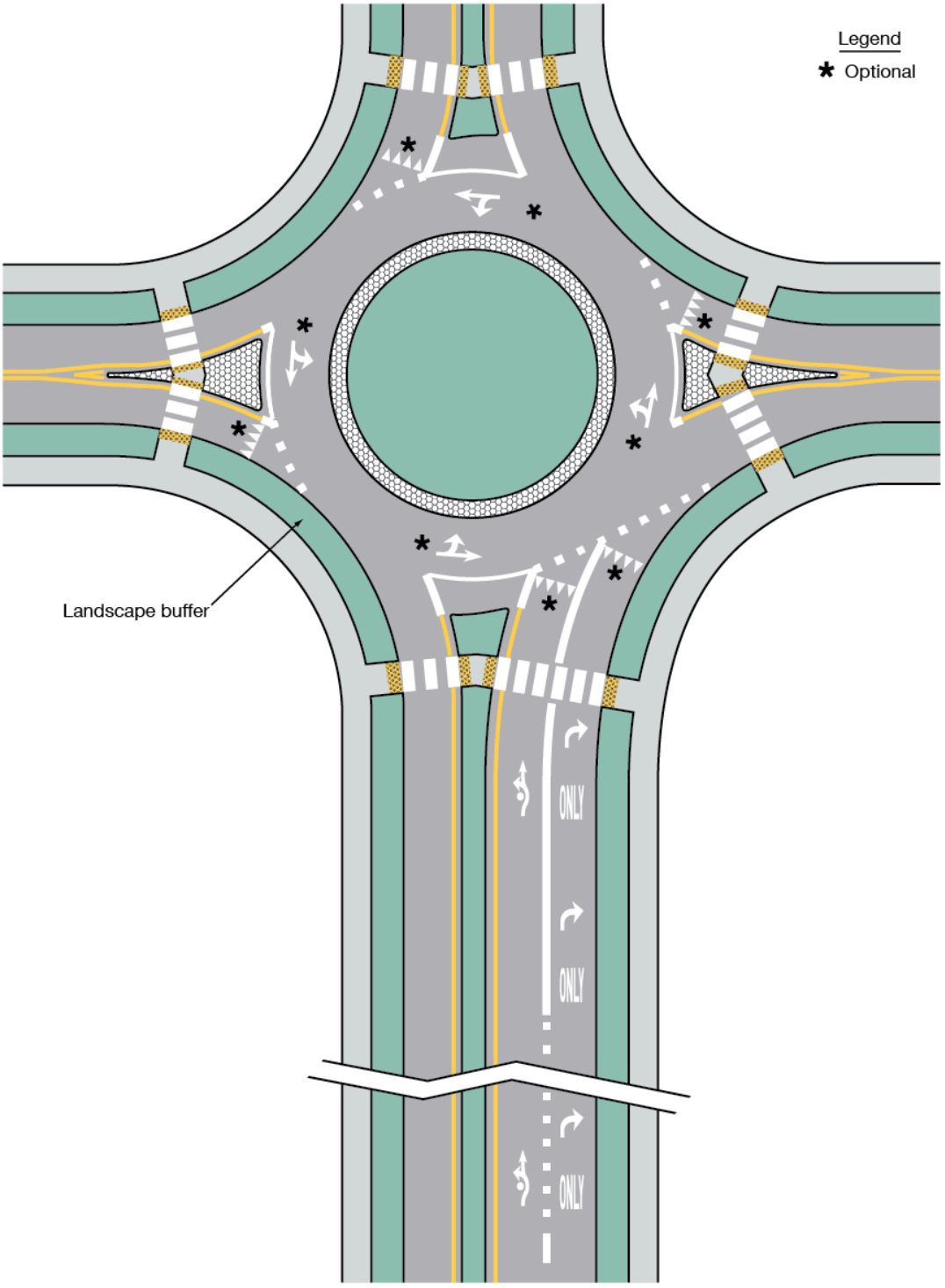


Figure 620.4.1.2 Example of Markings for a One-Lane Roundabout

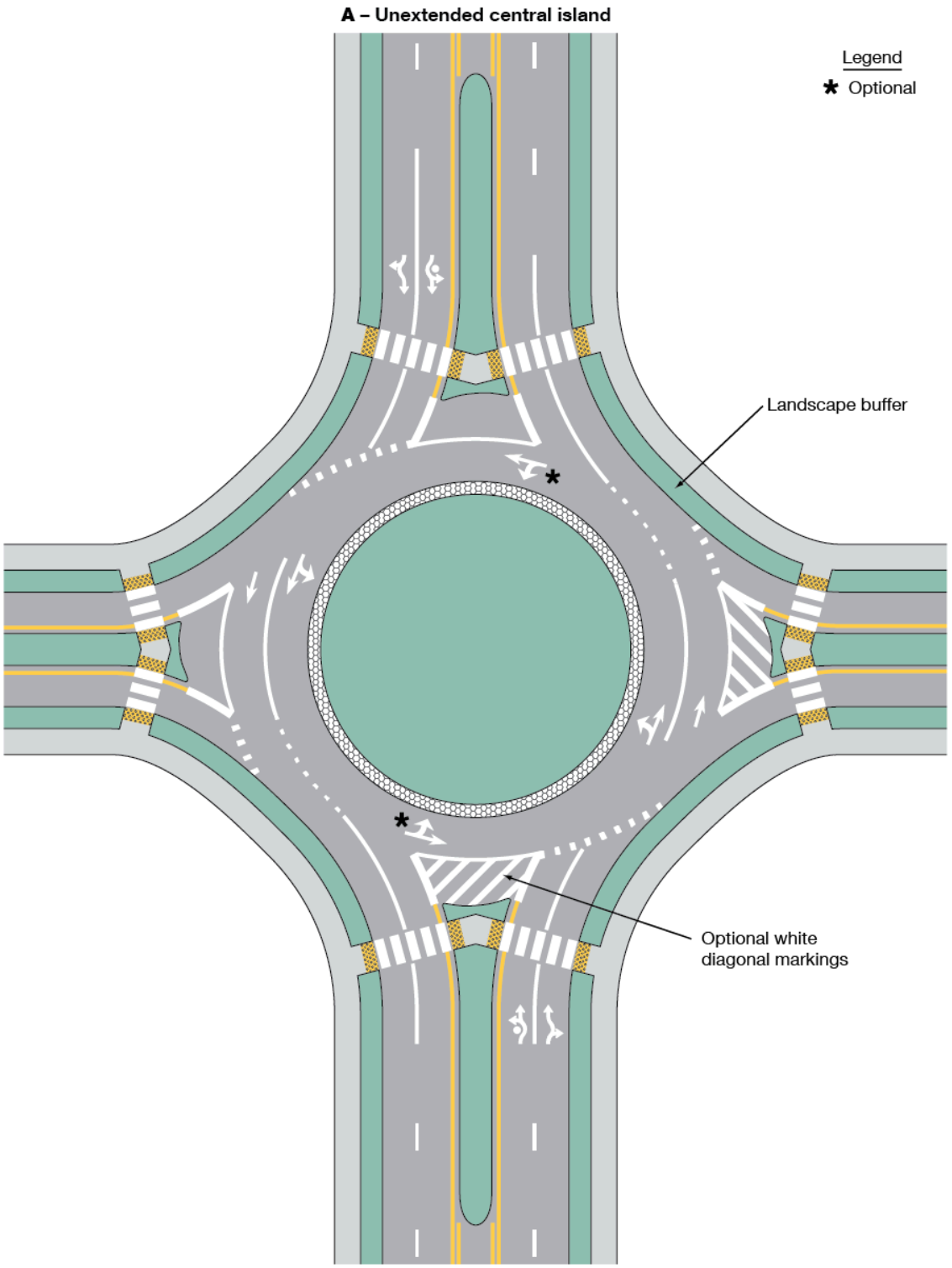


Figure 620.4.1.3 Example of Markings for a Two-Lane Roundabout with One-Lane and Two-Lane Approaches *(Sheet 1 of 2)*

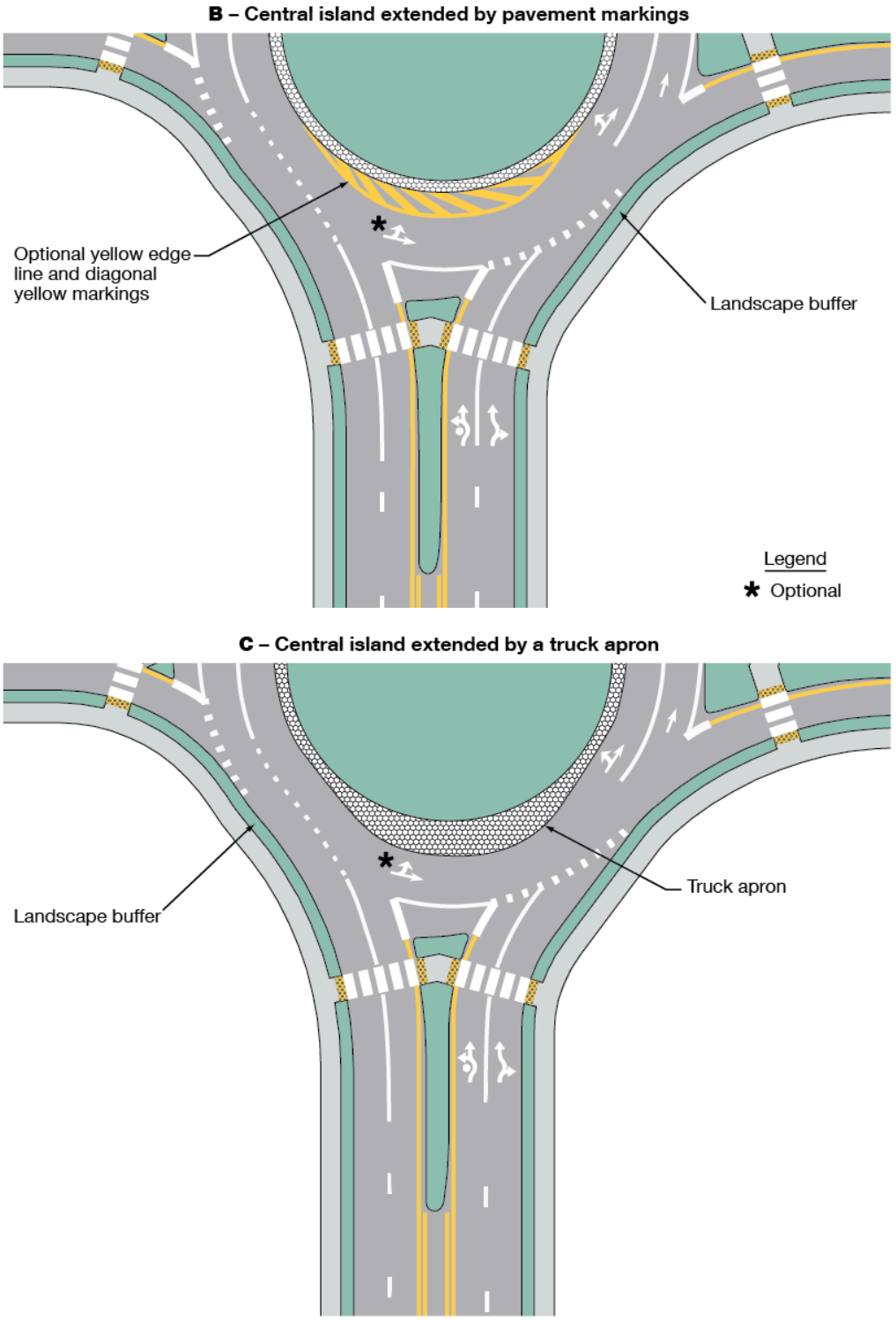


Figure 620.4.1.4 Example of Markings for a Two-Lane Roundabout with One-Lane and Two-Lane Approaches *(Sheet 2 of 2)*

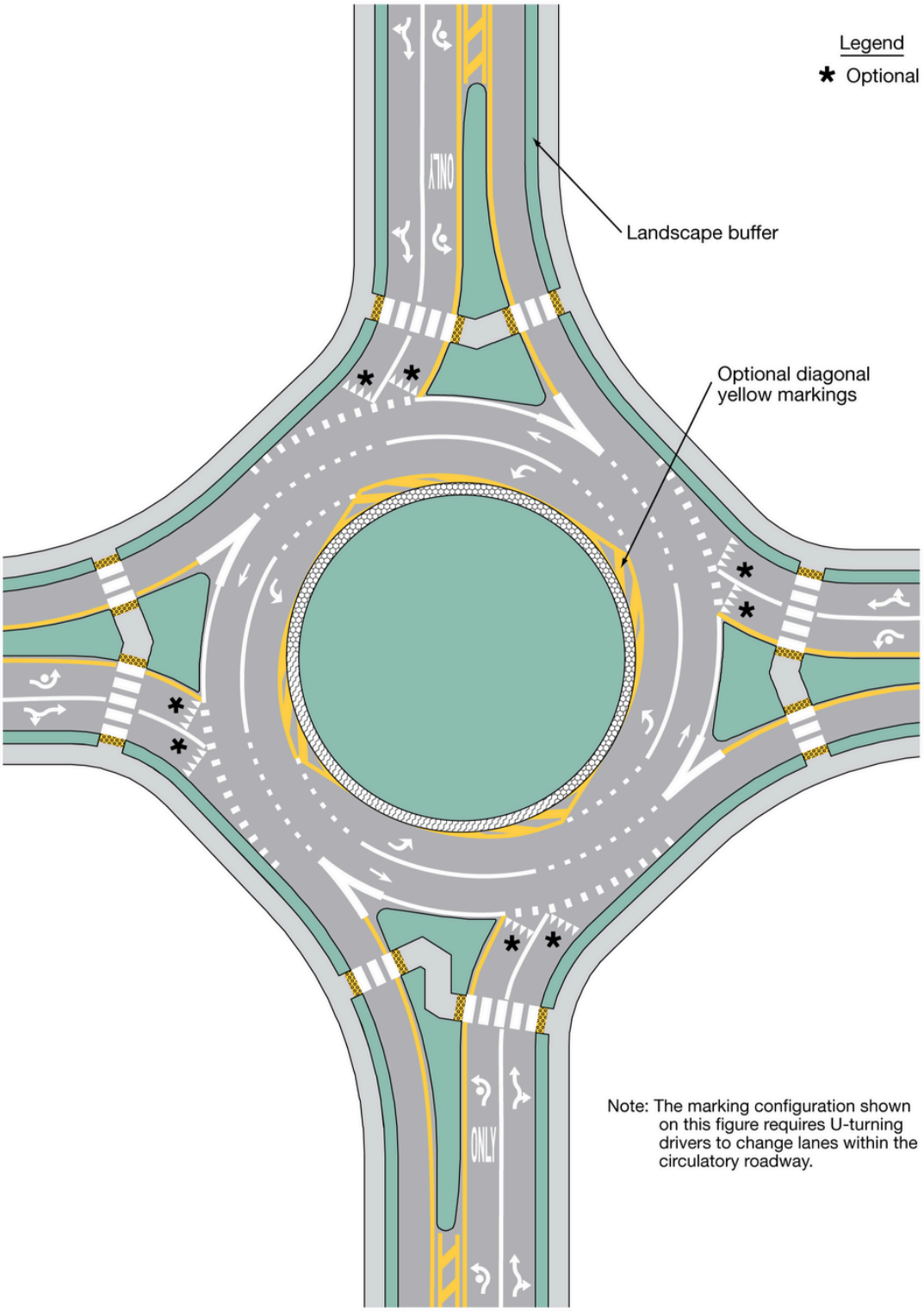


Figure 620.4.1.5 Example of Markings for a Two-Lane Roundabout with One-Lane Exits

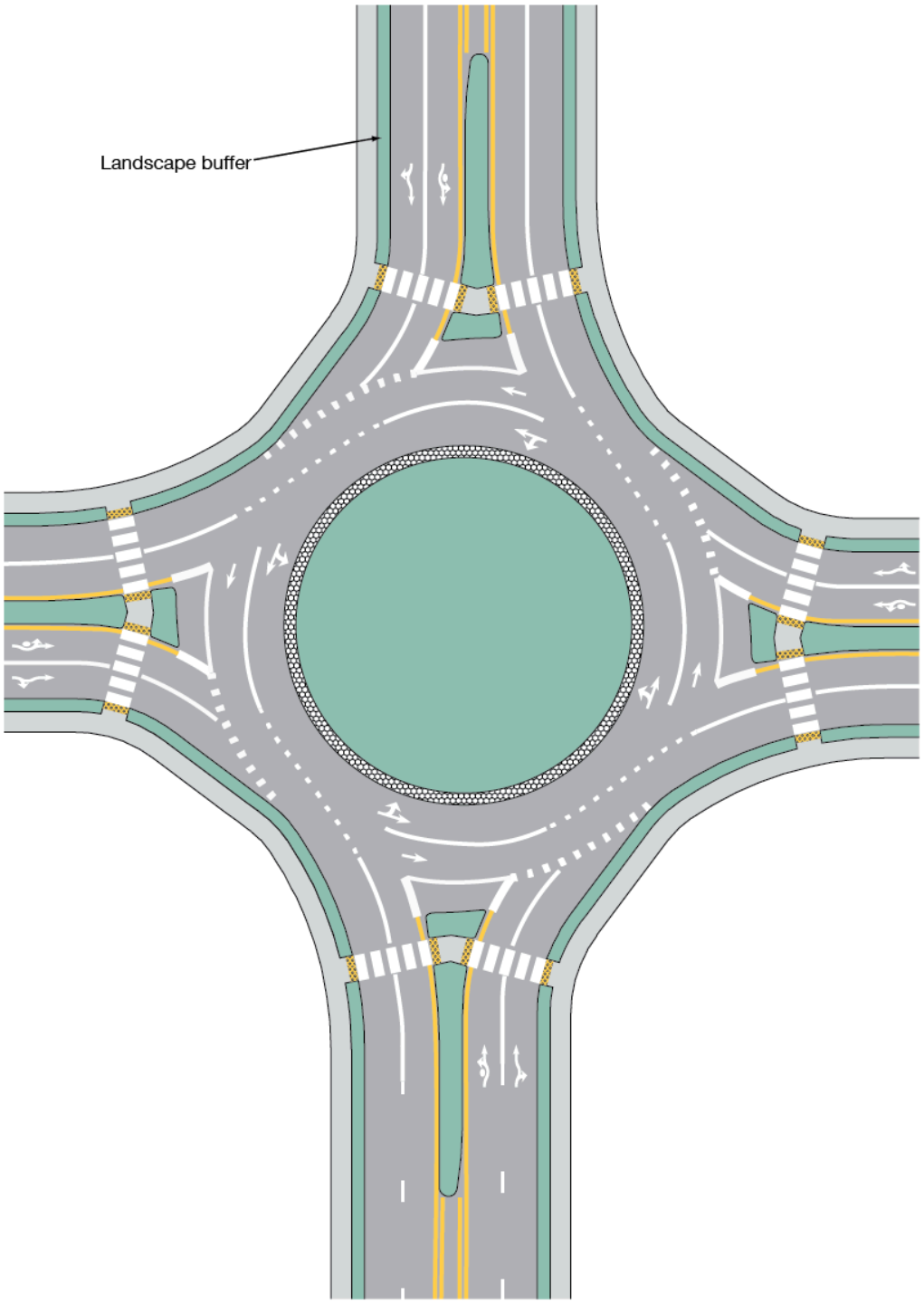


Figure 620.4.1.6 Example of Markings for a Two-Lane Roundabout with Two-Lane Exits

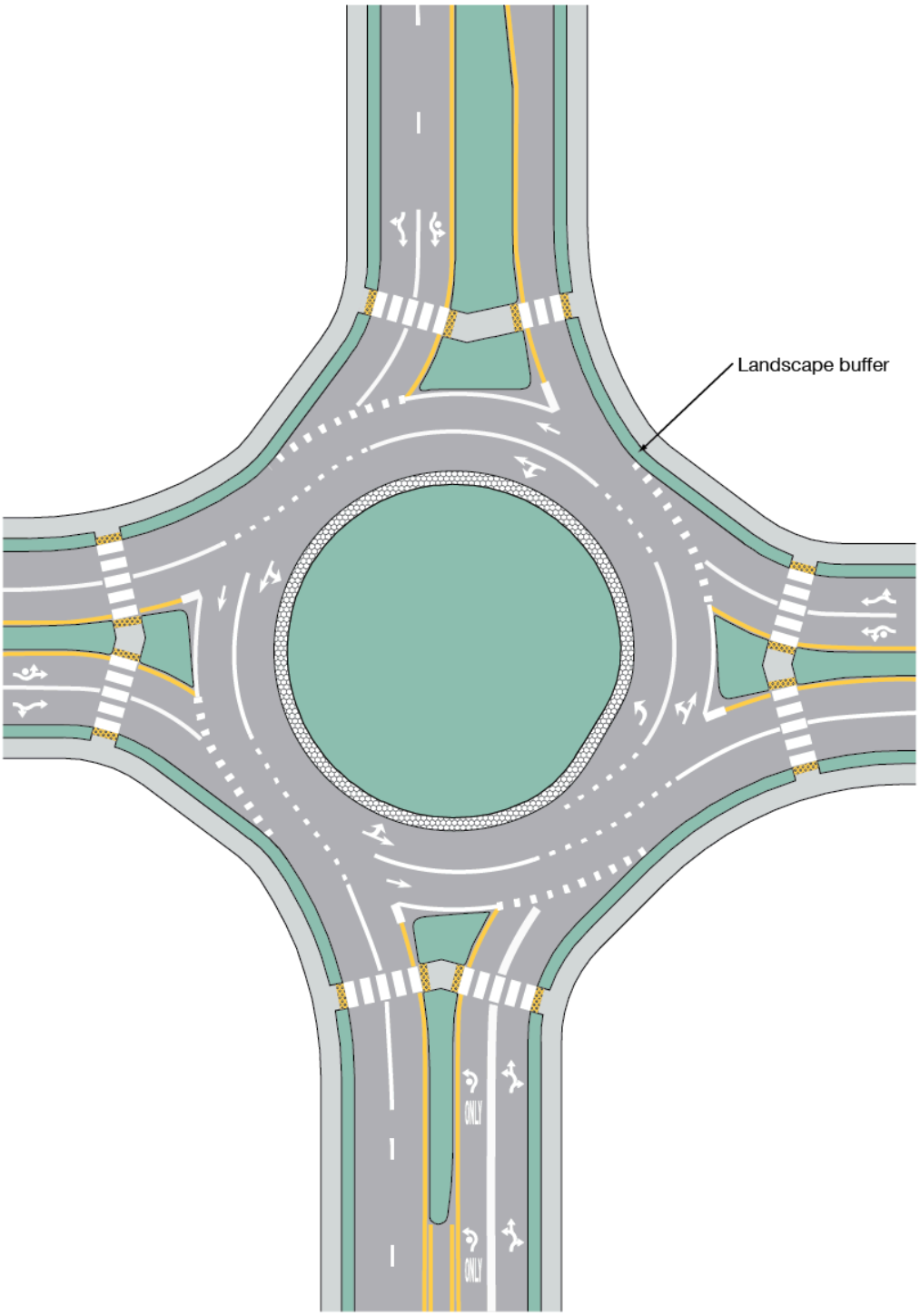


Figure 620.4.1.7 Example of Markings for a Two-Lane Roundabout with a Double Left Turn

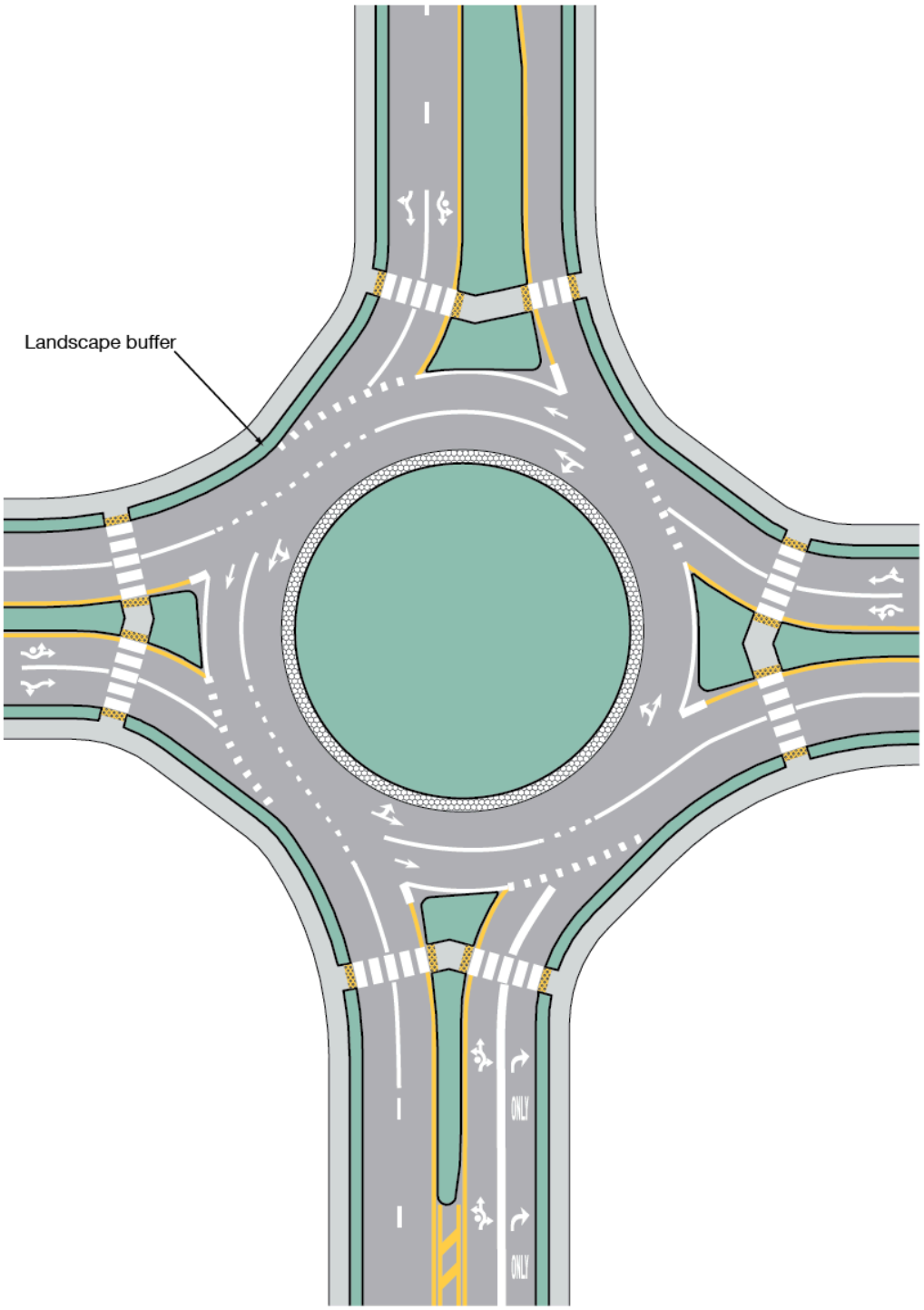


Figure 620.4.1.8 Example of Markings for a Two-Lane Roundabout with a Double Right Turn

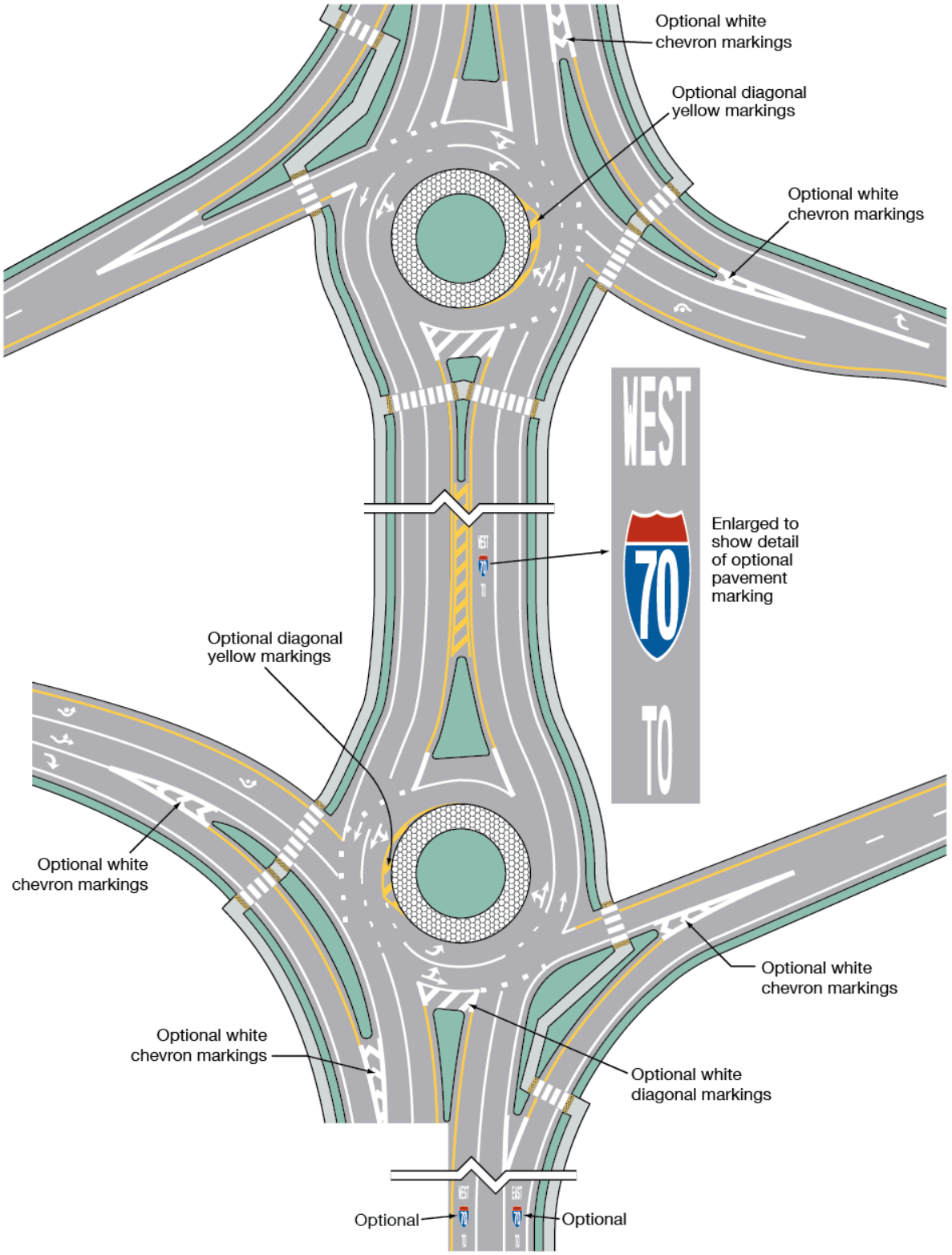


Figure 620.4.1.9 Example of Markings for a Diamond Interchange with Two Circular-Shaped Roundabout Ramp Terminals

620.4.2 White Lane Line Pavement Markings for Roundabouts (MUTCD Section 3D.02)

Standard. Multi-lane approaches to roundabouts shall have lane lines.

A through lane on a roadway that becomes a dropped lane (mandatory left-turn or right-turn lane) at a roundabout shall be marked with a dotted white lane line in accordance with EPG 620.2.8.

Guidance. Multi-lane roundabouts should have lane line markings within the circulatory roadway to continuously channelize traffic in the circulatory roadway and through the departure movement.

Standard. Continuous concentric lane lines shall not be used within the circulatory roadway of a roundabout.

Option. Channelizing lines (see EPG 620.2.9) and chevron and diagonal markings (see EPG 620.2.24) may be used on the approaches to and within the circulatory roadway of multi-lane roundabouts to separate traffic lanes, discourage lane changing, and/or compensate for off-tracking of larger trucks and vehicles.

Support. Reducing the spacing between lines of a broken (intermittent) lane line allows better delineation of the lower-radius curves typically found in circular intersections**.**

620.4.3 Edge Line Pavement Markings for Roundabout Circulatory Roadways (MUTCD Section 3D.03)

Guidance. A white edge line should be used on the outer (right-hand) edge of the circulatory roadway.

Where a white edge line is used for the circulatory roadway, it should be as follows (see Figure 620.4.1.1):

A. A solid line adjacent to the splitter island, and

B. A wide dotted white extension line (2-foot line segments separated by 4-foot gaps) across the lane(s) entering the roundabout.

Standard. Edge lines and edge line extensions shall not be placed across the exits from the circulatory roadway at roundabouts.

Option. A yellow edge line may be placed around the inner (left-hand) edge of the circulatory roadway (see Figure 620.4.1.1) and may be used to channelize traffic (see Drawing B in Figure 620.4.1.4).

620.4.4 Yield Lines for Roundabouts (MUTCD Section 3D.04)

Option. A yield line (see EPG 620.2.18) may be used to indicate the point behind which vehicles are required to yield at the entrance to a roundabout (see Figure 620.4.1.1 and 620.4.1.2).

620.4.5 Word and Symbol Pavement Markings for Roundabouts (MUTCD Section 3D.05)

Option. YIELD (word) (see Figure 620.4.1.1) and YIELD AHEAD (symbol or word) pavement markings may be used on approaches to roundabouts.

Word and/or route shield pavement markings may be used on an approach to or within the circulatory roadway of a roundabout to provide route and/or destination guidance information to road users (see Figure 620.4.1.9).

620.4.6 Arrow Pavement Markings for Roundabouts (MUTCD Section 3D.06)

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Guidance. Lane-use arrow pavement markings should not be used on single-lane approaches to circular intersections.

Lane-use arrows should be used on approaches to circular intersections with multi-lane approaches.

Standard. Lane-use arrow pavement markings shall not be provided between a crosswalk and a wide dotted line across the lane(s) entering the circular roadway.

Except as provided in the following Option paragraph, where lane-use arrows are used on the approaches to a roundabout, they shall be curved-stem (see Drawing F in Figure 620.2.22.1).

Option. Normal-stem lane use arrows may be used on the approaches to roundabouts where they more effectively indicate road geometry based on engineering judgment.

An oval or circle may be used with the lane-use arrows in the left-most lane to symbolize the central island (see Drawings B, C, and F in Figure 620.2.22.1).

Standard. If used, an oval or circle shall only be used with lane-use arrows in the left-most lane to symbolize the central island.

Guidance. If lane-use arrows are used on the approaches to a roundabout, the style used should match the style of the lane-use arrows (normal-stem or curved-stem) used on the regulatory lane-use signs on the approach.

If lane-use arrow pavement markings are used within the circulatory roadway of multi-lane roundabouts, normal-stem lane-use arrows (see EPG 620.2.22 and Figure 620.2.22.1) should be used.

Support. Details and sizes of the standard and curved-stem arrows that can be used for circular intersections are contained in the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)).

620.4.7 Markings for Other Circular Intersections (MUTCD Section 3D.07)

Option. The markings shown in EPG 620.4 may be used at other circular intersections if engineering judgment indicates that their presence will benefit drivers, pedestrians, or other road users. Figure 903.2.40.1 provides an example of markings at a mini-roundabout.

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620.5 Preferential Lane Markings for Motor Vehicles (MUTCD Chapter 3E)

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620.5.4 Markings for Part-Time Travel on a Shoulder (MUTCD Section 3E.04)

620.5.1 General (MUTCD Section 3E.01)

Guidance. Preferential lane markings are not currently used on MoDOT facilities. The Highway Safety and Traffic Division should be contacted for guidance when considering the use of preferential lane markings.

Support. Preferential lanes are established for one or more of a wide variety of special uses, including, but not limited to, bus only lanes, taxi only lanes, and light rail transit only lanes.

EPG 620.5 contains the pavement marking provisions for preferential lanes used by motor vehicles and light rail transit. EPG 914 contains information for pavement markings for bicycle lanes.

EPG 620.7 contains information for the use and application of colored pavement that can be used in preferential lanes to supplement the pavement markings described in EPG 620.5.

620.5.2 Longitudinal Markings (MUTCD Section 3E.02)

Support. Preferential lanes can take many forms depending on the level of usage and the design of the facility. They might be barrier-separated or buffer-separated from the adjacent general-purpose lanes, or they might be contiguous with the adjacent general-purpose lanes. Barrier-separated preferential lanes might be operated in a constant direction or be operated as reversible lanes. EPG 911 (MUTCD Section 1C.02) contains definitions of these terms.

Preferential lanes might be operated full-time (24 hours per day on all days), for extended periods of the day, part-time (restricted usage during specific hours on specified days), or on a variable basis (such as a strategy for a managed lane).

Standard. The left-hand and right-hand edge lines and lane lines used for preferential lanes that are adjacent to general-purpose lanes where traffic is flowing in the same direction shall be in accordance with Table 620.5.2.1.

Table 620.5.2.1 Standard Edge Line and Lane Line Markings for Preferential Lanes

Type of Preferential Lane	Left-Hand Line	Right-Hand Line
Barrier-Separated, Non-Reversible	A normal solid single yellow edge line	A normal solid single white edge line (see Drawing A in Figure 620.5.2.1)
Barrier-Separated, Left-Hand Side	A normal solid single yellow edge line	A wide solid double white line along both edges of the buffer space where crossing is prohibited (see Drawing A in Figure 620.5.2.2) A wide solid single white line along both edges of the buffer space where crossing is discouraged (see Drawing B in Figure 620.5.2.2) A wide broken (intermittent) single white line along both edges of the buffer space, or a wide broken (intermittent) single white line within the buffer space (resulting in wider lanes), where crossing is permitted (see Drawing C in Figure 620.5.2.3)
Barrier-Separated, Right-Hand Side	A wide solid double white line along both edges of the buffer space where crossing is prohibited, or a wide solid single white line along both edges of the buffer space where crossing is discouraged (see Drawing D in Figure 620.5.2.3) A wide broken (intermittent) single white line along both edges of the buffer space, or a wide broken (intermittent) single white line within the buffer space (resulting in wider lanes), where crossing is permitted (see Drawing D in Figure 620.5.2.3) A wide dotted single white line within the buffer space (resulting in wider lanes) where crossing is permitted for any vehicle to perform a right-turn maneuver (see Drawing D in Figure 620.5.2.3)	A normal solid single white edge line (if warranted)
Contiguous, Left-Hand Side	A normal solid single yellow edge line	A wide solid double white lane line where crossing is prohibited (see Drawing A in Figure 620.5.2.4) A wide solid single white lane line where crossing is discouraged (see Drawing B in Figure 620.5.2.4) A wide broken (intermittent) single white lane line where crossing is permitted (see Drawing C in Figure 620.5.2.4)
Contiguous, Right-Hand Side	A wide solid double white lane line where crossing is prohibited (see Drawing D in Figure 620.5.2.4) A wide solid single white lane line where crossing is discouraged (see Drawing D in Figure 620.5.2.4) A wide broken (intermittent) single white lane line where crossing is permitted (see Drawing D in Figure 620.5.2.4) A wide dotted single white lane line where crossing is permitted for any vehicle to perform a right-turn maneuver (see Drawing D in Figure 620.5.2.4)	A normal solid single white lane line (if warranted)

Notes:

1. If there are two or more preferential lanes, the lane lines between the preferential lanes shall be normal broken (intermittent) white lines.
2. The standard lane markings listed in this table are provided in a tabular format for reference.

If there are two or more preferential lanes for traffic moving in the same direction, the lane lines between the preferential lanes shall be normal width broken (intermittent) white lines.

Preferential lanes for motor vehicles shall have appropriate regulatory signs in accordance with MUTCD Sections 2G.03 through 2G.07.

Support. Figure 620.5.2.1 illustrates pavement markings used for barrier-separated preferential lanes. Figure 620.5.2.2 and 620.5.2.3 illustrates pavement markings used for buffer-separated preferential lanes. Figure 620.5.2.4 illustrates pavement markings used for contiguous preferential lanes.

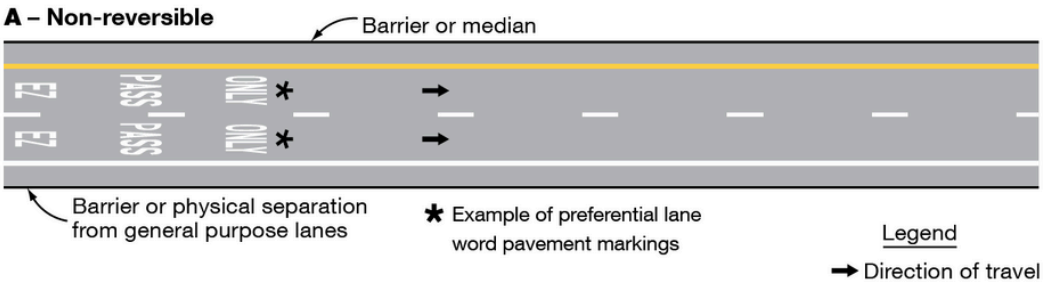


Figure 620.5.2.1 Markings for Barrier-Separated Preferential Lanes

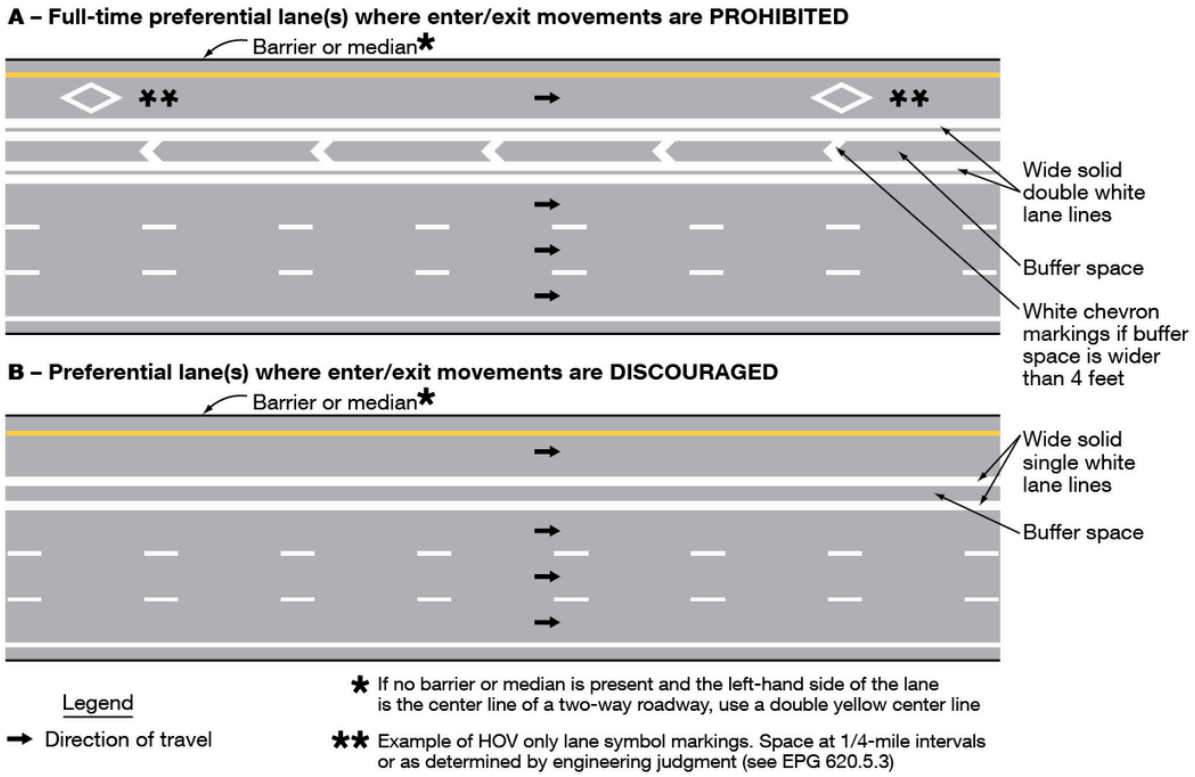


Figure 620.5.2.2 Markings for Buffer-Separated Preferential Lanes *(Sheet 1 of 2)*

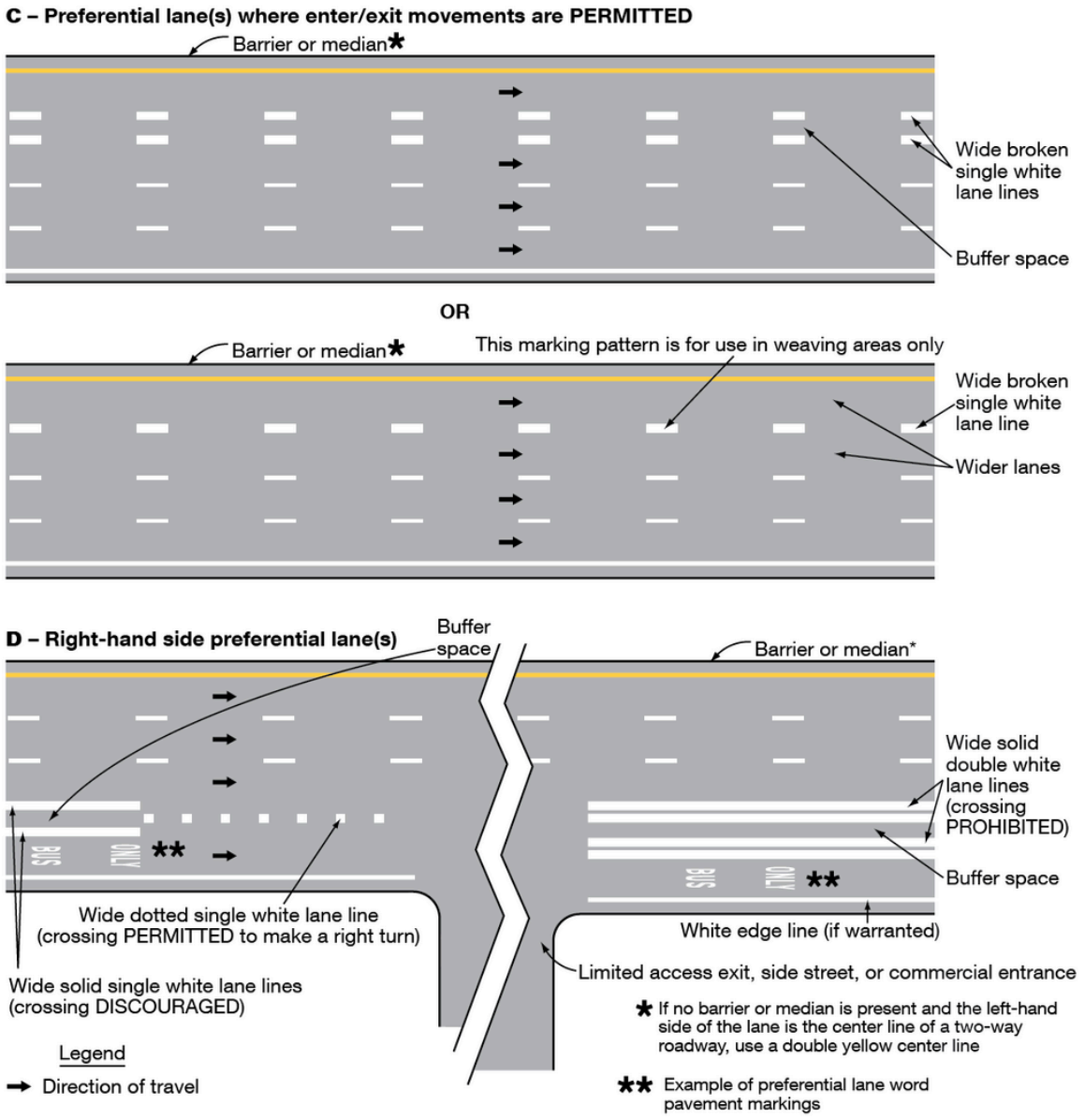


Figure 620.5.2.3 Markings for Buffer-Separated Preferential Lanes *(Sheet 2 of 2)*

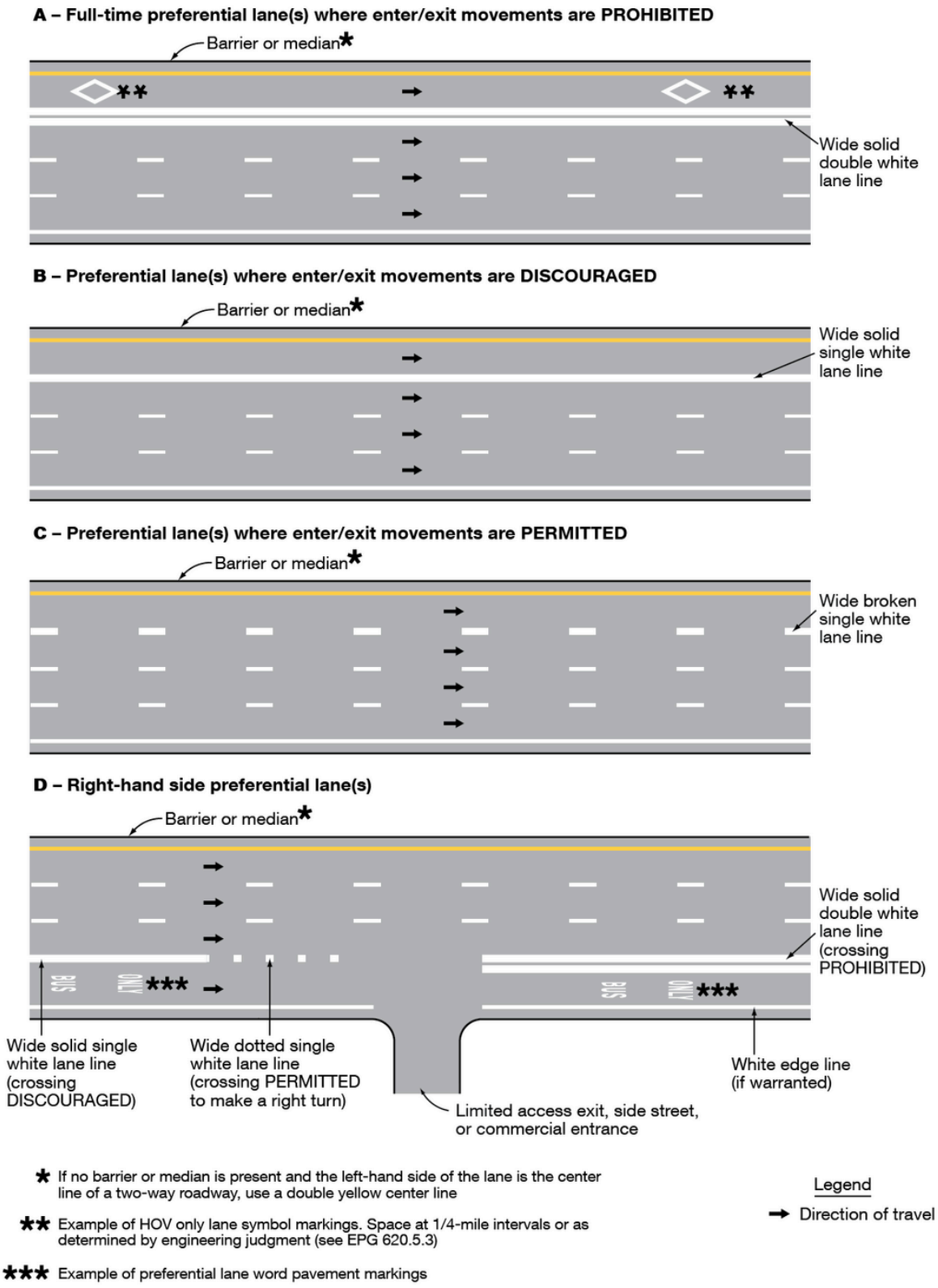


Figure 620.5.2.4 Markings for Contiguous Preferential Lanes

Guidance. Engineering judgment should determine the need for supplemental devices such as tubular markers or other channelizing devices (see EPG 620.8).

Where preferential lanes and other travel lanes are separated by a buffer space wider than 4 feet and crossing the buffer space is prohibited, chevron markings (see EPG 620.2.24) should be placed in the buffer area (see Drawing A in Figure 620.5.2.2).

The buffer space for a conventional road should be designed so that it is not misinterpreted as on-street parking, a bicycle lane, or any other type of lane.

Option. If a full-time contiguous preferential lane is separated from the other travel lanes by a wide broken (intermittent) single white line (see Drawing C in Figure 620.5.2.4), the spacing or skip pattern of the line may be reduced and the width of the line may be increased.

Standard. At direct exits from a preferential lane, dotted white line markings shall be used to separate the tapered or parallel deceleration lane for the direct exit (including the taper) from the adjacent continuing preferential through lane, to reduce the chance of unintended exit maneuvers.

The longitudinal pavement markings used for preferential lanes that are adjacent to general-purpose lanes where traffic is flowing in the opposite direction (see Figure 620.5.2.5) shall be in accordance with Table 620.5.2.2.

Table 620.5.2.2 Standard Center Line and Edge Line Markings for Counter-Flow Preferential Lanes on Divided Highways

Type of Preferential Lane	Center Line on Left-Hand Side	Edge Line on Left-Hand Side
Full-Time Contiguous	A normal width solid double yellow line	A normal solid single white line (if warranted)
Full-Time Buffer-Separated	A normal width solid double yellow line along both edges of the buffer space	A normal solid single white line (if warranted)

Support. Figure 620.5.2.5 illustrates pavement markings used for counter-flow preferential lanes on divided highways or on transitions to and from other divided highways such as bridges and crossovers.

Option. Tubular markers or other channelizing devices (see EPG 620.8) may also be used in addition to longitudinal markings to separate the opposing lanes when a counter-flow preferential lane operation is in effect.

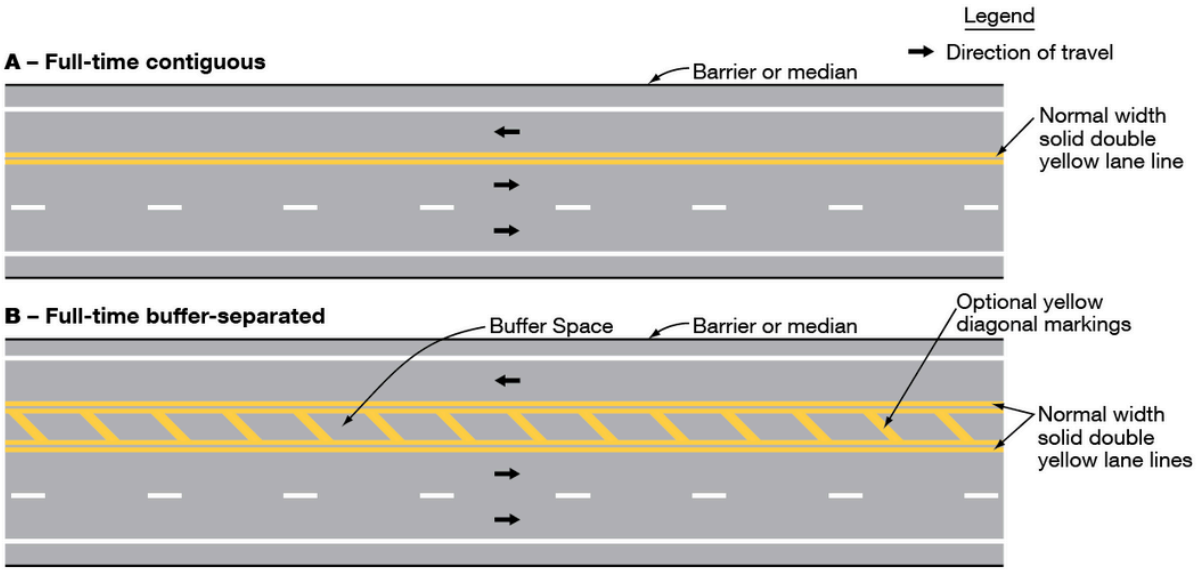


Figure 620.5.2.5 Markings for Counter-Flow Preferential Lanes on Divided Highways

620.5.3 Preferential Lane Word and Symbol Markings (MUTCD Section 3E.03)

Support. EPG 620.2.19 through EPG 620.2.21 contain information on general applications of word and symbol markings.

Standard. When a preferential lane is established, the preferential lane shall be marked with one or more of the following word or symbol markings for the preferential lane use specified:

A. Bus only lane or bus stop—the word marking BUS ONLY or BUS STOP.
B. Taxi only lane or taxi stand—the word marking TAXI ONLY or TAXI STAND.
C. Light rail transit lane—the word marking LRT ONLY.
D. Other type of preferential lane—a word marking appropriate to the restriction.

Guidance. If multiple preferential lane uses are allowed in a single lane, the word or symbol marking for each preferential lane should be used.

Standard. Pavement word or symbol markings for motorcycles and Inherently Low Emission Vehicles (ILEV) shall not be used to mark the preferential lane if motorcycles and ILEVs are allowed to use the preferential lane.

Static or changeable message regulatory signs (see MUTCD Sections 2G.03 through 2G.07) shall be used with preferential lane word or symbol markings.

All preferential lane word and symbol markings shall be white and shall be positioned laterally in the approximate center of the preferential lane.

Option. Lane-use arrow markings may be placed on the curb lanes on approaches to intersections to signify non-preferential road users can use the lane for turning movements.

Guidance. All longitudinal pavement markings, as well as word and symbol pavement markings, associated with a preferential lane should end at approximately where the Preferential Lane Ends (R3-12a or R3-12c) sign (see MUTCD Section 2G.07) designating the downstream end of the preferential only lane restriction is installed.

The spacing of the markings should be based on engineering judgment that considers the operating speed, block lengths, distance from intersections, and other factors that affect clear communication to the road user.

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In addition to a regular spacing interval, the preferential lane marking should be placed at strategic locations such as major decision points, direct exit ramp departures from the preferential lane, and along access openings to and from adjacent general-purpose lanes. At decision points, the preferential lane marking should be placed on all applicable lanes and should be visible to approaching traffic for all available departures. At direct exits from preferential lanes where extra emphasis is needed, the use of word markings (such as “EXIT” or “EXIT ONLY”) in the deceleration lane for the direct exit and/or on the direct exit ramp itself just beyond the exit gore should be considered.

620.5.4 Markings for Part-Time Travel on a Shoulder (MUTCD Section 3E.04)

Support. Shoulders are sometimes used to add capacity to a roadway in peak hour conditions to provide for transit or to provide higher throughput when open to all traffic.

A shoulder that has been opened to travel on a permanent, rather than a part-time basis is considered to be a travel lane and is signed and marked in accordance with other provisions of the EPG.

Standard. When part-time travel on a shoulder is open to all traffic, pavement word and symbol markings shall not be used in the shoulder.

When a shoulder is assigned part-time to a particular class or classes of vehicles, the shoulder shall be marked with one or more pavement word markings that identify the special use of the shoulder such as BUS ONLY, TRANSIT ONLY, or white lines formed in a diamond-shaped symbol (see EPG 620.5.3). A pavement word or symbol marking shall be provided in the shoulder immediately after exit and entry ramps (see Figure 620.5.4.1) or immediately departing an intersection at the full-width shoulder (see Figure 620.5.4.4). Appropriate regulatory signing (see MUTCD Section 2G.03) shall be installed with the pavement word or symbol markings.

The channelizing line emanating from the entrance ramp shall be a wide dotted line through the intersecting alignment of the shoulder to the theoretical gore (see Drawings A and B in Figure 620.5.4.1). At exit ramps, the channelizing line proceeding from the theoretical gore across the intersecting alignment of the shoulder shall be a wide dotted line (see Figure 620.5.4.1).

If used, the extension of the channelizing line at entrance ramps proceeding from the theoretical gore across the opening of the on-ramp alignment shall be a wide dotted line (see Drawing C in Figure 620.5.4.2) where it is demonstrated that traffic entering from an on-ramp stops or yields to traffic on the shoulder of the highway mainline.

An additional outside solid edge line shall be provided on the shoulder in accordance with EPG 620.2.10 and 620.2.11.

Guidance. Changes in edge line pattern or direction should occur at appropriate regulatory signs.

Option. At locations where traffic is allowed to enter, exit, or merge with the shoulder, a dotted edge line may be used either in a continuous manner or angled to the pavement edge (see Figure 620.5.4.4).

Red-colored pavement (see EPG 620.7.7) may be used on shoulders that allow only transit vehicles.

Standard. If used, red-colored pavement shall be discontinued on the shoulder through the influence area of the ramp (see Figure 620.5.4.1).

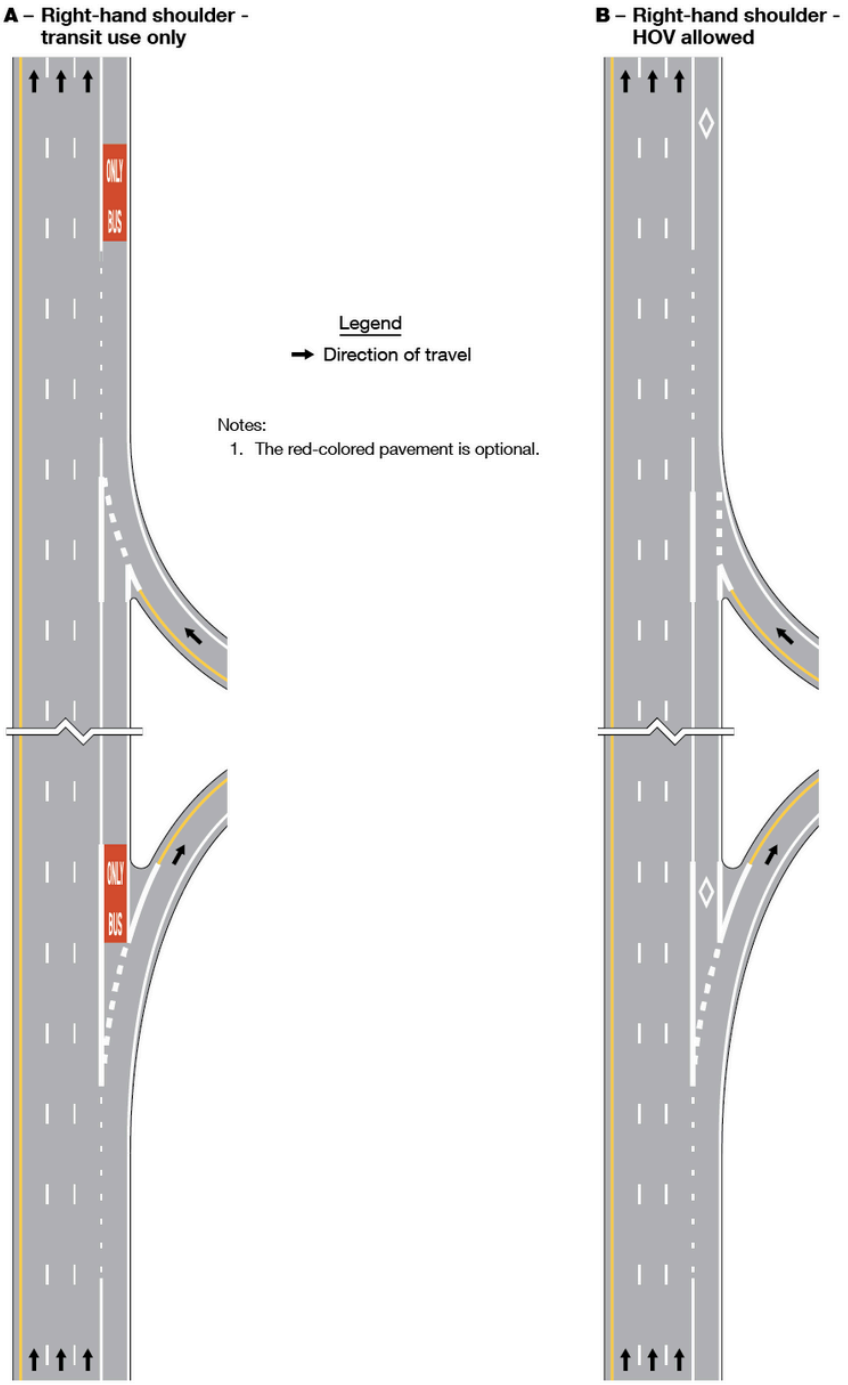


Figure 620.5.4.1 Markings for Part-Time Travel on Shoulder and Application of Pavement Word Markings *(Sheet 1 of 3)*

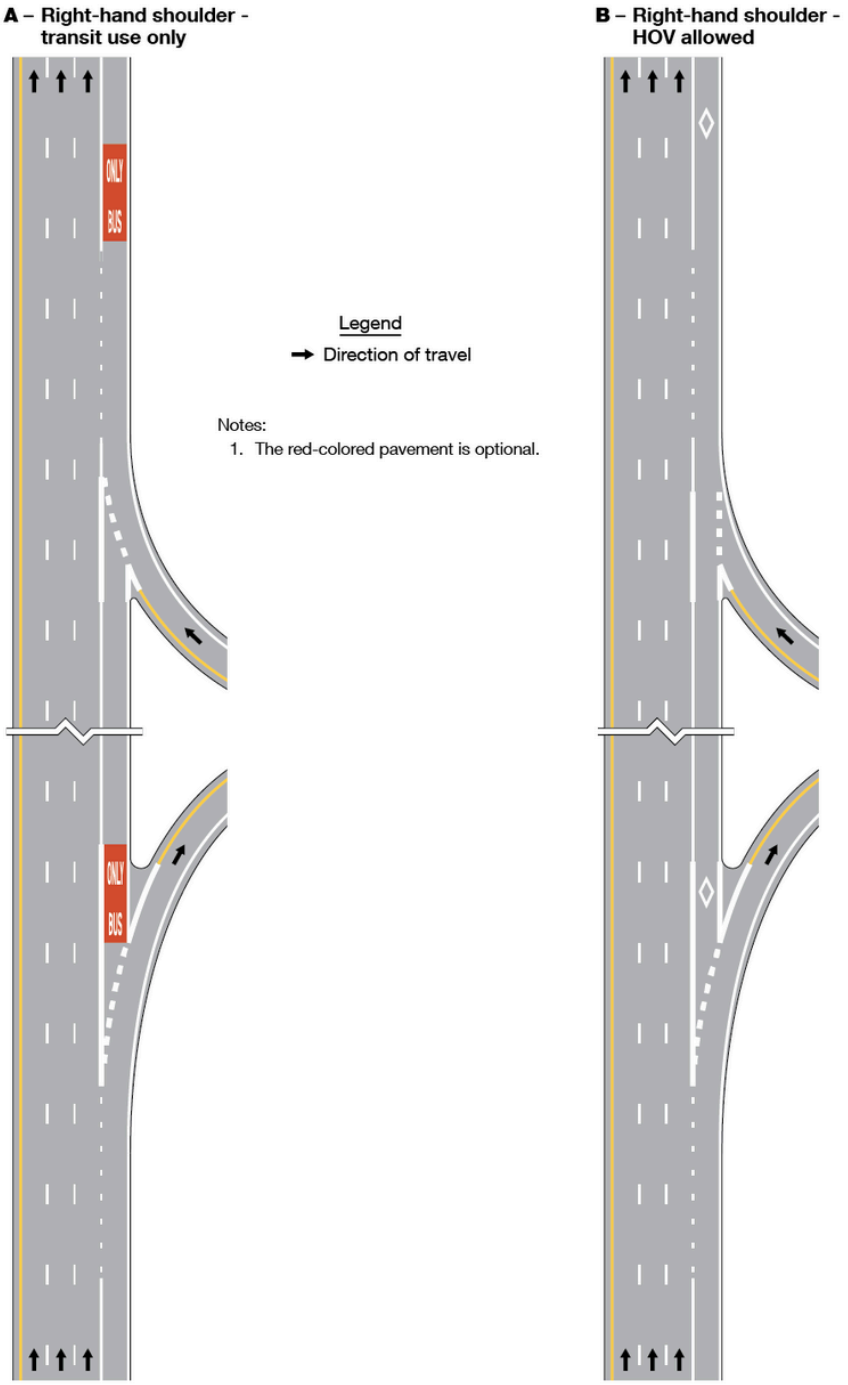


Figure 620.5.4.2 Markings for Part-Time Travel on Shoulder and Application of Pavement Word Markings *(Sheet 2 of 3)*

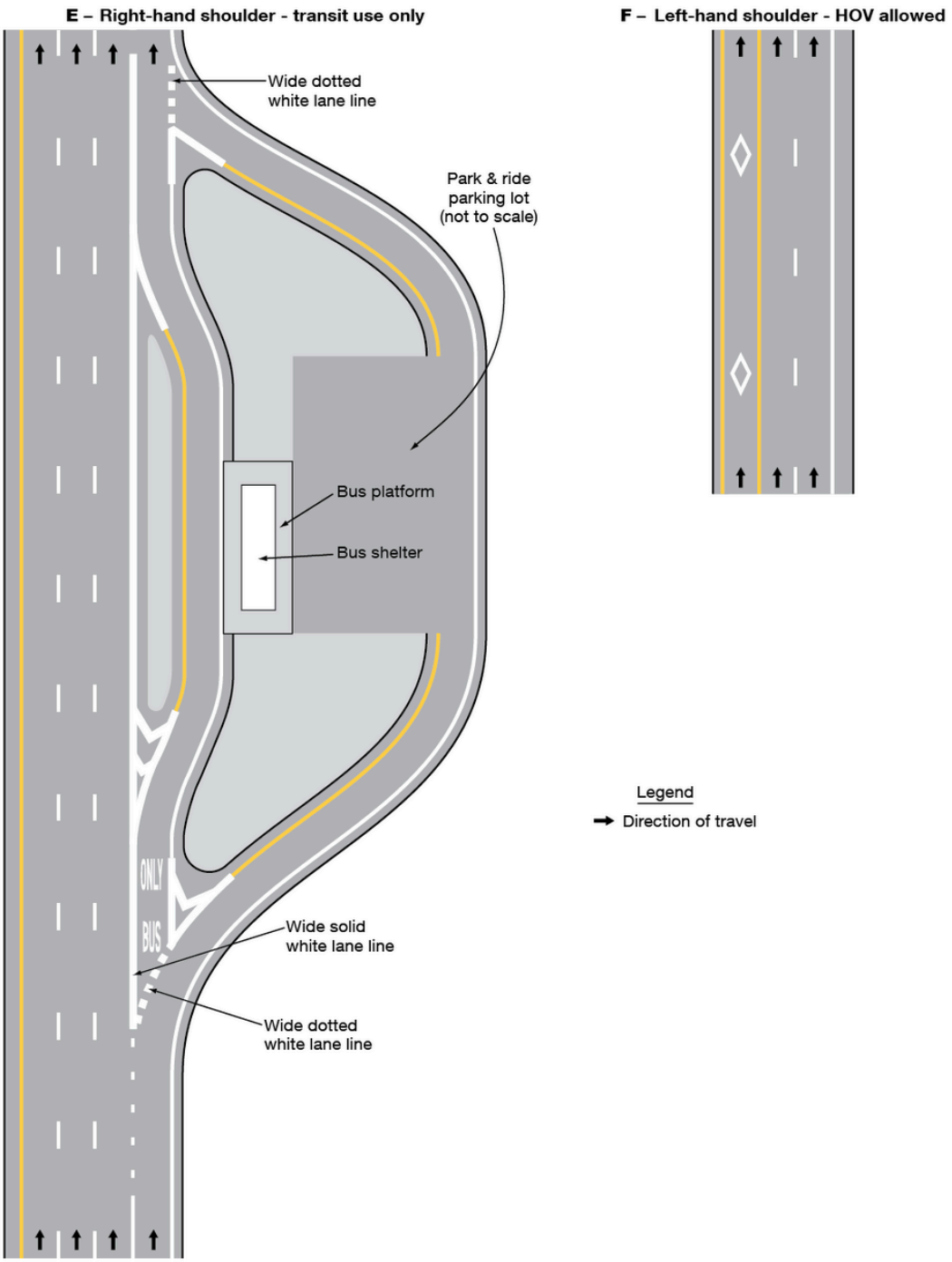


Figure 620.5.4.3 Markings for Part-Time Travel on Shoulder and Application of Pavement Word Markings *(Sheet 3 of 3)*

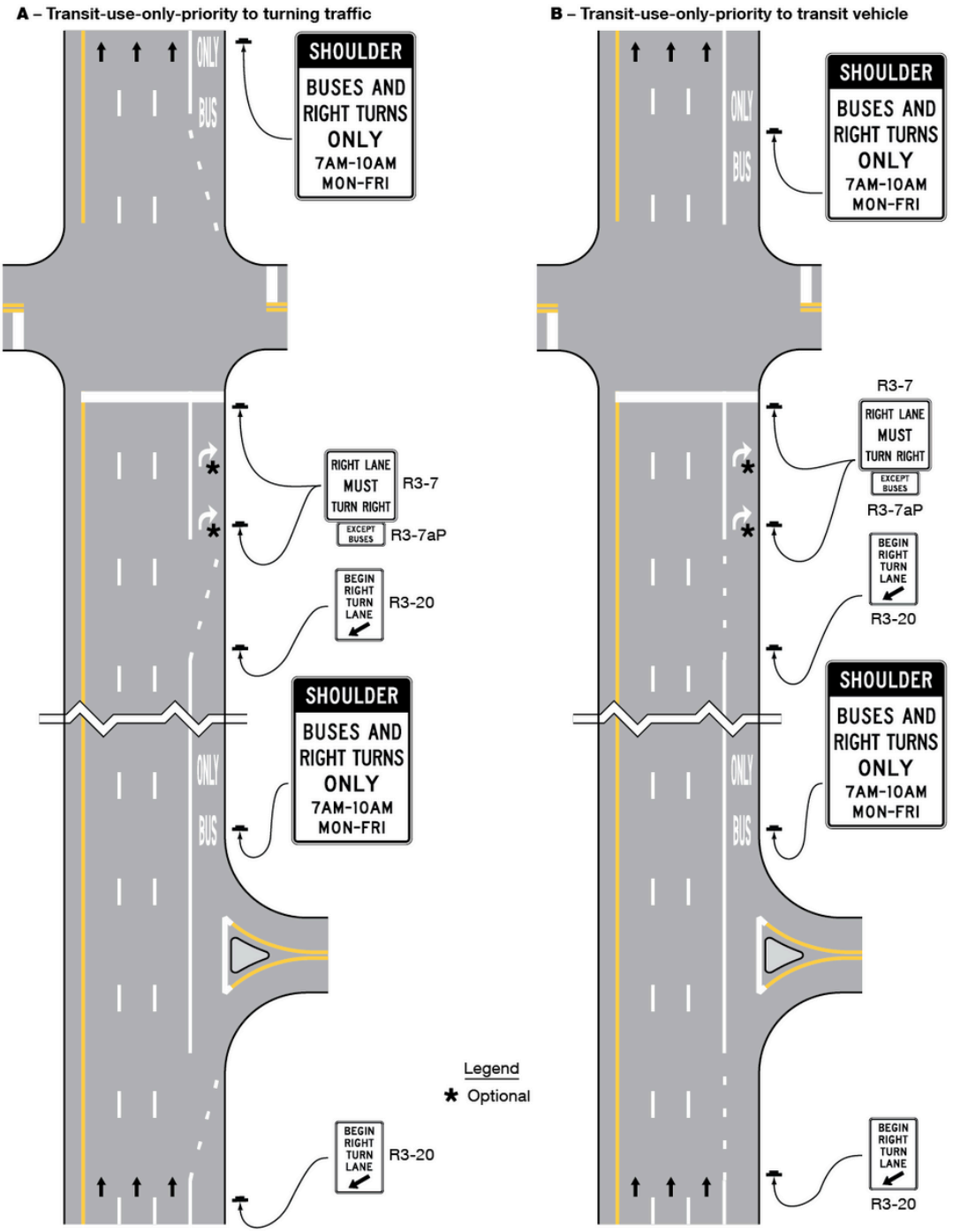


Figure 620.5.4.4 Markings for Part Time Travel on Shoulder Through Intersection

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620.6 Delineators (MUTCD Chapter 3G)

620.6.1 General (MUTCD Section 3G.01)

Support. Delineators are particularly beneficial at locations where the alignment might be confusing or unexpected, such as at lane-reduction transitions and curves. Delineators are effective guidance devices at night and during adverse weather. An important advantage of delineators in certain locations is that they remain visible when the roadway is wet or covered by snow.

Delineators are considered guidance devices to help road users navigate the roadway alignment, rather than warning devices.

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620.6.4 Placement and Spacing (MUTCD Section 3G.04)

620.6.5 Guardrail Delineation

620.6.6 Barrier Wall Delineation

Standard Plan
903.00 (https://www.modot.org/media/51221)

Option. Delineators may be used on long continuous sections of highway or through short stretches where there are changes in horizontal alignment.

620.6.2 Design (MUTCD Section 3G.02)

Standard. Delineators shall consist of retroreflective devices that are capable of clearly retroreflecting light under normal atmospheric conditions from a distance of 1,000 feet when illuminated by the high beams of standard automobile lights. They shall be mounted on crashworthy (see definition in EPG 911 (MUTCD Section 1C.02)) supports.

Retroreflective elements for delineators shall have a minimum vertical and horizontal dimension of 3 inches, or a minimum diameter dimension of 3 inches when circular.

Support. Within a series of delineators along a roadway, delineators for a given direction of travel at a specific location are referred to as single delineators if they have one retroreflective element for that direction, double delineators if they have two identical retroreflective elements for that direction mounted together, or vertically-elongated delineators if they have a single retroreflective element with an elongated vertical dimension to approximate the vertical dimension of two separate single delineators.

Option. A vertically-elongated delineator of appropriate size may be used in place of a double delineator.

620.6.3 Application (MUTCD Section 3G.03)

Standard. The color of delineators shall comply with the color of edge lines stipulated in EPG 620.1.3 and 620.2.10.

A series of single delineators shall be provided on the right-hand side of freeways and expressways and on at least one side of interchange ramps, except when either Condition A, Condition B, or Condition C is met, as follows:

A. On tangent sections of freeways and expressways when both of the following conditions are met:

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1. Inlaid pavement markers are used continuously on lane lines throughout all curves and on all tangents to supplement pavement markings, and
2. Roadside delineators are used to lead into all curves, or

B. On sections of roadways where continuous lighting is in operation between interchanges.
C. On interstate or other highways with Emergency Reference Markers (D10-5) (See EPG 903.9.4) installed on the right-hand side of the roadway.

Option. Delineators may be provided on other classes of roads.

A series of single delineators may be provided on the left-hand side of roadways.

Chevron Alignment (W1-8) signs may be used instead of or in addition to standard delineators, as provided in EPG 903.3.8.

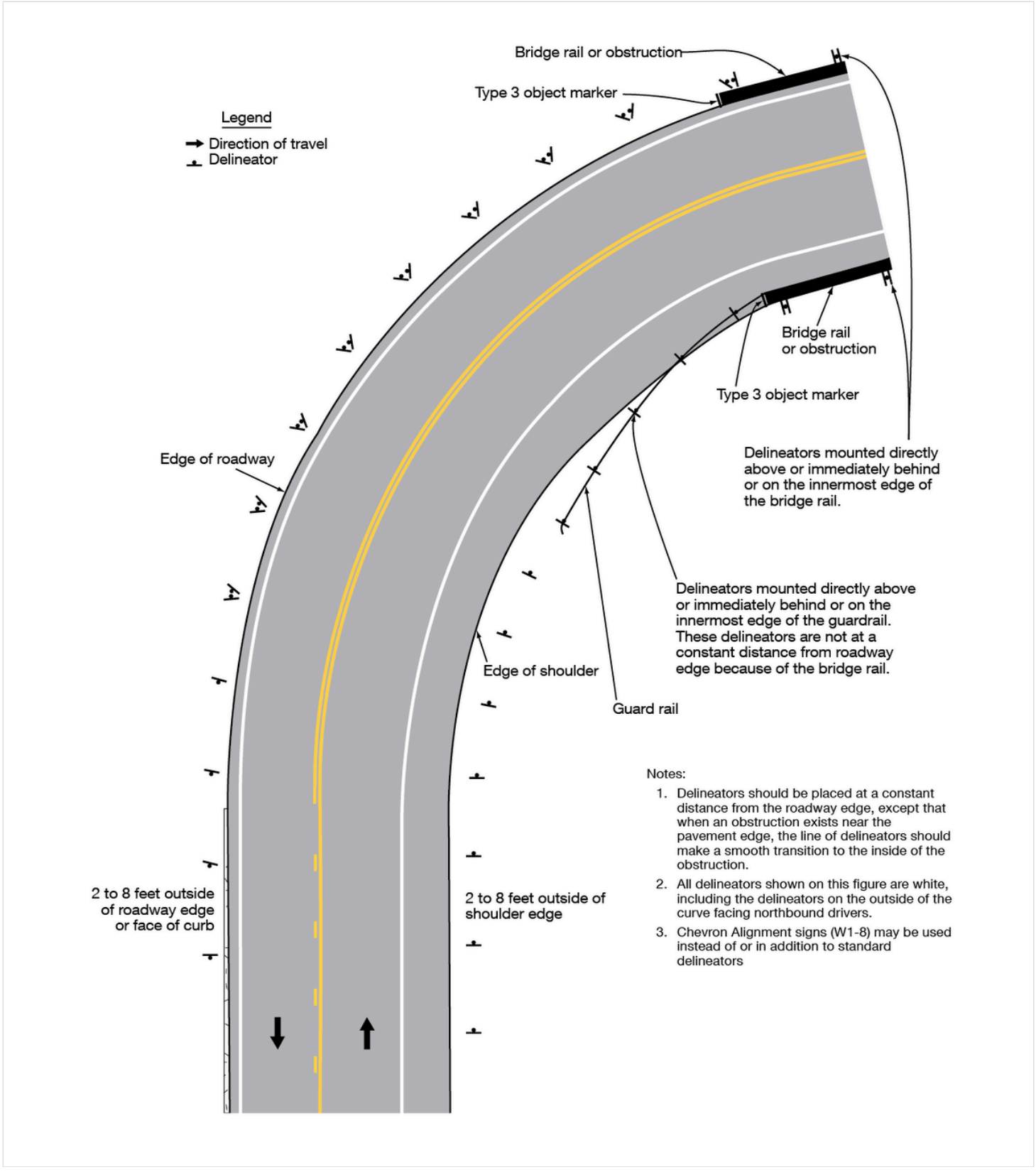


Figure 620.6.3.1 Examples of Delineator Placement

Standard. Delineators on the left-hand side of a two-way roadway shall be white (see Figure 620.6.3.1).

Guidance. A series of single delineators should be provided on the outside of curves on interchange ramps.

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Where median crossovers are provided for official or emergency use on divided highways and where these crossovers are to be marked with pavement markings, a double yellow delineator should be placed on the left-hand side of the through roadway on the far side of the crossover for each roadway.

Double or vertically-elongated delineators should be installed at approximately 100-foot intervals along acceleration and deceleration lanes.

A series of delineators should be used wherever guardrail or other longitudinal barriers are present along a roadway or ramp.

Option. A strip of retroreflective material may be used to enhance delineation at intersections. The retroreflective material may be installed on a sign support for signs located within the corner radius that face the intersecting road.

Standard. If a strip of retroreflective material is used on the sign support for delineation, it shall be at least 4 inches in width, it shall be placed for the full length of the support from the bottom of the sign and extending down the length of the post, with the bottom of the retroreflective strip not being taller than 2 feet above the edge of the roadway, and its color shall match the color of the adjacent edge line. The retroreflective strip for delineation shall be installed facing the direction of travel on the highway, not facing the intersecting road. The retroreflective strip shall not display any legend or other information. MoDOT's standard for this application uses a 4" x 72" aluminum panel with the retroreflective material applied to it where the panel can then be attached to the sign post using the same types of fasteners used to attach signs. These panels are available from MoDOT's third party sign fabricator.

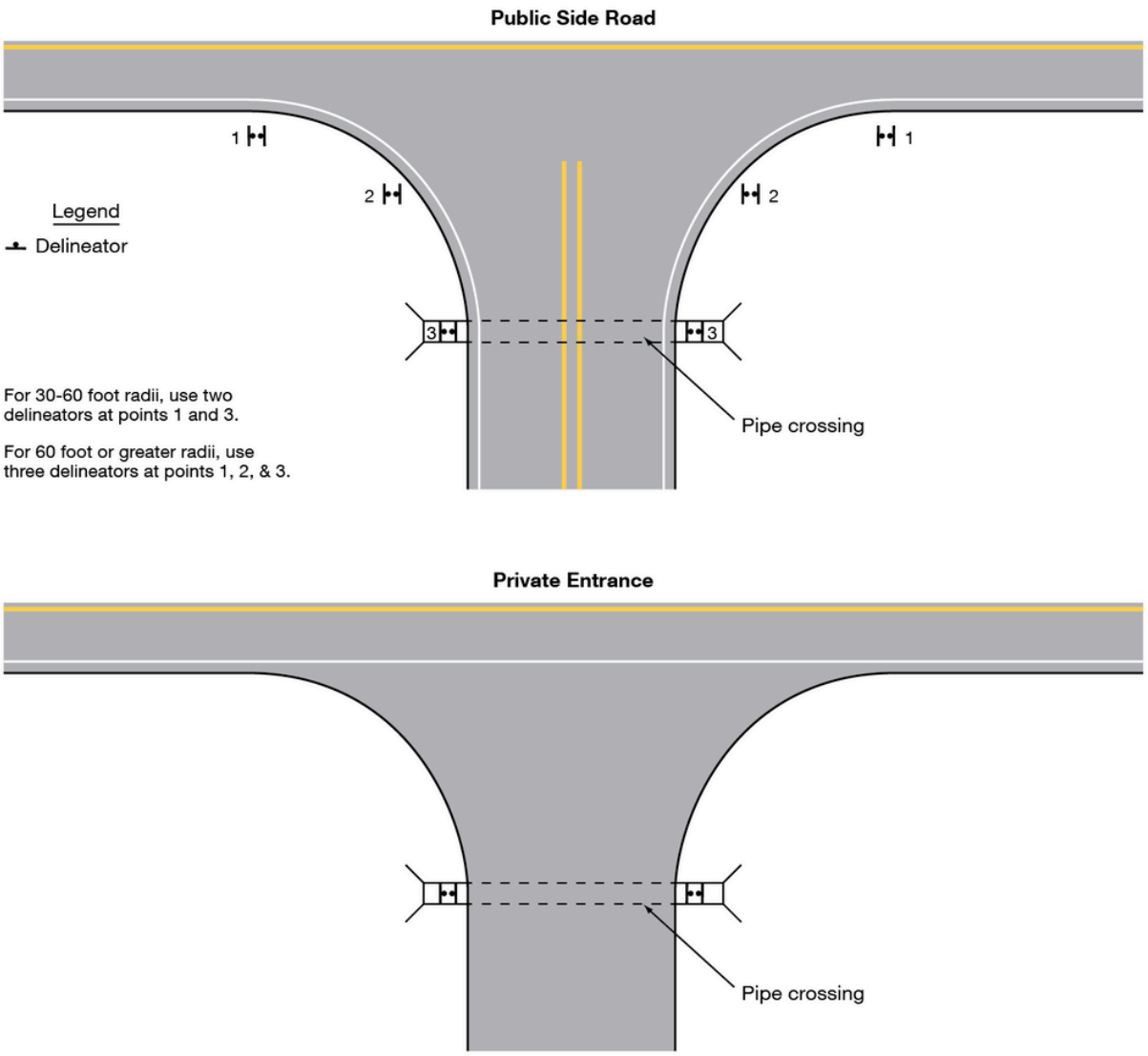


Figure 620.6.3.2 Installation of Delineators on Public Side Roads and Private Entrances

Option. Installation of delineators may be provided on public roads as defined in EPG 911 (MUTCD Section 1C.02). A maximum of three delineators can be installed per approach as indicated in Figure 620.6.3.2, Installation of Delineators on Public Side Roads and Private Entrances. Delineation of the right-hand side of the radius may be provided by the use of a strip of retroreflective material installed on the STOP sign post if the post is located appropriately.

A property owner may request the delineation of a private entrance.

Support. When delineation is used at a private entrance the preference of the department is to have the property owners use white reflective tape, but other colors are permitted.

Standard. When delineation is used at a private entrance the owner shall be responsible for the installation and maintenance of such delineation. MoDOT will allow the installation of one lightweight post such as a metal fence post at each end of the pipe crossing or within the radius of the entrance. If reflectors are used rather than tape, one reflector on each side of the post, or a total of four reflectors, will be permitted.

Option. Red delineators may be used on the reverse side of any delineator where it would be viewed by a road user traveling in the wrong direction on that particular ramp or roadway.

Standard. Red delineators shall be used on the back side of delineators at off ramps to discourage wrong way driving. The red delineators shall be used starting at the crossroad and extending to the start of the deceleration lane on the main line.

Guidance. Except as provided in the fourth Option paragraph of EPG 620.2.14, delineators of the appropriate color should be used to indicate a lane-reduction transition where either an outside or inside lane merges into an adjacent lane.

When used for lane-reduction transitions, the delineators should be installed adjacent to the lane or lanes reduced for the full length of the transition and should be so placed and spaced to show the reduction (see EPG 620.2.14 and Figure 620.2.14).

On a highway with continuous delineation on either or both sides, delineators should be carried through transitions.

620.6.4 Placement and Spacing (MUTCD Section 3G.04)

Guidance. Except as provided in the following paragraph, delineators should be mounted at a height, measured vertically from the bottom of the lowest retroreflective device to the elevation of the near edge of the roadway, of approximately 4 feet (see Standard Plan 903.00 (https://www.modot.org/media/51221).

Option. When mounted on the face of or on top of guardrails or other longitudinal barriers, delineators may be mounted at a lower elevation than the normal delineator height recommended in the previous paragraph.

Guidance. Delineators should be placed 2 to 8 feet outside the outer edge of the shoulder, or if appropriate, in line with the roadside barrier that is 8 feet or less outside the outer edge of the shoulder.

Delineators should be placed at a constant distance from the edge of the roadway, except where a guardrail or other longitudinal barrier is present. Where an obstruction intrudes into the space between the pavement edge and the extension of the line of the delineators, the delineators should be transitioned to be in line with or inside the innermost edge of the obstruction. Post mounted delineators should not be installed behind guardrail or barrier wall if guardrail delineation is present.

Delineators should not present a vertical or horizontal clearance obstacle for pedestrians.

Delineators should be spaced 528 feet apart on mainline tangent sections. Delineators should be spaced 100 feet apart on ramp tangent sections.

Option. On a highway with continuous delineation on either or both sides, the spacing between a series of delineators may be closer.

When uniform spacing is interrupted by such features as driveways and intersections, delineators which would ordinarily be located within the features may be relocated in either direction for a distance not exceeding ¼ of the uniform spacing. Delineators still falling within such features may be eliminated.

Delineators may be transitioned in advance of a lane transition or obstruction as a guide for oncoming traffic.

Guidance. The spacing of delineators should be adjusted on approaches to and throughout horizontal curves so that several delineators are always simultaneously visible to the road user. The approximate spacing shown in Table 620.6.4 should be used.

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Option. When needed for special conditions, delineators of the appropriate color may be mounted in a closely-spaced manner on the face of or on top of guardrails or other longitudinal barriers to form a continuous or nearly-continuous "ribbon" of delineation.

Support. Examples of delineator installations are shown in Figure 620.6.3.1.

Table 620.6.4 Approximate Spacing for Delineators on Horizontal Curves

Radius (R) of Curve	Approximate Spacing (S) on Curve
50 feet	20 feet
115 feet	25 feet
180 feet	35 feet
250 feet	40 feet
300 feet	50 feet
400 feet	55 feet
500 feet	65 feet
600 feet	70 feet
700 feet	75 feet
800 feet	80 feet
900 feet	85 feet
1,000 feet	90 feet

Notes:

1. Spacing for specific radii may be interpolated from table.
2. The minimum spacing should be 20 feet.
3. The spacing on curves should not exceed 300 feet.
4. In advance of or beyond a curve, and proceeding away from the end of the curve, the spacing of the first delineator is 2S, the second 3S, and the third 6S, but not to exceed 300 feet.
5. S refers to the delineator spacing for specific radii computed from the formula $S = \sqrt[3]{R - 50}$
6. The distances for S shown in the table above were rounded to the nearest 5 feet.

620.6.5 Guardrail Delineation

Standard. All guardrail shall be delineated in accordance with Section 606.10.2.3 (https://www.modot.org/missour-standard-specifications-highway-construction) of the Standard Specifications. The design of the guardrail delineators shall be in accordance with Standard Plan 903.00 (https://www.modot.org/media/51221) and Standard Specifications Sec 1065 (https://www.modot.org/missour-standard-specifications-highway-construction). The color of the retroreflective sheeting used shall match the color of the adjacent edge line. If no edge line is present, white shall be used on the right-hand side facing approaching traffic.

On two-lane roads with two-way traffic the guardrail shall be delineated with white retroreflective sheeting on both sides of the delineator, including at bridge approaches.

If guardrail is present at off ramps, the back side of the guardrail delineator shall be red retroreflective sheeting. The red sheeting is used on the back side of guardrail delineators from the crossroad to the start of the deceleration lane on the main line.

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Option. The use of the red sheeting on the back side of guardrail delineators may be used wherever there is a need to discourage wrong way driving.

620.6.6 Barrier Wall Delineation

Standard. Permanent barrier walls and bridge barrier walls shall be delineated in accordance with Standard Specifications Sec 617.30 (https://www.modot.org/business\standards_and_specs/SepcbookEPG.pgd#page=9). The design of the barrier wall delineators shall be in accordance with Standard Plan 903.00 (https://www.modot.org/media/51221) and Standard Specifications Sec 1065 (http://www.modot.org/business/standards_and_specs/SpecbokEPG.pdf#page=14). The color of the retroreflective sheeting used shall match the color of the adjacent edge line.

Guidance. Where there is traffic on both sides of a barrier wall, a two-sided delineator with retroreflective sheeting on both sides, should be used. On two-lane roads the bridge barrier walls should be delineated with white retroreflective sheeting on both sides of the delineator.

Standard. If barrier wall is present at off ramps, the back side of the barrier wall delineator shall be red retroreflective sheeting. The red sheeting is used on the back side of barrier wall delineators from the crossroad to the start of the deceleration lane on the main line.

Option. The use of the red sheeting on the back side of guardrail delineators may be used wherever there is a need to discourage wrong way driving.

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620.7 Colored Pavement (MUTCD Chapter 3H)

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620.7.7 Red-Colored Pavement for Public Transit Systems (MUTCD Section 3H.07)

620.7.1 Standardization of Application (MUTCD Section 3H.01)

Guidance. Colored pavements are not currently used on MoDOT facilities. The Highway Safety and Traffic Division should be contacted for guidance when considering the use of colored pavements.

Support. Colored pavements consist of differently-colored road paving materials, such as colored asphalt or concrete. Other surface treatments can be applied to the surface of a road, island, or area outside the traveled way to simulate a colored pavement.

If non-retroreflective colored pavement is used as a purely aesthetic surface treatment (see EPG 620.7.3) within the provisions of EPG 620.7 and are not intended to communicate regulations, warnings, guidance, or other information to road users, the colored pavement is not considered to be a traffic control device, even if it is located between the lines of a crosswalk.

Standard. If colored pavement is used within the traveled way, on flush or raised islands, or on shoulders to communicate regulations, warnings, guidance, or other information to road users, or if retroreflectivity is used, the colored pavement shall be considered a traffic control device and shall be limited to the colors and applications specified in EPG 620.7.

Except as provided in the first Option paragraph of EPG 620.7.7, colored pavement shall only be used if the corresponding regulations, warnings, or guidance are applicable at all times.

Guidance. Colored pavements used as traffic control devices should only be used where the color pavement contrasts significantly with adjoining paved areas.

Support. The chromaticity coordinates that define the ranges of acceptable colors for traffic control devices are found in the Appendix to Subpart F of 23 CFR 655.

Standard. If used, colored pavement shall only be used to supplement other markings as provided in the EPG.

Support. Longitudinal pavement markings, crosswalks, pavement marking symbols, and elongated route markers are not considered colored pavements.

620.7.2 Materials (MUTCD Section 3H.02)

Option. Colored pavements may be either retroreflective or non-retroreflective, in accordance with the provisions of EPG 620.7 for specific applications.

Guidance. If surface treatments are applied to the surface of a road, island, or other area outside the traveled way to simulate a colored pavement, pavement marking materials should be selected that will minimize loss of traction for road users (see the second paragraph of EPG 620.1.2).

Support. Providing for retroreflectivity, such as incorporating glass beads, can affect the skid resistance of pavement markings.

Installation of colored pavement to one lane or an area or portion of a multi-lane traveled way can create differentials in skid resistance values between the areas of colored pavement and non-colored pavement that might be unexpected by the road user.

620.7.3 Aesthetic Surface Treatments (MUTCD Section 3H.03)

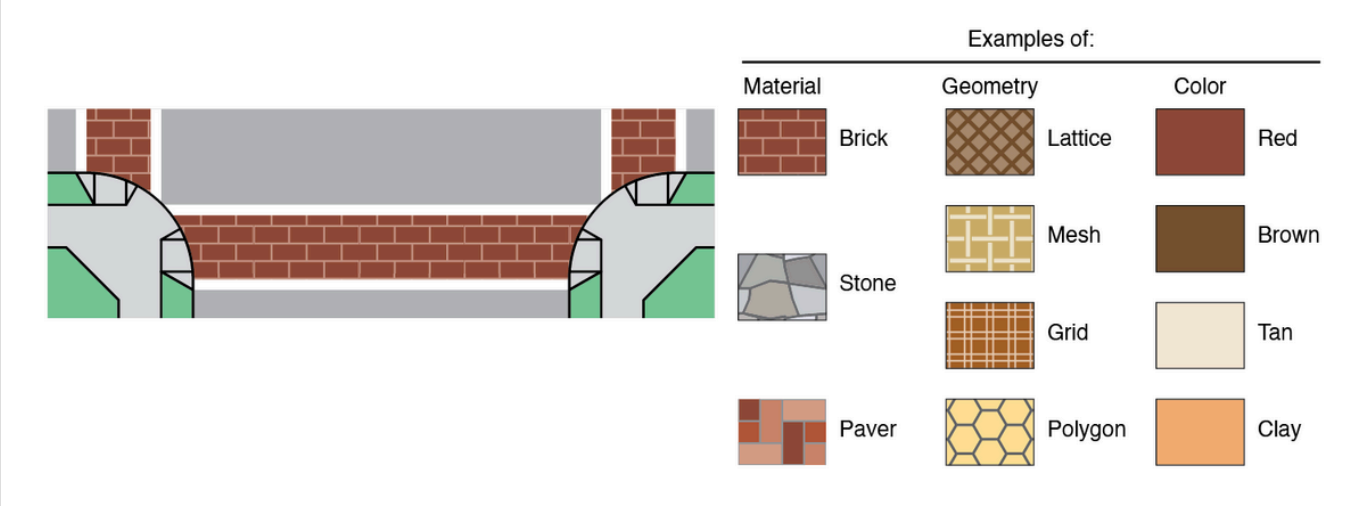


Figure 620.7.3 Aesthetic Treatments for Transverse Crosswalks

Support. Aesthetic surface treatments are sometimes used between the transverse lines within a crosswalk, in islands, in medians, in shoulders, within sidewalk extensions designated by pavement markings, or in other areas outside of the traveled way.

Common examples of materials used as aesthetic surface treatments include brick, paving bricks, paving stones, or other materials designed to simulate such paving. Some examples of geometries for aesthetic surface treatments include honeycomb, lattice, mesh, grid, and regular polygon patterns.

Surfaces with individual units laid out of plane and those that are heavily-textured, rough, or chamfered, could increase rolling resistance and subject pedestrians who use wheelchairs to the effects of vibration; it is desirable to minimize surface discontinuities.

Common examples of colors for aesthetic surface treatments incorporated into the material or geometry are brick red, rust, brown, burgundy, clay, tan, or similar earth-tone equivalents (see Figure 620.7.3).

Standard. Aesthetic surface treatments shall not interfere with traffic control devices.

Aesthetic surface treatments shall not be of a surface that can confuse pedestrians with vision disabilities that rely on tactile treatments or cues for navigation.

Colors used for aesthetic surface treatments shall be outside the chromaticity coordinates that define the ranges of acceptable colors for traffic control devices.

Patterns that constitute a purely aesthetic surface treatment shall be devoid of advertising and shall not contain elements of retroreflectivity.

Patterns that constitute a purely aesthetic surface treatment for the interior area of a crosswalk shall not be designed to encourage road users to remain in the crosswalk, engage or interact with the pattern, or otherwise inhibit users from crossing the street in a safe and efficient manner.

Guidance. Aesthetic surface treatments should not use colors or patterns that degrade the contrast of markings used to delineate an area, or that might be mistaken by road users as a traffic control application.

To provide contrast, a gap of at least one-half the width of the white transverse line used to establish the crosswalk, but not less than 6 inches, should be used between the white crosswalk lines and the aesthetic surface treatment, such as unmarked pavement or a black contrast line (see EPG 620.1.3).

To provide contrast, a gap of at least the width of the longitudinal line used to establish the area should be used between the longitudinal line and the aesthetic surface treatment, such as unmarked pavement or a black contrast line (see EPG 620.1.3). If the longitudinal line is a double line, the gap should be at least the width of one of the lines that makes up the double line.

Aesthetic surface treatments should not contain pictographs, illustrations, or symbols.

620.7.4 Yellow-Colored Pavement (MUTCD Section 3H.04)

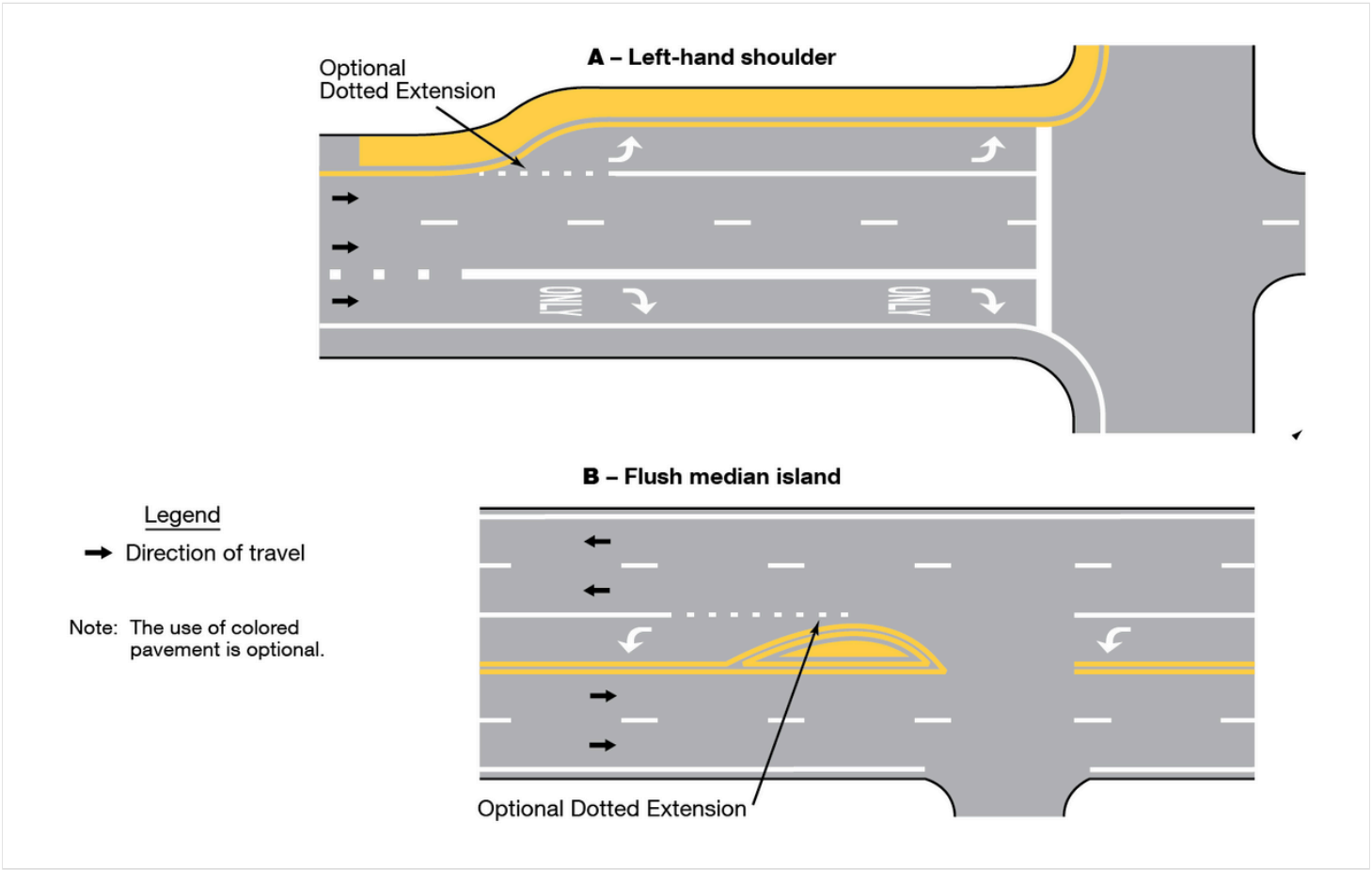


Figure 620.7.4 Examples of Yellow-Colored Pavement Applications

Support. Yellow-colored pavement is used to enhance the conspicuity of areas separating traffic traveling in opposite directions of travel and the left-hand edge of the roadway.

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Standard. If used, yellow-colored pavement shall be limited to:

A. Flush or raised median islands separating traffic flows in opposite directions,
B. Left-hand shoulders of divided highways, and
C. Left-hand shoulders of one-way streets or ramps.

Yellow-colored pavement shall not be incorporated into elements of the roadway that function as two-way left-turn lanes.

Yellow-colored pavement shall not be used on channelizing islands where traffic travels in the same general direction on both sides.

Option. Yellow-colored pavement may be installed for the entire length of the roadway, island, or shoulder, or for only a portion or portions of the roadway, island, or shoulder.

Support. An example of an application of yellow-colored pavement is shown in Figure 620.7.4.

620.7.5 White-Colored Pavement (Section 3H.05)

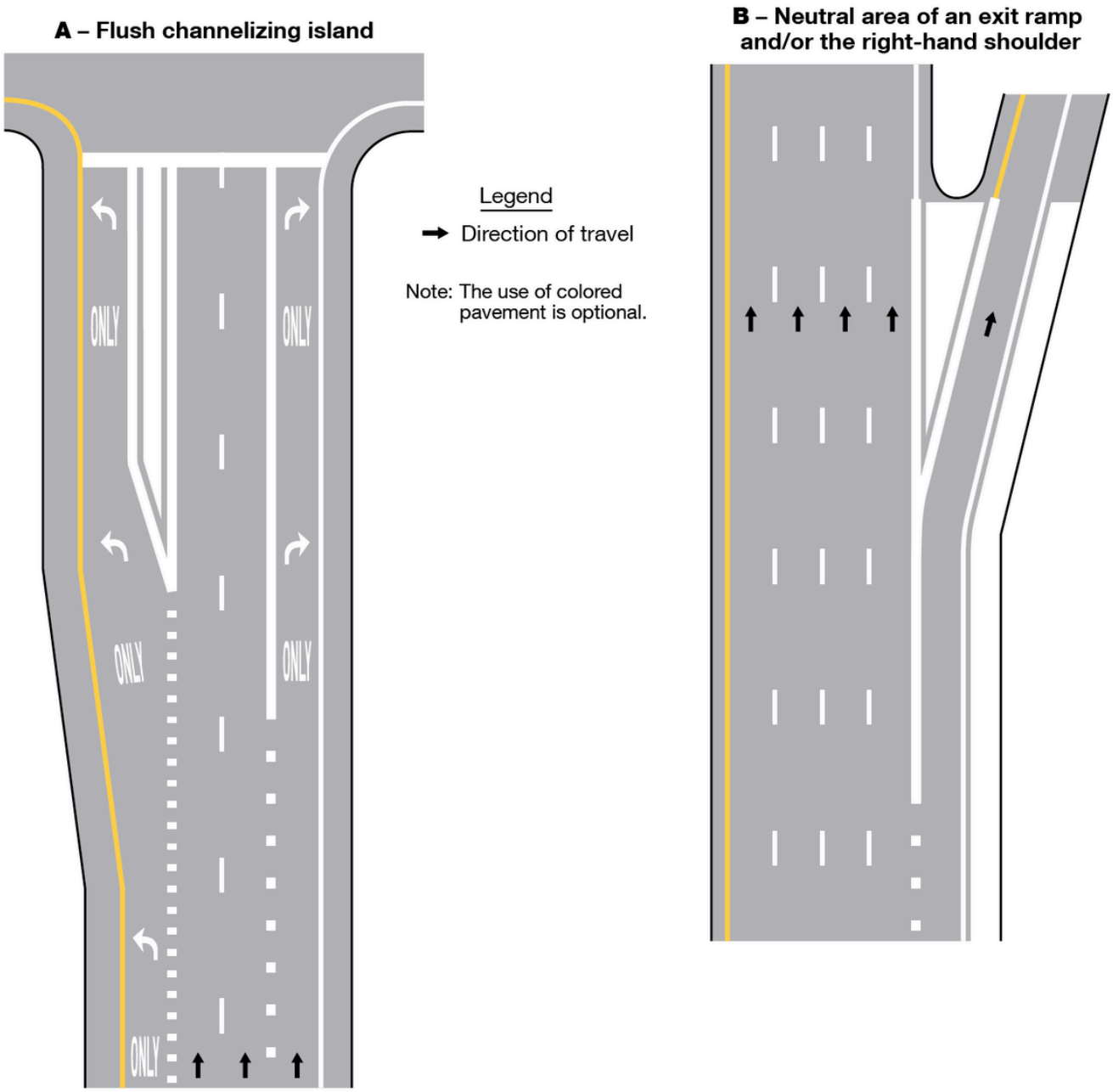


Figure 620.7.5 Examples of White-Colored Pavement Applications

Support. White-colored pavement is used to enhance the conspicuity of areas separating traffic traveling in the same direction of travel and the right-hand edge of the roadway**.**

Standard. If used, white-colored pavement shall be limited to:

A. Flush or raised channelizing islands where traffic passes on both sides in the same general direction,
B. Right-hand shoulders,
C. Exit gore areas, and
D. Entrance gore areas.

Guidance. When used on right-hand shoulders, white-colored pavement should be limited to areas not intended for use by motor vehicle traffic except those shoulders designated for emergency use.

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Option. White-colored pavement may be installed for the entire length of the roadway, island, or shoulder, or for only a portion or portions of the roadway, island, or shoulder.

White-colored pavement may be used instead of chevron markings (see EPG 620.2.15 and 620.2.24) in neutral areas.

Support. An example of an application of white-colored pavement is shown in Figure 620.7.5.

620.7.6 Green-Colored Pavement for Bicycle Facilities (MUTCD Section 3H.06)

Support. Green-colored pavement is used to enhance the conspicuity of locations where bicyclists are expected to operate, and areas where bicyclists and other traffic might have potentially conflicting, weaving, or crossing movements. Green-colored pavement is also used to enhance the conspicuity of word, symbol, and/or arrow pavement markings when these markings are used in certain bicycle facilities.

MoDOT does not typically install or maintain green-colored pavement for bicycle facilities.

Guidance. If green-colored pavement is installed on a MoDOT route, an agreement should be in place with the local agency that will maintain the green-colored pavement.

Standard. If used, green-colored pavement shall be limited to the applications described in Chapter 9E of the MUTCD.

Green-colored pavement shall not be:

A. Incorporated into electric-vehicle parking stations or parking stalls,
B. Incorporated into crosswalks (see EPG 620.3),
C. Used as a background for shared-lane markings (see EPG 914.5.9), or
D. Used instead of the required markings for bicycle facilities (see EPG 914.5).

If used, the pattern of the green-colored pavement supplementing dotted extension lines shall match the pattern of the dotted lines, thus filling in only the areas that are directly between a pair of dotted line segments. If used, the pattern of the green-colored pavement supplementing a dotted longitudinal line, which defines a bicycle lane (see the third Guidance paragraph of EPG 914.5.2), shall match the pattern of the dotted line, thus filling in only the areas that are directly between a line segment and the curb, or, in the absence of a curb, the edge of the roadway.

Guidance. If green-colored pavement is used within separated bicycle lanes on an independent alignment, it should be used only at the entrances to those facilities from roadways open to public travel or at conflict, weaving, or crossing locations.

If green-colored pavement is used within shared-use paths, it should be used only where pedestrian and bicyclist movements are separated and for only a portion (or portions) of the path designated for bicyclist use.

Option. Green-colored pavement may be installed for the entire length of a bicycle lane or bicycle lane extension or for only a portion (or portions) of the bicycle lane or bicycle lane extension.

Green-colored pavement may be installed for the entire length of a physically-separated bikeway within the roadway or for only a portion (or portions) of the physically-separated bikeway within the roadway.

Guidance. Appropriate regulatory (see MUTCD Chapter 9B) or guide signing (see MUTCD Chapter 9D) should be installed to provide related information to the presence of the colored pavement.

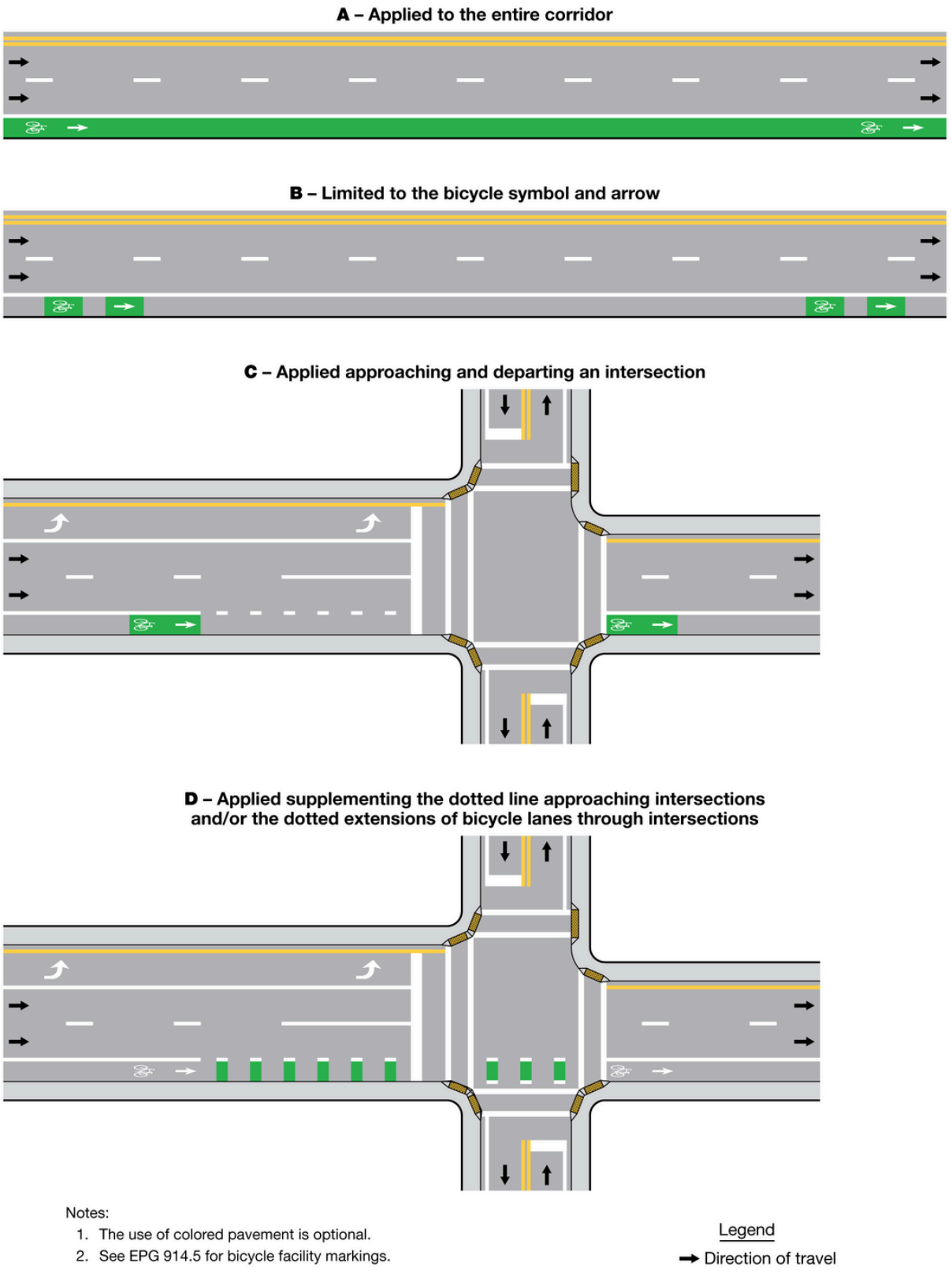


Figure 620.7.6 Examples of Green-Colored Pavement Applications

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Support. Examples of applications of green-colored pavement are shown in Figure 620.7.6.

620.7.7 Red-Colored Pavement for Public Transit Systems (MUTCD Section 3H.07)

Support. Red-colored pavement is used to enhance the conspicuity of locations, station stops, or travel lanes in the roadway exclusively reserved for vehicles of public transit systems or multi-modal facilities where public transit is the primary mode. These public transit vehicles include buses, streetcars, trolleys, light-rail trains, and rapid transit fleets.

Option. Red-colored pavement may be used where engineering judgment determines that one or more of the following conditions are expected to result from its application:

A. Increased travel speeds will be expected by the public transport vehicle after an exclusive lane or facility is provided,
B. Reduced overall service time through the corridor will be expected by the public transport vehicle,
C. Decreased rates of illegal parking or occupation of the transit or multi-mode lane or facility will be expected.

Standard. If used, red-colored pavement shall be applied only in lanes, areas, or locations where general-purpose traffic is not allowed to use, queue, wait, idle, or otherwise occupy the lane, area, or location where red-colored pavement is used.

Red-colored pavement shall be installed for the full width of the lane.

Option. Red-colored pavement may be used for full-time or part-time operations.

Red-colored pavement may be installed for the entire length of a restricted lane or for only a portion (or portions) of the restricted lane.

Red-colored pavement may be installed in a broken (intermittent) or dotted pattern where entrance into the transit lane is permitted by general traffic, for example where general traffic is allowed in a transit lane in advance of a turn.

Standard. Regulatory signs (see EPG 903.2.2 and MUTCD Section 2G.03) shall be used to establish the allowable use of the lane, area, or location. Regulatory signs shall also be used when it is determined that other vehicles will be allowed to enter the lane to turn or bypass queues.

Guidance. If red-colored pavement is used on public transit facilities separated from the roadway or on facilities on an independent alignment, it should be used only at the entrances to those facilities from roadways open to public travel.

Support. Examples of applications of red-colored pavement are shown in Figure 620.7.7.

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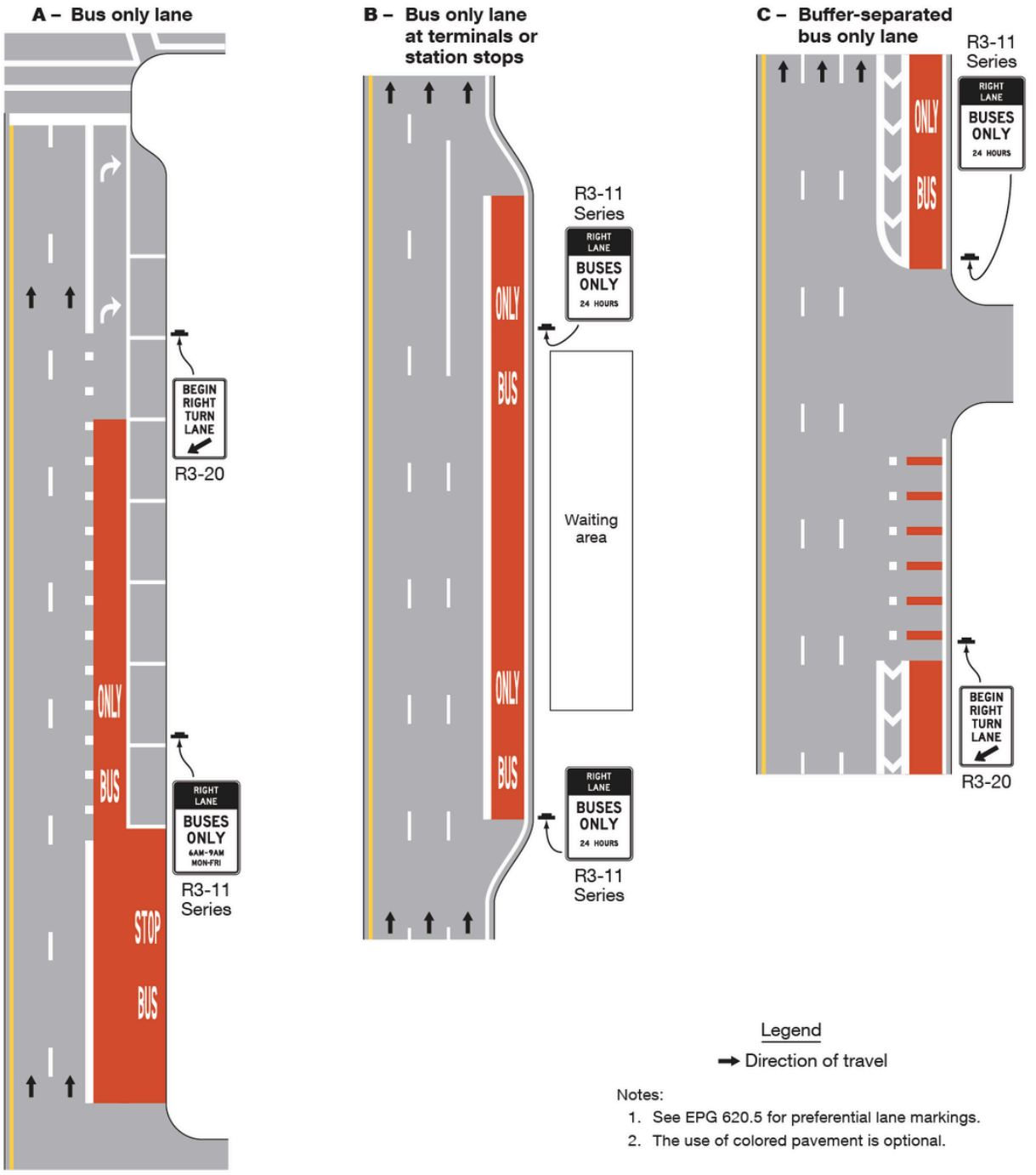


Figure 620.7.7 Examples of Red-Colored Pavement Applications

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620.8 Channelizing Devices used for Emphasis of Pavement Marking Patterns (MUTCD Chapter 3I)

620.8.1 Channelizing Devices (MUTCD Section 3I.01)

Option. Channelizing devices (see EPG 616.11.1 through 616.11.7) such as tubular markers, vertical panels, lane separators, drums, and barricades may be used for general traffic control purposes such as channelizing lines, islands, pedestrian facilities, or bicycle facilities. Channelizing devices may also be used along a center line to preclude turns or along lane lines to preclude lane changing, as determined by engineering judgment.

Support. Although they are not considered to be traffic control devices, raised islands (see EPG 620.9) are also sometimes used to channelize traffic.

Standard. Except for color, the design of channelizing devices, including, but not limited to, retroreflectivity, minimum dimensions, and mounting height, shall comply with the provisions of EPG 616.11.

Except as provided in the following Option paragraph, the color of channelizing devices used outside of temporary traffic control zones shall be the same color as the pavement marking that they supplement, or for which they are substituted, in accordance with EPG 620.1.3.

Option. The color of channelizing devices used to emphasize pavement marking patterns outside of temporary traffic control zones may be orange provided that the application of the orange-colored channelizing device is not permanent.

Support. Emergency incidents and planned special events are the most common temporary traffic control zones that would justify orange channelizing devices to emphasize standard pavement marking colors. These events do not necessitate police officers or other authorized personnel to obtain and deploy channelizing devices that match the color of the existing pavement marking.

Standard. For nighttime use, channelizing devices shall be retroreflective (as described in Part 6). On channelizing devices used outside of temporary traffic control zones, retroreflective sheeting or bands shall be white if the devices separate traffic flows in the same direction and shall be yellow if the devices separate traffic flows in the opposite direction or are placed along the left-hand edge line of a one-way roadway or ramp.

620.8.2 Tubular Markers (MUTCD Section 3I.02)

Standard. Tubular markers for permanent installations shall be a minimum of 36 inches in height and shall be a minimum of 2 inches wide facing road users.

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Guidance. Tubular markers should be affixed to the pavement or other surface either directly or by means of an attachment system that is affixed to the pavement or other surface. Tubular markers should normally be spaced no greater than the length of one line segment plus one gap of the broken (intermittent) lines used on the highway.

Option. Other spacing may be used based on engineering judgment.

Guidance. When tubular markers are used to supplement a R1-6 series sign (see EPG 903.2.19), they should not be used on the same pavement marking line where the R1-6 series sign is installed, because the tubular markers could obscure sign visibility.

Support. EPG 616.11.4 contains information for temporary installations of tubular markers.

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620.9 Marking and Delineation of Islands and Sidewalk Extensions (MUTCD Chapter 3J)

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620.9.6 Island Delineation (MUTCD Section 3J.06)
620.9.7 Sidewalk Extensions Designated by Pavement Markings (MUTCD Section 3J.07)

620.9.1 General (MUTCD Section 3J.01)

Support. EPG 620.9 addresses the marking and delineation of islands (see definition in EPG 911 (MUTCD Section 1C.02)) and sidewalk extensions designated by pavement markings. Definitions, types, sizes, and other criteria for the design of islands are set forth in "A Policy on Geometric Design of Highways and Streets," 2018 Edition, AASHTO.

EPG 620.3.10 contains information on pedestrian islands and medians.

EPG 620.7.4 and 620.7.5 contain information on colored pavement that can be used within islands.

Option. An island may be designated by curbs, pavement edges, pavement markings, channelizing devices, or other devices.

620.9.2 Approach-End Treatment (MUTCD Section 3J.02)

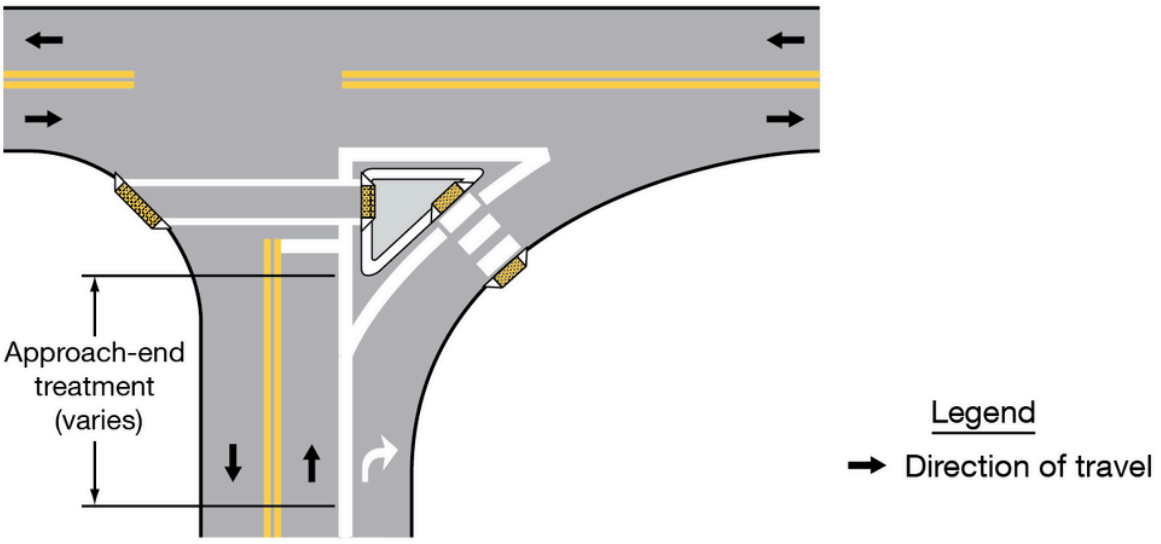


Figure 620.9.2 Example of Markings for an Approach-End Treatment to an Island

Support. An approach-end treatment to an island consists of longitudinal pavement markings and/or channelizing devices upstream of the island followed by a divergence of those pavement markings and/or channelizing devices concluding with a transition to other pavement markings that demarcate or outline the island (see Figure 620.9.2).

EPG 620.2.15 contains information on pavement markings that function as approach-end treatments for obstructions.

Guidance. The ends of islands first approached by traffic should be marked with an approach-end treatment, curb markings (see EPG 620.9.4), or both to guide vehicles into desired paths of travel along the island edge.

620.9.3 Islands Designated by Pavement Markings (MUTCD Section 3J.03)

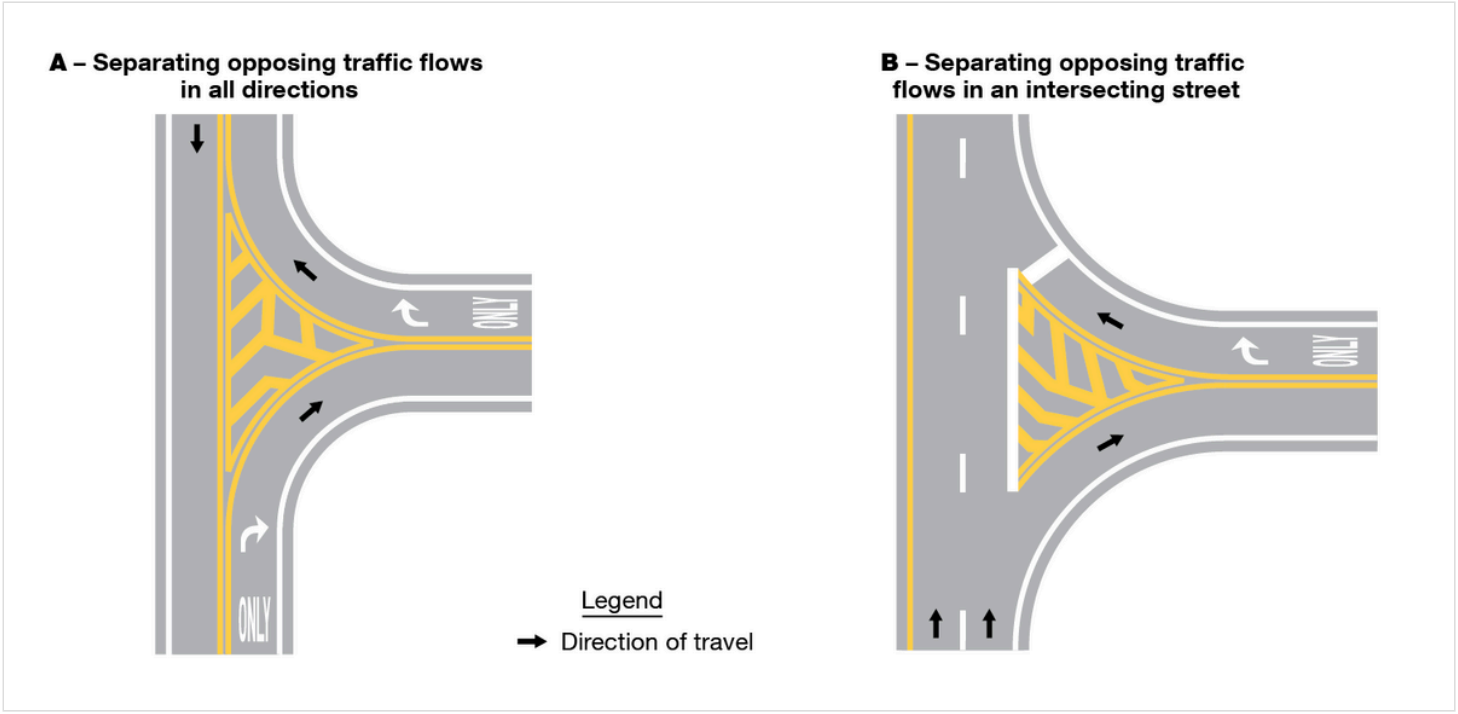


Figure 620.9.3 Examples of Island Designated by Pavement Markings

Standard. Except as provided in the following paragraph, islands formed by pavement markings only shall be established using channelizing lines, and shall be white when separating traffic flows in the same general direction or yellow when separating opposing directions of traffic.

If a continuous flush median island separating travel in opposite directions is used, two sets of double solid yellow lines shall be used to form the island (see Figure 620.2.3.3). Other markings in the median island area, such as diagonal lines (see EPG 620.2.24), shall also be yellow, except crosswalk markings which shall be white (see EPG 620.3).

If used, chevron or diagonal markings (see EPG 620.2.24) within the island shall be the same color as the channelizing line.

Option. Both chevron and diagonal markings of the same color may be used within the same island based on engineering judgment.

The area within the flush island delineated by pavement markings may use colored pavement in accordance with the provisions of EPG 620.7.

Support. Figure 620.9.3 illustrates examples of islands designated by pavement markings.

620.9.4 Curb Markings for Raised Islands (MUTCD Section 3J.04)

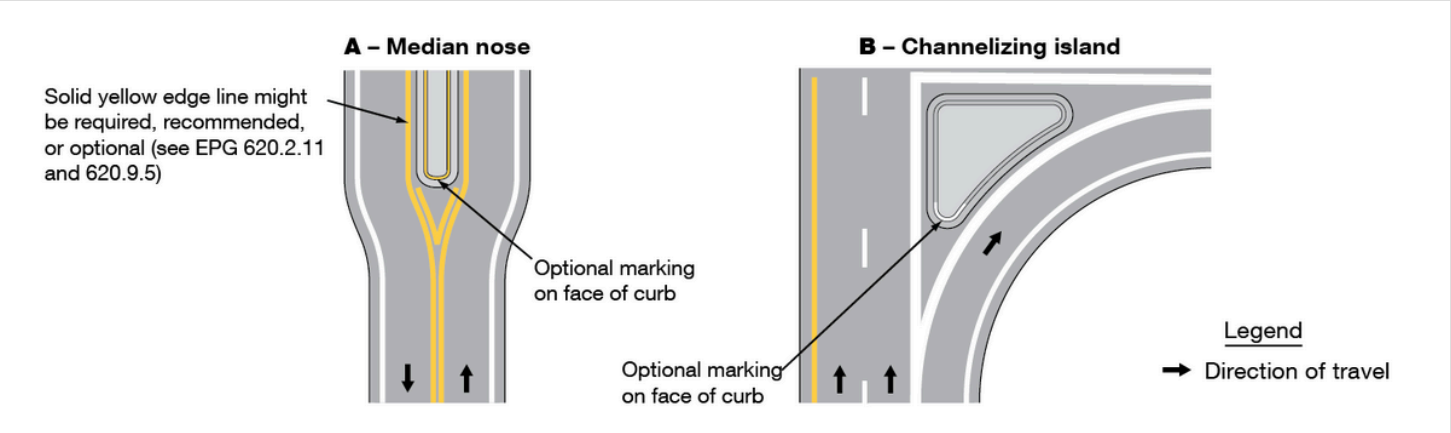


Figure 620.9.4 Examples of Curb Markings for Raised Islands

Guidance. Barrier curbs on raised islands with a minimum height of 6 inches should be marked with retroreflective markings or delineators (see EPG 620.9.6).

Standard. Where curbs are marked for delineation or visibility purposes, the colors shall comply with the general principles of markings (see EPG 620.1.3).

Guidance. Retroreflective solid yellow curb markings should be placed on the approach ends of raised medians and curbs of islands that are located in the line of traffic flow where the curb serves to channel traffic to the right of the obstruction (see Figure 620.9.4).

Retroreflective solid white curb markings should be used when traffic is permitted to pass on either side of the island (see Figure 620.9.4).

The retroreflective area should be of sufficient length to denote the general alignment of the edge of the island along which vehicles travel, including the approach end, when viewed from the approach to the island.

Option. An island with mountable curbs less than 3 inches tall may be marked with retroreflective markings or delineators.

Where the curbs of the islands become parallel to the direction of traffic flow or where the island is illuminated or marked with delineators, curb markings may be discontinued based on engineering judgment or study.

Curb markings at openings in a continuous median island may be omitted based on engineering judgment or study.

620.9.5 Pavement Markings for Raised Islands (MUTCD Section 3J.05)

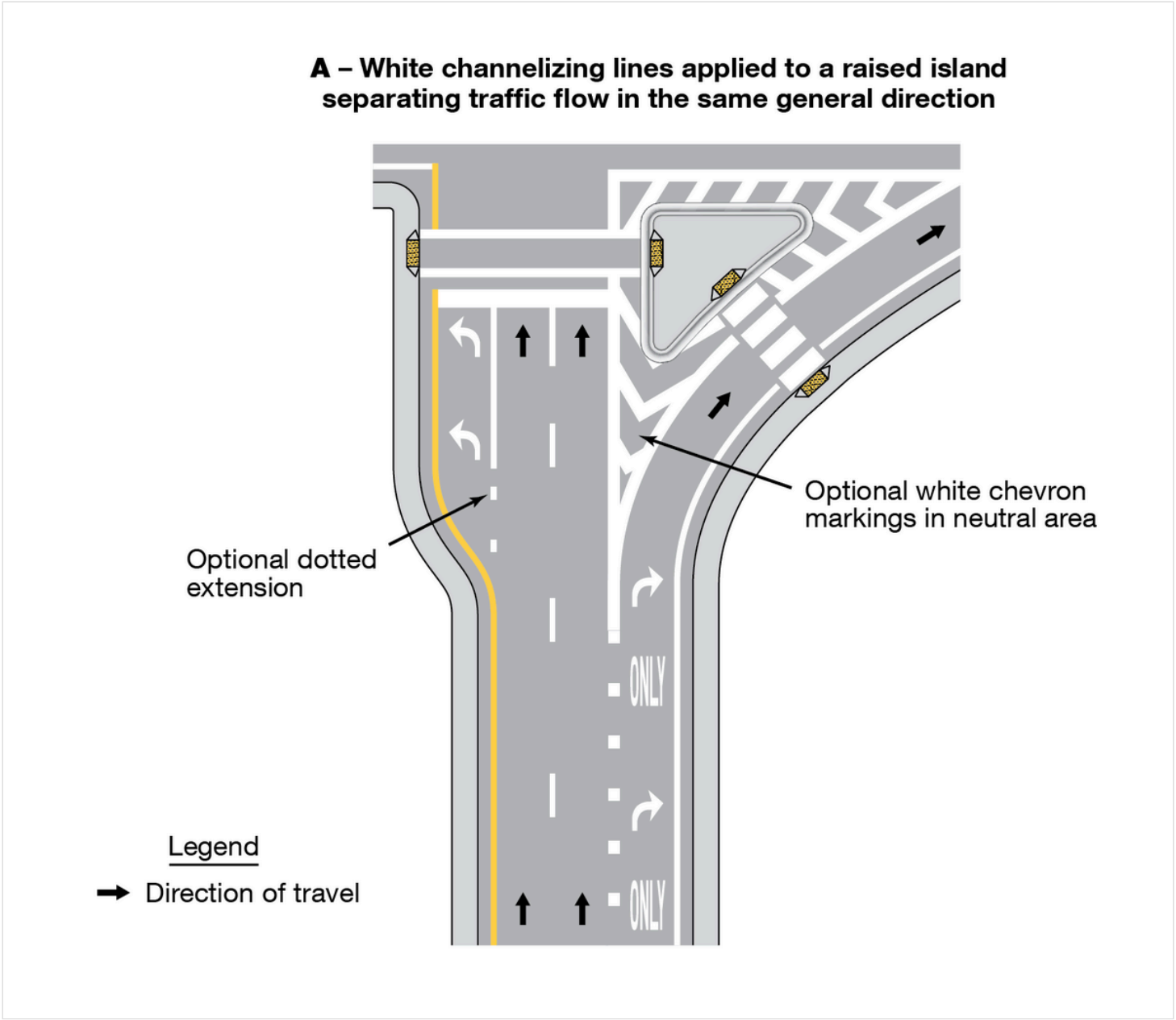


Figure 620.9.5.1 Examples of Pavement Markings for Raised Islands *(Sheet 1 of 2)*

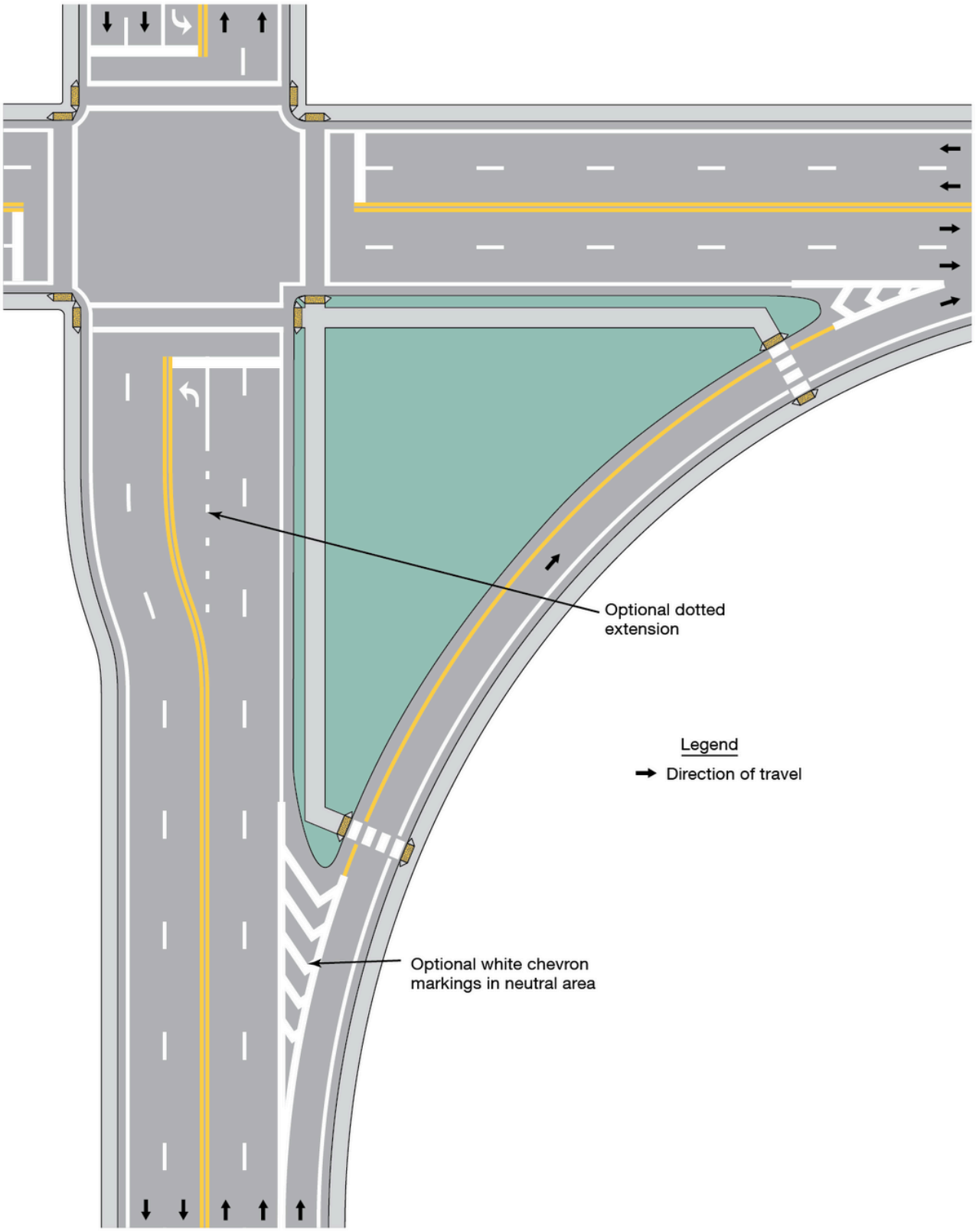


Figure 620.9.5.2 Examples of Pavement Markings for Raised Islands *(Sheet 2 of 2)*

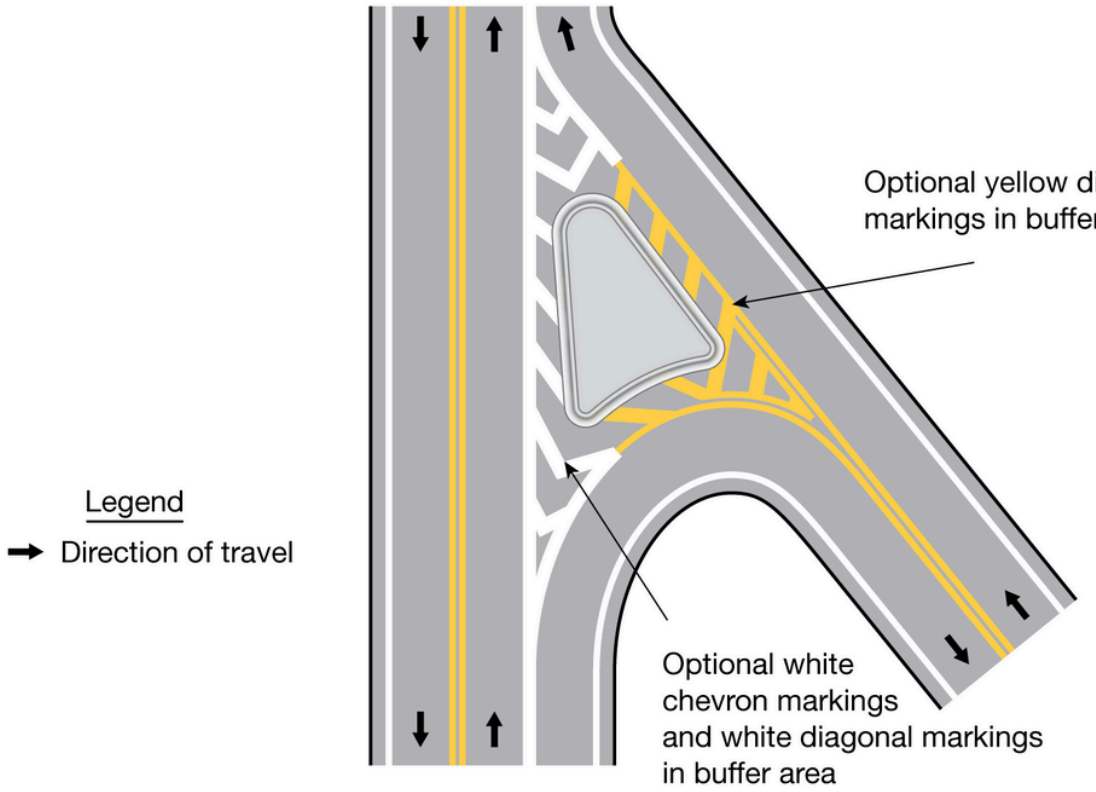


Figure 620.9.5.3 Examples of Optional Chevron and Diagonal Pavement Markings at a Raised Island

Support. Pavement markings for raised islands include the approach-end treatment (see EPG 620.9.2), channelizing lines, edge lines, and chevron or diagonal markings.

Option. Solid yellow edge lines (see EPG 620.2.10 and 620.2.11) may be used adjacent to raised islands separating travel in opposite directions (see Drawing A in Figure 620.9.4).

Standard. Except as provided in the following paragraph and in the second Guidance paragraph below, raised islands separating traffic flows in the same general direction shall be outlined with white channelizing lines (see Drawing A in Figure 620.9.5.1).

Option. Pavement markings for smaller raised islands may be omitted based on engineering judgment.

Guidance. Smaller raised islands without marked channelizing lines, edge lines, or chevron or diagonal markings should use curb markings (see EPG 620.9.4).

Where traffic passes on the right of a raised island separating traffic flows in the same general direction, a yellow edge line should be used adjacent to raised islands of discernible size or length instead of continuing the white channelizing line from the approach-end treatment (see Drawing B in Figure 620.9.5.2).

Support. Yellow edge lines adjacent to raised islands that separate traffic flows in the same general direction can be advantageous as a countermeasure for wrong-way entry or travel if the yellow edge line is of discernible length.

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Option. Chevron markings may be used in neutral areas formed by diverging channelizing lines at raised islands separating traffic flows in the same general direction.

Diagonal markings of an appropriate color may be used in buffer areas between the channelizing line and the raised island (see Figure 620.9.5.3).

620.9.6 Island Delineation (MUTCD Section 3J.06)

Guidance. Barrier curbs on raised islands with a minimum height of 6 inches should be marked with retroreflective markings (see EPG 620.9.4) or delineators.

Standard. Delineators installed on islands shall be the same colors as the related channelizing or edge lines except that, when only facing wrong-way traffic, they shall be red (see EPG 620.6.3).

Each roadway through an intersection shall be considered separately in positioning delineators to assure maximum effectiveness.

620.9.7 Sidewalk Extensions Designated by Pavement Markings (MUTCD Section 3J.07)

Support. Sidewalk extensions reclaim a portion of the roadway, sometimes including a portion of parking lanes, shoulders, and/or the traveled way, and repurpose that area for non-vehicular uses. They extend the sidewalk or other pedestrian space, shorten pedestrian crossing distances, alter the roadway geometry for speed management or channelizing, or serve other purposes.

Sidewalk extensions, sometimes referred to as curb extensions, neckdowns, bump outs, or bulb-outs typically are created by physical infrastructure including concrete or asphalt to form a physical narrowing of the roadway with the finished surface at the same level as the adjoining sidewalk.

Sidewalk extensions can also be designated by pavement markings for temporary or semi-permanent applications in which the finished surface is at the same level as the vehicular travel pavement. Where an adjoining curb and raised sidewalk are present, this type of application results in a multi-level sidewalk due to the difference in elevation between the adjoining pedestrian surfaces.

Sidewalk extensions designated by pavement markings differ from other paved areas designated by pavement markings that are intended to be traversable by a vehicle for authorized or emergency purposes.

Standard. Sidewalk extensions designated by pavement markings shall include a physical separator such as tubular markers or floating curbs to provide conspicuity for, and to prevent vehicles from traversing, the area of the sidewalk extension designated by pavement markings. Pavement markings shall be double solid lines connecting to the outside physical curb or, in the absence of a curb, to the edge of the roadway. The color of the double solid line shall comply with the provisions of EPG 620.1.3.

Support. The paved area between the double solid line forming the sidewalk extension designated by pavement markings and the sidewalk or other roadside area is not part of the roadway. Sidewalk extensions designated by pavement markings formed by double solid lines are distinct from areas such as shoulders or gore areas where travel is discouraged by the presence of a single line, or flush medians where travel is prohibited by a double solid line. Sidewalk extensions designated by pavement markings with double solid lines designate areas outside the roadway where vehicle traversal is prohibited.

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Areas formed by a single wide line are sometimes used to alter the roadway geometry for speed management or channelizing, or to serve other purposes, where pedestrians are not expected. These areas are not considered a sidewalk extension, and provisions to delineate areas where vehicle traversal is discouraged include channelizing lines (see EPG 620.2.9), edge lines (see EPG 620.2.10), and diagonal markings (see EPG 620.2.24).

Guidance. Channelizing devices such as tubular markers (see EPG 620.2.9) should be located adjacent to the double solid line outside the traveled way.

Support. When selecting other methods of physical separation, the visual contrast from adjoining pavement and maximum separation distances are considerations so they are visible to pedestrians having limited vision and detectable by pedestrians who travel with a long cane.

Sight lines and the visibility of road users within the sidewalk extension area are considerations when selecting methods of physical separation.

The swept path of turning design or other prevailing vehicle types is a consideration, especially if a larger vehicle is expected to traverse a portion of the sidewalk extension while turning where pedestrians might be present.

Standard. Crosswalk markings shall not be extended through sidewalk extensions designated by pavement markings.

Support. Accessibility provisions at sidewalk extensions designated by pavement markings are outside the scope of EPG 620. State and local organizations providing support services to pedestrians with vision disabilities can provide advice to the traffic engineer on site-specific accessibility decisions. In addition, orientation and mobility specialists or similar staff can provide advice to inform such decisions. The U.S. Access Board (https://www.access-board.gov) provides technical assistance for making pedestrian facilities accessible to persons with disabilities.

Guidance. Traffic control devices that are critical to the specific conditions at the sidewalk extension, such as STOP or YIELD signs or Pedestrian Crossing signs, should be located within the sidewalk extension designated by pavement markings. Their lateral offset (see EPG 903.1.16) should be measured from the center of the double solid line designating a sidewalk extension rather than from the physical curb line behind the sidewalk extension area so that the signs are more visible to approaching traffic and not occluded by any physical features placed within the sidewalk extension area.

Support. The location of accessible pedestrian signals (see EPG 902.11.2) is a consideration when providing a sidewalk extension designated by pavement markings.

Aesthetic surface treatments (see EPG 620.7) are sometimes used in sidewalk extensions designated by pavement markings to emphasize that the area is outside of the traveled way.

Standard. In accordance with the provisions of EPG 620.7.3, aesthetic surface treatments, if used within a sidewalk extension designated by pavement markings, shall be non-retroreflective.

Support. Figure 620.9.7 illustrates an example of a sidewalk extension designated by pavement markings.

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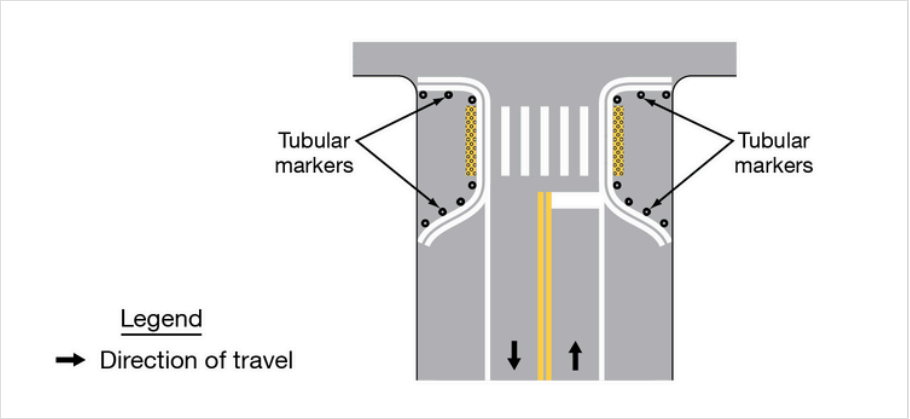


Figure 620.9.7 Examples of Sidewalk Extensions Designated by Pavement Markings

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620.10 Rumble Strip Markings (MUTCD Chapter 3K)

620.10.1 Longitudinal Rumble Strip Markings (MUTCD Section 3K.01)

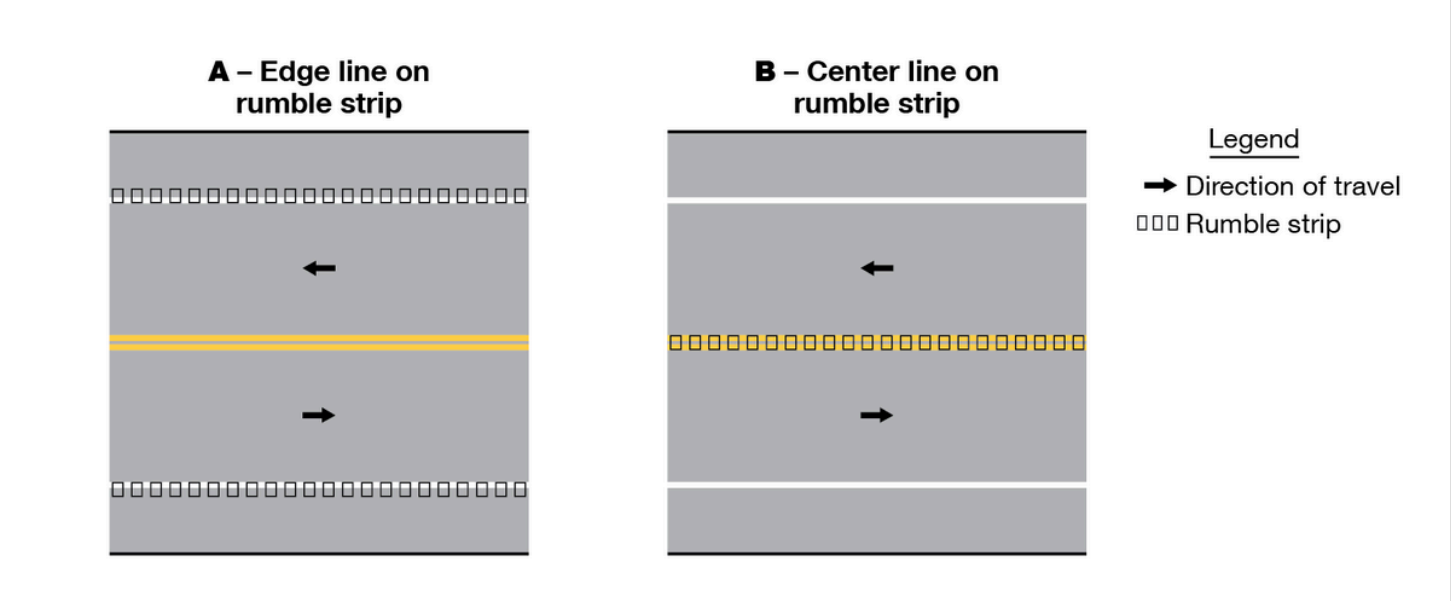


Figure 620.10.1 Examples of Longitudinal Rumble Strip Markings

Support. Longitudinal rumble strips consist of a series of rough-textured or slightly raised or depressed road surfaces intended to alert inattentive drivers through vibration and sound that their vehicle has left the travel lane. Shoulder rumble strips are typically installed along the shoulder near the travel lane. On divided highways, rumble strips are sometimes installed on the median side (left-hand side) shoulder as well as on the outside (right-hand side) shoulder. On two-way roadways, rumble strips are sometimes installed along the center line. See Standard Plan 620 (https://www.modot.org/media/16896) for details.

EPG 620 contains no provisions regarding the design and placement of longitudinal rumble strips. The provisions in EPG 620.10.1 address the use of markings in combination with a longitudinal rumble strip. Figure 620.10.1 illustrates markings used with or near longitudinal rumble strips.

Rumble strip markings provide notice to the driver that they are leaving their lane. They also provide increased visibility of the pavement markings during wet pavement conditions. Rumble strip markings are a system-wide safety improvement. Additional information on the use and application of rumble strip markings can be found in EPG 626.

Standard. Where edge line or centerline rumble strips are required, as noted in EPG 626, the edge line or center line marking shall be located over the rumble strip to create a rumble stripe.

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The color of an edge line or center line associated with a longitudinal rumble stripe shall be in accordance with EPG 620.1.3.

620.10.2 Transverse Rumble Strip Markings (MUTCD Section 3K.02)

Support. Transverse rumble strips consist of intermittent narrow, transverse areas of rough-textured or slightly raised or depressed road surface that extend across the travel lanes to alert drivers to unusual vehicular traffic conditions. Through noise and vibration, they attract the attention of road users to features such as unexpected changes in alignment and conditions requiring a reduction in speed or a stop.

EPG 620 contains no provisions regarding the design and placement of transverse rumble strips that approximate the color of the pavement. The provisions in EPG 620.10.2 address the use of markings in combination with a transverse rumble strip.

EPG 626.4 contains information related to transverse rumble strips.

Standard. Except as otherwise provided in EPG 626.4 for TTC zones, if the color of a transverse rumble strip used within a travel lane is not the color of the pavement, the color of the transverse rumble strip shall be either black or white.

Guidance. White transverse rumble strip markings used in a travel lane should not be placed in locations where they could be confused with other transverse markings such as stop lines or crosswalks.

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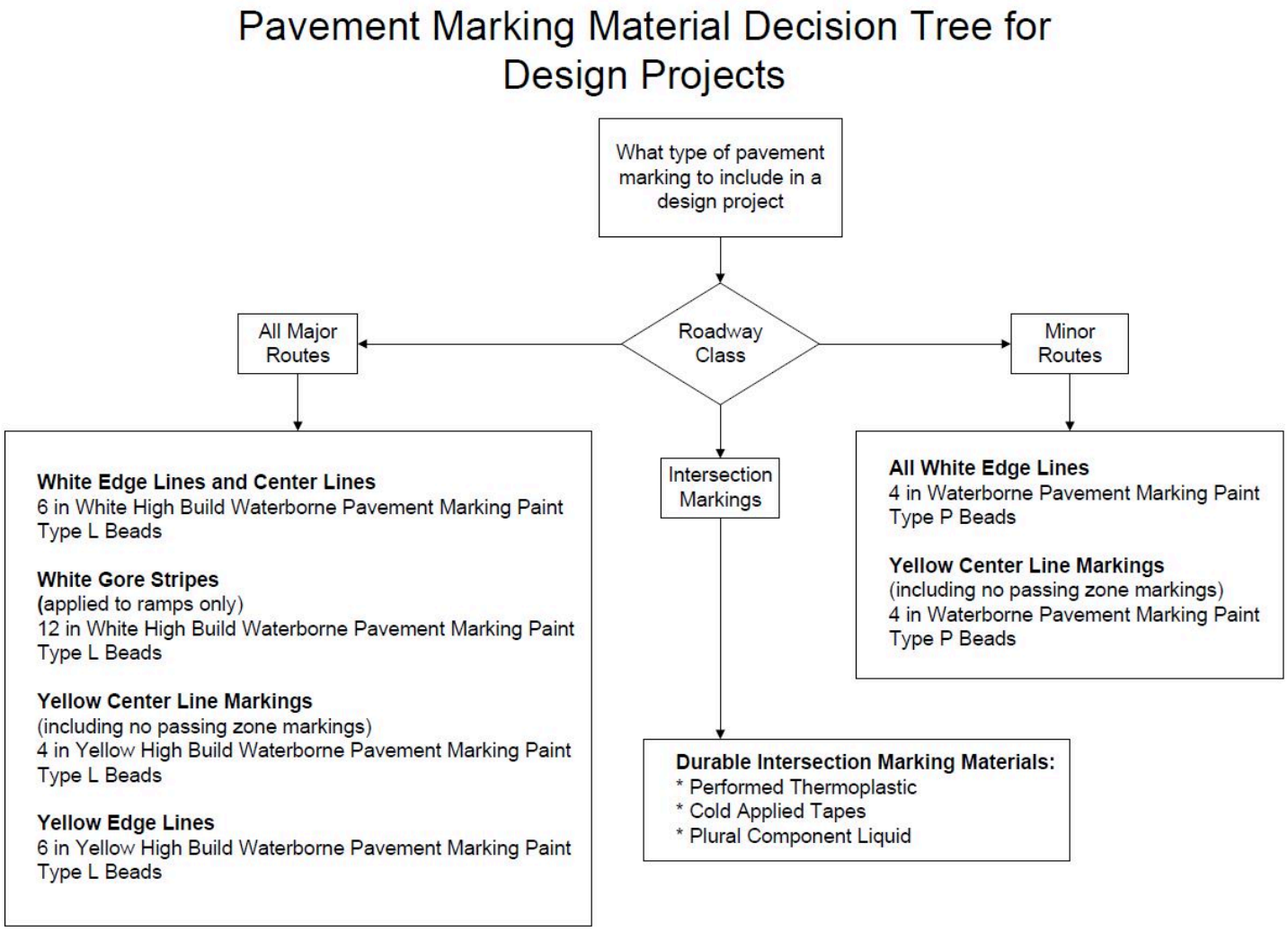
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620.11 MoDOT Pavement Marking Materials

Pavement Marking Guidelines

		Divided Highways	Undivided Highways	Intersection Markings
Contractor Installations	**Major Roads**	High Build Paint with Type L Beads	High Build Paint with Type L Beads	Durable Intersection Marking Material
	Minor Roads	Not applicable	Waterborne Paint with Type P Beads	
MoDOT Installations	**Major Roads** – shall be striped annually unless retroreflectivity exceeds requirements for new pavement markings[1]	Waterborne Paint with Type L beads (60° F and rising)	Waterborne Paint with Type PM beads (60° F and rising)	Durable Intersection Marking Material, preformed thermoplastic or waterborne paint with Type PM beads
	Regionally Significant Roads – shall be striped annually unless retroreflectivity exceeds requirements for new pavement markings[1]	Not applicable	Waterborne Paint with Type PM beads (50° F and rising) or Cold weather paint with Type PM beads (35° F to 50° F)	
	Minor Roads≥400 AADT – maximum of 50% striped annually			
	Minor Roads<400 AADT – maximum of 33.3% striped annually			
	Surface Treatments			

[1] See Pavement Marking Acceptance Table



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620.11.1 Permanent Pavement Markings
- 620.11.1.1 Wet Reflective Marking
- 620.11.1.2 Contrast Marking

620.11.2 Traffic Marking Paint Application Rates

620.11.3 Temporary Pavement Markings

620.11.4 Obliteration of Pavement Markings

620.11.1 Permanent Pavement Markings

The selection of permanent pavement markings shall be based on the Pavement Marking Guidelines table.

Support. Contract work consists of furnishing and installing durable intersection markings, cold weather paint, high build waterborne paint, waterborne pavement marking, or epoxy.

Standard. On the final lift of resurfacing projects and on all new pavements, all pavement marking will be provided by contract. On surface treatment projects, all pavement marking will be provided by MoDOT.

All permanent marking materials shall be installed in accordance with the manufacturer's recommendations. Durable pavement markings, such as epoxy, used for lane lines shall be installed in a groove.

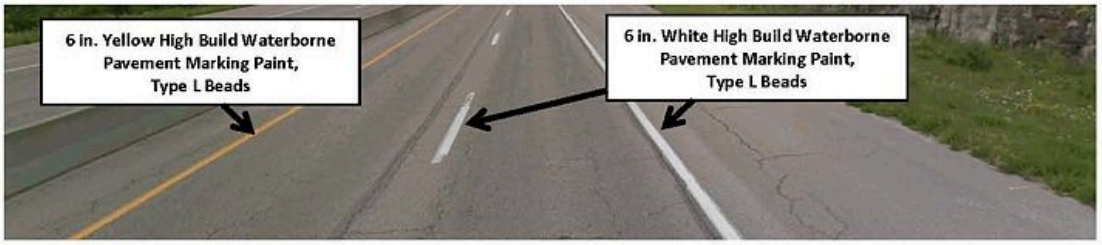
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Guidance. For road segments with different pavement types less than 1,000 ft. long, such as a concrete bridge deck surrounded by asphalt, the pavement marking type for the surrounding pavement should be continued through the segment and contrast marking would not be required on the bridge deck.

Major – Divided



Major – Divided



Major – Undivided Multilane



Major – 2 Lane Undivided



Minor – All



Figure 620.11.1

Support. The materials that MoDOT uses for pavement marking are:

A. Waterborne Paint. This material is the standard paint used by contractors and MoDOT forces. MoDOT forces use waterborne for all long line applications, while contracts should specify it on minor routes. Waterborne paint may be applied at a wet thickness of 15 mils to 24 mils. It may also be used for intersection markings when the life of the pavement is not expected to outlast a more durable product (see Temporary Removable Pavement Marking Tape). See EPG 620.13.
B. High Build Waterborne Paint. High Build paint can be applied in a thicker layer than normal waterborne paint and it is used by contractors when specified. High build paint may be applied at a wet thickness of up to 35 mils. High Build is one of two options for material to be used in contractor installations on divided highways. See EPG 620.13.
C. Cold weather paint. This material is used in special situations when specified. Cold weather paint is a water-based material that can be used at lower temperatures. Cold weather paint is normally applied at a wet thickness of 15 mils. See EPG 620.13.
D. Durable Intersection Marking Materials. Due to the excessive wear experienced in and around intersections, durable marking materials (preformed thermoplastic, cold applied tapes, extruded / sprayed thermoplastic or plural component liquid) should be used to mark intersection markings (stop bars, yield bars, arrows, words, symbols, hash bars, shields, etc.). These materials will remain in place longer and reduce maintenance requirements.
E. Temporary Removable Pavement Marking Tape. Temporary removable tape is used to delineate traffic lanes during construction. Preformed removable tape does not require special equipment to install or remove, however material costs are high, so it may only be cost effective in small quantities. The primary advantage is that the removal of this tape is inexpensive and will not scar the pavement. The primary disadvantages of tape are the higher material cost and weather constraints for installation. When establishing contract times and milestones, the potential timing of paving activities and weather constraints should be considered when selecting temporary pavement marking. A pay item for removal of the marking tape will be included if removal is required. Marking tape shall be applied as per manufacturer's recommendation.
F. Temporary Pavement Marking Tape. Temporary pavement marking tape is used in locations where the marking will be in place no more than two weeks. It is cost effective only in small quantities. Short-term pavement marking is not normally removed. If removal is required, removable tape is the preferred material. Short term marking should not be used for temporary lane transitions or bypasses. Marking tape shall be applied as per manufacturer's recommendation.
G. Temporary Raised Pavement Markers. Temporary raised pavement markers are used on contract leveling course and resurfacing projects on two or three lane roadways with no passing zone center striping to provide a temporary centerline until permanent marking is replaced. Temporary raised pavement markers are used in combination with the NO CENTER LINE sign. Temporary markers should also be used to provide a temporary lane line on 2-lane roadways with climbing lanes. Temporary markers may also be used to supplement other pavement marking in areas where emphasis is needed, such as on bypasses and lane transitions.

Markers dividing two lanes of traffic in the same direction have one reflective face that is white in color. The edgeline markers with two lanes of traffic in the same direction are yellow for the left edgeline and white for the right edgeline. Markers dividing two lanes of traffic in opposite directions have two opposing reflective faces that are yellow in color. The edge line markers with two lanes in opposite directions are white.

See Standard Plan 620.10 (https://www.modot.org/media/16897) for details on using temporary raised pavement markers.

Temporary raised pavement markers are used primarily on pavement surface treatment projects. Surface treatment is defined as any pavement surfacing as defined in Sec 413 (http://www.modot.org/business/standards_and_specs/SpecbookEPG.pdf#page=7) of the Standard Specifications. Type 1 markers are used for temporary edgeline marking and as part of the "cluster" marking of temporary lane lines.

Temporary raised pavement markers do require removal after the permanent marking is in place. They do not require a pay item for removal.

Standard. Snow plowable raised pavement markers (SRPMs) are neither being installed new nor reinstalled on any more projects. If the district chooses to leave the SRPM's in place, both the reflectors and the shoes shall be maintained. The districts must assure SRPMs that remain in the pavement are regularly inspected. Where cold milling is being done, the removal of the SRPMs is included in the cost of cold milling. On surface treatment and resurfacing projects SRPMs shall be removed before application of the surface treatment or resurfacing. SRPMs shall not be left in place and covered by surface treatment or resurfacing.

Support. The night visibility of pavement markings is a direct result of the presence and quantity of the spherical glass or ceramic "beads" that are embedded in the pavement marking material. There are several types of beads used by MoDOT.

A. Type P Beads. These are an intermediate blend of glass bead used by MoDOT forces and contractors when marking minor roadways. The "P" stands for performance.
B. Type L Beads. These are a "large" glass bead. These beads are used by MoDOT striping forces and contractors on major routes to provide a level of wet night time performance.

Support. See Standard Specifications for Highway Construction, Section 1048 (https://www.modot.org/missouri-standard-specifications-highway-construction), for material specifications of pavement markings.

Guidance. MoDOT forces typically apply beads to the wet paint at the rate shown in EPG 620.11.2. On contractor applied pavement markings, the glass beads are applied at a rate determined by the contractor to meet the minimum retroreflectivity requirements of the contract.

The bead guns on the stripers should be calibrated frequently to assure the proper application rate of beads is being applied to the painted line. The frequency of these calibrations is dependent on the bead guns and their ability to maintain a constant flow of beads. The calibration should be accomplished using an appropriate bead calibration kit. These kits contain a table to calculate the appropriate flow of beads for a given speed of the striper. This calibration should be performed a minimum of once every week of operation.

Spot checks should be performed using two methods. The first method is accomplished with the aid of an aluminum sign panel placed ahead of the striper on which the paint, without beads, is to be applied and a mil thickness gauge used to read the wet paint mil thickness. The bead application rate should also be checked at this time by measuring the volume of beads being dispensed over a given time period. These methods should be used to calibrate the striper at the beginning of each day.

The second method involves checking the amount of material used, both paint and beads, versus the miles marked. This method should be used throughout the remainder of the day to verify the proper material application rates are being maintained.

620.11.1.1 Wet Reflective Marking

Wet reflective markings are no longer used by MoDOT.

620.11.1.2 Contrast Marking

Guidance. Contrast marking should be used to enhance the visibility of white markings on concrete pavements. On either new concrete surfaces or diamond grinding projects, lane lines should include contrast markings. Contrast markings consist of standard white markings with an additional width of black marking on each side. Contrast markings should be maintained until the pavement ages or greys so that normal markings are adequate.

620.11.2 Traffic Marking Paint Application Rates

Standard. Typical application rates are:

Table 620.11.2 Pavement Marking Materials

Typical Application Rates of Pavement Marking Materials	
Material	**Application Rate**
Cold Weather Paint	15 mils min
High Build Waterborne Paint	up to 18 mils (Minor Roads)
High Build Waterborne Paint	22 mils min (Major Roads)
Epoxy	25 mils
Type PM Beads	10 lbs/100 sq. ft.
Type L Beads	15 lbs/100 sq. ft.

Yield Table for Liquid pavement Marking Materials		
Applied wet mil thickness	**Gallons used per mile of 4 in. line**	**Gallons used per mile of 6 in. line**
15	16.5	24.8
18	19.7	29.6
20	21.9	32.9
22	24.2	36.3
25	27.4	41.1
30	32.9	49.4

Guidance. Water borne paint should not be heated above 100 degrees Fahrenheit (refer to EPG 620.13 for the application of water borne paint).

During marginal weather conditions at the end of the striping season, in November and December, cold weather paint should be used.

620.11.3 Temporary Pavement Markings

Support. Temporary pavement marking consists of furnishing, installing, and maintaining non-permanent pavement marking in work zones to provide guidance to drivers until the project is complete. Standard Plan 620.10 (https://www.modot.org/media/16897) shows layouts for typical situations. There are several forms of temporary pavement markings which can be used, the selection of the type of marking is typically based on the type of work being performed and the duration of the project:

A. Temporary Pavement Marking Paint

1. Paint typically requires the use of large striping trucks to install resulting in a higher installation cost
2. Material costs are low making it cost effective to install in large quantities and over long stretches of roadway
3. It can be installed faster than other types of pavement marking material
4. placed under traffic
5. The primary disadvantage is that the removal of paint is expensive and will result in scarring of the pavement if applied to the final driving surface
6. A pay item for removal of paint will be included if removal is required

B. Temporary Removable Pavement Marking Tape

1. A preferred option over paint when a temporary marking must be applied to the final driving surface
2. The application of tape does not require the large striping trucks to install, only small hand operated carts so installation costs are lower compared to paint
3. The removal of this product does not require special equipment and does not scar the final driving surface resulting in a clean and low cost removal effort
4. The primary disadvantages are the material costs are high, the product will not work for temporary markings that must go through winter and the tape can peel up if traffic continually track over and/or turns on the tape possibly requiring additional maintenance and replacement over the duration of the installation, at no additional cost to MoDOT
5. A pay item for removal of the marking tape will be included if removal is required

C. Temporary Non-Removable Pavement Marking Tape

1. Non-Removable Tape has similar advantages and disadvantages as removable tape
2. This product is typically less expensive
3. This product is only used on pavements that are not the final driving surface, getting covered or removed as part of the resurfacing project
4. No pay item for removal will be included

D. Temporary Raised Pavement Markers

1. Temporary raised pavement markers are typically used on contract leveling course and resurfacing projects on two or three lane roadways to provide temporary markings until permanent marking is replaced
2. Temporary raised pavement markers are used in combination with the No Center Stripe sign described in EPG 616.10.3.
3. Temporary raised pavement markers are used to provide temporary guidance until the permanent pavement markings can be applied in 14 days or less. If temporary pavement marking must remain in place longer than 14 days, then a temporary paint should be used to supply guidance to motorists. If temporary paint is used, it shall be applied in the same location and patterns as the permanent pavement marking will be applied.
4. These markers are installed by hand requiring no special equipment or crews to install resulting is a lower cost installation.
5. The markers themselves are low cost for the length of roadway they address
6. Like tape, these markers can require maintenance and replacement over the duration of the installation, at no additional cost to MoDOT
7. Like tape, these markers are to be removed between intermediate lifts and after the permanent pavement marking is installed, with no pay item for removal being included
8. Temporary raised pavement markers may also be used to supplement other pavement marking in areas where emphasis is needed, such as on bypasses and lane transitions.
9. These markers should not be used for temporary lane transitions or bypasses.
10. Unlike paint or tape, temporary raised pavement markings do not mimic the permanent pavement marking patterns, but instead have unique installations based on the type of marking they are representing:
    - Markers dividing two lanes of traffic in the same direction have one reflective face that is white in color.
    - Markers dividing two lanes of traffic in opposite directions have two opposing reflective faces that are yellow in color.
    - Edge line markers are yellow for the left edge line and white for the right edge line.
    - Where markers are used to emphasize edge lines in sharp curves or tapers, recommended spacing is 15 feet.

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- Where they are used to emphasize intermittent lines or solid lines in tangent sections, recommended spacing is 40 feet.
- Other spacing may be used according to conditions see EPG 620.2.11, Raised Pavement Markers.

Option. Temporary marking tape may be used to establish experimental lanes or intersection markings to determine the markings effectiveness prior to installing the permanent markings. It may also be used to mark temporary centerlines following spot sealing and patching operations.

Temporary pavement marking may be used as a short term replacement for existing marking for grinding, milling and resurfacing, but no direct payment is made to the contractor as described in Standard Specification Section 620 (http://www.modot.org/business/standards_and_specs/SpecbookEPG.pdf#page=9).

Guidance. Temporary marking should be used with pay items where the traffic pattern has changed during construction due to bypasses, lane shifts, narrow lanes, etc.

When establishing contract times and milestones, the potential timing of paving activities and weather constraints should be considered when selecting temporary pavement marking.

Temporary pavement markings, other than temporary paint, should not be recommended for locations where it will be subject to heavy traffic for periods greater than 2 months, in areas of heavy turning movements or on short radius curves. In addition, it should not be used to provide pavement marking following completion of construction projects.

620.11.4 Obliteration of Pavement Markings

This work consists of removing all existing or temporary pavement marking which is conflicting or might mislead traffic. The exception is short term marking tape which should be in place two weeks or less.

During the process of detouring traffic around construction and maintenance areas and incorporating changes in traffic movements, it may be necessary to remove or obliterate inappropriate pavement markings on the roadway. If this is not done properly the original markings can misdirect traffic, resulting in possible conflicts for both motorists and workers.

Standard. The use of asphalt, black paint or other methods to cover conflicting markings shall not be allowed

All removal methods must comply with EPA and MDNR regulations concerning air quality and material disposal.

Guidance. Provisions should be made on the TCP for the removal of all conflicting or misleading markings. Pay items should be provided for removal of pavement marking when required.

Removal or obliteration of inappropriate pavement markings should be performed following the requirements outlined in the MoDOT Specifications for Highway Construction, Section 620.50.

Where pavement markings have been obliterated, nighttime inspections should be made to verify that the marking is no longer visible and does not interfere with the new pavement markings.

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620.14 Pavement Marking Maintenance

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620.14.1 Maintenance
620.14.2 Striping Report
620.14.3 Unauthorized Pavement Markings
620.14.4 School Logo Pavement Markings

620.14.1 Maintenance

Support. Pavement markings should provide acceptable guidance to motorists during both day and nighttime conditions. MoDOT's pavement marking maintenance is based on meeting or exceeding MoDOT's minimum retroreflectivity standards. These standards, and MoDOT's restriping policy, are designed to maintain pavement markings on state routes to meet and exceed the minimum MUTCD requirements for pavement marking performance.

MoDOT's striping plan is based on traffic volumes and frequency of snowplow activities. Routes with heavier traffic volumes and more frequent plowing during winter storms have a higher frequency of restriping compared to those routes with lower volumes which are plowed less often during a storm.

Standard. MoDOT annual district striping plans shall meet the following criteria:

A. Major Routes – Pavement markings on these routes shall be restriped annually

B. Regionally Significant (Continuous Operation) Routes – Pavement markings on these routes shall be restriped annually

C. Minor Routes with AADTs Greater than or equal to 400 – Fifty percent (50%) of these routes, not including regionally significant routes, shall be restriped annually, plus any roads that receive a surface treatment which obliterates the existing pavement markings

D. Minor Routes with AADTs Less than 400 – Thirty-three percent (33%) of these routes shall be restriped annually plus any roads that receive a surface treatment which obliterates the existing pavement markings

Option. Routes within the Major and Regionally Significant categories may be omitted from the annual restriping requirement if the pavement marking on a given route meets or exceeds MoDOT's retroreflectivity levels for a line to be expected to last through winter. See Pavement Marking Acceptance Table in EPG 620.16.5.

Guidance. The determination if a route may be omitted from the annual striping plan should be based on all of the following:

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A. The pavement markings on the entire route are evaluated for levels of retroreflectivity.

B. The daytime appearance looks consistent, providing the appearance of a solid line while traveling at speed.

C. The retroreflectivity of the markings exceed the MoDOT's thresholds for a line to last through winter. The retroreflectivity of the markings should be determined by one of the following methods:

1. Utilizing MoDOT's third party mobile retroreflectivity contractor to collect the data. The contractor can measure the retroreflectivity along the entire length of specified lines and provide a report. This report not only drives the decision to omit routes from the annual plan but also serves as documentation for the decision.
2. Using a mobile retroreflectometer.
3. Using a handheld retroreflectometer, following the guidance and sample sizes outlined in EPG 620.16. This is the least desirable option, especially for long segments, as it requires ground data collection and lane closures.

D. The data that was collected to make the determination the markings were satisfactory is documented and recorded and retained for xx years according to the document retention policy.

Option. Due to the number of miles of minor roadway a district has to maintain, the retroreflectivity performance on minor roads may be determined visually at night.

Guidance. If visual nighttime evaluations are used to evaluate minor road pavement markings, the retroreflectivity inspection should be performed on sections of roadway with a constant grade, no overhead lighting, sitting in the travel lane and measuring the length of marking visible with the low beams of the vehicle on. A line is considered satisfactory if it is visible for a minimum of 200 ft. or 5 lane line skips ahead of the vehicle by the driver/inspector using low beam headlights.

Standard. MoDOT shall ensure that adequate pavement marking is in place during the winter months on incomplete resurfacing projects. Temporary tabs or temporary tape of any kind are not qualifying markings for this application. The markings required shall represent the permanent marking patterns for the roadway providing the appropriate traffic control for the given situation meeting the guidelines of EPG 620. Such markings shall be marked on new asphalt type surfaces, or existing old pavement, and will be applied using the application rates for temporary markings found in the MoDOT Standard Specifications for Highway Construction, Section 620.10.

620.14.2 Striping Report

Support. MoDOT's striping program is managed primarily in MoDOT's Transportation Management System (TMS) Striping Database. This database houses the pavement marking inventory, its where the annual striping plan templates reside and are updated and where the federalization striping plans are developed.

Everyday activity relating to pavement marking, crew time, equipment and material usage, is entered and managed in the MoDOT Management System (MMS) (https://mms2.modot.mo.gov/). Information on the status and progress of the striping program can be acquired through MMS under the "RESULTS (https://mms.modot.mo.gov/Results/SingleActivityDashboard)".

MoDOT also tracks the efficiencies of our striping crews using a mobile app. Crews enter each activity type (start day, gun on time, one of the reasons the striping operation had to be terminated, lunch break, etc.) and the app records the time for each event. The app then creates a report and graph showing the percent of time dedicated to each event, allowing crews to identify areas where they can improve efficiencies or document issues like higher than normal equipment failure. This information can then be used to implement corrective action with the end goal of maximizing "gun on time" or the time the crews are actually applying pavement markings. This information is looked at, not only at the district level, but also at the statewide level as well. The information is used to improve efficiencies, but also to make decisions on the direction of the state's striping program.

Guidance. All striping crews should be using the efficiencies app to collect this data. This data collection should start May 1st and end November 1st. The app is not used early or late in the season as weather impacts are over representative during this part of the season and skews the data.

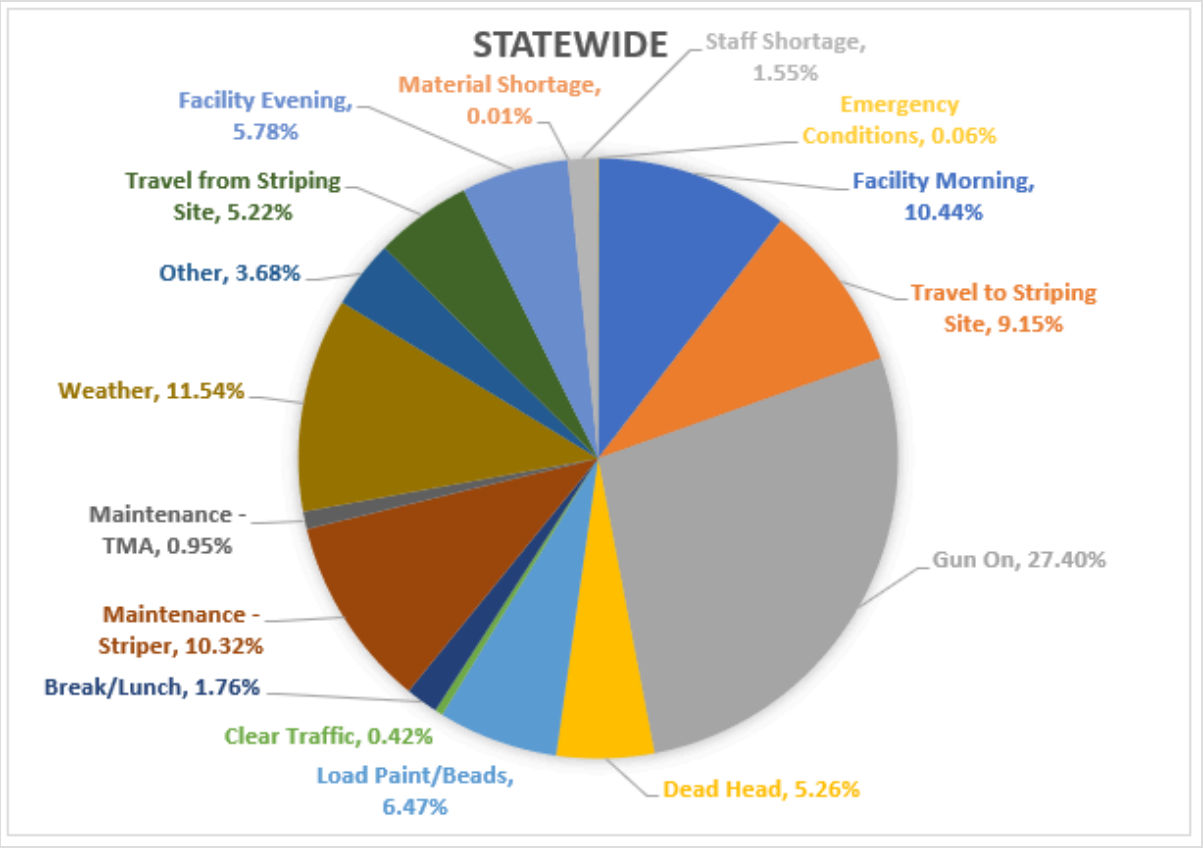


Figure 620.14.2

620.14.3 Unauthorized Pavement Markings

Support. In order to preserve the appearance of our highways, it is requested that marking on the roadway, for other than traffic regulations, be held to a minimum. These markings are considered detrimental to the traveling public and an unsightly marring of the roadway.

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Standard. All unauthorized pavement markings shall be removed as soon as the district's time schedule will permit.

620.14.4 School Logo Pavement Markings

Support. In years past, universities and colleges were permitted to paint their school logo on the exit ramps for the interchanges leading to their campus. Over the years most of these markings have faded away and are no longer present; however, there are a very limited number that remain. These markings are not compliant with the MUTCD and, therefore, are no longer permitted.

Standard. School logos shall not be installed on state highways. Existing school logos may remain in place but shall be allowed to fade away over time without being refreshed or updated.

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EPG articles are not referenced as "sections" but as EPG XXX.X to avoid confusion with MoDOT specs (which are contractually binding).

Contents

900.1 Incorporating the MUTCD into the EPG

900.2 Material Inspection for Traffic Control

900.2.1 Procedure

The **MoDOT MUTCD** is a historical reference document and not a policy manual. Refer to the articles of the EPG for MoDOT policies.

900.1 Incorporating the MUTCD into the EPG

History. The American Association of State Highway Officials (AASHO), now known as the American Association of State Highway and Transportation Officials (AASHTO), published a manual for rural highways in 1927, and the National Conference on Street and Highway Safety (NCSHS) published a manual for urban streets in 1930. To unify both standards, a joint committee of AASHO and NCSHS developed and published the original edition of the Manual on Uniform Traffic Control Devices (MUTCD) in 1935. That committee, now called the National Committee on Uniform Traffic Control Devices (NCUTCD), has been in continuous existence and contributes to the revisions of the MUTCD. The Federal Highway Administration (FHWA) has administered the MUTCD since the 1971 edition and is the sole authority over its content.

The U.S. Secretary of Transportation, under authority granted by the Highway Safety Act of 1966, decreed that traffic control devices on all streets and highways open to public travel in accordance with 23 U.S.C. 109(d) and 402(a) in each state shall be in substantial conformance with the Standards issued or endorsed by the FHWA. In 23 CFR 655.603, the MUTCD is adopted as the national standard for any street, highway, or bicycle trail open to public travel in accordance with 23 U.S.C. 109(d) and 402(a).

Support. Sections 226.010 and 227.220 of the Revised Statutes of Missouri authorize MoDOT to prescribe uniform traffic control devices on the state's highways.

Standard. The traffic control articles of the Engineering Policy Guide (EPG) serve as MoDOT's Manual on Uniform Traffic Control Devices. The EPG shall be used when applying traffic control devices to state-maintained routes. Any variations from the EPG for traffic control devices shall be approved by the State Highway Safety and Traffic Engineer.

Support. For the 11th Edition of the MUTCD, MoDOT established a MoDOT MUTCD document. Unlike other states, this document is only intended to be a historical reference document and not a policy manual. The EPG remains the policy document for practitioners to use when applying traffic control devices to state-maintained routes. The MoDOT MUTCD is displayed in track change mode, indicating differences between MoDOT content and the 11th Edition National MUTCD, denoting the content MoDOT did not adopt, changes to the manual, and notes indicating the justifications for these variations.

The EPG contains the relevant content from, and is in substantial conformance with, the National MUTCD. However, MoDOT only adopts those portions of the National MUTCD that are relevant to state-maintained highways, and in many cases adopts provisions that exceed those in the National MUTCD. For this reason, the National MUTCD cannot be used as a standalone guide when applying traffic control devices to Missouri state-maintained routes. Practitioners should reference the National MUTCD for standards, guidance, and support related to traffic control devices that are not included in the EPG.

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Guidance. Like the National MUTCD, the EPG is a permissive manual, meaning the articles of the EPG outline what is permissible regarding the application of traffic control devices to state-maintained roadways. When specific criteria for traffic control devices are not found in the EPG to address a specific concern or application, the Highway Safety and Traffic Division should be contacted for assistance. The Highway Safety and Traffic Division has access to additional resources, such as other MoDOT districts, FHWA, research facilities, and other states, from which MUTCD-compliant solutions can be sourced. If these solutions have the possibility of being applicable to more than one site, consideration will be made to include the solution in the EPG.

The articles of the EPG are not a substitute for engineering judgment. It is the intent that the provisions of the EPG be criteria for traffic control devices installed, but not a legal requirement for their installation.

900.2 Material Inspection for Traffic Control

This article establishes procedures for reporting the inspection of traffic control devices typically inspected and accepted by the resident engineer's staff. This encompasses lighting, signal and signing materials that do not have a corresponding Division 1000 Material Details specification or are not typically tested and inspected by Materials personnel.

Materials personnel inspects and accept materials specified in Division 1000 and some aspects of materials such as poles, posts and arms. See the Contract Sampling and Testing Requirements for the specific materials on particular projects that require a separate sample record. Generally, each material with a distinct AASHTOWARE Project (AWP) Material Code should have a separate sample record of inspection and acceptance.

900.2.1 Procedure

The material components for traffic control, including highway lighting, traffic signals and highway signing, that are not normally field inspected by Materials, will be inspected and documented. The construction inspector shall confirm that the material components presented by the contractor for use meet the applicable specifications. Any documentation required by the specifications will be obtained from the contractor or the contractor's agent prior to use of the material. That documentation will be filed with other project documentation as maintained by the resident engineer's staff.

900.2.2 Report

Using AWP, a sample record for Sec 901 (http://www.modot.org/business/standards and specs/SpecbookEPG.pdf#page=13), 902 (http://www.modot.org/business/standards_and specs/SpecbookEPG.pdf#page=13http://www.modot.org/business/standards_and_specs/SpecbookEPG.pdf#page=13) and 903 (http://www.modot.org/business/standards and specs/SpecbookEPG.pdf#page=13http://www.modot.org/business/standards_and_specs/SpecbookEPG.pdf#page=13) materials will be created by the resident engineer's staff. Three material codes have been provided to allow the creation of the required sample records to acknowledge the inspection of Traffic Control materials. The codes

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are 0901LHXX for highway lighting, 0902TSXX for signals and 0903HSXX for highway signing. These respective sample records, when appropriate, are to be created in lieu of the District Engineer's Certification (DEC).

Generally, each sample record is completed according to the instructions in Automation Guide. When the materials used for the particular Traffic Control measure come from several sources, the primary producer/supplier of the material may be selected. On the Tests Tab, the test designated as "Dist. Engr. Cert. Sig., Sign, Light" (SAA901AA) is selected and completed. The "Dist. Engr. Cert. Sig., Sign, Light" test states that "The materials and equipment listed by the contractor, including accessories and appurtenances, as required by the Specification and specifically approved by the construction inspector, were those which were incorporated into the work." Any exceptions should be listed on the Free Form Test. The Dist. Engr. Cert. Sig., Sign, Light test may be eliminated and the Free Form Test substituted if it includes, at a minimum, the statement "The materials and equipment listed by the contractor, including accessories and appurtenances, as required by Section [fill in the appropriate section for each sample record] and specifically approved by the construction inspector, were those which were incorporated into the work" [except as follows[1]]. [List the exceptions and the exceptions' reasons.]

A listing of the actual items used, their source and any supporting documentation should be included in the project files.

A cathodic protection material code, 3099SPBRCA (Cathodic Protection for Bridge), is provided to allow acceptance by the procedure described above.

[1] Optional, depending on circumstances.

Subcategories

This category has the following 2 subcategories, out of 2 total.

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- 908 Traffic Controls for School Areas (MUTCD Part 7) (4 P, 1 F)
- 913 Traffic Control for Railroad and Light Rail Transit Grade Crossings (MUTCD Part 8) (5 P, 1 F)

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Category:902 Signals (MUTCD Part 4)



Traffic signals are electrically powered traffic control devices that warn or direct vehicular and pedestrian traffic to take some specific action. Traffic signals provide for the orderly assignment of right of way to conflicting traffic movements at intersections.

Traffic signals are not a complete solution for traffic problems. Traffic signals can sometimes create additional congestion and cause additional delay to vehicles if improperly designed, installed, or maintained. Correctly designed and operated traffic signals installed at warranted locations will provide for the orderly movement of traffic, increase the intersection capacity, and in some instances, tend to reduce accidents. Coordinating and timing signals are very important.

Traffic signals are listed on the Statewide Transportation Improvement Program (STIP) in the description of the type of improvement if there is a probability of future signal control. If signals cannot be justified, they are to be eliminated from the program at the earliest possible date.

Traffic Pamphlet
Traffic Signals

There are many aspects to be considered when inspecting construction quality and this article provides construction inspection guidelines and guidelines for material inspections.

Articles in "902 Signals (MUTCD Part 4)"

The following 28 pages are in this category, out of 28 total.

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- 902.1 General (MUTCD Chapter 4A)
- 902.2 Traffic Control Signals (MUTCD Chapter 4B)
- 902.3 Traffic Control Signal Needs Studies (MUTCD Chapter 4C)
- 902.4 Design Features of Traffic Control Signals (MUTCD Chapter 4D)
- 902.5 Traffic Control Signal Indications (MUTCD Chapter 4E)
- 902.6 Steady (Stop-and-Go) Operation of Traffic Control Signals (MUTCD Chapter 4F)

- 902.7 Flashing Operation of Traffic Control Signals (MUTCD Chapter 4G)
- 902.8 Bicycle Signals (MUTCD Chapter 4H)
- 902.9 Pedestrian Control Features (MUTCD Chapter 4I)
- 902.10 Pedestrian Hybrid Beacons (MUTCD Chapter 4J)
- 902.11 Accessible Pedestrian Signals and Detectors (MUTCD Chapter 4K)
- 902.12 Rectangular Rapid Flashing Beacons (MUTCD Chapter 4L)
- 902.13 Traffic Control Signals for Emergency-Vehicle Access (MUTCD Chapter 4M)
- 902.14 Hybrid Beacons for Emergency-Vehicle Access (MUTCD Chapter 4N)
- 902.15 Traffic Control Signals for One-Lane, Two-Way Facilities (MUTCD Chapter 4O)
- 902.16 Traffic Control Signals for Freeway Entrance Ramps (MUTCD Chapter 4P)
- 902.17 Highway Traffic Signals at Toll Plazas (MUTCD Chapter 4R)
- 902.18 Flashing Beacons (MUTCD Chapter 4S)
- 902.19 Lane-Use Control Signals (MUTCD Chapter 4T)
- 902.20 In-Roadway Warning Lights (MUTCD Chapter 4U)
- 902.21 Designing a MoDOT Traffic Signal
- 902.22 Maintenance Guidelines
- 902.23 Traffic Signal Phasing and Operation
- 902.24 Traffic Control for Schools
- 902.25 Glossary
- 902.26 Construction Inspection Guidelines for Sec 902
- 902.27 Material Inspection for Sec 902
- 902.28 Laboratory Testing Guidelines for Sec 902

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902.1 General (MUTCD Chapter 4A)

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902.1.2 Meanings of Signal Indications (MUTCD Section 4A.02)
902.1.3 Meanings of Steady Vehicular Signal Indications (MUTCD Section 4A.03)
902.1.4 Meanings of Flashing Vehicular Signal Indications (MUTCD Section 4A.04)
902.1.5 Meanings of Bicycle Symbol Signal Indications (MUTCD Section 4A.05)
902.1.6 Meanings of Pedestrian Signal Indications (MUTCD Section 4A.06)
902.1.7 Lateral Offset of Signal Supports and Cabinets (MUTCD Section 4A.07)
902.1.8 Use of Signs at Signalized Locations (MUTCD Section 4A.08)
902.1.9 Use of Pavement Markings at Signalized Locations (MUTCD Section 4A.09)
902.1.10 Responsibility for Operation and Maintenance (MUTCD Section 4A.10)

902.1.1 Types (MUTCD Section 4A.01)

Support. The following types and uses of highway traffic signals and devices are discussed in EPG 902: traffic control signals; bicycle signal faces; pedestrian signal heads; hybrid beacons; rectangular rapid flashing beacons; emergency-vehicle traffic control signals; traffic control signals for one-lane, two-way facilities; traffic control signals for freeway entrance ramps; flashing beacons; and in-roadway warning lights.

902.1.2 Meanings of Signal Indications (MUTCD Section 4A.02)

Support. The "Uniform Vehicle Code" (see EPG 911 (MUTCD Section 1A.06)) is the primary source for the standards for the meanings of vehicular signal indications to both vehicle operators and pedestrians as provided in EPG 902.1.3 and 902.1.4, the standards for the meanings of separate bicycle signal face indications as provided in EPG 902.1.5, and the standards for the meanings of separate pedestrian signal head indications as provided in EPG 902.1.6.

The physical area that is defined as being "within the intersection" is dependent upon the conditions that are described in the definition of an intersection in EPG 911 (MUTCD Section 1C.02).

902.1.3 Meanings of Steady Vehicular Signal Indications (MUTCD Section 4A.03)

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Standard. The following meanings shall be given to steady highway traffic signal indications for vehicles and pedestrians:

A. Steady green signal indications shall have the following meanings:

1. Vehicular traffic facing a CIRCULAR GREEN signal indication is permitted to proceed straight through or turn right or left or make a U-turn movement except as such movement is modified by lane-use signs, turn prohibition signs, lane markings, roadway design, separate turn signal indications, or other traffic control devices. Vehicular traffic facing a CIRCULAR GREEN signal indication shall only be permitted to make a U-turn movement from the left-turn lane where Intersection Lane Control signs are installed indicating that the movement is permitted (see EPG 903.2.25). The Highway Safety and Traffic Division shall approve all new or reconstructed signal installations where U-turns are permitted during a permissive phase. Such vehicular traffic, including vehicles turning right or left or making a U-turn movement, shall yield the right-of-way to:

   (a) Pedestrians lawfully within an associated crosswalk, and

   (b) Other vehicles lawfully within the intersection.

   In addition, vehicular traffic turning left or making a U-turn movement to the left shall yield the right-of-way to other vehicles approaching from the opposite direction so closely as to constitute an immediate hazard during the time when such turning vehicle is moving across or within the intersection.
2. Vehicular traffic facing a GREEN ARROW signal indication, displayed alone or in combination with another signal indication, is permitted to cautiously enter the intersection only to make the movement indicated by such arrow, or such other movement as is permitted by other signal indications displayed at the same time. Vehicular traffic facing a GREEN ARROW signal indication shall only be permitted to make a U-turn movement from the left-turn lane where Intersection Lane Control signs are installed indicating that the movement is permitted (see EPG 903.2.25). Such vehicular traffic, including vehicles turning right or left or making a U-turn movement, shall yield the right-of-way to:

   (a) Pedestrians lawfully within an associated crosswalk, and

   (b) Other vehicles lawfully within the intersection.

3. Pedestrians facing a CIRCULAR GREEN signal indication, unless otherwise directed by a pedestrian signal indication or other traffic control device, are permitted to proceed across the roadway within any marked or unmarked associated crosswalk. The pedestrian shall yield the right-of-way to vehicles lawfully within the intersection or so close as to create an immediate hazard at the time that the green signal indication is first displayed.
4. Pedestrians facing a GREEN ARROW signal indication, unless otherwise directed by a pedestrian signal indication or other traffic control device, shall not cross the roadway.

B. Steady yellow signal indications shall have the following meanings:

1. Vehicular traffic facing a steady CIRCULAR YELLOW signal indication is thereby warned that the related green movement or the related flashing arrow movement is being terminated or that a steady red signal indication will be displayed immediately thereafter when vehicular traffic shall not enter the intersection. The rules set forth concerning vehicular operation under the movement(s) being terminated shall continue to apply while the steady CIRCULAR YELLOW signal indication is displayed.
2. Vehicular traffic facing a steady YELLOW ARROW signal indication is thereby warned that the related GREEN ARROW movement or the related flashing arrow movement is being terminated.

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The rules set forth concerning vehicular operation under the movement(s) being terminated shall continue to apply while the steady YELLOW ARROW signal indication is displayed.

3. Pedestrians facing a steady CIRCULAR YELLOW or YELLOW ARROW signal indication, unless otherwise directed by a pedestrian signal indication or other traffic control device shall not start to cross the roadway.

C. Steady red signal indications shall have the following meanings:

1. Vehicular traffic facing a steady CIRCULAR RED signal indication, unless entering the intersection to make another movement permitted by another signal indication, shall stop at a clearly marked stop line; but if there is no stop line, traffic shall stop before entering the crosswalk on the near side of the intersection; or if there is no crosswalk, then before entering the intersection; and shall remain stopped until a signal indication to proceed is displayed, or as provided below. Except when a traffic control device is in place prohibiting a turn on red or a steady RED ARROW signal indication is displayed, vehicular traffic facing a steady CIRCULAR RED signal indication is permitted to enter the intersection to turn right after stopping. The right to proceed with the turn shall be subject to the rules applicable after making a stop at a STOP sign.
2. Vehicular traffic facing a steady RED ARROW signal indication shall not enter the intersection to make the movement indicated by the arrow and, unless entering the intersection to make another movement permitted by another signal indication, shall stop at a clearly marked stop line; but if there is no stop line, before entering the crosswalk on the near side of the intersection; or if there is no crosswalk, then before entering the intersection; and shall remain stopped until a signal indication or other traffic control device permitting the movement indicated by such RED ARROW is displayed. When a traffic control device is in place permitting a turn on a steady RED ARROW signal indication, vehicular traffic facing a steady RED ARROW signal indication is permitted to enter the intersection to make the movement indicated by the arrow signal indication, after stopping. The right to proceed with the turn shall be limited to the direction indicated by the arrow and shall be subject to the rules applicable after making a stop at a STOP sign.
3. Unless otherwise directed by a pedestrian signal indication or other traffic control device, pedestrians facing a steady CIRCULAR RED or steady RED ARROW signal indication shall not enter the roadway.

902.1.4 Meanings of Flashing Vehicular Signal Indications (MUTCD Section 4A.04)

Standard. The following meanings shall be given to flashing highway traffic signal indications for vehicles and pedestrians:

A. A flashing green signal indication has no meaning and shall not be used.
B. Flashing yellow signal indications shall have the following meanings:

1. Vehicular traffic, on an approach to an intersection, facing a flashing CIRCULAR YELLOW signal indication is permitted to cautiously enter the intersection to proceed straight through or turn right or left or make a U-turn except as such movement is modified by lane use signs, turn prohibition signs, lane markings, roadway design, separate turn signal indications, or other traffic control devices. Vehicular traffic facing a flashing CIRCULAR YELLOW signal indication shall only be permitted to make a U-turn movement from the left-turn lane where Intersection Lane Control signs are installed indicating that the movement is permitted (see EPG 903.2.25). The Highway Safety and Traffic Division shall approve all new or reconstructed signal installations where U-turns are permitted during a permissive phase. Such vehicular traffic, including vehicles turning right or left or making a U-turn, shall yield the right-of-way to:

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(a) Pedestrians lawfully within an associated crosswalk, and

(b) Other vehicles lawfully within the intersection.

In addition, vehicular traffic turning left or making a U-turn to the left shall yield the right-of-way to other vehicles approaching from the opposite direction so closely as to constitute an immediate hazard during the time when such turning vehicle is moving across or within the intersection.

2. Vehicular traffic, on an approach to an intersection, facing a flashing YELLOW ARROW signal indication, displayed alone or in combination with another signal indication, is permitted to cautiously enter the intersection only to make the movement indicated by such arrow, or other such movement as is permitted by other signal indications displayed at the same time. Vehicular traffic facing a flashing YELLOW ARROW signal indication shall only be permitted to make a U-turn movement from the left-turn lane where Intersection Lane Control signs are installed indicating that the movement is permitted (see EPG 903.2.25). The Highway Safety and Traffic Division shall approve all new or reconstructed signal installations where U-turns are permitted during a permissive phase. Such vehicular traffic, including vehicles turning right or left or making a U-turn, shall yield the right-of-way to:

   (a) Pedestrians lawfully within an associated crosswalk, and

   (b) Other vehicles lawfully within the intersection.

   In addition, vehicular traffic turning left or making a U-turn to the left shall yield the right-of-way to other vehicles approaching from the opposite direction so closely as to constitute an immediate hazard during the time when such turning vehicle is moving across or within the intersection.

3. Pedestrians facing any flashing yellow signal indication at an intersection, unless otherwise directed by a pedestrian signal indication or other traffic control device, are permitted to proceed across the roadway within any marked or unmarked associated crosswalk. Pedestrians shall yield the right-of-way to vehicles lawfully within the intersection at the time that the flashing yellow signal indication is first displayed.
4. When a flashing CIRCULAR YELLOW signal indication(s) is displayed as a beacon (see EPG 902.18) to supplement another traffic control device, road users are notified that there is a need to pay extra attention to the message contained thereon or that the regulatory or warning requirements of the other traffic control device, which might not be applicable at all times, are currently applicable.

C. Flashing red signal indications shall have the following meanings:

1. Vehicular traffic, on an approach to an intersection, facing a flashing CIRCULAR RED signal indication shall stop at a clearly marked stop line; but if there is no stop line, before entering the crosswalk on the near side of the intersection; or if there is no crosswalk, at the point nearest the intersecting roadway where the driver has a view of approaching traffic on the intersecting roadway before entering the intersection. The right to proceed shall be subject to the rules applicable after making a stop at a STOP sign.
2.
3. Pedestrians facing any flashing red signal indication at an intersection, unless otherwise directed by a pedestrian signal indication or other traffic control device, are permitted to proceed across the roadway within any marked or unmarked associated crosswalk. Pedestrians shall yield the right-of-way to vehicles lawfully within the intersection at the time that the flashing red signal indication is first displayed.
4. When a flashing CIRCULAR RED signal indication(s) is displayed as a beacon (see EPG 902.18) to supplement another traffic control device, road users are notified that there is a need to pay extra attention to the message contained thereon or that the regulatory requirements of the other

traffic control device, which might not be applicable at all times, are currently applicable. Use of this signal indication shall be limited to supplementing STOP (R1-1), DO NOT ENTER (R5-1), or WRONG WAY (R5-1a) signs, and to applications where compliance with the supplemented traffic control device requires a stop at a designated point.

902.1.5 Meanings of Bicycle Symbol Signal Indications (MUTCD Section 4A.05)

Guidance. Bicycle symbol signal indications are not currently used on MoDOT facilities. Contact the Highway Safety and Traffic Division for guidance.

Standard. The following meanings shall be given to bicycle symbol signal indications for bicyclists:

A. Bicyclists facing a steady GREEN BICYCLE signal indication are permitted to enter the intersection only to make the movement indicated by the lane-use arrow(s) displayed on the Bicycle Signal sign (see EPG 914.2.10) that is located immediately adjacent to the signal face. Bicyclists proceeding into the intersection during the display of the steady GREEN BICYCLE signal indication shall yield the right-of-way to:

1. Pedestrians lawfully within an associated crosswalk, and
2. Other vehicles lawfully within the intersection.

B. Bicyclists facing a steady YELLOW BICYCLE signal indication are thereby warned that the related green movement is being terminated and that a steady RED BICYCLE signal indication will be displayed immediately thereafter when bicyclists shall not enter the intersection. The rules set forth concerning bicycle operation under the movement being terminated shall continue to apply while the steady YELLOW BICYCLE signal indication is displayed.

C. Bicyclists facing a steady RED BICYCLE signal indication shall not enter the intersection to make the movement indicated by the lane-use arrow(s) displayed on the Bicycle Signal sign (see EPG 914.2.10) that is located immediately adjacent to the signal face and, unless entering the intersection to make another movement permitted by another bicycle symbol signal indication, shall stop at a clearly marked stop line; but if there is no stop line, before entering the crosswalk on the near side of the intersection; or if there is no crosswalk, then before entering the intersection; and shall remain stopped until a GREEN BICYCLE signal indication permitting the movement indicated by such RED BICYCLE signal indication is displayed.

Except when a traffic control device is in place prohibiting a turn on red, bicyclists facing a steady RED BICYCLE signal indication are permitted to enter the intersection to turn right if there are no approach lanes for motor vehicle traffic to their right. The right to proceed with the turn shall be subject to the rules applicable after making a stop at a STOP sign.

D. A flashing GREEN BICYCLE signal indication has no meaning and shall not be used.

E. A flashing YELLOW BICYCLE signal indication has no meaning and shall not be used.

F. Bicyclists facing a flashing RED BICYCLE signal indication shall stop at a clearly marked stop line; but if there is no stop line, before entering the crosswalk on the near side of the intersection; or if there is no crosswalk, at the point nearest the intersecting roadway where the bicyclist has a view of approaching traffic on the intersecting roadway before entering the intersection. The right to proceed in the direction indicated by the lane-use arrow(s) displayed

on the Bicycle Signal sign (see EPG 914.2.10) that is located immediately adjacent to the signal face shall be subject to the rules applicable after making a stop at a STOP sign.

902.1.6 Meanings of Pedestrian Signal Indications (MUTCD Section 4A.06)

Standard. Pedestrian signal indications shall have the following meanings:

A. A flashing WALKING PERSON (symbolizing WALK) signal indication has no meaning and shall not be used.

B. Pedestrians facing a steady WALKING PERSON (symbolizing WALK) signal indication shall be permitted to start to cross the roadway in the direction of the signal indication, possibly in conflict with turning vehicles. Pedestrians shall yield the right-of-way to vehicles lawfully within the intersection at the time that the WALKING PERSON (symbolizing WALK) signal indication is first shown.

C. Pedestrians facing a flashing UPRAISED HAND (symbolizing DONT WALK) signal indication shall not start to cross the roadway in the direction of the signal indication. Any pedestrian who has already started to cross the roadway on a steady WALKING PERSON (symbolizing WALK) signal indication shall continue to proceed to the far side of the traveled way of the street or highway, unless otherwise directed by a traffic control device to proceed only to the median of a divided highway or only to some other island or pedestrian refuge area (see EPG 620.3.10).

D. Pedestrians facing a steady UPRAISED HAND (symbolizing DONT WALK) signal indication shall not enter the roadway in the direction of the signal indication.

902.1.7 Lateral Offset of Signal Supports and Cabinets (MUTCD Section 4A.07)

Guidance. The following items should be considered when placing signal supports and cabinets:

A. Reference should be made to the “Roadside Design Guide,” 4th Edition, 2011, AASHTO, and to the U.S. Department of Justice 2010 ADA Standards for Accessible Design, September 15, 2010, 28 CFR 35 and 36, Americans with Disabilities Act of 1990.

B. Signal supports should be placed as far as practicable from the edge of the traveled way without adversely affecting the visibility of the signal indications.

C. Where supports cannot be located based on the recommended AASHTO clearances, consideration should be given to the use of appropriate safety devices.

D. No part of a concrete foundation for a breakaway signal support should extend more than 4 inches above the ground level at any point. This limitation does not apply to the concrete foundation for a rigid support.

E. In order to minimize hindrance to the passage of persons with physical disabilities, a signal support or controller cabinet should not obstruct the sidewalk or the pedestrian access route such that less than 4 feet of clear space is available, or access from the sidewalk to the crosswalk. Refer to the Public Right-of-Way Accessibility Guidelines, published by the U.S. Access Board for pedestrian access route.

F. Controller cabinets should be located as far as practicable from the edge of the roadway.

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G. On medians, the minimum clearances provided in Items A through E for signal supports should be obtained, if practicable.

902.1.8 Use of Signs at Signalized Locations (MUTCD Section 4A.08)

Support. Traffic signal signs are sometimes used at highway traffic signal locations to instruct or guide pedestrians, bicyclists, or motorists. Among the signs typically used at or on the approaches to signalized locations are movement prohibition signs (see EPG 903.2.24), lane-control signs (see EPG 903.2.25 through EPG 903.2.27), pedestrian crossing signs (see EPG 903.2.46), pedestrian and bicycle actuation signs (see EPG 903.2.47), traffic signal signs (see EPG 903.2.48 and EPG 903.3.36), No Turn on Red signs (see EPG 903.2.49), Signal Ahead warning signs (see EPG 903.3.29), Street Name signs (see EPG 903.4.40), and Advance Street Name signs (see EPG 903.4.41).

Guidance. Regulatory, warning, and guide signs should be used at highway traffic signal locations as provided in Part 2 and as specifically provided elsewhere in EPG 902.

Support. EPG 903.2.25 contains information regarding the use of overhead lane-control signs on signalized approaches where lane drops, multiple-lane turns involving combined through-and-turn lanes, or other lane-use regulations that would be unexpected by unfamiliar road users are present.

Standard. If used, illuminated traffic signal signs shall be designed and mounted in such a manner as to avoid glare and reflections that seriously detract from the signal indications. Highway traffic signal faces shall be given dominant position and brightness to maximize their priority in the overall display.

The minimum vertical clearance and horizontal offset of the total assembly of traffic signal signs (see EPG 903.2.48) shall comply with the provisions of EPG 902.4.9 and 902.4.10.

STOP signs shall not be used in conjunction with any highway traffic signal operation, except in either of the following cases:

A. If the signal indication for an approach is a flashing red at all times, or

B. If a minor street or driveway is located within or adjacent to an area controlled by a traffic control signal, but does not require separate traffic signal control because an extremely low potential for conflict exists.

902.1.9 Use of Pavement Markings at Signalized Locations (MUTCD Section 4A.09)

Support. Pavement markings that clearly communicate the operational plan of an intersection to road users play an important role in the effective operation of highway traffic signals. By designating the number of lanes, the use of each lane, the length of additional lanes on the approach to an intersection, crosswalks, and the proper stopping points, the engineer can design the signal phasing and timing to best match the goals of the operational plan.

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Guidance. Pavement markings should be used at highway traffic signal locations as provided in EPG 620. If the road surface will not retain pavement markings, signs should be installed to provide the needed road user information.

902.1.10 Responsibility for Operation and Maintenance (MUTCD Section 4A.10)

Guidance. Prior to installing any highway traffic signal, the responsibility for the maintenance of the signal and all of the appurtenances, hardware, software, and the timing plan(s) should be clearly established by the responsible agency.

To this end the agency should:

A. Keep every controller assembly in effective operation in accordance with its predetermined timing schedule, check the operation of the controller assembly frequently enough to verify that it is operating in accordance with the predetermined timing schedule, and establish a policy to maintain a record of all timing changes and that only authorized persons are permitted to make timing changes;

B. Clean the optical system of the signal sections and replace the light sources as frequently as experience proves necessary;

C. Clean and service equipment and other appurtenances as frequently as experience proves necessary;

D. Provide for alternate operation of the traffic control signal during a period of failure, using flashing mode or manual control, or manual traffic direction by proper authorities as might be required by traffic volumes or congestion, or by erecting other traffic control devices;

E. Have properly-skilled maintenance personnel available without undue delay for all signal malfunctions and signal indication failures;

F. Maintain an inventory of spare equipment to minimize the interruption of highway traffic signal operation as a result of equipment failure;

G. Provide for the availability of properly-skilled maintenance personnel for the repair of all components;

H. Maintain the appearance of the signal displays and equipment; and

I. Follow appropriate procedures for operation and maintenance for all traffic signal control systems and equipment.

Support: See EPG 902.22 for additional MoDOT traffic signal maintenance information.

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902.2 Traffic Control Signals (MUTCD Chapter 4B)

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902.2.1 General (MUTCD Section 4B.01)

Support. Words such as pedestrians and bicyclists are used redundantly in selected Articles of EPG 902 to encourage sensitivity to these elements of "traffic."

Standards for traffic control signals are important because traffic control signals need to attract the attention of a variety of road users, including those who are older, those with vision disabilities, as well as those who are fatigued or distracted, or who are not expecting to encounter a signal at a particular location.

902.2.2 Advantages and Disadvantages of Traffic Control Signals (MUTCD Section 4B.02)

Support. When properly used, traffic control signals are valuable devices for safety and the control of vehicular and vulnerable road user traffic. They control the various traffic movements by alternating between directing them to stop and permitting them to proceed and thereby profoundly influence traffic flow. This accomplishes the need to safely separate road users in time in order to prevent crashes.

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

A. They reduce the frequency and severity of certain types of crashes, especially right-angle collisions and those involving vulnerable road users.
B. They provide for the orderly movement of traffic.
C. They increase the traffic-handling capacity of the intersection if:

1. Proper physical layouts and control measures are used, and

2. The signal operational parameters are reviewed and updated (if needed) on a regular basis (as engineering judgment determines that significant traffic flow and/or land use changes have occurred) to maximize the ability of the traffic control signal to satisfy current traffic demands.

D. They are coordinated to provide for continuous or nearly-continuous movement of traffic at a definite speed along a given route under favorable conditions.
E. They are used to interrupt heavy traffic at intervals to permit other traffic, vehicular or pedestrian, to cross.

Traffic control signals are often considered a panacea for all traffic problems at intersections. This belief has led to traffic control signals being installed at many locations where they are not needed, adversely affecting the safety and efficiency of motor vehicle, bicycle, and pedestrian traffic.

Traffic control signals, even when justified by traffic and roadway conditions, can be ill-designed, ineffectively placed, improperly operated, or poorly maintained. Improper or unjustified traffic control signals can result in one or more of the following disadvantages:

A. Excessive delay,
B. Excessive disobedience of the signal indications,
C. Increased use of less-adequate routes as road users attempt to avoid the traffic control signals, and
D. Significant increases in the frequency of collisions (especially rear-end collisions).

902.2.3 Alternatives to Traffic Control Signals (MUTCD Section 4B.03)

Guidance. Since road user delay and the frequency of some types of crashes are sometimes higher under traffic signal control than under STOP sign control, consideration should be given to providing alternatives to traffic control signals even if one or more of the signal warrants (see EPG 902.3) has been satisfied.

Option. These alternatives may include, but are not limited to, the following:

A. Installing signs along the major street to warn road users approaching the intersection;
B. Installing a roundabout to reduce fatal and serious injury crashes and vehicular conflicts that result in fatal and serious injury crashes (see EPG 913.1.12 if the location is in close proximity to a grade crossing);
C. Installing a pedestrian hybrid beacon (see EPG 902.10), rectangular rapid flashing beacons (see EPG 902.12), pedestrian-actuated Warning Beacons (see EPG 902.18), or In-Roadway Warning Lights (see EPG 902.20) if pedestrian safety is the major concern;
D. Relocating the stop line(s) and making other changes to improve the sight distance at the intersection;
E. Installing measures designed to reduce speeds on the approaches;
F. Installing a flashing beacon at the intersection to supplement STOP sign control;
G. Installing flashing beacons on warning signs in advance of a stop-controlled intersection on the major-street and/or minor-street approaches;
H. Adding one or more lanes on a minor-street approach to reduce the number of vehicles per lane on the approach;
I. Revising the geometrics at the intersection to channelize vehicular movements and reduce the time required for a vehicle to complete a movement, which could also assist pedestrians;

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J. Revising the geometrics at the intersection to add pedestrian median refuge islands and/or curb extensions;
K. Installing roadway lighting if a disproportionate number of crashes occur at night;
L. Restricting one or more turning movements, perhaps on a time-of-day basis, if alternate routes are available;
M. If the warrant is satisfied, installing multi-way stop control;
N. Employing other alternatives, depending on conditions at the intersection.

Support. EPG 233 contains information on intersection alternatives.

902.2.4 Basis of Installation of Traffic Control Signals (MUTCD Section 4B.04)

Support. A careful analysis of traffic operations, pedestrian and bicyclist needs, and other factors at a large number of signalized and unsignalized locations, coupled with engineering judgment, has provided a series of signal warrants, described in EPG 902.3, that define the minimum conditions under which installing traffic control signals might be justified.

MoDOT's general policy is to own, operate and maintain all traffic signals and flashers installed or constructed on the state highway system.

When the installation of a traffic signal is warranted, the cost of the signal (excluding emergency and school signals), installation and maintenance, and electrical power for operation, unless otherwise stated, will be borne by the Commission. Where possible, MoDOT takes advantage of any reduced power rates by including in the municipal and/or county agreement a phrase the city will pay for the power, with reimbursement to be made by the state. Where city/county power is not available, MoDOT pays for the power directly.

The need for signalizing an intersection will normally be recognized and initiated at the district level. A careful analysis of traffic operations, pedestrian and bicyclist needs, and other factors at a large number of signalized and unsignalized locations, coupled with engineering judgment, has provided a series of signal warrants, described in EPG 902.3, that define the minimum conditions under which installing traffic control signals might be justified.

Meeting the warrant requirements of the MUTCD alone is not necessarily a sufficient reason to install traffic signals. Since the installation of traffic control signals will operate either to the advantage or disadvantage of vehicles and persons controlled, the selection and use of traffic control devices is to be preceded by a thorough engineering study of the roadway and traffic conditions.

Guidance. The design (including the phasing, operation, and timing) of new traffic control signals should be based on an engineering study of roadway, traffic, and other conditions.

902.2.5 Basis of Removal of Traffic Control Signals (MUTCD Section 4B.05)

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Guidance. Engineering judgment should be applied in the review of operating traffic control signals to determine whether the type of installation and the timing program meet the current requirements of all forms of traffic.

If changes in traffic patterns eliminate the need for a traffic control signal, consideration should be given to removing it and replacing it with appropriate alternative traffic control devices, if any are needed.

If the engineering study indicates that the traffic control signal is no longer justified, and a decision is made to remove the signal, the removal should be accomplished using the following steps:

A. Determine the appropriate traffic control to be used after the removal of the signal.
B. Remove any sight-distance restrictions as necessary.
C. Inform the public of the removal study.
D. Flash or cover the signal heads for a minimum of 90 days, and install the appropriate STOP sign control or other traffic control devices.
E. Remove the signal if the engineering data collected during the removal study period confirms that the signal is no longer needed.

Option. Because Items C, D, and E in the third guidance paragraph of this Article are not relevant when a temporary traffic control signal (see EPG 902.4.11) is removed, a temporary traffic control signal may be removed immediately after Items A and B are completed.

Instead of total removal of a traffic control signal, the poles, controller cabinet, and cables may remain in place after removal of the signal heads for continued analysis.

Standard. After all of the above considerations have been evaluated and if the decision is made to proceed with the removal, the following steps shall be taken:

1. Central Office Traffic shall be advised and documentation of the above noted evaluations provided to support the decision.
2. Public notice of the intention to remove shall be made. This can consist of news releases, public hearings and presentations at city council meetings or canvassing parties affected by the removal. This is a very important step and the district must be prepared to answer any questions that might arise.
3. Establish a date for the signal to be turned off and notify Central Office Traffic.
4. Flash the signal heads for a minimum of 30 days. After the flash period, cover the signal heads for no less than 60 days. The type of flash used shall compliment the type of traffic control selected for the intersection, yellow/red for two-way stops and red/red for four-way stops.
5. After the 90 day transition period has been successfully completed, the physical removal of the signals can be initiated. A comprehensive removal shall be completed with all concrete foundations and bases removed to at least flush with the ground. Consideration shall be given to filling or securing any pull boxes.

Guidance. When a temporary traffic control signal is removed the appropriate traffic control to be used after removal of the signal is to be determined and any sight distance restrictions removed.

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902.3 Traffic Control Signal Needs Studies (MUTCD Chapter 4C)

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902.3.1 Studies and Factors for Justifying Traffic Control Signals (MUTCD Section 4C.01)

Standard. Except for a temporary traffic control signal (see EPG 902.4.11) installed in a temporary traffic control zone, before a traffic control signal is installed at a particular location, 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 that location.

The investigation of the need for a traffic control signal shall include an analysis of factors related to the existing operation and safety at the study location and the potential to improve these conditions, and the applicable factors contained in the following traffic 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

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

Support. Sections EPG 913.4.8 and EPG 913.4.14 contain information regarding the use of traffic control signals instead of gates and/or flashing-light signals at grade crossings.

Guidance. When considering the installation of a traffic control signal, alternatives to traffic control signals, including those listed in EPG 902.2.3, should also be considered.

A traffic control signal should not be installed unless one or more of the factors described in this Article are met. Signalization can be approved at the district level for locations meeting the criteria in this Article.

A traffic control signal should not be installed unless an engineering study indicates that installing a traffic control signal will improve the overall safety and/or operation of the intersection.

A traffic control signal should not be installed if it will seriously disrupt progressive traffic flow. Traffic signals that are too closely spaced can be a problem to coordinate and may result in a significant loss of operating efficiency. There are three primary areas of concern with close signal spacing:

A. Traffic Queuing. Queue spillback between intersections can cause a breakdown in signalized traffic flow. Ideally, signals are to be spaced to allow room for anticipated queues. A rule of thumb for spacing is eight times the largest cycle length used. An estimate of queues can be made using modeling software.
B. Signal Coordination. Signal spacing is an important factor in coordination of signals. In general, an analysis of signal coordination is to be done if a new signal will be in a coordinated system, and particularly if the distance from the nearest signal is less than 1000 feet.
C. Operating Efficiency. If the location of the proposed signal shows a potential for queue spillback problems or coordination problems, then the operation will result in a reduced efficiency for both the new signal as well as the adjacent signals. To quantify the reduction in efficiency, an analysis of signal timing and coordination is to be developed that addresses the queuing or coordination problem and compared to existing conditions using modeling software.

Parking on the approaches to the intersection should be reviewed to determine if it is necessary to restrict parking on one or more approaches in order to increase sight distance or to provide increased capacity at the intersection.

The engineering study should consider the effects of the right-turning vehicles from the minor-street approaches. Engineering judgment should be used to determine what, if any, portion of the right-turning traffic is subtracted from the minor-street traffic count when evaluating the count against the signal warrants listed above. If a separate channelized or "free" right with an adequate approach lane is available or proposed, the benefits of a traffic signal in accomplishing this movement are minimal. In such cases, the right-turning volumes for the affected approaches are not to be included in the warrant evaluation. Where the right-turning vehicles are under signal control or where there is a “free” right with no adequate approach lane, right-turning vehicles may be included in warrant analysis. Right-turn movements are typically permitted on red and right-turn movements only require gaps in one or two conflicting movements. As the right turn percentage of total approach volume increases, the benefit of signalization decreases. To account for this effect in warrant analysis, the percentage of right-turning vehicles used in warrant analysis is to be reduced as the right turn percentage of total approach volume increases. If right-turn movements on red are prohibited for an approach, the full right-turning volume is to be considered in warrant analysis. The following table is a guide for determining the number of right-turning vehicles to include in a warrant analysis.

Proposed Right Turn Condition	Right Turn Percentage (Right Turn Volume/Total Approach Volume)	Percent Right Turn Used in Warrant Analysis
Free Right with Adequate Lane	Any	0
Free Right without Adequate Approach	0 to 25	100
	25 to 50	75
	50 to 75	50
	75 to 100	25
RTOR Restricted	Any	100

Engineering judgment should also be used in applying various traffic signal warrants to cases where major-street approaches consist of one lane plus one left-turn or right-turn lane. The site-specific traffic characteristics should dictate whether a major-street approach is considered as one lane or two lanes. For example, for a major-street approach with one lane for through and right-turning traffic plus a left-turn lane, if engineering judgment indicates that it should be considered a one-lane approach because the traffic using the left-turn lane is minor, the total traffic volume approaching the intersection should be applied against the signal warrants as a one-lane approach. The major-street approach should be considered two lanes if approximately half of the traffic on the approach turns left and the left-turn lane is of sufficient length to accommodate all left-turning vehicles.

Similar engineering judgment and rationale should be applied to a minor-street approach with one through/left-turn lane plus a right-turn lane. In this case, the degree of conflict of minor-street right-turning traffic with traffic on the major street should be considered. Thus, right-turning traffic should not be included in the minor-street volume if the movement enters the major street with minimal conflict. The minor-street approach should be evaluated as a one-lane approach with only the traffic volume in the through/left-turn lane considered.

If a minor-street approach has one combined through/right-turn lane plus a left-turn lane, the approach should either be analyzed as a two-lane approach based on the sum of the traffic volumes using both lanes or as a one-lane approach based on only the traffic volume in the approach lane with the higher volume.

At a location that is under development or construction or at a location where it is not possible to obtain a traffic count that would represent future traffic conditions, hourly volumes should be estimated as part of an engineering study for comparison with traffic signal warrants. Except for locations where the engineering study uses the satisfaction of Warrant 8 to justify a signal, a traffic control signal installed under projected conditions should have an engineering study done within 1 year of putting the signal into steady (stop-and-go) operation to determine if the signal is justified. If not justified, the signal should be taken out of steady (stop-and-go) operation or removed.

Many times developers will submit projected volumes to justify the installation of a traffic signal. Projected volumes, if properly determined, can be accurate gauges of the expected traffic. Great care is to be taken evaluating an intersection for traffic signals when projections are used. The projections are to be part of a formal traffic impact study performed by a traffic engineering consultant. The consultant should refer to EPG 905.3.4 when determining the projected volumes at the intersection in question. Engineering judgment is used to determine if projected volumes warrant a traffic signal.

Option. Because of increased development along the state highway system by commercial and industrial complexes, along with certain public institutions and street developments, traffic flows are generated which require remedial measures to maintain efficient flow of traffic. Traffic signals may be considered for handling traffic at these developments using Warrant 1 or Warrant 3.

Standard. To qualify privately owned or publicly owned developments for traffic control measures the applicant shall first convey to the Commission, by permanent traffic control easement, that area of operation or area of work which falls on land not within the normal right of way boundaries. The requirements and conditions of the easement will be based on the traffic operational requirements.

Option. For signal warrant analysis, a location with a wide median may be analyzed as one intersection or as two intersections (see EPG 903.1.23) based on engineering judgment.

At an intersection with a high volume of left-turning traffic from the major street, the signal warrant analysis may be performed in a manner that considers the higher of the major-street left-turn volumes as the “minor-street” volume and the corresponding single direction of opposing traffic on the major street as the “major-street” volume.

For signal warrants requiring conditions to be present for a certain number of hours in order to be satisfied, any four consecutive 15-minute periods may be considered as 1 hour if the separate 1-hour periods used in the warrant analysis do not overlap each other and both the major-street volume and the minor-street volume are for the same specific 1-hour periods.

For signal warrant analysis, bicyclists may be counted as either vehicles or pedestrians.

Support. When performing a signal warrant analysis, bicyclists riding in the street with other vehicular traffic are usually counted as vehicles and bicyclists who are clearly using pedestrian facilities are usually counted as pedestrians.

Option. Engineering study data may include the following:

A. The number of vehicles entering the intersection in each hour from each approach during 12 hours of an average day. It is desirable that the hours selected contain the greatest percentage of the 24-hour traffic volume.
B. Vehicular volumes for each traffic movement from each approach, classified by vehicle type (heavy trucks, passenger cars and light trucks, public-transit vehicles, and, in some locations, bicycles), during each 15-minute period of the 2 hours in the morning and 2 hours in the afternoon during which the total traffic entering the intersection is the greatest.
C. Pedestrian volume counts on each crosswalk during the same periods as the vehicular counts in Item B and during the hours of highest pedestrian volume. Where young, elderly, and/or persons with physical or vision disabilities need special consideration, the pedestrians and their crossing times may be classified by general observation.
D. Information about nearby facilities and activity centers that serve the young, elderly, and/or persons with disabilities, including requests from persons with disabilities for accessible crossing improvements at the location under study. These persons might not be adequately reflected in the pedestrian volume count if the absence of a signal restrains their mobility.
E. The posted or statutory speed limit or the 85th-percentile speed on the uncontrolled approaches to the location.
F. A condition diagram showing details of the physical layout, including such features as intersection geometrics, channelization, grades, sight-distance restrictions, transit stops and routes, parking conditions, pavement markings, roadway lighting, driveways, nearby railroad crossings, distance to the nearest traffic control signals, utility poles and fixtures, and adjacent land use.
G. A collision diagram showing crash experience by type, location, direction of movement, severity, weather, time of day, date, and day of week for at least 1 year.
H. On-site photographs of all approaches and any special considerations.

The following data, which are desirable for a more precise understanding of the operation of the intersection, may be obtained during the periods described in Item B of the preceding paragraph:

A. Delay Study - Vehicle-hours of stopped-time delay determined separately for each approach.
B. Gap Study - The number and distribution of acceptable gaps in vehicular traffic on the major street for entrance from the minor street.
C. Speed Study - The posted or statutory speed limit or the 85th-percentile speed on controlled approaches at a point near to the intersection but unaffected by the control.
D. Pedestrian Delay Study - Pedestrian delay time for at least two 30-minute peak pedestrian delay periods of an average weekday or like periods of a Saturday or Sunday.
E. Queue Study - Queue length on stop-controlled approaches.
F. Signal Coordination Study - A time-space diagram for the coordinated signal system for each timing plan to be used is developed or revised to include the proposed signal installation. The time-space diagram is based on normal free flow speed for that time of day. It is necessary to develop realistic signal timing and offsets for the new signals. The time-space diagram is reviewed to determine the effects of the new signal on vehicle platooning through the coordinated system. This study can be further enhanced by using a traffic modeling program to help visualize actual conditions.

All of the above counts and data are to be obtained on an average day period.

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Support. The safe and efficient movement of all road users is the primary consideration in the engineering study to determine whether to install a traffic control signal or to install some other type of control or roadway configuration. Installation of a traffic control signal does not necessarily result in improved safety in every case. In some cases, the installation of a traffic control signal at an inappropriate location could adversely impact safety for one or more types of road users. The purpose of the engineering study is to evaluate all of the factors that are relevant to a specific location. The satisfaction of a warrant (or warrants) is one of the relevant factors in the engineering study, but it is not intended to be the only factor or even the overriding consideration. Agencies can install a traffic control signal at a location where no warrants are met, but only after conducting an engineering study that documents the rationale for deciding that the installation of a traffic control signal is the best solution for improving the overall safety and/or operation at the location.

Option. Adequate roadway capacity is always desirable and especially so at a signalized intersection. The widening of both the main highway and intersecting roadways may be necessary to reduce the delays caused by assignment of right of way at the intersection and the widening itself may reduce or eliminate the need for signalization. In general, it is always desirable to provide a left turn lane for each major approach at each intersection. This is especially so on a two-lane roadway where there are sizable volumes of left-turning traffic. The left turn lane provides a place to separately store left-turning traffic. Separating the through and turning vehicles will generally improve the capacity of the intersection as well as reducing the overall delay at the intersection and the opportunity for rear-end crashes.

902.3.2 Warrant 1, Eight-Hour Vehicular Volume (MUTCD Section 4C.02)

Support. The Minimum Vehicular Volume, Condition A (see Table 902.3.2), is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

The Interruption of Continuous Traffic, Condition B (see Table 902.3.2), is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

It is intended that Warrant 1 be treated as a single warrant. If Condition A is satisfied, then Warrant 1 is satisfied and analyses of Condition B and the combination of Conditions A and B are not needed. Similarly, if Condition B is satisfied, then Warrant 1 is satisfied and an analysis of the combination of Conditions A and B is not needed.

Guidance. The need for a traffic control signal should be considered if an engineering study finds that one of the following conditions exist for each of any 8 hours of an average day:

A. The vehicles per hour given in both of the 100 percent columns of Condition A in Table 902.3.2 exist on the major street and the more critical minor-street approach, respectively, to the intersection; or
B. The vehicles per hour given in both of the 100 percent columns of Condition B in Table 902.3.2 exist on the major street and the more critical minor-street approach, respectively, to the intersection.

Standard. These major-street and minor-street volumes shall be for the same 8 hours for each condition; however, the 8 hours that are selected for the Condition A analysis shall not be required to be the same 8 hours that are selected for the Condition B analysis.

Table 902.3.2. Warrant 1, Eight-Hour Vehicular Volume

Condition A - Minimum Vehicular Volume									
Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on more critical minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	500	400	350	280	150	120	105	84
2 or more	1	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1	2 or more	500	400	350	280	200	160	140	112
Condition B - Interruption of Continuous Traffic									
Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on more critical minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	750	600	525	420	75	60	53	42
2 or more	1	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1	2 or more	750	600	525	420	100	80	70	56

[a] Basic minimum hourly volume

[b] Used for combination of Conditions A and B after adequate trial of remedial measures

[c] May be used when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

[d] May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

Support. On the minor street, the more critical volume is not required to be on the same approach during each of these 8 hours. The more critical minor-street volume is the one that meets the warranting criteria for that approach, and in the case of a one-lane minor-street approach that is opposite from a multi-lane minor-street approach might not have the higher volume.

Option. If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 70 percent columns in Table 902.3.2 may be used in place of the 100 percent columns.

Guidance. The combination of Conditions A and B is intended for application at locations where Condition A is not satisfied and Condition B is not satisfied and should be applied only after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.

The need for a traffic control signal should be considered if an engineering study finds that both of the following conditions exist for each of any 8 hours of an average day:

A. The vehicles per hour given in both of the 80 percent columns of Condition A in Table 902.3.2 exist on the major street and the more critical minor-street approach, respectively, to the intersection; and
B. The vehicles per hour given in both of the 80 percent columns of Condition B in Table 902.3.2 exist on the major street and the more critical minor-street approach, respectively, to the intersection.

Standard. These major-street and minor-street volumes shall be for the same 8 hours for each condition; however, the 8 hours satisfied in Condition A shall not be required to be the same 8 hours satisfied in Condition B.

Support. On the minor street, the more critical volume is not required to be on the same approach during each of the 8 hours. The more critical minor-street volume is the one that meets the warranting criteria for that approach, and in the case of a one-lane minor-street approach that is opposite from a multi-lane minor-street approach might not have the higher volume.

Option. If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 902.3.2 may be used in place of the 80 percent columns.

902.3.3 Warrant 2, Four-Hour Vehicular Volume (MUTCD Section 4C.03)

Support. The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal. This warrant is based on existing traffic and is not normally used during project development.

Guidance. The need for a traffic control signal should be considered if an engineering study finds that, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the more critical minor-street approach (one direction only) all fall above the applicable curve in Figure 902.3.3.1 for the existing combination of approach lanes.

Support. On the minor street, the more critical volume is not required to be on the same approach during each of these 4 hours. The more critical minor-street volume is the one that meets the warranting criteria for that approach, and in the case of a one-lane minor-street approach that is opposite from a multi-lane minor-street approach might not have the higher volume.

Option. If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 902.3.3.2 may be used in place of Figure 902.3.3.1.

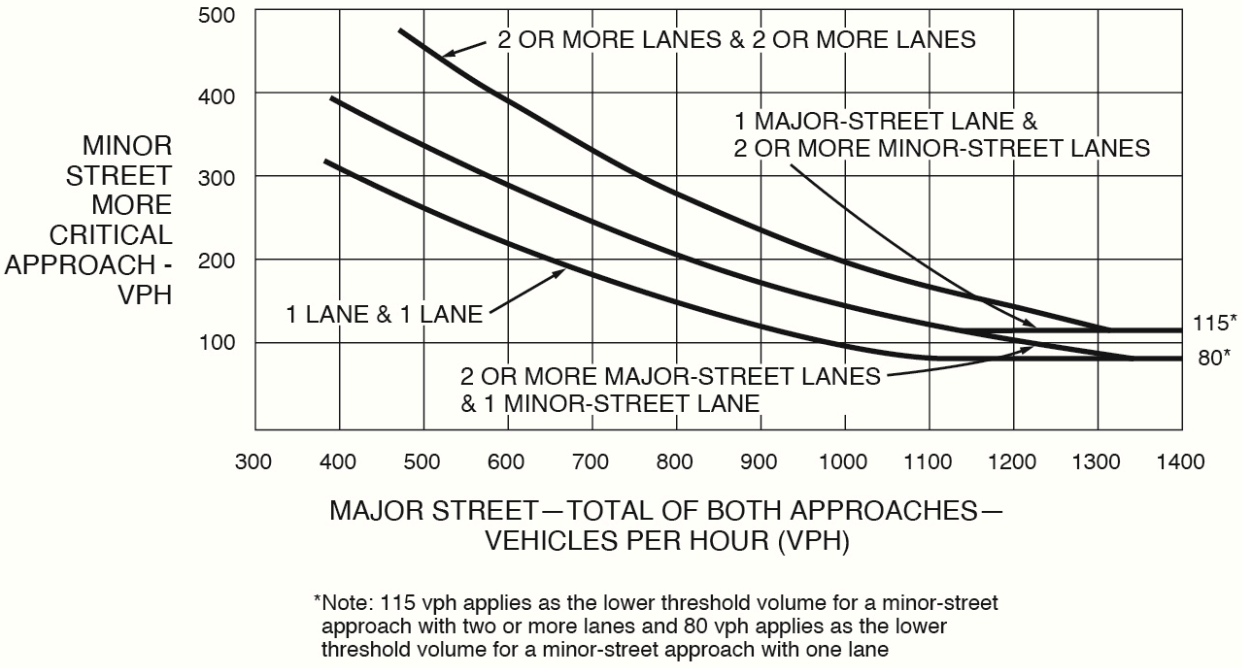


Figure 902.3.3.1 Warrant 2, Four-Hour Vehicular Volume

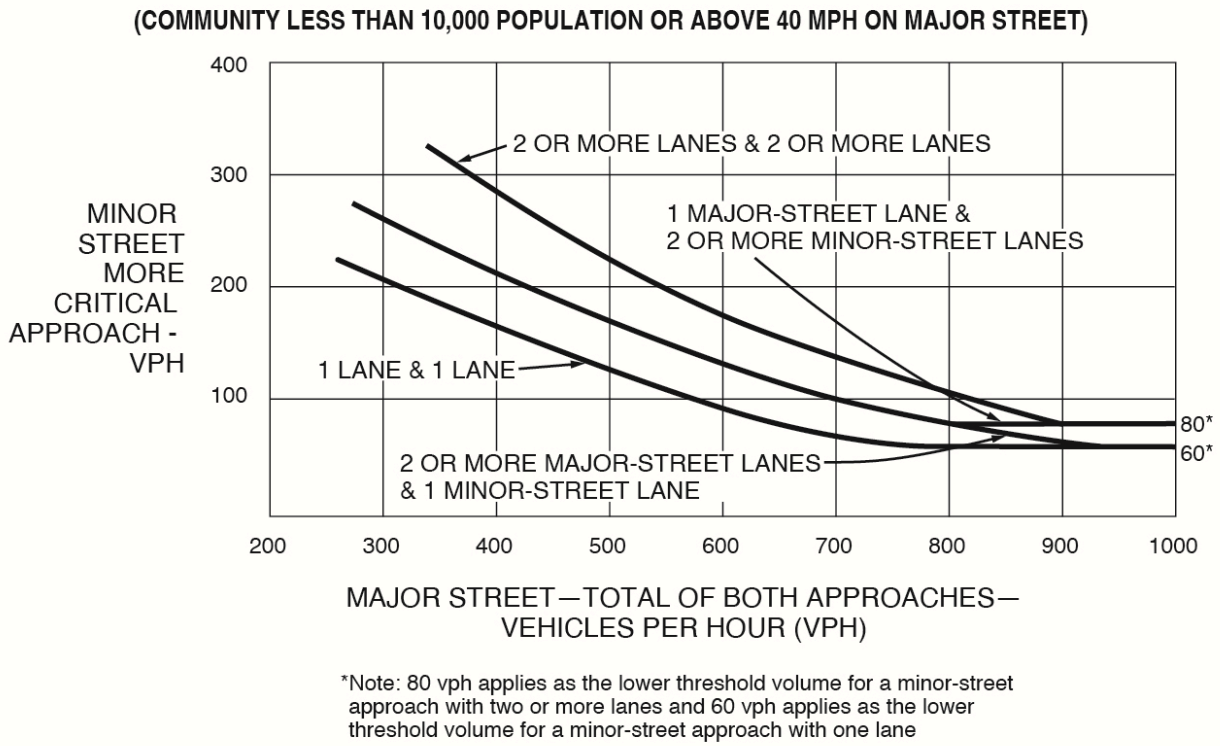


Figure 902.3.3.2 Warrant 2, Four-Hour Vehicular Volume (70% Factor)

902.3.4 Warrant 3, Peak Hour (MUTCD Section 4C.04)

Support. The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

Guidance. This signal warrant should be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.

The need for a traffic control signal should be considered if an engineering study finds that the criteria in either of the following two categories are met:

A. If all three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:

1. The total stopped-time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach, and
2. The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes, and
3. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.

B. The plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the more critical minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 902.3.4.1 for the existing combination of approach lanes.

Option. If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 902.3.4.2 may be used in place of Figure 902.3.4.1 to evaluate the criteria in Item B of the second guidance paragraph of this Article.

Guidance. If this warrant is the only warrant met and a traffic control signal is justified by an engineering study, the traffic control signal should be traffic-actuated.

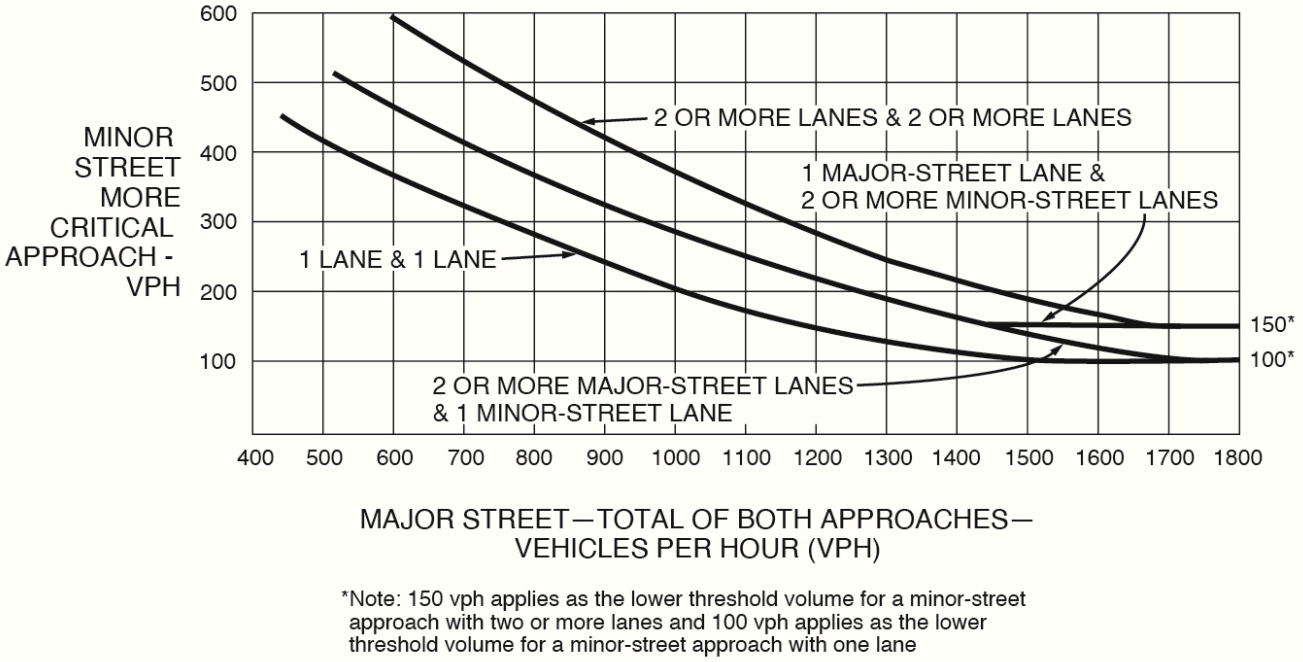


Figure 902.3.4.1 Warrant 3, Peak Hour

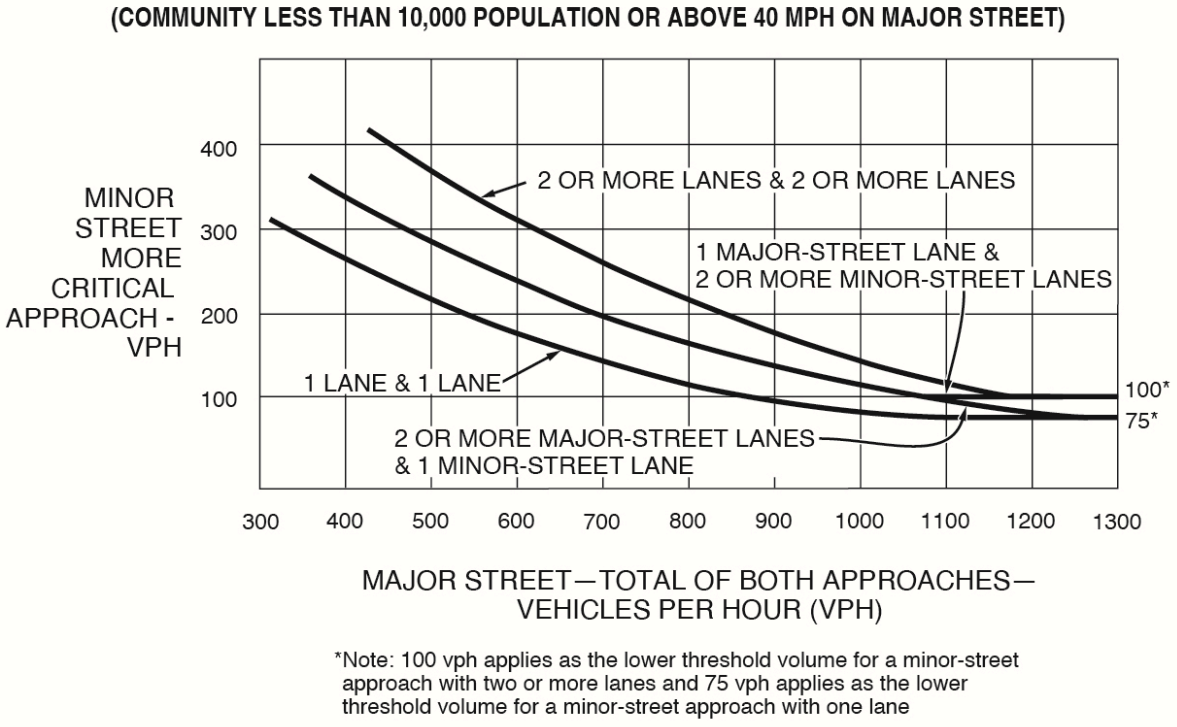


Figure 902.3.4.2 Warrant 3, Peak Hour (70% Factor)

902.3.5 Warrant 4, Pedestrian Volume (MUTCD Section 4C.05)

Support. The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

Guidance. The need for a traffic control signal at an intersection or midblock crossing should be considered if an engineering study finds that one of the following criteria is met:

A. For each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) all fall above the curve in Figure 902.3.5.1; or
B. For 1 hour (any four consecutive 15-minute periods) of an average day, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) falls above the curve in Figure 902.3.5.2.

Option. If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 35 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 902.3.5.3 may be used in place of Figure 902.3.5.1 to evaluate Item A of the first guidance paragraph of this Article, and Figure 902.3.5.4 may be used in place of Figure 902.3.5.2 to evaluate Item B of the first guidance paragraph of this Article.

Where there is a divided street having a median of sufficient width for pedestrians to wait, the criteria in Items A and B of the first guidance paragraph of this Article may be applied separately to each direction of vehicular traffic.

Guidance. The Pedestrian Volume signal warrant should not be applied at locations where the distance to the nearest traffic control signal or STOP sign controlling the street that pedestrians desire to cross is less than 1,000 feet, unless the proposed traffic control signal will not restrict the progressive movement of traffic.

Standard. If this warrant is met and a traffic control signal is justified by an engineering study, the traffic control signal shall be equipped with pedestrian signal heads complying with the provisions set forth in EPG 902.9

Guidance. If this warrant is met and a traffic control signal is justified by an engineering study, then:

A. If it is installed at an intersection or major driveway location, the traffic control signal should also control the minor-street or driveway traffic, should be traffic-actuated, and should include pedestrian detection.
B. If it is installed at a non-intersection crossing, the traffic control signal should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs, and should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection crossing, at least one of the signal faces should be over the traveled way for each approach, parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the crosswalk or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance, and the installation should include suitable standard signs and pavement markings.
C. Furthermore, if it is installed within a signal system, the traffic control signal should be coordinated.

Option. The criterion for the pedestrian volume crossing the major street may be reduced as much as 50 percent if the 15th-percentile crossing speed of pedestrians is less than 3.5 feet per second (see Figure 902.3.5.1 through 902.3.5.4).

A traffic control signal may not be needed at the study location if adjacent coordinated traffic control signals consistently provide gaps of adequate length for pedestrians to cross the street.

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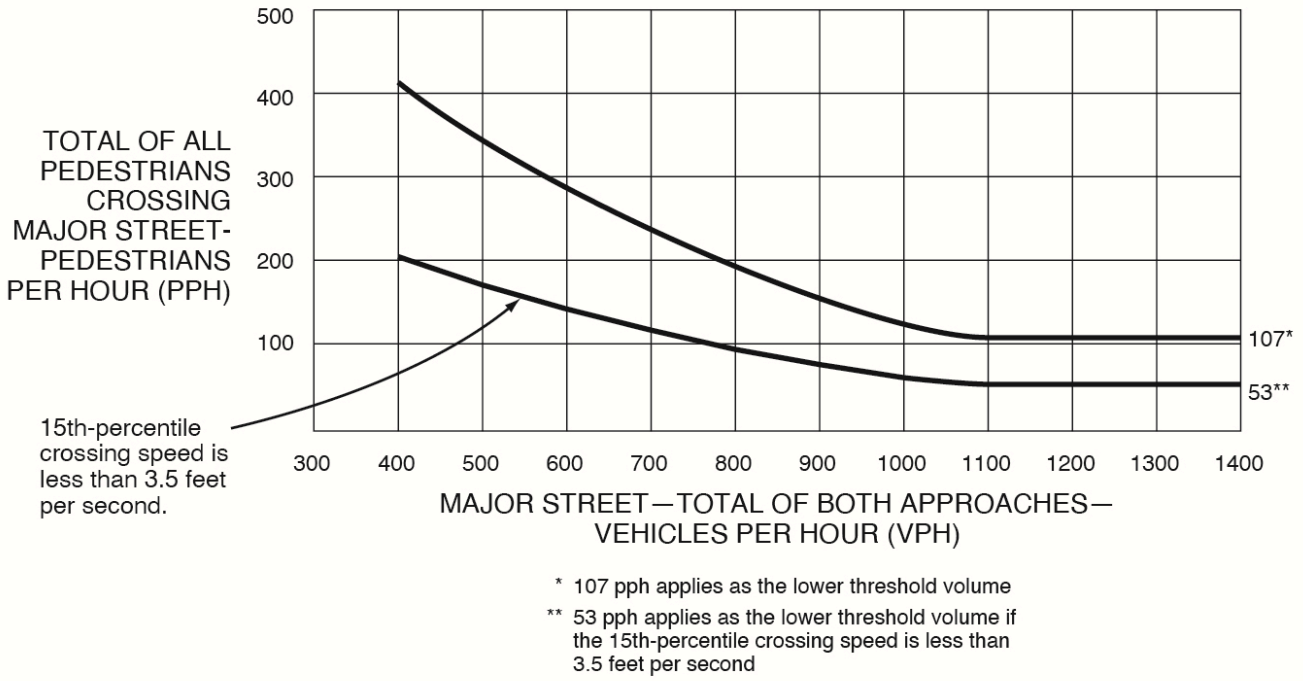


Figure 902.3.5.1 Warrant 4, Pedestrian Four-Hour Volume

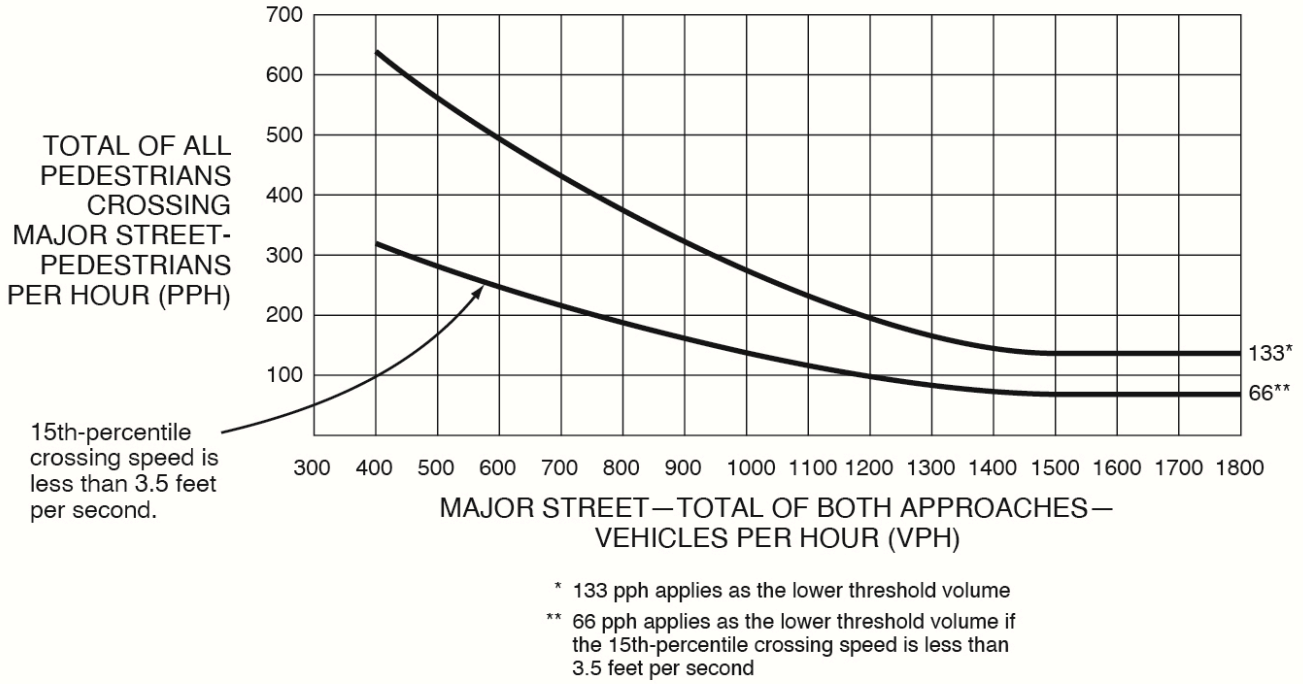


Figure 902.3.5.2 Warrant 4, Pedestrian Peak Hour

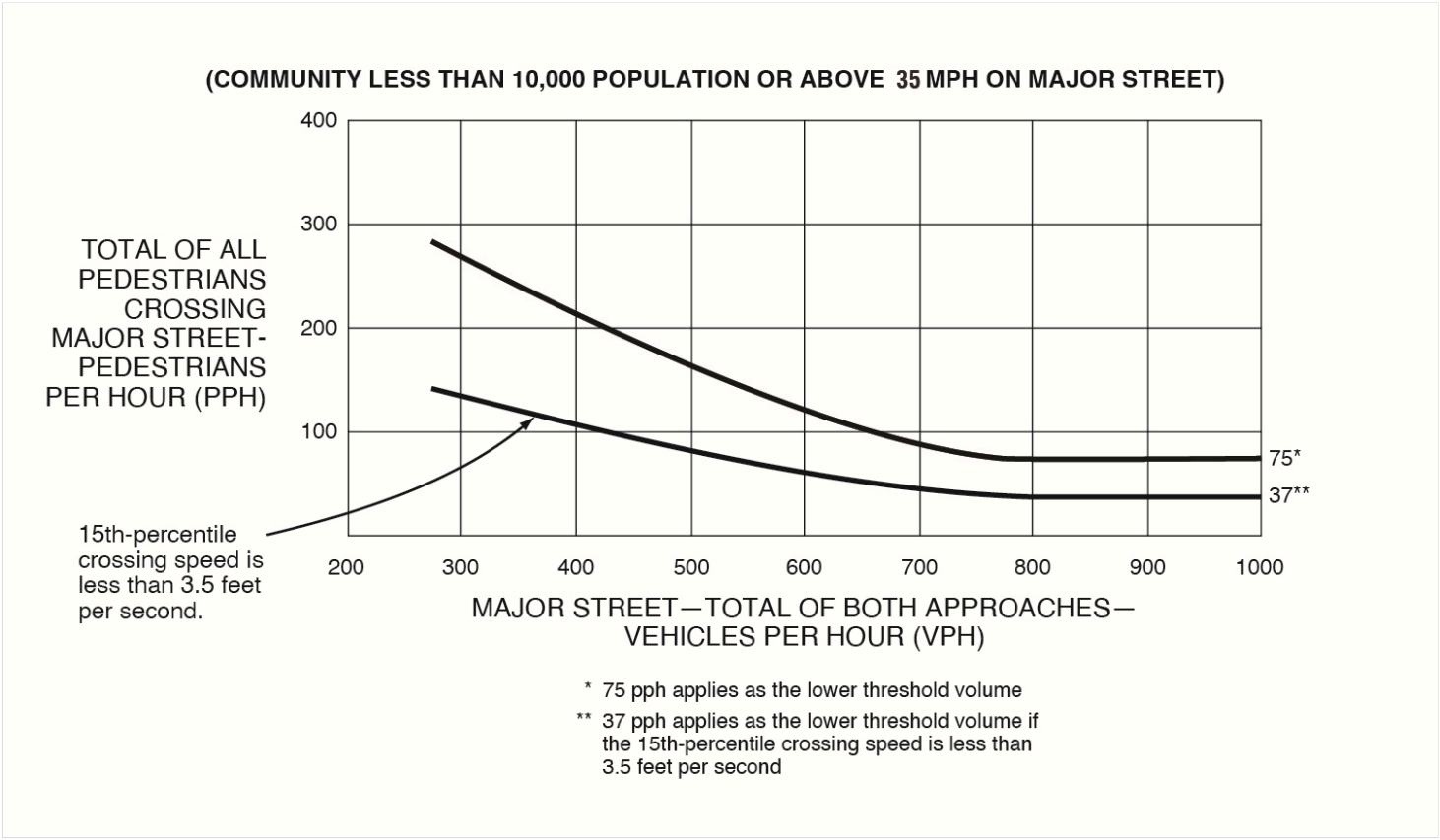


Figure 902.3.5.3 Warrant 4, Pedestrian Four-Hour Volume (70% Factor)

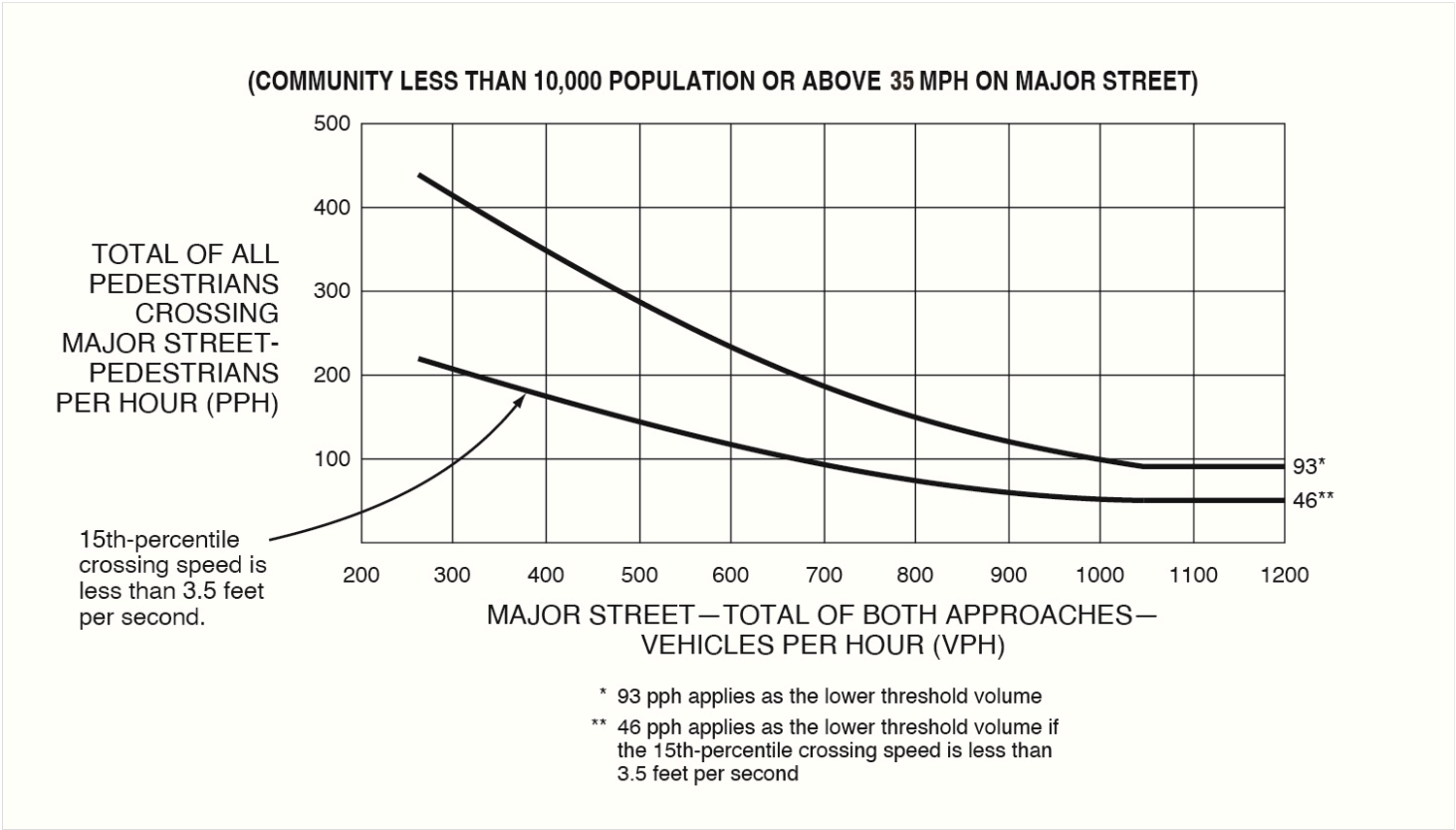


Figure 902.3.5.4 Warrant 4, Pedestrian Peak Hour (70% Factor)

902.3.6 Warrant 5, School Crossing (MUTCD Section 4C.06)

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Support. The School Crossing signal warrant is intended for application where the fact that schoolchildren cross the major street is the principal reason to consider installing a traffic control signal. For the purposes of this warrant, the word "schoolchildren" includes elementary through high school students.

Guidance. The need for a traffic control signal should be considered when an engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of schoolchildren at an established school crossing across the major street shows that the number of adequate gaps in the traffic stream during the period when the schoolchildren are using the crossing is less than the number of minutes in the same period and there are a minimum of 20 schoolchildren during the highest crossing hour.

Before a decision is made to install a traffic control signal, consideration should be given to the implementation of other remedial measures, such as warning signs and flashers, school speed zones, school crossing guards, or a grade-separated crossing.

The School Crossing signal warrant should not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 1,000 feet, unless the proposed traffic control signal will not restrict the progressive movement of traffic.

Standard. If this warrant is met and a traffic control signal is justified by an engineering study, the traffic control signal shall be equipped with pedestrian signal heads complying with the provisions set forth in EPG 902.9.

Guidance. If this warrant is met and a traffic control signal is justified by an engineering study, then:

A. If it is installed at an intersection or major driveway location, the traffic control signal should also control the minor-street or driveway traffic, should be traffic-actuated, and should include pedestrian detection.
B. If it is installed at a non-intersection crossing, the traffic control signal should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs and should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection crossing, at least one of the signal faces should be over the traveled way for each approach, parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the crosswalk or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance, and the installation should include suitable standard signs and pavement markings.
C. Furthermore, if it is installed within a signal system, the traffic control signal should be coordinated.

For further information, see EPG 908 Traffic Control for School Areas.

902.3.7 Warrant 6, Coordinated Signal System (MUTCD Section 4C.07)

Support. Progressive movement in a coordinated signal system sometimes necessitates installing traffic control signals at intersections where they would not otherwise be needed in order to maintain proper platooning of vehicles. This warrant is based on the premise that vehicular traffic has a tendency to disperse and increase headways between signalized intersections.

Guidance. The need for a traffic control signal should be considered if an engineering study finds that one of the following criteria is met:

A. On a one-way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning.
B. On a two-way street, adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.

The Coordinated Signal System signal warrant should not be applied where the resultant spacing of traffic control signals would be less than 1,000 feet.

902.3.8 Warrant 7, Crash Experience (MUTCD Section 4C.08)

Support. This warrant is based on crash experience at an intersection. The Crash Experience signal warrant conditions are intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal.

Guidance. The need for a traffic control signal should be considered if an engineering study finds that all of the following criteria are met:

A. Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and
B. At least one of the following conditions applies to the reported crash history (where each reported crash considered is related to the intersection and apparently exceeds the applicable requirements for a reportable crash):

1. The number of reported angle crashes and pedestrian crashes within a 1-year period equals or exceeds the threshold number in Table 902.3.8.1 for total angle crashes and pedestrian crashes (all severities); or
2. The number of reported fatal-and-injury angle crashes and pedestrian crashes within a 1-year period equals or exceeds the threshold number in Table 902.3.8.1 for total fatal-and-injury angle crashes and pedestrian crashes; or
3. The number of reported angle crashes and pedestrian crashes within a 3-year period equals or exceeds the threshold number in Table 902.3.8.2 for total angle crashes and pedestrian crashes (all severities); or
4. The number of reported fatal-and-injury angle crashes and pedestrian crashes within a 3-year period equals or exceeds the threshold number in Table 902.3.8.2 for total fatal-and-injury angle crashes and pedestrian crashes; and

C. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in Table 902.3.2 (see EPG 902.3.2), or the vph in both of the 80 percent columns of Condition B in Table 902.3.2 exists on the major

street and the more critical minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not less than 80 percent of the requirements specified in the Pedestrian Volume warrant (see EPG 902.3.5).

Standard. These major-street and minor-street volumes shall be for the same 8 hours.

To justify installation of a traffic signal by satisfaction of Warrant 7, an engineering study shall be submitted to the district to document satisfaction of the warrant criteria listed above. The study shall include analysis of relevant crash data. For further information, see EPG 905.2.2.

Support. On the minor street, the more critical volume is not required to be on the same approach during each of these 8 hours. The more critical minor-street volume is the one that meets the warranting criteria for that approach, and in the case of a one-lane minor-street approach that is opposite from a multi-lane minor-street approach might not have the higher volume.

Option. If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000:

A. The traffic volumes in the 56 percent columns in Table 902.3.2 may be used in place of the 80 percent columns.

B. Tables 902.3.8.3 and 902.3.8.4 may be used in place of Tables 902.3.8.1 and 902.3.8.2, respectively.

Support. The values in Tables 902.3.8.1 through 902.3.8.4 for Minimum Number of Reported Crashes that correspond to the Crash Experience signal warrant were derived using the safety performance functions (SPFs) in the Highway Safety Manual (HSM) (AASHTO, 2010) for stop-controlled and signalized intersections with characteristics that are considered typical. The values in Tables 902.3.8.1 through 902.3.8.4 are representative of average crash frequency for the given intersection condition. The values correspond to the threshold at which the signalized intersection safety performance outperforms the stop-controlled intersection, for otherwise identical conditions and equivalent traffic.

Table 902.3.8.1. Minimum Number of Reported Crashes in a One-Year Period

Number of through lanes on each approach		Total of all angle and pedestrian crashes (all severities)[a]		Total of fatal-and-injury angle and pedestrian crashes[a]	
Major Street	**Minor Street**	**Four Legs**	**Three Legs**	**Four Legs**	**Three Legs**
1	1	5	4	3	3
2 or more	1	5	4	3	3
2 or more	2 or more	5	4	3	3
1	2 or more	5	4	3	3

[a] Angle crashes include all crashes that occur at an angle and involve one or more vehicles on the major street and one or more vehicles on the minor street

Table 902.3.8.2. Minimum Number of Reported Crashes in a Three-Year Period

Number of through lanes on each approach		Total of all angle and pedestrian crashes (all severities)[a]		Total of fatal-and-injury angle and pedestrian crashes[a]	
Major Street	**Minor Street**	**Four Legs**	**Three Legs**	**Four Legs**	**Three Legs**
1	1	6	5	4	4
2 or more	1	6	5	4	4
2 or more	2 or more	6	5	4	4
1	2 or more	6	5	4	4

[a] Angle crashes include all crashes that occur at an angle and involve one or more vehicles on the major street and one or more vehicles on the minor street

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Table 902.3.8.3. Minimum Number of Reported Crashes in a One-Year Period

Community less than 10,000 population or above 40 mph on major street					
Number of through lanes on each approach		Total of all angle and pedestrian crashes (all severities)[a]		Total of fatal-and-injury angle and pedestrian crashes[a]	
Major Street	Minor Street	Four Legs	Three Legs	Four Legs	Three Legs
1	1	4	3	3	3
2 or more	1	10	9	6	6
2 or more	2 or more	10	9	6	6
1	2 or more	4	3	3	3

[a] Angle crashes include all crashes that occur at an angle and involve one or more vehicles on the major street and one or more vehicles on the minor street

Table 902.3.8.4. Minimum Number of Reported Crashes in a Three-Year Period

Community less than 10,000 population or above 40 mph on major street					
Number of through lanes on each approach		Total of all angle and pedestrian crashes (all severities)[a]		Total of fatal-and-injury angle and pedestrian crashes[a]	
Major Street	Minor Street	Four Legs	Three Legs	Four Legs	Three Legs
1	1	6	5	4	4
2 or more	1	16	13	9	9
2 or more	2 or more	16	13	9	9
1	2 or more	6	5	4	4

[a] Angle crashes include all crashes that occur at an angle and involve one or more vehicles on the major street and one or more vehicles on the minor street

902.3.9 Warrant 8, Roadway Network (MUTCD Section 4C.09)

Support. Installing a traffic control signal at some intersections might be justified to encourage concentration and organization of traffic flow on a roadway network. This warrant is based on existing traffic and is not normally used during project development.

Guidance. The need for a traffic control signal should be considered if an engineering study finds that the common intersection of two or more major routes meets one or both of the following criteria:

A. The intersection has a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic volumes, based on an engineering study, that meet one or more of Warrants 1, 2, and 3 during an average weekday; or
B. The intersection has a total existing or immediately projected entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a non-normal business day (Saturday or Sunday).

A major route as used in this signal warrant should have at least one of the following characteristics:

A. It is part of the street or highway system that serves as the principal roadway network for through traffic flow;
B. It includes rural or suburban highways outside, entering, or traversing a city; or
C. It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.

902.3.10 Warrant 9, Intersection Near a Grade Crossing (MUTCD Section 4C.10)

Support. The Intersection Near a Grade Crossing signal warrant is intended for use at a location where none of the conditions described in the other eight traffic signal warrants are met, but the proximity of a grade crossing on an approach controlled by a STOP or YIELD sign at a highway-highway intersection is the principal reason to consider installing a traffic control signal.

Guidance. This signal warrant should be applied only after adequate consideration has been given to other alternatives or after a trial of an alternative has failed to alleviate the safety concerns associated with the grade crossing. Among the alternatives that should be considered or tried are:

A. Providing additional pavement that would enable vehicles to clear the track or that would provide space for an evasive maneuver, or
B. Reassigning the stop controls at the highway-highway intersection to make the approach across the track a non-stopping approach.

The need for a traffic control signal should be considered if an engineering study finds that both of the following criteria are met:

A. A grade crossing exists on an approach controlled by a STOP or YIELD sign at a highway-highway intersection and the center of the track nearest to the intersection is within 140 feet of the stop line or yield line on the approach; and

B. During the highest traffic volume hour during which rail traffic uses the crossing, the plotted point representing the vehicles per hour on the major street (total of both approaches) of the highway-highway intersection and the corresponding vehicles per hour on the minor-street approach that crosses the track (one direction only, approaching the intersection) falls above the applicable curve in Figure 902.3.10.1 or 902.3.10.2 for the existing combination of approach lanes over the track and the distance D, which is the clear storage distance as defined in EPG 911 (MUTCD Section 1C.02).

The following considerations apply when plotting the traffic volume data on Figure 902.3.10.1 or Figure 902.3.10.2:

A. Figure 902.3.10.1 should be used if there is only one lane approaching the highway-highway intersection at the track crossing location and Figure 902.3.10.2 should be used if there are two or more lanes approaching the highway-highway intersection at the track crossing location.
B. After determining the actual distance D, the curve for the distance D that is nearest to the actual distance D should be used. For example, if the actual distance D is 95 feet, the plotted point should be compared to the curve for D=90 feet.
C. If the rail traffic arrival times are unknown, the highest traffic volume hour of the day should be used.

Option. The traffic volume on the minor-street approach to the highway-highway intersection may be multiplied by up to three adjustment factors as provided in the sixth paragraph through the eighth paragraph of this Article.

Because the curves are based on an average of four occurrences of rail traffic per day, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 902.3.10.1 for the appropriate number of occurrences of rail traffic per day.

Because the curves are based on typical vehicle occupancy, if at least 2% of the vehicles crossing the track are buses carrying at least 20 people, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 902.3.10.2 for the appropriate percentage of high-occupancy buses.

Because the curves are based on tractor-trailer trucks comprising 10% of the vehicles crossing the track, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 902.3.10.3 for the appropriate distance and percentage of tractor-trailer trucks.

Standard. If this warrant is met and a traffic control signal at the highway-highway intersection is justified by an engineering study, then:

A. The traffic control signal shall have actuation on the minor street,
B. Preemption control shall be provided in accordance with EPG 902.6.19 and EPG 913.4.9, and
C. The grade crossing shall have flashing-light signals (see EPG 913.4.2).

Guidance. If this warrant is met and a traffic control signal at the highway-highway intersection is justified by an engineering study, the grade crossing should have automatic gates (see EPG 913.4.3).

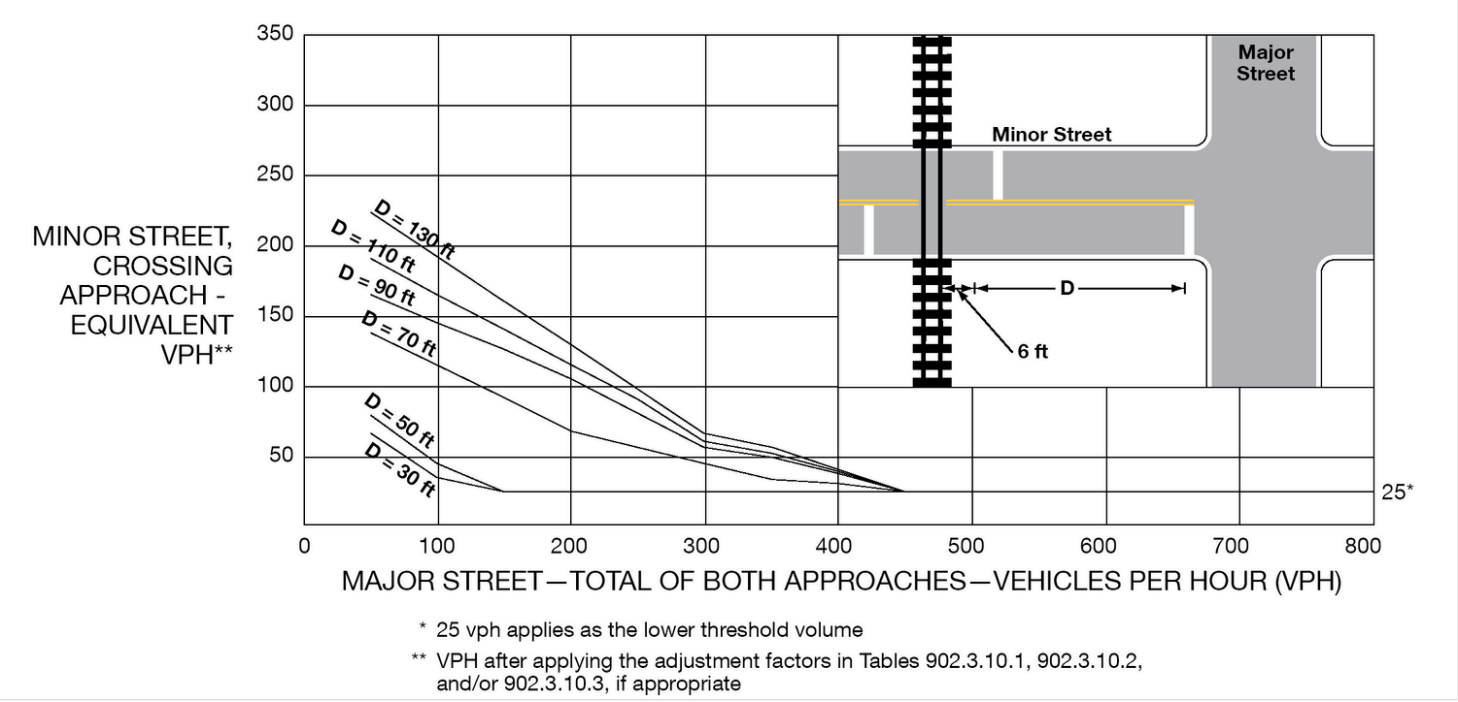


Figure 902.3.10.1. Warrant 9, Intersection Near a Grade Crossing (One Approach Lane at the Track Crossing)

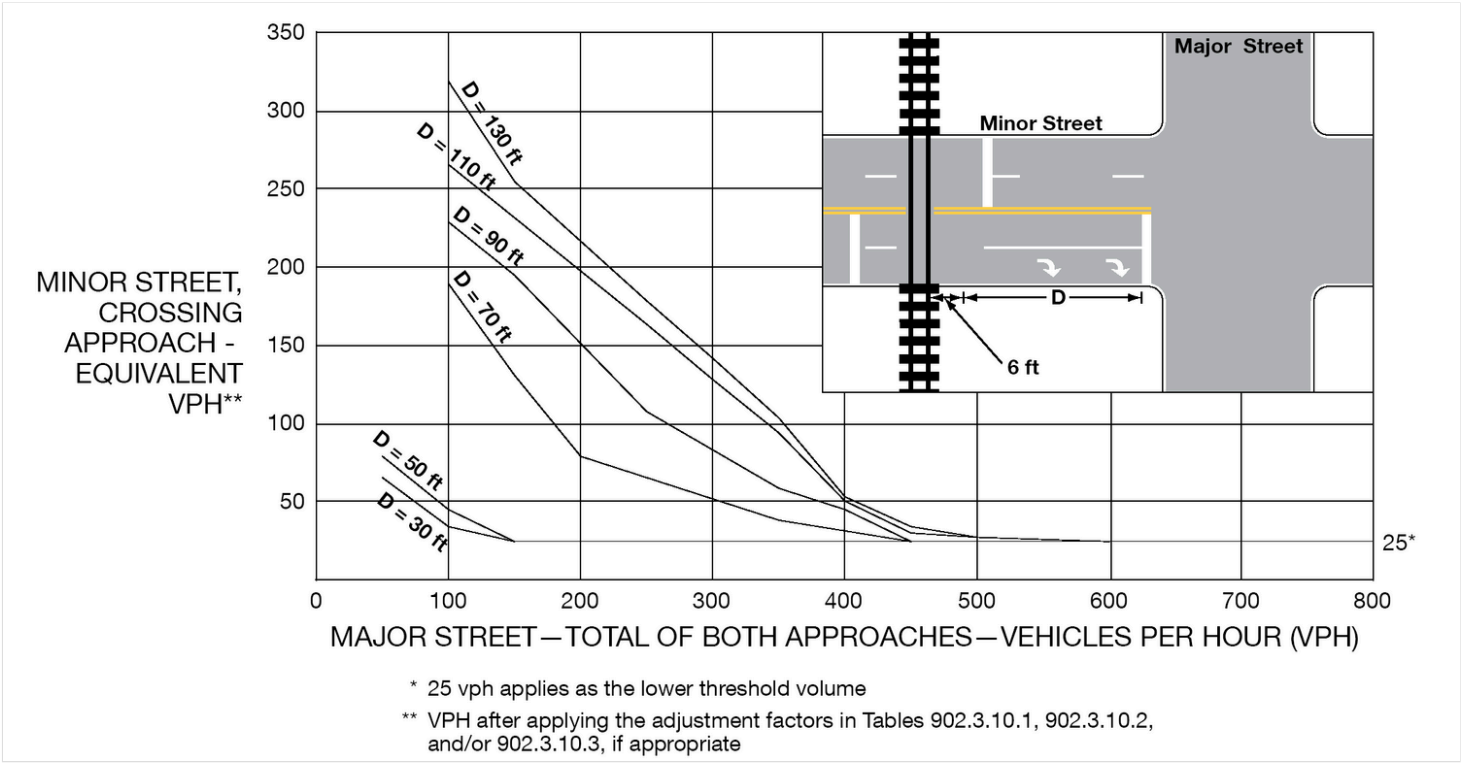


Figure 902.3.10.2. Warrant 9, Intersection Near a Grade Crossing (Two or More Approach Lanes at the Track Crossing)

Table 902.3.10.1. Warrant 9, Adjustment Factor for Daily Frequency of Rail Traffic

Rail traffic per day	Adjustment factor
1	0.67
2	0.91
3 to 5	1.00
6 to 8	1.18
9 to 11	1.25
12 or more	1.33

Table 902.3.10.2. Warrant 9, Adjustment Factor for Percentage of High-Occupancy Buses

% of high-occupancy buses* on minor-street approach	Adjustment factor
0%	1.00
2%	1.09
4%	1.19
6% or more	1.32
* A high-occupancy bus is defined as a bus occupied by at least 20 people.	

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Table 902.3.10.3. Warrant 9, Adjustment Factor for Percentage of Tractor-Trailer Trucks

% of tractor-trailer trucks on minor-street approach	Adjustment factor	
	D less than 70 feet	D of 70 feet or more
0% to 2.5%	0.50	0.50
2.6% - 7.5%	0.75	0.75
7.6% - 12.5%	1.00	1.00
12.6% - 17.5%	2.30	1.15
17.6% - 22.5%	2.70	1.35
22.6% - 27.5%	3.28	1.64
More than 27.5%	4.18	2.09

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902.4 Design Features of Traffic Control Signals (MUTCD Chapter 4D)

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902.4.1 General (MUTCD Section 4D.01)

Support. The features of traffic control signals of interest to road users are the location, design, and meaning of the signal indications. Uniformity in the design features that affect the traffic to be controlled, as set forth in this Manual, is especially important for the safety and efficiency of operations.

Traffic control signals can be operated in pretimed, semi-actuated, or full-actuated modes. For isolated (non-interconnected) signalized locations on rural high-speed highways, full-actuated mode with advance vehicle detection on the high-speed approaches is typically used. These features are designed to reduce the frequency with which the onset of the yellow change interval is displayed when high-speed approaching vehicles are in the “dilemma zone” such that the drivers of these high-speed vehicles find it difficult to decide whether to stop or proceed.

EPG 902.23.1 contains information regarding traffic control signal operation.

Standard. The design and operation of traffic control signals shall take into consideration the needs of all modes of traffic including access and safety.

When a traffic control signal is not in operation, such as before it is placed in service, during seasonal shutdowns, or when it is not desirable to operate the traffic control signal, the signal faces shall be covered, turned, or taken down to clearly indicate that the traffic control signal is not in operation.

Guidance. If a cover is placed over a traffic control signal face that is not in operation and that has a yellow retroreflective strip along the perimeter of its signal backplate (see the fifth option paragraph of EPG 902.4.6), the entire signal face, including the backplate, should be covered. If a traffic control signal face that is not in operation and that has a yellow retroreflective strip along the perimeter of its signal backplate is turned, the turned signal face should be oriented such that the yellow backplate border will not reflect light back to road users on any of the approaches to the intersection.

Standard. A traffic control signal shall control traffic only at the intersection or midblock location where the signal faces are placed.

Guidance. Midblock crosswalks should not be signalized if they are located within 1,000 feet from the nearest traffic control signal, unless supported by an engineering study or engineering judgment that indicates safe and efficient operation of the closely-spaced traffic control signals can be achieved.

Midblock crosswalks should not be signalized if they are located within 100 feet from side streets or driveways that are controlled by STOP signs or YIELD signs, unless supported by an engineering study or engineering judgment that considers restricting turning movements from the side street or driveway to eliminate conflicts with pedestrian and bicyclist movements.

Engineering judgment should be used to determine the proper phasing and timing for a traffic control signal. Since traffic flows and patterns change, phasing and timing should be reevaluated regularly and updated if needed.

Traffic control signals within ½ mile of one another along a major route or in a network of intersecting major routes should be coordinated, preferably with interconnected controller units. Where traffic control signals that are within ½ mile of one another along a major route have a jurisdictional boundary or a boundary between different signal systems between them, coordination across the boundary should be considered.

Support. Signal coordination need not be maintained between control sections that operate on different cycle lengths.

EPG 902.6.19 and EPG 913.4.9 contain information about coordination of traffic control signals with grade crossing signals.

902.4.2 Provisions for Pedestrians (MUTCD Section 4D.02)

Support. EPG 902.9 contains additional information regarding pedestrian control features, EPG 902.10 contains additional information regarding pedestrian hybrid beacons, and EPG 902.11 contains additional information regarding accessible pedestrian signals and detectors. EPG 642.4 contains information regarding what types of signal projects must be accompanied by ADA-related improvements.

Standard. Pedestrian signal heads shall be used in conjunction with vehicular traffic control signals under any of the following conditions, unless the pedestrian crossing is prohibited:

A. If the basis for traffic signal installation was justified by an engineering study and meeting either Warrant 4, Pedestrian Volume or Warrant 5, School Crossing (see EPG 902.3);
B. If an exclusive pedestrian signal phase or a leading pedestrian interval (LPI) is provided with all conflicting vehicular movements being stopped;
C. At an established signalized school crossing; or
D. Where there are existing pedestrian accommodations and engineering judgment determines that multi-phase signal indications (such as split-phase timing) would tend to confuse or cause conflicts with pedestrians using a crosswalk guided only by vehicular signal indications.

Guidance. Pedestrian signal heads should be installed for each marked crosswalk at a location controlled by a traffic control signal.

Standard. Where pedestrian movements regularly occur, pedestrians shall be provided with sufficient time to cross the roadway by adjusting the traffic control signal operation and timing to provide sufficient crossing time every cycle or by providing pedestrian detectors.

Guidance. Where certain pedestrian movements are prohibited at a traffic control signal location, a No Pedestrian Crossing (R9-3) sign (see EPG 903.2.46) should be used if it is impracticable to provide a barrier or other physical feature to physically discourage the pedestrian movements.

Support. Accessible pedestrian signals (see EPG 902.11) that provide information in non-visual formats (such as audible tones and/or speech messages, and vibrating surfaces) enhance safety and accessibility at signalized crossings for pedestrians with vision disabilities.

Option. Pedestrian signal heads may be used under other conditions based on engineering judgment.

902.4.3 Provisions for Bicyclists (MUTCD Section 4D.03)

Guidance. Bicycle symbol signal indications are not currently used on MoDOT facilities. Contact the Highway Safety and Traffic Division for guidance.

Standard. At installations where visibility-limited signal faces are used, signal faces shall be adjusted so bicyclists for whom the indications are intended can see the signal indications. If the visibility-limited signal faces cannot be aimed to serve the bicyclist, then separate signal faces (see EPG 902.8) shall be provided for the bicyclist.

On bikeways, signal timing and actuation shall be reviewed and adjusted to consider the needs of bicyclists.

Option. Where it is desired to provide separate signal indications to control bicyclist movements at a traffic control signal, bicycle signal faces may be used (see EPG 902.8).

Support. EPG 914.2.8, 914.2.10, 914.5.2, 914.5.6, and 914.5.7 contain additional provisions regarding bicyclist movements and actuation at traffic control signals.

902.4.4 Provisions for Transit Vehicles (MUTCD Section 4D.04)

Option. Where it is desired to provide separate signal indications to control transit vehicles at a traffic control signal, LRT signal indications may be used at intersections where special signal phases are used for transit vehicles (see EPG 913.4.15).

902.4.5 Number of Signal Faces on an Approach (MUTCD Section 4D.05)

Standard. The signal faces for each approach to an intersection or a midblock location shall be provided as follows:

A. If a signalized motor vehicle through movement exists on an approach, a minimum of two primary signal faces shall be provided for the through movement. Except for single lane approaches, if a signalized motor vehicle through movement does not exist on an approach, a minimum of two primary signal faces shall be provided for the signalized motor vehicle turning movement that is considered to be the major movement from the approach (also see EPG 902.6.16).
B. See EPG 902.6.2 through EPG 902.6.8 for left-turn (and U-turn to the left) signal faces.
C. See EPG 902.6.9 through EPG 902.6.15 for right-turn signal faces.

Option. Where a movement (or a certain lane or lanes) at the intersection never conflicts with any other signalized vehicular or pedestrian movement, a continuously-displayed single-section GREEN ARROW signal indication may be used to inform road users that the movement is free-flow and does not need to stop.

Support. In some circumstances where the through movement never conflicts with any other signalized vehicular or pedestrian movement at the intersection, such as at T-intersections with appropriate geometrics and/or pavement markings and signing, an engineering study might determine that the through movement (or certain lanes of the through movement) can be free-flow and not signalized.

Guidance. If two or more left-turn lanes are provided for a separately-controlled left-turn movement, or if a left-turn movement represents the major movement from an approach, two or more primary left-turn signal faces should be provided.

If two or more right-turn lanes are provided for a separately-controlled right-turn movement, or if a right-turn movement represents the major movement from an approach, two or more primary right-turn signal faces should be provided.

Support. Locating primary signal faces overhead on the far side of the intersection has been shown to provide safer operation by reducing intersection entries late in the yellow interval and by reducing red signal violations, as compared to post-mounting signal faces at the roadside or locating signal faces overhead within the intersection on a diagonally-oriented mast arm or span wire. On approaches with two or more lanes for the through movement, one signal face per through lane, centered over each through lane, has also been shown to provide safer operation.

Standard. Signal faces shall be provided as follows for all new or reconstructed signal installations (see Figure 902.4.5):

A. The minimum number and location of primary (non-supplemental) signal faces for through traffic shall be provided in accordance with Table 902.4.5.
B. If the number of overhead primary signal faces for through traffic is equal to the number of through lanes on an approach, one overhead signal face shall be located approximately over the center of each through lane.
C. Except for shared left-turn and right-turn signal faces, any primary signal face required by EPG 902.6.2 through EPG 902.6.16 for a mandatory turn lane shall be located overhead approximately over the center of each mandatory turn lane.
D. All primary signal faces shall be located on the far side of the intersection.
E. In addition to the primary signal faces, one or more supplemental pole-mounted or overhead signal faces should be considered to provide added visibility for approaching traffic that is traveling behind large vehicles.
F. All signal faces shall have backplates.

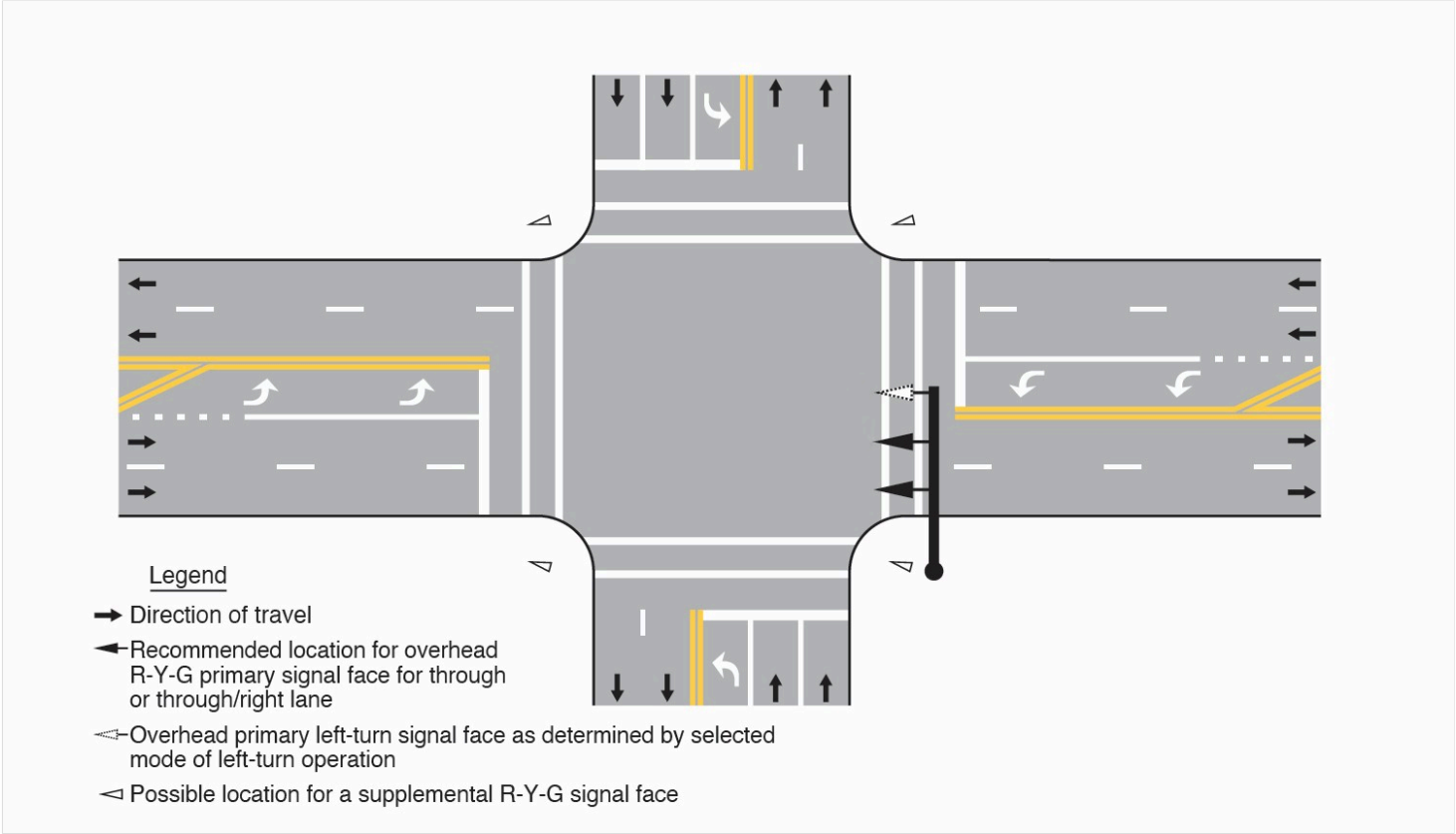


Figure 902.4.5 Recommended Vehicular Signal Faces for Approaches

Notes:

1. Signal faces for only one direction and only one possible set of geometrics (number of lanes, etc.) are illustrated. If there are fewer or more than two through lanes on the approach, see Table 902.4.5.

2. Any primary left-turn and/or right-turn signal faces, as determined by EPG 902.6.2 through 902.6.15, shall be overhead for each mandatory turn lane.

3. One or more pole-mounted or overhead supplemental faces shall be considered, based on the geometrics of the approach, to maximize visibility for approaching traffic.

4. All signal faces shall have backplates.

Table 902.4.5. Recommended Minimum Number of Primary Signal Faces for Through Traffic on Approaches

Number of Through Lanes on the Approach	Total Number of Primary Through Signal Faces for the Approach*	Minimum Number of Overhead-Mounted Primary Through Signal Faces for the Approach
1	2	1
2	2	2
3	3	3
4 or more	4 or more	4 or more
Notes: * A minimum of two through signal faces is always required (see EPG 902.4.5). These recommended numbers of through signal faces may be exceeded. Also, see cone of vision requirements otherwise indicated in EPG 902.4.7		

902.4.6 Visibility, Aiming, and Shielding of Signal Faces (MUTCD Section 4D.06)

Standard. The visibility of signal indications to approaching traffic shall be the highest priority for signal face placement and aiming.

Road users approaching a signalized intersection or other signalized area, such as a midblock crosswalk, shall be given a clear and unmistakable indication of whether they are being directed to stop or permitted to proceed.

The geometry of each intersection to be signalized, including vertical grades, horizontal curves, and obstructions as well as the lateral and vertical angles of sight toward a signal face, as determined by typical driver-eye position, shall be considered in determining the vertical, longitudinal, and lateral position of the signal face.

Guidance. At signalized midblock crosswalks, at least one of the signal faces should be over the traveled way for each approach.

The two primary signal faces required as a minimum for each approach should be continuously visible to traffic approaching the traffic control signal, from a point at least the minimum sight distance provided in Table 902.4.6 in advance of and measured to the stop line. This range of continuous visibility should be provided unless precluded by a physical obstruction or unless another signalized location is within this range.

Standard. If approaching traffic does not have a continuous view of at least two signal faces for at least the minimum sight distance shown in Table 902.4.6, a sign (see EPG 903.3.29) shall be installed to warn approaching traffic of the traffic control signal.

Option. If a sign is installed to warn approaching road users of the traffic control signal, the sign may be supplemented by a Warning Beacon (see EPG 902.18.3).

A Warning Beacon used in this manner may be interconnected with the traffic signal controller assembly in such a manner as to flash yellow during the period when road users passing this beacon at the legal speed for the roadway might encounter a red signal indication (or a queue resulting from the display of the red signal indication) upon arrival at the signalized location.

If the sight distance to the signal faces for an approach is limited by horizontal or vertical alignment, supplemental signal faces aimed at a point on the approach at which the signal indications first become visible may be used.

Guidance. Supplemental signal faces should be used if engineering judgment has shown that they are needed to achieve intersection visibility both in advance and immediately before the signalized location.

If supplemental signal faces are used, they should be located to provide optimum visibility for the movement to be controlled.

Standard. In cases where irregular street design necessitates placing signal faces for different street approaches with a comparatively small angle between their respective signal indications, each signal indication shall, to the extent practical, be visibility-limited by signal visors, signal louvers, optically programmable LED indications, or other means so that an approaching road user's view of the signal indication(s) controlling movements on other approaches is minimized.

Signal visors exceeding 12 inches in length shall not be used on free-swinging signal faces.

Signal visors shall be used on signal faces to aid in directing the signal indication specifically to approaching traffic, as well as to reduce "sun phantom," which can result when external light enters the lens.

Option. Special signal faces, such as visibility-limited signal faces, may be used such that the road user does not see signal indications intended for other approaches before seeing the signal indications for their own approach, especially if simultaneous viewing of both signal indications could cause the road user to be misdirected.

Support. Limiting the visibility of the indication is to be carefully done according to the manufacturer's recommendations. A single section of an optically limited head can be combined with conventional sections to create the needed visibility control. Due to the increased cost of optically limited heads, they may only be used at locations where needed.

Standard. Optically limited heads shall not be installed on a span wire since the control of the indication will be lost because of the movement of the span wire mounted head.

Standard. All vehicular signal faces shall have backplates.

Support. The use of backplates enhances the contrast between the traffic signal indications and their surroundings for both day and night conditions, which is also helpful to older drivers.

Standard. Ancillary legends of any kind that identify the purpose or operation of the signal face shall not be placed on the backplate.

Except as provided in the fourth option paragraph of this Article, the inside of signal visors (hoods), the entire surface of louvers and fins, and the front surface of backplates shall have a dull black finish to minimize light reflection and to increase contrast between the signal indication and its background.

Option. A yellow retroreflective strip with a minimum width of 1 inch and a maximum width of 3 inches may be placed along the perimeter of the face of a signal backplate to project a rectangular appearance at night.

Support. Backplates coupled with retroreflective strips around the perimeter improve the visibility of the signal face by introducing a controlled-contrast background.

Standard. For signalized intersection approaches with operating speeds equal to or greater than 55 miles per hour, signal backplates shall have a yellow retroreflective strip around the perimeter as described in the seventeenth paragraph (beginning with “Optically”) through the twenty-third paragraph (beginning with “Backplates”) of this Article.

Guidance. Retroreflective strips as described above should be installed on signal backplates at signalized intersections where enhanced signal visibility and conspicuity is desired in daytime and/or nighttime conditions. Such signalized intersections include, but are not limited to:

A. Signalized intersections with complex or confusing backgrounds;
B. Signalized intersections with automated enforcement;
C. Isolated signalized intersections; or
D. Signalized intersections that are the first signalized intersection upon entering a city or in an unexpected area.
E. Signalized intersections with a crash rate higher than comparable intersections.

Table 902.4.6. Minimum Sight Distance for Signal Visibility

85th-Percentile Speed	Minimum Sight Distance
20 mph	175 feet
25 mph	215 feet
30 mph	270 feet
35 mph	325 feet
40 mph	390 feet
45 mph	460 feet
50 mph	540 feet
55 mph	625 feet
60 mph	715 feet

Note:
Distances in this table are derived from stopping sight distance plus an assumed queue length for shorter cycle lengths (60 to 75 seconds).

902.4.7 Lateral Positioning of Signal Faces (MUTCD Section 4D.07)

Standard. At least one and preferably both of the minimum of two primary signal faces required for the through movement (or the major turning movement if there is no through movement) on the approach shall be located between two lines intersecting with the center of the approach at a point 10 feet behind the stop line, one making an angle of approximately 20 degrees to the right of the center of the approach extended, and the other making an angle of approximately 20 degrees to the left of the center of the approach extended. The signal face that satisfies this requirement shall simultaneously satisfy the longitudinal placement requirement described in EPG 902.4.8 (see Figure 902.4.7).

If both of the minimum of two primary signal faces required for the through movement (or the major turning movement if there is no through movement) on the approach are post-mounted, they shall both be on the far side of the intersection, one on the right and one on the left of the approach lane(s).

The required signal faces for through traffic on an approach shall be located not less than 8 feet apart measured horizontally perpendicular to the approach between the centers of the signal faces.

If more than one separate turn signal face is provided for a turning movement and if one or both of the separate turn signal faces are located over the roadway, the signal faces shall be located not less than 8 feet apart measured horizontally perpendicular to the approach between the centers of the signal faces.

Guidance. If horizontally-arranged or clustered signal faces are used, the minimum 8-foot horizontal separation between the two signal faces should be measured from the center of the right-most signal indication in the signal face on the left to the center of the left-most signal indication in the signal face on the right.

For signal faces located over the roadway, separate turn signal faces should be located at least 8 feet from the nearest traffic signal face for a different movement on the same approach measured horizontally perpendicular to the approach between the centers of the signal faces.

Guidance. If a signal face controls a specific lane or lanes of an approach, its position should make it readily visible to road users making that movement.

Standard. If a mandatory left-turn, right-turn, or U-turn lane is present on an approach and if a primary separate turn signal face controlling that lane is mounted over the roadway, the primary separate turn signal face shall not be positioned any farther to the right than the extension of the right-hand edge of the mandatory turn lane or any farther to the left than the extension of the left-hand edge of the mandatory turn lane.

Option. If opposing left turn lanes are substantially in line with each other across a signalized intersection and the primary indications are located over the roadway, the left-turn signal face should be offset 2 feet to the right of the centerline of the lane to prevent the signal faces from blocking the view from the opposing approaches.

Support. Supplemental turn signal faces mounted over the roadway are not subject to the positioning recommendations in the fifth standard paragraph of this Article.

Standard. For new or reconstructed signal installations, on an approach with a mandatory turn lane(s) for a permissive left-turn (or U-turn to the left) movement, signal faces that display a CIRCULAR GREEN signal indication shall not be post-mounted on the far-side median or mounted overhead above the mandatory turn lane(s) or the extension of the lane(s).

If supplemental post-mounted signal faces are used, the following limitations shall apply:

A. Left-turn arrows and U-turn arrows to the left shall not be used in near right signal faces that are located to the right of the through and/or right-turn lanes.
B. Right-turn arrows shall not be used in far left signal faces that are located to the left of the through and/or left-turn lanes. A far-side median-mounted signal face shall be considered a far left signal face for this application.

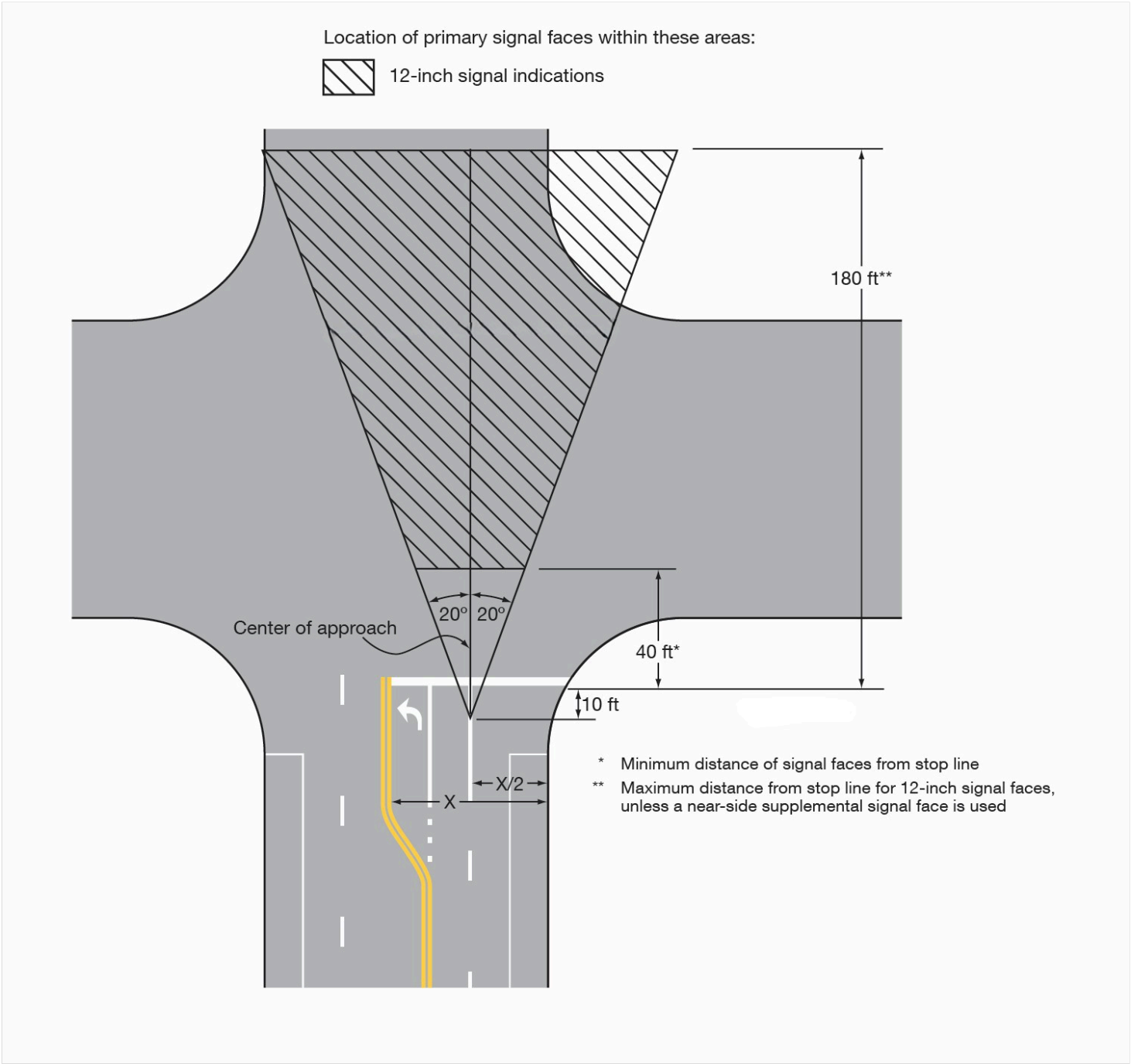


Figure 902.4.7. Lateral and Longitudinal Location of Primary Signal Faces

Note:

1. See EPG 902.5 for providing signal faces on an approach.

902.4.8 Longitudinal Positioning of Signal Faces (MUTCD Section 4D.08)

Standard. Except where the width of an intersecting roadway or other conditions make it physically impractical, the signal faces for each approach to an intersection or a midblock location shall be provided as follows:

A. A signal face installed to satisfy the requirements for primary left-turn signal faces (see EPG 902.6.2 through EPG 902.6.8) and primary right-turn signal faces (see Sections EPG 902.6.9 through EPG 902.6.15), and at least one and preferably both of the minimum of two primary signal faces required for the through movement (or the major turning movement if there is no through movement) on the approach shall be located:

1. No less than 40 feet beyond the stop line, and
2. No more than 180 feet beyond the stop line unless a supplemental near-side signal face is provided.

B. The primary signal faces that are used to satisfy the requirements of Item A shall simultaneously satisfy the lateral placement requirement described in EPG 902.4.7 (see Figure 902.4.7).

Guidance. Where the nearest signal face is located between 150 and 180 feet beyond the stop line, engineering judgment of the conditions, including the worst-case visibility conditions, should be used to determine if the provision of a supplemental near-side signal face would be beneficial.

Supplemental near-side signal faces should be located as near as practicable to the stop line.

902.4.9 Mounting Height of Signal Faces (MUTCD Section 4D.09)

Standard. The bottom of the signal housing and any related attachments to a vehicular signal face located over any portion of a highway that can be used by motor vehicles shall be at least 16 feet above the pavement.

The bottom of the signal housing (including brackets) of a vehicular signal face that is vertically arranged or horizontally arranged and not located over a roadway shall be a minimum of 9 feet and a maximum of 19 feet above the sidewalk or, if there is no sidewalk, above the pavement grade at the edge of pavement adjacent to the signal face.

Option. Except as provided in the second standard paragraph of this Article, where engineering judgment supports the installation of a supplemental signal indication, a mounting height greater than 19 feet above the sidewalk or edge of pavement may be used.

Standard. The top of the signal housing of a vehicular signal face located over any portion of a highway that can be used by motor vehicles shall not be more than 25.6 feet above the pavement.

Guidance. For viewing distances between 40 and 53 feet from the stop line, the maximum mounting height to the top of the signal housing of a vehicular signal face located over any portion of a highway that can be used by motor vehicles should be as shown in Figure 902.4.9.

The bottom of the signal housing (including brackets) of a vehicular signal face that is horizontally arranged and not located over a roadway or shoulder:

A. Should be a maximum of 22 feet above the sidewalk or, if there is no sidewalk, above the pavement grade at the edge of pavement adjacent to the signal face.
B. Should be a maximum of 22 feet above the median island grade of a center median island if located on the near side of the intersection.

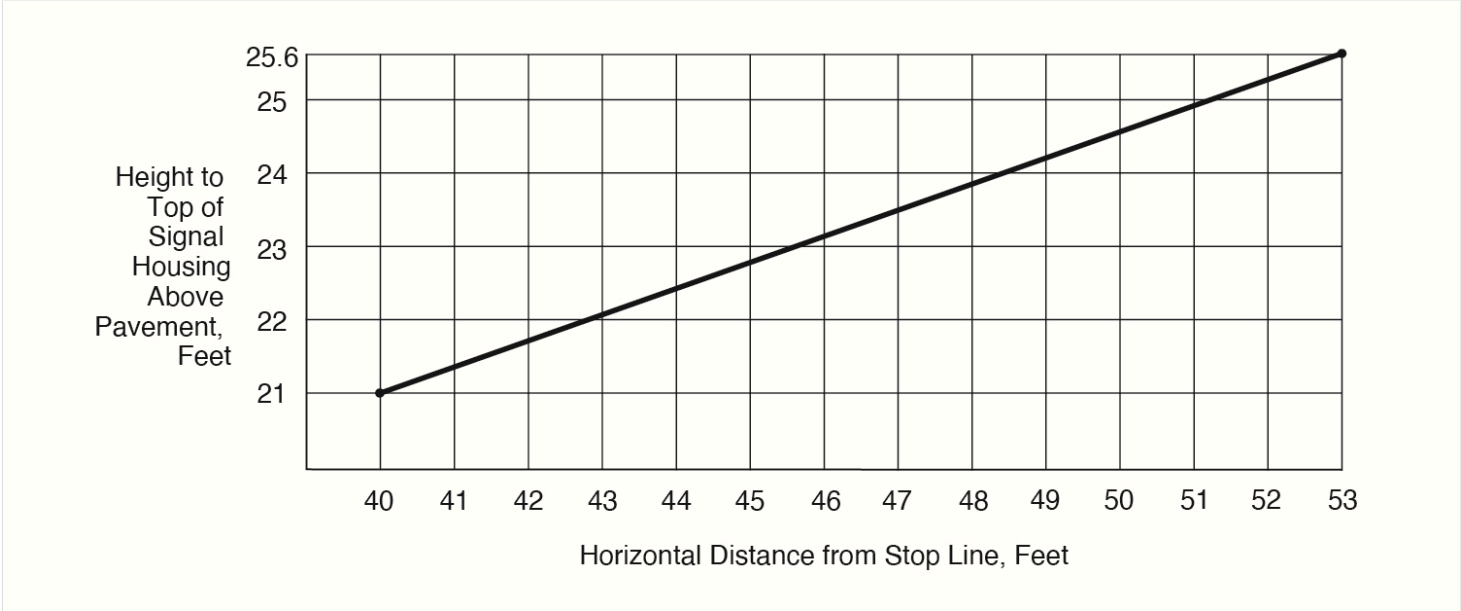


Figure 902.4.9 Maximum Mounting Height of Signal Faces that Are Located between 40 Feet and 53 Feet from the Stop Line

902.4.10 Lateral Offset (Clearance) of Signal Faces (MUTCD Section 4D.10)

Guidance. Signal faces mounted at the side of a roadway at less than 15 feet from the bottom of the housing and any related attachments should have a horizontal offset of not less than 2 feet from the face of a vertical curb, or if there is no curb, not less than 2 feet from the edge of a shoulder.

902.4.11 Temporary and Portable Traffic Control Signals (MUTCD Section 4D.11)

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Support. A temporary traffic control signal is generally installed using methods that minimize the costs of installation, relocation, and/or removal. Typical temporary traffic control signals are for specific purposes, such as for one-lane, two-way facilities in temporary traffic control zones (see EPG 902.15), for a haul-road intersection, or for access to a site that will have a permanent access point developed at another location in the near future. Portable traffic signals are temporary traffic signals.

Because a portable traffic control signal is considered to be a type of temporary traffic control signal, the provisions for temporary traffic control signals are also applicable to portable traffic control signals.

Standard. Advance signing shall be used when employing a temporary traffic control signal.

A temporary traffic control signal shall:

A. Meet the physical display and operational requirements of a conventional traffic control signal;
B. Be removed when no longer needed; and
C. Except as provided in the subsequent paragraph, be placed in the flashing mode during periods when it is not desirable to operate the signal in the steady mode, or the signal heads shall be covered, turned, or taken down to indicate that the signal is not in operation.

Option. If the temporary traffic control signal is capable of being operated in a semi-actuated mode, such that green signal indications are continually shown to major-street traffic except when responding to a minor-street approach vehicle call, it may be operated in a semi-actuated mode instead of being placed in a flashing mode.

Guidance. A temporary traffic control signal should be used only if engineering judgment indicates that installing the signal will improve the overall safety and/or operation of the location.

The use of temporary traffic control signals by a work crew on a regular basis in their work area should be subject to the approval of the jurisdiction having authority over the roadway.

A temporary traffic control signal should not operate longer than 30 days unless associated with a longer-term temporary traffic control zone project.

EPG 616.12.1 contains information about the use of temporary traffic control signals in temporary traffic control zones.

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902.5 Traffic Control Signal Indications (MUTCD Chapter 4E)

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902.5.5 Positions of Signal Indications Within a Horizontal Signal Face (MUTCD Section 4E.05)

902.5.1 Signal Indications – Design, Illumination, Color, and Shape (MUTCD Section 4E.01)

Standard. The illuminated part of each signal indication shall be circular or arrow, except those used for bicycle symbol signal indications, pedestrian signal heads and light rail transit signal indications.

Letters or numbers (including those associated with countdown displays) shall not be displayed as part of a vehicular signal indication.

Strobes shall not be used within or adjacent to any signal indication.

Except for the flashing vehicular and pedestrian signal indications and the distinctive indications for emergency-vehicle preemption (see EPG 902.6.19) that are expressly allowed by the provisions of this EPG 902, flashing displays shall not be used within or adjacent to any signal indications.

Each circular signal indication shall emit a single color: red, yellow, or green.

Each arrow signal indication shall emit a single color: red, yellow, or green.

The arrow, which shall show only one direction, shall be the only illuminated part of an arrow signal indication.

Arrows shall be pointed:

A. Vertically upward to indicate a straight-through movement,
B. Horizontally in the direction of the turn to indicate a turn at approximately or greater than a right angle, or
C. Upward with a slope at an angle approximately equal to that of the turn if the angle of the turn is substantially less than a right angle, or
D. In a manner that directs the driver through the turn if a U-turn arrow is used (see Figure 902.5.1)

All signal indications shall be Light Emitting Diode (LED).

The requirements of the Institute of Transportation Engineers' publications entitled "Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement," 2005, ITE, and "Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement," 2008, ITE, that pertain to

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the aspects of the signal head design that affect the display of the signal indications shall be met for light-emitting diode (LED) traffic signal modules.

Guidance. The intensity and distribution of light from each LED signal module should comply with the publications specified in the preceding paragraph, as appropriate.

If a signal indication is so bright that it causes excessive glare during nighttime conditions, some form of automatic dimming should be used to reduce the brilliance of the signal indication.



Figure 902.5.1 Typical Arrangement of U-Turn Signal Faces

902.5.2 Size of Vehicular Signal Indications (MUTCD Section 4E.02)

Standard. All vehicular signal indications shall be 12 inches.

902.5.3 Positions of Signal Indications Within a Signal Face – General (MUTCD Section 4E.03)

Support. Standardization of the number and arrangements of signal sections in vehicular traffic control signal faces enables road users who are color vision deficient to identify the illuminated color by its position relative to other signal sections.

Standard. Unless otherwise provided in the EPG for a particular application, each signal face at a signalized location shall have three, four, or five signal sections. Unless otherwise provided in the EPG for a particular application, if a vertical signal face includes a cluster (see EPG 902.5.4), the signal face shall have at least three vertical positions.

A single-section signal face shall be permitted at a traffic control signal if it consists of a continuously-displayed GREEN ARROW signal indication that is being used to indicate a continuous movement and positioned vertically upward to indicate a straight-through movement.

The signal sections in a signal face shall be arranged in a vertical or horizontal straight line, except as otherwise provided in EPG 902.5.4.

The arrangement of adjacent signal sections in a signal face shall follow the relative positions listed in EPG 902.5.4 or EPG 902.5.5, as applicable.

If a signal section that displays a CIRCULAR YELLOW signal indication is used, it shall be located between the signal section that displays the red signal indication and all other signal sections.

If a U-turn arrow signal section is used in a signal face for a U-turn to the left, its position in the signal face shall be the same as stated in EPG 902.5.4 and 902.5.5 for a left-turn arrow signal section of the same color.

A U-turn arrow signal indication pointing to the left shall not be used in a signal face that also contains a left-turn arrow signal indication.

Support. Figure 902.5.4 illustrates some of the typical arrangements of signal sections in signal faces that do not control separate turning movements. Figures 902.6.4 through 902.6.8 illustrate the typical arrangements of signal sections in left-turn signal faces. Figures 902.6.10 through 902.6.12 illustrate the typical arrangements of signal sections in right-turn signal faces.

902.5.4 Positions of Signal Indications Within a Vertical Signal Face (MUTCD Section 4E.04)

Standard. In each vertically-arranged signal face, all signal sections that display red signal indications shall be located above all signal sections that display yellow and green signal indications.

In vertically-arranged signal faces, each signal section that displays a YELLOW ARROW signal indication shall be located above the signal section that displays the GREEN ARROW signal indication to which it applies.

The relative positions of signal sections in a vertically-arranged signal face, from top to bottom, shall be as follows:

- CIRCULAR RED
- Steady left-turn RED ARROW
- Steady right-turn RED ARROW
- CIRCULAR YELLOW
- CIRCULAR GREEN
- Straight-through GREEN ARROW
- Steady left-turn YELLOW ARROW
- Flashing left-turn YELLOW ARROW
- Left-turn GREEN ARROW
- Steady right-turn YELLOW ARROW
- Flashing right-turn YELLOW ARROW
- Right-turn GREEN ARROW

Option. In a vertically-arranged signal face, signal sections that display signal indications of the same color may be arranged horizontally adjacent to each other at right angles to the basic straight line arrangement to form a clustered signal face (see Figure 902.6.7, Figure 902.6.14, and Figure 902.6.15).

Standard. Such clusters shall be limited to the following:

> A. Two or three different signal sections that display signal indications of the same color, or
> B. For only the specific case described in EPG 902.6.16 (see Drawing B in Figure 902.6.16.1, Figure 902.6.16.2, Figure 902.6.16.3) two signal sections, one of which displays a GREEN ARROW signal indication and the other of which displays a flashing YELLOW ARROW signal indication.

The signal section that displays a flashing yellow signal indication during steady mode operation:

A. Shall not be placed in the same vertical position as the signal section that displays a steady yellow signal indication, and
B. Shall be placed below the signal section that displays a steady yellow signal indication.

Support. Sections EPG 902.10.2 and EPG 902.14.2 contain exceptions to the provisions of this Article that are applicable to hybrid beacons.

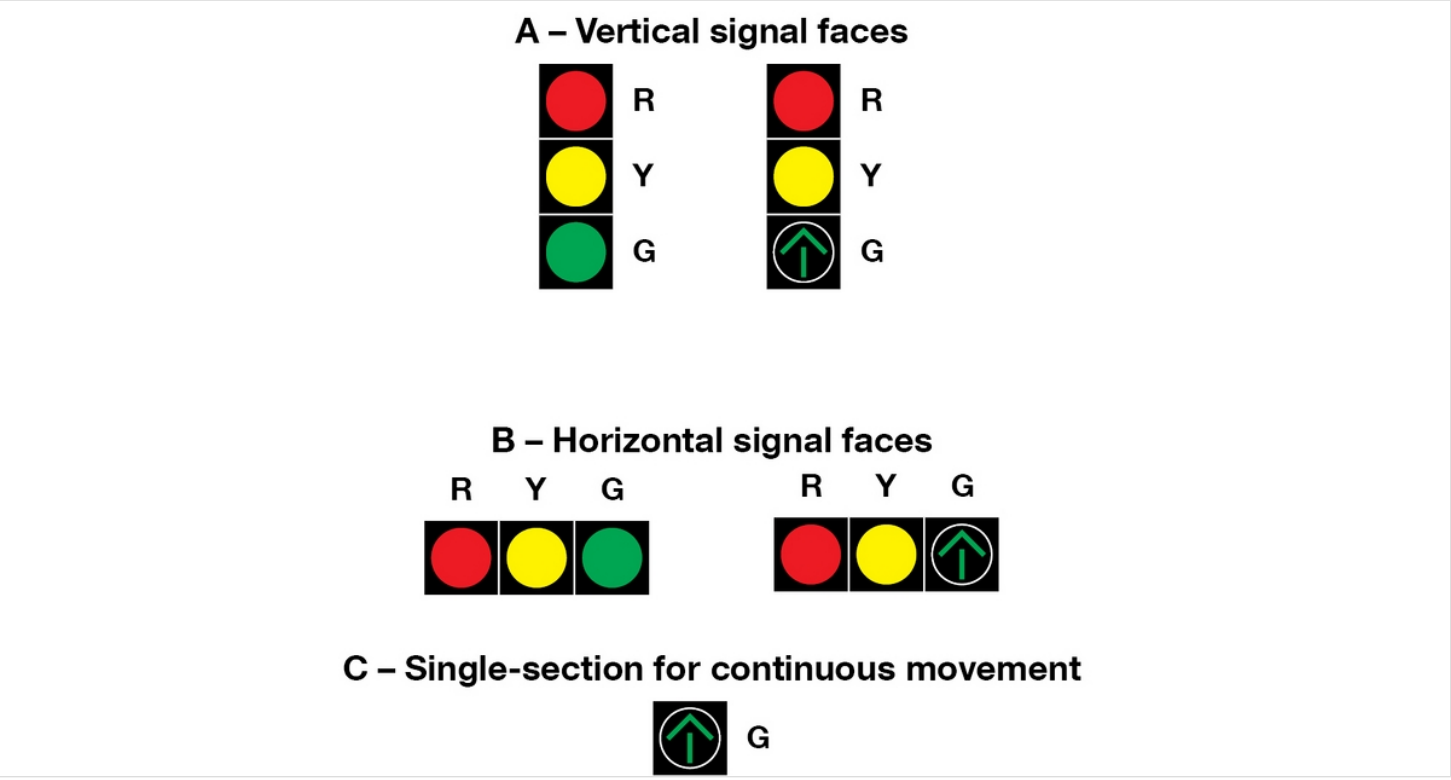


Figure 902.5.4 Typical Arrangements of Signal Sections in Signal Faces That Do Not Control Turning Movements

902.5.5 Positions of Signal Indications Within a Horizontal Signal Face (MUTCD Section 4E.05)

Support. Other than in emergency vehicle signals, MoDOT does not typically utilize horizontal signal faces unless engineering judgment deems necessary because of poor visibility or low clearance.

Standard. In each horizontally-arranged signal face, all signal sections that display red signal indications shall be located to the left of all signal sections that display yellow and green signal indications.

In horizontally-arranged signal faces, each signal section that displays a YELLOW ARROW signal indication shall be located to the left of the signal section that displays the GREEN ARROW signal indication to which it applies.

The relative positions of signal sections in a horizontally-arranged signal face, from left to right, shall be as follows:

- CIRCULAR RED
- Steady left-turn RED ARROW
- Steady right-turn RED ARROW
- CIRCULAR YELLOW

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- Steady left-turn YELLOW ARROW
- Flashing left-turn YELLOW ARROW
- Left-turn GREEN ARROW
- CIRCULAR GREEN
- Straight-through GREEN ARROW
- Steady right-turn YELLOW ARROW
- Flashing right-turn YELLOW ARROW
- Right-turn GREEN ARROW

Except as otherwise provided in EPG 902.6.4, 902.6.8, 902.6.11, and 902.6.15 for a three-section separate turn signal face with a flashing YELLOW ARROW signal indication, the signal section that displays a flashing yellow signal indication during steady mode operation:

A. Shall not be placed in the same horizontal position as the signal section that displays a steady yellow signal indication, and
B. Shall be placed to the right of the signal section that displays a steady yellow signal indication.

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902.6 Steady (Stop-and-Go) Operation of Traffic Control Signals (MUTCD Chapter 4F)

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902.6.19 Preemption Control of Traffic Control Signals (MUTCD Section 4F.19)

902.6.20 Priority Control of Traffic Control Signals (MUTCD Section 4F.20)

902.6.1 Application of Steady and Flashing Signal Indications during Steady (Stop-and-Go) Operation (MUTCD Section 4F.01)

Standard. When a traffic control signal is being operated in a steady (stop-and-go) mode, at least one indication in each signal face shall be displayed at any given time.

A signal face(s) that controls a particular vehicular movement during any interval of a cycle shall control that same movement during all intervals of the cycle.

Steady and flashing signal indications shall be applied as follows:

A. A steady CIRCULAR RED signal indication:

1. Shall be displayed when it is intended to prohibit traffic, except pedestrians directed by a pedestrian signal head, from entering the intersection or other controlled area. Turning after stopping is permitted as stated in Item C.1 of the first standard paragraph of EPG 902.1.3.
2. Shall be displayed with the appropriate GREEN ARROW signal indications when it is intended to permit traffic to make a specified turn or turns, and to prohibit traffic from proceeding straight ahead through the intersection or other controlled area, except in protected only mode operation (see EPG 902.6.6 and 902.6.13), or in protected/permissive mode operation with separate turn signal faces (see EPG 902.6.8 and 902.6.15).

B. A steady CIRCULAR YELLOW signal indication:

1. Shall be displayed following a CIRCULAR GREEN or straight-through GREEN ARROW signal indication in the same signal face.
2. Shall not be displayed in conjunction with the change from the CIRCULAR RED signal indication to the CIRCULAR GREEN signal indication.
3. Shall be followed by a CIRCULAR RED signal indication except that, when entering preemption operation, the return to the previous CIRCULAR GREEN signal indication shall be permitted following a steady CIRCULAR YELLOW signal indication (see EPG 902.6.19).
4. Shall not be displayed to an approach from which drivers are turning left permissively using a shared signal face or making a U-turn to the left permissively using a shared signal face unless one of the following conditions exists:

   (a) A steady CIRCULAR YELLOW signal indication is also simultaneously being displayed to the opposing approach;

   (b) An engineering study has determined that, because of unique intersection conditions, the condition described in Item (a) cannot reasonably be implemented without causing significant operational or safety problems and that the volume of impacted left-turning or U-turning traffic is relatively low, and those left-turning or U-turning drivers are advised that a steady CIRCULAR YELLOW signal indication is not simultaneously being displayed to the opposing traffic if this operation occurs continuously by the installation of a W25-1 sign (see EPG 903.3.36) with the legend ONCOMING TRAFFIC HAS EXTENDED GREEN; or

   (c) Drivers are advised of the operation if it occurs only occasionally, such as during a preemption sequence, by the installation of a W25-2 sign (see EPG 903.3.36) with the legend ONCOMING TRAFFIC MAY HAVE EXTENDED GREEN.

C. A steady CIRCULAR GREEN signal indication shall be displayed only when it is intended to permit traffic to proceed in any direction that is lawful and practical.
D. A steady RED ARROW signal indication shall be displayed when it is intended to prohibit traffic, except pedestrians directed by a pedestrian signal head, from entering the intersection or other controlled area to make the indicated turn. Except as described in Item C.2 of the first standard paragraph of EPG 902.1.3, turning on a steady RED ARROW signal indication shall not be permitted.
F. A steady YELLOW ARROW signal indication:

1. Shall be displayed in the same direction as a GREEN ARROW signal indication following a GREEN ARROW signal indication in the same signal face, unless:

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(a) The GREEN ARROW signal indication and a CIRCULAR GREEN (or straight-through GREEN ARROW) signal indication terminate simultaneously in the same signal face, or

(b) The green arrow is a straight-through GREEN ARROW (see Item B.1 in this Paragraph).

2. Shall be displayed in the same direction as a flashing YELLOW ARROW signal indication following a flashing YELLOW ARROW signal indication in the same signal face, when the flashing arrow indication is displayed as part of a steady mode operation, if the signal face will subsequently display a steady red signal indication.
3. Shall not be displayed in conjunction with the change from a steady RED ARROW or flashing YELLOW ARROW signal indication to a GREEN ARROW signal indication, except when entering preemption operation as provided in Item F.5(a) of this Paragraph.
4. Shall not be displayed when any conflicting vehicular movement has a green or yellow signal indication (including right turns that conflict with U-turns to the) or any conflicting pedestrian movement has a WALKING PERSON (symbolizing WALK) or flashing UPRAISED HAND (symbolizing DONT WALK) signal indication, except that a steady left-turn YELLOW ARROW signal indication used to terminate a flashing left-turn (or U-turn to the left) YELLOW ARROW signal indication in a signal face controlling a permissive left-turn (or U-turn to the left) movement as described in EPG 902.6.4 and 902.6.8 shall be permitted to be displayed when a CIRCULAR YELLOW signal indication is displayed for the opposing through movement. Vehicles departing in the same direction shall not be considered in conflict if, for each turn lane with moving traffic, there is a separate departure lane, and pavement markings or raised channelization clearly indicate which departure lane to use.
5. Shall not be displayed to terminate a flashing arrow signal indication on an approach from which drivers are turning left permissively or making a U-turn to the left permissively unless one of the following conditions exists:

   (a) A steady CIRCULAR YELLOW signal indication is also simultaneously being displayed to the opposing approach;

   (b) An engineering study has determined that, because of unique intersection conditions, the condition described in Item (a) cannot reasonably be implemented without causing significant operational or safety problems and that the volume of impacted left-turning or U-turning traffic is relatively low, and those left-turning or U-turning drivers are advised that a steady CIRCULAR YELLOW signal indication is not simultaneously being displayed to the opposing traffic if this operation occurs continuously by the installation of a W25-1 sign (see EPG 903.3.36) with the legend ONCOMING TRAFFIC HAS EXTENDED GREEN; or

   (c) Drivers are advised of the operation if it occurs only occasionally, such as during a preemption sequence, by the installation of a W25-2 sign (see EPG 903.3.36) with the legend ONCOMING TRAFFIC MAY HAVE EXTENDED GREEN.

6. Shall be terminated by a RED ARROW signal indication for the same direction or a CIRCULAR RED signal indication except:

   (a) When entering preemption operation, the display of a GREEN ARROW signal indication or a flashing YELLOW ARROW signal indication shall be permitted following a steady YELLOW ARROW signal indication.

   (b) When the movement controlled by the arrow is to continue on a permissive mode basis during an immediately following signal phase, the display of a CIRCULAR GREEN signal indication or flashing YELLOW ARROW signal indication shall be permitted following a steady YELLOW ARROW signal indication. To provide a red clearance interval, it shall be permitted to display a steady left-turn RED ARROW signal indication immediately following the steady left-turn YELLOW ARROW signal indication.

G. A flashing YELLOW ARROW signal indication shall be displayed as part of a steady (stop-and-go) mode of operation only when it is intended to permit traffic to cautiously enter the intersection to make a turn in the direction indicated by the arrow after yielding to pedestrians, if any, and/or to opposing traffic, if any.

H. A steady GREEN ARROW signal indication:

1. Shall be displayed only to allow vehicular movements, in the direction indicated, that are not in conflict with other vehicles moving on a green or yellow signal indication (including right turns that conflict with U-turns to the left) except for the situation regarding straight-through GREEN ARROWs (provided in the first option paragraph of this Article), even if the other vehicles are required to yield the right-of-way to the traffic moving on the GREEN ARROW signal indication, and are not in conflict with pedestrians crossing in compliance with a WALKING PERSON (symbolizing WALK) or flashing UPRAISED HAND (symbolizing DONT WALK) signal indication. Vehicles departing in the same direction shall not be considered in conflict if, for each turn lane with moving traffic, there is a separate departure lane, and pavement markings or raised channelization clearly indicate which departure lane to use.
2. Shall be displayed on a signal face that controls a left-turn movement when said movement is not in conflict with other vehicles moving on a green or yellow signal indication (when U-turns to the left are allowed, a right-turn GREEN ARROW signal indication shall not be simultaneously displayed to road user making a right turn from the conflicting approach to the left) and is not in conflict with pedestrians crossing in compliance with a WALKING PERSON (symbolizing WALK) or flashing UPRAISED HAND (symbolizing DONT WALK) signal indication. Vehicles departing in the same direction shall not be considered in conflict if, for each turn lane with moving traffic, there is a separate departure lane, and pavement markings or raised channelization clearly indicate which departure lane to use.
3. Shall not be required on the stem of a T-intersection or for turns from a one-way street.

Option. A steady straight-through green arrow signal indication may be used instead of a circular green signal indication in a signal face to discourage wrong-way turns under the following conditions, even if opposed by a simultaneous permissive left-turn movement:

A. On an approach intersecting a one-way street;
B. On an approach intersecting an interchange exit ramp;
C. On an approach with unique geometric design that prohibits turns; or
D. On an approach with pre-signals and the adjacent lanes are controlled separately (see EPG 913.4.11 and EPG 913.4.12).

If not otherwise prohibited, steady red, yellow, and green turn arrow signal indications may be used instead of steady circular red, yellow, and green signal indications in a signal face on an approach where all traffic is required to turn or where the straight-through movement is not physically possible.

Support. A signal face for a right-turn movement is normally not required if the movement is channelized. A yield sign would normally control a channelized right-turn movement (See EPG 903.2.5 and EPG 903.2.9).

Option. In cases where road users making a right-turn cannot readily judge conflicting movements, signal control may be necessary for the channelized right-turn movement. See EPG 902.6.9 for signal indications used for right-turn movements.

Support. EPG 902.6.16 contains information regarding the signalization of approaches that have a combined left-turn/right-turn lane and no through movement.

EPG 902.4.7 contains information regarding limitations on left-turn arrows, right-turn arrows, and U-turn arrows in supplemental signal faces.

Standard. A straight-through RED ARROW signal indication or a straight-through YELLOW ARROW signal indication shall not be displayed on any signal face, either alone or in combination with any other signal indication.

The following combinations of signal indications shall not be simultaneously displayed on any one signal face:

A. CIRCULAR YELLOW with CIRCULAR RED,
B. CIRCULAR GREEN with CIRCULAR RED, or
C. Straight-through GREEN ARROW with CIRCULAR RED.

Except as provided in the eighth standard paragraph of this Article, the above combinations shall not be simultaneously displayed on an approach as a result of the combination of displays from multiple signal faces unless the display is created by a signal face(s) devoted exclusively to the control of a right-turn movement and:

A. The signal face(s) controlling the right-turn movement is visibility limited from the adjacent through movement or positioned to minimize potential confusion to approaching road users, or
B. A RIGHT TURN SIGNAL (R10-10) sign (see EPG 902.6.9, 902.6.11, 902.6.13, and 902.6.15) is mounted adjacent to the signal face(s) controlling the right-turn movement.

Except as provided in the subsequent paragraph, the following combinations of signal indications shall not be simultaneously displayed on any one signal face or as a result of the combination of displays from multiple signal faces on an approach:

A. CIRCULAR GREEN with CIRCULAR YELLOW,
B. Straight-through GREEN ARROW with CIRCULAR YELLOW,
C. GREEN ARROW with YELLOW ARROW pointing in the same direction,
D. YELLOW ARROW with RED ARROW pointing in the same direction, or
E. GREEN ARROW with RED ARROW pointing in the same direction.

If a separate signal face is provided at a pre-signal (see EPG 913.4.11) or at a queue cutter signal (see EPG 913.4.12) for a left-turn and/or right-turn lane that extends from the downstream signalized intersection back to and across a grade crossing, the following combinations of signal indications shall be permitted to be simultaneously displayed as a result of the combination of displays from multiple signal faces at the pre-signal or queue cutter signal:

A. Straight-through GREEN ARROW with CIRCULAR RED,
B. Straight-through GREEN ARROW with CIRCULAR YELLOW, and
C. CIRCULAR YELLOW with CIRCULAR RED.

Except as otherwise provided in EPG 902.6.8, 902.6.15, 902.10.3, and 902.14.3, the same signal section shall not be used to display both a flashing yellow and a steady yellow indication during steady mode operation. Except as otherwise provided in EPG 902.6.4, 902.6.8, 902.6.11, and 902.6.13, the same signal section shall not be used to display both a flashing red and a steady red indication during steady mode operation.

Guidance. No movement that creates an unexpected crossing of pathways of moving vehicles or pedestrians should be allowed during any green or yellow interval, except when all three of the following conditions are met:

A. The movement involves only slight conflict, and
B. Serious traffic delays are substantially reduced by permitting the conflicting movement, and
C. Drivers and pedestrians subjected to the unexpected conflict are effectively warned thereof by a sign.

902.6.2 Signal Indications for Left-Turn Movements – General (MUTCD Section 4F.02)

Support. In EPG 902.6.3 through 902.6.8, provisions applicable to left-turn movements and left-turn lanes are also applicable to signal indications for U-turns to the left that are provided at locations where left turns are prohibited or not geometrically possible. Left-turning traffic is controlled by one of four modes as follows:

A. Permissive Only Mode—turns made on a CIRCULAR GREEN signal indication or a flashing left-turn YELLOW ARROW signal indication after yielding to pedestrians, if any, and/or opposing traffic, if any.
B. Protected Only Mode—turns made only when a left-turn GREEN ARROW signal indication is displayed.
C. Protected/Permissive Mode—both modes can occur on an approach during the same cycle.
D. Variable Left-Turn Mode—the operating mode changes among the protected only mode and/or the protected/permissive mode and/or the permissive only mode during different periods of the day or as traffic conditions change.

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Option. In areas having a high percentage of older drivers, special consideration may be given to the use of protected only mode left-turn phasing, when appropriate.

Standard. During a permissive left-turn movement, the signal faces for through traffic on the opposing approach shall simultaneously display green or steady yellow signal indications. If pedestrians crossing the lane or lanes used by the permissive left-turn movement to depart the intersection are controlled by pedestrian signal heads, the signal indications displayed by those pedestrian signal heads shall not be limited to any particular display during the permissive left-turn movement.

During a protected left-turn movement, the signal faces for through traffic on the opposing approach shall simultaneously display steady CIRCULAR RED signal indications. During a protected left-turn movement, a GREEN ARROW or a YELLOW ARROW signal indication shall not simultaneously be displayed to right-turning traffic on the opposing approach, except where a separate exclusive, no conflict lane is available for each left-turn and right-turn lane with moving traffic and pavement markings or raised channelization clearly indicate which exclusive, no conflict lane to use (see Item H.1 in the third standard paragraph of EPG 902.6.1). If pedestrians crossing the lane or lanes used by the protected left-turn movement to depart the intersection are controlled by pedestrian signal heads, the pedestrian signal heads shall display a steady UPRAISED HAND (symbolizing DONT WALK) signal indication during the protected left-turn movement.

If a combined left-turn/through lane exists on an approach, a left-turn GREEN ARROW or left-turn YELLOW ARROW signal indication shall not be displayed to the approach simultaneously with a CIRCULAR RED signal indication for the through movement, and a left-turn RED ARROW signal indication shall not be displayed to the approach simultaneously with a CIRCULAR GREEN or CIRCULAR YELLOW signal indication for the through movement.

A yellow change interval for the left-turn movement shall not be displayed when the status of the left-turn operation is changing from permissive to protected within any given signal sequence.

If the operating mode changes among the protected only mode and/or the protected/permissive mode and/or the permissive only mode during different periods of the day or as traffic conditions change, the requirements in EPG 902.6.3 through 902.6.8 that are appropriate to that mode of operation shall be met, subject to the following:

A. The CIRCULAR GREEN and CIRCULAR YELLOW signal indications shall not be displayed when operating in the protected only mode.
B. The left-turn GREEN ARROW and left-turn YELLOW ARROW signal indications shall not be displayed when operating in the permissive only mode.

Option. Additional static signs or changeable message signs may be used to meet the requirements for the variable left-turn mode or to inform drivers that left-turn green arrows will not be available during certain times of the day.

Support. EPG 902.6.3 through 902.6.8 describe the use of the following two types of signal faces for controlling left-turn movements

A. Shared signal face – This type of signal face controls both the left-turn movement and the adjacent movement (usually the through movement) and can serve as one of the two required primary signal faces for the adjacent movement. A shared signal face always displays the same color of circular indication that is displayed by the signal face or faces for the adjacent movement. If a shared signal face that provides protected/permissive mode left turns is mounted overhead for an approach that includes a mandatory left-turn lane, it is usually positioned over or slightly to the right of the extension of the lane line separating the left-turn lane from the adjacent lane. If a shared signal face that provides protected/permissive mode left turns is mounted overhead for an approach that does not include a mandatory left-turn lane, it is usually positioned over the center of the combined left-turn/straight-through lane.

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B. Separate left-turn signal face – This type of signal face controls only the left-turn movement and cannot serve as one of the two required primary signal faces for the adjacent movement (usually the through movement) because it displays signal indications that are applicable only to the left-turn movement. This type of signal face is used only for an approach that has a mandatory left-turn lane(s). If a separate left-turn signal face is mounted overhead at the intersection, it is positioned over the extension of the mandatory left-turn lane. In a separate left-turn signal face, a flashing left-turn YELLOW ARROW signal indication is used to control permissive left-turn movements.

EPG 902.4.7 contains provisions regarding the lateral positioning of signal faces that control left-turn movements.

It is not necessary that the same mode of left-turn operation or same type of left-turn signal face be used on every approach to a signalized location. Selecting different modes and types of left-turn signal faces for the various approaches to the same signalized location is acceptable.

Option. A signal face that is shared by left-turning and right-turning traffic may be provided for a combined left-turn/right-turn lane on an approach that has no through traffic (see EPG 902.6.16).

Support. See EPG 902.23.2 for additional information regarding left-turn phasing for signalized intersections.

902.6.3 Signal Indications for Permissive Only Mode Left-Turn Movements in a Shared Signal Face (MUTCD Section 4F.03)

Standard. If a shared signal face is provided for a permissive only mode left turn, it shall meet the following requirements (see Figure 902.6.1):

A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, and CIRCULAR GREEN. Only one of the three indications shall be displayed at any given time.
B. During the permissive left-turn movement, a CIRCULAR GREEN signal indication shall be displayed.
C. A permissive only shared signal face, regardless of where it is positioned and regardless of how many adjacent through signal faces are provided, shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.
D. If the permissive only mode is not the only left-turn mode used for the approach, the signal face shall be the same shared signal face that is used for the protected/permissive mode (see EPG 902.6.7) except that the left-turn GREEN ARROW and left-turn YELLOW ARROW signal indications shall not be displayed when operating in the permissive only mode.

Vehicular traffic shall only be permitted to make a U-turn movement from the left-turn lane where Intersection Lane Control signs are installed indicating that the movement is permitted (see EPG 903.2.25). The Highway Safety and Traffic Division shall approve all new or reconstructed signal installations where U-turns are permitted during a permissive phase.

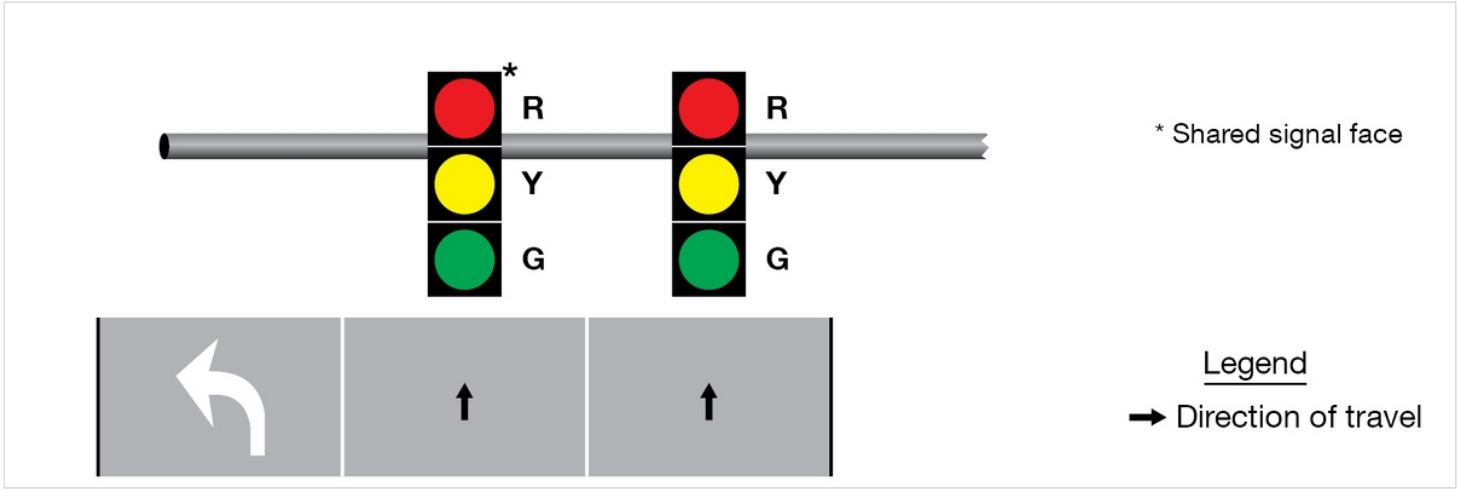


Figure 902.6.3 Typical Position of Shared Signal Faces for Permissive Only Mode Left Turns

902.6.4 Signal Indications for Permissive Only Mode Left-Turn Movements in a Separate Signal Face (MUTCD Section 4F.04)

Standard. A separate left-turn signal face shall not be used for an approach that does not include a mandatory left-turn lane.

If a separate left-turn signal face is being operated in a permissive only left-turn mode, a CIRCULAR GREEN signal indication shall not be used in that face.

If a separate left-turn signal face is being operated in a permissive only left-turn mode and a flashing left-turn YELLOW ARROW signal indication is provided, it shall meet the following requirements (see Figure 902.6.4):

A. It shall be capable of displaying the following signal indications: steady left-turn RED ARROW, steady left-turn YELLOW ARROW, and flashing left-turn YELLOW ARROW. Only one of the three indications shall be displayed at any given time.
B. During the permissive left-turn movement, a flashing left-turn YELLOW ARROW signal indication shall be displayed.
C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the flashing left-turn YELLOW ARROW signal indication.
D. It shall be permitted to display a flashing left-turn YELLOW ARROW signal indication for a permissive left-turn movement while the signal faces for the adjacent through movement display steady CIRCULAR RED signal indications and the opposing left-turn signal faces display left-turn GREEN ARROW signal indications for a protected left-turn movement.
E. During steady mode (stop-and-go) operation, the signal section that displays the steady left-turn YELLOW ARROW signal indication during change intervals shall not be used to display the flashing left-turn YELLOW ARROW signal indication for permissive left turns
F. During flashing mode operation (see EPG 902.7.1), the display of a flashing left-turn YELLOW ARROW signal indication shall be only from the signal section that displays a steady left-turn YELLOW ARROW signal indication during steady mode (stop-and-go) operation.
G. If the permissive only mode is not the only left-turn mode used for the approach, the signal face shall be the same separate left-turn signal face with a flashing YELLOW ARROW signal indication that is used for the protected/permissive mode (see EPG 902.6.8) except that the left-turn GREEN ARROW signal indication shall not be displayed when operating in the permissive only mode.

Vehicular traffic shall only be permitted to make a U-turn movement from the left-turn lane where Intersection Lane Control signs are installed indicating that the movement is permitted (see EPG 903.2.25). The Highway Safety and Traffic Division shall approve all new or reconstructed signal installations where U-turns are permitted during a permissive phase.

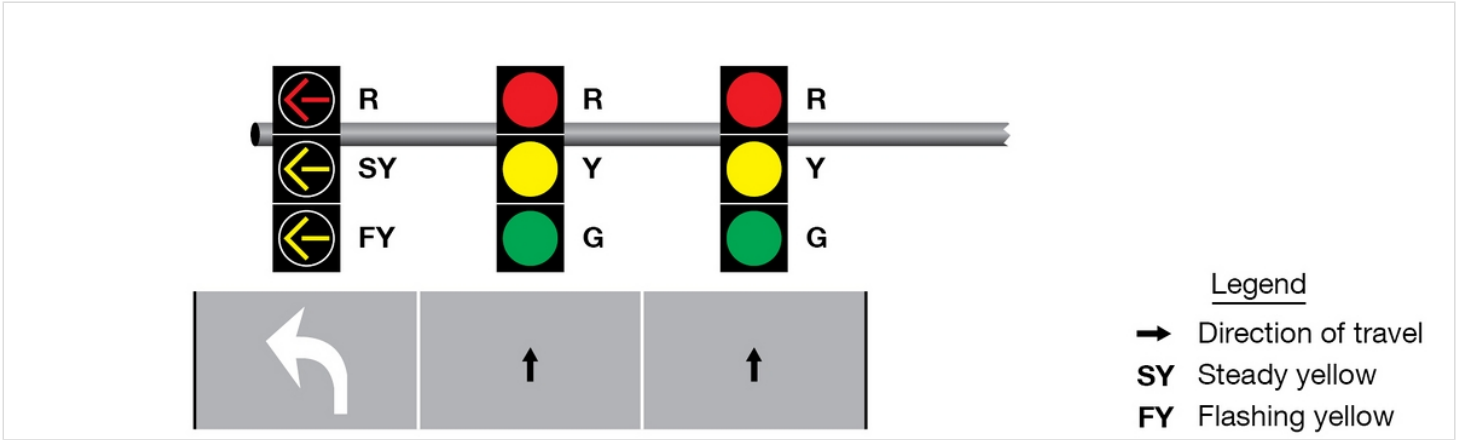


Figure 902.6.4 Typical Position of Separate Signal Faces with Flashing Yellow Arrow for Permissive Only Mode Left Turns

902.6.5 Signal Indications for Protected Only Mode Left-Turn Movements in a Shared Signal Face (MUTCD Section 4F.05)

Standard. A shared signal face shall not be used for protected only mode left turns unless the CIRCULAR GREEN and left-turn GREEN ARROW signal indications always begin and terminate together. If a shared signal face is provided for a protected only mode left turn, it shall meet the following requirements (see Figure 902.6.5):

A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, CIRCULAR GREEN, and left-turn GREEN ARROW. Only one of the three colors shall be displayed at any given time.
B. During the protected left-turn movement, the shared signal face shall simultaneously display both a CIRCULAR GREEN signal indication and a left-turn GREEN ARROW signal indication.
C. The shared signal face shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.
D. If the protected only mode is not the only left-turn mode used for the approach, the signal face shall be the same shared signal face that is used for the protected/permissive mode (see EPG 902.6.7).

Option. A straight-through GREEN ARROW signal indication may be used instead of the CIRCULAR GREEN signal indication in Items A and B in the first standard paragraph of this Article on an approach where a straight-through GREEN ARROW signal indication is also used instead of a CIRCULAR GREEN signal indication in the other signal face(s) for through traffic.

Standard. Vehicular traffic shall only be permitted to make a U-turn movement from the left-turn lane where Intersection Lane Control signs are installed indicating that the movement is permitted (see EPG 903.2.25).

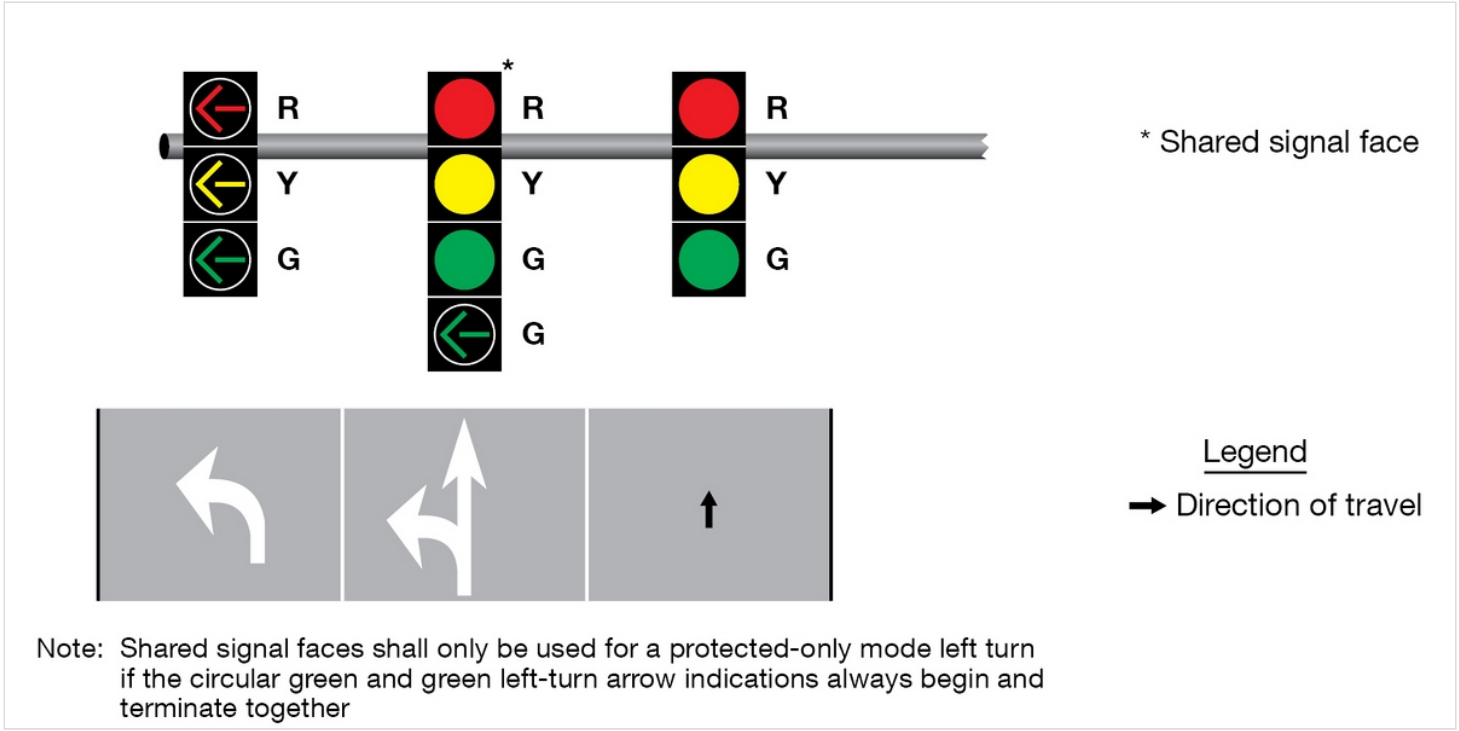


Figure 902.6.5 Typical Position of Shared Signal Faces for Protected Only Mode Left Turns

902.6.6 Signal Indications for Protected Only Mode Left-Turn Movements in a Separate Signal Face (MUTCD Section 4F.06)

Standard. A separate left-turn signal face shall not be used for an approach that does not include a mandatory left-turn lane.

If a separate left-turn signal face is provided for a protected only mode left turn, it shall meet the following requirements (see Figure 902.6.6):

A. It shall be capable of displaying, the following signal indications: steady left-turn RED ARROW, steady left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the three indications shall be displayed at any given time.
B. During the protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed.
C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication.
D. If the protected only mode is not the only left-turn mode used for the approach, the signal face shall be the same separate left-turn signal face that is used for the protected/permissive mode (see EPG 902.6.8 and Figure 902.6.8) except that the flashing left-turn YELLOW ARROW signal indication shall not be displayed when operating in the protected only mode.

Standard. Vehicular traffic shall only be permitted to make a U-turn movement from the left-turn lane where Intersection Lane Control signs are installed indicating that the movement is permitted (see EPG 903.2.25).

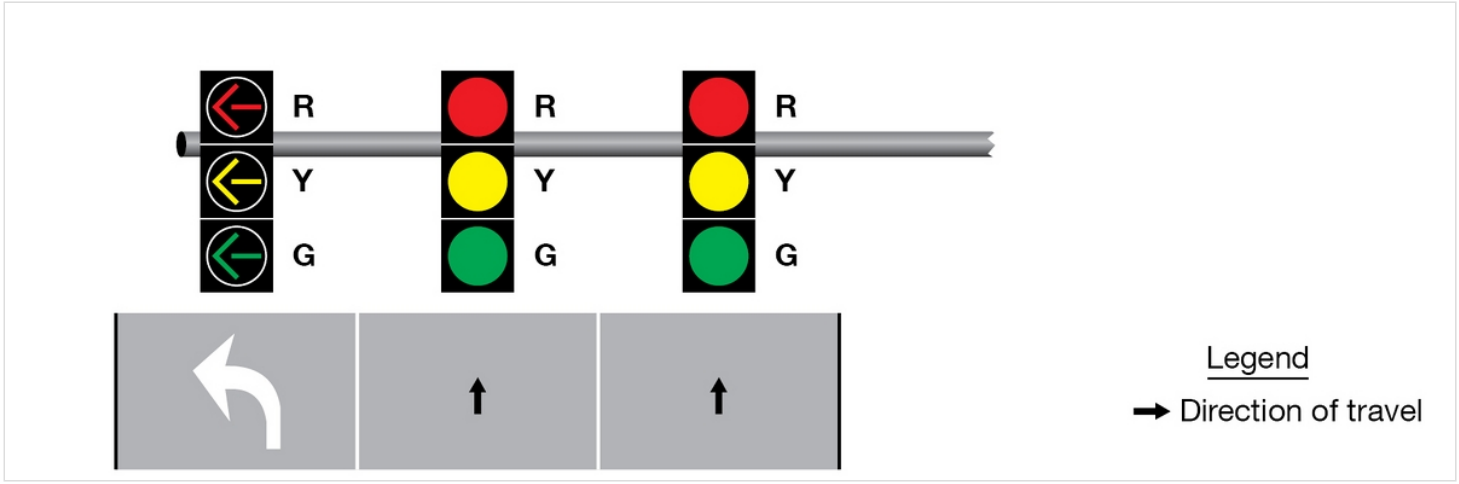


Figure 902.6.6 Typical Position of Separate Signal Faces for Protected Only Mode Left Turns

902.6.7 Signal Indications for Protected/Permissive Mode Left-Turn Movements in a Shared Signal Face (MUTCD Section 4F.07)

Standard. If a shared signal face is provided for a protected/permissive mode left turn, it shall meet the following requirements (see Figure 902.6.7):

A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, CIRCULAR green, steady left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the three circular indications shall be displayed at any given time. Only one of the two arrow indications shall be displayed at any given time. If the left-turn GREEN ARROW signal indication and the CIRCULAR GREEN signal indication(s) for the adjacent through movement are always terminated together, the steady left-turn YELLOW ARROW signal indication shall not be required.
B. During the protected left-turn movement, the shared signal face shall simultaneously display a left-turn GREEN ARROW signal indication and a circular signal indication that is the same color as the signal indication for the adjacent through lane on the same approach as the protected left turn.
C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication, unless the left-turn GREEN ARROW signal indication and the CIRCULAR GREEN signal indication(s) for the adjacent through movement are being terminated together. When the left-turn GREEN ARROW and CIRCULAR GREEN signal indications are being terminated together, the required display following the left-turn GREEN ARROW signal indication shall be either the display of a CIRCULAR YELLOW signal indication alone or the simultaneous display of the CIRCULAR YELLOW and left-turn YELLOW ARROW signal indications.
D. During the permissive left-turn movement, the shared signal face shall display only a CIRCULAR GREEN signal indication.
E. A protected/permissive shared signal face, regardless of where it is positioned and regardless of how many adjacent through signal faces are provided, shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.
F. A supplementary sign shall not be required. If used, it shall be a LEFT TURN YIELD ON GREEN (symbolic circular green) (R10-12) sign (see EPG 903.2.48).

Vehicular traffic shall only be permitted to make a U-turn movement from the left-turn lane where Intersection Lane Control signs are installed indicating that the movement is permitted (see EPG 903.2.25). The Highway Safety and Traffic Division shall approve all new or reconstructed signal installations where U-turns are permitted during a permissive phase.

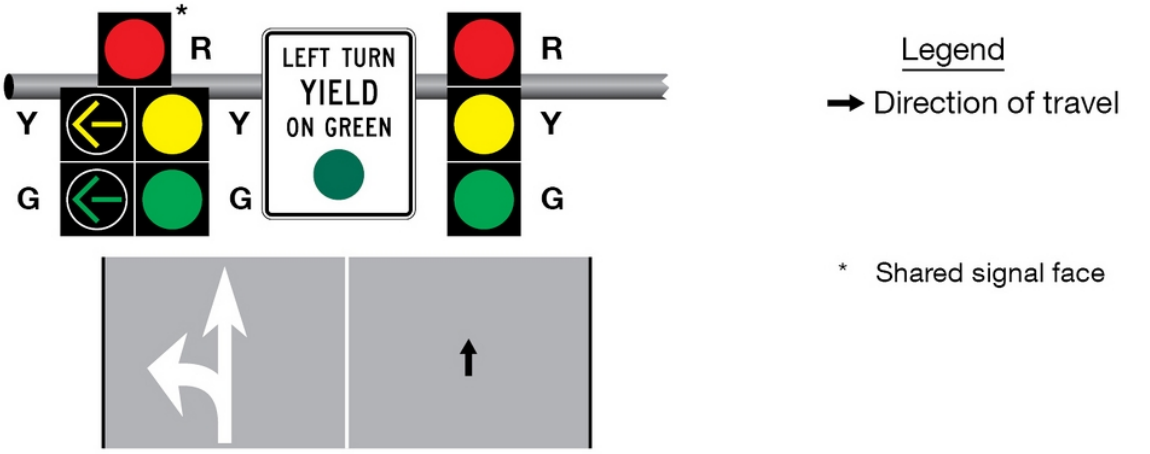


Figure 902.6.7 Typical Position of Shared Signal Faces for Protected/Permissive Mode Left Turns

902.6.8 Signal Indications for Protected/Permissive Mode Left-Turn Movements in a Separate Signal Face (MUTCD Section 4F.08)

Standard. A separate left-turn signal face shall not be used for an approach that does not include a mandatory left-turn lane.

If a separate left-turn signal face is being operated in a protected/permissive left-turn mode, a CIRCULAR GREEN signal indication shall not be used in that face.

If a separate left-turn signal face is being operated in a protected/permissive left-turn mode and a flashing left-turn YELLOW ARROW signal indication is provided, it shall meet the following requirements (see Figure 902.6.8):

A. It shall be capable of displaying the following signal indications: steady left-turn RED ARROW, steady left-turn YELLOW ARROW, flashing left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the four indications shall be displayed at any given time.
B. During the protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed.
C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication. It shall be permitted to display a steady left-turn RED ARROW signal indication immediately following the steady left-turn YELLOW ARROW signal indication to provide a red clearance interval.
D. During the permissive left-turn movement, a flashing left-turn YELLOW ARROW signal indication shall be displayed.
E. A steady left-turn YELLOW ARROW signal indication shall be displayed following the flashing left-turn YELLOW ARROW signal indication if the permissive left-turn movement is being terminated and the separate left-turn signal face will subsequently display a steady left-turn RED ARROW indication.
F. It shall be permitted to display a flashing left-turn YELLOW ARROW signal indication for a permissive left-turn movement while the signal faces for the adjacent through movement display steady CIRCULAR RED signal indications and the opposing left-turn signal faces display left-turn GREEN ARROW signal indications for a protected left-turn movement.
G. When a permissive left-turn movement is changing to a protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed immediately upon the termination of the flashing left-turn YELLOW ARROW signal indication. A steady left-turn YELLOW ARROW signal indication shall not be displayed between the display of the flashing left-turn YELLOW ARROW signal indication and the display of the steady left-turn GREEN ARROW signal indication.

H. The display shall be a four-section signal face with the steady left-turn YELLOW ARROW signal indication being displayed in a different section than the flashing left-turn YELLOW ARROW signal indication.
I. During steady mode (stop-and-go) operation where a four-section signal face is used, the signal section that displays the steady left-turn YELLOW ARROW signal indication during change intervals shall not be used to display the flashing left-turn YELLOW ARROW signal indication for permissive left turns.
J. During flashing mode operation (see EPG 902.7) where a four-section signal face is used, the display of a flashing left-turn YELLOW ARROW signal indication shall be only from the signal section that displays a steady left-turn YELLOW ARROW signal indication during steady mode (stop-and-go) operation.

The LEFT TURN YIELD ON FLASHING YELLOW ARROW (R10-12a) sign shall be installed adjacent to a four-section signal face operated in protective/permissive left-turn mode.

Vehicular traffic shall only be permitted to make a U-turn movement from the left-turn lane where Intersection Lane Control signs are installed indicating that the movement is permitted (see EPG 903.2.25). The Highway Safety and Traffic Division shall approve all new or reconstructed signal installations where U-turns are permitted during a permissive phase.

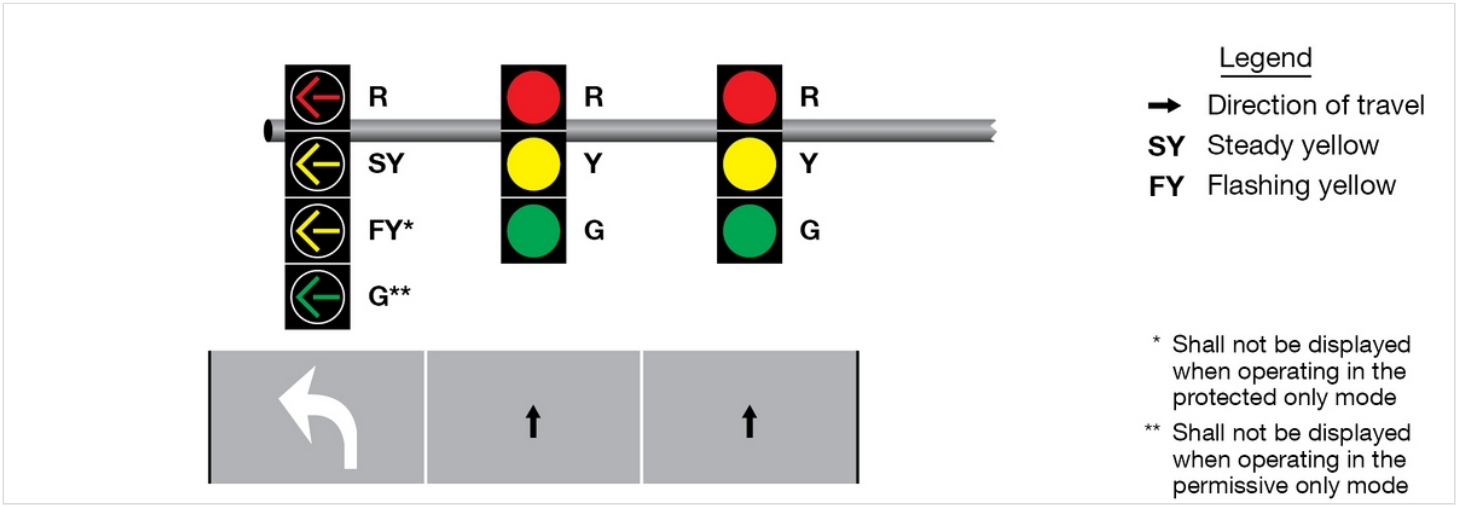


Figure 902.6.8 Typical Position of Separate Signal Faces with Flashing Yellow Arrow for Protected/Permissive Mode and Variable Mode Left Turns

902.6.9 Signal Indications for Right-Turn Movements – General (MUTCD Section 4F.09)

Support. Right-turning traffic is controlled by one of four modes as follows:

A. Permissive Only Mode—turns made on a CIRCULAR GREEN signal indication or a flashing right-turn YELLOW ARROW signal indication after yielding to pedestrians, if any.
B. Protected Only Mode—turns made only when a right-turn GREEN ARROW signal indication is displayed.
C. Protected/Permissive Mode—both modes occur on an approach during the same cycle.
D. Variable Right-Turn Mode—the operating mode changes among the protected only mode and/or the protected/permissive mode and/or the permissive only mode during different periods of the day or as traffic conditions change.

Right turns on a CIRCULAR RED signal indication are permitted, after stopping unless a traffic control device is in place prohibiting a turn on red (see EPG 902.1.3).

Standard. During a permissive right-turn movement, the signal faces, if any, that exclusively control U-turn traffic that conflicts with the permissive right-turn movement (see Item H.1 in the third standard paragraph of 902.6.1) shall simultaneously display steady U-turn RED ARROW signal indications. If pedestrians crossing the lane or lanes used by the permissive right-turn movement to depart the intersection are controlled by pedestrian signal heads, the signal indications displayed by those pedestrian signal heads shall not be limited to any particular display during the permissive right-turn movement. During a protected right-turn movement, a GREEN ARROW or a YELLOW ARROW signal indication shall not simultaneously be displayed to left-turning traffic on the opposing approach, except where a separate departure lane is available for each left-turn and right-turn lane with moving traffic and pavement markings or raised channelization clearly indicate which departure lane to use (see Item H.1 in the third standard paragraph of 902.6.1). Signal faces, if any, that exclusively control U-turn traffic that conflicts with the protected right-turn movement shall simultaneously display steady RED ARROW signal indications. If pedestrians crossing the lane or lanes used by the protected right-turn movement to depart the intersection are controlled by pedestrian signal heads, the pedestrian signal heads shall display a steady UPRAISED HAND (symbolizing DONT WALK) signal indication during the protected right-turn movement.

During the phase where a steady CIRCULAR RED signal indication is displayed for a right-turn movement and conflicting U-turns are allowed a RIGHT ON RED MUST YIELD TO U-TURN (R10-30) sign shall be installed for the right-turn movement. If the conflicting right turn is controlled by a yield sign, a RIGHT TURN MUST YIELD TO U-TURN (R10-30a) sign shall be installed.

When U-turns from a protected only mode for left turns are allowed, a right turn GREEN ARROW signal indication for a conflicting right turn movement shall not be simultaneously displayed.

If a combined right-turn/through lane exists on an approach, a right-turn GREEN ARROW or right-turn YELLOW ARROW signal indication shall not be displayed to the approach simultaneously with a CIRCULAR RED signal indication for the through movement, and a right-turn RED ARROW signal indication shall not be displayed to the approach simultaneously with a CIRCULAR GREEN or CIRCULAR YELLOW signal indication for the through movement.

If the operating mode changes among the protected only mode and/or the protected/permissive mode and/or the permissive only mode during different periods of the day or as traffic conditions change, the requirements in EPG 902.6.10 through 902.6.15 that are appropriate to that mode of operation shall be met, subject to the following:

A. The CIRCULAR GREEN and CIRCULAR YELLOW signal indications shall not be displayed when operating in the protected only mode.
B. The right-turn GREEN ARROW and right-turn YELLOW ARROW signal indications shall not be displayed when operating in the permissive only mode.

Option. Additional static signs or changeable message signs may be used to meet the requirements for the variable right-turn mode or to inform drivers that right-turn green arrows will not be available during certain times of the day.

Support. EPG 902.6.10 through 902.6.15 describe the use of the following two types of signal faces for controlling right-turn movements

A. Shared signal face – This type of signal face controls both the right-turn movement and the adjacent movement (usually the through movement) and can serve as one of the two required primary signal faces for the adjacent movement. A shared signal face always displays the same color of circular indication that is displayed by the signal face or faces for the adjacent movement.
B. Separate right-turn signal face – This type of signal face controls only the right-turn movement and cannot serve as one of the two required primary signal faces for the adjacent movement (usually the through movement) because it displays signal indications that are applicable only to the right-turn

movement. If a separate right-turn signal face is mounted overhead at the intersection, it is positioned over the extension of the mandatory right-turn lane. In a separate right-turn signal face, a flashing right-turn YELLOW ARROW signal indication is used to control permissive right-turn movements.

EPG 902.4.7 contains provisions regarding the lateral positioning of signal faces that control right-turn movements.

It is not necessary that the same mode of right-turn operation or same type of right-turn signal face be used on every approach to a signalized location. Selecting different modes and types of right-turn signal faces for the various approaches to the same signalized location is acceptable.

A signal face that is shared by left-turning and right-turning traffic may be provided for a combined left-turn/right-turn lane on an approach that has no through traffic (see EPG 902.6.16).

902.6.10 Signal Indications for Permissive Only Mode Right-Turn Movements in a Shared Signal Face (MUTCD Section 4F.10)

Standard. If a shared signal face is provided for a permissive only mode right turn, it shall meet the following requirements (see Figure 902.6.10):

A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, and CIRCULAR GREEN. Only one of the three indications shall be displayed at any given time.
B. During the permissive right-turn movement, a CIRCULAR GREEN signal indication shall be displayed.
C. A permissive only shared signal face, regardless of where it is positioned and regardless of how many adjacent through signal faces are provided, shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.
D. If the permissive only mode is not the only right-turn mode used for the approach, the signal face shall be the same shared signal face that is used for the protected/permissive mode (see EPG 902.6.14) except that the right-turn GREEN ARROW and right-turn YELLOW ARROW signal indications shall not be displayed when operating in the permissive only mode.

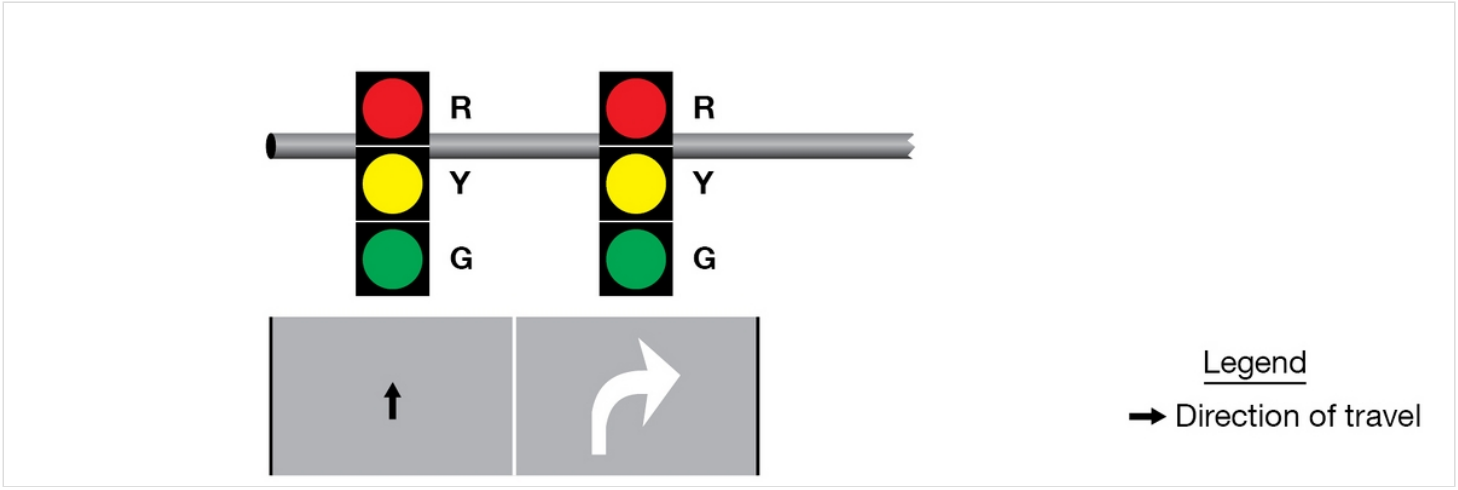


Figure 902.6.10 Typical Position of Shared Signal Faces for Permissive Only Mode Right Turns

902.6.11 Signal Indications for Permissive Only Mode Right-Turn Movements in a Separate Signal Face (MUTCD Section 4F.11)

Standard. A separate right-turn signal face shall not be used for an approach that does not include a mandatory right-turn lane.

If a separate right-turn signal face is being operated in a permissive only right-turn mode, a CIRCULAR GREEN signal indication shall not be used in that face.

If a separate right-turn signal face is being operated in a permissive only right-turn mode and a flashing right-turn yellow arrow signal indication is provided, it shall meet the following requirements (see Figure 902.6.11):

A. It shall be capable of displaying one of the following sets of signal indications:

1. Steady right-turn RED ARROW, steady right-turn YELLOW ARROW, and flashing right-turn YELLOW ARROW. Only one of the three indications shall be displayed at any given time.
2. Steady CIRCULAR RED, steady right-turn YELLOW ARROW, and flashing right-turn YELLOW ARROW. Only one of the three indications shall be displayed at any given time. If the CIRCULAR RED signal indication is sometimes displayed when the signal faces for the adjacent through lane(s) are not displaying a CIRCULAR RED signal indication, a RIGHT TURN SIGNAL (R10-10R) sign (see EPG 903.2.48) shall be used unless the CIRCULAR RED signal indication in the separate right-turn signal face is shielded, hooded, louvered, positioned, or designed such that it is not readily visible to drivers in the through lane(s).

B. During the permissive right-turn movement, a flashing right-turn YELLOW ARROW signal indication shall be displayed.
C. A steady right-turn YELLOW ARROW signal indication shall be displayed following the flashing right-turn YELLOW ARROW signal indication.
D. When the separate right-turn signal face is providing a message to stop and remain stopped, a steady right-turn RED ARROW signal indication shall be displayed if it is intended that right turns on red not be permitted (except when a traffic control device is in place permitting a turn on a steady RED ARROW signal indication) or a steady CIRCULAR RED signal indication shall be displayed if it is intended that right turns on red be permitted.
E. It shall be permitted to display a flashing right-turn YELLOW ARROW signal indication for a permissive right-turn movement while the signal faces for the adjacent through movement display steady CIRCULAR RED signal indications.
F. During steady mode (stop-and-go) operation, the signal section that displays the steady right-turn YELLOW ARROW signal indication during change intervals shall not be used to display the flashing right-turn YELLOW ARROW signal indication for permissive right turns.

G. During flashing mode operation (see EPG 902.7), the display of a flashing right-turn YELLOW ARROW signal indication shall be only from the signal section that displays a steady right-turn YELLOW ARROW signal indication during steady mode (stop-and-go) operation.
H. If the permissive only mode is not the only right-turn mode used for the approach, the signal face shall be the same separate right-turn signal face with a flashing YELLOW ARROW signal indication that is used for the protected/permissive mode (see EPG 902.6.15) except that the right-turn GREEN ARROW signal indication shall not be displayed when operating in the permissive only mode.

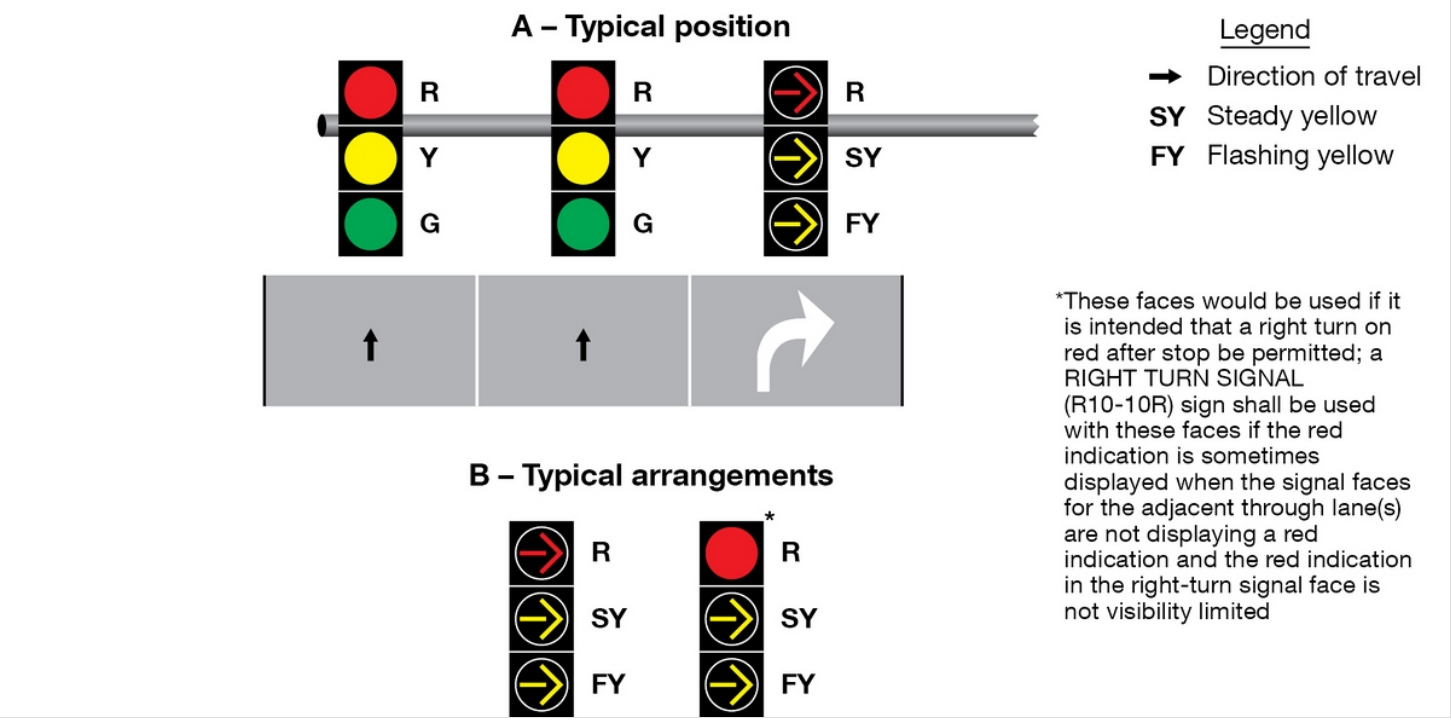


Figure 902.6.11 Typical Position and Arrangements of Separate Signal Faces with Flashing Yellow Arrow for Permissive Only Mode Right Turns

902.6.12 Signal Indications for Protected Only Mode Right-Turn Movements in a Shared Signal Face (MUTCD Section 4F.12)

Standard. A shared signal face shall not be used for protected only mode right turns unless the CIRCULAR GREEN and right-turn GREEN ARROW signal indications always begin and terminate together. If a shared signal face is provided for a protected only right turn, it shall meet the following requirements (see Figure 902.6.12):

A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, CIRCULAR GREEN, and right-turn GREEN ARROW. Only one of the three colors shall be displayed at any given time.
B. During the protected right-turn movement, the shared signal face shall simultaneously display both a CIRCULAR GREEN signal indication and a right-turn GREEN ARROW signal indication.
C. The shared signal face shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.
D. If the protected only mode is not the only right-turn mode used for the approach, the signal face shall be the same shared signal face that is used for the protected/permissive mode (see EPG 902.6.15).

Option. A straight-through GREEN ARROW signal indication may be used instead of the CIRCULAR GREEN signal indication in Items A and B in the preceding paragraph on an approach where a straight-through GREEN ARROW signal indication is also used instead of a CIRCULAR GREEN signal indication in the other signal face(s) for through traffic.

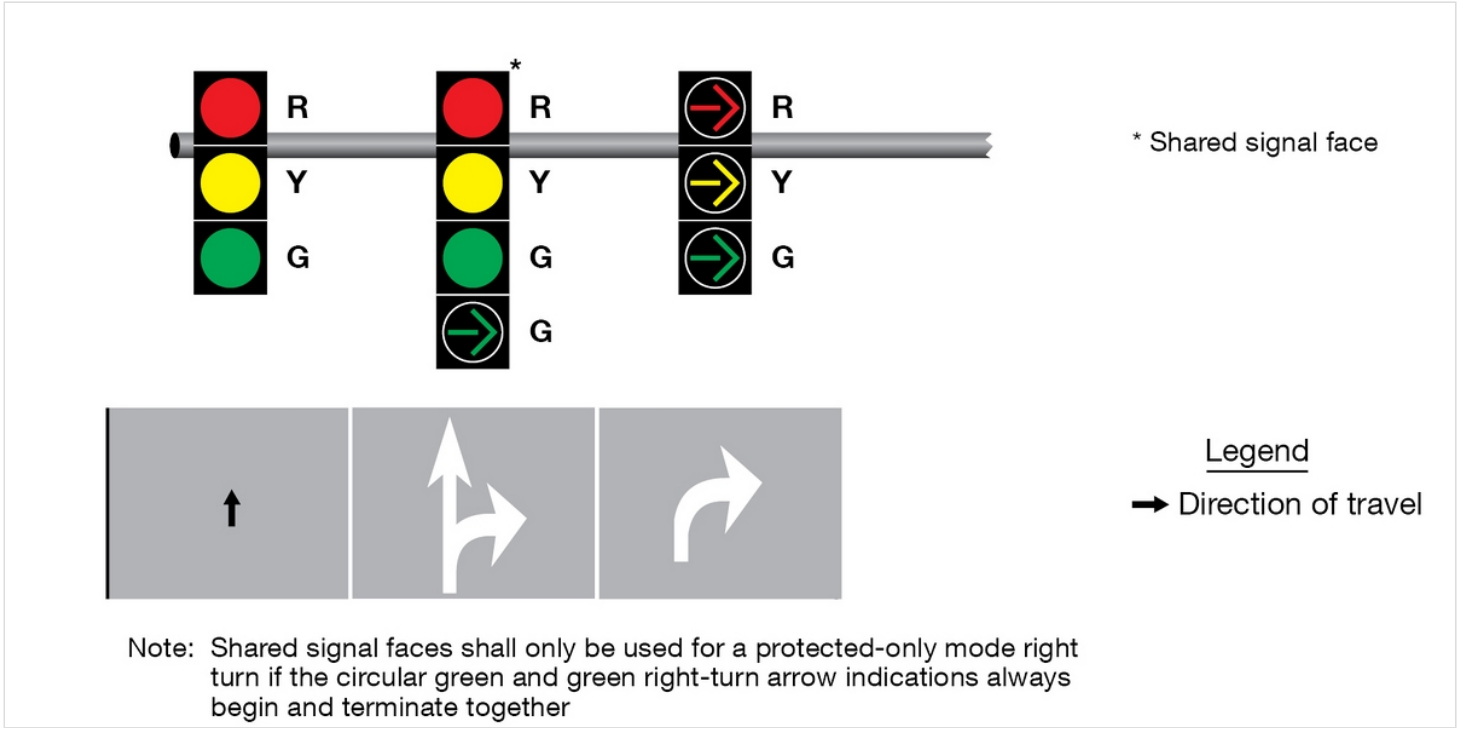


Figure 902.6.12 Typical Position of Shared Signal Faces for Protected Only Mode Right Turns

902.6.13 Signal Indications for Protected Only Mode Right-Turn Movements in a Separate Signal Face (MUTCD Section 4F.13)

Standard. A separate right-turn signal face shall not be used for an approach that does not include a mandatory right-turn lane.

If a separate right-turn signal face is provided for a protected only mode right turn, it shall meet the following requirements (see Figure 902.6.13):

A. It shall be capable of displaying one of the following sets of signal indications:

1. Steady right-turn RED ARROW, steady right-turn YELLOW ARROW, and right-turn GREEN ARROW. Only one of the three indications shall be displayed at any given time.
2. Steady CIRCULAR RED, steady right-turn YELLOW ARROW, and right-turn GREEN ARROW. Only one of three indications shall be displayed at any given time. If the CIRCULAR RED signal indication is sometimes displayed when the signal faces for the adjacent through lane(s) are not displaying a CIRCULAR RED signal indication, a RIGHT TURN SIGNAL (R10-10R) sign (see EPG 903.2.48) shall be used unless the CIRCULAR RED signal indication is shielded, hooded, louvered, positioned, or designed such that it is not readily visible to drivers in the through lane(s).

B. During the protected right-turn movement, a right-turn GREEN ARROW signal indication shall be displayed.
C. A steady right-turn YELLOW ARROW signal indication shall be displayed following the right-turn GREEN ARROW signal indication.
D. When the separate signal face is providing a message to stop and remain stopped, a steady right-turn RED ARROW signal indication shall be displayed with a NO TURN ON RED (R10-11) sign, if it is intended that right turns on red not be permitted.
E. If the protected only mode is not the only right-turn mode used for the approach, the signal face shall be the same separate right-turn signal face that is used for the protected/permissive mode (see EPG 902.6.15) except that a flashing right-turn YELLOW ARROW signal indication shall not be displayed when operating in the protected only mode.

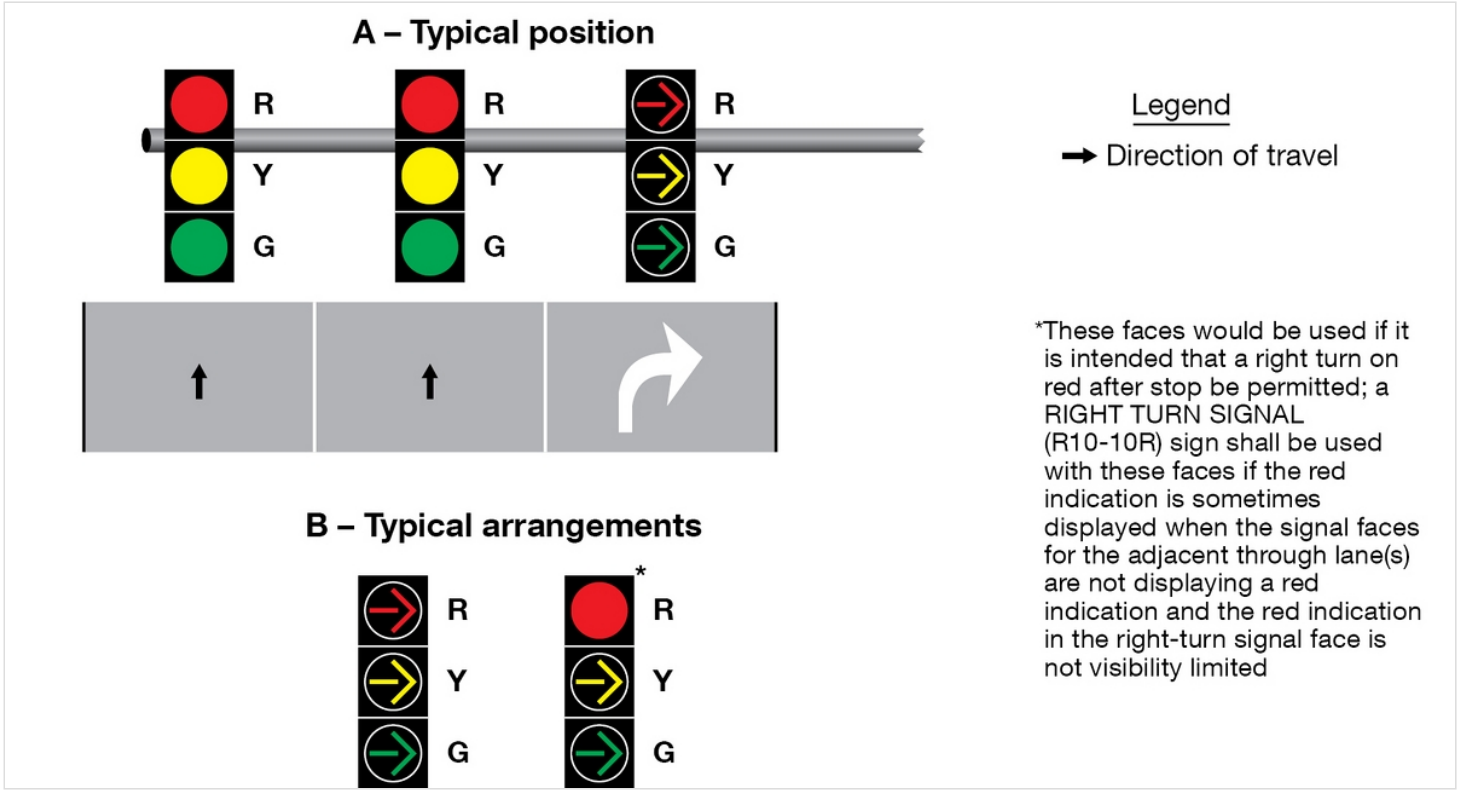


Figure 902.6.13 Typical Position and Arrangements of Separate Signal Faces for Protected Only Mode Right Turns

902.6.14 Signal Indications for Protected/Permissive Mode Right-Turn Movements in a Shared Signal Face (MUTCD Section 4F.14)

Standard. If a shared signal face is provided for a protected/permissive mode right turn, it shall meet the following requirements (see Figure 902.6.14):

A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, CIRCULAR green, steady right-turn YELLOW ARROW, and right-turn GREEN ARROW. Only one of the three circular indications shall be displayed at any given time. Only one of the two arrow indications shall be displayed at any given time. If the right-turn GREEN ARROW signal indication and the CIRCULAR GREEN signal indication(s) for the adjacent through movement are always terminated together, the steady right-turn YELLOW ARROW signal indication shall not be required.
B. During the protected right-turn movement, the shared signal face shall simultaneously display a right-turn GREEN ARROW signal indication and a circular signal indication that is the same color as the signal indication for the adjacent through lane on the same approach as the protected right turn.
C. A steady right-turn YELLOW ARROW signal indication shall be displayed following the right-turn GREEN ARROW signal indication, unless the right-turn GREEN ARROW signal indication and the CIRCULAR GREEN signal indication(s) for the adjacent through movement are being terminated together. When the right-turn GREEN ARROW and CIRCULAR GREEN signal indications are being terminated together, the required display following the right-turn GREEN ARROW signal indication shall be either the display of a CIRCULAR YELLOW signal indication alone or the simultaneous display of the CIRCULAR YELLOW and right-turn YELLOW ARROW signal indications.
D. During the permissive right-turn movement, the shared signal face shall display only a CIRCULAR GREEN signal indication.
E. A protected/permissive shared signal face, regardless of where it is positioned and regardless of how many adjacent through signal faces are provided, shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.

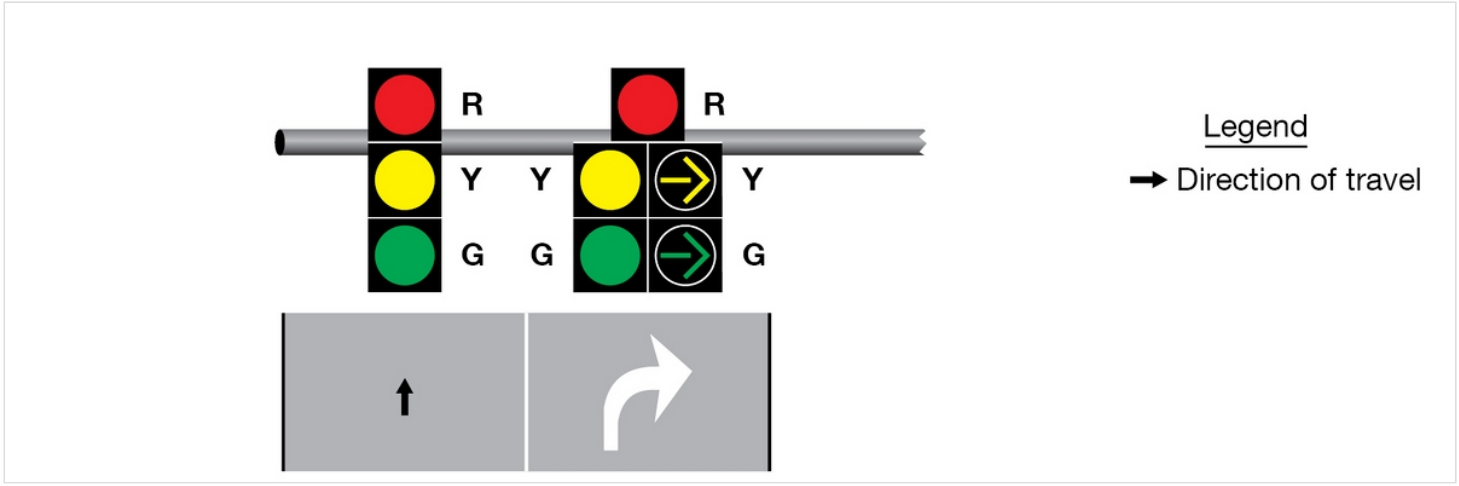


Figure 902.6.14 Typical Position of Shared Signal Faces for Protected/Permissive Mode Right Turns

902.6.15 Signal Indications for Protected/Permissive Mode Right-Turn Movements in a Separate Signal Face (MUTCD Section 4F.15)

Standard. A separate right-turn signal face shall not be used for an approach that does not include a mandatory right-turn lane.

If a separate right-turn signal face is being operated in a protected/permissive right-turn mode, a CIRCULAR GREEN signal indication shall not be used in that face.

If a separate right-turn signal face is being operated in a protected/permissive right-turn mode and a flashing right-turn yellow arrow signal indication is provided, it shall meet the following requirements (see Figure 902.6.15):

A. It shall be capable of displaying one of the following sets of signal indications:

1. Steady right-turn RED ARROW, steady right-turn YELLOW ARROW, flashing right-turn YELLOW ARROW, and right-turn GREEN ARROW. Only one of the four indications shall be displayed at any given time.
2. Steady CIRCULAR RED, steady right-turn YELLOW ARROW, flashing right-turn YELLOW ARROW, and right-turn GREEN ARROW. Only one of the four indications shall be displayed at any given time. If the CIRCULAR RED signal indication is sometimes displayed when the signal faces for the adjacent through lane(s) are not displaying a CIRCULAR RED signal indication, a RIGHT TURN SIGNAL (R10-10R) sign (see EPG 903.2.48) shall be used unless the CIRCULAR RED signal indication in the separate right-turn signal face is shielded, hooded, louvered, positioned, or designed such that it is not readily visible to drivers in the through lane(s).

B. During the protected right-turn movement, a right-turn GREEN ARROW signal indication shall be displayed.
C. A steady right-turn YELLOW ARROW signal indication shall be displayed following the right-turn GREEN ARROW signal indication. It shall be permitted to display a steady right-turn RED ARROW signal indication immediately following the steady right-turn YELLOW ARROW signal indication to provide a red clearance interval.
D. During the permissive right-turn movement, a flashing right-turn YELLOW ARROW signal indication shall be displayed.
E. A steady right-turn YELLOW ARROW signal indication shall be displayed following the flashing right-turn YELLOW ARROW signal indication if the permissive right-turn movement is being terminated and the separate right-turn signal face will subsequently display a steady red indication.
F. When a permissive right-turn movement is changing to a protected right-turn movement:

1. If a permissive left-turn movement from the opposing approach is being terminated simultaneously with the termination of the permissive right-turn movement, a steady right-turn YELLOW ARROW signal indication shall be displayed following the flashing right-turn YELLOW ARROW signal indication. To provide a red clearance interval, it shall be permitted to display a steady right-turn RED ARROW signal indication immediately following the steady right-turn YELLOW ARROW signal indication.
2. If a permissive left-turn movement from the opposing approach that is being terminated simultaneously with the termination of the permissive right-turn movement is not present, a right-turn GREEN ARROW signal indication shall be displayed immediately upon the termination of the flashing right-turn YELLOW ARROW signal indication. In this situation, a steady right-turn YELLOW ARROW signal indication shall not be displayed between the display of the flashing right-turn YELLOW ARROW signal indication and the display of the steady right-turn GREEN ARROW signal indication.

G. When the separate right-turn signal face is providing a message to stop and remain stopped, a steady right-turn RED ARROW signal indication shall be displayed if it is intended that right turns on red not be permitted (except when a traffic control device is in place permitting a turn on a steady RED ARROW signal indication) or a steady CIRCULAR RED signal indication shall be displayed if it is intended that right turns on red be permitted.

H. It shall be permitted to display a flashing right-turn YELLOW ARROW signal indication for a permissive right-turn movement while the signal faces for the adjacent through movement display steady CIRCULAR RED signal indications.

I. The display shall be a four-section signal face with the steady right-turn YELLOW ARROW signal indication being displayed in a different section than the flashing right-turn YELLOW ARROW signal indication.

J. During steady mode (stop-and-go) operation the signal section that displays the steady right-turn YELLOW ARROW signal indication during change intervals shall not be used to display the flashing right-turn YELLOW ARROW signal indication for permissive right turns.

K. During flashing mode operation (see EPG 902.7) the display of a flashing right-turn YELLOW ARROW signal indication shall be only from the signal section that displays a steady right-turn YELLOW ARROW signal indication during steady mode (stop-and-go) operation.

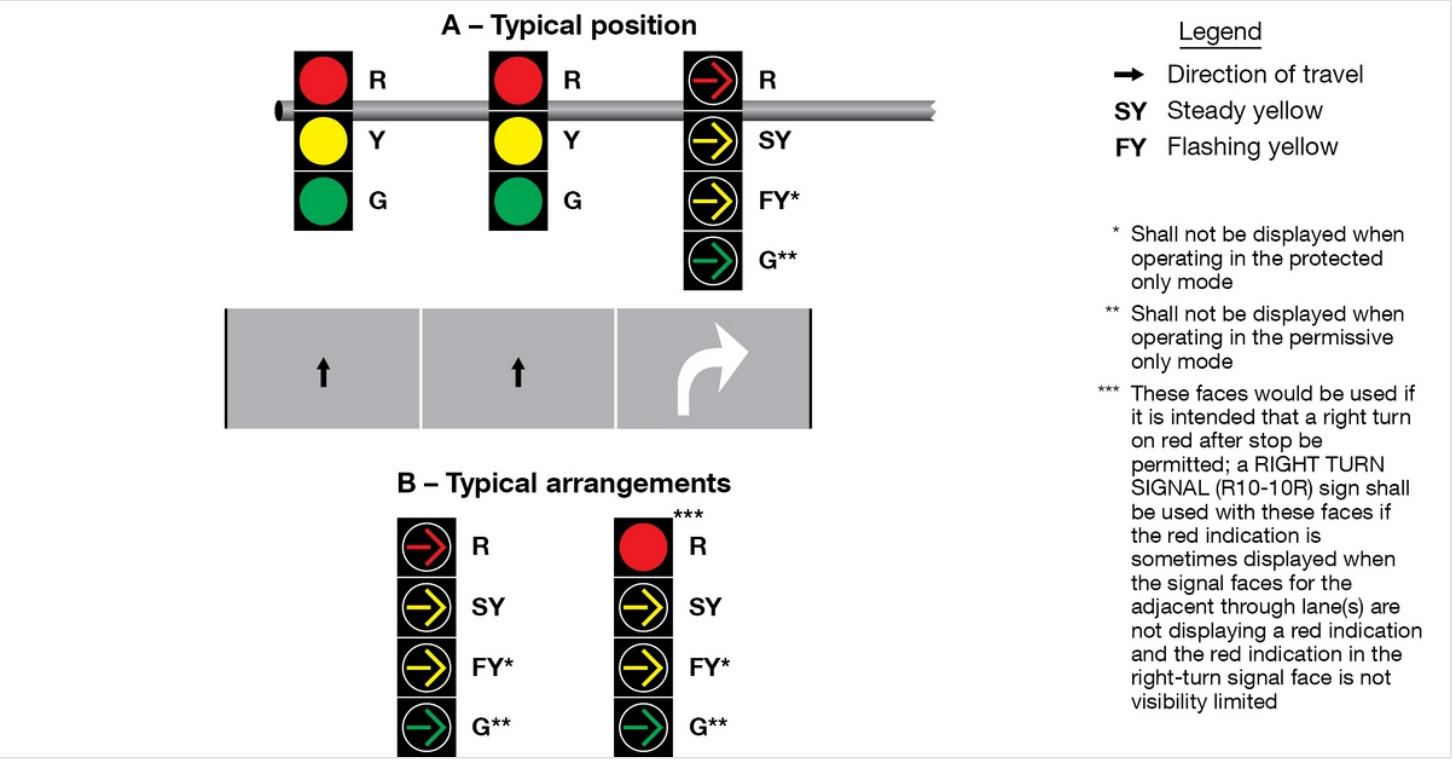


Figure 902.6.15 Typical Position and Arrangements of Separate Signal Faces with Flashing Yellow Arrow for Protected/Permissive Mode and Variable Mode Right Turns

902.6.16 Signal Indications for Approaches with No Through Movement (MUTCD Section 4F.16)

Support. The provisions of this Article apply only to approaches where no through movement exists, such as the stem of a T-intersection or where the opposite approach is a one-way roadway in the opposing direction.

Standard. Except for single-lane approaches, a minimum of two primary signal faces shall be provided for the signalized turning movement that is considered to be the major movement from the approach (see EPG 902.4.5). CIRCULAR GREEN and CIRCULAR YELLOW signal indications shall not be displayed to an approach with no through movement if:

A. The posted or statutory speed limit on the approach is 35 mph or higher,
B. The one-way roadway that opposes the approach is an exit ramp from a freeway or expressway, or
C. The one-way roadway that opposes the approach has a posted or statutory speed limit of 35 mph or higher.

Support. A lane from which left-turn and right-turn movements can both be made is sometimes provided on an approach that has no through movement, either as the only approach lane or as one of several approach lanes.

Option. If all of the lanes on the approach are designated as mandatory turn lanes and no lane is designated as a combined left-turn/right-turn lane, the left-turn and right-turn movements may start and terminate independently, and the left-turn and right-turn movements each may be operated in one or more of the modes of operation as described in EPG 902.6.2 through 902.6.15.

Standard. When a combined left-turn/right-turn lane exists on an approach, the left-turn and right-turn movements shall start and terminate simultaneously and the red signal indication used in each of the signal faces on the approach shall be a CIRCULAR RED.

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Support. This requirement for the use of CIRCULAR RED signal indications in signal faces for approaches having a combined lane for left-turn and right-turn movements is a specific exception to other provisions in this Article that would otherwise require the use of RED ARROW signal indications.

Standard. The signal faces provided for an approach with a combined left-turn/right-turn lane and no through movement shall be one of the following:

A. Except as provided in the second option paragraph of EPG 902.6.1 and the second standard paragraph of this Article, two or more signal faces, each capable of displaying CIRCULAR RED, CIRCULAR YELLOW, and CIRCULAR GREEN signal indications, shall be provided for the approach. This display shall be permissible regardless of the number of mandatory left-turn and/or right-turn lanes that exist on the approach in addition to the combined left-turn/right-turn lane and regardless of whether or not there are pedestrian or opposing vehicular movements that conflict with the left-turn or right-turn movements. However, if there is an opposing approach and the signal phasing protects the left-turn movement on the approach with the combined left-turn/right-turn lane from conflicts with the opposing vehicular movements and any signalized pedestrian movements, a left-turn GREEN ARROW signal indication shall also be included in the left-most signal face and shall be displayed simultaneously with the CIRCULAR GREEN signal indication.
B. If the approach has one or more mandatory turn lanes in addition to the combined left-turn/right-turn lane and there is no conflict with a signalized vehicular or pedestrian movement, and GREEN ARROW signal indications are used in place of CIRCULAR GREEN signal indications on the approach, the signal faces for the approach shall be:

1. A signal face(s) capable of displaying CIRCULAR RED, YELLOW ARROW, and GREEN ARROW signal indications for the mandatory turn lane(s), with the arrows pointing in the direction of the turn, and
2. A shared left-turn/right-turn signal face capable of displaying CIRCULAR RED, left-turn YELLOW ARROW, left-turn GREEN ARROW, right-turn YELLOW ARROW, and right-turn GREEN ARROW signal indications, in an arrangement of signal sections that complies with the provisions of EPG 902.5.4 or EPG 902.5.5.

C. If the approach has one or more mandatory turn lanes in addition to the combined left-turn/right-turn lane and there is a conflict with a signalized vehicular or pedestrian movement, and flashing YELLOW ARROW signal indications are used in place of CIRCULAR GREEN signal indications on the approach, the signal faces for the approach shall be as described in Items B.1 and B.2 of this Paragraph, except that flashing YELLOW ARROW signal indications shall be used in place of the GREEN ARROW signal indications for the turning movement(s) that conflicts with the signalized vehicular or pedestrian movement.

Support. Figure 902.6.16.1, Figure 902.6.16.2, and Figure 902.6.16.3 illustrates application of these Standards on approaches that have only a combined left-turn/right-turn lane, and on approaches that have one or more mandatory turn lanes in addition to the combined left-turn/right-turn lane.

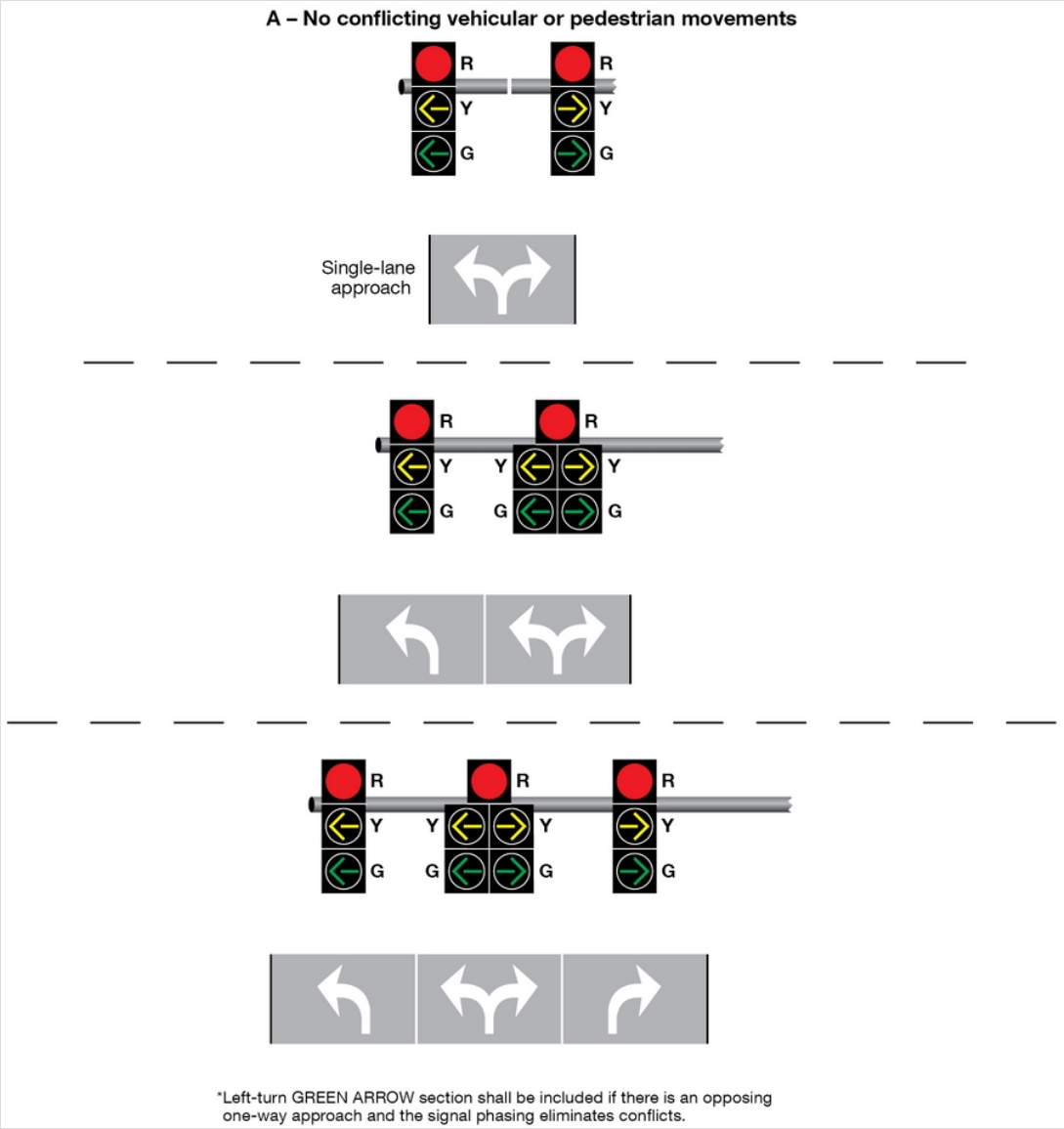


Figure 902.6.16.1 Signal Indications for Approaches with a Combined Left-Turn/Right-Turn Lane and No Through Movement *(Sheet 1 of 3)*

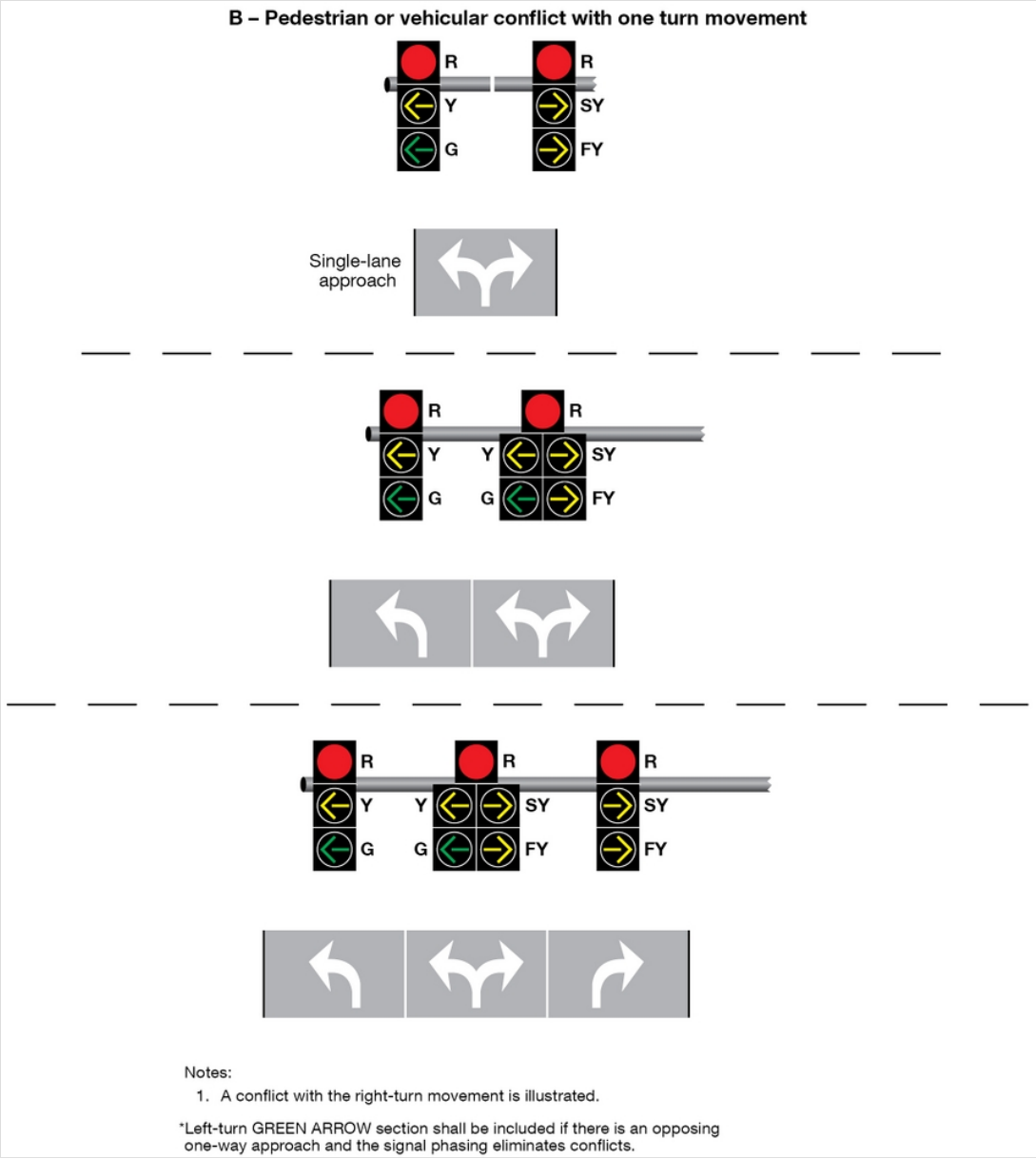


Figure 902.6.16.2 Signal Indications for Approaches with a Combined Left-Turn/Right-Turn Lane and No Through Movement *(Sheet 2 of 3)*

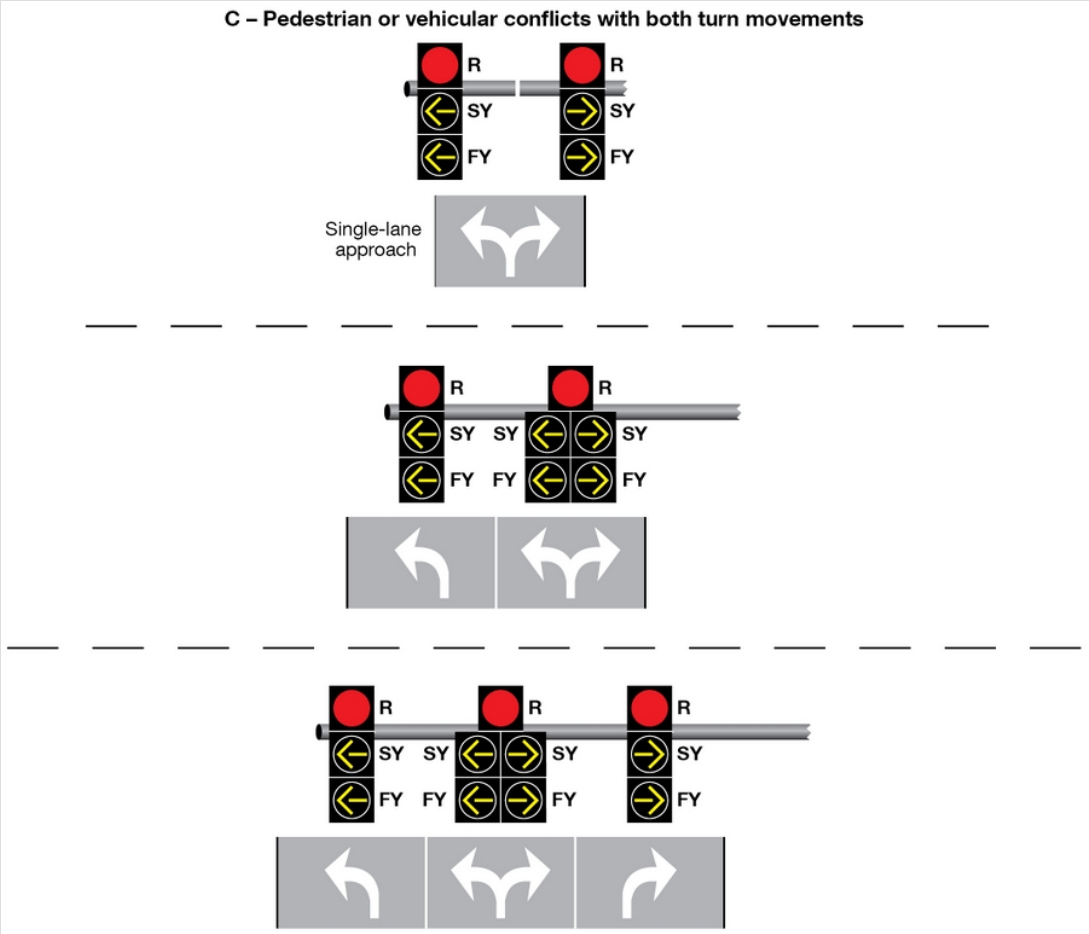


Figure 902.6.16.3 Signal Indications for Approaches with a Combined Left-Turn/Right-Turn Lane and No Through Movement *(Sheet 3 of 3)*

902.6.17 Yellow Change and Red Clearance Intervals (MUTCD Section 4F.17)

Support. The exclusive function of the yellow change interval is to warn traffic approaching a signalized location that their permission to proceed is being terminated after which they will be directed to stop, or in the case of a protected/permissive turning movement that their protected movement is being terminated after which they will need to perform their turn in a permissive manner.

Standard. A steady yellow signal indication shall be displayed following every CIRCULAR GREEN or GREEN ARROW signal indication and following every flashing YELLOW ARROW signal indication displayed as a part of a steady mode operation. This requirement shall not apply when a CIRCULAR GREEN, a flashing YELLOW ARROW signal indication is followed immediately by a GREEN ARROW signal indication.

The duration of the yellow change interval shall be determined using engineering practices.

Support. See EPG 902.23.7.2 when determining the yellow change interval.

EPG 902.6.1 contains provisions regarding the display of steady CIRCULAR YELLOW signal indications to approaches from which drivers are allowed to make permissive left turns.

Standard. When indicated by the application of engineering practices, the yellow change interval shall be followed by a red clearance interval to provide additional time before conflicting traffic movements, including pedestrians, are released.

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When used, the duration of the red clearance interval shall be determined using engineering practices.

Support. See EPG 902.23.7.2 when determining the duration of the red clearance interval.

Standard. The durations of yellow change intervals and red clearance intervals shall be consistent with the determined values within the technical capabilities of the controller unit.

The duration of a yellow change interval shall not vary on a cycle-by-cycle basis within the same signal timing plan.

Except as provided in the third option paragraph of this Article, the duration of a red clearance interval shall not be decreased or omitted on a cycle-by-cycle basis within the same signal timing plan.

Option. The duration of a red clearance interval may be extended from its predetermined value for a given cycle based upon the detection of a vehicle that is predicted to violate the red signal indication.

When an actuated signal sequence includes a signal phase for permissive/protected (lagging) left-turn movements in both directions, the red clearance interval may be shown during those cycles when the lagging left-turn signal phase is skipped and may be omitted during those cycles when the lagging left-turn signal phase is shown.

The duration of a yellow change interval or a red clearance interval may be different in different signal timing plans for the same controller unit.

Standard. The yellow change interval shall not be less than three seconds.

Guidance. A yellow change interval should have a maximum duration of 6 seconds. The longer intervals should be reserved for use on approaches with higher speeds. Except when clearing a one-lane, two-way facility (see EPG 902.15.2) or when clearing an exceptionally wide intersection, a red clearance interval should have a duration not exceeding 6 seconds.

Standard. Except for Warning Beacons mounted on advance warning signs on the approach to a signalized location (see EPG 903.3.29), signal displays that are intended to provide a “pre-yellow warning” interval, such as flashing green signal indications, vehicular countdown displays, or other similar displays, shall not be used at a signalized location.

Support. The use of signal displays (other than Warning Beacons mounted on advance warning signs) that convey a “pre-yellow warning” have been found by research to increase the frequency of crashes.

902.6.18 Preemption and Priority Control of Traffic Control Signals – General (MUTCD Section 4F.18)

Option. Traffic control signals may be designed and operated to respond to certain classes of approaching vehicles by altering the normal signal timing and phasing plan(s) during the approach and passage of those vehicles. The alternative plan(s) may be as simple as extending a currently displayed green interval or as complex as replacing the entire set of signal phases and timing.

Support. Some types or classes of vehicles supersede others when a traffic control signal responds to more than one type or class. In general, a vehicle that is more difficult to control supersedes a vehicle that is easier to control.

Option. Preemption or priority control of traffic control signals may also be a means of indicating to specified classes of vehicles at certain non-intersection locations, such as on approaches to one-lane bridges and tunnels, highway maintenance and construction activities, metered freeway entrance ramps, and transit operations, that they are permitted to proceed.

Guidance. When a traffic control signal that is returning to a steady mode from a dark mode (typically upon restoration from a power failure) receives a preemption or priority request, care should be exercised to minimize the possibility of vehicles or pedestrians being misdirected into a conflict with the vehicle making the request.

Option. During the change from a dark mode to a steady mode under a preemption or priority request, the display of signal indications that could misdirect road users may be prevented by one or more of the following methods:

A. Having the traffic control signal remain in the dark mode,
B. Having the traffic control signal remain in the flashing mode,
C. Altering the flashing mode,
D. Executing the normal start-up routine before responding, or
E. Responding directly to initial or dwell period.

Guidance. Traffic control signals operating under preemption control or under priority control should be operated in a manner designed to keep traffic moving.

Traffic control signals that are designed to respond under preemption or priority control to more than one type or class of vehicle should be designed to respond in the relative order of importance or difficulty in stopping the type or class of vehicle. The order of priority should be: train, heavy vehicle (fire vehicle, emergency medical service), light vehicle (law enforcement), light rail transit, rubber-tired transit.

Option. If engineering judgment indicates that light rail transit signal indications would reduce road user confusion that might otherwise occur if standard traffic signal indications were used to control these movements, light rail transit signal indications complying with EPG 913.4.15 and as illustrated in Figure 913.4.15 may be used for preemption or priority control of the following exclusive movements at signalized intersections

A. Public transit buses in “queue jumper” lanes, and
B. Public transit buses in semi-exclusive or mixed-use alignments.

Guidance. LRT signals are not currently used on MoDOT facilities. When considering the use of LRT signals the Highway Safety and Traffic Division should be contacted for guidance.

902.6.19 Preemption Control of Traffic Control Signals (MUTCD Section 4F.19)

Support. Preemption control (see definition in EPG 911 (MUTCD Section 1C.02)) is typically given to trains, boats, emergency vehicles, and light rail transit. Examples of preemption control include the following:

A. The prompt displaying of green signal indications at signalized locations ahead of fire vehicles, law enforcement vehicles, ambulances, and other official emergency vehicles;
B. A special sequence of signal phases and timing to expedite and/or provide additional clearance time for vehicles to clear the tracks prior to the arrival of rail traffic; and
C. A special sequence of signal phases to display a steady red indication to prohibit turning movements toward the tracks during the approach or passage of rail traffic.

Standard. During the transition into preemption control, the yellow change interval, and any red clearance interval that follows, shall not be shortened or omitted.

Option. During the transition into preemption control:

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A. Any pedestrian walk interval and/or pedestrian change interval may be shortened or omitted only when the traffic control signal is being preempted because rail traffic is approaching a grade crossing.
B. The red clearance interval, if any, may be omitted so that the return to the previous green signal indication follows a steady yellow signal indication in the same signal face.

Standard. During preemption control and during the transition out of preemption control:

A. Any yellow change interval, and any red clearance interval that follows, shall not be shortened or omitted.
B. A signal indication sequence from a steady yellow signal indication to a green signal indication shall not be permitted.

Guidance. Except for traffic control signals interconnected with light rail transit systems, traffic control signals with railroad preemption or coordinated with flashing-light signal systems should be provided with a back-up power supply.

If a traffic control signal or hybrid beacon is installed near or within a grade crossing or if a grade crossing with active traffic control devices is within or near a signalized highway intersection, EPG 913.4 should be consulted.

Support. EPG 913.4.9 contains additional information regarding preemption for grade crossings. EPG 913.4.10 contains information regarding prohibiting movements toward the grade crossing during preemption. EPG 913.4.11 and EPG 913.4.12 contain additional information regarding pre-signals and queue cutter signals, respectively, for grade crossings.

902.6.20 Priority Control of Traffic Control Signals (MUTCD Section 4F.20)

Support. Priority control (see definition in EPG 911 (MUTCD Section 1C.02)) is typically given to certain non-emergency vehicles such as light-rail transit vehicles operating in a mixed-use alignment and buses. Examples of priority control include the following:

A. The displaying of early or extended green signal indications at an intersection to assist public transit vehicles improve operations, and
B. Special phasing to assist public transit vehicles in entering the travel stream ahead of other waiting traffic.

Standard. During priority control and during the transition into or out of priority control:

A. The shortening or omission of any yellow change interval, and of any red clearance interval that follows, shall not be permitted.
B. The shortening of any pedestrian walk interval below that time described in EPG 902.9.6 shall not be permitted.
C. The omission of a pedestrian walk interval and its associated change interval shall not be permitted unless the associated vehicular phase is also omitted or the pedestrian phase is exclusive.
D. The shortening or omission of any pedestrian change interval shall not be permitted.
E. A signal indication sequence from a steady yellow signal indication to a green signal indication shall not be permitted.

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902.7 Flashing Operation of Traffic Control Signals (MUTCD Chapter 4G)

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902.7.1 Flashing Operation of Traffic Control Signals – General (MUTCD Section 4G.01)
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902.7.4 Flashing Operation – Transition Out of Flashing Mode (MUTCD Section 4G.04)

902.7.1 Flashing Operation of Traffic Control Signals – General (MUTCD Section 4G.01)

Standard. The light source of a flashing signal indication shall be flashed continuously at a rate of not less than 50 or more than 60 times per minute.

The displayed period of each flash shall be a minimum of ½ and a maximum of ⅔ of the total flash cycle.

Flashing signal indications shall comply with the requirements of other Sections of this Manual regarding visibility limiting or positioning of conflicting signal indications, except that flashing yellow signal indications for through traffic shall not be required to be visibility limited or positioned to minimize visual conflict for road users in separately-controlled turn lanes.

Each traffic control signal shall be provided with an independent flasher mechanism that operates in compliance with this Article.

A manual switch shall be provided to initiate the flashing mode. A conflict monitor (malfunction management unit) circuit and, if appropriate, an automatic means shall also be provided to initiate the flashing mode.

The flashing operation shall not be terminated by removing or turning off the controller unit or the conflict monitor (malfunction management unit) or both.

Support. There are two types of flashing operation:

A. All-direction cabinet flash – This type of flashing operation is initiated by the cabinet. The cabinet can be put to flash via a manual switch, or if the signalized intersection is operating inappropriately via a conflict monitor (malfunction monitoring unit).
B. All-direction programmed flash – This type of flash operation is programmed into the controller to flash the signal during specific times every day.

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Standard. All-direction cabinet flash is permitted to be made at any time.

Actuated intersections shall run steady (stop-and-go) mode at all times and shall not utilize all-direction programmed flash, except for school signals as covered in EPG 902.11.3. For pretimed intersections, every effort shall be made to upgrade the signalized intersection from pretimed to actuated operation.

Guidance. Several factors should be used with good engineering judgment when making the decision to implement all-direction programmed flashing operation for pretimed intersections. Among these is crash history, presence of pedestrian signal indications, and sight distance. If correctable crashes were a significant factor in the justification for installation of the signal, then all-direction flashing operation should not be acceptable at any time.

Standard. If stopping sight distance is below the values listed in Table 903.3.1, then flashing operation shall not be considered.

Guidance. Fully actuated signals within a coordinated system should be analyzed for possible free operation when other signals within the system are operating in all-direction programmed flash.

Support. An in-house MoDOT safety study identified that crashes at locations with late night/early morning flash tend to occur before 2 a.m. and in FHWA's publication Signalized Intersections: Informational Guide (FHWA-HRT-04-091), it was found that an estimated 78% reduction in right-angle collisions and an estimated 32% reduction in all collisions can be expected with the removal from late night/early morning flash mode.

EPG 902.9.6 and 902.11.4 contain information regarding the operation of pedestrian signal heads and accessible pedestrian signal detector push button locator tones, respectively, during flashing operation.

902.7.2 Flashing Operation – Transition Into Flashing Mode (MUTCD Section 4G.02)

Option. The transition from steady (stop-and-go) mode to flashing mode, if initiated by a conflict monitor (malfunction management unit) or by a manual switch, may be made at any time it is in fail-safe operation.

Standard. Programmed changes from steady (stop-and-go) mode to flashing mode shall be made under either of the following circumstances:

> A. At the end of the common major-street red interval (such as just prior to the start of the green in both directions on the major street), or
> B. Directly from a CIRCULAR GREEN signal indication to a flashing CIRCULAR YELLOW signal indication, or from a GREEN ARROW signal indication to a flashing YELLOW ARROW signal indication, or from a flashing YELLOW ARROW signal indication (see EPG 902.6.2, 902.6.4, 902.6.8, 902.6.9, 902.6.11, and 902.6.15) to a flashing YELLOW ARROW signal indication in a different signal section.

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During programmed changes into flashing mode, no green signal indication or flashing yellow signal indication shall be terminated and immediately followed by a steady red or flashing red signal indication without first displaying the steady yellow signal indication.

902.7.3 Flashing Operation – Signal Indications During Flashing Mode (MUTCD Section 4G.03)

Guidance. When a traffic control signal is operated in the flashing mode, there are two possible types of operation:

> A. Yellow-red flashing mode: For intersections where traffic volumes during flashing operation on the major street are significantly greater than traffic volumes on the minor street, a flashing yellow signal indication should be used for the major street and a flashing red signal indication should be used for the other approaches.
> B. Red-red flashing mode: For intersections where traffic volumes during flashing operation on all approaches are approximately equal, a flashing red signal indication should be used for all approaches. Complex intersections (5-leg, large widths, multiple dual left turn approaches) also operate with red indications for all approaches during flashing operation, regardless of traffic volumes.

When a system of interconnected signals is flashed, care should be taken to be consistent in flash color for the major street so as not to violate driver expectancy.

Support. A red/red flashing signal in the middle of a system of yellow/red flashing signals could lead to violations of the flashing red along the major street due to the expectancy of yellow flashing indications.

Fail-safe operation for a malfunctioning signal leads to all-direction flashing operation when tripped by a conflict monitor. Cabinet wiring determines all-direction flashing operation when a malfunction has occurred; this generally means malfunction flash will be red-red mode since it is wired the same as the start up from dark flash (see EPG 902.23.9).

Standard. When a traffic control signal is operated in the flashing mode, all of the green signal indications at the signalized location shall be dark (non-illuminated) and shall not be displayed in either a steady or flashing manner, except for single-section GREEN ARROW signal indications as provided in the fourth standard paragraph of this Article.

Flashing yellow signal indications shall be used on more than one approach to a signalized location only if those approaches do not conflict with each other.

When a traffic control signal is operated in the flashing mode, one and only one signal indication in every signal face at the signalized location shall be flashed.

No steady indications, other than a single-section signal face consisting of a continuously-displayed GREEN ARROW signal indication that is used alone to indicate a continuous movement in the steady (stop-and-go) mode, shall be displayed at the signalized location during the flashing mode. A single-section GREEN ARROW signal indication shall remain continuously displayed when the traffic control signal is operated in the flashing mode.

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If a signal face includes both circular and arrow signal indications of the color that is to be flashed, only the circular signal indication shall be flashed.

All signal faces that are flashed on an approach shall flash the same color, either yellow or red, except that separate turn signal faces (see EPG 902.6.4, 902.6.6, 902.6.8, 902.6.11, 902.6.13, and 902.6.15) shall be permitted to flash a RED ARROW signal indication when the adjacent through movement signal indications are flashed yellow. Shared signal faces (see EPG 902.6.3, 902.6.5, 902.6.7, 902.6.10, 902.6.12, and 902.6.14) for turn movements shall not be permitted to flash a CIRCULAR RED signal indication when the adjacent through movement signal indications are flashed yellow.

The appropriate RED ARROW or YELLOW ARROW signal indication shall be flashed when a signal face consists entirely of arrow indications. A signal face that consists entirely of arrow indications and that provides a protected only turn movement during the steady (stop-and-go) mode or that provides a flashing YELLOW ARROW signal indication for a permissive turn movement during the steady (stop-and-go) mode shall be permitted to flash the YELLOW ARROW signal indication during the flashing mode if the adjacent through movement signal indications are flashed yellow and if it is intended that a permissive turn movement not requiring a full stop by each turning vehicle be provided during the flashing mode.

Guidance. For dual or protected-only left turns programmed to flash, the indications should flash yellow arrow when the phasing was determined based on high traffic volumes. When the phasing was determined for intersection safety, the indications for the left turn should flash red.

Whether the signal flashes by cabinet wiring or controller programming, all signal indications should not flash simultaneously.

Support. Flashing all signal indications simultaneously causes a severe load fluctuation that reduces the life of the electrical equipment and can lead to malfunctions when the signal is in operation.

902.7.4 Flashing Operation – Transition Out of Flashing Mode (MUTCD Section 4G.04)

Standard. All changes from flashing mode to steady (stop-and-go) mode shall be made under one of the following procedures:

A. Yellow-red flashing mode: Changes from flashing mode to steady (stop-and-go) mode shall be made at the beginning of the major-street green interval (when a green signal indication is displayed to through traffic in both directions on the major street), or if there is no common major-street green interval, at the beginning of the green interval for the major traffic movement on the major street.
B. Red-red flashing mode: Changes from flashing mode to steady (stop-and-go) mode shall be made by changing the flashing red indications to steady red indications followed by appropriate green indications to begin the steady mode cycle. These green indications shall be the beginning of the major-street green interval (when a green signal indication is displayed to through traffic in both directions on the major street) or if there is no common major-street green interval, at the beginning of the green interval for the major traffic movement on the major street.

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The steady red clearance interval provided during the change from red-red flashing mode to steady (stop-and-go) mode shall have a minimum duration of 6 seconds.

When changing from the yellow-red flashing mode to steady (stop-and-go) mode at a location where there is a common major-street green interval, the flashing red signal indications for the minor street shall immediately change to steady red signal indications, and the flashing yellow signal indications for the through movements on the major street shall change to green signal indications in both directions (after the minor-street signal indications have been steady red for a short time, if desired), or the flashing yellow signal indications for the through movements on the major street shall change to steady yellow signal indications followed by a steady red clearance interval before changing to green signal indications in both directions.

Guidance. When changing from the yellow-red flashing mode to steady (stop-and-go) mode at a location where there is no common major-street green interval, the flashing red signal indications for the minor street should immediately change to steady red signal indications, and the flashing yellow signal indications for the through movements on the major street should change to steady yellow signal indications followed by a steady red clearance interval before changing to green signal indications for the major traffic movement on the major street.

Standard. During programmed changes out of flashing mode, no flashing yellow signal indication shall be terminated and immediately followed by a steady red or flashing red signal indication without first displaying a steady yellow signal indication.

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902.8 Bicycle Signals (MUTCD Chapter 4H)

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902.8.1 Use of Bicycle Signal Faces (MUTCD Section 4H.01)

Guidance. Bicycle signals are not currently used on MoDOT facilities. When considering the use of bicycle signals, the Highway Safety and Traffic Division should be contacted for guidance.

Option. A bicycle signal face may be used to provide separate control bicyclist movements for various situations, including the following:

A. To provide a protected bicycle signal phase or a leading or lagging bicycle interval;
B. To continue a through bicycle lane on the right-hand side of a mandatory right-turn lane (or on the left-hand side of a mandatory left-turn lane) that would otherwise be in non-compliance with the first paragraph of EPG 914.5.2 or the seventh paragraph of EPG 914.5.6;
C. To provide a bicycle interval for a counter-flow bicycle facility; or
D. To provide for unusual or unexpected arrangements of the bicyclist movement through complex intersections, conflict areas, or signal control.

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A bicycle signal face may be used at a mid-block traffic control signal where there are no motor vehicle movements parallel to the bicycle crossing.

Support. EPG 902.3 contains information on warrants for the installation of a new traffic control signal.

Guidance. The decision as to whether to incorporate a bicycle signal face(s) into a new traffic control signal design should be made during the engineering study performed in accordance with the first standard paragraph of EPG 902.3.1.

Engineering judgment should be exercised in determining whether or not it would be advantageous or beneficial to install a bicycle signal face(s) at an existing traffic control signal.

Support. Retrofitting existing circular traffic signals that are operated as bicycle signal faces with bicycle symbol signal faces is analogous to retrofitting existing traffic signals with pedestrian signals where such a determination is not required through an engineering study.

For the purpose of warrant analyses, provisions for classifying bicycles are provided in the fifth option paragraph of EPG 902.3.1 and the second paragraph of EPG 914.6.1.

Standard. If used, a bicycle signal face shall only be used to control bicyclist movements from a designated bicycle lane or from a separate facility, such as a shared-use path.

If used, a bicycle signal face shall only be used to control bicyclist movements where bicyclists moving on a GREEN BICYCLE or YELLOW BICYCLE signal indication are not in conflict with any simultaneous motor vehicle movement at the signalized location, including right (or left) turns on red.

Guidance. If used where motor vehicle traffic can make the same movements as bicyclists, a bicycle signal face should only be used if the bicyclist movement controlled by the bicycle signal face is sometimes allowed to proceed or sometimes required to stop at times when motor vehicle traffic, making the same movement and controlled by other vehicular signal faces, is required to stop or allowed to proceed, respectively.

902.8.2 Prohibited Uses of Bicycle Signal Faces (MUTCD Section 4H.02)

Standard. Bicycle signal faces shall not be used to control conflicting bicyclist movements from perpendicular or nearly perpendicular directions.

Bicycle signal faces shall not be used for controlling any bicyclist movement that is sharing an approach lane with motor vehicle traffic.

Bicycle signal faces shall not be used in any manner with respect to the design and operation of a hybrid beacon.

902.8.3 Bicycle Signal Signs (MUTCD Section 4H.03)

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Support. The primary purposes of the Bicycle Signal (R10-40, R10-40a, R10-41, R10-41a, R10-41b) sign (see EPG 914.2.10) are to inform road users that the signal indications in the bicycle signal face are intended only for bicyclists and to inform bicyclists which specific bicyclist movements are controlled by the bicycle signal face.

Standard. Except as provided in the subsequent paragraph, a Bicycle Signal (R10-40, R10-40a, R10-41, R10-41a, or R10-41b) sign shall be installed immediately adjacent to (including above or below) every bicycle signal face. The Bicycle Signal sign shall have a minimum size of 24 inches x 36 inches if it is placed next to an overhead-mounted bicycle signal face and shall have a minimum size of 12 inches x 21 inches if it is placed next to a post-mounted bicycle signal face.

Option. The Bicycle Signal sign may be omitted adjacent to a supplemental near-side bicycle signal face containing 4-inch indications.

902.8.4 Application of Bicycle Symbol Signal Indications during Steady (Stop-and-Go) Operation (MUTCD Section 4H.04)

Standard. Steady bicycle symbol signal indications shall be applied as follows:

A. A steady RED BICYCLE signal indication shall be displayed when it is intended to prohibit bicyclists in a designated bicycle lane or from a separate facility such as a shared-use path from entering the intersection or other controlled area. Turning after stopping shall be permitted as stated in Item C in the first Standard paragraph of EPG 902.1.5.

B. A steady YELLOW BICYCLE signal indication shall be displayed following a GREEN BICYCLE signal indication in the same bicycle signal face. A YELLOW BICYCLE signal indication shall not be displayed in conjunction with the change from the RED BICYCLE signal indication to a GREEN BICYCLE signal indication. The YELLOW BICYCLE signal indication shall be followed by a RED BICYCLE signal indication.

C. A steady GREEN BICYCLE signal indication shall be displayed only when it is intended to permit bicyclists in a designated bicycle lane or from a separate facility such as a shared-use path to enter the intersection as discussed in EPG 902.1.5.

902.8.5 Application of Bicycle Symbol Signal Indications during Flashing Operation (MUTCD Section 4H.05)

Standard. The mode of operation of the bicycle signal faces at a traffic control signal shall be the same as the mode of operation of the other traffic signal faces at the same signalized location. Bicycle signal faces shall operate in the steady (stop-and-go) mode when the other traffic signal faces are operating in the steady (stop-and-go) mode. Bicycle signal faces shall operate in the flashing mode when the other signal faces are operating in the flashing mode. Bicycle signal faces shall not be placed in a dark mode when other vehicular traffic signal faces are operating in the flashing mode.

Guidance. When a traffic control signal is operated in the flashing mode, bicycle signal faces should display a flashing RED BICYCLE signal indication if the other vehicular signal faces on the same approach are displaying flashing red signal indications or if there are no other vehicular signal faces

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on the same approach.

When a traffic control signal is operated in the flashing mode, bicycle signal faces should display a flashing YELLOW BICYCLE signal indication if the other vehicular signal faces for the through lanes on the same approach are displaying flashing yellow signal indications unless it is determined by engineering judgment that a flashing RED BICYCLE signal indication would provide a safer operation.

902.8.6 Layout of Bicycle Signal Faces (MUTCD Section 4H.06)

Standard. Bicycle signal faces shall consist of all bicycle symbol signal indications (see Figure 902.8.6). Circular or arrow signal indications shall not be used in a bicycle signal face.

Option. Bicycle signal faces may be oriented vertically or horizontally.

Standard. The layouts and arrangements of the bicycle signal face shall be in accordance with the following provisions:

A. Only the bicycle symbol shown on Page 6-7 in the FHWA 2004 Standard Highway Signs publication (see EPG 911 (MUTCD Section 1A.05)) shall be used for bicycle symbol signal indications and shall be proportioned to fit within the signal lens. The bicycle symbol shall only be positioned horizontally and shall face to the left.

B. The RED BICYCLE, YELLOW BICYCLE, and GREEN BICYCLE signal indications shall be in the same relative position to each other as specified for the CIRCULAR RED, CIRCULAR YELLOW, and CIRCULAR GREEN signal indications, respectively, in EPG 902.5.4 and EPG 902.5.5.

C. As a specific exception to the first option paragraph of EPG 902.5.4, two YELLOW BICYCLE signal indications or two GREEN BICYCLE signal indications shall not be arranged horizontally adjacent to each other at right angles to the basic straight line arrangement to form a clustered signal face.

Option. Backplates (see the second support paragraph and tenth standard paragraph of EPG 902.4.6) may be used with bicycle signal faces.

If a bicycle signal face having 4-inch signal indications is used, the accompanying visors may be omitted.

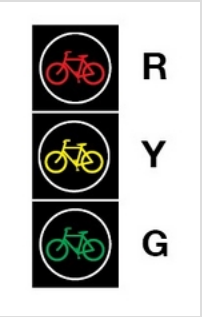


Figure 902.8.6 Typical Arrangements of Bicycle Signal Faces

902.8.7 Size of Bicycle Symbol Signal Indications (MUTCD Section 4H.07)

Standard. There shall be three nominal diameter sizes for bicycle signal indications: 4 inches, 8 inches, and 12 inches.

All signal indications to be maintained by MoDOT shall be 12 inches.

All signal indications in a bicycle signal face shall be of the same size.

Four-inch signal indications shall not be used for any bicycle signal face other than a supplemental, post-mounted, near-side bicycle signal face.

902.8.8 Placement of Bicycle Signal Faces (MUTCD Section 4H.08)

Standard. The provisions of EPG 902.4.5 through EPG 902.4.8 shall apply to the placement of the bicycle signal faces except as follows:

> A. As a specific exception to Item A in the first standard paragraph of EPG 902.4.5, a minimum of one primary bicycle signal face shall be provided to control traffic for the bicyclist movement, even if a bicyclist through movement exists.
>
> B. The primary bicycle signal face shall have either 8-inch or 12-inch signal indications, even if it is located at the near side of the signal-controlled location.
>
> C. When the primary bicycle signal face is located more than 120 feet beyond the stop line, a supplemental near-side bicycle signal face shall be provided.

Guidance. When the primary bicycle signal face is located more than 80 feet and up to 120 feet beyond the stop line, a supplemental near-side bicycle signal face should be provided.

A bicycle signal face should be separated horizontally or vertically from the nearest vehicular traffic signal face for the same approach by at least 3 feet measured either horizontally perpendicular to the approach between the centers of the signal faces or vertically from the center of the lowest signal

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indication of the top signal face to the center of the highest signal indication of the bottom signal face. If horizontally-arranged or clustered signal faces are used, the minimum 3-foot horizontal separation between the two signal faces should be measured from the center of the right-most signal indication in the signal face on the left to the center of the left-most signal indication in the signal face on the right.

Bicycle signal faces should be placed such that visibility is maximized for bicyclists and minimized for adjacent or conflicting vehicle movements not controlled by the bicycle signal face. Consideration should be given to using visibility-limited bicycle signal faces in situations where drivers not controlled by the bicycle signal face might be confused by viewing the bicycle signal indications, such as when the bicyclist movement controlled by the bicycle signal face is sometimes allowed to proceed or sometimes required to stop at times when motor vehicle traffic, making the same movement and controlled by other vehicular signal faces, is required to stop or allowed to proceed, respectively.

902.8.9 Mounting Height of Bicycle Signal Faces (MUTCD Section 4H.09)

Standard. The provisions of EPG 902.4.9 shall apply to the mounting height of bicycle signal faces except as follows:

A. The bottom of the signal housing (including brackets) of a bicycle signal face that is not located over a roadway or shoulder shall be a minimum of 7 feet above the sidewalk or ground, and
B. If 4-inch signal indications are used in a supplemental, post-mounted, near-side bicycle signal face, the bottom of the signal housing (including brackets) shall be a minimum of 4 feet and a maximum of 8 feet above the sidewalk or ground. Bicycle signal faces with 4-inch signal indications installed above a pedestrian sidewalk or pathway shall not project more than 4 inches into the pedestrian facility.

902.8.10 Intensity and Light Distribution of Bicycle Signal Faces (MUTCD Section 4H.10)

Guidance. Except for the 4-inch nominal size of the lens diameter, the intensity and distribution of light from each illuminated bicycle signal face should be similar to those recommended for vehicular traffic signal faces in accordance with the tenth standard paragraph of EPG 902.5.1 to the extent practical.

902.8.11 Yellow Change and Red Clearance Intervals for Bicycle Signal Faces (MUTCD Section 4H.11)

Standard. The provisions of EPG 902.6.17 shall apply to the duration of the yellow change and the red clearance intervals of a bicycle signal phase.

Guidance. The minimum duration of the yellow change interval of a bicycle signal phase should be 3 seconds.

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Support. The function of the yellow change interval is to warn bicyclists approaching a signalized location that their permission to proceed is being terminated after which they will be directed to stop. Providing clearance time for a bicyclist to travel through the intersection or conflict area is the purpose of the red clearance interval rather than the yellow change interval.

902.8.12 Bicycle Push Buttons (MUTCD Section 4H.12)

Option. Bicycle push buttons may be used for bicycle detection.

Support. The location of bicycle push buttons intended only for use by bicyclists and not pedestrians are determined by engineering judgment considering a reasonable reach without requiring most bicyclists to dismount.

Standard. Where used, push buttons intended to be used by both pedestrians and bicyclists shall be located and operated to meet all accessibility requirements (see EPG 902.9.5).

Bicycle push buttons shall be accompanied by an appropriate regulatory sign (R10-4, R10-24, or R10-26) explaining the purpose and operation of the push button (see EPG 903.2.47 and EPG 914.2.8).

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902.9 Pedestrian Control Features (MUTCD Chapter 4I)

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902.9.1 Pedestrian Signal Heads (MUTCD Section 4I.01)

Support. Pedestrian signal heads provide special types of traffic signal indications exclusively intended for controlling pedestrians. These signal indications consist of the illuminated symbols of a WALKING PERSON (symbolizing WALK) and an UPRAISED HAND (symbolizing DONT WALK).

EPG 902.4.2 contains information on when to use pedestrian signal heads.

Accessible pedestrian signals (see EPG 902.11) where pedestrian signal heads are used provide information in non-visual formats (such as audible tones and/or speech messages, and vibrating surfaces) so that a pedestrian with vision disabilities can know when to cross the street.

EPG 902.10 contains information regarding the use of pedestrian hybrid beacons and EPG 902.20 contains information regarding the use of In-Roadway Warning Lights at unsignalized marked crosswalks.

902.9.2 Size, Design, and Illumination of Pedestrian Signal Head Indications (MUTCD Section 4I.02)

Guidance. All pedestrian signal head indications at an intersection should be of the same size and design.

Standard. All new pedestrian signal head indications shall be displayed within a rectangular background and shall consist of symbolized messages (see Figure 902.9.2), except that existing pedestrian signal head indications with lettered or outline style symbol messages shall be permitted to be retained for the remainder of their useful service life. The symbol designs that are set forth in the “Standard Highway Signs” publication (see EPG 911 (MUTCD Section 1A.05)) shall be used. Each pedestrian signal head indication shall be independently displayed and emit a single color.

All new pedestrian signal indications shall be Light Emitting Diode (LED).

One section pedestrian signal heads shall include the UPRAISED HAND (symbolizing DONT WALK) and the WALKING PERSON (symbolizing WALK) symbols overlaid upon each other, and a light source that can display each symbol independently shall be used.

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The WALKING PERSON (symbolizing WALK) signal indication shall be white. The UPRAISED HAND (symbolizing DONT WALK) signal indication shall be Portland orange.

The requirements of the publication entitled “Pedestrian Traffic Control Signal Indicators – Light Emitting Diode (LED) Signal Modules,” 2011, ITE, that pertain to the aspects of the signal head design that affect the display of the signal indications shall be met for light-emitting diode (LED) pedestrian signal head modules.

Guidance. The intensity and distribution of light from each LED pedestrian signal head module should comply with the publications specified in the preceding paragraph, as appropriate.

Standard. When not illuminated, the WALKING PERSON (symbolizing WALK) and UPRAISED HAND (symbolizing DONT WALK) symbols shall not be readily visible to pedestrians at the far end of the crosswalk that the pedestrian signal head indications control.

For pedestrian signal head indications, the symbols shall be at least 9 inches high.

The light source of a flashing UPRAISED HAND (symbolizing DONT WALK) signal indication shall be flashed continuously at a rate of not less than 50 or more than 60 times per minute. The displayed period of each flash shall be a minimum of ½ and a maximum of ⅔ of the total flash cycle.

Guidance. Pedestrian signal head indications should be conspicuous and recognizable to pedestrians at all distances from the beginning of the controlled crosswalk to a point 10 feet from the end of the controlled crosswalk during both day and night.

If the pedestrian signal indication is so bright that it causes excessive glare in nighttime conditions, some form of automatic dimming should be used to reduce the brilliance of the signal indication.



Figure 902.9.2 Typical Pedestrian Signal Indications

902.9.3 Location and Height of Pedestrian Signal Heads (MUTCD Section 4I.03)

Standard. Pedestrian signal heads shall be mounted with the bottom of the signal housing including brackets not less than 7 feet or more than 10 feet above sidewalk level, and shall be positioned and adjusted to provide maximum visibility at the beginning of the controlled sidewalk.

Guidance. If pedestrian signal heads are mounted on the same support as vehicular signal heads, there should be a physical separation between them.

902.9.4 Countdown Pedestrian Signals (MUTCD Section 4I.04)

Standard. All pedestrian signal heads used at crosswalks shall include a pedestrian change interval countdown display in order to inform pedestrians of the number of seconds remaining in the pedestrian change interval.

The countdown display shall always be displayed simultaneously with the flashing UPRAISED HAND (symbolizing DONT WALK) signal indication displayed for that crosswalk.

Countdown pedestrian signals shall consist of Portland orange numbers that are at least 9 inches in height on a black opaque background. The countdown pedestrian signal shall be located immediately adjacent to the associated UPRAISED HAND (symbolizing DONT WALK) pedestrian signal head indication (see Figure 902.9.2).

The display of the number of remaining seconds shall begin only at the beginning of the pedestrian change interval (flashing UPRAISED HAND). After the countdown displays zero, the display shall remain dark until the beginning of the next countdown.

The countdown pedestrian signal shall display the number of seconds remaining until the termination of the pedestrian change interval (flashing UPRAISED HAND). Countdown displays shall not be used during the walk interval. Countdown displays shall not be used during the red clearance interval of a concurrent vehicular phase that is ending simultaneously with or after the end of the pedestrian phase.

Guidance. If used with a pedestrian signal head that does not have a concurrent vehicular phase, the pedestrian change interval (flashing UPRAISED HAND) should be set to be approximately 4 seconds less than the required pedestrian clearance time (see EPG 902.9.6) and an additional clearance interval (during which a steady UPRAISED HAND is displayed) should be provided prior to the start of the conflicting vehicular phase.

Because some technology includes the countdown pedestrian signal logic in a separate timing device that is independent of the timing in the traffic signal controller, care should be exercised by the engineer when timing changes are made to pedestrian change intervals.

If the pedestrian change interval is interrupted or shortened as a part of a transition into a preemption sequence (see EPG 902.6.19), the countdown pedestrian signal display should be discontinued and go dark immediately upon activation of the preemption transition.

902.9.5 Pedestrian Detectors (MUTCD Section 4I.05)

Option. Pedestrian detectors may be push buttons or passive detection devices.

Support. Passive detection devices register the presence of a pedestrian in a position indicative of a desire to cross, without requiring the pedestrian to push a button. Some passive detection devices are capable of tracking the progress of a pedestrian as the pedestrian crosses the roadway for the purpose of extending or shortening the duration of certain pedestrian timing intervals.

The provisions in this Article place pedestrian push buttons within easy reach of pedestrians who are intending to cross each crosswalk and make it obvious which push button is associated with each crosswalk. These provisions also position push button poles in optimal locations for installation of accessible pedestrian signals (see EPG 902.11). Information regarding reach ranges can be found in the U.S. Department of Justice 2010 ADA Standards for Accessible Design, September 15, 2010, 28 CFR 35 and 36, Americans with Disabilities Act of 1990.

Guidance. If pedestrian push buttons are used, they should be capable of easy activation requiring no more than 3.5 pounds of force, should not require tight grasping, pinching, or twisting of the wrist, and should be conveniently located near each end of the crosswalks. Except as provided in the two subsequent paragraphs, pedestrian push buttons should be located to meet all of the following criteria (see Figure 902.9.5.1):

A. Unobstructed and accessible within one or more of the reach ranges specified in Section 308, and from a clear ground space as specified in Section 305, of the 2010 ADA Standards for Accessible Design;
B. To provide a wheelchair accessible route from the push button to the ramp;
C. On the side of the curb ramp which is farthest from the center of the intersection;
D. Not greater than 10 feet from the edge of the associated curb ramp which is farther from the center of the intersection;

E. Not greater than 5 feet from the outside edge of the marked crosswalk farthest from the center of the intersection;
F. Not farther from the crosswalk than the stop line is, if present;
G. Between 30 inches and 6 feet from the face of the curb or from the outside edge of the shoulder (or if no shoulder exists, from the edge of the pavement);
H. With the face of the push button parallel to the crosswalk to be used;
I. At a mounting height of approximately 3.5 feet, but no more than 4 feet, above the sidewalk;
J. Allowing a minimum 4-foot continuous clear width for a pedestrian access route; and
K. Outside the flared side of the curb ramp, if present.

Where there are physical constraints that make it impracticable to place the pedestrian push button adjacent to a level all-weather surface, the surface should be as level as feasible.

Where there are physical constraints that make it impracticable to place the pedestrian push button between 30 inches and 6 feet from the face of the curb or from the outside edge of the shoulder (or if no shoulder exists, from the edge of the pavement), it should not be farther than 10 feet from the face of the curb or from the outside edge of the shoulder (or if no shoulder exists, from the edge of the pavement).

Except as provided in the subsequent paragraph, where two pedestrian push buttons are provided on the same corner of a signalized location, the push buttons should be separated by a distance of at least 10 feet.

Option. Where there are physical constraints on a particular corner that make it impracticable to provide the 10-foot separation between the two pedestrian push buttons the push buttons may be placed closer together or on the same pole.

Support. Figure 902.9.5.2 shows typical pedestrian push button locations for a variety of situations.

Standard. If a pedestrian push button is provided, a sign (see EPG 903.2.47) shall also be installed adjacent to the pedestrian push button detector explaining the purpose and use.

Option. At certain locations, a supplemental sign in a more visible location may be used to call attention to the pedestrian push button.

Standard. The positioning of pedestrian push buttons and the legends on the pedestrian push button signs shall indicate which crosswalk signal is actuated by each pedestrian push button.

If the pedestrian clearance time is sufficient only to cross from the curb or shoulder to a median of sufficient width for pedestrians to wait and the signals are pedestrian actuated, an additional pedestrian detector shall be provided in the median.

Guidance. The use of additional pedestrian detectors on islands or medians where a pedestrian might become stranded should be considered.

If used, special purpose push buttons (to be operated only by authorized persons) should include a housing capable of being locked to prevent access by the general public and do not need an instructional sign.

Standard. If used, a pilot light or other means of indication installed with a pedestrian push button shall not be illuminated until actuation. Once it is actuated, the pilot light shall remain illuminated until the pedestrian's green or WALKING PERSON (symbolizing WALK) signal indication is displayed.

Extended push button press features shall not be utilized.

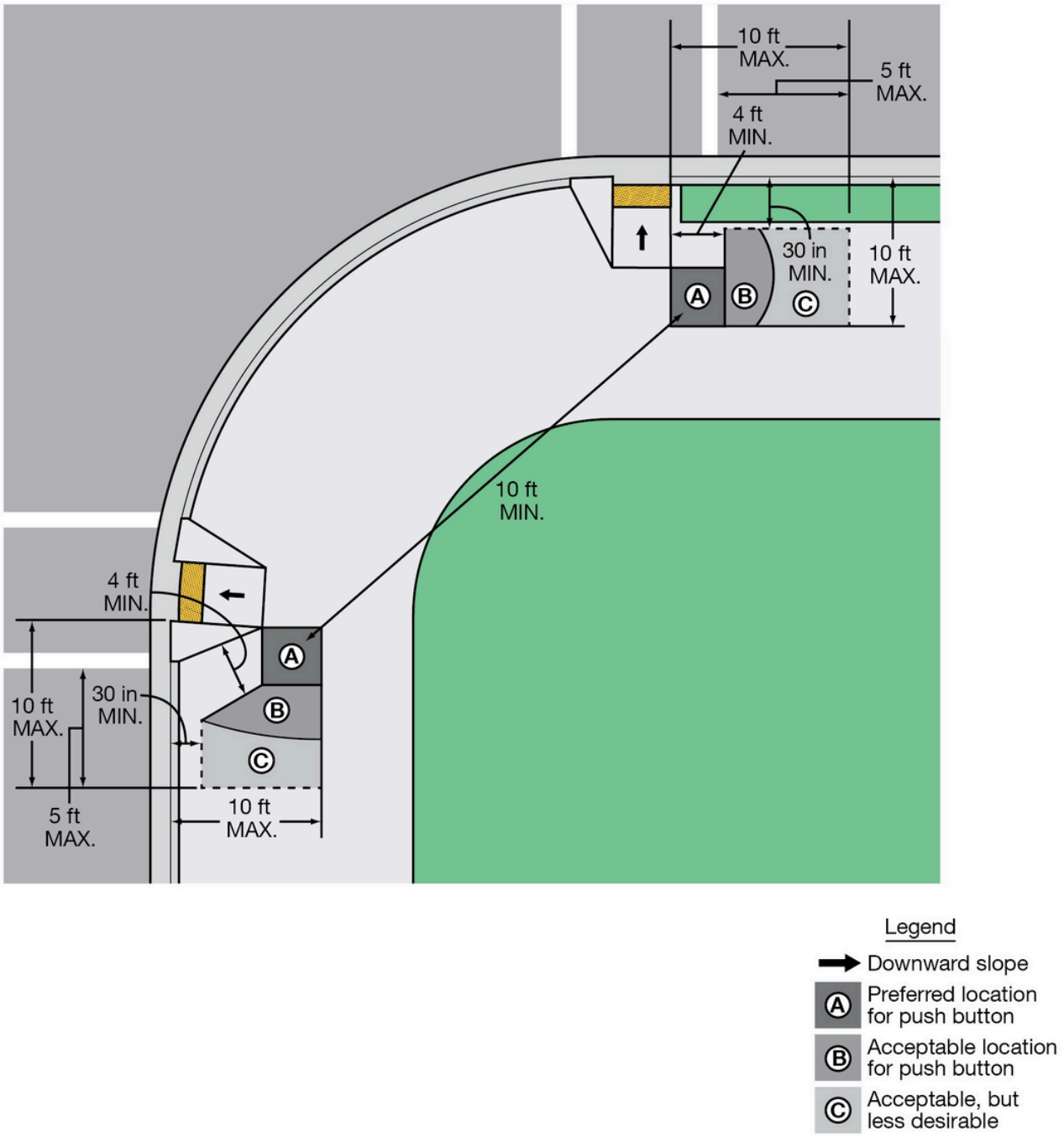


Figure 902.9.5.1 Preferred Push Button Location Area

Notes:

1. The push button detector should be located 5 feet or less from the outside edge of the marked crosswalk farthest from the intersection.
2. The push button detector should be located no farther from the crosswalk than the stop line, if one is present.
3. A 4-foot minimum unobstructed pedestrian access route should be maintained.
4. The maximum (MAX.) and minimum (MIN.) dimensions shown in this figure are recommendations.
5. Two pedestrian push buttons on the same corner should be separated by at least 10 feet. The 10-foot dimension shown in this figure is in reference to the placement of the push buttons within their respective areas.

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6. Figure 902.9.5.2 shows typical push button locations.
7. This figure is not drawn to scale.

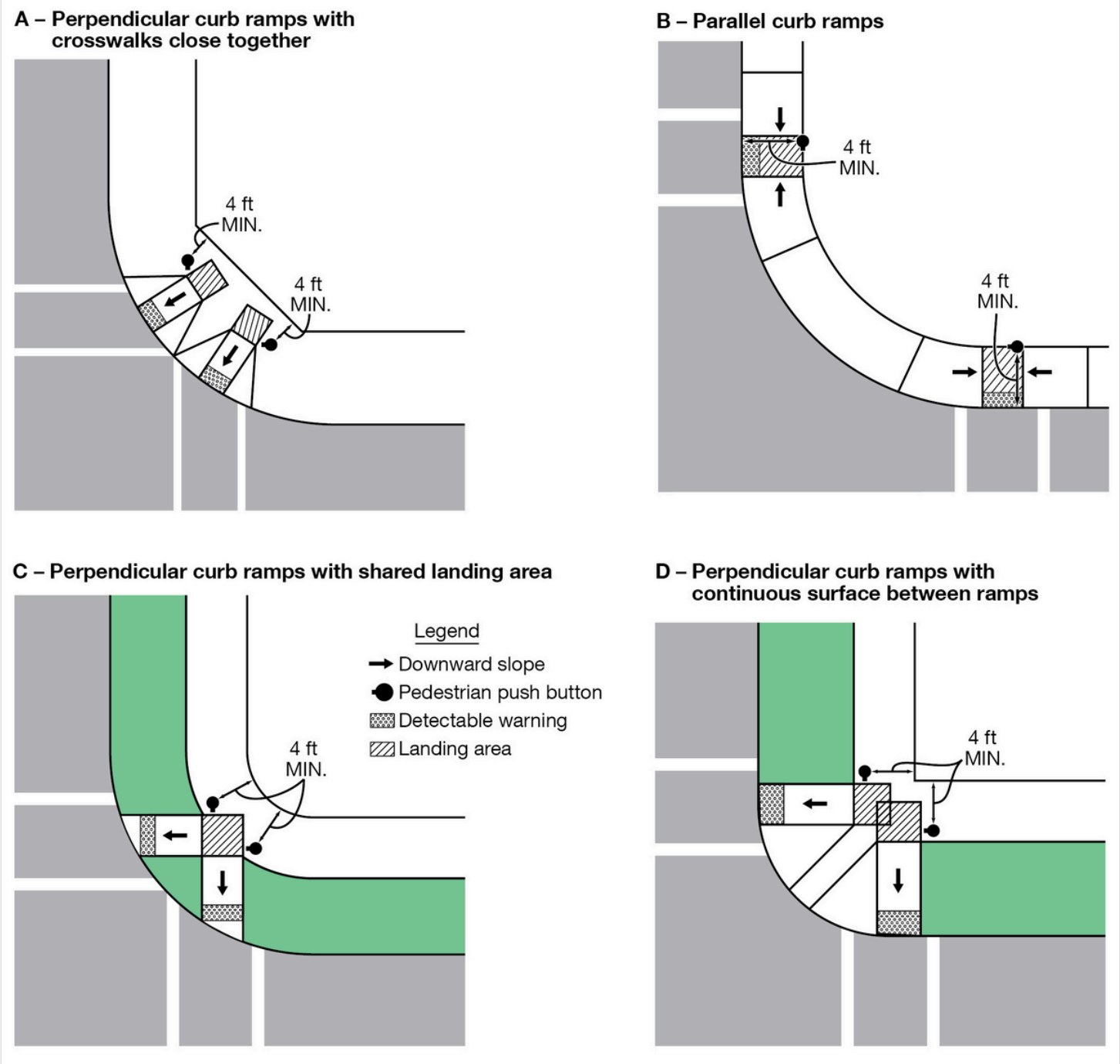


Figure 902.9.5.2 Typical Push Button Locations

Notes:

1. This figure is not drawn to scale.
2. These drawings are intended to describe the typical locations for pedestrian push button installations.

902.9.6 Pedestrian Intervals and Signal Phases (MUTCD Section 4I.06)

Standard. At intersections equipped with pedestrian signal heads, the pedestrian signal indications shall be displayed except when the vehicular traffic control signal is being operated in the flashing mode. At those times, the pedestrian signal indications shall not be displayed.

Except as provided in the third standard paragraph of EPG 902.10.3, when the pedestrian signal heads associated with a crosswalk are displaying either a steady WALKING PERSON (symbolizing WALK) or a flashing UPRAISED HAND (symbolizing DONT WALK) signal indication, a steady red signal indication shall be shown to any conflicting vehicular movement that is approaching the intersection or midblock location perpendicular or nearly perpendicular to the crosswalk. This requirement for a steady red signal indication does not apply to permissive turning movements.

A WALKING PERSON (symbolizing WALK) signal indication or a flashing UPRAISED HAND (symbolizing DONT WALK) signal indication shall not be active during a phase or interval which leads vehicles into the crosswalk.

When pedestrian signal heads are used, a WALKING PERSON (symbolizing WALK) signal indication shall be displayed only when pedestrians are permitted to leave the curb or shoulder.

A pedestrian change interval consisting of a flashing UPRAISED HAND (symbolizing DONT WALK) signal indication shall begin immediately following the WALKING PERSON (symbolizing WALK) signal indication. Following the pedestrian change interval, a buffer interval consisting of a steady UPRAISED HAND (symbolizing DONT WALK) signal indication shall be displayed for at least 3 seconds prior to the release of any conflicting vehicular movement. The sum of the time of the pedestrian change interval and the buffer interval shall not be less than the calculated pedestrian clearance time (see the ninth through nineteenth paragraphs of this Article). The buffer interval shall not begin later than the beginning of the red clearance interval, if used.

Option. During the yellow change interval, the UPRAISED HAND (symbolizing DONT WALK) signal indication may be displayed as either a flashing indication, a steady indication, or a flashing indication for an initial portion of the yellow change interval and a steady indication for the remainder of the interval.

Support. Figure 902.9.6 illustrates the pedestrian intervals and their possible relationships with associated vehicular signal phase intervals.

See EPG 902.23 for information related to MoDOT signal phasing and timing.

Guidance. Except as provided in the subsequent paragraph, the pedestrian clearance time should be sufficient to allow a pedestrian crossing in the crosswalk who left the curb or edge of pavement at the end of the WALKING PERSON (symbolizing WALK) signal indication to travel at a walking speed of 3.5 feet per second to at least the far side of the traveled way or to a median of sufficient width for pedestrians to wait.

Option. A walking speed of up to 4 feet per second may be used to evaluate the sufficiency of the pedestrian clearance time at locations where documented engineering judgement supports the use.

Guidance. Where pedestrians who walk slower than 3.5 feet per second, or pedestrians who use wheelchairs, routinely use the crosswalk, a walking speed of less than 3.5 feet per second should be considered in determining the pedestrian clearance time.

Except as provided in the subsequent paragraph, the walk interval should be at least 7 seconds in length so that pedestrians will have adequate opportunity to leave the curb or shoulder before the pedestrian clearance time begins.

Option. If pedestrian volumes and characteristics do not require a 7-second walk interval, walk intervals as short as 4 seconds may be used.

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Support. The walk interval is intended for pedestrians to start their crossing. The pedestrian clearance time is intended to allow pedestrians who started crossing during the walk interval to complete their crossing. Longer walk intervals are often used when the duration of the vehicular green phase associated with the pedestrian crossing is long enough to allow it.

Confusion is common among pedestrians as to the meaning of the pedestrian signal indications. This can result in a pedestrian turning back once the walk interval expires and not using the pedestrian change interval (flashing UPRAISED HAND) to complete their crossing. Countdown pedestrian indications (see EPG 902.9.4) and traffic signal pedestrian and bicyclist actuation signs (see EPG 903.2.47) can help mitigate confusion issues instead of lengthening the walk interval, since the pedestrian change interval is the critical time.

Guidance. The total of the walk interval and pedestrian clearance time should be sufficient to allow a pedestrian crossing in the crosswalk who left the pedestrian detector (or, if no pedestrian detector is present, a location 6 feet behind the face of the curb or 6 feet behind the edge of the pavement) at the beginning of the WALKING PERSON (symbolizing WALK) signal indication to travel at a walking speed of 3 feet per second to the far side of the traveled way being crossed or to the median if a two-stage pedestrian crossing sequence is used. Any additional time that is required to satisfy the conditions of this paragraph should be added to the walk interval.

Option. An exclusive pedestrian phase may be needed for pedestrian movements as determined by engineering judgement.

On a street with a median of sufficient width for pedestrians to wait, a pedestrian clearance time that allows the pedestrian to cross only from the curb or shoulder to the median may be provided.

Standard. Where the pedestrian clearance time is sufficient only for crossing from the curb or shoulder to a median of sufficient width for pedestrians to wait, median-mounted pedestrian signals, with pedestrian detectors (see EPG 902.9.5 and 902.11.1) if actuated operation is used, shall be provided and signing such as the R10-3d sign (see EPG 903.2.47) shall be provided to notify pedestrians to cross only to the median to await the next WALKING PERSON (symbolizing WALK) signal indication.

Support. Accessible pedestrian signals (see 902.11.1) where median-mounted pedestrian signals and detectors are used provide information in non-visual formats (such as audible tones and/or speech messages, and vibrating surfaces) so that a pedestrian with vision disabilities can know when to resume crossing the street after crossing to the median.

Option. During the transition into preemption, the walk interval and the pedestrian change interval may be shortened or omitted as described in EPG 902.6.19.

A brief leading pedestrian interval, during which an advance WALKING PERSON (symbolizing WALK) indication is displayed for the crosswalk while red indications continue to be displayed to parallel through and/or turning traffic, may be used to reduce conflicts between pedestrians and turning vehicles.

Support. Accessible pedestrian signals (see EPG 902.11) where leading pedestrian intervals are used provide information in non-visual formats (such as audible tones and/or speech messages, and vibrating surfaces) so that a pedestrian with vision disabilities can know when to cross the street in the absence of the audible cues normally provided when the onset of the vehicular and pedestrian movements coincide.

If a leading pedestrian interval is used without accessible features, pedestrians with vision disabilities might begin crossing at the onset of the vehicular movement when vehicle operators are not expecting them to begin crossing.

Guidance. If a leading pedestrian interval is used, it should be at least 3 seconds in duration and should be timed to allow pedestrians to cross at least one lane of traffic or, in the case of a large corner radius, to travel far enough for pedestrians to establish their position ahead of the turning traffic before the turning traffic is released.

If a leading pedestrian interval is used, consideration should be given to prohibiting turns across the crosswalk during the leading pedestrian interval.

At locations where a leading pedestrian interval is used, the minimum time for the WALKING PERSON (symbolizing WALK) indication should be the time provided for the leading pedestrian interval plus 7 seconds.

Support. At intersections with pedestrian volumes that are so high that drivers have difficulty finding an opportunity to turn across the crosswalk, the duration of the green interval for a parallel concurrent vehicular movement is sometimes intentionally set to extend beyond the pedestrian clearance time to provide turning drivers additional green time to make their turns while the pedestrian signal head is displaying a steady UPRAISED HAND (symbolizing DONT WALK) signal indication after pedestrians have had time to complete their crossings.

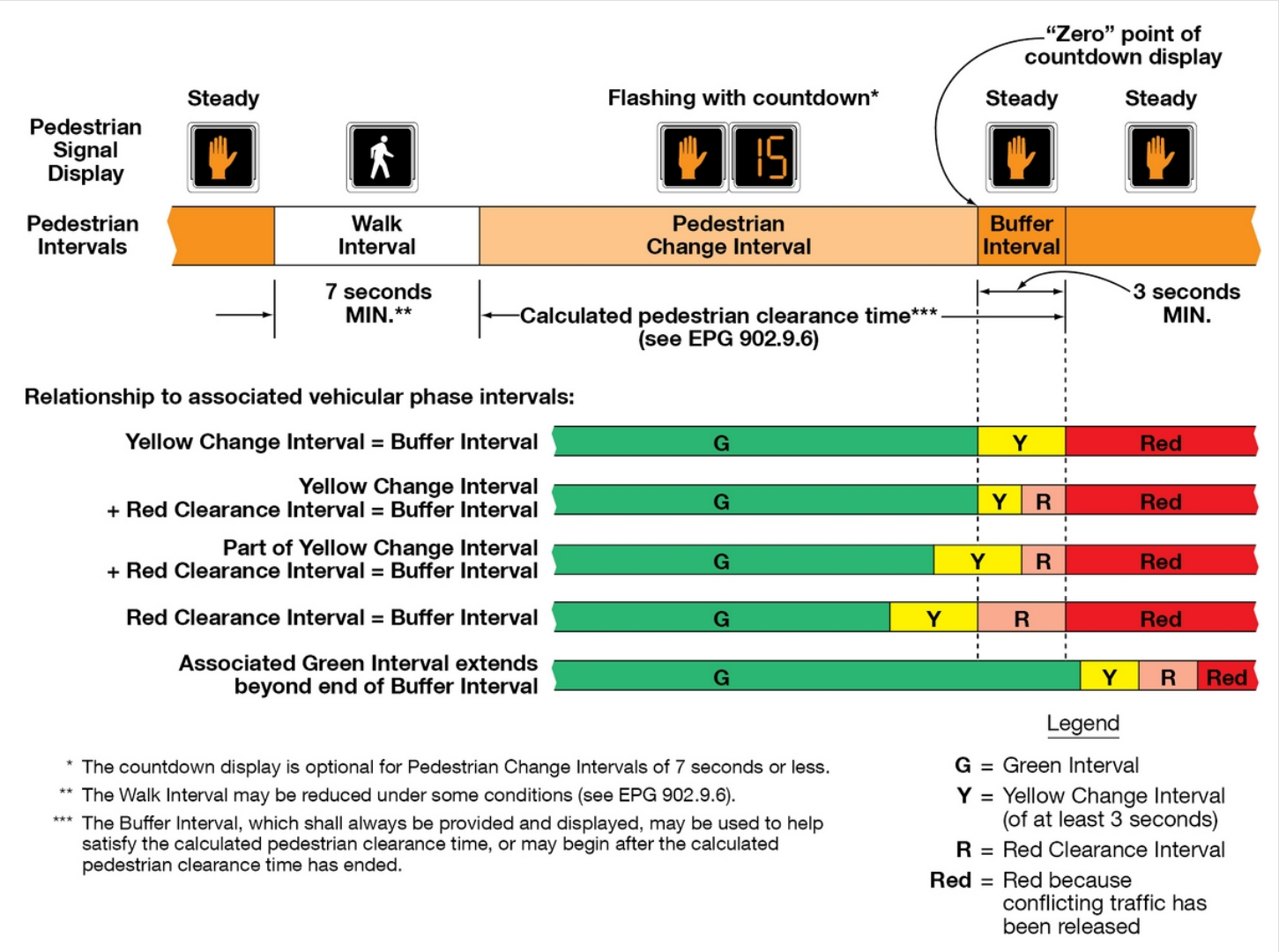


Figure 902.9.6 Pedestrian Intervals

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902.10 Pedestrian Hybrid Beacons (MUTCD Chapter 4J)

902.10.1 Application of Pedestrian Hybrid Beacons (MUTCD Section 4J.01)

Support. A pedestrian hybrid beacon is a special type of hybrid beacon used to warn and control traffic at an unsignalized location to assist pedestrians in crossing a street or highway at a marked crosswalk.

Option. A pedestrian hybrid beacon may be considered for installation to facilitate pedestrian crossings at a location that does not meet traffic signal warrants (see EPG 902.3), or at a location that meets traffic signal warrants under EPG 902.3.5 and/or EPG 902.3.6 but a decision is made to not install a traffic control signal.

Standard. If used, pedestrian hybrid beacons shall be used in conjunction with signs and pavement markings (see EPG 902.10.2) to warn and control traffic at locations where pedestrians enter or cross a street or highway. A pedestrian hybrid beacon shall only be installed at a marked crosswalk.

Guidance. If one of the signal warrants of EPG 902.3 is met and a traffic control signal is justified by an engineering study, and if a decision is made to install a traffic control signal, it should be installed based upon the provisions of EPG 902.4 through EPG 902.9 and EPG 902.11.

If a traffic control signal is not justified under the signal warrants of EPG 902.3 and if gaps in traffic are not adequate to permit pedestrians to cross, or if the speed for vehicles approaching on the major street is too high to permit pedestrians to cross, or if pedestrian delay is excessive, the need for a pedestrian hybrid beacon should be considered on the basis of an engineering study that considers major-street volumes, speeds, widths, and gaps in conjunction with pedestrian volumes, walking speeds, and delay.

For a major street where the posted or statutory speed limit or the 85th-percentile speed is 35 mph or less, the need for a pedestrian hybrid beacon should be considered if the engineering study finds that the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding total of all pedestrians crossing the major street for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 902.10.1.1 for the length of the crosswalk.

For a major street where the posted or statutory speed limit or the 85th-percentile speed exceeds 35 mph, the need for a pedestrian hybrid beacon should be considered if the engineering study finds that the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding total of all pedestrians crossing the major street for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 902.10.1.2 for the length of the crosswalk.

For crosswalks that have lengths other than the four that are specifically shown in Figures 902.10.1.1 and 902.10.1.2, the values should be interpolated between the curves.

Option. The criteria for the pedestrian volume crossing the major street shown in Figures 902.10.1.1 and 902.10.1.2 may be reduced as much as 50 percent if the 15th-percentile crossing speed of pedestrians is less than 3.5 feet per second.

Where there is a divided street having a median of sufficient width for pedestrians to wait, the criteria for the major-street traffic volume shown in Figures 902.10.1.1 and 902.10.1.2 may be applied separately to each direction of vehicular traffic. Satisfaction of the criteria for one direction of traffic allows for installation of a pedestrian hybrid beacon for the entire crossing.

Standard. If a pedestrian hybrid beacon is considered for a location that does not meet the criterion listed in this article, an engineering study shall be submitted and approved by the State Traffic Engineer prior to installation.

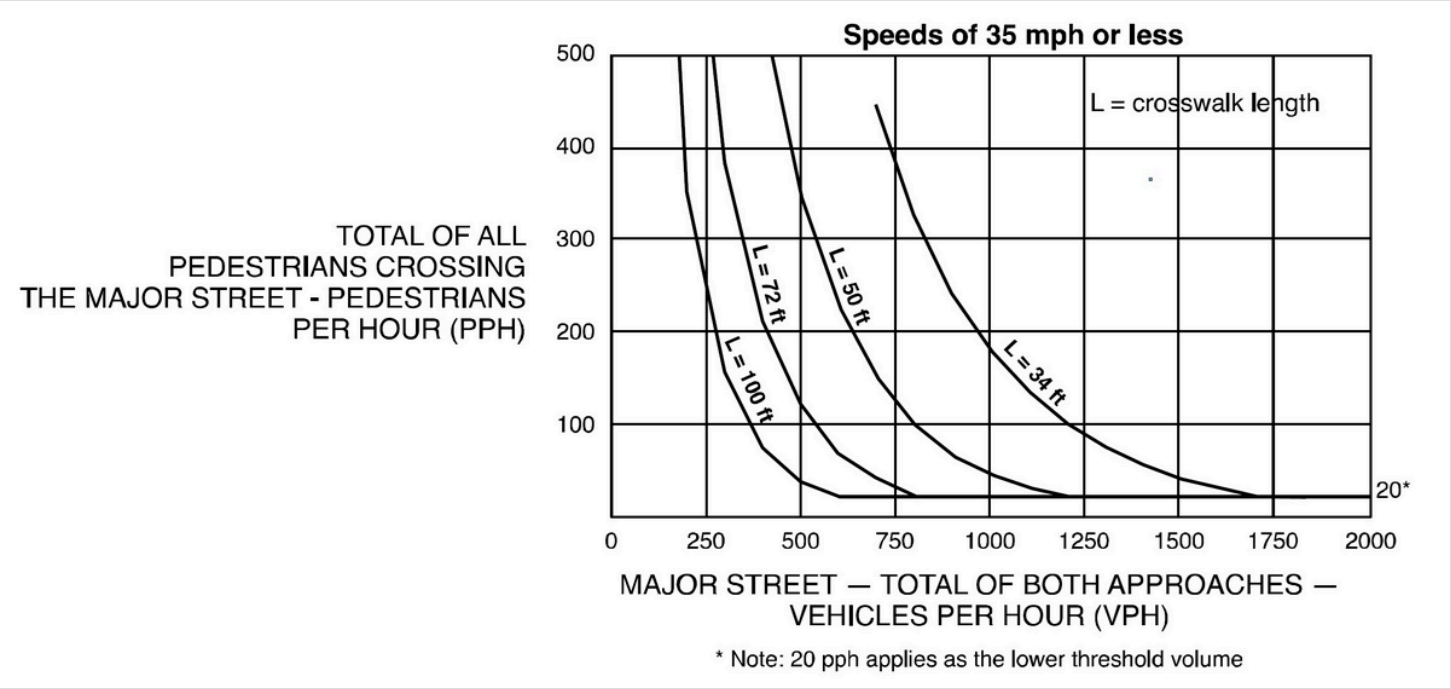


Figure 902.10.1.1 Guidelines for the Installation of Pedestrian Hybrid Beacons on Low-Speed Roadways

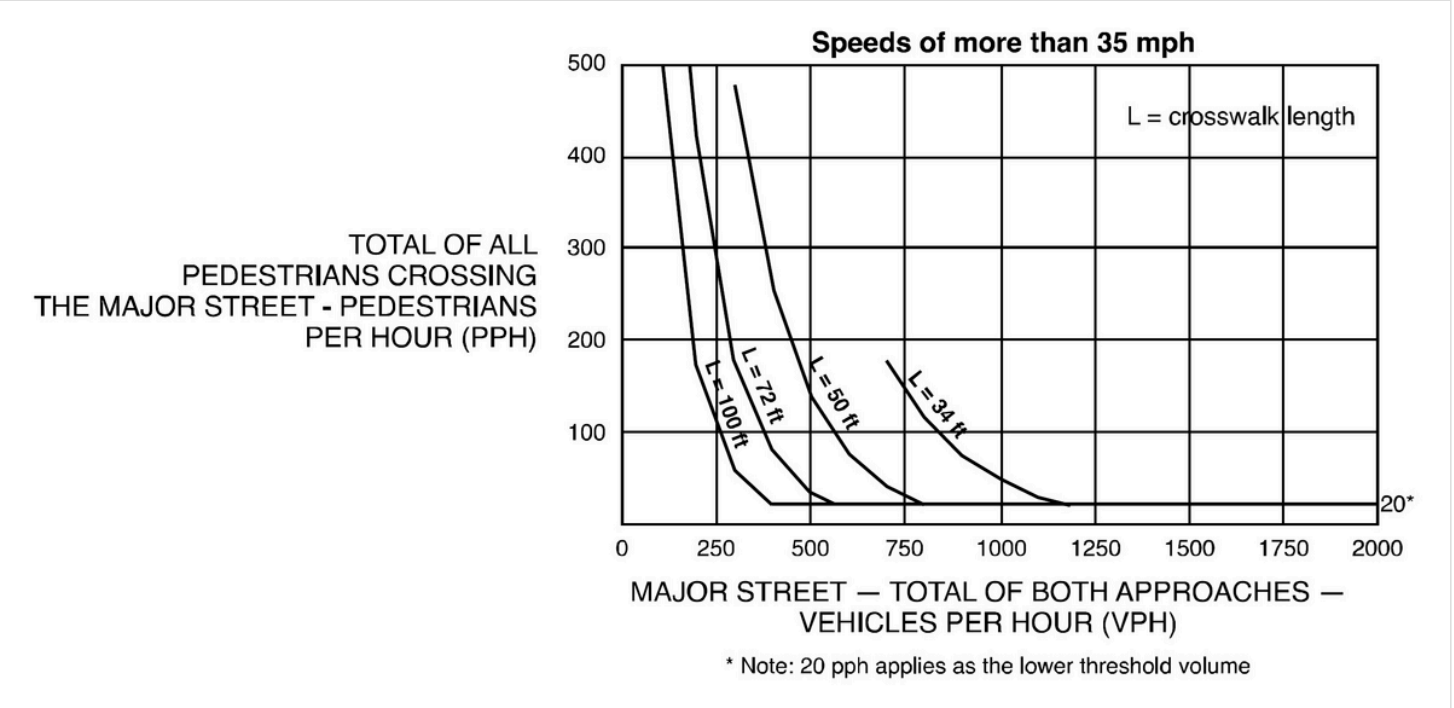


Figure 902.10.1.2 Guidelines for the Installation of Pedestrian Hybrid Beacons on High-Speed Roadways

902.10.2 Design of Pedestrian Hybrid Beacons (MUTCD Section 4J.02)

Standard. Except as otherwise provided in this Article, a pedestrian hybrid beacon shall meet the provisions of EPG 902.4 through EPG 902.7, EPG 902.9, and EPG 902.10.

A pedestrian hybrid beacon face shall consist of three signal sections, with a CIRCULAR YELLOW signal indication centered below two horizontally-aligned CIRCULAR RED signal indications (see Figure 902.10.2).

When an engineering study finds that installation of a pedestrian hybrid beacon is justified, then:

A. At least two pedestrian hybrid beacon faces shall be installed for each approach of the major street;
B. A stop line shall be installed for each approach to the crosswalk;
C. A pedestrian signal head complying with the provisions set forth in EPG 902.9 shall be installed at each end of the marked crosswalk;
D. The pedestrian hybrid beacon shall be pedestrian actuated; and
E. If the pedestrian hybrid beacon is installed at or immediately adjacent to an intersection with a minor street, a STOP sign shall be installed for each minor-street approach.

Guidance. When an engineering study finds that installation of a pedestrian hybrid beacon is justified, then:

A. Parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the marked crosswalk, or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance; and
B. If installed within a signal system, the pedestrian hybrid beacon should be coordinated.

On approaches having posted or statutory speed limits or 85th-percentile speeds in excess of 35 mph and on approaches having traffic or operating conditions that would tend to obscure visibility of roadside hybrid beacon face locations, both of the minimum of two pedestrian hybrid beacon faces should be installed over the roadway.

On multi-lane approaches having posted or statutory speed limits or 85th-percentile speeds of 35 mph or less, either a pedestrian hybrid beacon face should be installed on each side of the approach (if a median of sufficient width exists) or at least one of the pedestrian hybrid beacon faces should be installed over the roadway.

A pedestrian hybrid beacon should comply with the signal face location provisions described in EPG 902.4.5 through EPG 902.4.10.

Standard. A CROSSWALK—STOP ON RED (symbolic circular red) (R10-23) or a STOP ON RED—YIELD ON FLASHING RED AFTER STOP (R10-23a) sign (see EPG 903.2.48) shall be mounted adjacent to a pedestrian hybrid beacon face on each major street approach. If an overhead pedestrian hybrid beacon face is provided, the sign shall be mounted adjacent to the overhead signal face.

Option. A W11-2 (Pedestrian), S1-1 (School), or W11-15 (Trail) crossing warning sign with an AHEAD (W16-9P) supplemental plaque may be placed in advance of a pedestrian hybrid beacon. A Warning Beacon may be installed to supplement the W11-2, S1-1, or W11-15 sign.

Standard. Backplates (see EPG 902.4.6) shall be used with pedestrian hybrid beacons.

Support. Accessible pedestrian signals (see EPG 902.11) where a pedestrian hybrid beacon is used provide information in non-visual formats (such as audible tones and/or speech messages, and vibrating surfaces) so that a pedestrian with vision disabilities can know when to cross the street.

Guidance. If a Warning Beacon supplements a W11-2 sign in advance of a pedestrian hybrid beacon, it should be programmed to flash only when the pedestrian hybrid beacon is not in the dark mode.

Standard. If a Warning Beacon is installed to supplement the W11-2 sign, the design and location of the Warning Beacon shall comply with the provisions of EPG 902.18.1 and EPG 902.18.3.

Bicycle signal faces (see EPG 902.8) shall not be used at a pedestrian hybrid beacon.

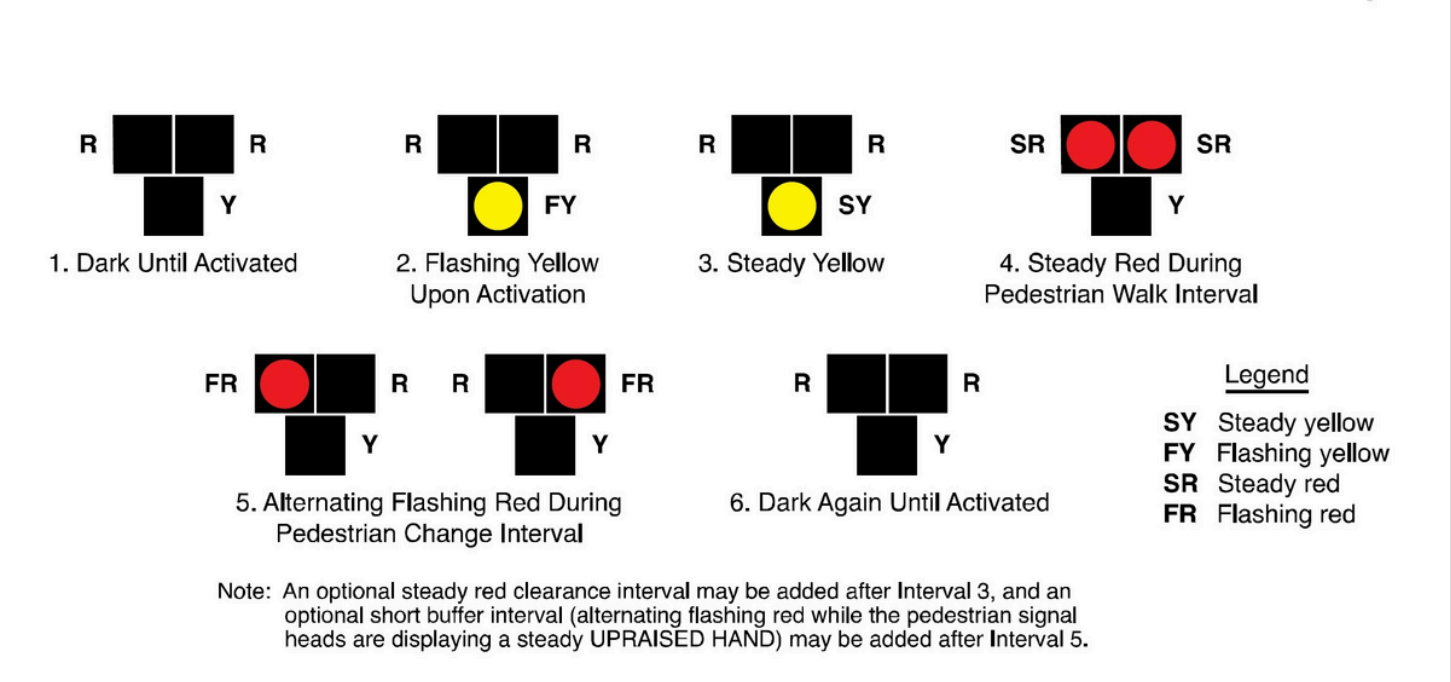


Figure 902.10.2 Sequence for a Pedestrian Hybrid Beacon

902.10.3 Operation of Pedestrian Hybrid Beacons (MUTCD Section 4J.03)

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Standard. Pedestrian hybrid beacon indications shall be dark (not illuminated) during periods between actuations.

Following an actuation by a pedestrian, a pedestrian hybrid beacon face shall display a flashing CIRCULAR YELLOW signal indication, followed by a steady CIRCULAR YELLOW signal indication, followed by both steady CIRCULAR RED signal indications during the pedestrian walk interval, followed by alternating flashing CIRCULAR RED signal indications during the pedestrian change interval (see Figure 902.10.2). Upon termination of the pedestrian change interval, the pedestrian hybrid beacon faces shall revert to a dark (not illuminated) condition.

Except as provided in the subsequent paragraph, the pedestrian signal heads shall continue to display a steady UPRAISED HAND (symbolizing DONT WALK) signal indication when the pedestrian hybrid beacon faces are either dark or displaying flashing or steady CIRCULAR YELLOW signal indications. The pedestrian signal heads shall display a WALKING PERSON (symbolizing WALK) signal indication when the pedestrian hybrid beacon faces are displaying steady CIRCULAR RED signal indications. The pedestrian signal heads shall display a flashing UPRAISED HAND (symbolizing DONT WALK) signal indication when the pedestrian hybrid beacon faces are displaying alternating flashing CIRCULAR RED signal indications. Upon termination of the pedestrian change interval, the pedestrian signal heads shall revert to a steady UPRAISED HAND (symbolizing DONT WALK) signal indication.

Option. Where the pedestrian hybrid beacon is installed adjacent to a roundabout to facilitate crossings by pedestrians with vision disabilities and an engineering study determines that pedestrians without vision disabilities can be allowed to cross the roadway without actuating the pedestrian hybrid beacon, the pedestrian signal heads may be dark (not illuminated) when the pedestrian hybrid beacon faces are dark.

Guidance. The duration of the flashing yellow interval should be determined by engineering judgment.

The duration of the flashing yellow interval should not vary on a cycle-by-cycle basis.

If the pedestrian hybrid beacon is coordinated as a part of a signal system, it should remain in the dark condition after a pedestrian actuation has been received until the point in the background cycle when the predetermined duration of the flashing yellow interval needs to be initiated in order to achieve the appropriate coordinated offset.

Option. If a minimum dark time between activations of the pedestrian hybrid beacon has been set on the controller, the pedestrian hybrid beacon may remain in the dark condition after a pedestrian actuation has been received until the minimum dark time has been provided.

Support. The minimum dark time is a preprogrammed time set in the controller that provides time between the pedestrian actuation and beginning of the flashing yellow interval. At locations in coordinated signal systems, the dark time can be variable based on when the pedestrian actuation occurs in the coordinated signal timing sequence.

Standard. The duration of the steady yellow change interval shall be determined using engineering practices in accordance with the provisions in EPG 902.6.17.

Guidance. A steady yellow change interval should have a minimum duration of 3 seconds and a maximum duration of 6 seconds (see EPG 902.6.17). The longer intervals should be reserved for use on approaches with higher speeds.

Option. A steady red clearance interval may be used after the steady yellow change interval.

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The alternating flashing CIRCULAR RED signal indications may continue to flash for a short period after the pedestrian change interval has terminated to provide a buffer interval for pedestrians.

Guidance. A pedestrian hybrid beacon that is located 200 feet or less from an active grade crossing should be preempted in accordance with the applicable provisions in EPG 902.6.19 and EPG 913.4.9.

Standard. If a pedestrian hybrid beacon is placed into a flashing mode by a conflict monitor (malfunction management unit) or by a manual switch, the pedestrian hybrid beacon faces shall display flashing CIRCULAR YELLOW signal indications to each approach of the major street and the pedestrian signal heads shall revert to a dark (not illuminated) condition.

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902.11 Accessible Pedestrian Signals and Detectors (MUTCD Chapter 4K)

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902.11.1 General (MUTCD Section 4K.01)

Standard. Accessible pedestrian signals and detectors shall be included as part of the design at new signalized intersections where pedestrians are present and shall be considered at existing intersections being altered. See EPG 642.4 Impact of the Project Category on ADA for additional guidance on the impact of the project category on Americans with Disabilities Act.

Support. Accessible pedestrian signals and detectors provide information in non-visual formats (such as audible tones and/or speech messages, and vibrating surfaces). The decision of when to use accessible pedestrian signals is subject to requirements of the Americans with Disabilities Act and Section 504 of the Rehabilitation Act of 1973.

The primary technique that pedestrians with vision disabilities use to cross streets at signalized locations is to initiate their crossing when they hear the traffic in front of them stop and the traffic alongside them begin to move, which often corresponds to the onset of the green interval. The existing environment is often not sufficient to provide the information that pedestrians with vision disabilities need to cross a roadway at a signalized location.

The following factors are relevant in determining whether a particular signalized location presents difficulties for pedestrians with vision disabilities to cross the roadway:

1. Potential demand for accessible pedestrian signals;
2. A request for accessible pedestrian signals;
3. Traffic volumes during times when pedestrians might be present, including periods of low traffic volumes or high turn-on-red volumes;
4. The complexity of the traffic signal phasing (such as split phases, protected turn phases, leading pedestrian intervals, and exclusive pedestrian phases); and
5. The complexity of the intersection geometry.

The factors that make crossing at a signalized location difficult for pedestrians with vision disabilities include: increasingly quiet vehicles, turns on red (which mask the beginning of the through phase), continuous turning movements, complex signal operations, circular intersections, and wide streets. In addition, low traffic volumes might make it difficult for pedestrians with vision disabilities to discern signal phase changes.

State and local organizations providing support services to pedestrians with vision and/or hearing disabilities can provide advice to the traffic engineer on site-specific accessibility decisions. In addition, orientation and mobility specialists or similar staff can provide advice to inform such decisions. The U.S. Access Board (www.access-board.gov (https://www.access-board.gov)) provides technical assistance for making pedestrian signal information accessible to persons with vision disabilities.

Standard. When used, accessible pedestrian signals shall be used in combination with pedestrian signal timing.

The information provided by an accessible pedestrian signal shall indicate which pedestrian crossing is served by each device.

Under steady (stop-and-go) operation, accessible pedestrian signals shall not be limited in operation by the time of day or day of week.

Accessible pedestrian signal detectors shall be push buttons or passive detection devices.

Option. At locations with pretimed traffic control signals or non-actuated approaches, pedestrian push buttons may be used to activate the accessible pedestrian signals.

Support. Accessible pedestrian signals are typically integrated into the pedestrian detector (push button), so the audible tones and/or messages come from the push button housing. They have a push button locator tone and a vibrotactile arrow, and can include audible beaconing and other special features.

Option. If deemed appropriate by MoDOT district traffic staff, the name of the street to be crossed may also be provided in accessible format, such as Braille or raised characters (see Figure 902.11.1). Tactile maps of crosswalks may also be provided.

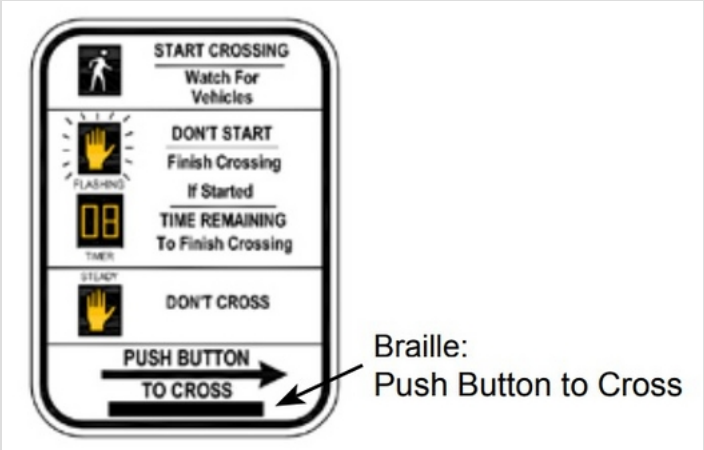


Figure 902.11.1 Example of Braille Sign Legend for Accessible Pedestrian Signals

Support. Specifications regarding Braille or raised characters can be found in the U.S. Department of Justice 2010 ADA Standards for Accessible Design, September 15, 2010, 28 CFR 35 and 36, Americans with Disabilities Act of 1990.

Standard. At accessible pedestrian signal locations where pressing the pedestrian push button is necessary to activate the walk interval, pressing the pedestrian push button shall activate both the walk interval and the accessible pedestrian signals.

902.11.2 Location (MUTCD Section 4K.02)

Support. Accessible pedestrian signals that are located as close as possible to pedestrians waiting to cross the street provide the clearest and least ambiguous indication of which pedestrian crossing is served by a device.

Guidance. Push buttons for accessible pedestrian signals should be located in accordance with the provisions of EPG 902.9.5 and should be located as close as possible to the crosswalk line furthest from the center of the intersection and as close as possible to the curb ramp.

Standard. If the curb ramp is not aligned with the crosswalk, the accessible pedestrian signal assembly shall be positioned with the face of the push button parallel to the crosswalk to be used, and not in the direction of the curb ramp orientation.

Except for the situation regarding simultaneous walk indications for all crosswalks, if two accessible pedestrian push buttons are placed less than 10 feet apart or on the same pole (see the seventh and eighth paragraphs of EPG 902.9.5), each accessible pedestrian push button shall be provided with the following features:

A. A push button locator tone,
B. A vibrotactile walk indication,
C. A speech walk message for the WALKING PERSON (symbolizing WALK) indication (see EPG 902.11.3), and
D. A speech push button information message (see EPG 902.11.5).

If two accessible pedestrian pushbuttons are placed greater than 10 feet apart, each accessible pedestrian pushbutton shall be provided with the following features:

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A. A push button locator tone,
B. A vibrotactile walk indication,
C. A percussive tone for the WALKING PERSON (symbolizing WALK) indication.

If the pedestrian clearance time is sufficient only to cross from the curb or edge of pavement to a median of sufficient width for pedestrians to wait and accessible pedestrian signal detectors are used, an additional accessible pedestrian signal detector shall be provided in the median.

902.11.3 Walk Indications (MUTCD Section 4K.03)

Support. Technology that provides different sounds for each non-concurrent signal phase has frequently been found to provide ambiguous information. Research indicates that a rapid percussive tone for each crossing coming from accessible pedestrian signal devices on separated poles located close to each crosswalk provides unambiguous information to pedestrians with vision disabilities. Vibrotactile indications provide information to pedestrians who are blind and deaf and are also used by pedestrians who are blind or who have low vision to confirm the walk signal in noisy situations.

Standard. Accessible pedestrian signals shall have both audible and vibrotactile walk indications.

Vibrotactile walk indications shall be provided by a vibrotactile arrow that is located on the push button (see the first standard paragraph of EPG 902.11.4). The vibrotactile arrow shall vibrate during the walk interval.

Accessible pedestrian signals shall have an audible walk indication during the walk interval only.

The audible walk indication shall be audible at the beginning of the associated crosswalk. The accessible walk indication shall have the same duration as the pedestrian walk signal except when the pedestrian signal rests in walk.

Guidance. If the pedestrian signal rests in walk, the accessible walk indication should be limited to the first 7 seconds of the walk interval. The accessible walk indication should be recalled by a button press during the walk interval provided that the crossing time remaining is longer than the pedestrian change interval.

Standard. Where two accessible pedestrian signals on one corner, or in a median, that are associated with different phases are placed less than 10 feet apart, the audible walk indication shall be a speech walk message (see the second standard paragraph of EPG 902.11.2). In all other cases, including at midblock crossings, on corners where only one accessible pedestrian signal is present, in a median, and on corners where two accessible pedestrian signals are separated by a distance of at least 10 feet, the audible walk indication shall be a percussive tone.

Support. At any given intersection, there may be a combination of speech messages and percussive tones depending on placement of accessible pedestrian pushbuttons at any given curb ramp.

Guidance. Each curb ramp should be evaluated individually for including speech messages and percussive tones.

Standard. Audible tone walk indications shall repeat at eight to ten ticks per second. Audible tones used as walk indications shall consist of multiple frequencies with a dominant component at 880 Hz.

Guidance. The volume of audible walk indications and push button locator tones (see EPG 902.11.4) should be set to be a maximum of 5 dBA louder than ambient sound, except when audible beaconing is provided in response to an extended push button press.

Automatic volume adjustment up to a maximum volume of 100 dBA in response to ambient traffic sound level shall be provided.

Guidance. The sound level of audible walk indications and push button locator tones should be adjusted to be low enough to avoid misleading pedestrians with vision disabilities when the following conditions exist:

A. Where there is an island that allows unsignalized right turns across a crosswalk between the island and the sidewalk.
B. Where multi-leg approaches or complex signal phasing require more than two pedestrian phases, such that it might be unclear which crosswalk is served by each audible tone.
C. At intersections where a diagonal pedestrian crossing is allowed, or where one street receives a WALKING PERSON (symbolizing WALK) signal indication simultaneously with another street.

Option. An alert tone, which is a very brief burst of high-frequency sound at the beginning of the audible walk indication that rapidly decays to the frequency of the walk tone, may be used to alert pedestrians to the beginning of the walk interval.

Support. An alert tone can be particularly useful if the walk tone is not easily audible in some traffic conditions.

Speech walk messages communicate to pedestrians which street has the walk interval. To be a useful system, the words and their meaning need to be correctly understood by all users in the context of the street environment where they are used. Because of this, tones are the preferred means of providing audible walk indications except where two accessible pedestrian signals on one corner are not separated by a distance of at least 10 feet.

If speech walk messages are used, pedestrians have to know the names of the streets that they are crossing in order for the speech walk messages to be unambiguous. In getting directions to travel to a new location, pedestrians with vision disabilities do not always get the name of each street to be crossed. Therefore, it is desirable to give users of accessible pedestrian signals the name of the street controlled by the push button. This can be done by means of a speech push button information message (see EPG 902.11.5) during the flashing or steady UPRAISED HAND intervals, or by raised print and Braille labels on the push button housing.

If speech walk messages are used, colloquial street names as shown on local signs are more likely to be understood by all users. For example, a speech walk message that includes “Broadway. Walk sign is on to cross Broadway.” is less ambiguous than “Business 65. Walk sign is on to cross Business 65.”

By combining the information from the push button message or Braille label, the vibrotactile arrow aligned in the direction of travel on the relevant crosswalk, and the speech walk message, pedestrians with vision disabilities are able to correctly respond to speech walk messages even if there are two push buttons on the same pole.

Standard. If speech walk messages are used to communicate the walk interval, they shall provide a clear message that the walk interval is in effect, as well as to which crossing it applies.

Speech walk messages that are used at intersections having pedestrian phasing that is concurrent with vehicular phasing shall be patterned after the model: “Broadway. Walk sign is on to cross Broadway.”

Speech walk messages that are used at intersections having exclusive pedestrian phasing shall be patterned after the model: “Walk sign is on for all crossings.”

Speech walk messages shall not contain any additional information, except they shall include designations such as “Street” or “Avenue” where this information is necessary to avoid ambiguity at a particular location.

Guidance. Speech walk messages should not state or imply a command to the pedestrian, such as “Cross Broadway now.” Speech walk messages should not tell pedestrians that it is “safe to cross,” because it is always the pedestrian’s responsibility to check actual traffic conditions.

Standard. A speech walk message is not required at times when the walk interval is not timing, but, if provided:

A. It shall begin with the term “wait.”
B. It need not be repeated for the entire time that the walk interval is not timing.

If a pilot light (see EPG 902.9.5) is used at an accessible pedestrian signal location, each actuation shall be accompanied by the speech message “wait.”

Option. Accessible pedestrian signals that provide speech walk messages may provide similar messages in languages other than English, if needed.

Standard. If used, speech walk messages in a language other than English shall be stated first in English, and then repeated in the second language, alternating back and forth while the walk interval is timing.

902.11.4 Vibrotactile Arrows and Locator Tones (MUTCD Section 4K.04)

Standard. To enable pedestrians with vision disabilities to distinguish and locate the appropriate push button at an accessible pedestrian signal location, and to help them align with the crosswalk, each push button shall clearly indicate by means of a vibrotactile arrow which crosswalk signal is actuated by the push button. Vibrotactile arrows shall be located on the button of the push button assembly, shall have high visual contrast (light on dark or dark on light), and shall be aligned parallel to the direction of travel on the associated crosswalk.

A locator tone shall be incorporated into the accessible pedestrian signal equipment to help pedestrians with vision disabilities locate the vibrotactile arrow, and the associated push button if a push button is provided.

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Support. A push button locator tone is a repeating sound that informs approaching pedestrians that a push button to actuate pedestrian timing or receive additional information exists, and that enables pedestrians with vision disabilities to locate the push button.

Standard. Push button locator tones shall have a duration of 0.15 seconds or less, and except as provided in the subsequent paragraph, push button locator tones shall repeat at 1-second intervals at all times that the audible walk indication is not active, including during the pedestrian change interval and during the time that the pedestrian signal is resting in walk (see the first guidance paragraph of EPG 902.11.3).

Option. The push button locator tone may default to a deactivated mode during periods when the steady UPRAISED HAND (symbolizing DONT WALK) signal indication is being displayed for the associated crosswalk if a passive pedestrian detection system is implemented that activates the locator tone at all times (other than when the audible walk indication is active) that a pedestrian is present within a 12-foot radius from the push button location. Where pedestrian facilities (such as sidewalks) are present, the passive detection requirement may be reduced such that it only applies to pedestrians who are on the pedestrian facilities within the 12-foot radius from the push button location.

Standard. Push button locator tones shall be deactivated when the traffic control signal or pedestrian hybrid beacon is operating in a flashing mode. This requirement shall not apply to traffic control signals or pedestrian hybrid beacons that are activated from a flashing or dark mode to a steady (stop-and-go) mode by pedestrian actuations.

Push button locator tones shall be intensity responsive to ambient sound.

Guidance. Push button locator tones should be audible 6 to 12 feet from the push button, or to the building line, whichever is less.

Support. EPG 902.11.3 contains additional provisions regarding the volume and sound level of push button locator tones.

902.11.5 Extended Push Button Press Features (MUTCD Section 4K.05)

Option. Pedestrians may be provided with additional features such as audible beaconing, or a speech push button information message as a result of an extended push button press.

Standard. If an extended push button press (see EPG 902.9.5) is used to provide any additional feature(s), a push button press of less than one second shall actuate only the pedestrian timing and any associated accessible walk indication, and a push button press of one second or more shall actuate the pedestrian timing, any associated accessible walk indication, and any additional feature(s).

Support. Audible beaconing is the use of an audible signal in such a way that pedestrians with vision disabilities can home in on the signal that is located on the far end of the crosswalk as they cross the street.

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Not all crosswalks at an intersection need audible beaconing. Audible beaconing is not appropriate at locations with channelized turns or split phasing, because of the possibility of confusion.

Guidance. Audible beaconing should be considered following an engineering study at:

A. Crosswalks longer than 70 feet, unless those crosswalks are divided by a median that has another accessible pedestrian signal with a locator tone;
B. Crosswalks that are skewed;
C. Intersections with irregular geometry, such as more than four legs;
D. Crosswalks where audible beaconing is requested by a person with vision disabilities; or
E. Other locations where a study indicates audible beaconing would be beneficial.

If audible beaconing is used, it should be initiated by an extended push button press.

Standard. If audible beaconing is used, the volume of the push button locator tone during the pedestrian change interval of the called pedestrian phase shall be increased up to a maximum of 100 dBA, and shall come from a loudspeaker that is mounted at the far end of the crosswalk at a height of 7 to 10 feet above the pavement.

Guidance. The audible beaconing loudspeaker mounted at the far end of the crosswalk should be within the width of the crosswalk.

Support. When the locator tone is active during the pedestrian change interval at a traffic control signal or pedestrian hybrid beacon where audible beaconing is used, the locator tone from the audible beaconing loudspeaker is at an elevated volume, while the locator tone from the accessible pedestrian signal is at its normal, quiet setting.

Option. The sound level of the accessible pedestrian signal walk indication and subsequent push button locator tone may be increased by an extended push button press.

Speech push button information messages may provide intersection identification, as well as information about unusual intersection signalization and geometry, such as notification regarding exclusive pedestrian phasing, leading pedestrian intervals, split phasing, diagonal crosswalks, and medians or islands.

Standard. If speech push button information messages are made available by actuating the accessible pedestrian signal detector, they shall only be actuated when the walk interval is not timing. They shall begin with the term “Wait,” followed by intersection identification information modeled after: “Wait to cross Broadway at Grand.” If information on intersection signalization or geometry is also given, it shall follow the intersection identification information.

Guidance. Speech push button information messages should not be used to provide landmark information or to inform pedestrians with vision disabilities about detours or temporary traffic control situations.

Support. Additional information on the structure and wording of speech push button information messages is included in the Institute of Transportation Engineers’ “Electronic Toolbox for Making Intersections More Accessible for Pedestrians Who Are Blind or Visually Impaired.”

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902.12 Rectangular Rapid Flashing Beacons (MUTCD Chapter 4L)

902.12.1 Application of Rectangular Rapid Flashing Beacons (MUTCD Section 4L.01)

Option. A pedestrian-activated and/or bicyclist-activated rectangular rapid flashing beacon (RRFB) may be used to provide supplemental emphasis to pedestrian, school, and trail warning signs at marked crosswalks across uncontrolled approaches.

Standard. An RRFB shall only be installed to function as a Warning Beacon (see EPG 902.18.3). Except as otherwise provided in this Article, all other provisions of the MUTCD applicable to Warning Beacons shall apply to RRFBs.

An RRFB shall only be used to supplement a post-mounted W11-2 (Pedestrian), S1-1 (School), or W11-15 (Trail) crossing warning sign with a diagonal downward arrow (W16-7P) plaque, or an overhead-mounted W11-2, S1-1, or W11-15 crossing warning sign, located at or immediately adjacent to a marked crosswalk.

Except for crosswalks across the approach to or egress from a roundabout, or crosswalks across free-flow turn lanes separated by a channelizing island, an RRFB shall not be used for crosswalks across approaches controlled by YIELD signs, STOP signs, traffic control signals, or pedestrian hybrid beacons.

Option. An additional RRFB may be installed on that approach in advance of the crosswalk, as a Warning Beacon to supplement a W11-2 (Pedestrian), S1-1 (School), or W11-15 (Trail) crossing warning sign with an AHEAD (W16-9P) or distance (W16-2P or W16-2aP) plaque.

Standard. If an additional RRFB is installed on the approach in advance of the crosswalk, it shall be supplemental to and not a replacement for the RRFB at the crosswalk itself.

902.12.2 Design of Rectangular Rapid Flashing Beacons (MUTCD Section 4L.02)

Standard. Each RRFB unit shall consist of two rapidly-flashed rectangular-shaped yellow indications, each with an LED-array based pulsing light source. The size of each RRFB indication shall be at least 5 inches wide by at least 2 inches high.

The two RRFB indications for each RRFB unit shall be aligned horizontally, with the longer dimension horizontal and with a minimum space between the two indications of at least 7 inches, measured from nearest edge of one indication to the nearest edge of the other indication. The outside edges of the RRFB indications, including any housings, shall not project beyond the outside edges of the W11-2, S1-1, or W11-15 sign that it supplements.

An RRFB unit shall not be installed independent of the crossing warning signs for the approach that the RRFB faces. If the RRFB unit is supplementing a post-mounted sign, the RRFB unit shall be installed on the same support as the associated W11-2 S1-1, or W11-15 crossing warning sign and plaque. If the RRFB unit is supplementing an overhead-mounted sign, the RRFB unit shall be mounted directly above the top of the sign or below the bottom of the sign.

Option. As a specific exception to the first guidance paragraph of EPG 902.18.1, the RRFB unit associated with a post-mounted sign and plaque may be located between and immediately adjacent to the bottom of the crossing warning sign and the top of the supplemental downward diagonal arrow plaque (or, in the case of a supplemental advance sign, the AHEAD or distance plaque) or within 12 inches above the crossing warning sign, rather than the recommended minimum of 12 inches above or below the sign assembly.

Standard. For any approach on which RRFBs are used to supplement post-mounted signs, at least two W11-2 S1-1, or W11-15 crossing warning signs (each with an RRFB unit and a W16-7P plaque) shall be installed at the crosswalk, one on the right-hand side of the roadway and one on the left-hand side of the roadway.

Guidance. On a divided highway, the left-hand side RRFB assembly should be installed in the median, if practicable, rather than on the far left side of the highway.

When a pedestrian refuge island is installed in the middle of an undivided highway, an RRFB assembly should be installed on the raised median, if practicable, in addition to on the far left side of the highway, for a total of three RRFB assemblies facing each direction of traffic.

Where the median island width is less than 10', a single RRFB assembly should be installed in the middle of the island with signs and beacons facing both directions of traffic.

Where the median island width is greater than 10' an RRFB assembly should be installed on each side of the median island. Each RRFB assembly should have a sign and beacon facing traffic nearest to it.

Standard. For any approach on which RRFBs are used to supplement an overhead-mounted sign, at least one W11-2 S1-1, or W11-15 crossing warning sign (without a W16-7P plaque) located approximately over the center of the lanes of the approach (or where optimum visibility can be achieved) shall be installed at the crosswalk.

If used at intersections, the design of the RRFBs shall conform to the requirements for post-mounted or overhead placement described in the third standard paragraph of this Article.

Option. RRFBs may be installed at intersections with more than one crosswalk on the same uncontrolled approach (see Figure 902.12.2).

Support. Devices for typical RRFB applications are shown in the RRFB Special Sheet Detail.

If used at intersections with two crosswalks on an uncontrolled approach, post-mounted RRFBs may be installed to face only one direction of travel at the first crosswalk that traffic encounters (see Figure 902.12.2).

Standard. The light intensity of the yellow indications during daytime conditions shall meet the minimum specifications for Class 1 yellow peak luminous intensity in the publication "Directional Flashing Optical Warning Devices for Authorized Emergency, Maintenance, and Service Vehicles J595," 2005, Society of Automotive Engineers (SAE).

Option. If the RRFB indications are so bright that they cause excessive glare during nighttime conditions, an automatic signal dimming device may be used to reduce the brilliance of the RRFB indications during nighttime conditions.

Standard. If pedestrian push button detectors (rather than passive detection) are used to actuate the RRFB indications, a PUSH BUTTON FOR WARNING LIGHTS/WAIT FOR GAP IN TRAFFIC (R10-25) sign (see EPG 903.2.47) shall be installed adjacent to a pedestrian push button detector explaining the purpose and use of the pedestrian push button detector.

Support. EPG 902.9.5 contains further information about pedestrian push button detector location criteria.

EPG 902.8.12 contains information about bicyclist push buttons.

Guidance. An audible information device should be used with RRFBs to assist pedestrians with vision disabilities.

Option. A small light directed at and visible to pedestrians in the crosswalk may be installed integral to the RRFB or pedestrian push button detector to give confirmation that the RRFB is in operation.

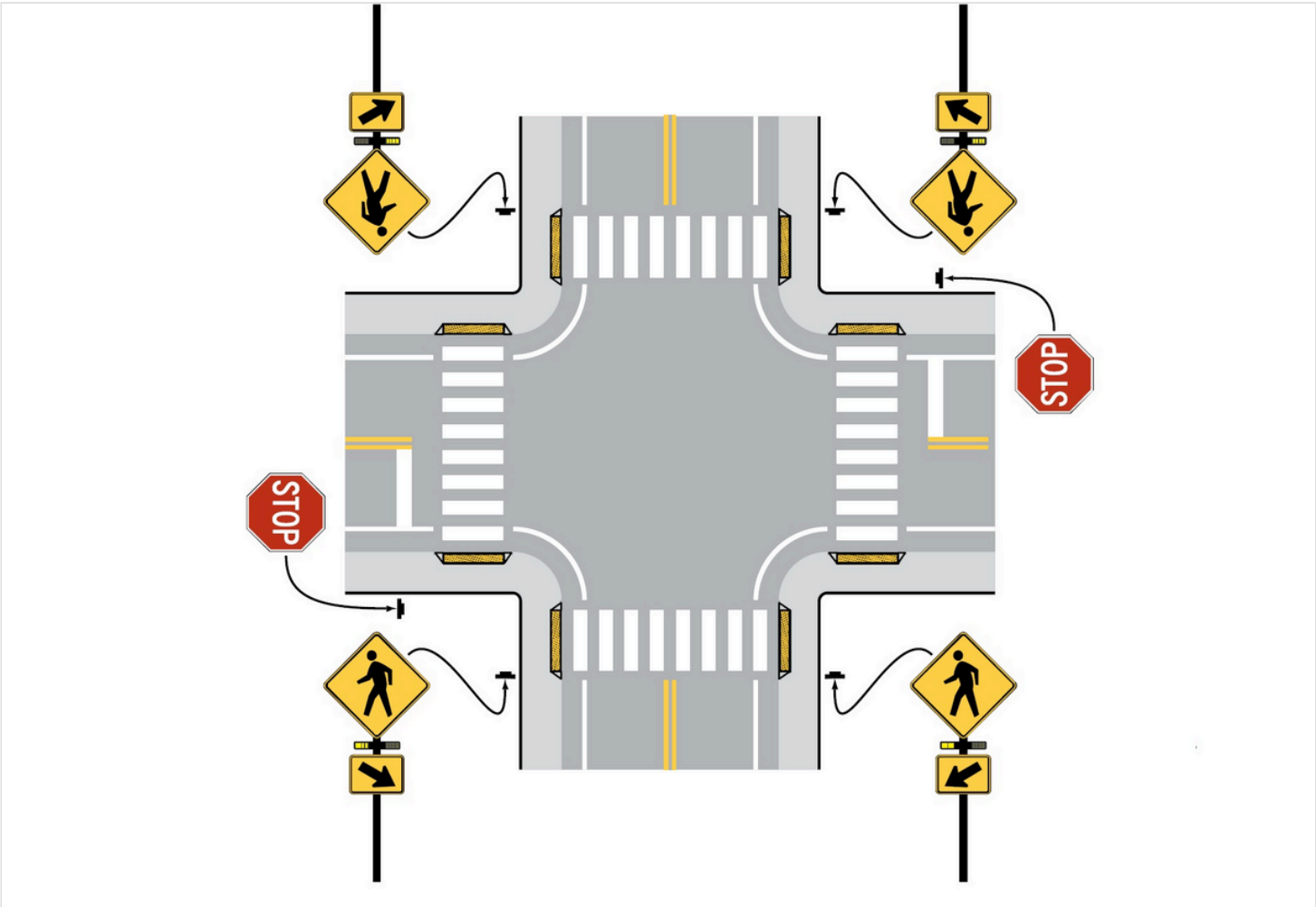


Figure 902.12.2 Example of RRFBs at Uncontrolled, Marked Crosswalks at an Intersection

Notes:

1. When activated, the RRFBs on both approaches shall simultaneously commence operation of their rapid flashing indications and shall cease operation simultaneously.
2. If place overhead, follow the requirements of the tenth paragraph of EPG 902.12.2, except that the signs may be placed approximately over the center of the intersection.

902.12.3 Operation of Rectangular Rapid Flashing Beacons (MUTCD Section 4L.03)

Standard. The RRFB shall be normally dark, shall initiate operation only upon pedestrian actuation, and shall cease operation at a predetermined time after the pedestrian actuation or, with passive detection, after the pedestrian clears the crosswalk.

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All RRFB units associated with a given crosswalk (including those with an advance crossing sign, if used) shall, when activated, simultaneously commence operation of their rapid flashing indications and shall cease operation simultaneously.

Guidance. The minimum duration of a predetermined period of operation of the RRFBs following each actuation should be based on the procedures for the timing of pedestrian clearance times for pedestrian signals (see EPG 902.9.6).

Support. One consideration for lengthening the duration of the predetermined period of operation of the RRFBs is adding the perception/reaction time for pedestrians to confirm that a vehicle will yield or stop.

Standard. The predetermined flash period shall be immediately initiated each and every time that a pedestrian is detected either through passive detection or as a result of a pedestrian pressing a push button detector, including when pedestrians are detected while the RRFBs are already flashing and when pedestrians are detected immediately after the RRFBs have ceased flashing.

When activated, the two yellow indications in each RRFB unit shall flash in a rapidly flashing sequence. As a specific exception to the requirements for the flash rate of beacons provided in the second standard paragraph of EPG 902.18.1, RRFBs shall use a much faster flash rate and shall provide 75 flashing sequences per minute.

Except as provided in the subsequent paragraph, during each 800-millisecond flashing sequence, the left and right RRFB indications shall operate using the following sequence:

A. The RRFB indication on the left-hand side shall be illuminated for approximately 50 milliseconds.
B. Both RRFB indications shall be dark for approximately 50 milliseconds.
C. The RRFB indication on the right-hand side shall be illuminated for approximately 50 milliseconds.
D. Both RRFB indications shall be dark for approximately 50 milliseconds.
E. The RRFB indication on the left-hand side shall be illuminated for approximately 50 milliseconds.
F. Both RRFB indications shall be dark for approximately 50 milliseconds.
G. The RRFB indication on the right-hand side shall be illuminated for approximately 50 milliseconds.
H. Both RRFB indications shall be dark for approximately 50 milliseconds.
I. Both RRFB indications shall be illuminated for approximately 50 milliseconds.
J. Both RRFB indications shall be dark for approximately 50 milliseconds.
K. Both RRFB indications shall be illuminated for approximately 50 milliseconds.
L. Both RRFB indications shall be dark for approximately 250 milliseconds.

The flash rate of each individual RRFB indication, as applied over the full flashing sequence, shall not be more than 5 flashes per second, to avoid frequencies that might cause seizures.

If an audible information device is used in conjunction with an RRFB, the audible information device shall not use vibrotactile indications or percussive indications. The audible information device shall include a speech message that says, “Warning lights are flashing.” The audible message shall be spoken twice.

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902.13 Traffic Control Signals for Emergency-Vehicle Access (MUTCD Chapter 4M)

902.13.1 Application of Emergency-Vehicle Traffic Control Signals (MUTCD Section 4M.01)

Support. An emergency-vehicle traffic control signal is a special traffic control signal that directs all conflicting traffic to stop in order to permit the driver of an authorized emergency vehicle to proceed into the roadway or intersection.

Standard. An Emergency-Vehicle Traffic Control Signal shall be installed only at intersections where an emergency vehicle facility is located on a state highway and the emergency vehicle, upon leaving the facility, enters directly onto that highway.

Option. An emergency-vehicle traffic control signal may be installed at a location that does not meet other traffic signal warrants such as at an intersection or other location to permit direct access from a building housing the emergency vehicle.

An emergency-vehicle hybrid beacon may be installed instead of an emergency-vehicle traffic control signal under the conditions described in EPG 902.14.1.

Guidance. If a traffic control signal is not justified under the signal warrants of EPG 902.3 and if gaps in traffic are not adequate to permit the timely entrance of emergency vehicles, or the stopping sight distance for vehicles approaching on the major street is insufficient for emergency vehicles, installing an emergency-vehicle traffic control signal should be considered. If one of the signal warrants of EPG 902.3 is met and a traffic control signal is justified by an engineering study, and if a decision is made to install a traffic control signal, it should be installed based upon the provisions of EPG 902.4 through EPG 902.9 and EPG 902.11.

The sight distance determination should be based on the location of the visibility obstruction for the critical approach lane for each street or drive and the posted or statutory speed limit or 85th-percentile speed on the major street, whichever is higher.

Standard. For a new emergency vehicle signal installation, the emergency entity, city, or other organization having control over the emergency equipment, shall be required to pay the full cost of construction and will be required to maintain the equipment.

Support. The MoDOT district uses the applicant's request and supporting data to approve the installation. If approval is given, a contract is executed between the Missouri Highway and Transportation Commission and the proper local authorities or organization that covers the

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installation, maintenance, and operation of such a signal.

Normally, a push button is located in the emergency facility. The push button and the connection (wireless or wired) to the signal will be provided and maintained by the emergency facility.

Upon completion of the installation, the requesting party will be responsible for all maintenance, replacement costs, and power costs.

The TR06 Emergency Vehicle Signal Agreement is the standard agreement to be used.

See EPG 902.6.18 for preemption.

902.13.2 Design of Emergency-Vehicle Traffic Control Signals (MUTCD Section 4M.02)

Standard. Except as otherwise provided in this Article, an emergency-vehicle traffic control signal shall meet the requirements of the EPG.

An Emergency Vehicle (W11-8) sign (see EPG 903.3.52) with an EMERGENCY SIGNAL AHEAD (W11-12P) supplemental plaque shall be placed in advance of all emergency-vehicle traffic control signals. If a Warning Beacon is installed to supplement the W11-8 sign, the design and location of the beacon shall comply with the Standards of EPG 902.18.1 and 902.18.3.

Guidance. At least one of the two required signal faces for each approach on the major street should be located over the roadway.

Standard. 12-inch diameter signal indications shall be used for emergency-vehicle traffic control signals.

An EMERGENCY SIGNAL (R10-13) sign (see EPG 903.2.48) shall be installed facing each major-street approach.

If an overhead signal face is provided, the EMERGENCY SIGNAL sign shall be mounted adjacent to the overhead signal face.

Guidance. An approach that only serves emergency vehicles should be provided with only one signal face consisting of one or more signal sections.

Support. See Figure 902.13.2 below for standard emergency vehicle signal installation.

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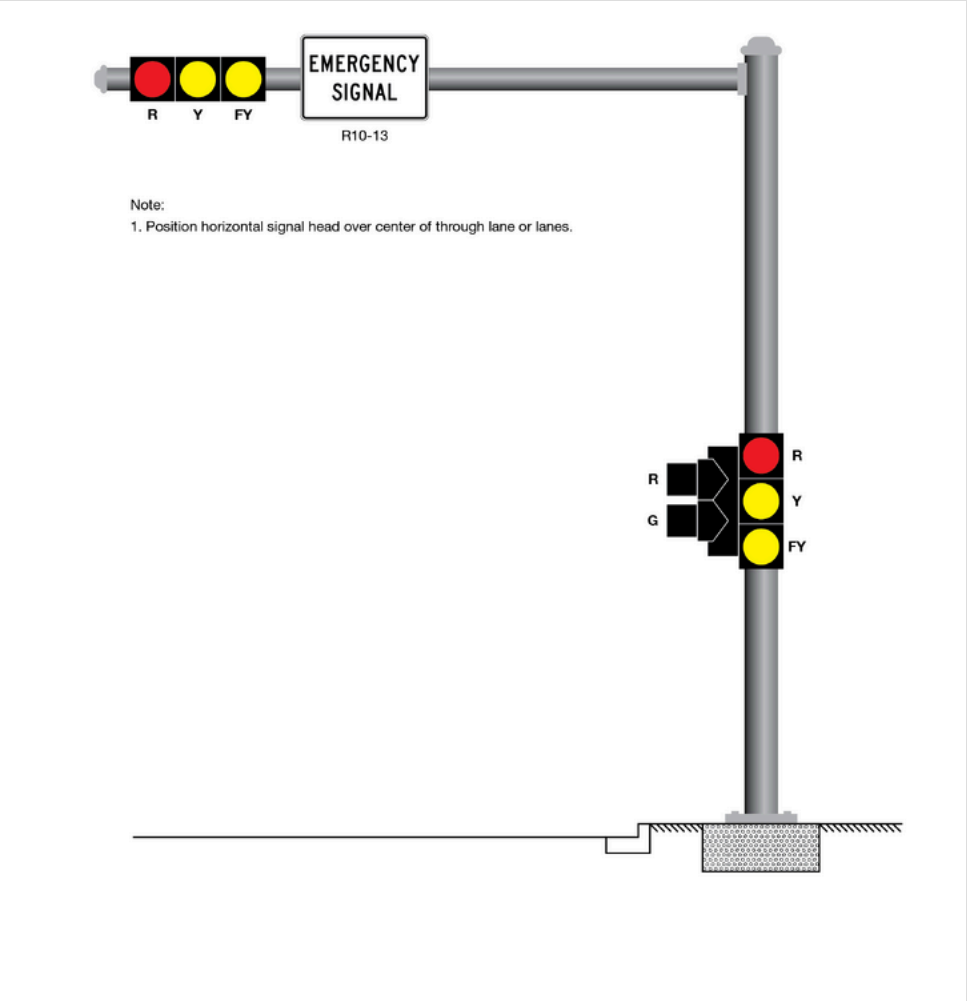


Figure 902.13.2 Typical Emergency Vehicle Signal Layouts

902.13.3 Operation of Emergency-Vehicle Traffic Control Signals (MUTCD Section 4M.03)

Standard. Green signal indications for emergency vehicles at signalized locations operating in the steady (stop-and-go) mode shall be obtained as provided in EPG 902.6.19.

As a minimum, the signal indications, sequence, and manner of operation of an emergency-vehicle traffic control signal installed at a midblock location shall be as follows:

A. The signal indication, between emergency-vehicle actuations, shall be flashing yellow. The flashing yellow signal shall be displayed in the normal position of the green signal indication, while the steady red and steady yellow signal indications shall be displayed in their normal positions.
B. When an emergency-vehicle actuation occurs, a steady yellow change interval followed by a steady red interval shall be displayed to traffic on the major street.
C. A yellow change interval is not required following the green interval for the emergency-vehicle driveway.

Emergency-vehicle traffic control signals located at intersections shall either be operated in the flashing mode (see EPG 902.7.1 and EPG 902.7.3) between emergency-vehicle actuations or be full-actuated or semi-actuated to accommodate normal vehicular and pedestrian traffic on the streets.

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Warning Beacons, if used with an emergency-vehicle traffic control signal, shall be flashed only:

A. For an appropriate time in advance of and during the steady yellow change interval for the major street, and
B. During the steady red interval for the major street.

Option. An emergency-vehicle traffic control signal sequence may be initiated manually from a local control point such as a fire station, law enforcement headquarters, other emergency vehicle facility, or from an emergency vehicle equipped for remote operation of the signal.

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902.14 Hybrid Beacons for Emergency-Vehicle Access (MUTCD Chapter 4N)

902.14.1 Application of Emergency-Vehicle Hybrid Beacons (MUTCD Section 4N.01)

Standard. Emergency-vehicle hybrid beacons shall be used only in conjunction with signs to warn and control traffic at an unsignalized location where emergency vehicles enter or cross a street or highway. Emergency-vehicle hybrid beacons shall be actuated only by authorized emergency or maintenance personnel.

Guidance. Emergency-vehicle hybrid beacons should only be used when all of the following criteria are satisfied:

A. The conditions justifying an emergency-vehicle traffic control signal (see EPG 902.13.1) are met;
B. An engineering study, considering the road width, approach speeds, and other pertinent factors, determines that emergency-vehicle hybrid beacons can be designed and located in compliance with the requirements contained in this Article and in EPG 902.18.1, such that they effectively warn and control traffic at the location; and
C. The location is not at or within 100 feet from an intersection or driveway where the side road or driveway is controlled by a STOP or YIELD sign.

902.14.2 Design of Emergency-Vehicle Hybrid Beacons (MUTCD Section 4N.02)

Standard. Except as otherwise provided in this Article, an emergency-vehicle hybrid beacon shall meet the requirements of the EPG.

An emergency-vehicle hybrid beacon face shall consist of three signal sections, with a CIRCULAR YELLOW signal indication centered below two horizontally aligned CIRCULAR RED signal indications (see Figure 902.14.2).

At least two emergency-vehicle hybrid beacon faces shall be installed for each approach of the major street and at least one of the emergency-vehicle hybrid beacon faces shall be installed over the roadway.

Guidance. On approaches having posted or statutory speed limits or 85th-percentile speeds in excess of 40 mph, and on approaches having traffic or operating conditions that would tend to obscure visibility of roadside beacon faces, both of the minimum of two emergency-vehicle hybrid beacon faces should be installed over the roadway.

An emergency-vehicle hybrid beacon should comply with the signal face location provisions described in Sections EPG 902.4.5 through EPG 902.4.10.

Standard. Stop lines and EMERGENCY SIGNAL—STOP ON FLASHING RED (R10-14 or R10-14a) signs (see EPG 903.2.48) shall be used with emergency-vehicle hybrid beacons for each approach of the major street.

Option. If needed for extra emphasis, a STOP HERE ON FLASHING RED (R10-14b) sign (see EPG 903.2.48) may be installed with an emergency-vehicle hybrid beacon.

Emergency-vehicle hybrid beacons may be equipped with a light or other display visible to the operator of the egressing emergency vehicle to provide confirmation that the beacons are operating.

Emergency-vehicle hybrid beacons may be supplemented with an advance warning sign, which may also be supplemented with a Warning Beacon (see EPG 902.18.3).

Standard. If a Warning Beacon is used to supplement the advance warning sign, it shall be programmed to flash only when the emergency-vehicle hybrid beacon is not in the dark mode.

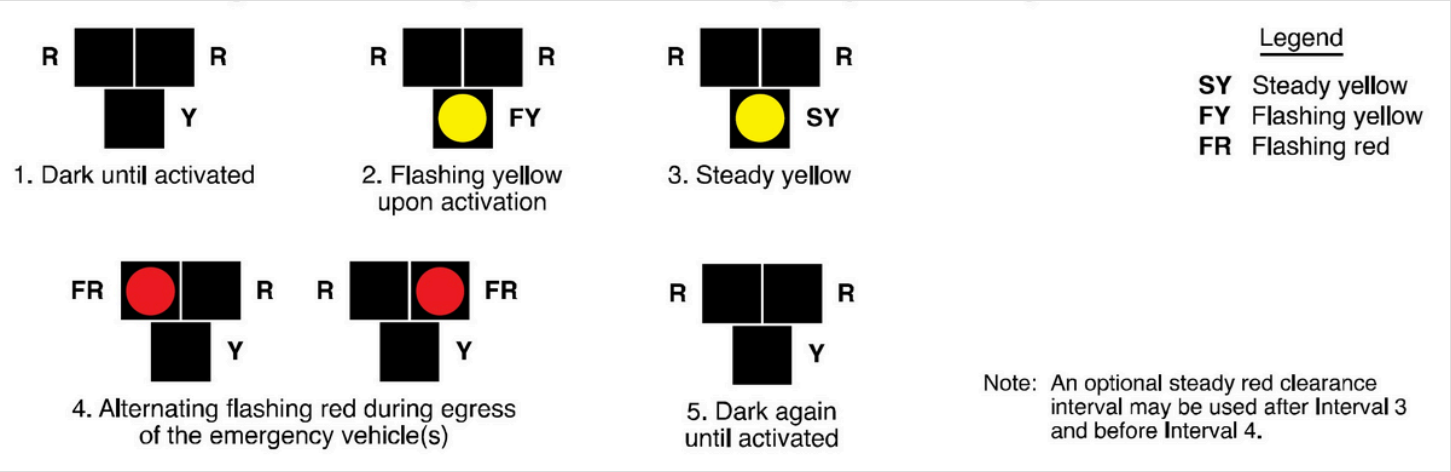


Figure 902.14.2 Sequence for an Emergency-Vehicle Hybrid Beacon

902.14.3 Operation of Emergency-Vehicle Hybrid Beacons (MUTCD Section 4N.03)

Standard. Emergency-vehicle hybrid beacons shall be placed in a dark mode (no indications displayed) during periods between actuations.

Upon actuation by authorized emergency personnel, the emergency-vehicle hybrid beacon faces shall each display a flashing yellow signal indication, followed by a steady yellow change interval, prior to displaying two CIRCULAR RED signal indications in an alternating flashing array for a duration of time adequate for egress of the emergency vehicles (see Figure 902.14.2). The alternating flashing red signal indications shall only be displayed when it is required that drivers on the major street stop and then proceed subject to the rules applicable after making a stop at a STOP sign. Upon termination of the flashing red signal indications, the emergency-vehicle hybrid beacons shall revert to a dark mode (no indications displayed) condition.

Guidance. The duration of the flashing yellow interval should be determined by engineering judgment.

Standard. The duration of the steady yellow change interval shall be determined using engineering practices in accordance with the provisions in EPG 902.6.17.

Guidance. A yellow change interval should have a minimum duration of 3 seconds and a maximum duration of 6 seconds (see EPG 902.6.17). The longer intervals should be reserved for use on approaches with higher speeds.

Option. A steady red clearance interval may be used after the steady yellow change interval.

Guidance. An emergency-vehicle hybrid beacon that is located 200 feet or less from an active grade crossing should be preempted in accordance with the applicable provisions in EPG 902.6.19 and EPG 913.4.9.

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Standard. If an emergency-vehicle hybrid beacon is placed into a flashing mode by a conflict monitor (malfunction management unit) or by a manual switch, the emergency-vehicle hybrid beacon faces shall display flashing yellow signal indications to each approach of the major street.

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902.15 Traffic Control Signals for One-Lane, Two-Way Facilities (MUTCD Chapter 4O)

902.15.1 Application of Traffic Control Signals for One-Lane, Two-Way Facilities (MUTCD Section 4O.01)

Support. A traffic control signal at a narrow bridge, tunnel, or roadway section that is not of sufficient width for two opposing vehicles to pass is a special signal that alternates which direction of travel is permitted to proceed.

Temporary traffic control signals (see EPG 902.4.11 and EPG 616.12.1) are the most frequent application of traffic control signals for one-lane, two-way facilities.

Guidance. Sight distance across or through the one-lane, two-way facility should be considered as well as the approach speed and sight distance approaching the facility when determining whether traffic control signals should be installed.

Option. At a narrow bridge, tunnel, or roadway section where a traffic control signal is not justified under the conditions of EPG 902.3, a traffic control signal may be used if gaps in opposing traffic do not permit the flow of traffic through the one-lane section of roadway.

902.15.2 Design of Traffic Control Signals for One-Lane, Two-Way Facilities (MUTCD Section 4O.02)

Standard. The provisions of EPG 902.4 through EPG 902.7 shall apply to traffic control signals for one-lane, two-way facilities, except that:

A. The durations of the red clearance intervals shall be adequate to clear the one-lane section of conflicting vehicles; and
B. Adequate means, such as interconnection, shall be provided to prevent conflicting signal indications, such as green and green, at opposite ends of the section.

902.15.3 Operation of Traffic Control Signals for One-Lane, Two-Way Facilities (MUTCD Section 4O.03)

Guidance. Traffic control signals at one-lane, two-way facilities should operate in a manner consistent with traffic requirements.

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Adequate time should be provided to allow traffic to clear the narrow facility before opposing traffic is allowed to move. Engineering judgment should be used to determine the proper timing for the signal.

Standard. When in the flashing mode, the signal indications shall flash red.

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902.16 Traffic Control Signals for Freeway Entrance Ramps (MUTCD Chapter 4P)

902.16.1 Application of Freeway Entrance Ramp Control Signals (MUTCD Section 4P.01)

Support. Ramp control signals are traffic control signals that control the flow of traffic entering the freeway facility. This is often referred to as “ramp metering.”

Freeway entrance ramp control signals are sometimes used if controlling traffic entering the freeway could reduce the total expected delay to traffic in the freeway corridor, including freeway ramps and local streets.

Guidance. The installation of ramp control signals should be preceded by an engineering study of the physical and traffic conditions on the highway facilities likely to be affected. The study should include the ramps and ramp connections and the surface streets that would be affected by the ramp control, as well as the freeway section concerned.

Support. Information on conditions that might justify freeway entrance ramp control signals, factors to be evaluated in traffic engineering studies for ramp control signals, design of ramp control signals, and operation of ramp control signals can be found in the FHWA’s “Ramp Management and Control Handbook.”

902.16.2 Design of Freeway Entrance Ramp Control Signals (MUTCD Section 4P.02)

Standard. Ramp control signals shall meet all of the standard design specifications for traffic control signals, except as otherwise provided in this Article.

The signal face for freeway entrance ramp control signals shall be either a two-section signal face containing red and green signal indications or a three-section signal face containing red, yellow, and green signal indications.

Option. Ramp control signals may be placed in the dark mode (no indications displayed) when not in use.

Ramp control signals may be used to control some, but not all, lanes on a ramp, such as when non-metered HOV bypass lanes are provided on a ramp.

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Standard. If only one controlled lane is present on an entrance ramp, or if more than one controlled lane is present on an entrance ramp and the ramp control signals are operated such that green signal indications are always displayed simultaneously to all of the controlled lanes on the ramp, then a minimum of two signal faces per ramp shall face entering traffic.

If two controlled lanes are present on an entrance ramp and the ramp control signals are operated such that green signal indications are not always displayed simultaneously to both of the controlled lanes on the ramp, then one signal face shall be provided over the approximate center of each separately-controlled lane.

If three or more controlled lanes are present on an entrance ramp and the ramp control signals are operated such that green signal indications are not always displayed simultaneously to all of the controlled lanes on the ramp, then one signal face shall be provided over the approximate center of each separately-controlled lane.

Guidance. Additional side-mounted signal faces should be considered for ramps with three or more separately-controlled lanes.

Option. For entrance ramps with only one controlled lane, the two required signal faces may both be mounted at the side of the roadway on a single pole (as a specific exception to the normal 8-foot minimum lateral separation of signal faces required by EPG 902.4.7), with the lower signal face installed at a minimum mounting height of 4.5 feet.

For entrance ramps with two or more controlled lanes, if two signal faces are installed for the right-hand lane or for the left-hand lane, the two signal faces for that lane may both be mounted at the closest side of the roadway on a single pole (as a specific exception to the normal 8-foot minimum lateral separation of signal faces required by EPG 902.4.7), with the lower signal face installed at a minimum mounting height of 4.5 feet.

Standard. Ramp control signals shall be located and designed to minimize their viewing by mainline freeway traffic.

Guidance. Regulatory signs with legends appropriate to the control, such as XX VEHICLE(S) PER GREEN or XX VEHICLE(S) PER GREEN EACH LANE (see EPG 903.2.50), should be installed.

When ramp control signals are installed on a freeway-to-freeway ramp, special consideration should be given to assuring adequate visibility of the ramp control signals, and multiple advance warning signs with flashing Warning Beacons should be installed to warn road users of the metered operation.

902.16.3 Operation of Freeway Entrance Ramp Control Signals (MUTCD Section 4P.03)

Guidance. Operational strategies for ramp control signals, such as periods of operation, metering rates and algorithms, and queue management, should be determined by the operating agency prior to the installation of the ramp control signals and should be closely monitored and adjusted as needed thereafter.

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When the ramp control signals are operated only during certain periods of the day, a RAMP METERED WHEN FLASHING (W3-8) sign (see EPG 903.3.30) should be installed in advance of the ramp control signal near the entrance to the ramp, or on the arterial on the approach to the ramp, to alert road users to the presence and operation of ramp meters.

Standard. The RAMP METERED WHEN FLASHING sign shall be supplemented with a Warning Beacon (see EPG 902.18.3) that flashes when the ramp control signal is in operation (controlling the flow of traffic entering the freeway). Flashing light-emitting diode (LED) units shall not be used within the legend or border of the sign.

Support. The use of LEDs in the legend or border of signs is described in EPG 903.1.12.

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902.17 Highway Traffic Signals at Toll Plazas (MUTCD Chapter 4R)

Not Currently Used by MoDOT

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902.18 Flashing Beacons (MUTCD Chapter 4S)

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902.18.6 Interactive Flashing Beacon
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902.18.1 General Design and Operation of Flashing Beacons (MUTCD Section 4S.01)

Support. A flashing beacon is a highway traffic signal with one or more signal sections that operates in a flashing mode. It can provide traffic control when used as an Intersection Control Beacon (see EPG 902.18.2) or it can provide warning when used in other applications (see EPG 902.18.3, 902.18.4, and 902.18.5).

A flashing beacon can be installed by MoDOT or by outside parties. An engineering study is to be performed to determine the need for them.

The removal or installation of a flashing beacon on the State Highway System requires approval of the District Traffic Engineer or designee.

Standard. Flashing beacon units, their mountings, signal visors, and backplates shall comply with the provisions of EPG 902.4 and 902.5 except as otherwise provided in this Article.

Beacons shall be flashed at a rate of not less than 50 or more than 60 times per minute. The illuminated period of each flash shall be a minimum of ½ and a maximum of ⅔ of the total cycle.

A beacon shall not be included within the border of a sign except for Interchange Exit Direction signs with advisory speed panels (see EPG 903.5.25).

All flashing beacon signal indications shall be 12 inches in diameter.

Guidance. If used to supplement a warning or regulatory sign, the edge of the beacon signal housing should normally be located no closer than 12 inches outside of the nearest edge of the sign or from the nearest edge of any of the signs and plaques in a sign assembly.

Option. An automatic dimming device may be used to reduce the brilliance of flashing yellow signal indications during night operation.

Backplates (see EPG 902.4.6) may be used with flashing beacons.

902.18.2 Intersection Control Beacon (MUTCD Section 4S.02)

Standard. An Intersection Control Beacon shall consist of one or more signal faces directed toward each approach to an intersection. Each signal face shall consist of one or more signal sections of a standard traffic signal face, with flashing CIRCULAR YELLOW or CIRCULAR RED signal indications in each signal face. They shall be installed and used only at an intersection to control two or more directions of travel.

Application of Intersection Control Beacon signal indications shall be limited to the following:

A. Yellow on one route (normally the major street) and red for the remaining approaches that are controlled by STOP signs, or
B. Red for all approaches (if all of the intersection approaches are controlled by STOP signs).

Flashing yellow signal indications shall not face conflicting vehicular approaches.

A STOP sign (see EPG 903.2.4) shall be used on approaches to which a flashing red signal indication is displayed on an Intersection Control Beacon.

If two horizontally-aligned red signal indications are used on an approach for an Intersection Control Beacon, they shall be flashed simultaneously to avoid being confused with grade crossing flashing-light signals. If two vertically-aligned red signal indications that have a physical separation between them are used on an approach for an Intersection Control Beacon, they shall be flashed alternately.

Twelve-inch signal indications shall be used for Intersection Control.

When an overhead beacon is authorized for installation at an intersection, the support pole shall be placed in accordance with the AASHTO Roadside Design Guide clear zone guidelines.

All intersection control beacons shall be installed and/or maintained to provide a minimum clearance of 16 feet and a maximum clearance of 19 feet above the pavement grade.

A pole on state right of way owned by others shall not be used to support a span wire flasher. If an adjustment of the location for a department installed pole cannot be made, the existing pole shall be moved at the expense of the owner.

Support. Hybrid beacons (pedestrian and emergency) are not considered intersection control beacons and are not subject to provisions stated in the section.

Provisions for pedestrian hybrid beacons are described in EPG 902.10.

Provisions for emergency hybrid beacons are described in EPG 902.14.

Guidance. An intersection control beacon should be considered at intersections when any of the following conditions apply:

A. A required stop after a long period of uninterrupted speed,

B. A required stop on a long tangent section of roadway where cross-street traffic may have trouble judging the distance and speed of an oncoming vehicle,

C. A stop condition not readily visible to the approaching driver,

D. A situation where traffic on the major roadway may not be aware of cross-street traffic.

An Intersection Control Beacon should not be mounted on a pedestal in the roadway unless the pedestal is within the confines of a traffic or pedestrian island.

Option. Supplemental signal indications may be used on one or more approaches in order to provide adequate visibility to approaching road users.

Intersection Control Beacons may be used at intersections where traffic or physical conditions do not justify conventional traffic control signals but crash rates indicate the possibility of a special need.

An Intersection Control Beacon is generally located over the center of an intersection; however, it may be used at other suitable locations.

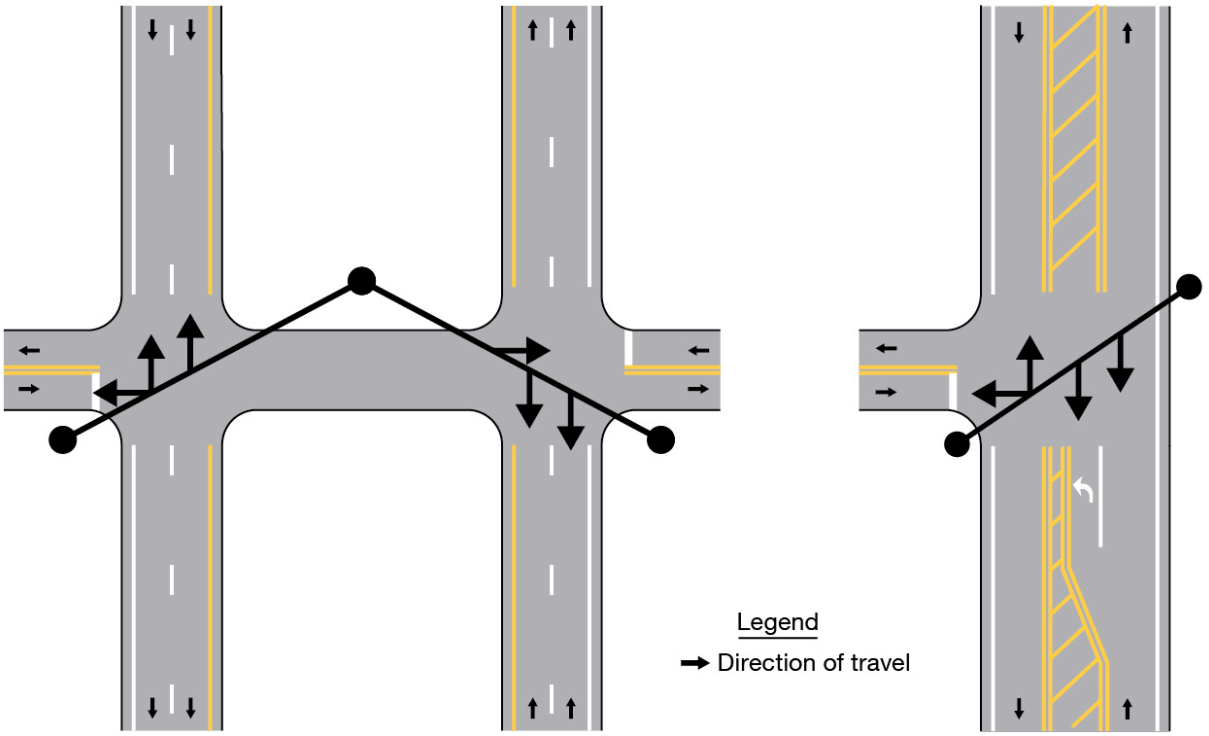


Figure 902.18.2 Typical Intersection Control Beacon Configuration

902.18.3 Warning Beacon (MUTCD Section 4S.03)

Support. Typical applications of Warning Beacons include the following:

A. As supplemental emphasis to signs or object markers on or in front of obstructions that are in or immediately adjacent to the roadway;
B. As supplemental emphasis to warning signs;
C. As emphasis for midblock crosswalks;
D. As supplemental emphasis to regulatory signs, except STOP, DO NOT ENTER, WRONG WAY, and SPEED LIMIT signs; and
E. In conjunction with a regulatory sign that includes the phrase WHEN FLASHING in its legend to indicate that the regulation is in effect or that the condition is present only at certain times. EPG 903.1.12 prohibits the use of flashing light-emitting diode (LED) units within the legend or border of the sign in conjunction with the phrase WHEN FLASHING in its legend.

Standard. A Warning Beacon shall consist of one or more signal sections of a standard traffic signal face with a flashing CIRCULAR YELLOW signal indication in each signal section.

A Warning Beacon shall be used only to supplement an appropriate warning or regulatory sign or marker.

Warning Beacons, if used at intersections, shall not face conflicting vehicular approaches.

Guidance. The condition or regulation justifying Warning Beacons should largely govern their location with respect to the roadway.

If an obstruction is in or adjacent to the roadway, illumination of the lower portion or the beginning of the obstruction or illumination of the sign on or in front of the obstruction, in addition to the beacon, should be considered.

Warning Beacons should be operated only during those periods or times when the condition or regulation exists.

Option. If Warning Beacons have more than one signal section, they may be flashed either alternately or simultaneously.

Warning Beacons that are actuated by pedestrians, bicyclists, or other road users may be used as appropriate to provide additional warning to vehicles approaching a crossing or other location.

Guidance. An audible information device should be used with pedestrian-actuated Warning Beacons to assist pedestrians with vision disabilities.

Standard. If an audible information device is used in conjunction with a pedestrian-actuated Warning Beacon at a pedestrian crossing, the audible information device shall not use vibrotactile indications or percussive indications. The audible information device shall include a speech message that says, “Warning lights are flashing.” The audible message shall be spoken twice.

Option. Warning Beacons may be installed in conjunction with School Zone signing (See EPG 908.2.2) at the request of the school district and at their cost.

Warning Beacons may be installed in conjunction with Emergency Vehicle (W11-8) signs (See 903.3.44) at the request of the emergency vehicle service district and at their cost.

Standard. Warning Beacons installed in conjunction with school zone signing shall only operate when there is activity at the school.

Support. Emergency vehicle Warning Beacons are set up to operate only when emergency vehicles are exiting the station or garage on a duly authorized emergency run. These Warning Beacons enhance the meaning of the advanced signing by only flashing when emergency activity is occurring.

902.18.4 Speed Limit Sign Beacon (MUTCD Section 4S.04)

Standard. A Speed Limit Sign Beacon shall be used only to supplement a Speed Limit sign.

A Speed Limit Sign Beacon shall consist of one or more signal sections of a standard traffic control signal face, with a flashing CIRCULAR YELLOW signal indication in each signal section. The signal indications shall have a nominal diameter of not less than 12 inches. If two signal indications are used, they shall be vertically aligned. If two signal indications are used, they shall be alternately flashed.

Option. A Speed Limit Sign Beacon may be used with a fixed or variable Speed Limit sign. If applicable, a flashing Speed Limit Sign Beacon (with an appropriate accompanying sign) may be used to indicate that the displayed speed limit is in effect.

Speed Limit Sign beacons may be installed in conjunction with School Speed Limit signing (See EPG 908.2.5) at the request of the school district and at their cost.

Standard. When School Speed Limit signing (See EPG 908.2.5) is installed, Speed Limit Sign Beacons shall be installed in conjunction with the School Speed Limit Signing.

Speed Limit Sign Beacons installed in conjunction with School Speed Limit signing shall only operate at times when the school speed limit applies.

902.18.5 Stop Beacon (MUTCD Section 4S.05)

Standard. A Stop Beacon shall be used only to supplement a STOP sign, a DO NOT ENTER sign, or a WRONG WAY sign.

A Stop Beacon shall consist of one or more signal sections of a standard traffic signal face with a flashing CIRCULAR RED signal indication in each signal section. If two horizontally-aligned signal indications are used for a Stop Beacon, they shall be flashed simultaneously to avoid being confused with grade crossing flashing-light signals. If two vertically-aligned signal indications are used for a Stop Beacon, they shall be flashed alternately.

The edge of the signal housing of a Stop Beacon shall be not less than 12 inches or more than 24 inches from the nearest edge of the STOP sign, DO NOT ENTER sign, or WRONG WAY sign that it supplements.

902.18.6 Interactive Flashing Beacon

Option. Types of interactive flashing beacons may be any of the previously mentioned types of beacons. These beacons may be accompanied with signs that reinforce the message. Examples include: beacons activated by approaching traffic or excessive speed, beacons used to give advance warning of a yellow change interval at a signalized intersection or beacons used to notify motorists of traffic stopped ahead. Beacons activated when motorists exceed a posted speed may be used where conditions require a reduction in traffic speed. Examples of this use include low speed curves or where drivers regularly exceed the posted speed limit. Beacons activated a few seconds before (or at the start of) the yellow change interval at a signalized intersection may be used to give high speed traffic advance warning of the signal changing from green to yellow.

Standard. Interactive flashing beacons shall be activated only when required.

902.18.7 Procedures for Advance Beacon Installations by Outside Parties

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Standard. Advance beacons such as school warning, school speed limit, and emergency vehicle warning beacons are installed under contract. The district will obtain appropriate signed contracts and will follow execution guidelines in EPG 153.21. These contracts deal with the installation and transfer of ownership of the installation from the outside party to the Commission.

Support. The following standard contracts are available:

1. TR8 - Installation of Roadside Flashers for School Operation
2. TR26 - Installation of Roadside Flashers for Emergency Vehicle Operation

Standard. Plans for installation shall be the responsibility of the outside party and shall conform to the latest standards of MoDOT.

Once the contract is executed, a permit to work on MoDOT's right-of-way shall be obtained by the outside party. Once issued, the outside party may proceed to install the beacons. A contractor or the outside party shall complete the installation; however, a licensed electrician shall supervise the installation. The outside party needs to coordinate with MoDOT prior to installation of the flasher to have MoDOT personnel verify hardware and equipment is acceptable for use on the state highway system. Upon completion of installation, MoDOT personnel shall verify correct installation prior to release of the permit and acceptance of the flasher.

General layouts for an intersection control beacon are illustrated in Figure 902.18.2.

All costs shall be the responsibility of the outside party. This includes but is not limited to installation and power; however, the signs and mounting brackets shall be supplied by MoDOT. All specifications shall be met to ensure the proper installation is in place.

Beacons shall be active only during those times when the conditions of the advance signing are applicable or when the enhancement of the signed message is needed. The times of operation, timing, and method of operation are approved by MoDOT.

The contract shall establish responsibility for future maintenance, power costs, programming ownership, and replacement equipment.

Flashing beacons shall only be installed on advanced signing or on school speed limit signing.

Only one flasher assembly shall be permitted per approach.

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902.19 Lane-Use Control Signals (MUTCD Chapter 4T)

Not Currently Used by MoDOT

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902.20 In-Roadway Warning Lights (MUTCD Chapter 4U)

902.20.1 Application of In-Roadway Warning Lights (MUTCD Section 4U.01)

Support. In-Roadway Warning Lights are special types of highway traffic signals installed in the roadway surface to warn road users that they are approaching a condition on or adjacent to the roadway that might not be readily apparent and might require the road users to reduce their speed and/or come to a stop. This includes situations warning of marked school crosswalks, marked midblock crosswalks, marked crosswalks on uncontrolled approaches, marked crosswalks in advance of roundabouts as described in EPG 620.4, and other roadway situations involving pedestrian crossings.

Standard. In-Roadway Warning Lights shall not be used for any application that is not described in this Article.

When used, In-Roadway Warning Lights shall be flashed and shall not be steadily illuminated.

Support. Steadily illuminated lights installed in the roadway surface are considered to be internally illuminated raised pavement markers (see EPG 620.2.16).

Option. In-Roadway Warning Lights may be flashed in a manner that includes a continuous flash of varying intensity and time duration that is repeated to provide a flickering effect (see EPG 902.20.2).

Standard. If used, In-Roadway Warning Lights shall not exceed a height of ¾ inch above the roadway surface.

902.20.2 In-Roadway Warning Lights at Crosswalks (MUTCD Section 4U.02)

Option. In-Roadway Warning Lights may be installed at certain marked crosswalks, based on an engineering study or engineering judgment, to provide additional warning to road users.

Standard. If used, In-Roadway Warning Lights at crosswalks shall be installed only at marked crosswalks with applicable warning signs. They shall not be used at crosswalks controlled by YIELD signs, STOP signs, traffic control signals, or pedestrian hybrid beacons.

If In-Roadway Warning Lights are used at a crosswalk, the following requirements shall apply:

A. Except as provided in the third and fourth option paragraphs of this Article, they shall be installed along both sides of the crosswalk and shall span its entire length.

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B. They shall initiate operation based on pedestrian actuation and shall cease operation at a predetermined time after the pedestrian actuation or, with passive detection, after the pedestrian clears the crosswalk.
C. They shall display a flashing yellow light when actuated. The flash rate shall be at least 50, but not more than 60, flash periods per minute. If they are flashed in a manner that includes a continuous flash of varying intensity and time duration that is repeated to provide a flickering effect, the flickers or pulses shall not repeat at a rate that is between 5 and 30 per second to avoid frequencies that might cause seizures.
D. They shall be installed in the area between the outside edge of the crosswalk line and 10 feet from the outside edge of the crosswalk.
E. They shall face away from the crosswalk if unidirectional, or shall face away from and across the crosswalk if bidirectional.

If used on one-lane, one-way roadways, a minimum of two In-Roadway Warning Lights shall be installed on the approach side of the crosswalk. If used on two-lane roadways, a minimum of three In-Roadway Warning Lights shall be installed along both sides of the crosswalk. If used on roadways with more than two lanes, a minimum of one In-Roadway Warning Light per lane shall be installed along both sides of the crosswalk.

Guidance. If used, In-Roadway Warning Lights should be installed in the center of each travel lane, at the center line of the roadway, at each edge of the roadway or parking lanes, or at other suitable locations away from the normal tire track paths.

The location of the In-Roadway Warning Lights within the lanes should be based on engineering judgment.

Option. On one-way streets, In-Roadway Warning Lights may be omitted on the departure side of the crosswalk.

Based on engineering judgment, the In-Roadway Warning Lights on the departure side of the crosswalk on the left-hand side of a median may be omitted.

Unidirectional In-Roadway Warning Lights installed at crosswalk locations may have an optional, additional yellow light indication in each unit that is visible to pedestrians in the crosswalk to indicate to pedestrians in the crosswalk that the In-Roadway Warning Lights are in fact flashing as they cross the street. These yellow lights may flash with and at the same flash rate as the light module in which each is installed.

Guidance. If used, the period of operation of the In-Roadway Warning Lights following each actuation should be sufficient to allow a pedestrian crossing in the crosswalk to leave the curb or shoulder and travel at a walking speed of 3.5 feet per second to at least the far side of the traveled way or to a median of sufficient width for pedestrians to wait. Where pedestrians who walk slower than 3.5 feet per second, or pedestrians who use wheelchairs, routinely use the crosswalk, a walking speed of less than 3.5 feet per second should be considered in determining the period of operation.

An audible information device should be used with In-Roadway Warning Lights to provide assistance for pedestrians with vision disabilities.

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Standard. If pedestrian push buttons (rather than passive detection) are used to actuate the In-Roadway Warning Lights, a PUSH BUTTON FOR WARNING LIGHTS/WAIT FOR GAP IN TRAFFIC (R10-25) sign (see EPG 903.2.47) shall be installed adjacent to a pedestrian push button detector explaining the purpose and use of the pedestrian push button detector.

Where the period of operation is sufficient only for crossing from a curb or shoulder to a median of sufficient width for pedestrians to wait, median-mounted pedestrian actuators shall be provided.

If an audible information device is used in conjunction with In-Roadway Warning Lights, the audible information device shall not use vibrotactile indications or percussive indications.

Guidance. If an audible information device is used in conjunction with In-Roadway Warning Lights, the audible message during the time that the lights are flashing should be a speech message that says, “Warning lights are flashing.” The audible message should be spoken twice.

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902.21.1 New Signal Installations

Standard. New signalized intersections shall accommodate pedestrians with curb ramps, accessible pedestrian signals and detectors (with audible tones or messages, and vibratory surfaces), and pavement markings if sidewalks are present or planned.

Guidance. Normal procedure for installation of traffic control signals, after having been found warranted and justified, is to provide for their installation through normal construction programming. If the need for a traffic signal becomes a matter of urgency, signals can be considered for installation through department forces, contract, or a combination of the two. It is in no way considered as a replacement for the normal construction programmed signal installation. In addition, warranted signals can be installed at developments by permit.

After it has been identified that signals are needed at an intersection, it will be necessary to identify funding for the installation. The type of installation and the source of funding will depend on many factors. It is usually necessary to develop a priority list of intersections, since funding is not available to signalize every intersection that meets signal warrants. District Traffic will determine the signal control type before design of the preliminary signal layout is started.

902.21.1.1 Conditions for installation by permit

Guidance. When an installation is warranted and justified under any of the warrants in this policy and if the owner of the commercial establishment desires the traffic signal to be installed in advance of the time it can be scheduled for installation by the department, the owner can apply for a permit for such installation. The following conditions will apply:

Standard. The applicants shall provide a complete design of intersection. Design features shall be in accordance with Commission design practices. Plans shall be prepared by a qualified engineer and developed under MoDOT's guidelines and shall require approval by the department.

Geometric improvements shall be constructed in accordance with Commission's standards and specifications.

The applicant shall pay all costs for the permanent signal installation and any required geometric improvements. The Commission will provide electrical power, maintenance of the signal after it is completed and accepted and future replacement if needed, all at no cost to the applicant. Upon completion and acceptance of the installation, the signal and all appurtenances shall become the property of the state.

An agreement with the Commission for the installation of the traffic signal shall be executed as part of the permit. The standard contract "Agreement for the Installation of a Traffic Signal by Others to be Maintained by the Commission" (TR16) is available.

902.21.1.2 Installation Cost of Signals

Standard. If the need is established by a traffic study and the intersection meets a warrant(s), a method of funding the installation shall be determined.

Guidance. Ideally, a signal to be installed will be placed upon the Right of Way and Construction Program but other methods of funding may be available.

902.21.1.3 Right of Way and Construction Funding

Guidance. The installation of permanent signals could be funded by Right of Way and Construction funds.

Standard. For new construction or programmed major improvements, intersections that are currently signalized or meet warrants for signals shall have permanent signals included in the design.

Option. If no improvements are programmed, it may be possible to program permanent signal installations.

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Support. Contact district Design or Planning for information on status of programmed projects or the possibility of programming signals. In some cases, signals could be installed on a high hazard project that is also part of the Right of Way and Construction program.

902.21.1.4 District Funding

Option. It may become necessary to install signals prior to the time they can be provided through the normal Right of Way and Construction Program. Intersections that satisfy the warrants described in EPG 902.3, may qualify for the installation of signals with internal funds.

902.21.1.5 Funding by Others

Guidance. If an industrial plant, factory, or commercial entrance meets a warrant for signal installation, the owner can provide, at no cost to MoDOT, the traffic signal and the intersection geometric improvements.

Standard. Signalization and geometric improvements shall be designed and constructed in accordance with existing MoDOT design standards and a permit shall be required. The traffic signal, after installation, becomes the property of MoDOT. At no cost to the owner, MoDOT shall provide power, maintain, replace or upgrade the traffic signal. Work zone traffic control for intersection improvements shall also be in accordance with existing MoDOT design standards.

Guidance. These installations of permanent signals are usually completed through the permit process. When a design project is in an area where a commercial entrance meets signal warrants, MoDOT is to install signals.

At locations where peak hour commercial signals are being installed, advanced flashers with applicable advanced warning signing are to be installed.

The policies for school signals, fire station signals and other special signal installations are covered in later sections.

902.21.2 Agreements

Support. The municipal and/or county agreement for a project located within a municipality or county contains the general requirements for cooperation between the state and the city or county for the efficient operations of traffic signals proposed by the state. An additional agreement is executed to cover the operation and maintenance of state-installed and owned traffic control signals and devices, highway lighting, signing and pavement marking (see EPG 153 Agreements and Contracts). Detailed information concerning the sequence for preparing and executing a project agreement is available in EPG 235.2.3 Project Agreements. All agreements are reviewed by the Chief Counsel's Office upon receipt of the necessary information from the district. It is important the agreements be completed as early in the development of plans for construction projects as possible. Copies of all agreements are submitted to Design for submission to FHWA as part of the Plans, Specifications and Estimate (P. S. & E.) documents.

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Standard. It shall be the responsibility for each district to establish record keeping, operational and maintenance programs utilizing these guidelines.

902.21.3 Nonstandard Structures

If any lighting or signal installation being considered will use a special or nonstandard structure or with dimensions exceeding those shown in the standard plans, Traffic (http://sharepoint/systemdelivery/tr/Pages/default.aspx) and Bridge (http://sharepoint/systemdelivery/br/pages/default.aspx) are to be consulted early in the project planning regarding the installation's feasibility and necessary contract provisions. Examples of this situation are high mast lighting and exceeding arm lengths on the standard plans.

Adaptive Traffic Signals

Evaluation of an Adaptive Traffic Signal System: Route 291 in Lee's Summit (http://library.modot.mo.gov/RDT/reports/Ri08026/or10020.pdf)

See also: Research Publications (https://www.modot.org/research-publications)

Since designing details for nonstandard installations is typically performed by an outside engineer employed by the contractor or producer and is certified to MoDOT, the project contract documents must include appropriate requirements about the design standards used. Since structures beyond MoDOT's standard designs are involved, a performance-based specification of the design signed and sealed by a Missouri Registered Professional Engineer is needed from the contractor. Certification to the current AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals including the latest fatigue provisions is required.

902.21.4 Documentation of Warrants

Guidance. Documentation of information pertaining to signal warrants should be completed and approved by district traffic. The district will be responsible for approving the warrants.

Option. Traffic signal warrant analysis. Justification of warrants may be documented by comparing traffic volumes to signal warrant thresholds. Documentation is required on all new signal installations and existing signals being upgraded form temporary to permanent signals or where significant geometric or signal revision are being made. It is not necessary to analyze all warrants (e.g. if Warrant 1, Eight-Hour Vehicular Volume is satisfied, Warrant 2, Four Hour Vehicular Volume does not have to be documented).

Support. See EPG 902.3.1 for information regarding traffic signal warrants.

902.21.5 Preparation of Plans

Guidance. Design should be accomplished as listed below:

- Obtain traffic counts.
- Analyze signal warrants, if necessary.
- Determine the type of interconnection system to include, if needed.

- Determine the number of signal phases and phasing sequence required to accommodate various traffic movements.
- Determine appropriate left turn phasing control and indications to use.
- Determine the signal indications, location and type mounting of each signal face.
- Determine the type and location of detectors.



- Determine the location of power supply assembly and signal controller.
- Determine the type and location of pull boxes and conduit runs.
- Determine the number and sizes of conductor cables required.
- Determine the breaker ratings for the power supply assembly and controller.
- Verify vehicle turning paths, especially regarding left turning movements and whether u-turns are allowed at the signal.

902.21.5.1 Preliminary Layout

Guidance. The first step in beginning the design is preparation of a preliminary layout. If drainage or pavement detail design plans are prepared using a scale of 1 in. = 20 ft., reproductions of these plans should be used for design of the traffic signal installation with considerable savings in work and time, provided the reproduction is made at an early design stage before details that are not pertinent to the traffic signal installation have been added to the plans.

Signal faces, posts, detectors, and pull boxes are numbered to provide a means of tabulating quantities. A suggested method of numbering is to number the posts and pull boxes first.

Standard. Signal faces and detectors are numbered to reflect the associated signal phase number (see EPG 902.5.3 Signal Phasing). Signal heads located in front of left turn auxiliary lanes are numbered to reflect a separate left turn phase even if the left turn phase is not being used. Pedestrian heads are numbered to reflect the phase they are associated with.

Guidance. The following applicable features should be shown on the preliminary layout:

- Pavement outlines, existing and proposed, with lane widths and curb types noted
- Sidewalks, crosswalks, stop lines, lane lines
- Islands, noting type (i.e. raised with 6 in. curb, mountable, flush, etc.)

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- Approach grades for all approaches
- Vehicle speeds for all approaches
- Parking conditions
- Bus stops
- Entrances, utilities, drainage structures
- Location of nearby railroad or fire station
- Distance to nearest traffic signals for all approaches
- Land use, such as parking lots, service stations, etc.
- Sight-distance restrictions, including adjacent buildings
- Proposed traffic phasing and type of controller (might be shown on a D-38 sheet instead)
- Arrows showing pavement lane use
- Location of signal posts, controller, power supply, signal faces and their indications
- Type, size and locations of detectors
- Pull box locations and conduit runs
- Traffic volumes for construction and design years with peak hour
- Title block stating location
- Sign location and type
- Turning radii dimensions
- Existing signals
- Interconnection to other signals
- Right of way limits and type
- North arrow
- All streets identified
- Number signal faces, posts, detectors, and pull boxes.

Traffic should review the preliminary signal layout if the district chooses additional review. Representatives of Design and Traffic are available to furnish advice during design and plan preparation. The preliminary signal layout is approved in the district.



A "Signal Head, Type 11S, Pedestrian", as noted on the D-37A sheet, is a two-face, side-of-pole mounted pedestrian indication. Thus, one signal post will have two pedestrian indications, one for NB/SB crossing and one for the EB/WB crossing, as shown above.

902.21.5.2 Final Plans

Guidance. Refer to EPG 103.1 Bid Opening and Award Process for information on preparing final plans. In addition to what is shown on the preliminary plans, the following "D-Sheets" (https://www.modot.org/d-sheets) are to be included:

- Form D-37A - Details locations and types of pull boxes, bases, posts, arms, and indications
- Form D-37B - Conduit and cable types and quantities are charted here
- Form D-37C - Items relating to the signal controller from the power supply, cabinet, coordination interface, detectors, and load switches are detailed.
- Form D-37D - Schematic of the conduit and cable installations. No geometric or signal head details are shown.
- Phasing sheets (D-38 series)

    Form D-38

    Form D-38A

    Form D-38B

    Form D-38C

    Form D-38D

    Form D-38E



A "Signal Head, Type 1S, Pedestrian", has one face for one crossing and mounted like the above photo.

902.21.6 Location of Signals and Appurtenances

902.21.6.1 Signal Post Bases

Support. Bases for mast arm signals located in islands or behind curbs are Type A. Type F (flush-mounted) bases are used beyond shoulders or sidewalk locations where the only location for the post is in a sidewalk. Type C bases are used for post top-mounted signals.

Guidance. A signal head or its bracket should not obstruct the crosswalk or sidewalk. A luminaire can be placed on a mast arm signal post to provide basic lighting without affecting the base design. Care should be taken to avoid conflicts with overhead utilities when installing lights on signal posts.

Standard. Signal post bases are not installed in medians narrower than 4 ft., face-to-face with curbs, and are preferably installed only in medians 6 ft. wide or more. Wherever practical, signal post bases are not to be located in median islands or divided highway medians. Median-located signal post bases shall have 7 ft. to 10 ft. of clearance to the median nose. All post bases shall be located a minimum 2 ft. behind curbs or 2 ft. beyond the shoulder.



Type A and Type F signal post bases

902.21.6.2 Location of Controllers

Guidance. Controllers are placed in non-hazardous locations and oriented so the signal controlled traffic movements can be observed while standing by the controller.

Standard. It is the expectation that signal controllers shall not be located in the clear zone; however, if this standard cannot be met there are countermeasures that shall be considered. The first countermeasure to be considered is placing a barrier around the controller. Central Office Design can be consulted for barrier options. The other countermeasure is a unique controller base or cabinet design. Central Office Highway Safety and Traffic can be consulted in deciding the best option for the location.

Guidance. Standard Plan 902.10 (https://www.modot.org/media/16910) and Standard Plan 902.30 (https://www.modot.org/media/16914) show cabinet bases. The designer coordinates with traffic to determine the type of base to be used and indicates that information on the D-37C sheet.

902.21.6.3 Service Pole and Power Supply Assembly

Standard. If the power source is off the right of way, a service pole or pedestal for the power supply assembly shall be located 2 ft. to 4 ft. inside the right of way line as near as practical to the controller location. If the power source is on the right of way, the power supply assembly shall be located as close as possible to the power source. The placement of the power supply is compatible with adjacent design features. Power supplies shall not be installed in medians or right turn islands. Only Type 1 (pole-mounted) or Type 2 (pedestal-mounted) secondary service power supplies are used.

Guidance. The Type 2 power supply is the preferred design. If the power source is distant from the controller location, a complete conduit run is provided from the power supply to the controller.

Option. For temporary traffic signal installations, it is permissible to use overhead cables between the power supply and the controller.

Standard. The location of the service pole or pedestal, and the equipment to be mounted thereon, and the furnishing of power to this assembly shall all be approved or agreed to in writing by the utility company concerned before final plans are submitted to Design. A copy of this letter shall be sent to Design with the final plans.



Cabinet base

902.21.6.4 Signal Appurtenances on Bridges

Standard. When traffic signal appurtenances are constructed on a bridge, a detailed layout shall be submitted to Bridge and Design. The preliminary traffic signal layout is to be reviewed by Design prior to submittal of the layout to Bridge. Bridge will provide detail design of the appurtenances on or through the structure. The District's submittal to Bridge shall reflect the location and size of conduits, post bases, pull boxes, and junction boxes.

902.21.7 Detectors

Support. Detectors are devices used with actuated controllers to sense the presence of vehicles or pedestrians to assign right of way on the basis of actual demand. Detector location is dependent upon stop line and crosswalk location, therefore, stop line and crosswalk locations are to be reviewed with district Traffic before locating detectors.

There are several different types of vehicle detection technology available. Each has distinct advantages particularly suited to certain circumstances or conditions. Inductive loops have been the prevalent technology for several years, but other options such as video, microwave and radar are available. Table 902.21.7.1 outlines the strengths and weaknesses of each detector type.

The decision to select a detection system is usually at the contractors option unless certain situations exist that require a particular type.

902.21.7.1 Optional Bidding of Traffic Signal Detectors

Guidance. So that every effort is made to increase the competition for installation of traffic signal detectors on signal projects, contractors should be allowed to bid optional traffic signal detectors. The core team should look at signal detector options or combination of options that bring the best value to the project. While optional bidding is generally advantageous for all projects, circumstances occasionally arise that cause one signal detector type to be preferred over others or the number of alternate detectors to be bid upon for a project are limited. The core team decision, which will include the concurrence of the Design Liaison Engineer, is documented with a memo in eProjects.

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Considerations for not allowing optional bids on signal detectors or limiting the types of signal detectors to be bid upon in a given project need to be evaluated for each intersection within that project. Strengths and weaknesses for each type of signal detector are provided in the table below. Consideration should be given to initial construction cost, long-term maintenance cost and continuity.

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Table 902.21.7.1 Strengths and Weaknesses of Signal Detectors

Type of Detector	Strengths	Weaknesses
Inductive Loop	Flexible design satisfies large variety of applications.	Installation requires pavement cut.
	Mature, well-understood technology.	Improper installation decreases pavement life.
	Large experience base. Provides basic traffic parameters (e.g., volume, presence, occupancy, speed, headway and gap).	Installation and maintenance require lane closure.
	Insensitive to inclement weather such as rain, fog and snow.	Wire loops subject to stresses of traffic and temperature.
	Provides best accuracy for count data as compared with other commonly used techniques.	Multiple detectors usually required to monitor a location.
	Common standard for obtaining accurate occupancy measurements.	Detection accuracy may decrease when design requires detection of a large variety of vehicle classes.
	High frequency excitation models provide classification data.	Requires new installation when changing geometrics.
	Low initial cost.	Milling and grinding operations damage installation.
	Easy set-up and installation.	Remote monitoring unavailable.
	Very reliable.	-
	Large detection area.	-
Microloop	Can be used where loops are not feasible (e.g., bridge decks, poor pavement condition).	Installation requires pavement cut or tunneling under roadway.
	Some models are installed under roadway without need for pavement cuts. However, boring under roadway is required.	Cannot detect stopped vehicles unless special sensor layouts and signal processing software are used.
	Insensitive to inclement weather such as snow, rain and fog.	Small detection area.
	Less susceptible than loops to stresses of traffic.	Requires extensive training.
	Long service life.	Requires installation expertise.
	Milling and grinding operations have no effect.	-
Microwave	Typically insensitive to inclement weather at the relatively short ranges encountered in traffic management applications.	Continuous Wave (CW) Doppler sensors cannot detect stopped vehicles.
	Direct measurement of speed.	Requires precise positioning.
	Multiple lane operation available.	Detects only similar movements.
	Milling and grinding operations have no effect.	Multiple units needed to detect several movements.

	May not require traffic control to install.	-
	Cost less than a microloop.	-
	Best suited for short-term installations.	-
	Best for reusability.	-
	Reliable and accurate.	-
	Large detection area.	-
	Good for advance detections zones (dilemma zone detection).	-
Radar	Transmits multiple beams for accurate measurement of vehicle position, speed and class.	Operation may be affected by fog when visibility is less than 20 ft. or blowing snow is present.
	Multiple lane operation available.	Installation and maintenance, including periodic lens cleaning, require lane closure.
Ultrasonic	Multiple lane operation available.	Environmental conditions such as temperature change and extreme air turbulence can affect performance. Temperature compensation is built into some models.
	Capable of over-height vehicle detection.	Large pulse repetition periods may degrade occupancy measurement on freeways with vehicles traveling at moderate to high speeds.
Video Image Processor	Monitors multiple lanes and multiple detection zones/lane.	Installation and maintenance, including periodic lens cleaning, require lane closure when camera is mounted over roadway (lane closure may not be required when camera is mounted at side of roadway)
	Easy to add and modify detection zones.	Performance affected by inclement weather such as fog, rain, and snow; vehicle shadows; vehicle projection into adjacent lanes; occlusion; day-tonight transition; vehicle/road contrast; and water, salt grime, icicles, and cobwebs on camera lens.
	Rich array of data available.	Requires 50- to 70-ft. camera mounting height (in a side-mounting configuration) for optimum presence detection and speed measurement.
	Provides wide detection area when information gathered at one camera location can be linked to another.	Some models susceptible to camera motion caused by strong winds or vibration of camera mounting structure.
	Good for poor pavement conditions and bridge decks.	Generally cost-effective when many detection zones within the camera field-of-view or specialized data are required.
	May not require traffic control to install or maintain.	-
	Remote viewing, configuration and monitoring available.	-
	Milling and grinding operations have no affect.	-

902.21.7.1.1 Project Details

Guidance. It is likely there will be specific requirements for certain approaches in any project. Section 2.1 of the JSP, Optional Traffic Signal Detectors (https://epg.modot.org/forms/JSP/JSP0709.docx), should list the details for all detector locations that will not be covered by the chosen option or options. Examples include utilizing existing detection for unaffected approaches, limiting or disqualifying options for back detection, or requiring advanced options (volume, speed, occupancy, etc.) as needed.

902.21.7.1.2 Plans for Projects with Optional Detection

Guidance. Plans for all projects with optional signal detectors should contain:

- Typical layout showing location of all detection zones desired.
- All pay items for signal detectors should be per each.
- Applicable Job Special Provision (OPTIONAL TRAFFIC SIGNAL DETECTORS JSP-07-XX) should be inserted in the Job Special Provisions.
- Final plans will be changed to reflect the type of detector chosen.

902.21.7.2 Induction Loop Detectors

Support. This detector can be used for single and multiple lane detection. Operative speed is 0 to 80 mph and detection is non-directional. The zone of influence can be reduced so actuation will not occur unless the loop is driven upon. This actuation can be presence as well as motion. The cost of this type detector is dependent on the number and size of loops.

Each loop consists of two or more turns of #14 AWG (2.5 mm^2) stranded wire placed in sawed slots in the existing pavement, or in the "B" or "C" course of asphaltic resurfacing. Separate conduits for each detector's lead wire to the pull box must be provided to facilitate individual loop replacement. The loop wires are spliced to a shielded #14 AWG (2.5 mm^2) lead-in cable in the pull box. The lead-in cable is continuous to the controller cabinet.

Standard loop dimensions are 6 ft. x 30 ft. for stop line detection. Advance loop detectors on high speed approaches, closed loop system detectors, or speed detectors are 6 ft. x 6 feet.

Standard Plan 902.50 (https://www.modot.org/media/16916) shows detector configurations. The dimensions of loops are shown on the plans. Typical layouts for microloop detectors are available.

Option. Where conditions such as the location of a bridge end do not allow 30 ft. for the location of a stop line loop detector, a shorter detector may be used.

Standard. In this case additional detection with a second loop detector or another type of detector is to be installed to provide a 30 ft. minimum detection zone.

Guidance. Each loop or detection zone will require a sensor unit that is housed in the controller cabinet. Sensor units (amplifiers or detectors) with 2-channel card-rack mounted versions will be used. Each 2-channel unit is capable of handling two loops or detection zones. The loop or detection

zone associated with each phase is to be shown on the detector schedule on the D-37C sheet. Each loop is assigned a card position and channel on the D-37 sheet. Detection zones are not assigned a card position or channel. Suggested assignments are as follows:

Channel Number	Card Position							
	1	2	3	4	5	6	7	8
1	Phase 1	1 or 6	6	6	3	3 or 8	8	8
2	Phase 5	5 or 2	2	2	7	7 or 4	4	4

The quantity of 2-channel detectors is indicated below the assignment chart. Even if only one channel of the two-channel card detector is used, the entire unit is counted as a card detector and is paid for as such. The maximum number of card detectors is 8.

902.21.7.2.1 Location of Detectors

Support. Location of detectors is critical with respect to the efficient operation of actuated control; therefore, their location is carefully designed.

Standard. Loop detectors are not to be located in "E" joints, bridge expansion joints or other full depth joints.

902.21.7.2.2 Detectors for Left Turn Lanes

Guidance. These detectors should be placed as close to the stop line as practical, as this is a relatively slow movement. This location allows a minimum green time and thereby provides the most efficient operation.

902.21.7.2.3 Detectors for Through Traffic

Support. Loop detectors, 30 ft. long, located at the stop line in each lane, are normally used to detect through traffic. Full traveled pavement detector coverage is essential for efficient operation.

Guidance. Detectors are placed so no more than a 6 ft. gap in coverage is allowed across the traveled pavement. When a physical barrier is not provided between opposing flows of traffic, the field of detector actuation is to come no closer than 3 ft. to the centerline.

Advance Detectors

Guidance. On approaches with operating speeds of 45 mph or greater, advance detection is to be considered to allow adequate time for a vehicle to pass through the intersection with a green signal indication. An advance detector is located at a distance back from the stop bar determined by the Driver Reaction to Yellow chart. This range of distance from the stop line within which drivers are often indecisive is known as the dilemma zone. To provide dilemma zone protection on high speed approaches, the detector should be placed at least five seconds travel time from the stop line.

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Refer to EPG 902.5.37.3 Detection on High-Speed Approaches for additional information.

902.21.7.3 Time Delay Unit

Support. This type of detector amplifier is used with vehicle detectors to delay the input signal from the detector to the controller. This will help prevent "false calls" into the controller which may cause the controller to service a phase where there is no vehicle waiting. Time delay functions are also available within newer signal controller firmware.

Guidance. If controller based time delay functions are not available time delay detectors should be considered for any of the following conditions:

- Exclusive right turn lanes where right turns are permitted on red.
- Exclusive left turn lanes where there is no adjacent divisional median island.
- Exclusive left turn lanes where protected-permissive left turn phasing (with a five-section signal head) is used.

Time delay detectors can be used in other situations as needed. Refer to EPG 902.5.37 Detector Settings for additional information.

902.21.7.4 Video Detectors

Support. Video detection systems can be desirable for pavement preservation, maintenance, or safety reasons. Advantages of this system are saw cuts are not necessary in new pavement or where pavement is in poor condition and sawing could cause further deterioration. Detection zones can be changed to accommodate intersection geometric changes and changes in traffic flow. Troubleshooting the detector can also take place at the cabinet rather than in the roadway. Video detection can be used in locations where joint placement prohibits the use of sawed loops. Finally, video detection can have safety advantages, as work in the roadway might not be required for installation or maintenance. Video detection systems are paid for as a lump sum unit, which includes the cameras, wire, cable, mounting equipment, monitors, processor units, etc. One camera can be capable of covering more than one detection zone. When plans include retrofitting a new detection system into an existing signalized intersection, check with district Traffic to determine if the existing controller equipment is compatible with the operation of a video detection system before making that selection.

902.21.7.5 Microloop Detectors

Support. Microloop detectors can be used at locations where it is undesirable to saw loops in the pavement, such as bridge decks. Typically, 5 probes are used for stop bar detection. Advance detection can be accomplished with as few as 1 probe per lane. Where the end of a bridge divides the detection area, a combination of microloop detectors and an induction loop detector can be used. Typically 2 or 3 probes and a short quadrapole detector are used for this configuration. Guidance for typical layouts for microloop detectors is available. Microloops have a narrow range of detection, so standard practice is to stagger them 2 ft. from the centerline of the lane. When possible, probes are not to be installed over traffic on overpass bridges.

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Microloops require special lead-in cables that are continuous from the probes to the controller and are provided with the probes. The quantity of lead-in cable is itemized separately on the D-37 sheet. The total quantity is included in the pay item for loop detector lead-in cable.

Special detection equipment is required for these probes in the controller cabinet. This equipment is available in 2-channel rack mounted units. The 2-channel cards are installed in the same card rack as the induction loop detectors. The probes must have separate card positions since probes and induction loops cannot be combined on the same detector card.

902.21.8 Accessible Pedestrian Signals and Detectors - Additional Requirements

Additional requirements for accessible pedestrian signals are provided below.

Guidance. The bolt pattern of the pushbutton station should be compatible with older pushbuttons. This will allow equipment to be easily upgraded at existing signalized intersections.

902.21.8.1 Mechanical/Electrical Requirements

Standard. Accessible pedestrian signals shall include the following mechanical and electrical requirements.

Pushbutton station shall be constructed of aluminum. Tactile arrows and actuator shall be made of brass or corrosion-resistant metal alloy or non-metallic material.

The actuator shall be a minimum of 2 inches in diameter, raised, contrast visually with the housing and shall have a solid state, piezo type switch rated at a minimum of 20 million actuations. A maximum force of 3.5 lbs. shall be required to activate the switch.

The accessible pedestrian signal shall operate at a voltage no greater than 24 volts.

Support. Accessible pedestrian signal assembly may be monolithic or a separate actuator and sign.



Some manufacturers provide a 2-wire accessible pedestrian signal system that uses the existing wiring from previously installed standard pushbuttons. For installation, a control unit is installed in the controller cabinet. Wiring this device requires correct connection of wires from pedestrian signal heads, particularly where two parallel crosswalks do not operate concurrently to provide accurate messages using two wires.

The 3-wire and 4-wire systems are typically designed for intersections where pushbutton wires do not exist, though they can also be installed on intersections with existing pushbutton wires. For installation, the wires from the accessible pedestrian signal run to a control unit in the pedestrian head. Each system is independent of the others and each accessible pushbutton signal responds to the messaging provided by the pedestrian signal head it is connected to.

Option. Additional features may include Bluetooth or wireless capabilities to allow for programming using a manufacturer developed app on a tablet or cell phone.

902.21.8.2 Environmental Requirements

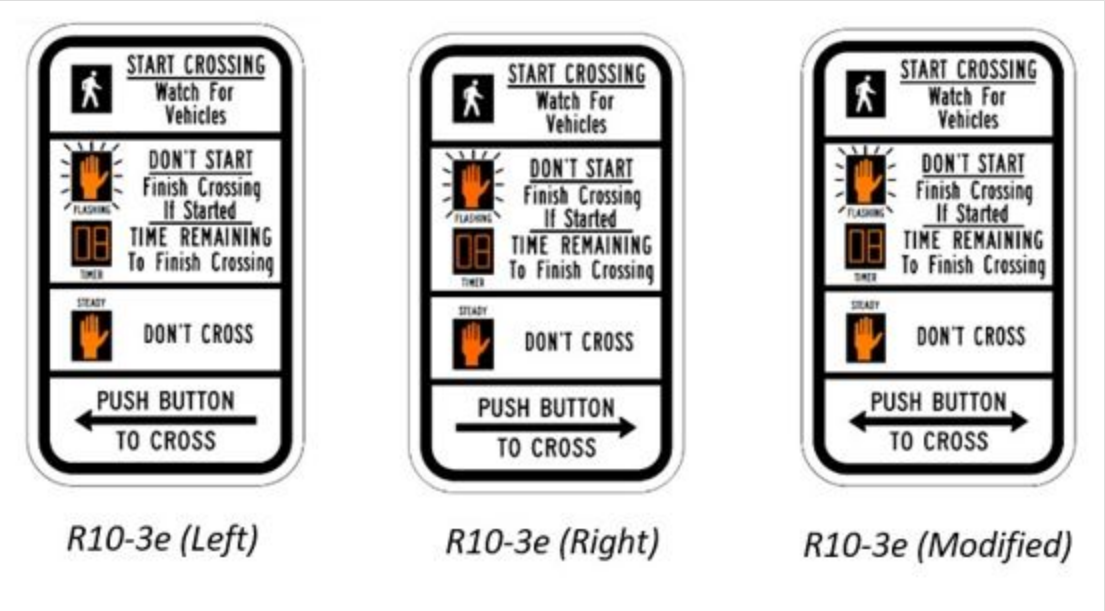
Standard. The accessible pedestrian signal shall be fully operational between -30° F to +165° F (-34° C to +74° C), shall not allow ice to form such to impede the operation of the button and shall have a weatherproof speaker.

902.21.8.3 Pedestrian Information Sign Requirements

Standard. The accessible pedestrian signal shall include a pedestrian information sign. The pedestrian information sign shall be post mounted or integral to the Pedestrian Pushbutton Station. The sign shall:

A) Be in accordance with the provisions of EPG 902.9.5?,
B) Be a 9"x15" R10-3e,

C) Be fabricated as flat sheet (SH) in accordance with all applicable sections of MoDOT's Standard Specifications for Construction and Standard Plans.



R10-3e (Left), R10-3e (Right), R10-3e (Modified)

902.21.9 Pull Boxes

Support. Concrete and preformed pull boxes are shown on Standard Plan 902.20 (https://www.modot.org/media/16912) and are defined in the standard specifications. The type of pull box to be used is specified on the plans and on the D-37A sheet.

Guidance. It is desirable to locate a pull box out of the travelway of vehicles. When a pull box is located in the travelway, auxiliary lanes or shoulders, a concrete pull box is specified. When a pull box is located outside the shoulder, behind curb or guardrail, or in non-mountable islands, a preformed pull box is specified. In impervious soil, a pull box with a concrete bottom (Type II drain) is used with a 2 in. pipe drain to an adjacent ditch, slope, or drain structure. Both concrete and preformed pull boxes can be installed with Type II drains. One of three types of Type II drains can be used depending on the adjacent drainage features. Type A is used where there are no adjacent drainage features. Type B is used where the pull box is adjacent to a ditch or slope. Type C is used where the pull box is adjacent to a storm sewer. The elevation of the controller must be higher than the elevation of any pull box in the conduit run.

Standard. Regardless of the type of soil, if the intersection is adjacent to any ditch, slope, or drainage structure, at least one pull box in the conduit system shall have a Type II drain into the adjacent drainage feature. Pull boxes, controllers and other signal appurtenances are not installed in drainage ditches.

The number of pull boxes shall be kept to a minimum. Pull boxes are placed at each end of a conduit line under pavement, except where the conduit run terminates in a service pole. A pull box is required adjacent to detectors to permit a splice between the detector leads and the detector lead-in cable from the controller. A pull box is provided near each post base. A pull box is located at the controller and all wiring, except power supply cables, is routed through this pull box. Pull boxes shall be located a

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minimum of 2 ft. (0.6 m) from the outside edge of the appurtenance they serve to provide a minimum amount of working area and clearance for conduit elbows and bends. Pull boxes for detectors and signal posts are combined in some instances by skewing the conduit to detectors located in or under the pavement from the pull box provided adjacent to the signal post. This is not permitted where the distance involved exceeds 50 feet.

Guidance. When two or more intersections are to be interconnected, pull box spacing is recommended to be 1500 ft. when fiber optic cable is the only cable in the conduit with Class 2 pull boxes. Class 2 pull boxes are adequate to accommodate the minimum bending radius of the fiber optic cable.

Pull box dimensions are shown in the standard plans. Pull boxes are sized according to the following criteria:

- The smallest preformed pull box is a Class 1 pull box. These boxes are used at locations with 22 or fewer entering conductors. Where required, a standard concrete pull box is used.
- When there are more than 22 but fewer than 69 entering conductors a Class 2 preformed pull box is used. This box is probably the most frequently used preformed pull box. Where required, a standard concrete pull box is used.
- When there are 69 or more entering conductors a Class 3 preformed pull box is used. Where required, a double concrete pull box is used.
- When fiber optic cable is to be installed as part of a project, the Class 5 preformed pull box is used at the signal cabinet and Class 2 pull boxes between intersections.

902.21.10 Conduit System

Support. Electrical connections between traffic signals, detectors, the controller, and power supply in each traffic signal installation or system are made by means of cable installed within closed conduit systems. Cable is exposed only on span wire assemblies. A conduit system provides ease of installation, maintenance, and protection from accidental cutting of the cables. Pull boxes are provided to reduce the number of conduit runs and to facilitate cable pulling and splicing detector leads.

902.21.10.1 Conduit Size

Guidance. Standard conduit size, except those between a loop detector and the first adjacent pull box to the loop detector, is 3 inches. Except for unusual cases, it is preferable to limit the maximum conduit size to 4 inches. When more area is required than is available in this size conduit, parallel lines of conduit providing the required area are used.

Conduit, used solely for loop detectors lead in, can be 1 inch. A conduit run is required for each loop detector. Conduit used solely for interconnect cable, can be 2 inches.

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If conduit is being installed in an existing median, use conduit in trench or pushed conduit as required.

902.21.10.2 Conduit Locations

Guidance. Pavement crossings are kept to a minimum. Where alternate conduit locations can achieve the same results, a rough cost comparison is made to determine the most economical plan.

Standard. A minimum of two 3 in. conduits are provided from the first pull box to the controller. A separate conduit containing the power supply cables is provided from the power supply assembly to the controller.

Option. It may run directly from the service pole to the controller without entering a pull box unless the distance from the power supply to the controller is greater than 200 feet. Pull boxes are provided so conduit runs are no more than 200 ft. long.

Support. Conduit slopes are determined in the field by the engineer.

902.21.11 Control and Power Cable

902.21.11.1 Control Cable

Standard. All cable runs are continuous between the signal appurtenances and the controller, except for the cables to loop detectors where splices are required with the detector leads. This reduces maintenance and improves servicing by eliminating most splicing. Voltage drop is kept to a minimum by using a common wire size and separate conductors for each signal head. Number 16 AWG minimum size conductors shall be used for all multi-conductor signaling circuits.

The number of conductors required for traffic signal equipment is as follows:

- Vehicle signal - 7
- Pedestrian signal - 5
- Push button detector - 2
- Loop detector lead-in cable - 2 - #14 AWG
- Loop detector in-duct - 1 - #14 AWG
- Remote On-Off switch - 3
- Luminaires on signal posts - 2 - #12 AWG

The number of various cable combinations is kept to a minimum, preferably no more than four types for each contract, and preferably cables with two, three, five and seven conductors.

Support. These combinations have had the most frequent use and are more likely to be available to contractors. The maximum length of cable in the fewest possible sizes generally will result in lower unit bid prices as the cable is furnished in reels of minimum length.

Available single conductor and multi-conductor cable combinations and their cross-sectional areas are shown below:

Table 902.21.11.1.1 TRAFFIC SIGNAL CABLE AND WIRE

CONDUCTOR TYPE	CABLE SIZE, AWG	AREA, $in.^2$
Single Conductor (stranded), Based on XHHW-2 conductors for power and equipment grounding)	1c. - #12	0.0181
	1c. - #10	0.0243
	1c. - #8	0.0437
	1c. - #6	0.0590
	1c. - #4	0.0814
	1c. - #3	0.0962
	1c. - #2	0.114
	1c. - #1	0.153
	1c. - #1/0	0.1825
Multi-Conductor Control (stranded), (for signaling circuits)	2c. - #16	0.083
	3c. - #16	0.083
	5c. - #16	0.117
	7c. - #16	0.137
Ground Wire (solid)	1c. - #6	0.021
	1c. - #1	0.066
Induction Loop Detector Cable (stranded)	2c. - #14 (lead-in)	0.102
	1c. - #14 (in duct)	0.023
Interconnect Comm. Cable-Closed Loop Systems (stranded)	3 pair #16	0.208
Other types of cables may be required. Obtain specification from manufacturers.		
Nominal outside diameter of coax cable shall be 0.305 in. The cable shall be in accordance with Belden Type 8281, West Penn P806 or approved equal.		

Table 902.21.11.1.2 Conduit Sizing

NOMINAL SIZE, in.	INSIDE DIAMETER, in.	INSIDE AREA, $in.^2$.	ALLOWABLE OCCUPIED AREA, $in.^2$
3	3.042	7.27	2.91

902.21.11.2 Power Cable

Standard. Single conductor cable is used for power cable. Two insulated power cables and a suitably sized ground are required for each traffic signal installation to supply 120 volt, 60 Hz, single-phase alternating current to the controller cabinet. Minimum conductor size for power cable is #8 AWG.

Option. Larger sizes may be required where power requirements are high or where power must be carried over a distance where voltage drop is a consideration. See EPG 902.21.11.5 for sizing power supply cables.

Standard. The maximum allowable voltage drop from the power source to the controller is five percent in order to ensure a high efficiency of operation and long life of the electrical components of the controller.

Guidance. The voltage drop in any electrical circuit is directly dependent upon current and wire resistance. According to Ohm's Law the voltage drop in a line is equal to the current in amperes multiplied by the resistance of the line in ohms. The equation to be used to calculate voltage drop is as follows:

E = I x R

E = Voltage

I = Current (in amperes)

R = Resistance (in ohms)

The areas of wires in circular mils and the resistance in ohms per 1000 ft. to be used in calculations are shown below:

Table 902.21.11.2.1 Properties for Conductors

SIZE (AWG)	AREA (Circular Mils)	AC RESISTANCE AT 167°F (75°C) (OHMS/1000 ft.)
8	16,510	0.78
6	26,240	0.49
4	41,740	0.31
3	52,620	0.25
2	66,360	0.20
1	83,690	0.16
0	105,600	0.13

Table 902.21.11.2.2 Power Cable Sizing

SIZE (AWG)	AREA (Circular Mils)	MAX LOAD (AMPS)
8	10,381-16,510	40
6	16,511-26,240	50
4	26,241-41,740	70
3	41,741-52,620	85
2	52,621-66,360	95
1	66,361-83,690	110
1/0	83,691-105,600	150

Table 902.21.11.2.3 Equipment -Power Requirements

	ITEM	WATTS	AMPS
Controller Breaker	Controller Unit (any type) with accessories	480	4.0
	Signal Lamp, 12 in.	20	0.17
Lighting Breaker	Luminaire	150	1.3
Auxiliary Breaker (15 amps)	Cabinet Fan, Outlet and Cabinet Lamp	240	2.0

Table 902.21.11.2.4 Circuit Breaker Sizing

CALCULATED LOAD IN AMPS	CIRCUIT BREAKER TRIP RATING
0-12.00	15
12.01-16.00	20
16.01-24.00	30
24.01-32.00	40
32.01-40.00	50
40.01-48.00	60
48.01-56.00	70
56.01-64.00	80
64.01-72.00	90
72.01-80.00	100

Support. Example to determine voltage drop.

Given: 300 ft. from power source to controller cabinet

#4 AWG Power Supply Cable
1 Controller Unit W/Acc., 4.0 amps
10 Signal Lamps, 1.7 amps
4-150 watt HPS Luminaires, 5.2 amps

Cabinet Fan, Outlet & Lamp, 2.0 amps
Total: 12.9 amps

Voltage Drop (V_d)= I (amps) x R (resistance)

V_d = 12.9 amps x 2 x 300 ft x 0.31 ohms/1000 ft = 2.4 volts

902.21.11.3 Ground Wire

Standard. A #6 AWG solid or stranded equipment grounding conductor, in conduit, shall be used to connect overhead mounted signal heads on bridge structures to the controller ground. A controller mounted on a structure is grounded by means of a #1 AWG, solid or stranded grounding electrode conductor in conduit connected to a ground rod in the first pull box located off the structure, providing the conductor length does not exceed 200 feet. Over this distance, a larger size wire is used as determined by calculation. Number 6 AWG, solid or stranded equipment grounding conductor shall be used to electrically bond all steel conduits in pull boxes to the power company ground. A properly sized equipment grounding conductor shall be provided in all conduits to provide an effective ground path from each post to the ground bus in the controller cabinet. Plan quantities are not computed for ground wire, but conduit is to be sized accordingly (see Table 902.21.11.1.1).

902.21.11.4 Circuit Breaker Trip Rating

902.21.11.4.1 At Controller

Guidance. Separate the total amperage load into:

- Controller Breaker - Controller with accessories, and signal lamps.
- Lighting Breaker - Luminaires.
- Auxiliary Breaker - Cabinet fan, lamp and outlet. (15 amps)

Amperage requirements for signal equipment are shown in Table 902.21.11.2.3. To determine the maximum number of lamps illuminated during any one interval of the time cycle, total the number of lamps for each signal head as follows:

- Three-Section Head - 1 Lamp
- Four-Section Head - 1 or 2 Lamps
- Five-Section Head - 2 Lamps

To determine breaker rating, refer to Table 902.21.11.2.4 and select the appropriate breaker size based on the calculated load. Controller and auxiliary circuit breakers are required. When luminaires are specified on signal posts, a separate lighting control cabinet is provided on the outside of the controller cabinet containing a circuit breaker, photocell and other equipment as required. Electrical power to the luminaires is controlled through the photocell switch.

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Standard. The breaker rating for the controller, auxiliary and lighting breakers are to be shown on the D-37C sheet. The auxiliary breaker is specified as 15 amps.

Guidance. See Table 902.21.11.2.4 for sizing controller and lighting breakers.

902.21.11.4.2 At Power Supply

Standard. Circuit breakers at the power supply shall be sized to protect the power supply cables.

Guidance. To determine the appropriate trip ratings of the power supply circuit breaker, refer to Table 902.21.11.2.4.

902.21.11.5 Cable Size from Power Supply to Controller

Guidance. Power to the controller is supplied through three single-conductor cables. The maximum factored amperage for the installation is determined by totaling required amperage for the controller(s), accessories, signal lamps, luminaires, and cabinet fan, lamp and outlet and multiplying the total by 1.25. Use Table 902.21.11.2.3 to determine power requirements. The size of each of the cables is to meet or exceed the computed area as determined by the following formula:

$$\text{Area (circular mils)} = (L \times I \times 2K)/V = (L \times I \times 25.8)/6$$

Where

K = 12.9 ohm - circular mils per foot @ 75º C

L = Length from controller to service pole plus (ft) additions

I = Maximum load in amps

V = 6 volts (5% of 120V), the maximum allowed voltage drop

After the required area is computed, use Table 902.21.11.2.2 to determine the size wire to be used. If the maximum factored amperage exceeds the maximum load for that wire size as shown in Table 902.21.11.2.2, use the wire size required to carry the load.

902.21.12 Traffic Signal Poles

Guidance. Permanent signals are installations using steel mast arm poles or steel span wire, underground conduit and basic intersection lighting. Temporary signals are installed using wood poles. They are used for construction projects or where a project will be replacing them in the near future. Mast arm pole signal installations are preferable, but each case is decided on its own merits and the funding available. If a street is to be widened or an intersection is to be reconstructed in the near future, the temporary traffic signal installation is designed to conform to the final layout, as nearly as is practical, and if future interconnection can be predicted, the temporary traffic signal controller is equipped for this eventuality.

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The signals, lighting, and intersection geometrics are constructed according to current Design standards. Permanent signals are typically installed with construction projects or at locations where there are no programmed major roadway projects that would affect the signals.

902.21.12.1 Span Wire Signals

Guidance. Span wire signals are installed with wood or steel span wire poles and overhead wiring. Temporary signals are designed as wood pole span wire signals as shown in the standard plans. A steel span wire post is recommended where guy wires for a wood pole cannot be used, especially for long spans.

Span wire signals can be installed by contract, by MoDOT forces, or a combination of the two. Span wire signals are typically installed where limited right-of-way or limited space for underground conduit necessitate their use. Temporary span wire signals can be installed where there is a future construction project that will install signals or where there is no work currently programmed. If no work is programmed, it would be preferable to pursue the programming of a permanent signal installation.

Standard Diagonal span wire signals, excluding intersection control beacons, shall not be used. Span wire signals are to be installed with basic lighting on the signal poles (silhouette lighting) or direct reflectance lighting if raised islands are installed unless other basic lighting is in place. Off-signal, direct reflectance lighting could be needed if raised islands are present.

A pole on state right of way owned by others shall not be used to support span wire signals. If an adjustment of the location for a department installed pole cannot be made, the existing pole shall be moved at the expense of the owner.

Option. For temporary span wire traffic signals, the power supply may be installed on one of the span wire poles if it is close to the right of way line or utility company facility. If not, a separate power supply is to be installed at the right of way line or utility company facility. If possible, the power supply is to be installed to be compatible with future construction.

If the signal controller can be located to be compatible with future construction, then it may be installed on a concrete base at the permanent location.

902.21.13 Modifying Existing Traffic Signal Installations

Guidance. The preliminary layout for modifying existing traffic signal installations shows both the existing and proposed installation. The final plans show existing appurtenances to remain in place, be abandoned or removed. Existing features are shown as dashed lines and new features as solid lines. Temporary signals are investigated and considered when existing signals are to be modified. Using existing conduit during signal modifications should be carefully evaluated and new conduit should be considered.

902.21.14 Temporary Signals During Upgrades

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Guidance. Existing signals are not to be taken out of service during signal modifications, unless absolutely necessary.

Option. Wood pole cable spans may be used as needed to facilitate the modifications. A scaled layout of the temporary signal is included in the plans showing all items, including cables. These installations are paid for as temporary traffic signals, per lump sum.

902.21.15 Quantities

Guidance. When the plans are completed, the quantities of materials required are tabulated on the D-37 sheets. The use of identification symbols on the D-37 sheets eliminates unnecessary repetition as to location of each appurtenance in the tabulation of conduit and cable quantities. Both conduit and cable quantities are carefully calculated, as plan quantities are the basis of payment. It is not necessary to show signal quantities on the "2-B" sheets of roadway plans.

902.21.16 Conduit

Guidance. These quantities are calculated or scaled from the plans to the nearest linear foot. Measurement is made from center-to-center of all pull boxes, post bases, and controllers. The center-to-center distance is modified to allow for the proper amount of conduit required for construction.

- A quantity of 2 ft. added to the center-to-center distance provides the length necessary to turn the conduit up to ground level for a Type F or Type C base.
- A quantity of 4 ft. added to the center-to-center distance provides the length necessary to turn the conduit up to ground level and to the top of a Type A base or ground mounted controller cabinet base.
- If the conduit runs between two pull boxes, 1 ft. is subtracted from the center-to-center distance at each end, totaling 2 feet.

902.21.17 Cable

Guidance. These quantities are calculated or scaled from the plans to the nearest linear foot. Measurement is made from center of pull box to center of pull box or center of signal post, controller, or service pole. Cable from the controller to the loop detectors is measured to the first pull box adjacent to the detector where the splice to the detector leads is made. Pole and bracket cable must be used from the signal post base to the luminaire. At the signal post base, the pole and bracket cables are spliced to the 2c - #12 AWG using a fused slip connector assembly as shown in Standard Plan 901.02 (https://www.modot.org/media/16905). Signal heads mounted on the side of mast arm signal posts are provided with conductor cable connection to the controller separate from that provided for the overhead mounted signal head if the side mounted signal does not operate identically with the signal on the mast arm. When the signals operate identically during all signal phases, a 7-conductor cable is provided to the signal head on the mast arm from the controller and a 7-conductor jumper cable is provided from the signal head on the mast arm to the side mounted signal. This is done to ensure the mast arm signal will continue to operate in the event of an accident that disables the side mounted signal. If two signal heads mounted on the same mast arm operate identically during all phases, a 7-conductor jumper cable can be provided between terminal compartments and only one 7-

conductor cable is required to the controller. A maximum of two 7-conductor jumpers are allowed between three signal heads. The cable length for the jumper is included in the cable quantities for that cable run. A signal head located in front of a left turn auxiliary lane has a separate 7-conductor cable to the controller even if a left turn phase is not being used.

Additional cable quantities are added to the center-to-center measurement to provide slack and to provide for the cable to be turned up and connected to terminal strips in the controller, signal head terminal compartments, signal head disconnect hangers, and detectors, or to the service head of the power supply assembly as follows:

- 6 ft. of each cable passing through each pull box. 3 ft. if the cable terminates in the pull box, as in Lead-In or In-Duct loop detector cable.
- 8 ft. of each cable at the controller.
- 13 ft. of each cable at side mounted and post top mounted vehicular signal heads.
- 10 ft. of each cable at side mounted and post top mounted pedestrian signal heads.
- 9 ft. of each cable to pedestrian pushbutton detectors located on posts.
- 21 ft. of each cable at each signal post with mast arm plus the length of the mast arm or distance to the first signal terminal compartment.
- 35 ft. of each cable at the service pole supporting the power supply assembly.
- 8 ft. of each cable when connecting to a pedestal mounted power supply.
- The length required to turn up the post and connect to span wire mounted detectors or signal heads.
- 30 ft. plus the bracket arm length for cables to luminaires on signal posts.
- 60 ft. of fiber cable at pull boxes adjacent to signal or splice cabinets.
- 10 ft. of fiber cable passing through each pull box.

The cable quantities on each D-37 sheet are totaled to the nearest linear foot. The total of all D-37 sheets is rounded to the nearest 10 linear feet on the estimate.

902.21.18 Color Sequence

Guidance. The color sequence, or interval sequence of signal indications showing all possible variations in indications due to phase skipping or auxiliary equipment, is shown on a D-38 sheet that accompanies the plans. Several standard signal phasing and layout (D-38) sheets are available. If used, these sheets are to be reviewed and modified as necessary according to conditions.

902.21.19 Utility Conflicts

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Guidance. Where overhead signal mountings are used, the design should be checked to ensure there is no conflict with existing overhead wiring as well as underground utilities.

902.21.20 Estimate

Guidance. Any estimate dealing with traffic signals should be reviewed by district Traffic for proper inclusion of needed items. Common items such as controller type, cabinet size, signal and pedestrian heads and indications, and non-contractual items can be miscategorized or omitted. Accurate bid items will greatly reduce the need for more expensive change orders during the construction of the signal.

902.21.21 Job Special Provisions

Guidance. All Job Special Provisions (JSPs) should be reviewed by district Traffic for applicability and thoroughness. Special equipment not yet accounted for in the Standard Specification must be detailed by a JSP in order to have a bid quantity. JSPs should also be used to ensure MoDOT communication lines through project limits are kept intact (if required). Any other special construction methods needed to ensure a properly operating signal must be detailed by a JSP.

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902.22 Maintenance Guidelines

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902.22.1 Controllers and Equipment

902.22.1.1 Controller and Cabinet Replacement Program

Guidance. Routine replacement of control equipment assists in maintaining and operating a reliable system. Signal controllers should be replaced at 10 years of age or older and cabinets should be replaced at 25 years of age or older.

Option. Cabinets and controllers may be replaced sooner than the recommended age. Controllers or cabinets experiencing higher than normal maintenance should be considered for replacement regardless of age.

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Support. Controllers replaced under this replacement program do not automatically generate a need to modify ADA-related pedestrian accommodations. However, some controller replacements will lead to a need for such changes. For more information on this subject, see EPG 642.4 Impact of the Project Category on ADA.

902.22.1.2 Approved Product List (https://www.modot.org/traffic) and Equipment Evaluations

Support. MoDOT has developed an Approved Products List (APL) containing many items used in signals and lighting. The APL is based on equipment that meets department specifications and has been tested for a specified test period with satisfactory performance. This list helps MoDOT purchase reliable products for traffic signals and highway lighting. This list is included in the bid requests for applicable equipment purchases and is also included in construction contracts that include signals or lighting.

MoDOT frequently tests new products and equipment for signals. These new products can be installed on a construction project, purchased on parts orders or with controller orders. Only a limited number of units will be accepted for test statewide until an item is added to the approved products list.

Standard. All equipment evaluations are coordinated through Traffic and are reviewed by the Traffic Signal Quality Circle. The vendor supplying the equipment must fill out the New Product Evaluation Form (https://www.modot.org/traffic) and provide equipment specifications and a certification that the equipment meets MoDOT specifications before the test is performed. The equipment is tested for the period specified on the approved products list.

Option. Products that are not performing satisfactorily may be replaced at any time if the vendor cannot provide timely correction of the problem or if unsatisfactory operation of the intersection results.

Standard. Upon completion of the test, the district shall complete the Product Evaluation Form - Signal and Lighting Equipment and submit it to Traffic. The evaluation is reviewed by the Traffic Signal Quality Circle for addition to the APL or for rejection.

If a vendor is proposing a product that does not meet department specifications, the vendor shall provide a written explanation to Traffic of why the product does not meet the current specifications and why the product should be evaluated. If approved for evaluation, the product is tested for the specified period as described above. After evaluation and if the product is satisfactory, Traffic will consider making a recommendation to revise the applicable specifications. If specifications are not revised, then the products that does not meet specifications will not be added to the approved products list.

902.22.1.3 Experimental Equipment

Guidance. MoDOT often evaluates experimental equipment for traffic signals. Experimental equipment can be new products or products that vary considerably from our current standards or practices. The evaluation of experimental products can be initiated by district or Central Office staff, as part of a research project, as an implementation of an employee idea, etc.

The evaluation of experimental equipment for traffic signals is coordinated through Traffic and may involve other functional units such as Research. If the evaluation is part of a research project, then the project will provide guidelines for testing. Products can be evaluated in a similar manner to that described in EPG 902.22.1.2 Some items to consider before evaluating experimental equipment are as follows:

- What improvement will the equipment provide?
- Does the equipment conform to National and State standards?
- Is the equipment cost effective?
- Are funds available?
- What are the advantages and disadvantages of the equipment?
- How will the effectiveness of the equipment be tracked?
- What criteria will be used to determine if the equipment is satisfactory?

The Product Evaluation Form – Signal and Lighting Equipment can be used for evaluation of experimental equipment.

902.22.2 Annual Orders and District Signal and Lighting Equipment Purchases

Guidance. Highway Safety and Traffic Division will coordinate annual orders for signal and lighting equipment purchases. The intent of annual orders is to combine orders from all districts to develop larger quantities and to save duplication of work.

Standard. Annual orders are limited to items that will be purchased in larger quantities and can be bid competitively. For signal and lighting annual orders, it is important that only these types of items be included in the requests. Proprietary items, model specific replacement parts, and small quantity items are to be purchased at the district level.

Option. There are many common "off-the-shelf" items that can be purchased at local suppliers, saving time, and in many cases money. Traffic staff may ask the districts to order some items from annual orders on their own if it does not appear they will benefit from the annual order process.

Standard. District purchases are to follow General Services' guidelines for purchasing.

Support. Some information that General Services might need to include in equipment bids are:

- Reference to the Standard Specifications (if applicable). Indicate the exact section that applies.
- Reference to the approved products list (if applicable). Include a copy of the current list.
- Supplemental specifications (if applicable). Include a copy of the specifications. An example is signal controller purchases. Traffic maintains supplemental purchase specifications for controllers and other items.

902.22.3 Signal Maintenance

Support. Traffic signal maintenance activities can be divided into three major areas: preventive maintenance, emergency repairs, and follow-up work. Signal maintenance personnel are responsible for these tasks.

See EPG 902.1.10 for MUTCD content regarding traffic signal maintenance.

Guidance. If a traffic signal is dark for signal maintenance, consideration should be given to notifying the police agency whose jurisdiction the signal is located in. If the signal can be flashed instead of dark, a request for police assistance might not be necessary unless the time of day, traffic volumes and congestion dictate a need.



If it is necessary to turn the signal off or a malfunction occurs and traffic cannot be handled by a flashing operation or stop signs cannot be installed immediately, the police should be notified that their assistance is requested until the signal can be repaired or stop signs can be installed.

902.22.3.1 Preventive Maintenance

Support. Preventive maintenance (PM) for traffic signals, includes the systematic inspection, cleaning, testing, adjustment and completion of non-emergency repairs needed to ensure it will function as efficiently and reliably as intended throughout its expected life cycle.

A warranted and well-maintained signalized intersection is one of the best services that can be offered to the public by the department. When efficiently operated it represents a direct savings through reductions in delay, fuel consumption, and greenhouse gas emissions while providing safe intersection traffic control. In the long run, a well-executed preventive maintenance program will reduce the number of emergency maintenance calls and will help ensure reliable and efficient traffic control.

Standard. A schedule of inspections shall be prepared for the purpose of preventive maintenance in accordance with the recommended guidelines set forth herein and administrative supervision shall be maintained to see that maintenance is performed as scheduled. MoDOT's standard for performing these inspections is to evaluate each traffic signal within a two-year time span.

Guidance. Several factors should be considered when preparing the preventive maintenance schedule to ensure the effort is focused in the most useful locations. Each traffic signal will differ as to the maintenance attention required at different times in its expected life cycle. Preventive maintenance efforts in addition to that described in the Department's standard should be focused on traffic signals identified through review and consideration of the following.

- **Review of the frequency of call reports**

A statistical report should be prepared at least once each year from the MoDOT Customer Service Center call report database. Those signals producing the highest 20% of call reports should be reviewed to determine if extra maintenance efforts could improve reliability. Call reports that proved to be signal timing related rather than maintenance related should be removed from this analysis and forwarded to engineering staff for review.

- **Review of recent modifications, additions, or contract work**

  Signals that have received recent modifications and newly constructed signals can certainly benefit from a thorough, post-project inspection. Inspection by trained signal maintenance personnel can help ensure that any potential maintenance issues are discovered early and resolved before problems develop. Any traffic signal that has undergone modifications or construction since the last inspection cycle should be considered for an additional preventive maintenance review.

- **Review of previous inspection reports**

  Traffic signals that might have structures or features nearing the end of their life cycle might need more frequent inspections to help determine and prioritize replacement needs. The type of signal structure, vulnerability to accident damage and exposure to extreme weather might also be cause for more frequent inspections. Signals needing this additional focus can be identified through review of any concerns noted on previous preventive maintenance inspection reports and should be considered for inclusion in the preventive maintenance inspection schedule.

Reports in checklist (https://epg.modot.org/forms/general_files/TS/902.5.8.3.1_checklist.xlsx) format are available to aid the preventive maintenance process for cabinet and control equipment and for signal supports, signal heads and pull boxes. More detailed preventive maintenance guidance can often be found in the manufacturer's equipment manuals for the many varied components of signal structures and control.

A preventive maintenance program should include the following:

LED Signal Indications

Scheduled replacement of LED indications should be accomplished every 10 years. Inspection of the indications between changes should include visual verification that each indication is operating and is oriented properly within the signal head.

Signal Heads

All signal heads should be plumb and in proper alignment to be visible from the appropriate lane. Signal heads capable of programmable viewing angles should be checked for visibility and non-visibility from the appropriate lanes. The points of signal head attachment, especially on span-wire installations and post top mounting should be checked to see that all components are sound and secure. If top mounted signal heads are loose and cannot be tightened, consideration should be given to installing a longer pedestal post and side mounting the head. Check that all setscrews are in place and tight.

Overhead signals and associated hardware should be checked for proper clearance over the roadway. Signal section doors should be observed to see that they are tightly secured to the signal section housing. The condition of the signal heads should be evaluated to determine if replacement might be

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necessary. Backplates and signal visors should be checked for proper attachment and condition and replaced if necessary.

Signal Supports

Signal support posts should be plumb or raked as planned. Steel posts and mast arms should be inspected at seams and joints for signs of stress or fatigue. Particular attention should be directed to the base plate and mast arm plate joints and associated welds. Any indication of stress or cracking should be marked and called to attention for further evaluation. Bolts and nuts should be checked for tightness and rust. Where possible anchor bolts should be visually examined for signs of rust or deterioration. Steps should be taken to replace any missing handhole or post top covers. Wooden support poles should be checked for bending and general condition.

Concrete signal post bases should be checked for settling or shifting, cracking, severe spalling or similar weather-related deterioration. The gap between the post foundation and the post base plate should be filled with galvanized wire screen. On older installations, grout might have been used to fill this gap. If this is the case, consider removing the grout and installing wire mesh if the grout is broken or appears to be retaining moisture.

Guy cables, support cables, tether cables and anchors should be checked for tautness and for signs of strain. The cable's physical condition should be checked to see that there are no broken strands. Cable attachment clamps should be checked for tightness. Anchors should be checked for movement and general condition. Anchors and guy cables can loosen up over time as they are subjected to wind loads, changing soil conditions and even vehicle accidents. This loosening can affect clearance of the signal over the roadway. Clearance between the roadway and the bottom of signal heads is to be maintained between 16 and 19 feet.

To minimize signal head movement, cable spans should not have excessive sag. Tether cables should be maintained in a straight line across the bottom of the signal heads. If excessive sag is found, the cable should be tightened. Minimizing movement does not only enhance signal head visibility but also reduces stress on the signal heads, cables and associated hardware.

Vehicle and Pedestrian Detection

Each detector should be observed to see if it is operating properly. Equipment is available for troubleshooting detectors. It is highly desirable to make and record the impedance and resistance of each loop when installed. Such information can be invaluable in trouble shooting induction loop detection systems. Each push button should be pressed to confirm that it actuates the pedestrian phase. Check pedestrian signs for condition and proper alignment.

Pull Boxes

All pull boxes should be checked for cracking of the concrete apron, and condition of the lid. Signs of settling could indicate sidewall failure. Consideration should be given to adding a drain if the pull box is holding water. Detector loop splices and the grounding system should also be checked for tightness and condition.

Cabinets

The outside surface of the cabinet should be inspected for overall physical condition. Brush and vegetation should be under control in the area around the cabinet. Doors should fit tightly when closed and the gasket should seal properly. Locks and hinges should move freely and be lubricated if necessary. The inside of the cabinet should be clean, and all assemblies should be

free of dust, pests or signs of moisture intrusion. Filters should be in good condition and replaced or cleaned to ensure proper ventilation. Ventilation fans should be checked for operation and the appropriate thermostat setting should be verified. Anchor bolts on the cabinet should be checked for tightness to the base. The conditions of the duct seal and cabinet seal as well as the ground rod clamp and wire should also be evaluated. Cabinet documentation including wiring diagrams, timing sheets, work records and intersection layout or plan sheets should be present. Police door lock, flash switch and manual control should be checked for proper operation.

All terminals should be checked for tightness. Relays, plug-in modules, and connectors should also be checked for proper fit and operation. A voltage measurement should be made and recorded at the main voltage input terminal block. This voltage measurement should agree with the voltage measurement at the service disconnect and should be within the tolerances of the signal control equipment. Voltages at the field terminals should also be checked. Lightning protection devices should be examined to see that they are in condition to activate if a surge should occur. If no lightning protection is present at the service line input, it should be added.

Flashers should be checked to ensure they operate with a flash rate of 50 to 60 times per minute.

Controllers

Verify that the cabinet timing sheet matches the programming currently in the controller. Check for the proper operation of programmed functions.

Preemption Equipment

Preemption equipment should be regularly checked for proper operation. Preemption equipment is typically installed at critical intersections (near railroad tracks or emergency vehicle routes) so malfunctioning preemption equipment should be repaired or replaced as quickly as possible.

MoDOT's preventive maintenance measures should extend only to the equipment owned and maintained by MoDOT. When preemption equipment is not owned, operated, and maintained by MoDOT, testing of preemption system operation should be coordinated with the other involved agency and can be scheduled separately from the preventive maintenance inspection.

Utility Service

The utility service should be examined to ensure that the electric meter enclosure, conduit and boxes are in sound condition and securely mounted. Surge protection should be present at the service. Circuit breakers should be sized appropriately and labeled as to their function. All electrical connections must be tight and the service should be properly grounded. Supply voltage should be measured at the service disconnect or main breaker and low or high supply voltages should be reported to the utility company for correction if tolerances are exceeded with which the signal control equipment is designed to work. If the service is an overhead drop, ensure that the drop and connection point is clear of tree limbs.

Battery Backup Power Supplies

Enclosures or cabinets for battery backup systems should be inspected using many of the same inspection points considered for traffic signal control cabinets. Inspect the cabinet for physical damage. Locks, hinges, doors, ventilation, and moisture seal should all be evaluated. Battery condition and age should be considered and noted on the inspection form. Connection points should be examined to ensure they are securely fastened and free of corrosion. Control unit

self-tests and power transfer tests can be very useful in validating the system. Careful consideration of the potential effect on signal operation is essential before scheduling and performing such testing.

902.22.3.2 Conflict Monitor and Malfunction Monitor Testing

Guidance. It is important to test monitors periodically to ensure their reliability. Monitors should be tested according to the following guidelines: Annual tests should be conducted and recorded as part of the annual preventive maintenance procedure. The documentation of these procedures should be stored with other permanent records. It is recommended that field tests be performed during low traffic volume periods in order to minimize disruption to traffic.

902.22.3.2.1 Conflict Monitor Unit Test Procedure

Guidance. The conflict monitor should be tested annually with a computerized conflict monitor tester. This is done by removing the intersection's monitor and running a complete test with the conflict monitor tester unit. If the test is to be completed in the field, a spare monitor should be installed temporarily while the test is being performed. Monitors can also be shop-tested by rotating pre-tested monitors to the field. Documentation of the tested monitor should include the following:

1. Date
2. Name of Technician
3. Location – includes intersection name, city and/or county
4. Serial number of conflict monitor
5. Comments regarding fail or pass conditions

The monitoring unit’s permissive programming card should be inspected for physical condition. The jumpers or diodes that establish monitor channel concurrency should also be evaluated and verified as correct for the intersection in question.

Failed monitors should either be repaired so that they pass the monitor test or replaced with a monitor that passes the test.

To ensure the reliability of the computerized monitor tester, a calibration of the unit should be done annually. The units need to be returned to the manufacturer in order for this calibration to be done properly. The districts should establish a yearly program of having their conflict monitor testers returned to the manufacturer and the recalibration performed.

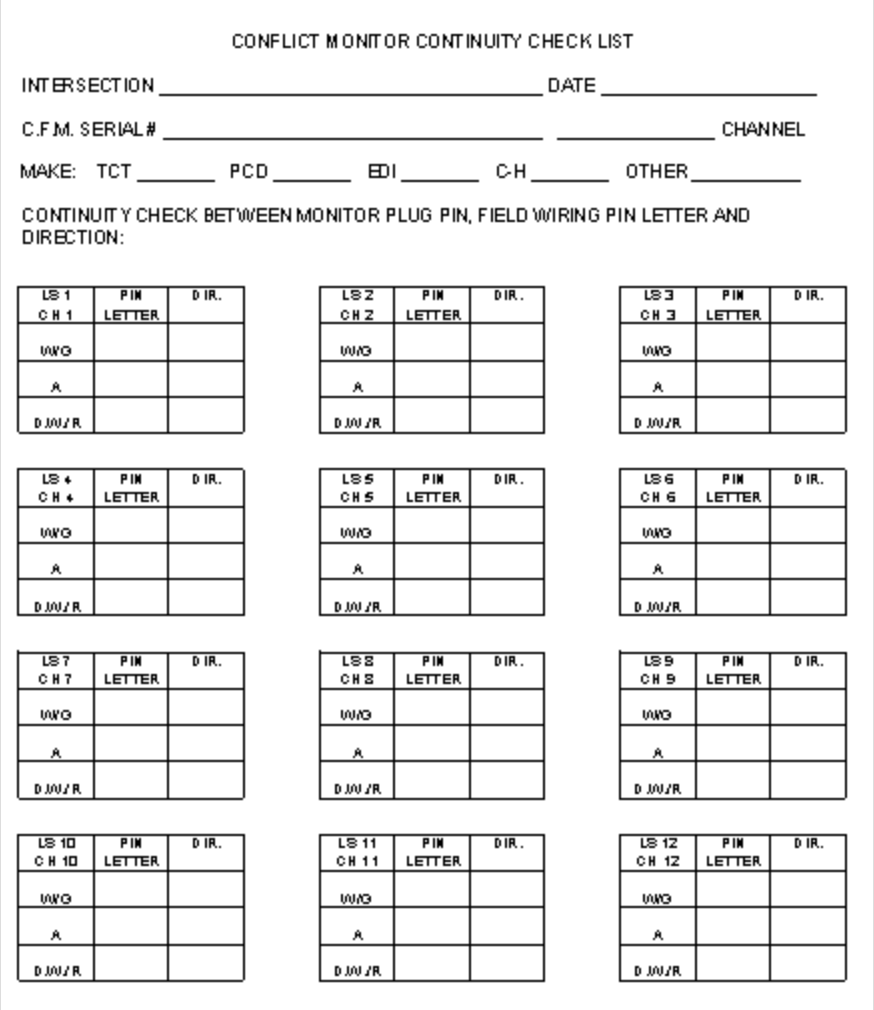
902.22.3.2.2 Cabinet Test Procedures

Guidance. Two tests should be performed to check the cabinet wiring and operation as related to conflict monitoring functions. These tests should be performed as part of initial cabinet setup and should be repeated at the time of any cabinet wiring modifications or additions. These tests are not required during annual preventive maintenance monitor unit testing.

(A) Conflict Test An actual conflict condition is induced by means of a jumper wire. This is most commonly done by placing one end of the jumper wire on a green terminal output and the other end on a conflicting green terminal output. Once power is applied to either green terminal, the conflict

monitor should trip causing signal control to be transferred to flashing operation. A push button with leads and alligator clips can be helpful for performing this test. (B) Harness Test

For solid-state pre-timed, NEMA TS1 and Type 170/2070 controllers, the monitor harness or harnesses should be tested for continuity and to ensure that all wiring to the monitor is intact and that the correct load switch circuit goes to the correct channel in the conflict monitor. The results of the test are recorded on the Conflict Monitor Continuity Checklist.



CONFLICT MONITOR CONTINUITY CHECK LIST

INTERSECTION _____ DATE _____

C.F.M. SERIAL # _____ _____ CHANNEL

MAKE: TCT _____ PCD _____ EDI _____ C-H _____ OTHER _____

CONTINUITY CHECK BETWEEN MONITOR PLUG PIN, FIELD WIRING PIN LETTER AND DIRECTION:

LS 1 CH 1	PIN LETTER	DIR.
WG		
A		
DWR		

LS 2 CH 2	PIN LETTER	DIR.
WG		
A		
DWR		

LS 3 CH 3	PIN LETTER	DIR.
WG		
A		
DWR		

LS 4 CH 4	PIN LETTER	DIR.
WG		
A		
DWR		

LS 5 CH 5	PIN LETTER	DIR.
WG		
A		
DWR		

LS 6 CH 6	PIN LETTER	DIR.
WG		
A		
DWR		

LS 7 CH 7	PIN LETTER	DIR.
WG		
A		
DWR		

LS 8 CH 8	PIN LETTER	DIR.
WG		
A		
DWR		

LS 9 CH 9	PIN LETTER	DIR.
WG		
A		
DWR		

LS 10 CH 10	PIN LETTER	DIR.
WG		
A		
DWR		

LS 11 CH 11	PIN LETTER	DIR.
WG		
A		
DWR		

LS 12 CH 12	PIN LETTER	DIR.
WG		
A		
DWR		

Conflict Monitor Continuity Checklist

Conflict Monitor Continuity Checklist

This test should be performed during initial cabinet set-up and any time changes are made that affect the monitor wiring or operation (i.e. phasing changes). This test can also be performed at other times as needed. The harness test is not required for NEMA TS2 controllers since the cabinet diagnostics continuously check cabinet conditions.

Conflict Monitor Harness Tester (https://epg.modot.org/files/a/a7/902.8.3.2.2_Conflict_Monitor_Harness_Tester.doc) presents the procedure for using a harness tester. The harness tester also shows connector terminations for 6 and 12-channel conflict monitors. More detailed information on conflict monitors is found in the NEMA Standards Publication No. TS-1, Traffic Control

Systems. A similar device can also be developed for Type 170/2070 controllers. This tester can be helpful as a troubleshooting tool as it can be used to isolate some cabinet wiring problems.

902.22.3.3 Emergency Maintenance

Guidance. Occasionally traffic signals, flashers and lights malfunction or are damaged from vehicle crashes, acts of nature and/or other unexplained phenomena. Some of these occurrences will constitute an emergency requiring an immediate response, while others might indicate a lower priority response. Sound judgment should be used when evaluating the priority of signal malfunctions or damage.

Generally, flashers have lower priority than traffic signals. Refer to the Incident Response Plan (http://sp/sites/sm/IRPDocuments/SitePages/IRP%20Home.aspx) and Incident Response Priorities (http://sp/sites/sm/IRPDocuments/Shared%20Documents/PUBLISHED/APPENDICES/AppendiceII%20-%20Incident%20Response%20Priorities.pdf) for detailed information regarding emergency response for traffic signals, flashers and lights.

902.22.3.4 Maintenance Limits

Guidance. No major repair should be attempted while the controller is in service. Where possible, the availability of a spare unit for each type of assembly minimizes interruption of signal operation when that unit must be removed for servicing or repair.

Field servicing of solid-state equipment should be limited to the exchange of modules and assemblies known to be good for those thought to be defective. Due to the sensitivity of some parts, it is important that they be stored in the shipping containers until used and then handled with minimum hand contact.



During after-hours, the electrician might have to contact the highway patrol or local police and the power company.

902.22.3.5 Equipment Replacement and Repair

Guidance. Sound judgment should be used when making decisions about replacing or repairing malfunctioning signal equipment. When possible, field repairs should be limited to operations that result in minimal down time to signal operation. Shop repairs are preferable where spare equipment can be installed to maintain signal operation.

When deciding to repair or replace a piece of equipment, consider these factors:

- Relative condition of the piece of equipment.
- Remaining usable life of the piece of equipment.
- Cost of repairs in personnel time or repair shop costs vs. cost of new equipment.
- Availability of replacement parts.
- Is the piece of equipment functionally obsolete?

The evaluation of these factors might determine that it is more cost effective to replace a piece of equipment than to repair it.

Option. Repair work may be performed by district personnel or may be sent to a repair shop. This decision is based on the available expertise of personnel, time demands on the shop and the nature of the malfunction.

902.22.3.5.1 Crash Damage to Controllers

Standard. Occasionally a crash will result in the destruction of a signal controller. Whenever this occurs, MoDOT tries to collect for the damages incurred. The following depreciation schedule shall be applied when determining the present worth of an existing controller that has been damaged.

Age, In Years	Worth, % of Original Value
0-1	100
1-2	99
2-3	98
3-4	96
4-5	93
5-6	89
6-7	85
7-8	80
8-9	74
9-10	67
10-11	60
11-12	52
12-13	43
13-14	33
14-15	23
15-16	12
16 or More	2

902.22.3.5.2 Crash Damage to Signal Heads and Supports

Standard. Whenever damages occur to signal heads and their supports as the result of a crash, collection for damages shall also be attempted. Straight line depreciation shall be used with a 15-year life used for all signal heads and all temporary span wire supports. A 25-year life shall be used for all permanent supports.

902.22.4 Record Keeping

Standard. Each district shall keep and maintain documentation on each signalized intersection. Each district will be required to maintain (1) Signal Maintenance Files and (2) a Module and Assembly Repair File. The Signal Maintenance File shall be kept on a per intersection basis, whereas the Module and Assembly Repair File shall be kept on a module and assembly type basis. Refer to Figure 902.22.4.1 for guidelines regarding record keeping for signal-related information.

Standard. The information being recorded shall be accurate and legible. Completing documentation for each signalized intersection requires more time of those involved in signal operation and maintenance, but the time required to do so is considered minimal and over a period of time will more than justify the time spent.

It is important to retain records for the appropriate amount of time before information is discarded. For more specific details on document retention, review MoDOT's Retention Schedule.

In general, design and construction-related information such as design plans and contracts are retained permanently. For signals constructed on contracts administered by Construction, Construction typically retains contract records. Design typically retains plans for projects that are let under the right of way and construction program. For signals constructed by permit, department forces, or a combination of department forces and contract work, district traffic is responsible for retaining design and construction documentation.

All other records pertaining to operation and maintenance of traffic signals shall be retained a minimum of seven years. Each district is responsible for retaining these records. The following reports and records should be maintained. Some example forms for various records are included, but districts can choose to modify them as needed in order to meet their specific needs.

1. Signal, Flasher, and Lighting Inventories

Traffic Signal, Flasher, and Lighting Inventories

These inventories contain each signalized intersection, flasher installation, and lighting installation on MoDOT right of way. The inventories are part of the Transportation Management System (TMS) (http://tms/home/). District personnel shall maintain the TMS signal, flasher, and lighting inventories on an ongoing basis. Guidance is available in the Traffic Signal, Flasher, and Lighting Training Manual.

2. Intersection Plans

Intersection plans are provided for each signalized intersection, although plans for older installations can be difficult to find. At a minimum, the documentation shall be in the form of signal plan sheets from the final plans of the project or drawings. The plans shall show the lane widths, all signal indications and their location, detector placement, and approximate geometrics with regard to skew. Intersection plans shall be available in the district office, in the signal shop's signal maintenance file, and can be scanned and stored in the signal inventory in TMS.

3. Signal Phasing and Timing Record

Signal phasing and timing is determined, computed, and stored by district office personnel. Old signal phasing and timing shall be archived. This documentation shall be accessible

electronically or at the controller cabinet, at the signal shop, and at the district office or TMC. It can also be stored within the signal inventory in TMS.

4. Traffic Signal Service History

A historical record of the service history shall be kept in the controller cabinet. Entries shall be completed by anyone observing the operation of the equipment or performing maintenance. The date of the observation or call to the controller shall be indicated with a very brief note of explanation and initialed by the person entering the information. This form shall be filed in the signal shop whenever the sheet becomes full. See Figure 902.22.4.2 for an example form.

5. Preventive Maintenance (PM) Checklists

Checklist
Statewide Signal/Lighting/Flasher Preventive Maintenance Checklist

There is a checklist available for preventive maintenance (https://epg.modot.org/forms/general_files/TS/902.5.8.3.1_checklist.xlsx): PM Checklist for Signal Supports, Heads, Pull Boxes, and Cabinet and Control Equipment. The list contains a number of items relating to the intersection operation that shall be examined on a periodic basis in accordance with the recommended guidelines set forth herein. Each item on the list shall be examined during the PM check. A check opposite of each individual item indicates that item has been examined and found in proper operating and physical condition. On completion, the PM checklist shall be returned to the signal shop for review and subsequently placed in the signal maintenance file for that particular intersection.

6. Emergency Signal Maintenance Work Records

This record is essentially an emergency work record that can be used to record any maintenance activity performed at an intersection that is not considered preventive maintenance. The record shall be maintained as either a paper copy or a computer database.

(Figure 902.22.4.3 and Figure 902.22.4.4).

7. Bench Repair Label

The bench repair sticker shall be attached to any component, module, or assembly when it is removed from an intersection and taken to the signal shop for repair. When the unit is repaired, the label is completed, indicating what was done or replaced during the repair. When the unit is ready to be returned to service, the label is then placed in the module and assembly repair file for that particular unit.

8. Conflict Monitor Information

Conflict monitor test results, cabinet test results, conflict monitor card programming and any other important information shall be kept in the signal shop. Forms for documenting conflict monitor programming include:

- Figure 902.22.4.5 (Conflict Monitor Program Card)
- Figure 902.22.4.6 (NEMA TS2 Conflict Monitor Program Card) and
- Conflict Monitor Program.

9. Cabinet Drawings

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Cabinet drawings and other critical paperwork shall be kept in the controller cabinet, in the signal shop, and can also be stored in the signal inventory in TMS.

Guidance. District personnel should store all intersection photographs within the TMS signal inventory in TMS. Photographs should be updated as needed, but the older photos should always be retained. Intersection photographs that can be beneficial include, but are not limited to, photographs of the signal cabinets, components within the signal cabinet, and the power supply.

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902.23.1 Traffic Signal Operation

Support. Traffic signals can operate independently of any other traffic control signal ("isolated" operation) or their operation can be related to other traffic control signals ("coordinated" operation) forming a traffic control signal system.

Traffic control signals can be operated in pretimed, full-actuated, or semi-actuated control.

902.23.1.1 Pre-timed Control

Support. Pre-timed controllers direct traffic to stop or permit it to proceed according to a predetermined fixed cycle length and a division of the fixed cycle time between the various approaches to the intersection regardless of the actual vehicle demand. The sequence in which the signal indications are shown, and the time-relation of the signal to other signals are also pre-selected. Any or all of these features can be changed to accommodate specific needs.

In pre-timed operation, signal sequence is controlled by signal plans, which define the order of the signal intervals that are displayed. The amount of time given to each interval in a signal plan is determined by a timing plan. The time of the day at which specific timing and/or signal plan programs begin or end can be predetermined locally or remotely.

Pre-timed control can work well at intersections with tight spacing (i.e. diamond interchanges or central business district). However, traffic actuated controllers are preferred at most intersections: actuated controllers can run pre-timed but pre-timed controllers cannot run actuated.

902.23.1.2 Fully-actuated Control

Support. A fully actuated controller uses detection for all movements to determine the display and duration of vehicle and/or pedestrian movements at an intersection. The controller is able to skip those movements where no demand is present.

Fully actuated controllers have the flexibility of operating fully actuated, semi-actuated or pre-timed. The type of operation can also be changed by time of day.

Fully actuated controllers are available in two primary types, the NEMA, National Electrical Manufacturers Association, or the Type 170/2070 (Caltrans TEES, Caltrans Transportation Electrical Equipment Specifications). Both are keyboard entry and software driven machines. The NEMA controllers make up the bulk of the actuated controllers used in the state.

NEMA TS1 standards (refer to EPG 902.23.12.1 NEMA TS1) define the basic operating parameters of the controller as well as the inputs and outputs of the unit. This has led to the interchangeability of NEMA controllers between manufacturers. Most of the manufacturers have enhanced the operating software, adding many features that can be unique to that make and model. However, to be certified as a NEMA controller the basic operating functions are identical.

The NEMA TS2 standard (refer to EPG 902.23.12.1 NEMA TS2) expands the features of the TS1 standard, providing a higher level of standardization and interchangeability of equipment. TS2 also defines many of the features that have evolved in the current NEMA controller technology. Some TS2 functionality can be part of a TS1 cabinet.

The Type 170/2070 (refer to EPG 902.23.12.1 Type 170/2070) controller defines the hardware of the controller and allows the user to choose the software to run the controller. This has led to a great and almost total interchangeability of the controller and cabinet hardware but has left the user to evaluate and standardize on the software to run the intersection. Most of the features of the software are similar to the NEMA parameters. Although some hybrid versions of the 2070 have been created that can be used in NEMA cabinets, the true 170/2070 style controllers are designed for mounting in a 19” rack and meet Caltrans TEES (Caltrans Transportation Electrical Equipment Specifications).

All fully actuated controllers are able to respond to the traffic at the intersection. Minimum green times for called phases as well as extensions, when there continues to be traffic present, are programmable. There are also maximum green times, when a phase must be terminated to serve other calls, as well as yellow change and red clearance intervals that are programmable. There are other features available on a per phase basis such as pedestrian movements, added initial, maximum initial, minimum gap, time to reduce, time before reduction, minimum and maximum recalls. These features allow the fully actuated controller to serve the traffic in the most efficient manner.

The phases in an actuated controller can be assigned or grouped in many ways to provide unique operations that best serve the intersection's needs. The most common is the dual ring eight-phase configuration. This arrangement allows for separate through and left turn phases for up to four approaches. The opposing left turns are typically on concurrently, either leading or lagging. Through the software, the phases can be repositioned to provide a lead-lag left operation if so desired. Examples of typically used configurations are found in Signal Phasing and Layout Examples (http://sp/sites/sl/programdelivery/design/SignalsandLighting/Shared%20Documents/Signal_Phasing_and_Layout_Examples.pdf#search=signal%20phasing%20layout).

Efficient actuated operation is dependent on the type and placement of the detectors. Poor detector placement can have a serious impact on the delay and capacity of an intersection. Different types of detection are discussed in EPG 902.5.7 and EPG 902.15.3. Typically, stop bar presence detection is

used. A common presence detector is a 6 ft. x 30 ft. area. Mainline through detection can be supplemented with advanced detectors located a distance from the stop bar based on the speed of approaching traffic.

Full actuation and advance vehicle detection on high-speed approaches are typically used to reduce the frequency of vehicles in the “dilemma zone”. The dilemma zone is the area where the onset of the yellow change interval creates difficulty for the driver to decide whether to stop or proceed.

902.23.1.3 Semi-actuated Control

Support. Semi-actuated intersection control refers to intersections where a fully actuated controller is used but one or more phases are not actuated. Typically, the mainline through phases are not actuated and the side streets and the mainline lefts are actuated. Timing for the non-actuated phases can be accomplished by using recalls. The non-actuated phases will remain in green until there is a call from one of the other movements and the minimum green timer is expired. The actuated phases work the same as in fully actuated control. To avoid or minimize unnecessary delay at isolated intersections fully actuated control is preferable to semi-actuated control.

902.23.1.4 Comparison of Pre-timed and Actuated Control

Support. Each principal type of traffic signal control, pre-timed and actuated, possesses certain advantages not afforded by the other. The following discussion is intended to bring out basic differences in the different types of control, as to their operating characteristics and suitability for various traffic requirements. It is to be remembered that each type of control is capable of being modified in various ways for improved efficiency and flexibility.

With basic pre-timed control, a consistent and regularly repeated sequence of signal indication is given to traffic. Pre-timed control is particularly adaptable to intersections where it is desired to coordinate signal operation with closely spaced intersections.

Actuated control differs basically from pre-timed control in that signal indications are not of fixed length, but are determined by and conform within certain limits to the changing traffic flow or to the background cycle, if coordinated. The length of the cycle and sequence of phases might or might not remain the same from cycle to cycle since phases will not be serviced unless there are detections from waiting vehicles or pedestrians.

902.23.1.5 Advantages of Pre-timed Control

Support. Advantages of pre-timed control include the following:

- Consistent starting time and duration of intervals can facilitate more precise coordination with adjacent traffic signals.
- Pre-timed control can permit the operation of two or more very closely spaced intersections to operate at maximum efficiency.
- Pre-timed control is not dependent on vehicle detectors. Thus, the maintenance needs can be reduced.

- Pre-timed control can be more acceptable than actuated control in areas where large and fairly consistent pedestrian volumes are present, and where confusion might occur with the operation of pedestrian push buttons.

902.23.1.6 Advantages of Actuated Control

Support. Advantages of actuated control include the following:

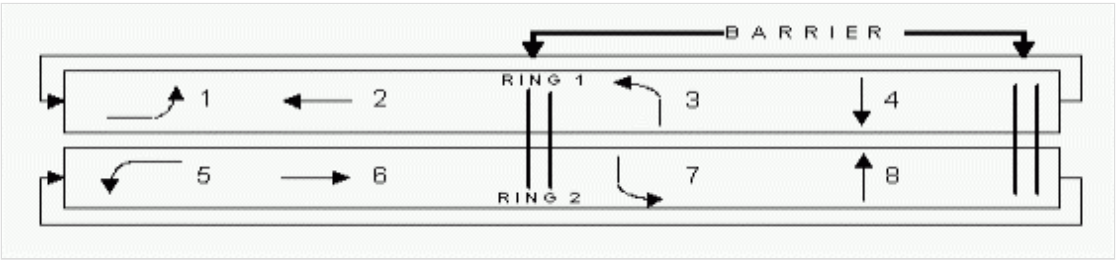
- Can provide maximum efficiency at intersections where fluctuations in traffic cannot be anticipated or programmed with pre-timed control.
- Can provide maximum efficiency at complex intersections where one or more movements are sporadic or subject to variation in volume.
- Can provide the advantages of continuous signal control even in periods of light traffic without causing unnecessary delay to traffic on the major street.
- Can be used at locations where traffic signal control is warranted for only brief periods during the day.

902.23.2 Signal Phasing

Support. The phasing of a signal determines the order that movements are serviced. A study of traffic movements at the intersection is made to determine permitted and controlled movements. From this, the number and sequence of traffic phases is determined, which in turn determines the interval or color sequence and types of signal indications to be used. In general, the most efficient operation is obtained with the fewest possible phases; however, each signal installation is designed to provide safe and efficient control of conflicting traffic movements.

Guidance. The following articles provide guidelines for selecting phasing. Several examples are also shown in Signal Phasing and Layout Examples (https://epg.modot.org/forms/general_files/TS/Signal_Phasing_and_Layout_Examples.pdf#search=signal%20phasing%20layout).

The typical phase arrangement at most intersections is with eight phases grouped into two sets of movements, or "rings". NEMA designates the assignments as follows:



NEMA Ring

A general form for actuated controller sequencing of an intersection is available. However, districts might have their own forms that are specific to the controller or software that is used at the intersection.

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Phase assignment should be kept uniform in accordance with this ring structure whenever possible. Mainline left turns should be assigned to phases 1 and 5, with mainline through movements assigned to phases 2 and 6. Side street left turns should be assigned to phases 3 and 7, with through movements assigned to phases 4 and 8. Other phase numbering schemes can be used, but consistency should be maintained throughout the district.

As shown above, mainline leading left indications are displayed first. Phases on opposite sides of the "barrier" cannot operate together (such as phases 2 and 4). Phases on the same side of the barrier in one ring can run concurrently with phases in the other ring (e.g. phase 3 can be on at the same time as phase 8). Only one phase per ring can be on at any given time. (For example, if phase 2 is on, then no other phases in ring 1, such as phases 1, 3, or 4 can be on at the same time.)

902.23.3 Left Turn Phasing

Support. Guidelines are available to aid in determining the proper left turn phasing for signalized intersections.

Left Turn Phasing Warrants (https://epg.modot.org/forms/general_files/TS/Left_Turn_Phasing.xlsx)

Left turn indications at signalized intersections are designed so they are neither overly restrictive nor inconsistent from the driver's point of view. The Left Turn Phasing Warrants are available in an interactive spreadsheet for safety warrants and capacity warrants to determine the amount of protection to be given to a left turn movement. These warrants are based upon accepted safety and capacity values for signalized intersections.

When factors such as sight distance, speed of opposing vehicles, etc. make permissive turns undesirable, the permissive left turn option is removed. Safety warrants are checked first; if an approach requires protected-only phasing for safety reasons, it is unnecessary to check the capacity warrants.

Once safety considerations are satisfied, Capacity Warrants will need to be analyzed. Capacity Warrants are divided into three parts: Permissive-Only left turns, Protected/Permissive left turns, and Protected-Only left turns. This criterion is used when designing or upgrading a signal installation.

In order to provide the proper phasing at an intersection, it will be necessary to check Capacity Warrants for several hours for each approach. For example, if only the peak hour is checked, the phasing will most likely be too restrictive for the rest of the day. It is recommended that the peak periods plus a sample of off-peak hours be checked before choosing the phasing.

When traffic volumes at an intersection are approaching the thresholds listed in the capacity warrants variable left turn phasing can be used by time of day. Variable left turn phasing allows for the selection of either protected only, protected/permissive, or permissive only left turn phasing. This can be used to provide appropriate phasing for varying volumes throughout the day. The protected left turn phase can be omitted by time of day and flashing yellow arrow operation allows for removal of the permissive left

turn in addition to removal of the protected left turn phase. It can be used only on approaches with "positive" signal lane control, in that each approach lane has its own signal indication. Refer to EPG 902.23.5 for more information on flashing yellow arrow indications. Otherwise, the most appropriate left turn phasing is chosen based on the results of the Capacity Warrants.

When the flashing yellow arrow indication is used to provide variable phasing, each hour during a typical day is evaluated to determine proper phasing throughout the day. The Variable Left Turn Worksheet can help evaluate each hour during the day. During initial installation the flashing yellow arrow indication can allow the selection of more restrictive phasing initially and then change to a less restrictive mode if appropriate.

Note that some overlap may occur when analyzing the volumes at each approach (i.e., the data for one hour might satisfy parts of the criteria for both permissive-only and protected/permissive left turns). Therefore, it will be necessary to check at least two of the three parts of the criteria. When an overlap does occur, previous experience and/or evaluation studies at the location is to indicate whether the situation is better served by the more or less restrictive phasing that is determined using the criteria.

The left turn phasing guidelines, below, give safety and capacity considerations for selecting left turn phasing. The interactive spreadsheet allows for the user to directly enter criteria and see suggested thresholds based on these formulas. These guidelines are used when reviewing design plans and when modifying the phasing of an existing installation.

902.23.3.1 Guidelines for Variable Left-Turn Phasing

This is a guide for the selection of variable left turn phasing hour-by-hour. Guidelines based on safety and capacity are provided.

Definition of Terms

The following terms are used in these guidelines :

VLT = The left turn volume per hour per approach.

(VLT)pp = The number of vehicles attempting to make permissive left turns during the permissive part of a protected/permissive left turn per hour per approach.

VO = The opposing volume per hour per approach per lane (excluding free right turn volume and volume serviced by a separate right turn phase).

cp = The cycle length (in seconds) when those volumes occur using permissive-only phasing[1].

cpp = The cycle length (in seconds) when those volumes occur using protected/permissive phasing[1].

gp = The green time (in seconds) common to both VLT and VO during that cycle using permissive-only phasing[1].

gpp = The green time (in seconds) common to both (VLTLT)pp and VO during that cycle using protected/permissive phasing[1].

TP = The time allocated to the protected left turn movement using protected/permissive phasing[1].

[1] These green times are used in the calculations regardless of the existing phasing. For phasing configurations not currently used it will be necessary to develop realistic timing for that phasing configuration. A signal timing computer program can be helpful in developing this timing.

Adjustment of Left Turn Volumes

This evaluation considers the number of vehicles attempting to make permissive left turns during the permissive part of a protected/permissive left turn. Therefore, the effects of protected left turns should be eliminated. This can be handled using the following method:

(VLT)pp = VLT - VP,

where the variable VP is the number of left turn vehicles served by the protected left turn indication. If this formula yields a negative number, use 0 for (VLT)pp. Assuming that vehicles enter the intersection at a rate of 2 seconds/vehicle, the volume using the protected movement in a one-hour period is:

$$VP = \frac{T_p(sec/cycle) \times 3600(sec/hr)}{2(sec/vehicle) \times c_{pp}(sec/cycle)}$$

Safety Criteria

Protected Only Left Turns

Protected-Only left turns shall be provided full-time when the number of opposing lanes ≥ 4.

Note: If the number of opposing lanes = 3, protected/permissive should be considered using engineering judgment.

The following factors should be considered when counting the number of opposing lanes crossed by left-turning traffic:

Through Lanes. Any lane in which through traffic is permitted shall be counted, even if turns are also permitted from that lane.
Left-Turn Lanes. Opposing exclusive left-turn lanes should usually not be counted, because typically opposing left turns do not conflict with each other.
Right-Turn Lanes. It may be acceptable to exclude opposing right-turn lanes. Omitting right-turn lanes is particularly appropriate where the right-turn movement is physically channelized from opposing through lanes and not under signal control. It may be desirable to include right-turn lanes in the count of opposing lanes where right-turn volume is heavy or where conflicts with left-turns are unusually high.

Protected-Only left turns should be provided full-time when any one of the following criteria are satisfied:

A. Sight Distance:

< 200 ft. for 25 mph
< 240 ft. for 30 mph
< 280 ft. for 35 mph
< 320 ft. for 40 mph
< 360 ft. for 45 mph
< 400 ft. for 50 mph
< 440 ft. for 55 mph

B. Number of Correctable Crashes By Upgrading to Protected Only Phasing > 5 over 12 months

Note: The correctable crashes should involve the SAME Left Turn approach. Only those approaches satisfying that criteria should be upgraded.

C. Number of Observed Traffic Conflicts > 48 Conflicts / 11 Hour Day

Note: Conflicts occur when motorists on the OPPOSITE APPROACH must respond to the actions of motorists making the subject left-turn movement. Therefore, conflicts should be measured by observing the intersection from the opposite approach. Only those approaches satisfying the criteria should be upgraded.

D. Speed (prevailing)

≥ 50 mph AND ≥ 2 opposing through lanes
= 45 mph AND a study indicates that the number of gaps is insufficient to turn safely

E. ≥ 2 left turn lanes.

Note: If there are two left turn lanes and one opposing through lane with low speed and low volume, protected/permissive might be considered using engineering judgment.

F. Unusual intersection geometrics that make permissive left turns difficult.

Protected/Permissive Left Turns

Note: Protected/Permissive left turns should be provided when the following criteria is satisfied.

A. Number of Observed Traffic Conflicts > 29 Conflicts / 11 Hour Day

Note: The number of conflicts are those occurring on the OPPOSITE APPROACH that are caused by the subject left-turn movement. Only those approaches satisfying the criteria should be upgraded.

Capacity Criteria

Permissive-Only Left Turns

Note: Permissive-Only left turns are an option when one of the criteria in (A.) is satisfied in conjunction with (B.).

A. VLT < 100 Vehicles per Hour

VLT < 2 Vehicles per Cycle[1]

VO < 100 Vehicles per Hour

[1] This criteria is only valid if observations at the intersection show that drivers tend to make left turns during the clearance interval on a regular basis. These field checks should be made during the hour(s) in which either the highest left turn volume or the highest opposing volume occurs.

B. VLT + VO < 600 x (gp/cp)

Protected/Permissive Left Turns

Note: Protected/Permissive left turns should be provided when one of the criteria in (A.) is satisfied in conjunction with one of the criteria in (B.).

A. VLT > 100 Vehicles per Hour AND VO > 100 Vehicles per Hour

VLT > 2 Vehicles per Cycle[1] AND VO > 100 Vehicles per Hour

VLT + VO > 600 x (gp/cp)

[1] This criteria is only valid if observations at the intersection show that drivers tend to make left turns during the clearance interval on a regular basis. These field checks should be made during the hour(s) in which either the highest left turn volume or the highest opposing volume occurs.

B. (VLT)pp + VO < 1200 x (gpp/cpp)
(VLT)pp x VO < 50,000

Protected-Only Left Turns

Note: Protected-Only left turns should be provided when any one of the following criteria are satisfied.

A. (VLT)pp + VO > 1200 x (gpp/cpp) for 3 or more hours if considering permanent phasing change

B. (VLT)pp x VO> 50,000 for 3 or more hours if considering permanent phasing change

Protected left turn movements should be provided with an adequate turn bay or a separate turning lane, depending upon the volumes using the intersection and the existing intersection geometry. Protected-Only left turns should not be used with shared lanes unless split phase operation is used.

902.23.3.2 Leading and Lagging Left-Turns

Support. A leading left turn is a left turn that precedes or is accompanied by the first through movement in a direction. A lagging left turn is a left turn that follows the last through movement or is on at the end of the green time for a through movement.

At locations where a left turn lane is needed but cannot be provided, some relief is achieved by the use of a leading or lagging green period for the direction of traffic with the heavy left turn.

Leading and lagging left turn phasing is typically used to improve coordination on mainline routes where modifying the left turn phasing will provide a significant improvement in coordination. Lead-lag protected-permissive phasing is not normally used on uncoordinated approaches. Lead-lag phasing can be helpful where a short left-turn bay exceeds its capacity. The lagging left can prevent the turn bay overflow from blocking through traffic.

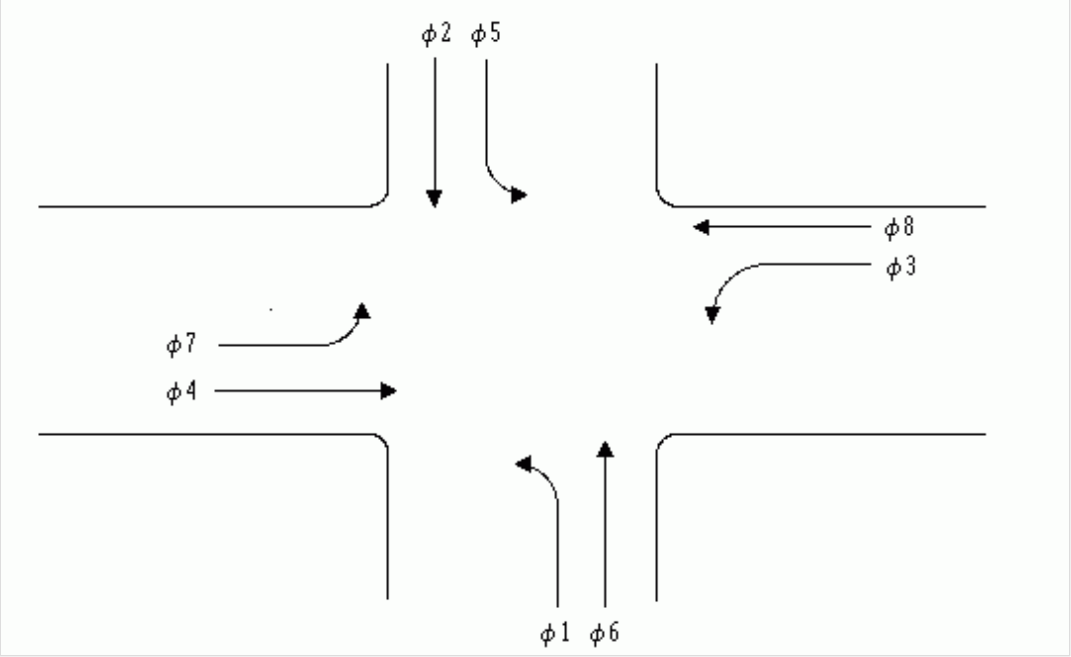
902.23.3.3 Split Phasing

Support. Split phasing is servicing a street one approach at a time. Because split phasing is a very inefficient use of green time, other alternatives, including geometric improvements are often preferred. Split phasing greatly impedes coordination if used on a main line and decreases the efficiency of the

whole intersection by increasing the amount of time needed to serve both approaches separately. This phasing is used when the intersection geometry (i.e. offset intersection) doesn't allow the operation of concurrent phases. For intersections with existing split phasing, use care when modifying phasing to include permissive left turns.

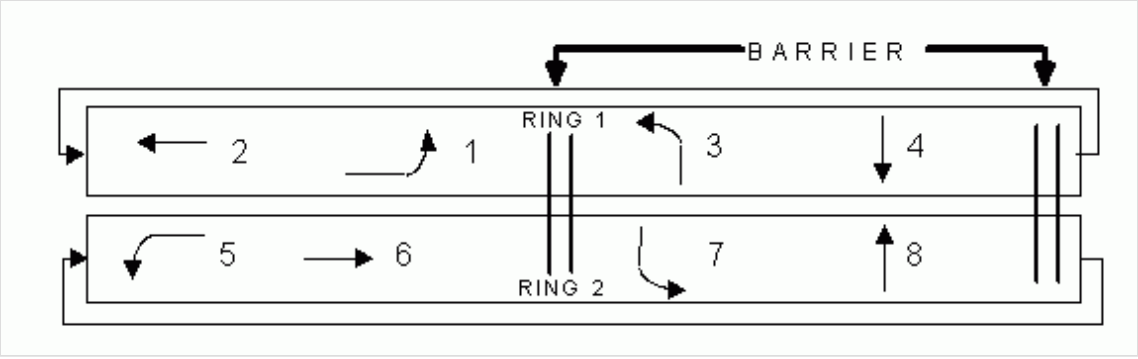
902.23.3.4 Alternate Sequences

Support. When needed, the normal NEMA ring sequence can be altered to fit operating conditions, with restrictions as detailed in EPG 902.23.3. The most common application is to provide lead-lag left turns. Assume this phasing assignment for the following intersection:



Alternate Sequence

In order to allow the northbound phase 1 to become a lagging left turn, the sequence of phase 1 and phase 2 must be programmed to switch. Under this alternate sequence, the ring structure would be:



Alternate Sequence Ring

This ring sequence starts with southbound left and through, and ends on the left side of the barrier with northbound left and through. Sequencing on the right side of the barrier is unchanged. More than one alternate sequence can be programmed.

902.23.4 Left Turn Lanes

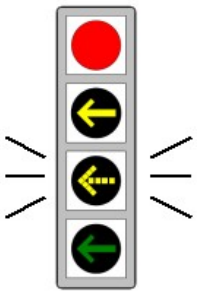
Guidance. It is nearly always desirable to have left turn lanes at any intersection, whether or not signals are present, if there is a need for that turning movement. The warrants outlined in NCHRP 457 – "Engineering Study Guide for Evaluating Intersection Improvements" (http://onlinepubs.trb.org/onlinepubs/nchrp/esg/esg.pdf), will be used as a basis for determining the need for left turn lanes.

Dual Left Turns

Guidance. It is generally agreed that two left turn lanes is to be considered when the left-turn volume exceeds 300 VPH. Where dual left turn lanes are provided, the second left turn lane has been found to operate at 80% or less of the efficiency of the first left turn lane. A capacity analysis of the intersection is to be made when considering dual left turns. If all the movements operate at a satisfactory level of service, than the dual left turn may not be needed. The installation of dual lefts typically requires expensive geometric and signal modifications.

Geometric considerations must also be carefully reviewed at a potential dual left turn. Ideally, dual lefts are to be two exclusive turn lanes. Using a shared lane for the second left turn lane is to be carefully analyzed before using. A shared through and left lane reduces the capacity for the through movement and usually requires split phasing. Turning radii from each of the left turn lanes is to be designed to accommodate side-by-side turning of the largest vehicles typically using that approach. See Markings for Dual Left Turn Lanes for dual left turn striping. Advance signing for the dual left is recommended.

Where the flow of the dual left turn lanes will carry traffic downstream must be taken into account. There is to be at least two through lanes of traffic of sufficient length to handle the completion of the dual turning lanes. Any lane reduction after a dual left turn is to take place far enough away from the intersection so as to provide adequate merging distances. Turning one lane of the dual left into another downstream turning lane is to be clearly signed in advance of the dual left turn.



902.23.5 Guidelines for Use of the Flashing Yellow Left Arrow (FYA)

Support. This subarticle is a starting point for installations and other steps needed to successfully implement the flashing yellow arrow (FYA) for left turns at signalized intersections. The flashing yellow arrow has replaced the circular green ball for the permissive movement for left turns.

Standard. The turning movement for FYA operation must have a separate signal head. Shared indications are not allowed.

Video

Flashing Yellow Arrow animation

Worksheet and Brochure

Left Turn Phasing Warrants (https://epg.modot.org/forms/general_files/TS/Left_Turn_Phasing.xlsx)

Flashing Yellow Arrow brochure

Support. Verify the installation of a stacked 4-section head is possible at a location with an existing 5- or 3-section head. If the turn head has a circular green being shared as the 2nd through indication, then a dedicated signal head will be needed for the 2nd through. Check field wiring to ensure there are enough dedicated conductors to drive the new signal heads. More conductors will be needed for a FYA head than a 5-section head, since each indication must be driven from the cabinet and not jumpered off the adjacent through.

Standard. A LEFT TURN YIELD ON FLASHING ARROW (R10-27a) sign shall be mounted adjacent to the head.

When a new signal is being built or where an existing signal is being reconstructed, the FYA shall be used for the permissive left turn movement. All new cabinets shall be configured for FYA operation on all left turns.

Studies

NCHRP Study 493 (http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_493.pdf)

NCHRP Study 123 (http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w123.pdf)

Safety Evaluation of Permissive Flashing Yellow Arrows for Left-Turn Movements in Missouri (https://spexternal.modot.mo.gov/sites/cm/CORDT/cmr23-005.pdf)

Support. Verify the sign can be installed. Any existing left turn sign will need to be removed.

902.23.5.1 Installation Strategy and Guidelines

Guidance. Carefully considering where to first install the FYA can help with public acceptance. The Left Turn Phasing Warrants (safety and capacity) worksheet should be help determine what type of left turn signal phasing should be used.

The FYA will likely require a 16-position backpanel at locations with any current or anticipated signalized pedestrian control and/or dedicated overlaps, where pedestrian channels are put in the last 4 channels. However, the FYA components, if not immediately used, should be deactivated for future use.

Support. Run “Left Turn Phasing warrants” worksheet for safety and capacity warrants. Volume. Collect volume data for each approach where the FYA will be installed. This includes at a minimum, the proposed left turn movement and opposing through volumes during times where phasing may possibly change.

For each FYA approach, enter the relevant data into the “Left Turn Phasing” worksheet to determine 24 hour-by-hour what phasing option can be used. Follow recommended phasing choice for each hour.

If on an approach the number of “protected-only” hours in a day are numerous, then consideration to full-time “protected-only” phasing should be given.

902.23.5.1.1 Removing Protected-Only Turn Phasing: When Not To

Standard. Protected-only left turn phasing shall not be removed if opposing sight distance is inadequate for permissive left turns, operating speed is too great, or there are too many opposing through lanes. The Left Turn Safety Warrants still apply.

Guidance. If the approach passes Left Turn Safety Warrants, exercise engineering judgment before going from protected-only to FYA protected-permissive. Consider whether the protected-only left turn was installed for other safety reasons (crash prevention when under less restrictive phasing), before operating a possible FYA installation protected-permissive.

902.23.5.1.2 Installation – Best Candidates

Guidance. When considering locations for initial installation look for:

a) Isolated signals OR

b) Adjacent signals within a coordinated signal corridor within common political boundaries (minimum two signals) AND

c) One of the following conditions for each of the signals:

- Mainline left turn approach(es) that currently operate protected/permissive.
- Mainline permissive-only left turn approach(es) having the capability to run part-time protected/permissive or protected-only.

Upgrading sidestreet approaches as well at these chosen signals is preferred.

Additional installations could also include:

- Adjacent signals to first installation and possibly across another political boundary
- Another corridor in another political entity well away from other upgraded locations
- Nearby coordinated corridor with heavy protected-permissive left turn phasing

902.23.5.2 Equipment for Reconstructed Signals

Support.

Cabinet. Examine the existing cabinet to determine how many load switch bays are unused and how many pedestrian load switches are in operation. Each FYA approach will require either one open load switch OR one in-use pedestrian load switch (to utilize the unused yellow channel) in addition to the current load switch for a protected permissive turn.

Cabinet Modification. Contact the cabinet vendor to provide red-lined cabinet prints that will show the needed changes. Once installation is completed, acquire 4 clean prints that reflect the final modifications.

Controller. Controller must be capable of FYA operation. Some controllers are too old to be upgraded to FYA operation. If utilizing an existing controller, check with controller's vendor for capability.

Conflict Monitor. FYA operation requires a special conflict monitor. Check with signal equipment vendors for applicable models. Consider purchasing backup conflict monitors so if the installed model fails, an applicable conflict monitor is immediately available.

902.23.5.3 Equipment for New Construction

Support.

Cabinet. Develop plans with the ultimate number of FYA approaches accounted for. Install the cabinet with an appropriate number of load switches configured for full implementation of both left turn and right turn FYA. This may require a 16-position backpanel for locations with pedestrians and overlap movements.

Controller and Conflict Monitor. Regardless if Sec 1092 (http://www.modot.org/business/standards_and_specs/SpecbookEPG.pdf#page=14) requires FYA logic, including a footnote on the D-37C sheet to reinforce FYA logic is necessary for new controllers and conflict monitors.

Signal Heads. Make sure FYA indications are noted on the intersection plan sheet and quantity included on D-37A sheet for those approaches where FYA will be installed on the project.

Support.

Other Plan Items. On D37-D sheet, include notation on which indications are to be wired to FYA outputs. On D38-A sheet, make sure the FYA indications are included in the Phasing Sequence chart.

902.23.5.4 Signal Hardware Purchases (Internal Retrofit)

Support. If the decision has been made to upgrade an existing signal by MoDOT forces, then plenty of lead time must be given to have all of the needed equipment on hand and ready to install. The district might elect to utilize a private contractor to do all or some of the retrofit. Purchasing of the equipment and/or contractor services will be done through General Services with detailed information given on the following items:

St. Louis District contract submittal example

- Quantity of items
- Traffic Control Plan
- Cabinet print numbers
- Specify Commission furnished vs. contractor furnished items clearly (if any)
- Completion date
- Specific days and times of installation allowed due to local traffic conditions
- Disposition of removed equipment
- Signing

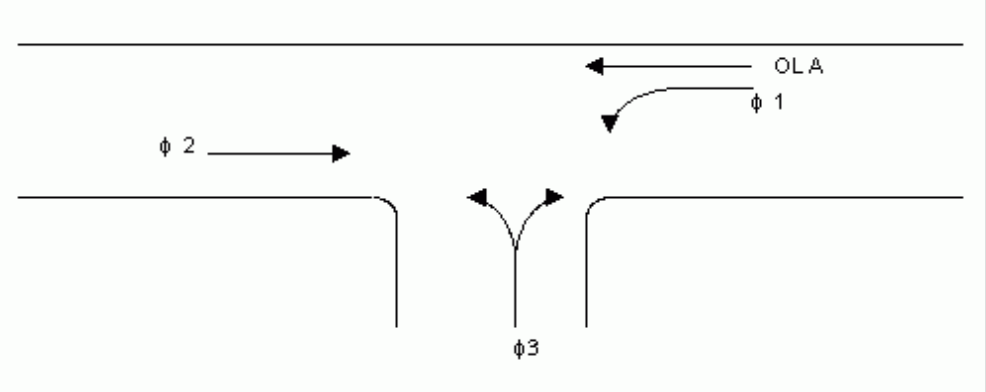
For a district's first installation, it is advisable to acquire the upgraded controller and monitor a few weeks in advance of the installation date so in-depth bench testing can be done by all interested parties.

902.23.5.5 Regional Cooperation

Support. Installation of the FYA at another agency's signals might not be possible. One of the critical requirements of this option is that each lane on the approach have its own signal head. The left turn signal head cannot be sharing its circular indications with the adjacent through lanes. If an agency does not use this type of control, they cannot use the FYA. If the adjacent agency's signals are using positive lane control, then cooperation in the form of simultaneous FYA installations can be explored.

902.23.6 Overlaps and Right Turn Phasing

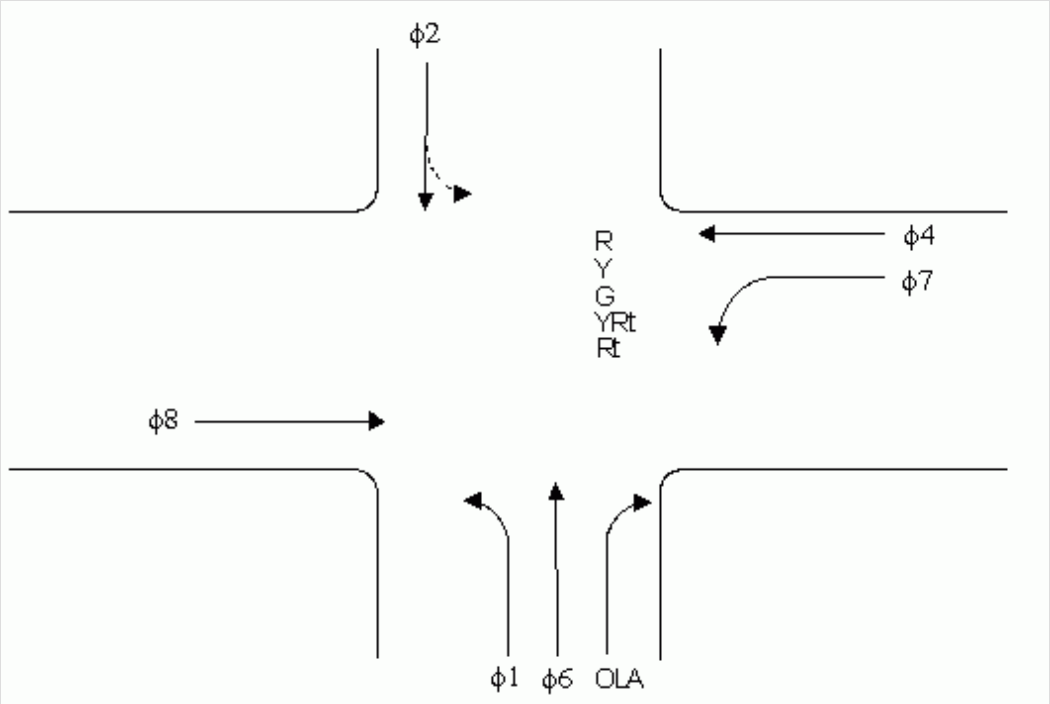
Support. An "overlap" provides a green or flashing yellow arrow indication for a traffic movement during the green intervals of two or more phases. The overlap green indication can be displayed during the change period between two or more phases if these phases are consecutive. Overlaps are also used to facilitate the operation of flashing yellow arrows for permissive turn movements. An overlap can be integrated into an actuated controller to supplement the flow of traffic. A simple application of an overlap is shown below:



Simple Overlap Application

For this case, a through movement is labeled "OLA" (OverLap A). OLA indication can be green while either phase 1 or phase 2 is green. While phase 1 is timing out the change period in transition to phase 2, the OLA indication remains green since OLA follows concurrently. OLA indication is red when phase 3 is green or yellow.

Overlaps need not be used when normal NEMA dual ring structure can be utilized. In the previous example, the overlap is to be assigned to phase 6. A more practical application is for signalizing a right turn movement as shown below:



Practical Application for Signalizing a Right Turn

In this case, the right turn phase is labeled "OLA" (Overlap A). OLA will display a green right while either phase 1 or phase 7 is green and will display a ball green when phase 2 and phase 6 are green. It receives no additional time, since its time comes from phases 1 and 7.

902.23.7 Signal Timing

Support. Once the proper phasing has been determined for an intersection, the proper timings for the signal indications must be developed in order to function efficiently.

902.23.7.1 Green Interval

902.23.7.1.1 Minimum Green

Guidance. The minimum green is the shortest green time of a phase. Green times that are too short can lead to frequent and needless stops.

The following minimum green times are generally recommended:

Mainline Through Movement: 10 seconds

Side street Through Movement: 7 seconds

Protected Left Turn: 7 seconds

Option. In some cases, the minimums may can be set higher. For heavily traveled mainline throughs lacking back detection, a higher minimum may be desired to reduce the chances of the controller quickly cycling off the mainline green to other phases.

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Standard. Minimum green shall not be set below five seconds for green indications.

902.23.7.1.2 Maximum Green

Guidance. Maximum green times are set on an actuated controller as low as possible, but high enough to adequately handle most of the vehicle demands. Maximum greens set too low result in less flexibility in the phase's timings based on detector activity, since there is very little time between the minimum and maximum for the fluctuation in traffic. Maximum greens set too high can result in unnecessary delays during periods of detector failures and increase the delay for other approaches.

The following maximum green times are recommended:

Mainline Through Movement: 40 to 70 seconds

Left Turn Movements: 15 to 50 seconds

Side street Through Movements: 20 to 50 seconds

Observation is the final factor in deciding the proper setting for maximum green. In low volume and/or low speed situations, lower maximums might be advantageous. Some approaches might need more than the usual times, at different times of the day.

Support. Controllers allow for different maximum settings to be enacted through the time clock. This is useful if heavy demand on a certain phase can be accurately predicted and set to a time of day. This is also useful with semi-actuated control where the mainline timing is controlled by a maximum recall since mainline demand typically changes by time of day. Controller clocks should be set by a central signal system if utilized; however, if there is not a central signal system it is recommended to set the controller clock using www.time.gov to remain consistent.

Guidance. Although the concept of a cycle length is usually reserved for pre-timed control and coordinated actuated control, it can be applied to isolated, actuated control. The temptation to set all maximums at an isolated intersection extremely high should be avoided. Maximum settings too high result in longer delay for other approaches and defeat the flexibility of actuated control by creating needless backups. See EPG 902.23.5 Coordination for more discussion on cycle lengths for all types of control.

902.23.7.2 Yellow Change and Red Clearance Intervals

Standard. A steady yellow signal indication shall be displayed following every CIRCULAR GREEN or GREEN ARROW signal indication and following every flashing YELLOW ARROW signal indication displayed as a part of a steady mode operation. This requirement shall not apply when a CIRCULAR GREEN or a flashing YELLOW ARROW signal indication is followed immediately by a GREEN ARROW signal indication.

The exclusive function of the yellow change interval shall be to warn traffic of an impending change in the right of way assignment.

Support. The yellow change interval and the red clearance interval (all indications displaying red) are required to prepare the intersection for the transfer of right of way. These intervals permit vehicles that are either within the intersection or so close to it that they cannot comfortably stop to clear the intersection, and to permit those vehicles that can come to a comfortable stop to do so.

Standard. The total time for the yellow change interval and the red clearance interval is the change period. All change periods shall be updated using the criteria below.

Change Interval Timing Worksheet

Support. To determine the appropriate yellow change interval and red clearance interval, ITE has developed a Kinematic Model – Formula shown below. The duration of change and clearance intervals, as well as the appropriateness of red clearance intervals, is a topic with no clear consensus. The following formula is developed based on a kinematic model of stopping behavior to determine the duration of the yellow and red indications and is in common use throughout the country.

Change Period:

$$CP = t + \frac{V}{2a + 64.4g} + \frac{W + L}{V}$$

Guidance:

CP = nondilemma change period (yellow plus all red), seconds

t = perception-reaction time, recommended as 1.0 second

V = approach speed (recommended as 85^{th} or 15^{th} percentile speed), ft/sec

g = percent grade (positive for upgrade, negative for downgrade), expressed as a decimal

a = deceleration rate, recommended as 10 ft/sec^2

W = width of intersection from stop line to end of far side crosswalk (if present), ft.

L = length of vehicle, recommended as 20 ft.

Support. A spot-speed study on an approach to an intersection will produce a range (or distribution) of speeds. The 85^{th} percentile speed is used to determine the yellow change and red clearance interval. A spot-speed study is performed during free flow conditions (typically during off-peak periods) to obtain the highest 85^{th} percentile speed to be used in the equation. It is important, however, to also consider slower traffic going through the intersection at the 15^{th} percentile speed. Low speeds and wide intersections or large left turn radii are a combination that can require a longer change period (yellow plus all-red). For this reason, it might be necessary to calculate the equation using both the 85^{th} and 15^{th} percentile speeds. Engineering judgment is used to determine whether the 85^{th} or 15^{th} percentile speed be used.

Using this equation for approaches with steep downgrades yields such long intervals that they appear unreasonable to drivers as well as the engineer. The remedy is not to ignore the physics of the situation when an unusually long phase change period results from a steep grade or from high approach speeds.

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The remedy might come from other devices such as warning signs, advanced detection or other countermeasures.

Districts can use the Change Interval Timing Worksheet to calculate the yellow change and red clearance intervals. Keep a printout of the spreadsheet with signal correspondence for future reference.

The sum of the first two terms in the formula is the yellow change interval and the red clearance interval is the last term. The purpose of the yellow change interval is to warn approaching traffic of the imminent change in the assignment of right of way. The first two terms include a reaction time, a deceleration element and approach speed, which are all necessary to determine a yellow change interval that will either allow the driver to come to a stop or proceed through the intersection. The red clearance interval is used to provide additional time following the yellow change interval before conflicting traffic is released. The last term in the formula includes the intersection width, length of vehicle and approach speed, which are all necessary in determining the intersection clearing time.

Standard. The yellow change interval shall not be less than three seconds.

Guidance. The yellow change interval should not exceed six seconds. The red clearance interval should not exceed six seconds.

Option. Based on engineering judgment, adjustments to the yellow change interval and red clearance interval may be made provided for each interval:

1) Yellow and all-red are not less than the calculated values using t = 1 second and a = 10 ft/sec^2 AND

2) Yellow does not go below the appropriate minimum of 3 seconds AND

3) Yellow and all-red do not go above the appropriate maximum of 6 seconds OR

4) Special conditions exist (e.g. Single Point Urban Interchange, Continuous Flow Interchange, Dual Lefts, etc.).

Standard. If the conditions are such that the district recommends using values that result in a yellow change interval less than what is calculated by the formula (using the values of t = 1 second and a = 10 ft/sec^2) and/or a red clearance interval less than what was calculated by using the formula, then a high level of discussion/collaboration with Central Office Traffic Division shall be made.

Support. EPG 902.23.11 contains provisions regarding the display of steady CIRCULAR YELLOW signal indications to approaches from which drivers are allowed to make permissive left turns.

Standard. The durations of yellow change intervals and red clearance intervals shall be consistent with the determined values within the technical capabilities of the controller unit. The duration of a yellow change interval shall not vary on a cycle-by-cycle basis within the same signal timing plan.

The duration of a red clearance interval shall not be decreased or omitted on a cycle-by-cycle basis within the same signal timing plan.

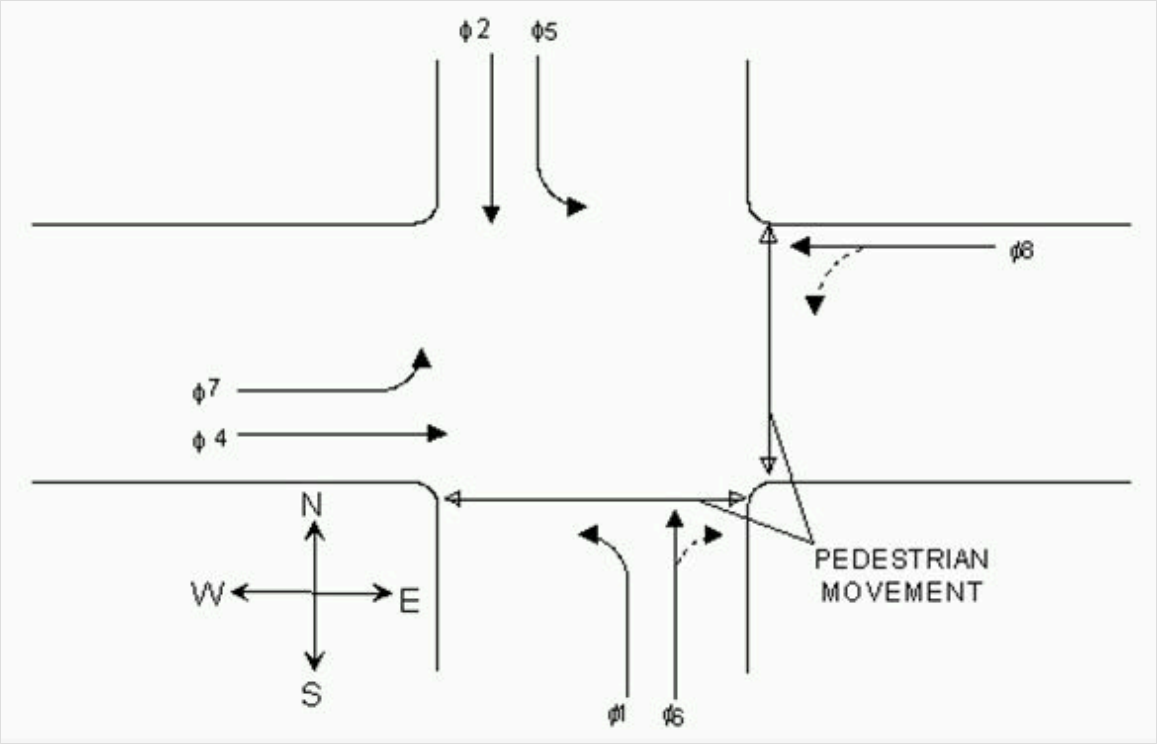
Standard. Except for warning beacons mounted on advance warning signs on the approach to a signalized location (see EPG 903.6.28), signal displays that are intended to provide a "pre-yellow warning" interval, such as flashing green signal indications, vehicular countdown displays, or other similar displays, shall not be used at a signalized location.

Support. The use of signal displays (other than warning beacons mounted on advance warning signs) that convey a "pre-yellow warning" have been found by research to increase the frequency of crashes.

902.23.7.3 Pedestrian Signal Timing

Guidance. If a pedestrian signal head is used that does not have a concurrent vehicular phase (exclusive pedestrian movement), the pedestrian change interval (flashing UPRAISED HAND) should be set to be approximately 4 seconds less than the required pedestrian clearance time and an additional clearance interval (during which a steady UPRAISED HAND is displayed) should be provided prior to the start of the conflicting vehicular phase. See Figure 902.9.6.

Every effort is to be made to display the WALK indications with a green phase or interval. This "phase-associated" pedestrian operation lessens the overall delay to drivers. Using a fully actuated intersection as shown:



Phase-Associated Pedestrian Operation

The pedestrian WALK and flashing DON'T WALK indications for northbound-southbound on the east side of the intersection would be displayed only during phase 6. Likewise, the indications for eastbound-westbound on the south side would be displayed only during phase 4.

Standard. Under no circumstance will a pedestrian WALK or flashing DON'T WALK indication be active during a phase or interval which leads vehicles into the crosswalk.

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Guidance. Using the previous example, the pedestrian indications for northbound-southbound cannot be active during phase 5, or any phase for the east-west direction of travel. Pedestrian indications are allowed in conjunction with the phase 6 right turn (using the permissive indication) and/or the phase 5 southbound yielding left turn, if allowed, since the pedestrian movement has legal right-of-way over the northbound right turn or southbound yielding left turn.

Under rare circumstances, an exclusive movement might be needed for the pedestrian indications.

Other options should be considered prior to the installation of an exclusive pedestrian movement.

902.23.8 Detector Settings

Support. With actuated control and properly timed detectors, the green time can be distributed to the needed movement and taken away when demand is gone. In order to keep this rotation of phases moving along without dwelling on a movement with little demand, the settings must be programmed to match the type, size and location of the detectors.

902.23.8.1 Stop Bar Detectors

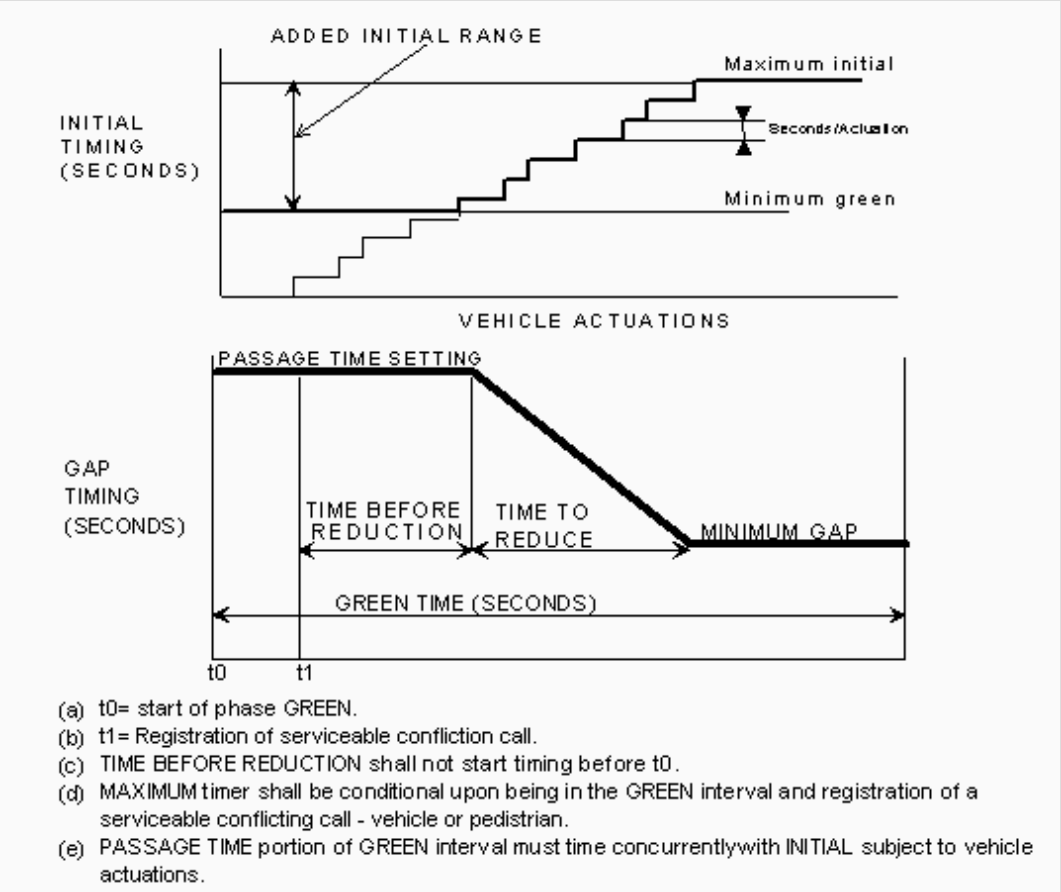
Support. The most common placement of detection senses the vehicle at the stop bar. This location is generally used for minor approaches, mainline turning lanes, and low-speed mainline through lanes. When this location is used, the type of detection is set for "presence". Presence detection allows for a call to be placed to the controller whenever a vehicle is in the zone of detection, and the call is not removed until the vehicle leaves the detected zone.

The setting to control the time to elapse without a vehicle call before changing phases is the "passage" or "gap" time. This timer will reset if a vehicle is detected before the max green has timed out and extend the green indication. If the timer reaches zero before another call is placed, the controller "gaps out" and serves the next phase.

Settings for the passage time vary on how much of a gap to allow between successive vehicles before the following vehicle loses the right of way. Generally, the larger the detection zone the shorter the passage time.

902.23.8.2 Advance Detectors and Gap Reduction

Support. Advance detectors are used for through movements on the major roadway to create a detection zone in advance of the stop bar, especially if the 85^{th} percentile speeds on the major roadway are 45 mph or more. These detectors are typically placed a distance of five seconds behind the stop bar at the 85^{th} percentile speed. Because of the long spacing from the stop bar, sole use of the standard passage time would result in extended green times with large gaps. Gap reduction control provides a means of decreasing the passage time as the speed of the flow increases.



Gap reduction settings and added initial time

The settings for gap reduction control are (terms may vary from brand to brand, consult controller manual for terminology):

1. Passage Time. When used in gap reduction control, passage time becomes the maximum gap time allowed. Its purpose is to provide sufficient time so a vehicle moving at the prevailing speed can travel from the detector to the stop bar.

2. Minimum Gap. This is the smallest gap time allowed, and is the lowest time allowed after gap reduction has occurred.

3. Time Before Reduction. This setting is the time to postpone the start of gap reduction from passage time to minimum gap time. This time is usually set up to allow any queue to accelerate up to a free flow speed.

4. Time To Reduce. After "Time Before Reduction" has reached zero, this timer begins. This is the time allowed for gap reduction to go from its passage time to the minimum gap time. Reduction is linear.

5. Added Initial. This setting allows the controller to increase the minimum green time to account for the vehicles stored between the detector and the stop bar at the beginning of the green interval. Without this setting, the minimum green would have to be set high enough to ensure all vehicles could clear the intersection. This time is set based on the number of seconds added for each detection while the phase is not green, usually 0.5 to one second added to the programmed minimum per actuation.

The benefit of these settings is best realized when stop bar detection is not used on the approach or is de-activated during the approach green interval.

902.23.8.3 Detection on High-Speed Approaches

Support. With signals installed on high-speed roadways (85th percentile speed of 45 mph or more), a single advance detector may not be able to be placed in the proper location to keep vehicles from the "dilemma zone" conflict. The "dilemma zone" is the area approaching the intersection where drivers first see a yellow indication but is too far away to proceed through the intersection, and too close to stop comfortably. If an advance detector is placed too close to the intersection, it may not detect fast vehicles in time to control them with gap timing. If placed too far back with high gap times, the mainline will be needlessly favored with long green times.

One option using in-ground detection is the placement of two pulse detectors per lane per approach spaced far enough apart to take a high-speed vehicle through the intersection. One detector is placed eight seconds in advance of the stop bar and the second is placed five seconds in advance of the stop bar (based on an operating speed at the 85th percentile). Minimum gap is set to three seconds using gap reduction control.

This allows for a vehicle approaching the intersection at the 85th percentile speed to hit the first detector and extend their call for at least three seconds once gap reduction is finished. At the 85th percentile speed, they will hit the next detector five seconds away from the stop bar, and extend their call another three seconds. After this second extension, the vehicle is two seconds away from the stop bar. This is close enough to allow it to clear during the yellow and red intervals. Any vehicles moving faster than the 85th percentile speed will hit the five second detector before the gap times out, and vehicles traveling slower will gap-out before reaching the five second detector.

Advanced detection can also be helpful to the motorist by enabling the signal to terminate a conflicting phase (when possible an appropriate) while the motorist is still approaching the intersection; thus providing the motorist a “quicker” green light upon arriving at the intersection.

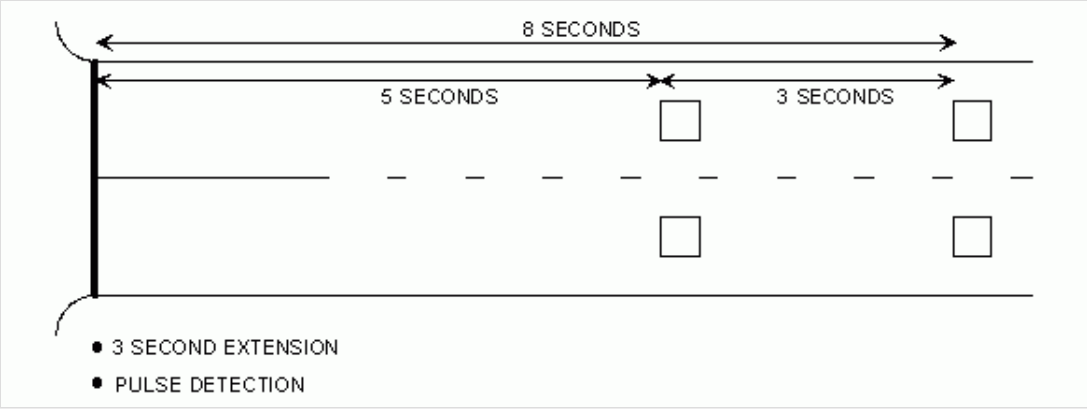


Figure 902.23.8.3

Table 902.23.8.3 is a reference for detector placement.

Table 902.23.8.3 Vehicular Distance Traveled

Speed		Time, in seconds													
mph	ft./sec	1	5	8	10	15	20	25	30	35	40	45	50	55	60
		Distance Traveled in Feet													
1	**1.5**	1.5	7.3	11.7	15	22	29	37	44	51	59	66	73	81	88
2	**2.9**	2.9	15	23	29	44	59	73	88	103	117	132	147	161	176
3	**4.4**	4.4	22	35	44	66	88	110	132	154	176	198	220	242	264
4	**5.9**	5.9	29	47	59	88	117	147	176	205	235	264	293	323	352
5	**7.3**	7.3	37	59	73	110	147	183	220	257	293	330	367	403	440
10	**14.7**	15	73	117	147	220	293	367	440	513	587	660	733	807	880
15	**22.0**	22	110	176	220	330	440	550	660	770	880	990	1100	1210	1320
20	**29.3**	29	147	235	293	440	587	733	880	1027	1173	1320	1467	1613	1760
25	**36.7**	37	183	293	367	550	733	917	1100	1283	1467	1650	1833	2017	2200
30	**44.0**	44	220	352	440	660	880	1100	1320	1540	1760	1980	2200	2420	2640
35	**51.3**	51	257	411	513	770	1027	1283	1540	1797	2053	2310	2567	2823	3080
40	**58.7**	59	293	469	587	880	1173	1467	1760	2053	2347	2640	2933	3227	3520
45	**66.0**	66	330	528	660	990	1320	1650	1980	2310	2640	2970	3300	3630	3960
50	**73.3**	73	367	587	733	1100	1467	1833	2200	2567	2933	3300	3667	4033	4400
55	**80.7**	81	403	645	807	1210	1613	2017	2420	2823	3227	3630	4033	4437	4840
60	**88.0**	88	440	704	880	1320	1760	2200	2640	3080	3520	3960	4400	4840	5280
65	**95.3**	95	477	763	953	1430	1907	2383	2860	3337	3813	4290	4767	5243	5720
70	**102.7**	103	513	821	1027	1540	2053	2567	3080	3593	4107	4620	5133	5647	6160
75	**110.0**	110	550	880	1100	1650	2200	2750	3300	3850	4400	4950	5500	6050	6600
80	**117.3**	117	587	939	1173	1760	2347	2933	3520	4107	4693	5280	5867	6453	7040
85	**124.7**	125	623	997	1247	1870	2493	3117	3740	4363	4987	5610	6233	6857	7480
90	**132.0**	132	660	1056	1320	1980	2640	3300	3960	4620	5280	5940	6600	7260	7920

902.23.8.4 Delay and Extend Detector Settings

Support.

(A) Delay Settings. When a vehicle travels into the detection zone, the detector amplifier immediately receives the call. In some cases, the call might not be needed immediately. A common situation is a dedicated right turn lane and stopping the opposing direction is usually not needed. A delay is programmed to keep the call from registering in the controller until a certain amount of time has passed. This time might be programmed in some detector processors, or in the controller. After the programmed time has passed, the call is recognized by the controller.

In NEMA controllers, care is taken as to where the delay time is programmed. If the delay time is set up in the detector processor, then every call going through that detection zone will be delayed. This will cause quick gap-outs if the delay time is near the gap time and no other normal detection is set up for that movement. If delay time is programmed in the controller, then the delay time is for all detectors in a movement, but delay is usually turned off when that movement is green. This will not allow for an immediate call in a lane where detection delay is needed when facing a red indication.

In 170 controllers, delay time can be programmed independently for each detector input.

(B) Extend Settings. In other cases, the detector call might need to be longer than the time the vehicle is within the detection zone. An extension time can be programmed into either the detection processor or controller to hold the call for a certain period of time. Once the vehicle leaves the detection zone, the extend timer begins to countdown, and holds the call in until reaching zero. Common applications are where the detection zone is in advance of the stop bar, and the call is needed until the vehicle passes the stop bar. Advance detectors on pulse setting for dilemma zone prevention are another application. Extension time allows the call to stay on while the vehicle clears the intersection.

As with delay settings, care is taken as to what movements need extension timing.

902.23.8.5 Locking and Non-Locking Detector Setting

Support. When a signal is red for an actuated movement with no recall option, the vehicle detection is registered in the controller whenever a vehicle enters the detection zone. When the vehicle is allowed to leave the intersection before getting a green indication, usually on a right turn on red, it might not be necessary to call that movement if all vehicles have left the detection zone. The detector input for that movement can be set to "non-locking" in order to keep the call from stopping opposing directions. The movement will be served with green if a vehicle remains in the detection zone while set to non-locking. If the movement is set for "locking", then a call remains for that movement until it is served with a green indication, regardless of the presence of vehicles after the initial call.

Commonly, non-locking is used for dedicated right turn lanes, and protected-permissive left turn lanes. Locking is usually for through lanes and protected left turn lanes. Other situations, such as odd detection zone locations, might require a different locking technique. Locking detector setting is also recommended for instances where it has been observed a frequent and recurring problem of motorists “overshooting” the stop bar and leaving the detection zone; thus failing to get served by that phase.

902.23.8.6 Recalled Phases

Support. The use of the recall feature for an approach can increase the potential for drivers to receive a green signal before they reach the intersection, thus minimizing the number of stops. There are three main recall options:

1. Min(imum) Recall. This will place a continuous request for service for minimum green on the selected phases. A recalled phase will stay green if no other conflicting calls have been received.

2. Max(imum) Recall. This will place a continuous request for service of maximum green on the selected phases. Once the maximum time has expired, the next phase will be served if there is a detected call. It is commonly used for movements without detectors in semi-actuated approaches.

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3. Soft Recall. This places a continuous request on the selected phase only in the absence of any conflicting calls. Soft recall is only used at fully actuated signals. This is similar to minimum recall, except that a phase with soft recall may be skipped in the absence of actual demand. Soft Recall is typically used when you want the signal to “default” back to a movement in the absence of any traffic.

Guidance. Recommended uses of minimum and soft recall are as follows:

Min(imum) Recall. Is typically beneficial at fully actuated intersections with an obvious mainline that will need to be served every cycle can be placed under minimum recall. Where detector reliability is an issue, minimum recall is also beneficial

Soft Recall. Is typically beneficial where volumes are more balanced or less predictable and where the signal has protected left turn phases. Soft recall allows for a more efficient use of the ring structure than minimum recall does.

Support. Example:

Using an 8-phase intersection with standard ring structure, and phases 2 and 6 assigned are to the mainline through directions.

There are no vehicles in any detection zone when a vehicle enters the detection zone for phase 4 (sidestreet through).

The signal cycles to serve the phase 4 with minimum green.

Just as the minimum green starts, another vehicle enters the detection zone for phase 3 (sidestreet left), and no vehicle calls on any mainline phases.

Minimum Recall: After serving phase 4, the signal will cycle to phases 2 and 6 and show at least the minimum green time (or more if any other actuations on that phase), and then serve phase 3.

Soft Recall: After serving phase 4, the signal will recognize phases 2 and 6 with no vehicle calls and not serve them and go right to phase 3.

902.23.8.7 Detector Call Switching

Support. Controllers allow for detector calls to be transferred to phases other than the ones assigned. This feature is very useful on approaches with protected-permissive left turn phasing and detection on a left turn lane and the opposing through lanes.

Example: Take a standard 4-way intersection with phase 1 as the northbound left turn, phase 6 the northbound through, phase 2 southbound through, and standard ring structure:

Phase 1 is a protected-permissive left turn. After phase 1 gaps or maxes out, phase 2 goes green along with phase 6 until they both max or gap-out. Without detector switching, a vehicle waiting to make a yielding northbound left turn would not be detected and would be susceptible to gap-outs caused by phase 6 detectors, even though time is left in the max timer for a yielding left turn. When detector switching is programmed for phase 1 calls to be transferred to phase 6, the vehicle waiting on the phase 1 detector is then placing a call on phase 6 once phase 1 goes yellow and continues to call phase 6 until leaving the detector or reaching phase 6's max time. Once phase 6 goes yellow, the phase 1 detection returns to phase 1 and allows the protected left turn to come up next cycle.

Advantages to this setting are the reduction of quick changes of phases late at night with sporadic traffic, and the reduction of yielding left-turn conflicts.

902.23.8.8 Phase Re-Service

Support. Phase re-service, or conditional re-service, allows for the standard phase sequence to reverse and display green for non-conflicting directions that have already been served. The most common application is re-serving protected left turns when the opposing throughs gap-out.

Example: Take a standard actuated 4-way intersection with phase 1 a northbound left turn, phase 6 the northbound through, phase 2 southbound through, and standard ring structure:

In this case, the phase 1 indication is a protected-only left turn. After phase 1 is served, phase 2 begins its green time along with phase 6. Re-service of the odd-numbered phase is allowed under these conditions:

1. The even phase in the same ring (phase 2 in this example) has gapped out and is resting in green.

2. There is a call across the ring barrier to another phase (a side street call for this example).

3. The even phase in the opposite ring is still extending and there is enough time left in its max timer. This time must be equal to or greater than the re-serviced phase's minimum green time plus opposing through phase yellow and all-red time.

During the re-service period, gap control is timed by phase 6 detectors and not phase 1 detectors. Therefore, if the northbound through gaps out with demand still present on the northbound left turn, both directions will terminate together.

Advantages to this setting are in reducing the delay for re-serviced left turns. Again, care is to be taken when using this setting at a coordinated intersection. Re-service will not be possible when used with coordinated phases, and available time to re-service side street phases will be almost non-existent. This setting works best at isolated intersections, or when coordinated signals are not running coordination (Free Operation).

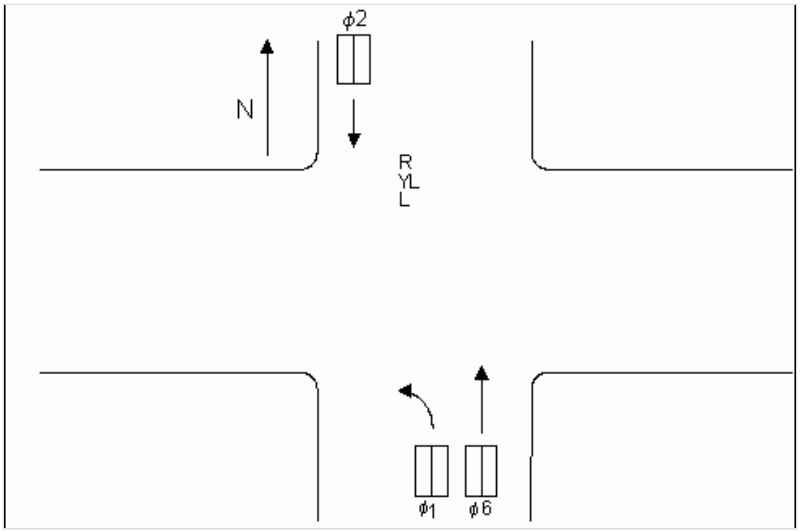


Figure 902.23.8.8

902.23.9 Power Outages at Signalized Intersections

Standard. Each district shall develop a power outage plan for signalized intersections that includes information about the installation, use, and recovery of Temporary Stop Signs (TSS) and the installation of battery backup systems. This subarticle provides information for these items.

902.23.9.1 Temporary Stop Signs at Signalized Intersections

Support. Temporary Stop Signs (TSS) refer to stop signs that meet the MUTCD stop sign design requirements for regulatory signs and are temporarily installed at signalized intersections where the traffic signals cannot function due to damage and/or power outage. These temporary placements include but are not limited to roll-up stop signs, temporary mounts on the signal vertical upright, or stop signs mounted on other crash worthy devices.

Standard. If used, such signs shall remain at the intersection until power at the non-functioning signalized intersection has been restored (see EPG 902.23.9.1.4 Recovery).

902.23.9.1.1 Conditions For Use

Guidance. TSS may be erected at locations where a signalized intersection is non-functioning. A non-functioning signalized intersection is defined as an intersection that is equipped with a traffic signal that is damaged and/or without power which cannot display proper indications to control traffic.

After verifying that the signal is non-functioning, Districts should contact the appropriate utility company to notify them of the power outage, if applicable, and to determine if power will be restored in a reasonable amount of time (at the District's discretion). If used, the TSS should be deployed as soon as practical depending on location of the signalized intersection and the stored TSS. Districts should also request police assistance for traffic control if they are not already present at the site or aware of the power outage. Outside of normal business hours, it might be necessary for the electrician or maintenance personnel to directly contact the highway patrol or local police and the power company. When a signalized intersection is non-functioning, then TSS may be installed when one of the following conditions is met:

- When the traffic signal is both damaged and without power, or
- When the traffic signal is without power and restoration of power using an alternate power source is not possible.

Standard. When TSS are utilized at a signalized intersection that is non-functioning, the District shall decide whether the power shall be disconnected or whether the signal should be switched to flash to avoid conflicts when power is restored. If switched to flash, the flash shall be red-red since TSS will be installed on all approaches, if used, at a signalized intersection without power (dark signals are to be treated like a 4-way stop according to the Missouri Driver's Guide). The TSS shall not be displayed at the same time as any signal indication is displayed other than a flashing red.

A request shall be made of the nearest maintenance building, emergency responder, or external emergency responder (whomever stores the TSS) to bring stop signs to the intersection. Personnel or emergency responders instructed in signal operation shall disconnect the power or switch the signal to flash operation (external emergency responders will do this in the signal cabinet police door) before placing the TSS. Without this change in operation, the traffic signal could return to steady (stop-and-go) mode within seconds after the signal is repaired or power is restored, which would cause conflicts between the signal and the TSS (conflicting green or yellow indications with a stop sign for the same approach). The signal shall be visible to traffic on all approaches and all these approaches will flash upon restoration of power (see EPG 902.23.9.2 for more information regarding Startup from Dark).

Guidance. When law enforcement is present at a non-functioning signalized intersection to direct traffic, then the TSS that have been placed should be covered or removed to avoid conflicts (the law enforcements authority supersedes the TSS).

Option. If it has been determined that the power outage will last for an extended amount of time (at the district's discretion) the signal heads may be covered to reduce the confusion of approaching motorists.

Guidance. If signal heads are covered, the appropriate enforcement agency should be advised and asked to occasionally monitor the intersection. Also, the power company should be advised and asked to notify proper personnel when the power is restored.

902.23.9.1.2 Location and Placement

Standard. The signalized intersection locations for installation of TSS shall meet the conditions of use in EPG 902.23.9.1.1 and shall be at the discretion of the district. Each District shall develop a list of critical signalized intersections to establish a priority for TSS installation. The TSS prioritized installation list developed by each district shall be in each district's Power Outage Plan.

Guidance. The installation of TSS should begin at the identified critical intersections and should be prioritized as follows (as applicable to each district):

1. Signals with railroad preemption
2. Signals with a speed limit greater than 50 mph
3. Signals with a high accident rate

4. Intersections difficult to flag or require multiple flaggers (non-routine roadway configurations/geometry, SPUIs, multi-lane approaches, etc.)

5. Signals with high volumes (freeway type off-ramps, major roadways, etc.)

6. Signals with frequent power outages

7. Signals located at schools.

As battery backup systems are installed (see EPG 902.23.9.3 Battery Backup Systems at Signalized Intersections) at signalized intersections, districts should re-evaluate their list of prioritized intersections for the installation of TSS.

Standard. When used, TSS shall be placed in a location where they are visible to all lanes on all roadways. On two-way roadways, stop signs shall be erected on the right-hand side of all approaches. On divided highways, stop signs shall be erected on both the right and, if possible, on the left-hand side or at location for best visibility of all approaches.

Guidance. If the power outage is widespread, additional personnel should be requested to help with the placement of the signs.

902.23.9.1.3 Storage and Distribution

Guidance. Each District should store enough TSS to be deployed at the critical signalized intersections identified in the District Power Outage Plan.

Standard. TSS shall be distributed by the district to the district's maintenance personnel or emergency responders or external emergency responders on an as-needed basis. It shall be the responsibility of the district to develop a means of distribution.

902.23.9.1.4 Recovery

Standard. TSS shall remain at the intersection until power at the non-functioning signalized intersection has been restored. Power will remain disconnected or the signal will flash until TSS are removed. Immediately following TSS removal, personnel or emergency responders instructed in signal operation shall restore signal operation in accordance with the procedures set forth in EPG 902.23.9.2 Steady (stop-and-go) Mode for transition to steady (stop-and-go) mode.

The recovery of the TSS shall be accomplished by using the district's maintenance personnel or emergency responders or external emergency responders by either of the following:

- Complete removal from each intersection.
- Stockpiling outside of the intersection to avoid conflicts with the signalized intersection (stockpiled signs shall not be faced towards the traveling public and stored not to damage sheeting) and stored in a location to not become a roadside hazard.

A detailed recovery plan for each intersection with TSS shall be developed in the district's Power Outage Plan.

902.23.9.2 Start up from Dark at Signalized Intersections

Standard. When a signalized intersection has been damaged and/or is without power the district shall have either disconnected the power or switched the signal to flash to avoid conflicts when power is restored. If switched to flash, the flash shall be red-red since TSS will be installed on all approaches, if used, at a signalized intersection without power (dark signals are to be treated like a 4-way stop according to the Missouri Drive's Guide). If TSS are in place, the power shall remain disconnected or the signal shall operate in flash mode until TSS are removed and personnel or emergency responders instructed in signal operation restore signal operation.

Steady (stop-and-go) Mode

Standard. When power is reconnected or when the signal is switched from flash to steady (stop-and-go) mode, the controllers shall be programmed for startup from flash. The signal shall flash red-red for 7 seconds and then change to steady red clearance for 6 seconds followed by beginning of major-street green interval or if there is no common major-street green interval, at the beginning of the green interval for the major traffic movement on the major street.

902.23.9.3 Battery Backup Systems at Signalized Intersections

902.23.9.3.1 Installation/Placement

Standard. Each district shall develop a list of critical signalized intersections to establish a priority for the installation of Battery Backup Systems (BBS) as part of the district's Power Outage Plan.

Guidance. The installation of BBS should begin at the identified critical intersections and should be prioritized as follows (as applicable to each district):

1. Signals with railroad preemption
2. Signals with a speed limit greater than 50 mph
3. Signals with a high accident rate
4. Intersections difficult to flag or require multiple flaggers (non-routine roadway configurations/geometry, SPUIs, multi-lane approaches, etc.)
5. Signals with high volumes (freeway type off-ramps, major roadways, etc.)
6. Signals with frequent power outages
7. Signals located at schools.

Each district's prioritized installation list for BBS should be based on their traffic conditions and needs. The prioritized TSS installation list will need to be reevaluated as BBS are installed.

902.23.9.3.2 Duration

Standard. BBS shall be capable of operating at a minimum of 2 hours in steady (stop-and-go) mode and a minimum of 2 hours in flash operation.

Guidance. Any signalized intersection with BBS should have a generator socket for extended operation.

902.23.10 Control Features for Non-coordinated Signals

Support. Control features for non-coordinated signals include:

1. Isolated Operation. Actuated operation can effectively minimize traffic delays at locations where coordination is not a consideration.

2. Traffic Density Timing. The traffic density timing feature provides for the initial green interval and/or the allowable traffic gap that ends the green interval, to be automatically adjusted according to traffic flow variations.

The added initial setting increases the minimum green interval according to the number of vehicle actuations received during the preceding red interval (some controllers use both actuations received during the yellow and red intervals). This setting is intended for use where the shortest practical minimum green interval is not adequate for the traffic that can be stored between the advance detectors and the stop bar. The initial part of the green interval (minimum initial), remains short when few cars have arrived during the red interval, but it increases (added initial) a fixed amount per actuation during the red interval up to the maximum initial. At intersections with advance detection only (no stop bar detection), vehicles need more time to enter the intersection before they lose the right of way.

Gap reduction which allows the passage time to decrease as the speed of the flow increases is another setting commonly used at locations with advance detection.

Features of density control are discussed in EPG 902.5.37.2.

3. Recall Operation. Each phase of a controller is equipped with a recall feature. With recall disabled, the phase responds only to its detectors. With recall enabled, the controller can place a call to service that phase without vehicles being detected. This is accomplished by the controller placing a single call back to the phase when the clearance interval is initiated.

Recall comes in several variations and has different uses. Minimum recall is normally used on the mainline through phases. Minimum recall guarantees the timing of the minimum green for the phase selected with additional green available through actuations. Using this feature on the mainline through is advantageous since during periods of light activity the controller will rest with the main street through green indications on. Maximum recall guarantees the timing of the maximum green interval for the phase selected. This feature is normally used when the detection for a phase has been disabled due to failure or removal. In this instance, the phase will always be serviced for the maximum green interval programmed that is to be adjusted accordingly.

Many actuated controllers also have a feature called "soft recall" that allows the selected phase to be serviced only if there are no other conflicting calls. This feature can be used on the main street during periods of light traffic. The advantage over minimum recall is the controller can skip

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servicing the main street, if no real calls exist, and move on to the next called phase. This can provide a quicker response during the periods of light traffic.

For more information about Recall Phases refer to EPG 902.5.37.6 (https://epg.modot.org/index.php/902.5_Traffic_Control_Signal_Features_(MUTCD_Chapter_4D)#902.5.37.6_Recalled_Phases).

902.23.11 Coordination

Support. Coordination can provide nearly uninterrupted travel, resulting in one of the greatest benefits to motorists. Coordination provides many benefits other than less delay: the reduction of stops, crashes, fuel consumption, emissions, and driver frustration makes coordination one of the best values for the dollars spent.

902.23.11.1 How Coordination Works

Support. The key to coordinating signals is a common cycle length among all signals within the limits of the system. However, using a fraction of the cycle length, such as a half-cycle, can be used in some cases in order to reduce side-street delay while still maintaining mainline coordination. The start of a certain phase at each intersection, called the coordinated phase (usually the mainline through), is synchronized to a system reference point. This system reference provides a signal to each controller once every cycle. The cycle length is the total time it takes for a signal to serve all phases. The amount of time it takes for the coordinated phase at an intersection to start after the system reference is called the offset. Different offsets along a series of coordinated signals will provide different starting times of the coordinated phases. By setting offsets based on the speed of traffic in a certain direction, stops can be greatly minimized by starting the mainline green at that point where traffic from a previous signal just reaches the next signal.

Another important factor in coordination is what cycle length to run. Because volumes of traffic fluctuate throughout the day, different cycle lengths and offsets can be run to more efficiently handle the changing demands of volume in the system. Higher cycle lengths are generally used in the morning and evening peak times. Peak lunch times can also necessitate an increased cycle length. Weekend traffic can also justify cycle times that differ from weekday timing. Off-peak times use shorter cycle lengths. In a coordinated system, the time of day that each cycle length begins and ends must be the same for every controller for progression to work.

902.23.11.2 Planning a Coordinated System

902.23.11.2.1 Determine System Limits

Guidance.

Identification of how many signals to coordinate is the first step in building a signal system. Generally, knowledge of the arterial flow is a good start. Arterial streets where you can expect a group of vehicles to travel from one signal to another without a significant loss of vehicles turning off to another arterial or development can give reasonable limits.

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The upper limit on spacing for coordinated signals has been assumed to be 1/2 mile. However, if the flow of vehicles can be maintained at a greater distance, then there is likely no reason to disregard additional signals in the system. Computer software can be used to establish the limits of a coordinated system. The "coupling index (CI)" formula can also be used if computer software is not available:

$$CI = V / L$$

where:

CI = Coupling Index

V = 2-way volume on the link in vehicles per hour

L = Length of link in ft.

The link is bounded by two signalized intersections. The units of the CI are meaningless.

For planning purposes, a CI equal to or greater than 0.3 during any hour indicates the possibility of including the signals within the system. For analysis of existing systems, a CI equal to or greater than 0.5 indicates the signals is to be coordinated during the hour analyzed, if they can be operated on equal cycle lengths. The CI formula provides a very simplistic method of determining the system limits.

The final factor in determining coordination limits is engineering judgment. Factors to consider for including a signal within a coordinated system are whether the intersection is over-saturated, already part of a system for the intersecting arterial or can be serviced with the system's cycle length.

All newly constructed signals should be reviewed for coordination and implemented if needed. Non-coordinated signals should be reviewed periodically to determine if coordination is to be provided.

902.23.11.2.2 Determine Timing Plans to Use

Guidance. The purpose of different timing plans is to match the traffic conditions in order to provide the best cycle lengths and split times. In most systems, the basic timing plans used during a week are:

1. Off-Peak
2. AM Peak
3. PM Peak
4. Late-Night Operation

Off-Peak operation generally uses lower cycle lengths than AM and PM peaks. Late-night operation can be free control or a short cycle length to minimize delays for the side street when signal coordination control is desired.

In addition, the traffic conditions along a system might not be adequately handled by only one off-peak plan. Mid-day and weekend patterns can greatly differ from off-peak patterns and could require separate plans. Even AM and PM peaks might require more than one plan if volumes and distribution greatly vary during those times.

Ideally, a 24-hour count of each intersection is to be obtained for at least a five-day period that includes a weekend but not a major holiday. This provides typical weekday and weekend traffic conditions. If every intersection cannot be counted, the major intersections are to be counted in this manner. From these counts, the times when traffic characteristics change in amount and/or directional distribution are to be charted.

In order to change from one timing plan to another, a transition period occurs which disrupts the coordination flow. Therefore, the start and end times of each plan should occur well before and after the worst hour during which the timing plan runs. If the transition occurs during times of peak flow, then any benefits provided by the additional plan can be lost by the disruption in coordination. If the transition cannot be made without disrupting the coordinated flow, then one plan should be used for a longer period in order to keep traffic moving. The timing plan chosen might not provide ideal conditions throughout the entire time it is in effect but should be set up to handle the worst hour of traffic during that time.

In addition to regular time-of-week timing plans, yearly conditions might require other timing plans. Arterials servicing seasonal tourist locations, large shopping centers and large schools will likely require the capability of timing plans that satisfy those seasonal conditions. For the best timing results, counts should be done that will take these conditions into account.

902.23.11.2.3 Determine Cycle Lengths for Timing Plans

Guidance. In most coordinated systems, the cycle length requirements differ from intersection to intersection for a timing plan. In order to run a coordinated system, a common cycle length will have to be chosen. Typically, computer software is used to determine appropriate cycle lengths. However, if computer software is unavailable the following procedures will provide a rough, but effective, cycle length to apply to an arterial.

902.23.11.2.3.1 Determine Minimum Cycle Lengths

Standard. The minimum cycle length in each system shall be determined by, the critical intersection, the intersection with the highest volume to capacity ratio.

Guidance. The critical intersection will likely have side street volumes that demand a significant amount of green time. In order to achieve any benefits of coordination, the proper amount of green time will need to be allotted to both the through traffic and the side street traffic. Two methods for determining minimum cycle length are:

(A) Critical Lane Volumes

Minimum Recommended Cycle Lengths

Sum of Critical Lane Volumes	Number of Phases		
	2	3-4	5-8
800	30	45	60
900	35	55	70
1000	40	60	80
1100	45	70	90
1200	55	85	110
1300	70	105	120
1400	90	120	*
1500	120	*	*
* Intersection might be over capacity. Maximum recommended cycle is 120 seconds.			

The table above presents a way of determining minimum cycle length based on the sum of critical lane volumes and number of phases at the intersection.

(B) *Highway Capacity Manual (HCM)*

Appendix II for the "Signalized Intersections" chapter in the HCM presents a more detailed method of determining minimum cycle length. It is recommended to use the "Pre-timed Signals" procedure in the "Allocation of Green Time" section regardless of the type of control used, since a free-operating, fully-actuated signal will have to run nearly pre-timed operation in a coordinated system.

902.23.11.2.3.2 Final Determination of Cycle Length

Guidance. The determination of the minimum cycle length at the critical intersection should provide a starting point as to a practical cycle length for the system, but it should not be interpreted as an absolute value. Slight variations up or down might be required to best meet the demands of each intersection. Most arterial optimization software will require the user to input a lower and upper range for proper performance. If optimization software is not being used, the cycle length that provides the best service for the critical intersection should be used as the system's cycle length for that timing plan.

902.23.11.2.4 Determine Phase Times and Sequence for Each Intersection

Guidance. Computer software determines phase times and sequence when determining the cycle length. When calculating by hand, green times and sequences for each intersection should be determined after a cycle length has been determined. Since the purpose of coordination is to favor the progression of the coordinated phase, every effort is to be made to maximize the amount of green time and provide the best sequence to that phase.

902.23.11.2.4.1 Phase Times

Guidance. In order to run a pre-determined cycle length, actuated phases must be terminated, or forced off, after a certain amount of time regardless of the presence of vehicles. Actuated phases can still gap-out or be skipped if no calls are present but cannot extend past its force-off time for that

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timing plan. Non-actuated phases must extend to their entire force-off time. This force-off time per phase usually includes the green time and change period times.

If optimization software is being used, the program will generally give a force-off distribution for each intersection in the system. For non-computer planning, there are several methods to determine phase times. As with the cycle length determination, the HCM Appendix II in the "Signalized Intersections" chapter provides a basic procedure to allocate green time.

902.23.11.2.4.2 Phase Sequence

Guidance. When more than two phases are used, the sequence in which the indications are displayed must be determined for each timing plan. The usual choice is when to display a protected left turn in relation to the mainline green: at the start (lead) or the end (lag). The use of lead-lag for protected left turns on the mainline can greatly affect the progression. (See EPG 902.5.27.1 Leading and Lagging Left-Turns.)

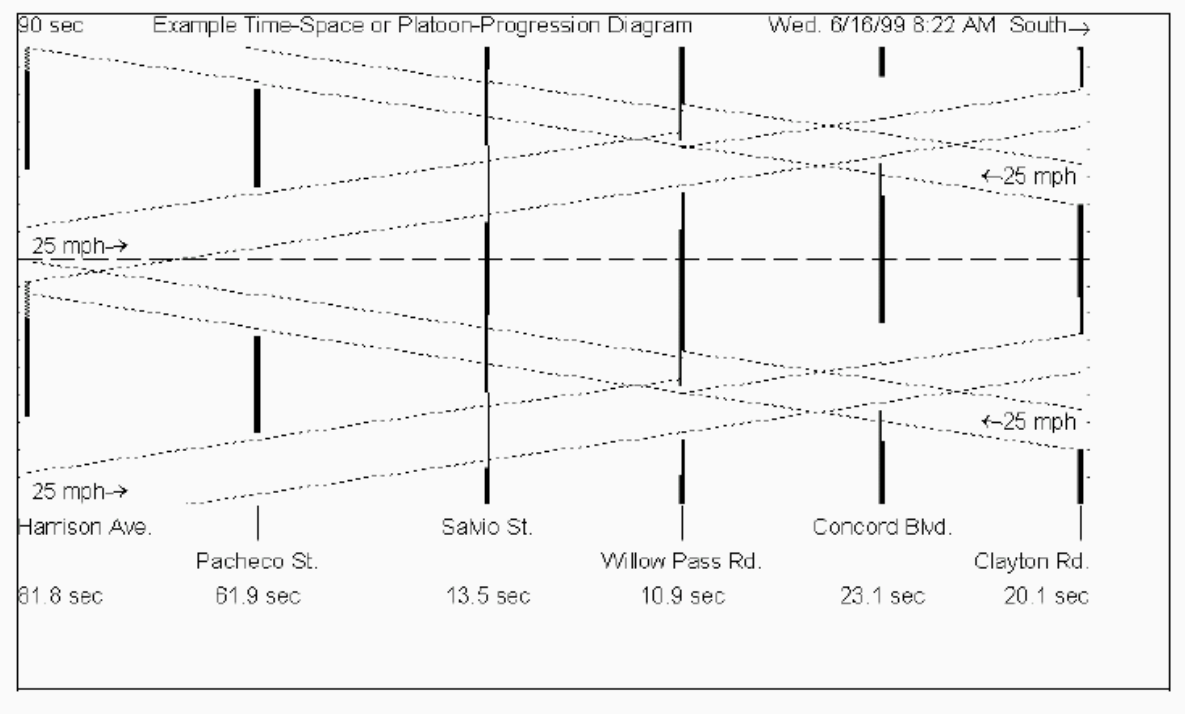
If optimization software is being used, the program will generally give a mainline sequence at each intersection that maximizes the green band. Side street sequencing is usually left up to the user. There might be some timing plans where the side street sequence becomes a factor in coordination. A heavy left turn onto the mainline might call for a sequence that puts the side street left turn indications at a point in the cycle that allows for the group to clear a downstream intersection.

902.23.11.2.5 Determine Offsets and Transition in Each Timing Plan

Guidance. Once the cycle length, phase timings, and sequence have been determined, it is necessary to determine when to begin the coordinated phase in relation to the master cycle offset reference. The master cycle offset reference is a defined point during a 24-hour period to run the background cycle. In most cases, midnight is used as the master cycle reference point. The offset for each intersection will, if properly set, provide for progressed flow in the desired direction.

Option. Different offsets may be used for each timing plan at each intersection.

Guidance. The most common way to represent the flow of traffic on an arterial is the use of a time-space diagram. This type of graphical representation uses an x-y axis plot of red and green time, phase sequences, cycle lengths, and intersection spacing to display how well a platoon of vehicles moves from one end of the arterial to the other. The x-axis is a scale of the intersections by feet, and the y-axis represents the time scale in seconds (the x- and y-axis might be switched depending on the program used to create it.). Multiple cycles are laid out on the y-axis, with solid lines representing mainline red time. A green band represents the flow of vehicles whose slope represents the speed of the platoon along the artery. An example is shown below.



It will be assumed the user has a computer with a time-space diagram program available. Hand-drawn time-space diagrams are cumbersome, difficult to lay out, and nearly impossible to modify when changes are needed on the street. All further discussion on time-space diagrams will be based on the computer applications.

902.23.11.2.5.1 Offset Determination

Guidance. Determination of the offset using computer software can be accomplished by the following:

(1) Enter basic information into the software program

a. Distances between intersections, in feet. Measured from the center of each intersection.

b. Phase times and sequence for each intersection.

c. Speed of platoon between each intersection. For some arterials, it might be possible to maintain the same speed from end to end, but real conditions usually make this impractical to assume. Conditions such as closely spaced intersections, steep grades, and areas of heavy traffic will likely degrade free-flow speeds. Initially, the 85th percentile speeds, if known, can be used.

d. Local controller's offset reference point. This is the point in the local cycle that the offset is referenced to and is the starting point of the local cycle (cycle zero). This point is typically at the beginning or end of the coordinated movements, usually the mainline throughs. Movements which are to be favored under coordination are designated as coordinated phases and the offset reference will be related to these movements. Many controllers offer options for the location of the offset reference.

One or both of the coordinated phases typically start at local cycle point zero. If only one coordinated phase begins at local cycle zero with the other coordinated phase starting later in the cycle, this is referred to as "start of first coordinated green". If a second coordinated phase begins at local cycle zero after the start of the first coordinated phase, this setup is called "start of last coordinated green". If both coordinated phases begin together at cycle

zero, either reference can be used. Additional options for offset reference are available in many controllers, see the manual of your specific controller for more options.

e. Initial offset time, if available. If previous analysis used arterial optimization software to arrive at the cycle length and phase times, it likely provided an offset based on the desired direction of progression. This provides a good starting point but will likely need to be adjusted to match field conditions. If hand-calculation methods were used, the initial offset can be entered as zero and adjusted within the time-space diagram program.

(2) Fine-Tune the Green Band

After the basic information is entered, the user can open the time-space diagram to view the initial conditions entered. If all the information was accurately entered, this view will show what the user can expect to see on the street under the given conditions. The display will show, beginning at either end, the start and end of the green time projected in the direction of travel by straight lines. The slope of the lines is a function of the travel speed of the platoon. The area between these two lines is referred to as the green band. The bottom line of the green band represents the first car leaving the first intersection, with the top line the last car to clear before the indications turn red for mainline.

Ideally, the goal is to keep this green band unbroken from one end of the arterial to the other for the direction the user wants to favor during that timing plan. However, in some cases, it might be more efficient to break the green band if a larger green band can be obtained following the break. For instance, a 30-second green band would probably be more efficient than a 10-second green band through the system. It is not uncommon that obtaining a continuous green band is impossible through the entire system particularly in large systems where two-direction progression is desired or where signal spacing is not optimal.

During AM or PM peaks, it is common to favor one direction of flow. Off-peak plans usually require progression in both directions. In order to adjust green bands through the green time at an intersection, the user can usually move the intersection's phase time display up or down in relation to the y-axis directly on the screen and instantly see the effect on the green bands. This is graphically changing the offset time of the intersection. Once the user has adjusted all the intersections to show the best green bands, the final offset values is to be recorded for programming into the on-street controller. If all values have been entered correctly into the time-space diagram program, and then into the controllers, the user should see similar conditions on the street as shown on the computer screen.

902.23.11.2.5.2 Timing Plan Transition Determination

Support. When a controller changes timing plans, it needs a way to change to different phase times, offsets and possibly phase sequences as smoothly as possible in order to minimize the effect on progression. The two major transition methods are discussed here, since they are available on most every brand of controller, and either can be selected to best suit conditions.

(1) Dwell Method. For this method, the controller will stop its cycle countdown and dwell at the local offset point in the cycle for either a predetermined amount of time, or until the master cycle zero point is reached, whichever comes first. Most controllers will dwell in the green time of the coordinated phases.

The major advantage of this method is the transition can be completed in one cycle length if no set dwell time is programmed. Disadvantages to this method become more apparent as cycle lengths increase. Indefinite dwell times can cause up to a one-cycle delay before resuming normal operation. This becomes critical if the side street demand is high, or if the offset dwell point is on the side street and mainline has to stop more frequently during transition. If side street

demand is low the use of the dwell method with a high or indefinite dwell time will allow for a quick transition with minimal impact.

(2) Shortway Method (also commonly known as smooth transition). For this method, the cycle length is varied, it can be either higher or lower than its standard value until the proper offset is achieved. The amount of variance is usually no more or less than 20% of the desired cycle length. The major advantage of this method is it allows all other phases to be served with at least minimum green time, which is critical at intersections with many phases. The drawback to this method is that it might take several cycles to achieve the proper offset.

902.23.11.2.6 Adaptive Control

Support. Most traffic control systems today are based on time-of-day schedules where the traffic signal settings (cycle length, green times, offsets) are set by time-of-day based on historical data on traffic demand (e.g., am peak hour turning movement counts). However, some signal systems with two-way communication or central communication systems can escape the need to predict traffic flow and better account for variations such as weather, incidents, or major traffic generator events.

Traffic Responsive

Traffic responsive systems rely on user-defined timing plans consisting of cycle length, split times, and offsets, but instead of a scheduled time for enacting plans, a traffic responsive system will select a plan based on observed volumes and occupancies. There is no guarantee that a traffic responsive system will have a plan for the observed conditions, therefore plans must be developed to handle a needed situation in advance.

Since the response to the variation in volume and/or occupancy is a change in timing plans for these types of systems, care will be needed to ensure that timing plans enacted by the system are in operation for a significant minimum duration to prevent frequent timing plan transitions.

Traffic Adaptive

Traffic adaptive systems discard the need for timing plans based on cycle lengths, splits, and offsets. Instead, these systems generally respond to changes in traffic on a system-wide basis quite rapidly on a cycle-by-cycle basis for each intersection. Other than for system failure backup purposes, storage of traditional timing plans is not required – a traffic adaptive system continually computes the traffic control plan.

A truly traffic adaptive system will adjust the settings at traffic signals based on real-time data on traffic conditions, and can best respond to unexpected or unplanned events, such as incidents, special events, weather, etc., since they adapt the timings based on observed traffic data. Similarly, adaptive systems will improve performance over time-of-day plans when the traffic patterns have a high degree of variability. Also, adaptive systems will reduce the adverse effects of offset transition, preemption, and transit priority. However, extensive traffic detector instrumentation is required, and intersection controller equipment for adaptive systems is often more complex than for the other control categories.

Support. Installation of adaptive traffic signal systems are recommended for further consideration for corridors where traffic demand changes quickly or in an unpredictable manner, where

Adaptive Traffic Signals in Lee's Summit

Summary (https://spexternal.modot.mo.gov/sites/cm/CO

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traditional timing plans are unable to accommodate coordination in two directions of travel, or where travel times are at least 50 percent higher than free flow travel times after signal timing plans have been optimized.

RDT/or10020_Adv.pdf#search=%27%27%27Adaptive%20Traffic%20Signals%20in%20Lee%E2%80%99s%20Summit)

See also: Research Publications (https://www.modot.org/research-publications)

Traffic Adaptive "Light"

A hybrid of both the responsive and adaptive systems, adaptive "light" systems retain the need for traditional timing plans and fixed schedules for timing plan implementation but can change the split at each phase of the traffic signal cycle based on traffic measurements upstream of the intersection and demand on minor movements. Small changes in cycle time and offset are made during time periods ranging from each cycle to a few minutes. Benefits include the ability to adjust timing plans without the requirement to manually generate new plans – developed plans can be left in operation for a longer time and not require re-optimization. Another benefit is that the need for additional detection is far less for a "light" system than a fully adaptive system.

For additional information refer to FHWA's Traffic Control Systems Handbook (http://www.ops.fhwa.dot.gov/publications/fhwahop06006/chapter_3p2.htm#3-8).

902.23.11.3 How to Interconnect for Coordination

Guidance. The method of coordination explained above is the same for every controller in a system. How that data is communicated between controllers and what information needs to be accessed remotely should be determined when desiring signal interconnectivity.

902.23.11.3.1 Determine Type of Interconnect

Guidance. The most basic interconnection system only requires an output from a master to the locals with a signal that controls:

1. Offset Break
2. Dial 2 On
3. Dial 3 On
4. Flash/Free Operation On

The basic setup offers no communication back from the locals to the master, and can be adequately handled with seven-conductor hardwire. If the need for coordination on the arterial is critical, and the flexibility of remote monitoring of all intersections and multiple timing plans are needed, a closed-loop system with fiber optic communication should be used.

If there is doubt as to how well coordination will work, or funding for a permanent type of interconnect is not available, then time base coordination (TBC) utilizing internal clocks of the controllers should be used. This allows for a very good demonstration of how coordination will affect the arterial. Also, TBC can be used on intersections outside the existing system limits to determine if interconnection needs to be extended.

Not every controller cabinet in use is set up for interconnection. If the signal has been operating outside of a coordinated system, an interconnect panel or device might be necessary to complete a connection to the controller. The final connection is through the controller's Ethernet port. If the controller lacks this port, another type of controller that can accept Ethernet connectivity will be needed.

902.23.11.3.2 Types of Interconnect

902.23.11.3.2.1 Time Base Coordination (TBC)

Support. If coordination is between signals is desired but interconnection is not feasible, time base coordination can be used. The most important component in a TBC system is a highly accurate clock at each controller. Controllers have clocks built in and can respond to internal offset breaks and timing program changes. The advantage of TBC is its lower initial cost. Disadvantages are that the clocks drifting can cause significant disruptions in coordination and any program change needs to be made to each individual controller. The only way to maintain clock synchronization, with no additional equipment, is physical presence to re-synchronize the controllers on a regular basis.

The time clock in each controller acts as the synchronizer. All controllers in the system are set to the proper time within one second of each other. It is imperative that clocks be off no more than one second of any other clock in the system in order to ensure accurate coordination.

Because there is no master controller in a TBC system, the locals must act as their own masters and be responsible for producing an accurate offset break. Even if the clocks are synchronized in a system, the master cycle offset reference point must be the same for proper coordination.

The following diagram shows how critical common offset reference can be to a TBC system:

Example: A TBC system with two controllers running a 70 second cycle starting at 6 a.m.

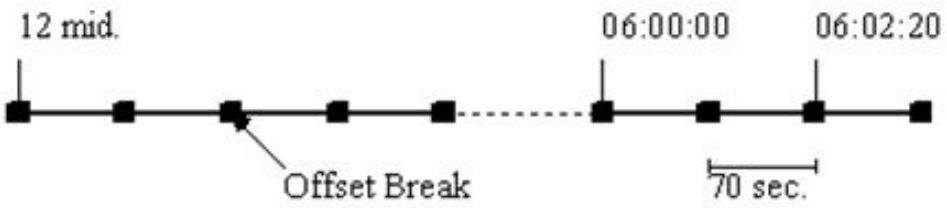
Controller 1 - Sync Reference: Midnight

At 6 a.m., this controller will look back to midnight and calculate when to time an offset break by starting the first 70-second cycle at midnight.



Controller 2 - Sync Reference: Start of Timing Plan

At 6 a.m., this controller will begin to time offset breaks every 70 seconds.



Due to the use of two different references, Controller 1's offset break is 30 seconds after Controller 2's. Therefore, if different offset references are used the coordination between the signals will be lost.

Because a TBC system does not have a master controller to give each local a signal as to what timing plan to run, each local is responsible for changing timing plans. The timing plans can be designated by different numbers (i.e. Cycle 3/Split 1 or Timing Plan 06) if the cycle length is similar, but for consistency, it is advisable to keep the same designation in each controller for each timing plan.

The start of each timing plan is typically at the same time for each controller, especially if the offset reference is the start of the timing plan. If all controllers are operating at a midnight reference for offset breaks, then timing plans which begin at slightly staggered times could be used with a slight delay in the onset of proper coordination. If the offset reference is at the start of the timing plan, then slightly staggered start times will give different times that the offset breaks start, and ruin coordination.

902.23.11.3.2.2 Ethernet-Over-Copper Interconnect

Support. For basic Ethernet-over-copper coordination, the controllers do not need to be the same model. However, the controllers' internal command language must be the same. Failure to respond accurately to the desired timing plan can ruin any coordination effort.

One controller is to be designated as the master controller and send the proper coordination signals to the locals. CAT 6 cable is run into each cabinet and connected either directly to the controller, or through an ethernet switch in order to synchronize time clocks, switch coordination plans, and more.

Small systems isolated from central communication can use peer-to-peer communication to synchronize time clocks, switch coordination plans and more. The interconnect method can be CAT 6 or fiber optic cable (commonly run underground in conduit and pull boxes), by radio link between signals, or any combination of these methods.

902.23.11.3.2.3 Fiber Optic Cable Interconnect

Support. Fiber optic cable is the preferred method for interconnecting both short and long runs between signals. The fiber optic cable is run into each cabinet and connected to an internal controller modem or an Ethernet switch, which translates the optical information into data the controller can recognize.

Fiber optic interconnect has several advantages over copper wire interconnect cables. Fiber does not transmit electrical energy from lightning which helps prevent lightning damage to control equipment. The signal demands on the fiber optic capacity is small enough that the cable run can be used in the future for other uses such as real-time video surveillance and connection to ITS systems.

The disadvantages of fiber are the need for higher technical expertise to install and maintain the cable and expensive special equipment.

902.23.11.3.2.4 Wireless Interconnect

Support. Wireless interconnect is an option when it is not practical, physically or financially, to run conduit and fiber optic cable between the controllers. Types of wireless interconnect may include cellular, which connects back to the central system, or radio, which connects point to point.

902.23.11.3.2.5 Mixed Interconnection

Support. Not every system needs to have the same type of interconnection between all controllers. In some locations where hardwire interconnect can be installed between controllers and other links have physical barriers which prevent conduit, wireless interconnect might be a viable option to complete the system. Any mix of hardwire, fiber and wireless can be used as long as the end protocol is the same.

902.23.11.4 Communication between Controllers

Support. Regardless of the type of communication between controllers, several basic items will be received by all intersections to operate a system properly. More advanced systems can be remotely accessed and monitored from a central computer system.

902.23.11.4.1 Master and Local Controllers

Support. In all systems, one controller or central computer system is responsible for keeping an accurate clock running, generating an offset reference and storing timing plan start and stop times. A controller in this capacity is referred to as the master controller of the system, and it can also act as the controller for a specific intersection. It transmits this information to the other controllers in the system which are called local controllers. The locals can have similar information stored in them as the master (e.g. synchronized time clock, timing plan start and stop times), but use this information only as a backup in case of failure in communication with the master. The local controllers are responsible for having each timing plan the master might call for loaded into their memory. The timing plan in the local controllers must include phase times for each interval that add up to the proper cycle length called for from the master, and the offset value unique to that intersection. Offsets and what timing plans to run are transmitted from the master and are recognized by the locals. Every local must interpret the master signal as the same command. Failure by one local to recognize this signal will disrupt coordination in the system.

902.23.11.4.2 Closed Loop

Support. Closed loop systems allow for remote access to the local controllers through the master controller in order to monitor, change or upload information at each intersection. Any information that can be programmed or stored at a local controller can be remotely accessed in a closed loop system. Remote access can be through a computer connected to the master or front panel access to the locals at the master controller.

902.23.11.4.3 Central Control Systems

Support. In centralized systems, a central computer makes control decisions and directs the actions of individual controllers. Each intersection requires only a standard controller and communication link to the central computer.

Central systems have the following characteristics:

- They depend on reliable communications networks. Since real-time control commands are transmitted from the central computer to the local intersections, any interruption in the communications network forces the local controllers to operate without that real-time control and revert to its backup plan via time-based control. If an interruption in communication occurs while in coordination a transition is required from central control to local control. During this transition, signal coordination is usually lost for a short period of time. For this reason, communications networks for centralized systems usually include some form of reliable communications, such as fiber optics.

- They depend on reliable central computers. Without the central computers, centrally controlled systems cannot happen. When the central computer is down the system has the same problems as when the communications network is down, except that the problem affects all intersections, not just the few that are on that communications branch. Staff dedicated to healthy computer system operations is a must for reliable central control.

- They are expensive. Most of the cost in a central system is providing the communications networks – easily a much higher investment than the central system's software.

- They provide excellent surveillance response time. The system's communications network is reliable enough to allow mandatory real-time control communications. In most situations, this requirement ensures once-per-second return of surveillance information such as status of phases and detectors, and controller alarms requiring maintenance attention.

- They allow centralized control algorithms. This is the one area where centrally controlled systems have a distinct advantage over traditional "interconnect" systems – the ability to define a signal coordination plan by need instead of physical connection to each intersection. As long as a controller has some sort of communication link back to the central computer, the intersections so designated can run in coordination. Central control allows these system limits to vary by both time of day and on manual needs such as incident response for detour routes.

Many traffic adaptive systems require a central computer to calculate the optimization algorithm for the entire network. Only a centrally controlled system can provide this capability.

902.23.11.5 Diamond Interchanges

Support. Due to the close spacing of both ends of a standard or compressed diamond interchange it is extremely important to offer coordination between both ends of the interchange. This can be accomplished with pre-timed or actuated control.

This discussion primarily relates to standard diamond interchanges, however similar considerations can also be made for half diamond and other diamond interchange variations. If a signalized roadway (i.e. outer roadway) is very close to a ramp intersection, a different configuration might be required.

Option. Coordination between both ends may be accomplished by running a pre-timed operation during the critical peak times and actuated operation during the off-peak times. This option is to be evaluated carefully, as coordination during actuated operation may not be optimal.

Guidance. The merits of each setup should be evaluated for the best operation at each location. The following are recommended criteria for selecting the best setup. A cost comparison might also be helpful in deciding which setup to use.

Actuated Control with One Controller:

- Overall interchange operates below capacity.
- No more than two mainline or ramp left turn movements require critical coordination.
- There is sufficient left turn storage between the ramps.

Actuated Control with Two Controllers:

- Overall interchange operates below capacity during off-peak.
- None of the movements require critical coordination during off peak.
- There is sufficient spacing and left turn storage between ramps for non-coordinated operation during off-peak.

Pre-timed Control with Two Controllers:

- Overall interchange operates near or at capacity.
- Most or all of the mainline and ramp left turn movements require critical coordination.
- There is not sufficient left turn storage between the ramps.

Diamond Interchange Examples provides examples of phasing configurations for diamond interchanges.

902.23.12 Controller Assembly Components

902.23.12.1 Controller Unit

Support. The controller unit (CU) is a solid-state traffic actuated unit. The CU interfaces with a number of low voltage (logic level) input and output functions to control signal lamps, receive inputs from detectors, operate in coordinated systems, etc. Additional information on types of control is found in EPG 902.5.2 Traffic Signal Operation.

NEMA TS1

The NEMA TS1 is a common cabinet configuration for solid state controllers. The back panel for a TS1 cabinet configuration has terminals that are used to interface with the other devices in the cabinet, call certain features of the controller, as well as to display the indications on the street. Harnesses are

provided to route the wiring from the controller to the rear of the back panel. By using jumpers on the front of the back panel, the inputs and outputs of the controller can be assigned. The physical makeup of the back panel is described in Sec 902 (http://www.modot.org/business/standards_and_specs/SpecbookEPG.pdf#page=13).

NEMA TS2

The NEMA TS2 standard replaces much of the discrete cabinet wiring with high speed serial communications interfaces. In addition, the communications allow the CU, malfunction management unit (MMU), backpanel, and detector rack to exchange information on a regular basis, performing redundant checks on each other.

The TS2 Type 1 standard uses EIA-485 serial communications interfaces and Synchronous Data Link (SDLC) communication protocol to link the major cabinet components. The serial data is converted to analog inputs and outputs in the back panel and detector rack by a bus interface unit (BIU).

The back panel for a TS2 cabinet configuration is also used for the termination of controller inputs and outputs. Load switch drivers and other functions of the controller have terminals on the back panel that are used to interface with the other devices in the cabinet and to display the indications on the street. The back panel is linked to the CU through one or more BIUs. Load switch assignments and other back panel functions are configured through the controller software. Discrete wiring is still provided between the back panel and the MMU to monitor load switch outputs.

Type 170/2070

Cabinets for Type 170/2070 Controllers use a 19 in. rack assembly to secure equipment and follow Caltrans standards (California Department of Transportation). The controller unit and cabinet assemblies are attached to the racks. Cabinet assemblies consist of the power supply assembly, power distribution assembly (PDA), input file, and output file. The power supply and PDA provide power, circuit protection and surge suppression for cabinet equipment. The PDA houses the flasher and auto/flash switch. The input file houses card rack detectors, isolators and other input devices. The output file houses load switches, flash transfer relays and the monitor. Other auxiliary equipment can be rack mounted or mounted by other means. Terminations for wiring are made on the back of associated cabinet assemblies.

902.23.12.2 Conflict Monitor Unit / Malfunction Management Unit

Support. All solid-state controllers have a conflict monitor unit (CMU) or a malfunction management unit (MMU) to supervise the operation of the traffic signals. The primary purpose of this unit is to guarantee that conflicting signal indications are not displayed on the street at the same time. If such a conflict is detected, the unit will automatically put the intersection into a flashing condition. The intersection will remain in flash until the monitor unit is reset and the problem that caused the failure is corrected.

These monitors can also monitor the absence of signal indications on the street. The absence of a load on the output side of the load switch when that output is turned on will cause the monitor to put the intersection into a flashing condition. This occurs when all the bulbs of the same color on a particular phase are burned out or when a wiring failure causes loss of power to the indications.

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Standard. For phases with only one signal head (i.e. a left turn phase with a single turn lane), load resistors shall be adequate for the output so that a single indication outage will not cause the intersection to go to flash.

Support. Each conflict monitor has a program card that is unique for that intersection. On the program card, jumpers are installed to tell the unit which movements, or channels, are considered compatible. Those positions not having jumpers are considered as conflicts and will trip the monitor.

The monitors also check the controller. If power is lost to the controller or if the internal 24-volt DC voltage of the controller is lost, the monitor will trip, and the intersection will go into flash. Some of the newer conflict monitors available exceed the minimum specifications set out by NEMA.

In NEMA TS2 cabinets, communications between the MMU and the CU allow the ability to monitor for fault conditions between the major cabinet components. Certain fault conditions will cause the intersection to go into flash. Some examples of these faults are the loss of serial communications, incompatibility between MMU program card and CU phase sequences and discrepancies between load switch outputs and CU phase outputs. In no case is a solid-state controller operated without a monitor unit.

902.23.12.3 Load Switches

Support. The operating voltages of the solid-state controller are 24 volts DC. This voltage must be converted to 120-volt AC in order to drive the signal indications. The load switch is a solid-state device that converts the 24-volt DC output from the controller to the 120-volt AC needed by the indications. Each load switch can handle three circuits. Normally, one switch is assigned for each phase and it handles the green, yellow and red outputs. A separate load switch is used to control pedestrian indications, if they are present at the intersection. Strategies used for flashing yellow arrow indications vary.

902.23.12.4 Auxiliary Interfaces

Support. Other auxiliary interfaces might also be needed in the controller cabinet. Examples of these include hardwire interconnect interfaces, closed loop system interfaces and preempt interfaces. These typically consist of a panel or unit that brings external inputs, outputs and communications into the CU.

902.23.12.5 Detector Interface

Support. The detector interface provides connections between the CU and the detection devices. In solid-state pre-timed and NEMA TS1 controllers, the connections are made through the back panel. In NEMA TS2 controllers, the detector inputs and outputs are linked to the CU through a BIU. In Type 170/2070 cabinets, the input file serves as the detector interface.

902.23.13 Detectors

Support. The basic goal of a detector is to provide a valid input to the controller unit of the need to provide service. There are many types of detectors currently in use and more are consistently being developed. Detector types include, but are not limited to, pedestrian push buttons, inductive loops, video detection, and radar detection.

There are two primary types of detection: pulse (or passage) and presence. In pulse detection the detector provides a short instantaneous call to the controller that demand is present and then the call is dropped. Presence detection registers that demand is present and will retain the call so long as there is demand.

A resource for information on additional detector types, alternate loop designs, and many other aspects of detectors is FHWA's *Traffic Detector Handbook* (https://www.fhwa.dot.gov/publications/research/operations/its/06108/) (also available through ITE).

902.23.13.1 Induction Loop Detectors

Support. Induction loop detectors consist of wire that is placed in the pavement that senses the passage or presence of metal objects (i.e. vehicles). The detectors' inductance is based on the number of turns of wire in the saw cuts in the pavement, and the current flowing through them. The passage or presence of a metal mass changes the inductance of the loop. The detector amplifier then measures this change in inductance and when the set thresholds are exceeded, detection is registered.

902.23.13.1.1 Loop Configuration

Support. The most common arrangement of the loop detector is the quadrapole. This layout, a rectangle with an additional cut down the middle, provides the greatest sensitivity of detecting small vehicles, motorcycles, and bicycles while reducing the occurrence of cross talk between loops in adjacent lanes and false calls from adjacent lanes. The typical quadrapole loop is 6 ft. wide by 30 ft. long located at the stop bar in each lane. Quadrapole detectors shorter than 30 ft. are sometimes used when field conditions don't allow for full size loops.

Another widely used loop configuration is the 6 ft. x 6 ft. square loop. This loop, which is centered in the lane, is typically used for detection in advance of the signal. This layout is more susceptible to cross talk and false detections but with proper adjustments of the amplifier, good performance can be achieved. This loop configuration is also typically used for vehicle counting. A variation of this loop is a diamond shaped loop. By turning the square loop 45 degrees, the more sensitive corners can be centered on the lane.

There are additional loop layouts, such as the skewed loop, round loops and several other variations available. See Comparison of Induction Loop Detector Designs and Standard Plan 902.50 (https://www.modot.org/media/16916) for more information.

902.23.13.1.2 Induction Loop Detector Amplifiers

Support. Induction loop detector amplifiers are installed in the controller cabinet and are available in shelf-mount and rack-mount configurations. The shelf-mount units are self-contained and are connected to the controller backpanel through a wiring harness. Rack-mount units are installed in a

card rack with separate power supplies. Type 170/2070 and NEMA TS2 controllers use only rack-mount detectors. The TS2 detectors have additional diagnostics that are linked to the CU through the serial communications.

902.23.13.2 Probes

Support. Probes are point detectors that are installed in the pavement. There are two types: micro-loops and wireless probes. They operate on a similar principal to a conventional loop detector. Micro-loops have a continuous lead in to the controller cabinet. Wireless probes sometimes require repeaters.

Probes are typically used at locations where the pavement is not able to support the cutting of a loop or right of way is limited. The principal drawback is a smaller detection zone, but through the use of several probes in an array, probes can closely simulate a long detector.

902.23.13.3 Microwave (Radar)

Support. Consisting of an emitter/sensor mounted either above or adjacent to the pavement, microwave detectors measure the Doppler shift in the microwave frequency and detect the passage of a vehicle. Simple microwave units are designed to place a call if an approaching vehicle is sensed for one lane or the entire approach. More advanced microwave detectors can define multiple zones of detection with one unit and can measure speeds. Microwave detectors are also directional; they can distinguish if a vehicle is approaching or leaving the detector.

A big advantage of microwave detectors is that they do not need to be installed in the pavement. This can allow for greater flexibility in installation as well as avoiding the problems associated with being in the pavement.

902.23.13.4 Video Detection

Support. Video detection consists of a video camera mounted above or adjacent to the pavement and a unit that processes the video signal to generate vehicle calls and other information. The processing unit uses software to draw zones of detection on the video output.

Video detection typically has a higher initial cost but offers the advantages of being completely out-of-pavement and allowing considerable flexibility in detector placement and configuration. Video detection can require one or several cameras to be effective and requires a rigid mounting location for the cameras. Higher mounting locations will provide more effective detection. One of the most common disadvantages of video detection is the potential for poor performance during inclement weather.

902.23.13.5 Closed Loop System Detectors

Support. The objective of system detectors is to gather data that the system master uses to make decisions on timing plan and offset patterns (see EPG 902.23.11 Coordination for more information). The data from these detectors can also be used as a monitoring tool for the system. The primary

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difference between system detectors and standard detectors is that system detectors do not have direct control over signal phase times. The master can use data from the system detectors to make system wide decisions based on parameters set by the user.

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Highway Signing Information (http://sharepoint/systemdelivery/TR/signing/SitePages/Home2.aspx)

Signing Agreements

■ TR15 Process (http://sp/sites/ts/signing/SignAgrmnts/_layouts/15/WopiFrame.aspx?sourcedoc=%7b23561969-7F35-4C78-A00C-930AB4B4279D%7d&file=TR15%20Process%20-%20Signing%20Paid%20by%20Applicant.docx&action=default)

■ TR 32, Process for Renewal – Supplemental Signing Agreement (http://sp/sites/ts/signing/SignAgrmnts/_layouts/15/WopiFrame.aspx?sourcedoc={A1753AC5-CB96-4FEE-8145-1A5E8AB26F84}&file=TR32%20Process%20for%20Renewal%20-%20Supplemental%20Signing%20Agreement.doc&action=default)

■ TR42 Process for Others (http://sp/sites/ts/signing/SignAgrmnts/_layouts/15/WopiFrame.aspx?sourcedoc=%7b1DEE67CC-80C0-401A-BDA6-267073AA20E5%7d&file=TR42%20Process%20for%20Others%20-%20Signing%20Installed%20and%20Maintained%20by%20Applicant.doc&action=default)

■ TR47 Process for Wayfinding (http://sp/sites/ts/signing/SignAgrmnts/_layouts/15/WopiFrame.aspx?sourcedoc=%7b1EE9F05C-B155-49C8-8DC9-6FBA9693DA19%7d&file=TR47%20Process%20for%20Wayfinding%20-%20%20Wayfinding%20Signing%20Agreement.doc&action=default)

D-28, Sign Design Order Form (https://epg.modot.org/forms/DE%202017%20Forms/DELiaison/D-28.doc)

College Signing Qualification List (http://sp/sites/ts/signing/_layouts/15/WopiFrame.aspx?sourcedoc={58A51A09-9874-470E-A292-286258033E57}&file=College%20Signing%20Qualification%20List%20Spreadsheet.xls&action=default)

Memorial Hwy / Bridge Naming Application (https://www.modot.org/sites/default/files/documents/Memorial%20Highway%20Naming%20application%20update_2018.pdf)

Approved Products

■ Approved Products List (http://www.modot.mo.gov/business/contractor_resources/traffic.htm)

■ New Product Evaluation Form (https://www.modot.org/traffic)

AASHTO Route Marking Application Form (http://sp.route.transportation.org/Pages/default.aspx)

Sign Management System (http://wasprod/sms/)

Standard Specifications for Highway Construction

Sec 903 (http://www.modot.org/business/standards_and_specs/SpecbookEPG.pdf#page=13)

Sec 1042 (http://www.modot.org/business/standards_and_specs/SpecbookEPG.pdf#page=14)

Standard Plans for Signing

Std. Plan 903.01 (https://www.modot.org/media/16919)

Std. Plan 903.02 (https://www.modot.org/media/16920)

Std. Plan 903.03 (https://www.modot.org/media/16921)

Std. Plan 903.04 (https://www.modot.org/media/16922)

Std. Plan 903.05 (https://www.modot.org/media/16923)

Std. Plan 903.06 (https://www.modot.org/media/16924)

Std. Plan 903.07 (https://www.modot.org/media/16925)

Std. Plan 903.08 (https://www.modot.org/media/16926)

Std. Plan 903.10 (https://www.modot.org/media/16927)

Std. Plan 903.12 (https://www.modot.org/media/16928)

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Support. The standards, guidance and options this article of the EPG relates directly to the signing installed within the right-of-way of highways maintained by MoDOT.

Do Not Replace / Limited Use

- Do Not Replace / Limited Use Sign List
- Do Not Replace / Limited Use PowerPoint Guidance

Missouri Logos Contact Information (https://missouri.interstatelogos.com/)

Std. Plan 903.60 (https://www.modot.org/media/16929)

Sign Post Selection Tools

- Sign Post Selection Guide
- Printable Sign Post Selection Guide for use in the field

Because MoDOT does not use many of the "common" size signs in the FHWA's Standard Highway Signs and Markings book, we produced our own sign detail policy, Sign Management System Sign (SMS) Catalog (http://wasprod/sms/) (for internal use only). MoDOT's SMS Sign Catalog meets and/or exceeds the minimums of the FHWA's Standard Highway Signs and Markings book. MoDOT's Highway Safety and Traffic Division is responsible for sign design on the state highway system. Any unique sign or sign that isn't currently in the SMS Sign Catalog will be designed using the principles and minimums in the FHWA's Standard Highway Signs and Markings book and the current MUTCD.

The districts are responsible for proper review of signing plans for accuracy, to ensure that standards are met and deviations from the standards are justified.

MoDOT has the authority to install signs or any other traffic control device on state right-of-way or give permission to others to do so. MoDOT also has the authority to remove any devices not authorized from the right-of-way. Sections 226.010 (https://revisor.mo.gov/main/OneSection.aspx?section=226.010) and 227.220 (https://revisor.mo.gov/main/OneSection.aspx?section=227.220) of the Revised Statutes of Missouri authorize MoDOT to prescribe uniform traffic control devices on the state's highways.

Per Section 300.175 (https://revisor.mo.gov/main/OneSection.aspx?section=300.175) of the Revised Statutes of Missouri, the display of unauthorized signs is prohibited.



Articles in "903 Highway Signing (MUTCD Part 2)"

The following 23 pages are in this category, out of 23 total.

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- 903.1 General (MUTCD Chapter 2A)
- 903.2 Regulatory Signs and Barricades (MUTCD Chapter 2B)
- 903.3 Warning Signs and Object Markers (MUTCD Chapter 2C)
- 903.4 Guide Signs—Conventional Roads (MUTCD Chapter 2D)
- 903.5 Guide Signs - Freeways and Expressways (MUTCD Chapter 2E)
- 903.6 Toll Road Signs (MUTCD Chapter 2F)
- 903.7 Preferential and Managed Lane Signs (MUTCD Chapter 2G)
- 903.8 General Information Signs (MUTCD Chapter 2H)

- 903.9 General Service Signs (MUTCD Chapter 2I)
- 903.10 Specific Service Signs (MUTCD Chapter 2J)
- 903.11 Tourist-Oriented Directional Signs (MUTCD Chapter 2K)
- 903.12 Changeable Message Signs (MUTCD Chapter 2L)
- 903.13 Recreational, Historic Site, and Cultural Interest Area Signs (MUTCD Chapter 2M)
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903.1 General (MUTCD Chapter 2A)

903.1.1 Function and Purpose of Signs (MUTCD Section 2A.01)

Support. The EPG contains Standards, Guidance, and Options for the signing of all types of highways, and site roadways open to public travel within the right-of-way maintained by MoDOT. The functions of signs are to provide regulations, warnings, and guidance information for road users. Words, symbols, and arrows are used to convey the messages. Signs are not typically used to confirm rules of the road.

Detailed sign requirements are located in the following articles of the EPG:

- EPG 903.2 - Regulatory Signs and Barricades
- EPG 903.3 - Warning Signs and Object Markers
- EPG 903.4 - Guide Signs for Conventional Roads
- EPG 903.5 - Guide Signs for Freeways and Expressways
- EPG 903.6 - Toll Road Signs – Not used on MoDOT facilities
- EPG 903.7 - Preferential and Managed Lane Signs – Not used on MoDOT facilities
- EPG 903.8 - General Information Signs
- EPG 903.9 - General Service Signs
- EPG 903.10 - Specific Service Signs
- EPG 903.11 - Tourist-Oriented Directional Signs
- EPG 903.12 - Changeable Message Signs
- EPG 903.13 - Recreational, Historic Site, and Cultural Interest Area Signs
- EPG 903.14 - Emergency Management Signs – Not used on MoDOT facilities

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903.1.24 Priority Order of Signs

Definitions and acronyms that are applicable to signs are provided in EPG 911 (MUTCD Section 1C.02).

MoDOT typically will not use signing to confirm rules of the road or state laws. The application of such signing will typically be used when a new law is passed for educational purposes, with the signs remaining in place until the end of their service life and then removed. Some signs may be left in place at strategic locations such as major entry points into the state.

Standard. The decision to install and maintain signs to confirm rules of the road or state laws shall be made by the MoDOT Highway Safety and Traffic Division along with the MoDOT Executive Leadership Team.

903.1.2 Standardization of Application (MUTCD Section 2A.02)

Support. It is recognized that urban traffic conditions differ from those in rural environments, and in many instances signs are applied and located differently. Where pertinent and practical, the EPG sets forth separate recommendations for urban and rural conditions. This generally applies to sign mounting heights.

Guidance. Signs should be used only where justified by engineering judgment or studies, as provided in EPG 911 (MUTCD Section 1D.03).

Results from traffic engineering studies of physical and traffic safety or operational factors should indicate the locations where signs are deemed necessary or desirable.

Roadway geometric design and sign application should be coordinated so that signing can be effectively placed to give the road user any necessary regulatory, warning, guidance, and other information.

Standard. Each standard sign (see first paragraph of EPG 903.1.4) shall be displayed only for the specific purpose as prescribed in the EPG. Before any new highway, site roadway open to public travel (see definition in EPG 911 (MUTCD Section 1C.02)), detour, or temporary route is opened to public travel, all necessary signs shall be in place. Signs required by road conditions or restrictions shall be removed when those conditions cease to exist or the

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903.1.3 Classification of Signs (MUTCD Section 2A.03)

Standard. Signs sh ll be defined by their function s follows:

A. Regulatory signs give notice of traffic laws or regulations.
B. Warning signs give notice of a situation that might not be readily apparent.
C. Guide signs show route designations, destinations, directions, distances, services, points of interest, and other geographical, recreational, or cultural information.

Support. Barricades are described in EPG 903.2.60 and 616.11.7.

Object markers are described in EPG 903.3.70.

903.1.4 Design of Signs (MUTCD Section 2A.04)

Support. The EPG shows many standard signs and object markers approved for use on streets, highways, bikeways, and pedestrian crossings. Standard signs and object markers have a standardized design, shape, background, and legend as shown in the EPG.

In the provisions for individual standard signs and object markers, the general appearance of the legend, color, and size are shown in the accompanying tables and illustrations, and are not always detailed in the text.

The MoDOT Highway Safety and Traffic Division maintains design files of standard signs, object markers, alphabets, symbols, and arrows that meet or exceed MUTCD standards and are used to detail, order, and fabricate signs used on MoDOT routes.

The basic requirements of a sign are that it be legible to those for whom it is intended and that it be understandable in time to allow for a proper response. Desirable attributes include:

A. High visibility by day and night; and
B. High legibility (adequately-sized letters, symbols, or arrows, and a short legend for quick comprehension by a road user approaching a sign).

Standardized colors and shapes are specified so that the several classes of traffic signs can be promptly recognized. Simplicity and uniformity in design, position, and application are essential for a sign to be effective.

Standard. The term legend shall include all word messages and symbol and arrow designs that are intended to convey specific meanings.

Uniformity in design shall include shape, color, dimensions, legends, letter style, borders, and illumination or retroreflectivity.

Standardization of these designs does not preclude further improvement by minor modifications to the orientation of symbols (see EPG 903.1.9), width of borders, or layout of word messages, but all shapes and colors shall be as indicated.

All symbols (see EPG 903.1.9) shall be unmistakably similar to, or mirror images of, the adopted symbol signs, all of which are shown in the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)). Symbols and colors shall not be modified unless otherwise provided in the EPG. All symbols, colors, or other design features for signs not shown in the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)) shall be approved by the MoDOT Highway Safety and Traffic Division and shall follow the MUTCD procedures for experimentation and change described in EPG 911 (MUTCD Section 1B.01).

Where a standard word message is applicable, the wording shall be as provided in the EPG.

In situations where word messages are necessary other than those provided in the EPG (see the first Option paragraph below), the signs shall be of the same shape and color as standard signs of the same functional type.

Where the legend of a standard sign is a symbol or a combination of a symbol and words, an alternative word legend shall not be allowed in place of the symbol, except as otherwise provided in the EPG.

Where a standard sign provided in the EPG or the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)) is applicable, an alternative legend sign or alternative sign design shall not be allowed in place of the standardized legend or design except as provided in the EPG.

Where a standard sign provided in the EPG or the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)) is applicable, but the legend is variable, such as for destination names, an alternative sign design or dimensions shall not be allowed in place of the standardized design for the non-variable elements except as provided in the EPG.

Option. The MoDOT Highway Safety and Traffic Division may develop special word legend signs in situations where engineering judgment determines roadway conditions make it necessary to provide road users with additional regulatory, warning, or guidance information, such as when road users need to be notified of special regulations or warned about a situation that might not be readily apparent. Unlike colors that have not been assigned or symbols that have not been approved for signs, new word legend signs may be used without the need for experimentation.

Support. The message conveyed by some special word legend signs might be unclear to the road user. Although experimentation is not required for such word legends, they might still warrant an evaluation to determine comprehension or possible misinterpretation of the intended message by the road user.

Scanning graphics are graphics designed for scanning by machine, and include bar codes, quick-response (QR) codes or other matrix bar-code formats, or similar graphics.

tandard. U ess otherwise provided in the EPG for a specific sign or as provided in the Option paragraph below telephone numbers, Internet addresses, e-mail addresses, domain names, uniform resource locators (URL), metadata tags (“hash-tags”), and scanning graphics (see Support paragraph above) for the purpose of obtaining information (other than those for maintenance or inventory purposes per the provisions of the second Standard paragraph below) shall not be displayed on any sign, plaque, sign panel, or changeable message sign.

Option. Internet addresses, e-mail addresses, telephone numbers, scanning graphics, or other graphics for the purpose of conveying information may be displayed on the face of signs, plaques, sign panels, and changeable message signs that are oriented away from or otherwise not readily visible to operators of motor vehicles but rather are intended for viewing only by pedestrians, occupants of parked vehicles, and driving automation systems if approved by the MoDOT Highway Safety and Traffic Division.

Standard. Pictographs (see definition in EPG 911 (MUTCD Section 1C.02)) shall not be displayed on signs except as specifically provided in the EPG for a particular type of sign. Pictographs shall be simple, dignified, and devoid of any advertising and shall not contain any scanning graphics (see first Support paragraph above) for the purpose of conveying information. When used to represent a political jurisdiction (a State, county, or municipal corporation) the pictograph shall be the official designation adopted by the jurisdiction, except as provided otherwise in the EPG. When used to represent any other type of jurisdiction, the pictograph shall be the official designation adopted by the jurisdiction. When used to represent a college or university, the pictograph shall be the official seal adopted by the institution. College or university pictographs shall not include pictorial representations of university or college programs, or athletic mascots.

No items other than official traffic control signs, inventory stickers or decals, sign installation dates, manufacturer name, sign sizes, sign designations, anti-vandalism stickers, inventory or maintenance codes, and maintenance-related scanning graphics shall be mounted on the back of a sign.

Only the MoDOT ID logo shall be displayed on the face of a sign to identify the sign as MoDOT property and define the penalties for tampering with the sign. The MoDOT ID logo shall match the detail and installation location as displayed in Standard Plan 903.02 (https://www.modot.org/media/16920).

903.1.5 Shapes (MUTCD Section 2A.05)

Standard. Particular shapes, as shown in Table 903.1.5, shall be used exclusively for specific signs or a series of signs, unless otherwise provided in the EPG for a particular sign or class of signs.

Table 903.1.5, Use of Sign Shapes

Shape	Signs
Octagon*	Stop (R1-1)**
Equilateral Triangle (downward-pointing)*	Yield (R1-2)**
Circle*	Grade Crossing Advance Warning (W10-1)**
Pentagon (upward-pointing)*	School (S1-1) (squares bottom corners)**
Crossbuck (two rectangles in a perpendicular "X" configuration)*	Grade Crossing (R15-1)**
Diamond	Warning Series
Rectangle (including square)	Regulatory Series Guide Series*** Warning Series
Key: * This shape shall be limited exclusively to the sign(s) indicated. ** This sign shall be exclusively the shape shown. *** Guide series includes general service, specific service, tourist-oriented directional, general information, recreational and cultural interest area, and emergency management signs. **Note:** Signs with standardized designs shall not be modified to accommodate a different shape except as provided in the EPG.	

The Crossbuck is a shape exclusive to the Grade Crossing (R15-1) sign and shall not be obscured by mounting a different shape sign on the back of the Crossbuck (see EPG 913.2.3).

Guidance. Shapes that are exclusive to a particular sign (STOP, YIELD, Railroad Advance, School, Warning, and Crossbuck signs) should not be obscured by another sign mounted on the back of the same assembly protruding or extending beyond the edge of the sign with the exclusive shape. The following methods should be considered in lieu of mounting a sign on the back of another sign that would obscure the exclusive shape of the sign:

A. Install the signs on separate mountings to maintain the exclusive shape.
B. Increase the size of the sign with the exclusive shape and/or decrease the size of the sign mounted behind the sign with the exclusive shape so the sign installed on the back does not obscure its shape.

Where the lateral space available in which to install a standard sign is constrained, such as mounting on a narrow median barrier or adjacent to a retaining wall, the following methods should be considered to maintain the shape of the sign:

A. Angle the sign up to 45 degrees toward the roadway while still maintaining adequate legibility.
B. Install the sign at a different location that still provides adequate advance warning, supplementing the sign with a Distance plaque (see EPG 903.3.60), if appropriate.
C. Reduce the size of the sign, but supplement it with a duplicate sign on the opposite side of the roadway (see EPG 903.1.11).
D. In addition to either angling or reducing the size of the sign, supplement it with a duplicate warning sign and Distance plaque at an upstream location.
E. Mount the sign asymmetrically on the sign support, such as when the support is mounted on a bridge parapet or railing, such that the edge of the sign does not overhang the roadway, shoulder, or other areas used by bicyclists or pedestrians.

Option. Where the shape of the sign cannot be maintained due to lateral constraints, the following methods may be considered:

. For warnin sig s or ot er types of sig s d splayed in a horizon ally-orien ed recta le, the legend may be displayed in a vertically-oriented rectangle.
B. When mounted overhead, the word legend for a standard warning sign may be displayed in a horizontally-oriented rectangle.

Su ort. Provisions for mounting height of signs that overhang any portion of the traveled way are contained in EPG 903.1.15.

Provisions for lateral offset are contained in EPG 903.1.16.

Standard. Modifications to sign shapes, such as cutting off the left and right points of a diamond, shall not be allowed. This applies to both permanent and temporary traffic control signs.

Option. Where the methods described in the first Guidance paragraph of this article are impracticable, the legend of the warning sign may be displayed in a vertically-oriented rectangle.

903.1.6 Colors (MUTCD Section 2A.06)

Standard. The colors to be used on signs and their specific uses on signs shall be as provided in the applicable articles of the EPG. The color coordinates and values shall be as described in 23 CFR, Part 655, Subpart F, Appendix.

Colors (see EPG 911 (MUTCD Section 1D.05)) shall be consistent across the face of a sign or a sign panel. Color gradients (smooth or defined gradual transitions either within a color or transition to another color) shall not be allowed.

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able 903 6, Common Uses of Sign Colors

Type of Sign	Legend								Background								
	Black	Green	Red	Wh te	Yellow	Orange	Fluorescent Yellow-Green[1]	Fluorescent Pink	Black	Blue	Brown	Green	Fluorescent Orange	Red	White	Fluorescent Yellow	Purpl
Regulatory	X		X	X					X					X	X		
Prohibitive			X	X[2]										X[2]	X		
Permissive		X													X		
Warning	X															X	
Pedestrian	X															X	
Bicycle	X															X	
Guide				X								X					
Interstate Route				X						X				X			
State Route	X														X		
U.S. Route	X														X		
Street Name				X								X					
Destination				X								X					
Reference Location				X								X					
Information				X						X		X					
Road User Service				X						X							
Recreational				X							X	X					
Temporary Traffic Control	X												X				
Incident Management	X												X				
School	X																
Changeable Message Signs																	
Regulatory			X[4]	X					X								
Warning, Pedestrian, Bicycle					X				X								
Temporary Traffic Control					X	X			X								
Guide				X					X			X[3]					
Motorist Services				X					X	X[3]							
Incident Management					X			X	X								
School							X		X								

[1] MoDOT has conducted research on the use of Fluorescent Yellow-Green for Pedestrian and Bicycle Signs. Research did not indicate any safety benefit, therefo School signs only.

[2] Legend and background color combination for use only as identified for specific signs in the EPG or FHWA's Standard Highway Signs publication

[3] These alternative background colors would be provided by blue or green lighted pixels such that the entire CMS would be lighted, not just the legend.

[4] Red is used only for the circle and diagonal or other red elements of a similar static regulatory sign.

Notes:

1. The purpose of the information in this table is to provide a general overview of common color combinations. The color combinations and orientations for signs shall not be modified. For signs with unique legends, the shape and color shall be the same as standard signs of the same functional type.
2. The colors shown for changeable message signs are for those with electronic displays.

Support. Common uses of sign colors are shown in Table 903.1.6. Color schemes on specific signs are shown in the illustrations located in each applicable EPG article.

Whenever white is specified in the EPG or in the FHWA's “Standard Highway Signs” publication (see EPG 911 (MUTCD Section 1A.05)) as a color, it is understood to include silver-colored retroreflective coatings or elements that reflect white light.

The colors coral and light blue are being reserved for uses that will be determined in the future by the Federal Highway Administration.

nformation regard ng olor coding of d stinations on gui signs, in lud ng ommunity wayf nding signs, is ontained n EPG 903.4.

903.1.7 Dimensions (MUTCD Section 2A.07)

Support. To standardize signing throughout the state highway system, MoDOT has predetermined the sizes for all highway signs; refer to the appropriate EPG article. Larger sizes are designed for use on freeways and expressways, and can also be used in oversized applications to enhance road user safety and convenience on other facilities, especially on multi-lane divided highways and on undivided highways having five or more lanes of traffic and/or high speeds. The intermediate sizes are designed to be used on other highway types. MoDOT does not adopt smaller sized signs for bikeways or other off-road applications as MoDOT typically does not maintain these types of facilities. MoDOT's minimum sign sizes generally exceed the MUTCD minimum sign sizes. The MUTCD minimum sizes in these cases are intended more for low-speed, local jurisdictional roadways and not for state highways. The sign size tables at the beginning of each EPG signing article lists the correct sign sizes for MoDOT applications.

Standard. The sign dimensions prescribed in the sign size tables in the various EPG articles shall be used unless engineering judgment determines that other sizes are appropriate. All sign sizes smaller than the prescribed dimensions shall be approved by the MoDOT Highway Safety and Traffic Division.

Guidance. The sizes shown in the Oversized columns in the various sign size tables in the EPG should be used for those special applications where speed, volume, or other factors result in conditions where increased emphasis, improved recognition, or increased legibility is needed, as determined by engineering judgment or study.

Except as provided in the Standard paragraph below, and where specifically prohibited in the EPG, increases above the minimum prescribed sizes should be used where greater legibility or emphasis is needed. If signs larger than the prescribed sizes are used, the overall sign dimensions will typically be increased in 12-inch increments.

Standard. Where a maximum allowable sign size is prescribed, increases in sign size above the maximum size shall not be allowed.

Where engineering judgment determines that sizes that are different from the minimum prescribed dimensions are appropriate for use, standard shapes and colors shall be used. Standard proportions shall be retained as much as practicable. Any application of size which is different from those given in the EPG shall first be approved by the MoDOT Highway Safety and Traffic Division.

903.1.8 Word Messages (MUTCD Section 2A.08)

Standard. Except as otherwise provided in the EPG, all word messages shall be aligned horizontally across a sign, reading left to right.

Except as provided in EPG 903.1.4, all word messages shall use standard wording as shown in the EPG and in the FHWA's “Standard Highway Signs” publication (see EPG 911 (MUTCD Section 1A.05)).

All sign lettering, numerals, and other characters shall be of the Standard Alphabets as provided in the FHWA's “Standard Highway Signs” publication (see EPG 911 (MUTCD Section 1A.05)), unless otherwise provided in the EPG.

The sign lettering for names of places, streets, and highways shall be composed of a combination of lower-case letters with initial upper-case letters. The sign lettering for other legends shall be composed of upper-case letters, unless otherwise provided in the EPG for a particular sign or type of message.

Except as provided in EPG 903.5, when a mixed-case legend is used, the nominal loop height of the lower-case letters shall be ¾ of the height of the initial upper-case letter.

The unique letter forms for each of the Standard Alphabet series shall not be stretched, compressed, warped, or otherwise manipulated.

Any non-standard or variable sign shall be detailed by the MoDOT Highway Safety and Traffic Division for signs installed by MoDOT forces as well as those installed by contractors on MoDOT projects.

Support. EPG 903.4.3 contains information regarding the acceptable methods of modifying the length of a word for a given letter height and series.

Guidance. Word messages should be as brief as practical to convey a clear, simple meaning, and the lettering should be large enough to provide the necessary legibility distance. A minimum specific ratio of 1 inch of letter height per 30 feet of legibility distance should be used.

Abbreviations (see EPG 911 (MUTCD Section 1D.08)) should be kept to a minimum, except as otherwise prescribed in the EPG.

Word messages should not contain periods, apostrophes, question marks, ampersands, or other punctuation or characters that are not letters, numerals, or hyphens unless necessary to avoid confusion.

Support. Diacritical marks on words or names that are adapted to English are not normally needed on signs for comprehension or navigational purposes.

A legend in a secondary language, in addition to English, may be displayed on the face of signs, plaques, sign panels, and changeable message signs that are oriented away from or otherwise not readily visible to operators of motor vehicles, but rather are intended for viewing only by pedestrians and occupants of parked vehicles.

Guidance. The solidus (slanted line or forward slash) is intended to be used for fractions only and should not be used to separate words on the same line of legend. Instead, a hyphen should be used for this purpose, such as “TRUCKS - BUSES.”

Standard. Fractions shall be displayed with the numerator and denominator diagonally arranged about the solidus. The overall height of the fraction is measured from the top of the numerator to the bottom of the denominator, each of which is vertically aligned with the upper and lower ends of the solidus. The overall height of the fraction shall be determined by the height of the numerals within the fraction, and shall be 1.5 times the height of an individual numeral within the fraction.

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xcept as otherwi e prov ded in the EPG, di tances shall be displayed on signs using fractions of a m le rat er than decimals.

Support. The FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)) contains details regarding the layouts of fractions on signs.

Guidance. When initials are used to represent an abbreviation for separate words (such as "U S" for a United States route), the initials should be separated by a space of between ½ and ¾ of the letter height of the initials.

When an Interstate route is displayed in text form instead of using the route shield, a hyphen should be used for clarity, such as "I-70."

Support. Letter height is expressed in terms of the height of an upper-case letter. For mixed-case legends (those composed of an initial upper-case letter followed by lower-case letters), the height of the lower-case letters is derived from the specified height of the initial upper-case letter based on a prescribed ratio. Letter heights for mixed-case legends might be expressed in terms of both the upper- and lower-case letters, or in terms of the initial upper-case letter alone. When the height of a lower-case letter is specified or determined from the prescribed ratio, the reference is to the nominal loop height of the letter. The term loop height refers to the portion of a lower-case letter that excludes any ascending or descending stems or tails of the letter, such as with the letters "d" or "q." The nominal loop height is equal to the actual height of a non-rounded lower-case letter whose form does not include ascending or descending stems or tails, such as the letter "x." The rounded portions of a lower-case letter extend slightly above and below the baselines projected from the top and bottom of such a non-rounded letter so that the appearance of a uniform letter height within a word is achieved. The actual loop height of a rounded lower-case letter is slightly greater than the nominal loop height and this additional height is excluded from the expression of the lower-case letter height.

903.1.9 Symbols (MUTCD Section 2A.09)

Standard. Symbol designs shall in all cases be unmistakably similar to those shown in the EPG and in the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)).

Option. Although most standard symbols are oriented facing left, mirror images of these symbols may be used where the reverse orientation might better convey to road users a direction of movement.

Support. New symbol designs are adopted by the Federal Highway Administration based on research evaluations to determine road user comprehension, sign conspicuity, and sign legibility.

Sometimes a change from word messages to symbols requires significant time for public education and transition. Therefore, the EPG sometimes includes the practice of using educational plaques to accompany new symbol signs.

Guidance. New standard warning or regulatory symbol signs should be accompanied by an educational plaque where engineering judgment determines that the plaque will improve road user comprehension during the transition from word message to symbol signs.

Option. Educational plaques may be left in place as long as they are in serviceable condition.

Standard. A symbol used for a given category of signs (regulatory, warning, or guide) shall not be used for a different category of signs, except as specifically authorized in the EPG.

A recreational and cultural interest area symbol (see EPG 903.13) shall not be used on streets or highways outside of recreational and cultural interest areas.

A recreational and cultural interest area symbol (see EPG 903.13) shall not be used on any regulatory or warning sign on any street, road, or highway.

903.1.10 Sign Borders (MUTCD Section 2A.10)

Standard. Unless otherwise provided, signs shall have a border of the same color as the legend in order to outline their distinctive shape and thereby give them easy recognition and a finished appearance.

The corners of all sign borders shall be rounded, except for STOP signs.

Guidance. A dark border on a light background should be set in from the edge, while a light border on a dark background should extend to the edge of the sign. A border for 30-inch signs with a light background should be from ½ to ¾ inch in width, ½ inch from the edge. For similar signs with a light border, a width of 1 inch should be used. For other sizes, the border width should be of similar proportions, but should not exceed the stroke-width of the major lettering of the sign. On signs exceeding 72 x 120 inches in size, the border should be 2 inches wide. On unusually large signs with oversized letter heights, route shields, or other legend elements, the border should be 2.5 inches wide and should not exceed 3 inches in width. Except for STOP signs and as otherwise provided in EPG 903.5.13, the corners of the sign should be rounded to a radius that is concentric with that of the border.

Support. EPG 903.1.12 contains information regarding the use of light-emitting diode (LED) units within the border of a sign.

903.1.11 Enhanced Conspicuity for Standards Signs (MUTCD Section 2A.11)

Option. Based upon engineering judgment, where the improvement of the conspicuity of a standard regulatory, warning, or guide sign is desired, any of the following methods may be used, as appropriate, to enhance the sign's conspicuity (see Figure 903.1.11):

A. Increasing the size of a standard regulatory, warning, or guide sign.
B. Dual signing of a standard regulatory, warning, or guide sign by adding a second identical sign on the left-hand side of the roadway at the same location.
C. Adding a fluorescent yellow rectangular header panel above a standard regulatory sign, with the width of the panel corresponding to the width of the standard regulatory sign. A legend of "NOTICE," "STATE LAW," or other appropriate text may be added in black letters within the

eader panel f r a period o time determined by engineering judgment.
D. Adding a Warning Beacon (see EPG 902.18.3) to a standard regulatory (o er t an a STOP, DO NOT ENTER, WRONG WAY, or a Speed Limit sign), warning, or guide sign.
E. Adding a Speed Limit Sign Beacon (see EPG 902.18.4) to a standard Speed Limit sign.
F. Adding a Stop Beacon (see EPG 902.18.5) to a STOP, DO NOT ENTER, or WRONG WAY sign.
G. Adding a rectangular rapid-flashing beacon (see EPG 902.12) to a Pedestrian, School, or Trail warning sign at an uncontrolled marked crosswalk.
H. Adding light-emitting diode (LED) units within the symbol, legend, or border of a standard regulatory, warning, or guide sign, as provided in EPG 903.1.12.
I. Adding a strip of retroreflective material to the sign support in accordance with the provisions of the second Standard paragraph below.
J. Using other methods that are specifically allowed for certain signs as described elsewhere in the EPG. The MoDOT Highway Safety and Traffic Division will evaluate any new methods to improve sign conspicuity.

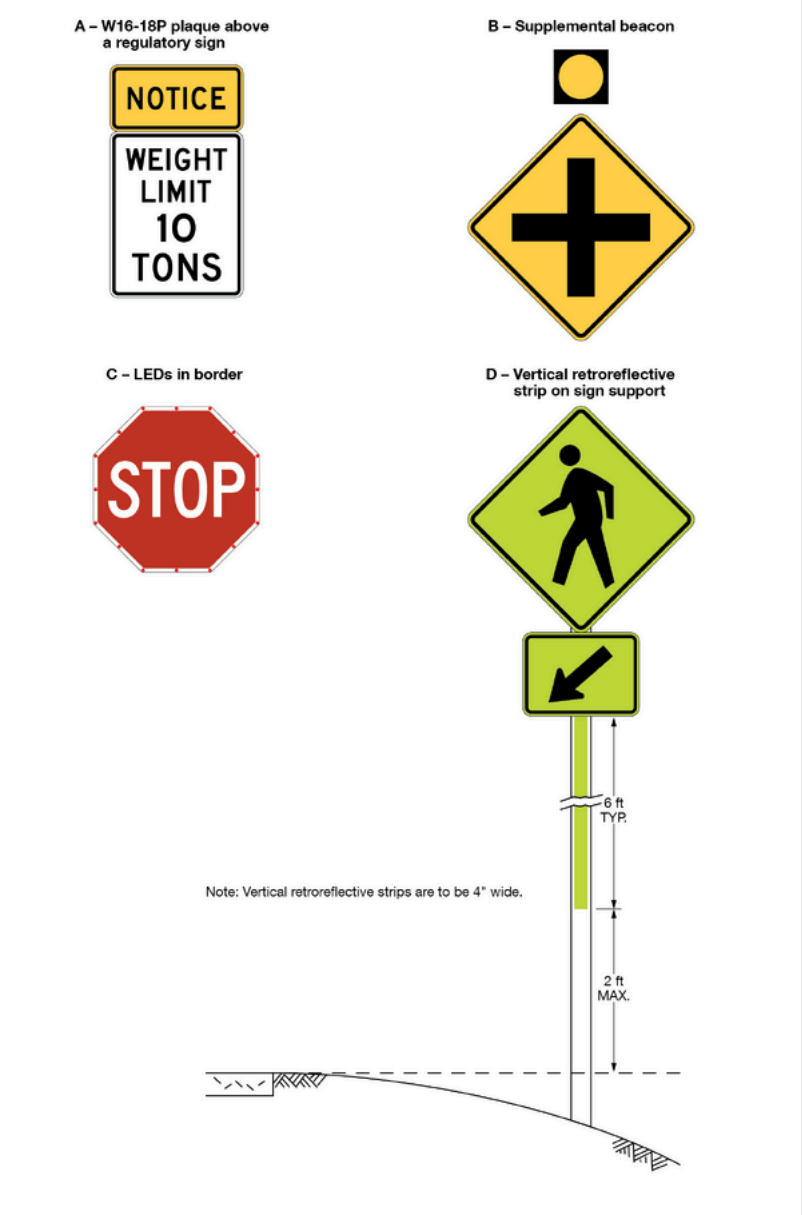


Figure 903.1.11 Examples of Enhanced Conspicuity for Signs

Support. Sign conspicuity improvements can also be achieved by removing non-essential and illegal signs from the right-of-way (see EPG 911 (MUTCD Section 1D.02)), and by relocating signs to provide better spacing. EPG 903.1.20 contains information on excessive use of signs.

Standard. Strobe lights shall not be used to enhance the conspicuity of highway signs.

If a strip of retroreflective material is used on the sign support, it shall be at least 4 inches in width, it shall be placed for the full length of the support from the bottom of the sign and extending down the length of the post, with the bottom of the retroreflective strip not being taller than 2 feet above the edge of the roadway, (see Figure 903.1.11), and its color shall match the background color of the primary sign, except that the color of the strip for the YIELD and DO NOT ENTER signs shall be red. The retroreflective strip shall not display any legend or other information. MoDOT's standard for this application uses a 4" x 72" aluminum panel with the retroreflective material applied to it where the panel can then be attached to the signpost using the same types of fasteners used to attach signs. These panels are available from MoDOT's third party sign fabricator. Retroreflective strips shall not be placed on the sign supports below green, blue, or brown guide signs and shall only be placed below regulatory, warning, and school signs, and route marker assemblies.

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or a post ounte sign installation, placing a d plicat sign in the sam assembly facing the sam direction of traffic shall not be permitte as a m tho of enhancing conspicuity.

If plaques are used, they shall be installed below the main sign, up to two plaques.

Option. Retroreflective strips may be used to help identify and delineate the location of rural and unlit intersections and expressway crossovers, giving drivers visual cues where these intersections are located in dark nighttime conditions, see EPG 620.6.3 for information regarding this application.

903.1.12 LEDs Used for Conspicuity Enhancement o Standard Signs (MUTCD Section 2A.12)

Support. This article regarding light-emitting diode (LED) units applies to the use of illuminated elements that supplement a sign legend to enhance the conspicuity of the sign.

LED units that are used to illuminate the full sign display, background, or legend are changeable message signs (CMS), which are covered in EPG 903.2, 903.3, 903.12, and 908.

The application of LED units in compliance with the third Standard paragraph below does not create a changeable message sign because the legend of the sign is always displayed when the LED units are not illuminated. Changeable message or blank-out signs whose legends change or extinguish by means of illuminated elements are addressed elsewhere in the EPG.

Approved LED sign manufacturers that are MUTCD compliant and whose products have been evaluated by MoDOT are listed in the MoDOT's Traffic Approved Products List (APL) found on MoDOT's public website (https://www.modot.org/traffic).

Standard. If LED enhanced signs are used, only those products listed on the Traffic APL shall be permitted.

Option. New products may be considered for the APL, however, before being used they must first be vetted by the MoDOT Highway Safety and Traffic Division and its APL review process. The LED Sign Compliance Checklist can be used to verify if a manufacturer's LED sign is in compliance with the MUTCD and can be considered for the APL.

Light-emitting diode (LED) units may be used individually within the symbol, legend, or border of a sign to enhance the sign conspicuity and legibility (see EPG 903.1.11).

Except as provided in the sixth Standard paragraph below, LED units may either operate continuously or be actuated.

Standard. Where LED units are used to enhance the conspicuity of a sign, the sign shall otherwise comply with the requirements for retroreflection and illumination for nighttime viewing (see EPG 903.1.21).

Except as provided in the Option and Support paragraphs below, and for changeable message signs, neither individual LEDs nor groups of LEDs shall be placed within the background area of a sign.

The application of LEDs to display sign legends or symbols shall use a maximum pitch of 20 millimeters to cover the stroke width of the letter or symbol.

The LEDs shall not protrude outside the sign border or legend when used in such applications, shall have a maximum diameter of ¼ inch, and shall be the following colors based on the type of sign:

A. White or red, with STOP, YIELD, DO NOT ENTER, or WRONG WAY signs.
B. White, with other regulatory signs.
C. White or yellow, with warning signs.
D. White or green, with guide signs.
E. White, yellow, or orange, with temporary traffic control signs.
F. White or yellow, with pedestrian or bicycle warning signs.
G. White or fluorescent yellow-green, with school area signs.

If flashed, all LED units shall flash simultaneously at a steady rate between 50 and 60 times per minute. All the LED units in a sign legend or border shall be illuminated simultaneously with no sequential (chasing) or variable flash rates (dancing), except as otherwise allowed in the EPG. A cluster of LEDs shall not be used within the border of a sign.

Where used in STOP or YIELD signs, flashing LED units shall operate continuously. Actuation of the LED units shall not be allowed.

Flashing LED units shall not be used within the legend or border of a Speed Limit sign to indicate that the displayed speed limit is in effect.

LED units shall not be used within the legend or border of a sign in conjunction with the phrase WHEN FLASHING in its legend (see Item E in the first paragraph of EPG 902.18.3 for the use of Warning Beacons to indicate when a regulatory or warning message is in effect).

Where LED units are used along the edge of a sign, at least one LED unit shall be placed along each edge of the sign, in addition to one LED unit at each corner of the sign, so that the distinct outline of the sign shape is recognized under nighttime viewing conditions. The LED units along each side of the sign shall be spaced approximately equidistantly. For a circular sign shape, the number of LED units shall clearly form the appearance of a circle and not be perceived as some other shape.

The uniformity of the sign design shall be maintained without any decrease in visibility, legibility, or driver comprehension during either daytime or nighttime conditions. The LED units shall have the capability to be dimmed automatically by a timing mechanism or a device sensitive to ambient light (photoelectric cell) such that the LEDs do not reduce the visibility of the sign legend.

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Option. For STOP, YIELD, DO NOT ENTER, and WRONG WAY signs, LEDs may be placed within the border or within one border width within the background of the sign.

Support. EPG 616.4.2 contains information about STOP/SLOW paddles used by flaggers. EPG 908.4.1 contains information about STOP paddles used by adult crossing guards.

Other methods of enhancing the conspicuity of standard signs are described in EPG 903.1.11.

903.1.13 Standardization of Location (MUTCD Section 2A.13)

Support. Standardization of position cannot always be attained in practice. Examples of heights and lateral locations of signs for typical installations are illustrated in Figure 903.1.13.1, and examples of locations for some typical signs at intersections are illustrated in Figure 903.1.13.2 and EPG 616.16.

Examples of advance signing on intersection approaches are illustrated in EPG 616.16. EPG 903.2, 903.3, and 903.4 contain provisions regarding the application of regulatory, warning, and conventional guide signs, respectively.

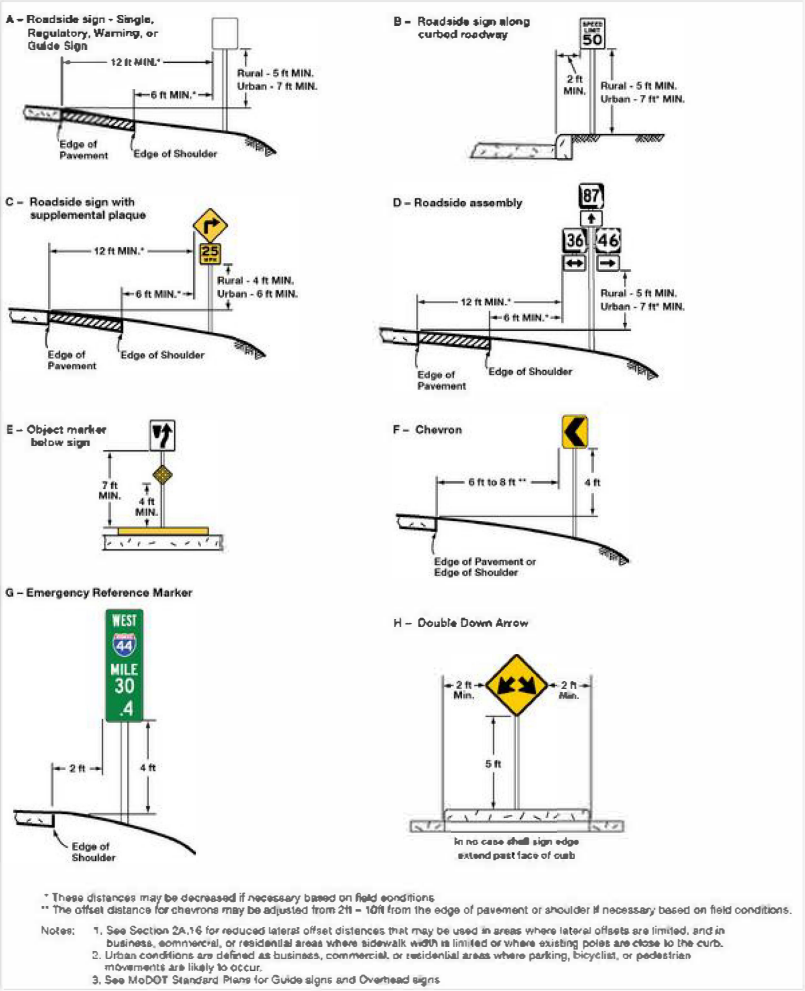
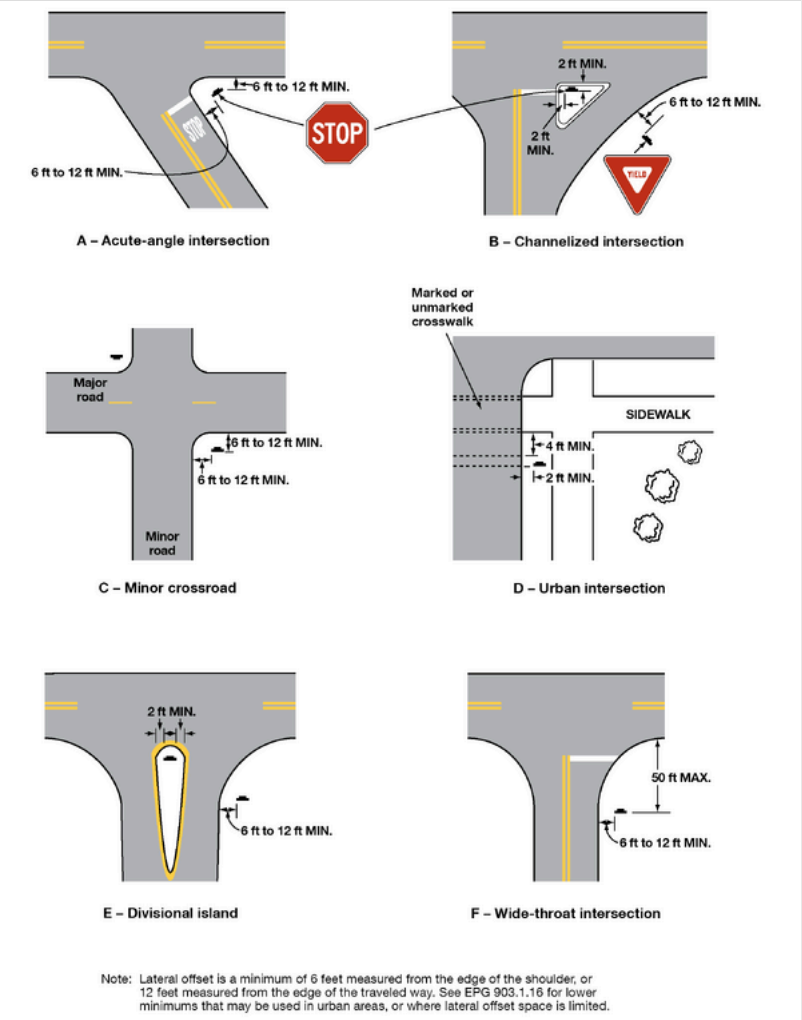


Figure 903.1.13.1 Examples of Locations for Some Typical Signs at Intersections



igure 903 1.1 Examples of Locations for Some Typical Signs at Intersections

Standard. Signs requiring separate decisions by the road user shall be spaced sufficiently far apart for the appropriate decisions to be made.

Guidance. One of the factors considered when determining the appropriate spacing of signs should be the posted or 85th percentile speed.

Mainline signs on freeways and expressways should be visible a minimum of 800 feet and signs on conventional roads should be visible a minimum of 200 feet (minimum sign spacing in EPG 903.4 and EPG 903.5. These distances should be considered when determining spacing between signs and when evaluating sign legibility during sign inspections. When these minimum sign spacing distances are not achievable, engineering judgement should be used to determine if the sign can be relocated to improve visibility, provide advance signing or determine if a reduced sign spacing distance is appropriate.

Except as provided in the third Guidance paragraph below, signs should be located on the right-hand side of the roadway where they are easily recognized and understood by road users. Signs in other locations should be considered only as supplementary to signs in the normal locations, except as otherwise provided in the EPG.

Signs should be individually installed on separate posts or mountings except where:

A. One sign supplements another;
B. Route or directional signs are grouped to clarify information to motorists;
C. Regulatory signs that do not conflict with each other are grouped, such as Turn Prohibition signs posted with ONE WAY signs or a parking regulation sign posted with a Speed Limit sign; or
D. Street Name signs are posted with a STOP or YIELD sign.

Signs should be located so that they:

A. When post mounted, are installed on a breakaway assembly, regardless of where they are located on right-of-way,
B. Optimize nighttime visibility,
C. Minimize the effects of mud splatter and debris,
D. Do not obscure each other,
E. Do not obscure the sight distance to approaching vehicles on the major street for drivers who are stopped on minor-street approaches, and
F. Are not hidden from view.

Except for STOP, YIELD, DO NOT ENTER, and WRONG WAY signs, or as otherwise provided in the EPG, where a sign on a one-way roadway indicates an action intended exclusively or primarily for a road user in the left-hand lane or at the left-hand side of that roadway, such as LEFT LANE MUST TURN LEFT (R3-7) or LEFT LANE ENDS (W9-1), the sign should be located on the left-hand side of the roadway. In the case of a divided road, the sign should be located in the median.

ption. Si ns located on the left-hand s de of a one-way roadway or in the median of a div ded road, in accordance w th the Gu dance para raph above, may be supplemented by an identical sign located on the right-hand side of the roadway.

Support. The clear zone (see definition in EPG 911 (MUTCD Section 1C.02)) is the total roadside border area, starting at the edge of the traveled way, available for an errant driver to stop or regain control of a vehicle. The width of the clear zone is dependent upon traffic volumes, speeds, and roadside geometry. Additional information can be found in the "Roadside Design Guide," 4th Edition, 2011, AASHTO. Based on the Roadside Design Guide, the clear zone only accounts for 80% of vehicles leaving the roadway, leaving 20% traveling outside the clear zone, this is the reason all MoDOT signs are required to be on breakaway sign supports.

Guidance. With the increase in traffic volumes and the need to provide road users regulatory, warning, and guidance information, an order of priority for sign installation should be established.

Support. An order of priority is especially critical where space is limited for sign installation and there is a demand for several different types of signs. Overloading road users with too much information is not desirable. Priority according to type of sign will depend on the specific situation and conditions of the site at which the signs are to be installed. For example, in the vicinity of an exit ramp, guide signs and warning signs for the exit ramp might take precedence over supplemental guide signs or a mainline Speed Limit sign where there is no change in the speed zone.

Guidance. Because regulatory and warning information is typically more critical to the road user than guidance information, regulatory and warning signing whose locations are critical should be displayed rather than guide signing in cases where conflicts occur. In such cases, the guide sign should be relocated to another appropriate location where it will still be effective. In other cases, such as at a decision point, the guide sign should take precedence over other signs whose locations are not as critical to an immediate decision or action necessary by the road user. In all cases, careful attention should be given to minimizing sign clutter (see EPG 903.1.20). Community wayfinding and acknowledgment guide signs should have a lower priority as to placement than other guide signs. Signs conveying information of a less-critical nature should be moved to less-critical locations or omitted.

Option. Under some circumstances, such as on curves to the right, signs may be placed on median islands or on the left-hand side of the road. A supplementary sign located on the left-hand side of the roadway may be used on a multi-lane road where traffic in a lane to the right might obstruct the view to the right.

Guidance. In urban areas where crosswalks exist, signs should not be placed within 4 feet in advance of the crosswalk (see Drawing D in Figure 903.1.13.2).

903.1.14 Overhead Sign Installation (MUTCD Section 2A.14)

Standard. Overhead sign installations shall be limited to MoDOT regulatory, warning, and guide sign installations, unless otherwise specified in the EPG. Supplemental signs or aesthetic messages shall not be displayed on overhead structures, which also apply to structures constructed and installed by another jurisdiction over a state route. Supplemental signs or aesthetic messages include, but are not limited to Welcome To signs, Welcome To monuments, and Community Wayfinding signs.

Guidance. Overhead signs should be used on freeways and expressways, at locations where some degree of lane-use control is desirable, and at locations where space is not available at the roadside. It is recommended that justification be provided when mounting signs overhead.

Support. The operational requirements of the present highway system are such that overhead signs have value at many locations. The factors to be considered for the installation of overhead sign displays are not definable in specific numerical terms. In some cases, overhead mounting of a sign might be required by other provisions of the EPG.

MoDOT has established the following general criteria for the use of overhead signs on the state highway system:

Standard. Overhead signs shall be used in the following applications:

A. EXIT ONLY lane drops,
B. Complex interchange design, including, but not limited to:
    1. Directional ramps, and
    2. Ramp splits
C. Three or more lanes in each direction in urban areas,
D. Closely-spaced interchanges,
E. Multi-lane exits,
F. Consistency of sign message location through a series of interchanges,
G. Junction of two freeways, and
H. Complex intersection guide signs, including, but not limited to:
    1. Multi-lane roundabouts,
    2. Diverging Diamond Interchanges, and
    3. Single Point Urban Interchanges.

Guidance. Overhead signs should be used in the following applications:

A. Reduction of basic lanes in a LANE ENDS application and
B. Left-side exit ramps.

Option. Overhead signs may be used in the following applications:

A. Insufficient space for post-mounted signs,
B. Restricted sight distance,
C. Traffic volume at or near capacity,
D. Large percentage of trucks,
E. In urban areas with ambient light issues which obscure the visibility of the ground mounted sign,
F. Locations where there is a history of crashes with a ground-mounted sign, and

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. High-sp d traffic.

Over-crossing structures may be used to support overhead signs.

Support. Under some circumstances, the use of over-crossing structures as sign supports might be the only practical solution that will provide adequate viewing distance. The use of such structures as sign supports might eliminate the need for the foundations and sign supports along the roadside.

903.1.15 Mounting Height (MUTCD Section 2A.15)

Standard. The provisions of this article shall apply unless specifically stated otherwise for a particular sign or object marker elsewhere in the EPG.

Support. Mounting heights in the EPG and in Standard Plan 903.03 (https://www.modot.org/media/16921) are nominal dimensions, meaning these dimensions represent the minimum mounting height, as well as the maximum mounting heights unless otherwise stated. The mounting height, measured from the roadway surface to the bottom of the sign, is only increased in order to meet the minimum distance requirements from the bottom of the sign to the ground directly below the sign. Minimum mounting heights ensure the installations meet breakaway standards as well as placing the signs at the appropriate level for visibility. Installing signs taller than these nominal dimensions will move the signs outside the driver's normal line of sight negatively affecting the signs legibility and visibility.

In addition to the provisions of this article, information affecting the minimum mounting height of signs as a function of crash performance can be found in the "Roadside Design Guide," 4th Edition, 2011, AASHTO.

Standard. In rural areas, the minimum height, measured vertically from the bottom of the sign to the elevation of the near edge of the pavement, of signs installed at the side of the road shall be 5 feet (see Figure 903.1.13.1).

In business, commercial, or residential areas where parking, bicyclist, or pedestrian movements are likely to occur, or where the view of the sign might be obstructed, the minimum height, measured vertically from the bottom of the sign to the top of the curb, or in the absence of curb, measured vertically from the bottom of the sign to the elevation of the near edge of the traveled way, of signs installed at the side of the road shall be 7 feet (see Figure 903.1.13.1).

Option. The height to the bottom of a secondary sign mounted below another sign may be 1 foot less than the height specified in the Standard paragraphs above.

Standard. The minimum height of signs, measured vertically from the bottom of the sign to the sidewalk shall be 7 feet.

If the bottom of a secondary sign that is mounted below another sign is mounted lower than 7 feet above a pedestrian sidewalk or pathway (see EPG 616.3.2), the secondary sign shall not project more than 4 inches into the pedestrian facility.

Support. EPG 914.1.2 contains provisions for the minimum mounting height of signs on shared-use paths.

Standard. All sign installations shall meet the installation, mounting height and lateral offset of MoDOT specifications for the type of signs support being used, see Standard Plan 903.03 (https://www.modot.org/media/16921).

Option. A route sign assembly (see Figures 903.4.25.1 through 903.4.25.3) consisting of a route sign and auxiliary signs may be treated as a single sign for the purposes of this article.

The mounting height may be adjusted when supports are located near the edge of the right-of-way on a steep backslope in order to avoid the sometimes less desirable alternative of placing the sign closer to the roadway.

Standard. Signs that are post-mounted on a median barrier shall not overhang any portion of the traveled way.

New overhead sign installations shall provide a vertical clearance of not less than 18 feet from the highest point of pavement or shoulder (including mountable curbs located within the shoulder limits) to the lowest point of the sign, light fixture, or sign bridge over the entire width of the pavement and shoulders, except where the structure on which the overhead signs are to be mounted or other structures along the roadway near the sign structure have a lesser vertical clearance. No overhead sign installations shall have a mounting height that is lower than 17 feet.

Option. If the vertical clearance of other structures along the roadway near the sign structure is less than 16 feet, the vertical clearance to an overhead sign structure or support may be as low as 1 foot higher than the vertical clearance of the other structures in order to improve the visibility of the overhead signs.

In special cases the clearance to overhead signs may be reduced if necessary because of substandard dimensions in tunnels and other major structures such as double-deck bridges.

Signs may be raised above the standard vertical clearance to improve visibility and avoid other obstructions such as signal equipment.

Guidance. While a maximum mounting height for signs is generally not prescribed in the EPG, the nominal mounting heights should be adhered to, ensuring that signs are not mounted at such a height as to be out of the road user's normal field of vision (see the second paragraph of this article and the third paragraph of EPG 911 (MUTCD Section 1D.09)), especially in urban settings where signs are mounted on traffic signal or light poles.

Support. Figure 903.1.13.1 illustrates some examples of the mounting height requirements contained in this article.

See EPG 903.17.4 for information regarding vertical clearances for overhead signs.

903.1.16 Lateral Offset (MUTCD Section 2A.16)

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tandard. Fo ov head sign supports, the minimum late al offset fr m the edge of th sh uld (or if no sh uld exists, f m the edge of th pa ment) to the near edge of overhead sign supports (cantilever or sign bridges) shall be 6 feet. Overhead sign supports shall have a barrier or crash cushion to shield them if they are within the right-of-way.

See EPG 903.17.3 for information regarding lateral offset of overhead sign supports.

Post-mounted sign and object marker supports shall be crashworthy (see EPG 911 (MUTCD Section 1D.11)) if within the right-of-way.

Guidance. For post-mounted signs, the minimum lateral offset should be 12 feet from the edge of the traveled way. If a shoulder wider than 6 feet exists, the minimum lateral offset for post-mounted signs should be 6 feet from the edge of the shoulder.

Supports for signs mounted laterally behind a longitudinal barrier should be placed so that the near edge of the support is located beyond the deflection distance of the longitudinal barrier and the edge of the sign does not extend beyond the face of the barrier towards traffic.

Support. The minimum lateral offset requirements for object markers are provided in EPG 903.3.

The minimum lateral offset is intended to keep trucks and cars that use the shoulders from striking the signs or supports. The minimum lateral offset requirements do not supersede the requirement for crashworthiness (see the second Standard paragraph of this article) if the sign is located within the right-of-way.

Guidance. All supports should be located as far as practical from the edge of the shoulder. Advantage should be taken to place signs behind existing roadside barriers, on over-crossing structures, or other locations that minimize the exposure of the traffic to sign supports.

Option. Lesser lateral offsets may be used on connecting roadways or ramps at interchanges, but not less than 6 feet from the edge of the traveled way.

On conventional roads in areas where it is impractical to locate a sign with the lateral offset prescribed by this article because of roadside features such as terrain or vegetation, a lateral offset of at least 2 feet may be used.

A lateral offset of at least 1 foot from the face of the curb may be used in business, commercial, or residential areas where sidewalk width is limited or where existing poles are close to the curb.

Guidance. Overhead sign supports and post-mounted sign and object marker supports should not obstruct the sidewalk or the pedestrian access route such that less than 4 feet of clear space is available.

Support. Guidance for maintaining sign shape in laterally-constrained conditions is described in EPG 903.1.5.

Figure 903.1.13.1 and 903.1.13.2 illustrate some examples of the lateral offset requirements contained in this article.

903.1.17 Orientation (MUTCD Section 2A.17)

Guidance. Unless otherwise provided in the EPG, signs should be vertically mounted at right angles to the direction of, and facing, the traffic that they are intended to serve.

Where mirror reflection from the sign face is encountered to such a degree as to reduce legibility, the sign should be turned slightly away from the road. On curved alignments, the angle of placement should be determined by the direction of approaching traffic rather than by the roadway edge at the point where the sign is located.

903.1.18 Posts and Mountings (MUTCD ection 2A.18)

Standard. Sign posts, foundations, and mountings shall be so constructed as to hold signs in a proper and permanent position, and to resist swaying in the wind or displacement by vandalism.

Support. See Standard Plan 903.03 (https://www.modot.org/media/16921) for additional information regarding posts and mounting. The Standard Plans are compliant with the latest edition of AASHTO's "Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals."

Option. Where permitted, signs may be placed on existing supports used for other purposes, such as highway traffic signal supports or overhead sign supports. This does not include utility poles or light poles.

Support. EPG 903.1.11 contains criteria for enhanced conspicuity of standard signs.

EPG 903.1.15 and 903.1.16 contain lateral and height placement criteria for signs placed on existing supports.

Standard. If mounted to the sign support, equipment for powering electronic components of a sign, including solar panels, the sign support shall be a traffic signal pedestal pole with a breakaway base so as to not to compromise the crashworthy performance of the sign installation (see EPG 911 (MUTCD Section 1D.11)). Such equipment shall be mounted so as not to obscure the shape of the sign. Any wiring installed in the breakaway base shall include appropriate breakaway fuse connectors.

903.1.19 Maintenance (MUTCD Section 2A.19)

Guidance. Maintenance activities should consider proper position, cleanliness, legibility, and daytime and nighttime visibility (see EPG 903.1.21 and 903.1.22). Damaged or deteriorated signs or object markers should be replaced.

o assure adequate main enance, a schedule for inspect g (at n ght), trimming vege ation, an replacing signs an object markers should be established. Employees of highway, law enforcement, and other public agencies whose duties require that they travel on the roadways should be encouraged to report any damaged, deteriorated, or obscured signs or object markers at the first opportunity. While MoDOT's sign maintenance program relies on nighttime inspections, random daytime inspections are encouraged to identify needs between scheduled nighttime inspections.

Steps should be taken to see that weeds, trees, shrubbery, and construction, maintenance, and utility materials and equipment do not obscure the face of any sign or object marker.

A regular schedule of replacement of lighting elements for illuminated signs should be maintained.

Support. See EPG 903.20.4 for additional information related to sign inspection.

903.1.20 Excessive Use of Signs (MUTCD Section 2A.20)

Guidance. Signs should be used and located judiciously, minimizing their proliferation in order to maintain their effectiveness. Regulatory and warning signs should be used conservatively because these signs, if used to excess, tend to lose their effectiveness. Route signs and directional guide signs for primary routes and destinations should be used frequently at strategic locations because their use promotes efficient operations by keeping road users informed of their location. In all cases, however, sign clutter (see the Support paragraph below) should be avoided and minimized as much as practicable.

Support. Sign clutter is the proliferation of sign installations or assemblies along the roadway or roadside, either separately or grouped, to such an extent that adequate spacing between installations necessary for orderly processing of the sign messages by the driver cannot be achieved. Sign clutter can reduce the effectiveness of one or more signs in a sequence of signs.

The basic role of traffic control devices is to provide only as much information to the road user as necessary to promote the safe and efficient operation of streets and highways. Sign clutter can result from the overuse of MUTCD-compliant signs and or signs that display information unrelated to traffic operation, navigation, or transportation information. Examples of such signs would include, but are not limited to, those displaying the birthplace or home of a noted person, local sports team accomplishments, population information, and self-described qualities of a community such as "friendly" or "open for business."

Guidance. Signs and other traffic control devices should be installed and maintained from a systematic standpoint rather than individually. When a new sign is installed, the existing signs in the vicinity should be considered for replacement, relocation, or removal as a result of the new sign that is installed. Existing systems of signs should be reviewed periodically for evidence of sign clutter and adjustments should be made accordingly.

Support. EPG 903.1.13 contains information regarding an order of priority for signs where available spacing along the roadway is limited.

903.1.21 Retroreflection and Illumination (MUTCD Section 2A.21)

Support. There are many materials currently available for retroreflection and various methods currently available for the illumination of signs and object markers. New materials and methods continue to emerge. New materials and methods can be used as long as the signs and object markers meet the standard requirements for color, both by day and by night.

This article applies to visibility of signs at night or in low-light or adverse weather conditions, whose legends are otherwise visible under typical daytime viewing conditions.

Standard. All traffic control signs on MoDOT right-of-way shall be retroreflective to show the same shape and similar color by both day and night, unless otherwise provided in the EPG for a particular sign or group of signs.

Where the color black is specified for the legend or background of a sign, an opaque and non-retroreflective material shall be used.

The requirements for sign illumination shall not be considered to be satisfied by street or highway lighting.

In special conditions when illuminated signs are permitted to be used per the EPG, sign symbols, word messages, and backgrounds shall be illuminated by a light behind the sign face through a translucent material.

Retroreflection of sign elements shall be accomplished by the means shown in Table 903.1.21.

Table 903.1.21, Retroreflection of Sign Elements

Means of Retroreflection	Sign Element
A material that has a smooth, sealed outer surface over a microstructure that reflects light	Symbol Word message Border Background
Note: Illuminated signs are not used by MoDOT. Cities and counties may use illuminated street name signs if a maintenance agreement is in place.	

Guidance. Overhead sign installations should not be illuminated unless an engineering study shows a need for illumination, e.g. fog prone areas.

Support. Information regarding the use of retroreflective material on the sign support is contained in EPG 903.1.11.

nformation regard ng oDOT she ting types is contained n EPG 903.16.3.

903.1.22 Maintaining Minim m Retroreflectivity (MUTCD Section 2A.22)

Support. Retroreflectivity is one of several factors associated with maintaining n ghttim sign v sib lity (se EPG 903.1.21).

Standard. MoDOT shall use an assessment or management method that is designed to maintain sign retroreflectivity at or above the minimum lev ls in Table 903.1.22. Local jurisdictions who maintain sections of state routes and the signs on those sections under maintenance agreements shall maintain those signs in accordance with one of the MUTCD assessment methods.

Table 903.1.22, Minimum Maintained Retroreflectivity Levels

Sign Color	Beaded Sheeting Type (ASTM D4956)			Prismatic Sheeting	Additional Criteria
	I	II	III		
White on Green	W*; G ≥ 7	W*; G ≥ 15	W*; G ≥ 25	W ≥ 250; G ≥ 25	Overhead
	W*; G ≥ 7	W ≥ 120; G ≥ 15			Post-mounted
White on Blue	W*; B ≥ 3	W*; B ≥ 5	W*; B ≥ 12	W ≥ 250; B ≥ 12	Overhead
	W*; B ≥ 3	W ≥ 120; B ≥ 7			Post-mounted
White on Brown	W*; Br ≥ 1	W*; Br ≥ 5	W*; Br ≥ 10	W ≥ 350; Br ≥ 10	Overhead
	W*; Br ≥ 1	W ≥ 150; B ≥ 5			Post-mounted
Black on Yellow or Black on Orange	Y*; O*	Y ≥ 50; O ≥ 50			[2]
	Y*; O*	Y ≥ 75; O ≥ 75			[3]
White on Red	W ≥ 35; R ≥ 7				[4]
Black on White	W ≥ 50				-

[1] The minimum maintained retroreflectivity levels shown in this table are in units of cd/lx/m^2 measured at an observation angle of 0.2° and an entrance angle of -4.0°.

[2] For word legend and fine symbol signs measuring at least 48 inches and for all sizes of bold symbol signs.

[3] For word legend and fine symbol signs measuring less than 48 inches.

[4] Minimum sign contrast ratio ≥ 3:1 (white retroreflectivity ÷ red retroreflectivity).

[*] This sheeting type shall not be used for this color for this application.

Bold Symbol Signs

- W1-1,2 - Turn and Curve
- W1-3,4 - Reverse Turn and Curve
- W1-5 - Winding Road
- W1-6,7 - Large Arrow
- W1-8 - Chevron
- W1-10 - Intersection in Curve
- W1-11 - Hairpin Curve
- W1-15 - 270 Degree Loop
- W2-1 - Cross Road
- W2-2,3 - Side Road
- W2-4,5 - T and Y Intersection
- W2-6 - Circular Intersection
- W2-7,8 - Double Side Roads
- W3-1 - Stop Ahead
- W3-2 - Yield Ahead
- W3-3 - Signal Ahead
- W4-1 - Merge
- W4-2 - Lane Ends
- W4-3 - Added Lane
- W4-5 - Entering Roadway Merge
- W4-6 - Entering Roadway Added Lane
- W6-1,2 - Divided Highway Begins and Ends
- W6-3 - Two-Way Traffic
- W10-1,2,3,4,11,12 - Grade Crossing Advance Warning
- W11-2 - Pedestrian Crossing
- W11-5 - Farm Equipment
- W11-7 - Equestrian Crossing
- W11-10 - Truck Crossing
- W12-1 - Double Arrow
- W16-5P,6P,7P - Pointing Arrow Plaques
- W20-7 - Flagger
- W21-1 - Worker

Fine Symbol Signs (symbol signs not listed as bold symbol signs)

Special Cases

- W3-1 - Stop Ahead: Red retroreflectivity ≥ 7
- W3-2 - Yield Ahead: Red retroreflectivity ≥ 7; White retroreflectivity ≥ 35
- W3-3 - Signal Ahead: Red retroreflectivity ≥ 7; Green retroreflectivity ≥ 35
- W3-5 - Speed Reduction: White retroreflectivity ≥ 50
- For non-diamond shaped signs, such as W14-3 (No Passing Zone), WP-4P (Cross Traffic Does Not Stop), or W13-1P,2,3,6,7 (Speed Advisory Signs), use the largest sign dimension to determine the proper minimum retroreflectivity level.

Note: All MoDOT signs shall be fabricated as retroreflective for durability and longevity

Support. Compliance with the Standard in the paragraph above is achieved by having a method in place and using the method to maintain the minimum levels established in Table 903.1.22. Provided that an assessment or management method is being used, MoDOT would be in compliance with the Standard in the paragraph above even if there are some individual signs that do not meet the minimum retroreflectivity levels at a particular point in time.

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oDOT ha a s n insp ction proce to maintain s n r troreflectivity at or above th minimum level . Se EPG 903.20.4 for additional information related to sign inspection.

903.1.23 Median Opening Treatments for Divided Highways (MUTCD Section 2A.23)

Guidance. A divided highway crossing should be signed and marked as separate intersections when both of the following conditions are present:

A. The paths of opposing left turns from the divided highway cross each other (see Figure 903.1.23), and
B. There is adequate storage in the interior approaches for the design vehicles expected to cross the divided highway.

If either one or both of the conditions in the Guidance paragraph above do not exist, the divided highway crossing should be signed and marked as a single intersection.

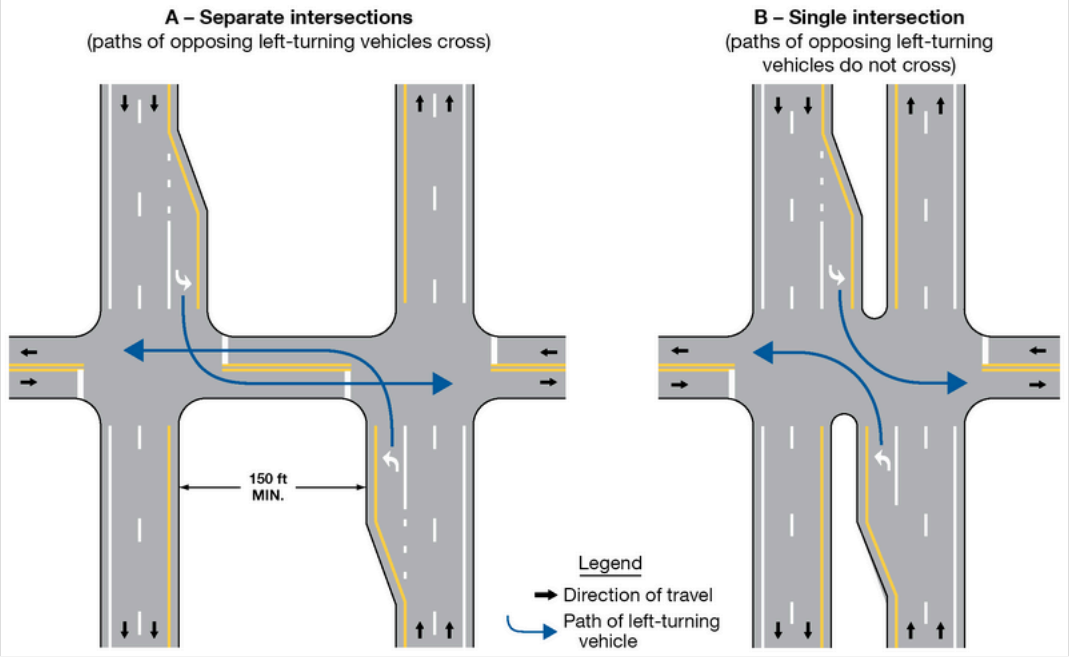


Figure 903.1.23 Intersection Configuration at a Divided Highway Crossing

At the crossing of two divided highways, engineering judgment should be used to determine the number of separate intersections.

Support. Divided highway crossings with median widths 150 feet or greater might function as two intersections depending upon the interaction of the opposing left-turn vehicle paths and the available interior storage in the median for a crossing vehicle. Other factors that could determine whether a divided highway crossing is operating as one or two intersections include:

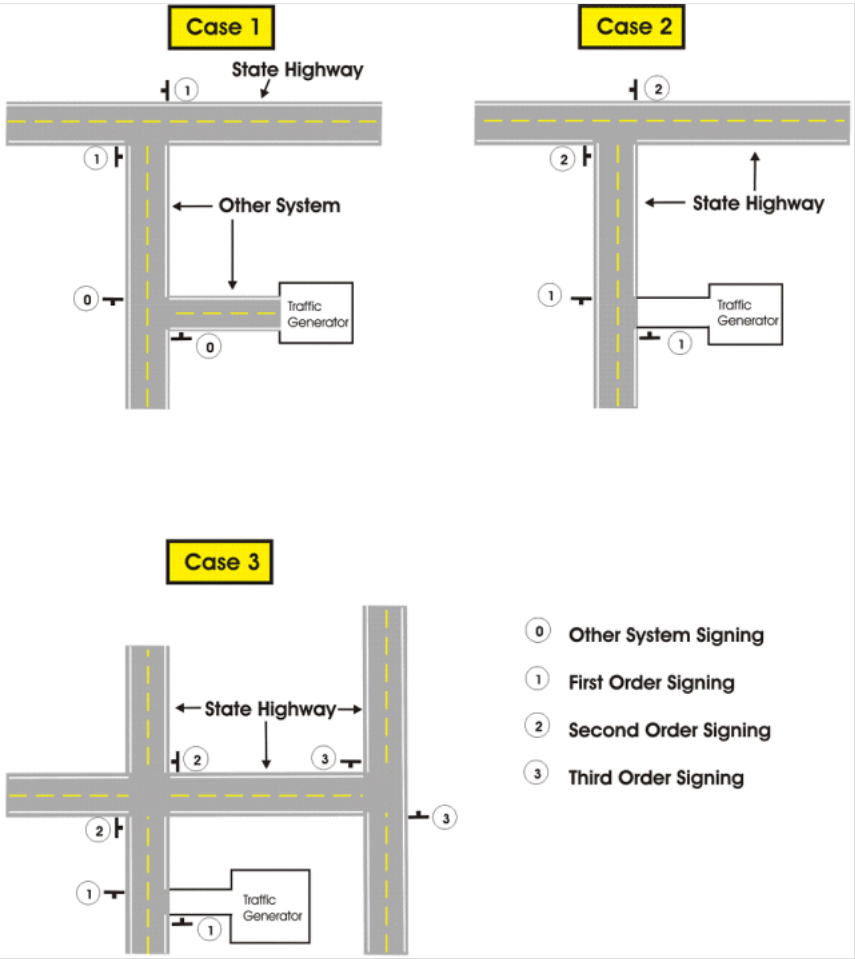
A. The geometric design of the divided highway crossing,
B. The use of positive offset mainline left-turn lanes,
C. The length of the median opening (as measured parallel to the center line of the divided highway),
D. The geometric design of the median noses,
E. Other roadway geometric considerations such as a skewed side street approach or a variable median width,
F. Intersection sight distance,
G. The physical characteristics of the design vehicle, and
H. The observed prevailing driver behavior with regard to opposing left-turn path interaction.

903.1.24 Priority Order of Signs

Standard. The order classification of signs shall be defined as follows (refer to Figure 903.1.24):

1. First Order Signing. Signs that are installed in advance of the closest intersection or interchange where motorists turn off of the state highway system to arrive at the desired traffic generator or site. First order signing will always be on state right-of-way.
2. Second Order Signing. Signs that are installed in advance of the intersection or interchange where motorists turn to access the highway where the first order signing is provided. Second order signing will always be on state right-of-way and shall require the use of first order signing on state right-of-way.
3. Third Order Signing. Signs that are installed in advance of the intersection or interchange where motorists turn to access the highway where the second order signing is provided. Third order signing will always be on state right-of-way and shall require the use of first order and second order signing on state right-of-way.

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igure 903 1.2 Sign Order Classification

Support. In general, as the “order” of signing increases, the functional classification of road stays the same or increases. For example, if first order signing is on a four-lane U.S. route, second order signing should be on another U.S. route, expressway, or a freeway. In this example case, second order signing should not be placed on a two-lane lettered route.

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903.2 Regulatory Signs and Barricades (MUTCD Chapter 2B)

903.2.1 Applica of Regulat Signs (MUTC Section 2B.01)

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903.2.20 Speed Limit Sign (R2-1) (MUTCD Section 2B.21)

903.2.21 Combined Maximum and Minimum Speed Limits Sign (R2-4a) (MUTCD Section 2B.24)

903.2.22 Speed Limit XX Except Where Posted Sign (R2-5d)

903.2.23 Higher Fines Signs and Plaque (MUTCD Section 2B.25)

903.2.24 Movement Prohibition Signs (R3-1 through R3-4, R3-18, and R3-27) (MUTCD Section 2B.26)

903.2.25 Intersection Lane Control Signs (R3-5 through R3-8) (MUTCD Section 2B.27)

Standard. Regulatory signs shall be used to inform road users of selected traffic laws or regulations and to indicate the

903.2.26 Mandatory Movement Lane Control Signs (R3-5, R3-5a, and R3-7) and Plaques (MUTCD Section 2B.28)

903.2.27 Optional Movement Lane Control Signs (R3-6 Series) (MUTCD Section 2B.29)

903.2.28 Advance Intersection Lane Control Signs (R3-8 Series) (MUTCD Section 2B.30)

903.2.29 Two-Way Left-Turn-Only Signs (R3-9a and R3-9b) and Plaques (MUTCD Section 2B.32)

903.2.30 Jughandle Signs (R3-23, R3-24, R3-25, and R3-26 Series) (MUTCD Section 2B.35)

903.2.31 DO NOT PASS Sign (R4-1) (MUTCD Section 2B.36)

903.2.32 PASS WITH CARE Sign (R4-2) (MUTCD Section 2B.37)

903.2.33 KEEP RIGHT EXCEPT TO PASS Sign (R4-16) and SLOWER TRAFFIC KEEP RIGHT Sign (R4-3) (MUTCD Section 2B.38)

903.2.34 Keep Right and Keep Left Signs (R4-7 Series and R4-8 Series) (MUTCD Section 2B.39)

903.2.35 DO NOT DRIVE ON SHOULDER Sign (R4-17) (MUTCD Section 2B.43)

903.2.36 Selective Exclusion Signs and Plaques (MUTCD Section 2B.45)

903.2.37 DO NOT ENTER Sign (R5-1) (MUTCD Section 2B.46)

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903.2.39 Wrong-Way Traffic Control at Interchange Ramps (MUTCD Section 2B.48)

903.2.40 ONE WAY Signs (R6-1 and R6-2) (MUTCD Section 2B.49)

903.2.41 Divided Highway Crossing Signs (R6-3 and R6-3a) (MUTCD Section 2B.50)

903.2.42 Parking, Standing, and Stopping Signs (R7 and R8 Series) (MUTCD Section 2B.52)

903.2.43 Design of Parking, Standing, and Stopping Signs (MUTCD Section 2B.53)

903.2.44 Placement of Parking, Standing, and Stopping Signs (MUTCD Section 2B.54)

903.2.45 Emergency Restriction Signs (R8-7) (MUTCD Section 2B.55)

903.2.46 Pedestrian Crossing Signs (R9-3) (MUTCD Section 2B.57)

903.2.47 Traffic Signal Pedestrian and Bicyclist Actuation Signs (R10-3b, R10-3d, R10-3e, R10-4, and R10-25) (MUTCD Section 2B.58)

903.2.48 Traffic Signal Signs and Plaques (R10-5 through R10-23a) (MUTCD Section 2B.59)

903.2.49 No Turn on Red Signs (R10-11 and R10-30a) (MUTCD Section 2B.60)

903.2.50 Ramp Metering Signs (R10-28 and R10-29) (MUTCD Section 2B.61)

903.2.51 KEEP OFF MEDIAN Sign (R11-1) (MUTCD Section 2B.62)

903.2.52 ROAD CLOSED Sign (R11-2) and LOCAL TRAFFIC ONLY Signs (R11-3 and R11-4) (MUTCD Section 2B.63)

903.2.53 Weight Limit Sign (R12-1) (MUTCD Section 2B.64)

903.2.54 Weigh Station Sign (R13 Series) (MUTCD Section 2B.65)

903.2.55 TRUCK ROUTE Sign (R14-1) (MUTCD Section 2B.66)

applicability of the legal

903.2.56 Photo Enforced Signs and Plaques (R10-18a and R10-19P) (MUTCD Section 2B.69)

903.2.57 STATE LAW MOVE OVER OR SLOW DOWN FOR STOPPED EMERGENCY VEHICLES Sign (R16-25) (MUTCD Section 2B.71)

903.2.58 Headlight Use Signs (R16-5a) (MUTCD Section 2B.73)

903.2.59 Seat Belt Symbol (MUTCD Section 2B.74)

903.2.60 Barricades (MUTCD Section 2B.75)

903.2.61 NO PARKING ALL TRAILERS AND TRUCKS OVER 6 TONS (R7-36)

903.2.62 STOP FOR SCHOOL BUS SIGN (R16-26)

903.2.63 Other Regulatory Signs

903.2.64 Engine Brake Muffler Required Signing

903.2.65 Regulatory Signs For Trash/Dumping (R5-26, R5-28)

903.2.66 Regulation Signs For Roadside Parks and Commuter Parking Lots (R20-1)

903.2.67 Rest Area Regulatory Signing (R20-2, R20-3, R20-4)

903.2.68 Access Management Signing (R21-1 through R21-5)

903.2.69 Trucks and Buses 300 Ft Interval Sign (R4-30)

903.2.70 FINES DOUBLED ENDS Sign (R2-20)

requirements.

Regulatory signs shall be installed at or near where the regulations apply. The signs shall clearly indicate the requirements imposed by the regulations and shall be designed and installed to provide adequate visibility and legibility in order to obtain compliance.

Regulatory signs shall be retroreflective or illuminated (see EPG 903.1.21).

903.2.2 Design of Regulatory Signs (MUTCD Section 2B.02)

Standard. Regulatory signs shall be rectangular unless specifically designated otherwise in the EPG. Regulatory signs shall be designed in accordance with the sizes, shapes, colors, and legends contained in the FHWA "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)).

Support. The use of educational plaques to supplement symbol signs is described in EPG 903.1.9.

The use of LEDs in the border or legend of regulatory signs is described in EPG 903.1.12.

Standard. LED signs displaying a part-time prohibitory message incorporating a red circle and diagonal of a static sign shall display a red symbol that approximates the same red circle and diagonal as closely as possible. The symbol of the action to be prohibited shall be displayed in white LEDs on a black background.

A regulatory sign displayed entirely with LEDs and incorporated within the border of a larger full-matrix changeable message sign shall display the regulatory sign legend in the size, shape, color, and legend of the standard regulatory sign.

903.2.3 Size of Regulatory Signs (MUTCD Section 2B.03)

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Standard. Except as provided in EPG 903.1.7, the minimum sizes for regulatory signs shall be as shown in Table 903.2.3.

Support. EPG 903.1.7 contains information regarding the applicability of the various columns in Table 903.2.3.

Guidance. The minimum sizes for regulatory signs facing traffic on exit and entrance ramps at interchanges should be as shown in the column of Table 903.2.3 that corresponds to the mainline roadway classification (Expressway/Freeway).

Standard. The minimum size for WRONG WAY and DO NOT ENTER signs on ramps facing the opposite direction of travel where a road user could wrongly enter the ramp from a conventional road shall be the size listed in the Conventional Road - Standard column of Table 903.2.3. See EPG 903.2.37 and 903.2.38 for additional information.

Option. The minimum size for WRONG WAY and DO NOT ENTER signs on ramps facing the opposite direction of travel where a road user could wrongly enter the ramp from a conventional road may be increased to the size in the Conventional Road – Oversized column of Table 903.2.3 when the need for greater emphasis has been determined based on engineering judgement.

Table 903.2.3, Regulatory Sign and Plaque Sizes

Sign or Plaque	Sign Designation	EPG Article	Conventional Road (in. x in.)			Freeway/Expressway (in. x in.)
			Standard	Oversized	Special	Mainline and Ramps
Stop	R1-1	903.2.4	36 X 36	48 X 48	-	48 X 48
Yield	R1-2	903.2.5	48 X 48 X 48	60 X 60 X 60	-	60 X 60 X 60
To Oncoming Traffic (plaque)	R1-2aP	903.2.5	36 X 30	-	-	-
All-Way (plaque)	R1-3P	903.2.4	30 X 12	-	-	-
Yield Here To Pedestrians	R1-5	903.2.18	36 X 36	-	-	-
Yield Here to Trail Crossing	R1-5d	903.2.18	36 X 42	-	-	-
In-Street Pedestrian Crossing - Yield	R1-6	903.2.19	12 X 36	-	-	-
In-Street Trail Crossing - Yield	R1-6d	903.2.19	12 X 36	-	-	-
Speed Limit	R2-1	903.2.20	36 X 48	48 X 60	-	48 X 60
Combined Speed Limit	R2-4a	903.2.21	-	-	-	48 X 96
Speed Limit _ Except Where Posted	R2-5d	903.2.22	36 X 48	-	-	36 X 48
Fines Doubled Ends	R2-20	903.2.71	36 X 30	-	-	36 X 30
No Right Turn	R3-1	903.2.24	36 X 36	48 X 48	24 X 24 - 30 X 30	48 X 48
No Left Turn	R3-2	903.2.24	36 X 36	48 X 48	24 X 24 - 30 X 30	48 X 48
No Turns	R3-3	903.2.24	36 X 36	48 X 48	24 X 24 - 30 X 30	36 X 36
No U Turn	R3-4	903.2.24	36 X 36	48 X 48	24 X 24 - 30 X 30	-
Right (Left/Ahead) Only	R3-5, 5a	903.2.26	30 X 36	-	-	-
Straight and Right (Left)	R3-6	903.2.27	30 X 36	-	-	-
Optional Movement U and Left Turn	R3-6a	903.2.27	30 X 36	-	-	-
Optional Movement Left Turns	R3-6b	903.2.27	30 X 36	-	-	-
Right (Left) Lane Must Turn Right (Left)	R3-7	903.2.26	36 X 36	-	-	-
Advance Intersection Lane Control	R3-8,8a,8b,8xa, 8xb,8xc	903.2.28	Varies X 30	-	-	-
Two-Way Left Turn Only (overhead)	R3-9a	903.2.29	30 X 36	-	-	-
Center Lane Two-Way Left Turn Only (post-mounted)	R3-9b	903.2.29	24 X 36	36 X 48	-	-
No U Turn/No Left Turn	R3-18	903.2.24	36 X 36	48 X 48	24 X 24 - 30 X 30	-
No Straight Through	R3-27	903.2.24	36 X 36	48 X 48	24 X 24 - 30 X 30	48 X 48
Do Not Pass	R4-1	903.2.31	36 X 48		36 X 48	-

Pass With Care	R4-2	903.2.32	36 X 48		48 X 60	-
Slower Traffic Keep Right	R4-3	903.2.33	36 X 48	48 X 60	48 X 60	48 X 60
Keep Right	R4-7	903.2.34	24 X 30	36 X 48	36 X 48	48 X 60
Keep Right (horizontal arrow)	R4-7a	903.2.34	36 X 48	48 X 60	48 X 60	48 X 60
Keep Right (45° arrow)	R4-7b	903.2.34	36 X 48	48 X 60	-	84 X 96
Narrow Keep Right	R4-7c	903.2.34	18 X 30	-	-	-
Keep Left	R4-8	903.2.34	24 X 30	36 X 48	-	48 X 60
Keep Left (horizontal arrow)	R4-8a	903.2.34	36 X 48	48 X 60	-	48 X 60
Keep Left (45° arrow)	R4-8b	903.2.34	36 X 48	48 X 60	-	84 X 96
Narrow Keep Left	R4-8c	903.2.34	18 X 30	-	-	-
Keep Right Except to Pass	R4-16	903.2.33	36 X 48	-	-	-
Do Not Drive on Shoulder	R4-17	903.2.35	36 X 48	-	-	-
Next Passing Lane _ Miles	R4-28	903.2.69	-	-	-	-
End Passing Lanes	R4-29	903.2.69	-	-	-	-
Do Not Enter	R5-1	903.2.37	36 X 36	48 X 48	-	48 X 48
Wrong Way	R5-1a	903.2.39	42 X 30	-	-	42 X 30
No Trucks	R5-2	903.2.36	36 X 36	-	-	
Except Local Deliveries (plaque)	R5-2aP	903.2.36	36 X 18	-	-	
Engine Brake Muffler Required	R5-23	-	30 X 30	-	-	30 X 30
No Fishing from Bridge	R5-25	903.2.36	18 X 24	-	-	18 X 24
No Dumping	R5-28	903.2.66	-	-	-	48 X 24
Authorized and Emergency Vehicles Only	R5-29	903.2.36	-	-	-	24 X 30
Do Not Stop on Tracks	R5-31	903.2.45	24 X 30	-	-	-
One Way	R6-1	903.2.40	36 X 12	48 X 18	-	48 X 18
One Way	R6-2	903.2.40	24 X 30	30 X 36	-	-
Divided Highway (4-legged)	R6-3	903.2.41	30 X 24	-	-	36 X 30
Divided Highway (T-intersection)	R6-3a	903.2.41	30 X 24	-	-	36 X 30
No Parking Signs	R7 series	903.2.43	18 X 24	-	-	-
Reserved Parking	R7-8	903.2.43	18 X 24	-	-	-
Van Accessible (plaque)	R7-8aP	903.2.43	18 X 9	-	-	-
No Parking on Bridge	R7-35	903.2.43	18 X 24	-	-	18 X 24
No Parking Trucks and Trailers Over 6 Tons	R7-36	903.2.62	18 X 24	36 X 48	-	-
Tow Away Zone (plaque)	R7-201P, R7-201ap	903.2.43	18 X 9	-		
This Side of Sign (plaque)	R7-202P	903.2.43	18 X 9	-	-	
Emergency Stopping Only	R8-7	903.2.45	48 X 36	-	-	48 X 36
No Pedestrian Crossing (symbol)	R9-3	903.2.46	18 X 24	-	-	-

No Pedestrian Crossing	R9-3a	903.2.46	18 X 24	-	-	-
Pedestrian Signal Series	R10-3 & R10-4 series	903.2.47	9 X 15	-	-	-
Left on Green Arrow Only	R10-5	903.2.48	24 X 30	30 X 36	-	30 X 36
Stop Here on Red	R10-6	903.2.48	24 X 36	-	-	-
Do Not Block Intersection	R10-7	903.2.48	24 X 30	-	-	-
Right Turn Signal	R10-10R	-	30 X 36	-	-	-
No Turn on Red	R10-11	903.2.49	30 X 36	-	-	-
Left Turn on Green (Ball)	R10-12	903.2.48	24 X 30	30 X 36	-	30 X 36
Left Turn Yield on Flashing Yellow Arrow	R10-12a	903.2.48	24 X 30	30 X 36	-	30 X 36
Emergency Signal	R10-13	903.2.48	36 X 24	-	-	-
Emergency Signal Stop on Flashing Red	R10-14	903.2.48	36 X 42	-	-	-
Emergency Signal - Stop on Flashing Red (overhead)	R10-14a	903.2.48	60 X 24	-	-	-
Stop Here on Red	R10-14b	903.2.48	24 X 36	-	-	-
Turning Vehicles Yield to Pedestrians	R10-15	903.2.48	30 X 30	-	-	-
Traffic Signal Photo Enforced	R10-18a	903.2.56	30 X 42	36 X 54	-	-
Photo Enforced (symbol plaque)	R10-19P	903.2.56	24 X 12	48 X 24	-	-
Crosswalk - Stop on Red	R10-23	903.2.48	24 X 30	-	-	-
Stop on Red - Yield on Flashing Red After Stop	R10-23a	903.2.48	24 X 30	-	-	-
Push Button for Warning Lights - Wait for Gap in Traffic	R10-25	903.2.47	9 X 12	-	-	-
XX Vehicles per Green	R10-28	903.2.50	24 X 30	-	-	-
XX Vehicles per Green Each Lane	R10-29	903.2.50	36 X 24	-	-	-
Right Turn on Red Must Yield to U-Turn	R10-30	903.2.49	30 X 36	-	-	-
Right Turn Must Yield To U-Turn	R10-30a	903.2.49	36 X 24	-	-	-
Keep Off Median	R11-1	903.2.51	48 X 60	48 X 60	-	-
Road Closed	R11-2	903.2.52	48 X 30			-
Road Closed _ Miles Ahead Local Traffic Only	R11-3	903.2.52	60 X 30			-
Road Closed to Thru Traffic	R11-4	903.2.52	60 X 30			-
Weight Limit XX Tons	R12-1	903.2.53	36 X 48			36 X 48
Weigh Station Signs	R13 series	903.2.54	Varies			Varies
Truck Route	R14-1	903.2.55	24 X 18			-
State Law Move Over or Slow Down for Stopped Emergency Vehicles	R16-25	903.2.57	120 X 60			120 X 60

Primary Seatbelt City/Country	R16-27B	-	30 X 36			-
State Law Buckle Up / Phone Down	R16-30	903.2.59	48 X 30			-
State Law Buckle Up / Phone Down	R16-30a	903.2.59	-			72 X 48
Roadside Park Signs	R20-1	903.2.66	30 X 30			-
Rest Area Regulations	R20-2	903.2.67	30 X 36			-
Commuter Parking Regulations	R20-3	903.2.67	42 X 48			-
Rest Area Signs	R20 Series	903.2.67				Varies

903.2.4 STOP Sign (R1-1) and ALL-WAY Plaque (R1-3P) (MUTCD Section 2B.04)



R1-1



R1-3P

Standard. When it is determined that a full stop is always required on an approach to an intersection, a STOP (R1-1) sign shall be used.

Secondary legends shall not be used on STOP sign faces.

The STOP sign shall not be displayed using a changeable message sign.

At intersections where all approaches are controlled by STOP signs (see EPG 903.2.11), an ALL-WAY (R1-3P) supplemental plaque shall be mounted below each STOP sign. The ALL-WAY plaque shall have a white legend and border on a red background.

Supplemental plaques with legends such as 2-WAY, 3-WAY, 4-WAY, or other numbers of ways shall not be used with STOP signs.

Support. The use of the CROSS TRAFFIC DOES NOT STOP (W4-4P Series) and other plaques with variations of this legend is described in EPG 903.3.65.

Guidance. The TRAFFIC FROM LEFT (RIGHT) DOES NOT STOP (W4-4aP) plaque or ONCOMING TRAFFIC DOES NOT STOP (W4-4bP) plaque should be used at intersections where STOP signs control all but one approach to the intersection, unless the only non-stopped approach is from a one-way street.

Support. The design and application of Stop Beacons are described in EPG 902.18.5.

903.2.5 YIELD Sign (R1-2) (MUTCD Section 2B.05)



R1-2



R1-2aP

Support. The YIELD sign requires road users to yield the right-of-way to other traffic on certain approaches to an intersection or on a two-way approach to a one-way section of roadway, such as a narrow bridge or underpass. Vehicles controlled by a YIELD sign need to slow down to a speed that is reasonable for the existing conditions or stop when necessary to avoid interfering with conflicting traffic.

Standard. The YIELD (R1-2) sign shall not be displayed using a changeable message sign.

903.2.6 General Considerations (MUTCD Section 2B.06)

Support. Unsignalized intersections represent the most common form of intersection right-of-way control. Selection of control type might be impacted by specific requirements of State law or local ordinances.

Roundabouts and traffic circles are circular intersection designs and are not traffic control devices. The decision to convert an intersection from a conventional intersection to a circular intersection is an engineering design decision and not a traffic control device decision. As such, criteria for conversion from a conventional intersection to a circular intersection are not included in EPG 903.

Guidance. The type of traffic control used at an unsignalized intersection should be the least restrictive that provides appropriate levels of safety and efficiency for all road users.

Support. Some types of right-of-way control that can exist at an unsignalized intersection in order from the least restrictive to the most restrictive are the following:

A. Yield control (see EPG 903.2.9): YIELD signs are placed on all approaches (for a circular intersection), or in the median of a divided highway. The YIELD signs are placed on the minor road.

B. Minor road stop control (see EPG 903.2.10): STOP signs are typically placed on opposing approaches (for a four-leg intersection) or on a single approach (for a three-leg intersection). The STOP signs are normally placed on the minor road. EPG 903.2.7 contains guidance on selecting the minor road.

C. All-way stop control (see EPG 903.2.11): STOP signs are placed on all approaches to the intersection.

Guidance. When selecting a form of intersection control, the following factors should be considered:

A. Motor vehicle, bicycle, and pedestrian traffic volumes on all approaches**;** where the term units/day or units/hour is indicated, it should be the total of motor vehicle, bicycle, and pedestrian volume;
B. Driver yielding behavior with regard to all modes of conflicting traffic, including bicyclists and pedestrians;
C. Number and angle of approaches;
D. Approach speeds;
E. Sight distance available on each approach;
F. Reported crash experience; and
G. The presence of a grade crossing near the intersection.

Standard. YIELD or STOP signs shall not be used for speed control.

Access to the state highway system from city streets, county roads or other significant private road approaches shall be controlled by installation of MoDOT STOP signs. Significant private roads are those that service 3 or more private residences.

Option. Stop signs, based on engineering judgment and a traffic study justifying the need, may be installed for a private road approach servicing fewer than 3 private residences, or a commercial entrance.

Standard. Because the potential for conflicting commands could create driver confusion, YIELD or STOP signs shall not be used in conjunction with any traffic control signal operation, except in the following cases:

A. If the signal indication for an approach is a flashing red at all times;
B. If a minor street or driveway is located within or adjacent to the area controlled by the traffic control signal, but does not require separate traffic signal control because an extremely low potential for conflict exists; or
C. If a channelized turn lane is separated from the adjacent travel lanes by an island and the channelized turn lane is not controlled by a traffic control signal.

STOP signs and YIELD signs shall not be installed on different approaches to the same unsignalized intersection if those approaches conflict with or oppose each other, except as provided for in Items A and B in the first paragraph of EPG 903.2.9.

Portable or part-time STOP or YIELD signs shall not be used except for emergency and temporary traffic control zone purposes.

A portable or part-time (folding) STOP sign that is manually placed into view and manually removed from view shall not be used during a power outage to control a signalized approach unless the maintaining agency establishes that the signal indication that will first be displayed to that approach upon restoration of power is a flashing red signal indication and that the portable STOP sign will be manually removed from view prior to resuming stop-and-go operation of the traffic control signal.

Option. When a STOP sign or YIELD sign is knocked down and it is not possible to repair the assembly immediately, a temporary sign of the same likeness (STOP sign for STOP and YIELD sign for YIELD) may be installed on a portable sign support at the location until the permanent assembly can be repaired. See EPG 948 for additional information regarding Incident Response Planning.

Support. The use of STOP signs at grade crossings is described in EPG 913.2.4 and EPG 913.2.5.

EPG 914.2.1 contains provisions regarding the assignment of priority where a shared-use path crosses a roadway.

903.2.7 Determining the Minor Road for Unsignalized Intersections (MUTCD Section 2B.07)

Guidance. The selection of the minor road to be controlled by STOP signs should be based on one or more of the following criteria:

A. A roadway intersecting a highway,
B. A roadway with the lower functional classification,
C. A roadway with the lower traffic volume,
D. A roadway with the lower speed limit, and/or
E. A roadway that intersects with a roadway that has a higher priority for one or more modes of travel.

When two roadways that have relatively equal volumes, speeds, and/or other characteristics intersect, the following factors should be considered in selecting the minor road for installation of STOP signs:

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A. Controlling the direction that conflicts the most with established pedestrian crossing activity or school walking routes;
B. Controlling the direction that has obscured vision, dips, or bumps that already require drivers to use lower operating speeds;
C. Controlling the direction that has the best sight distance from a controlled position to observe conflicting traffic; and
D. Stopping the direction that has the longest distance of uninterrupted flow approaching the intersection.

903.2.8 Right-of-Way Intersection Control Considerations (MUTCD Section 2B.08)

Guidance. Before converting to a more restrictive form of right-of-way control at an unsignalized intersection, the following alternative treatments to address safety, operational, or other concerns should be among those to be considered:

A. Where stop controlled, installing Stop Ahead signs on the appropriate approaches to the intersection;
B. Removing parking on one or more approaches;
C. Removing sight distance obstructions;
D. Installing signs along the major street to warn road users approaching the intersection;
E. Relocating the stop line(s) and making other changes to improve the sight distance at the intersection;
F. Installing measures designed to reduce speeds on the approaches;
G. Installing an Intersection Control Beacon (see EPG 902.18.2) or Stop Beacon (see EPG 902.18.5) at the intersection to supplement STOP sign control;
H. Installing a Warning Beacon (see EPG 902.18.3) on warning signs in advance of a stop-controlled intersection on major-street and/or minor-street approaches;
I. Adding one or more lanes on a minor-street approach to reduce the number of vehicles per lane on the approach;
J. Revising the geometrics at the intersection to channelize vehicular movements and reduce the time required for a vehicle to complete a movement, which could also assist pedestrians;
K. Revising the geometrics at the intersection to add pedestrian median refuge islands and/or curb extensions;
L. Installing roadway lighting if a disproportionate number of crashes occur at night;
M. Restricting one or more turning movements on a full-time or part-time basis if alternate routes are available;
N. Installing on the major street a pedestrian-actuated device: Warning Beacon (see EPG 902.18.3), rectangular rapid-flashing beacon (see EPG 902.12.1), or In-Roadway Warning Lights (see EPG 902.20), if pedestrian safety is the major concern;
O. If the warrant is satisfied, installing all-way stop control;
P. Installing a pedestrian hybrid beacon (see EPG 902.10) on the major street to address pedestrian safety;
Q. Installing a circular intersection; and
R. Employing other alternatives, depending on conditions at the intersection.

903.2.9 Yield Control (MUTCD Section 2B.10)

Guidance. YIELD signs should be installed at an intersection when any of the following conditions apply:

A. At the second intersection of a divided highway crossing or median break functioning as two separate intersections (see Figure 903.2.41.2). In this case, a YIELD sign should be installed at the entrance to the second intersection.
B. For a channelized turn lane that is separated from the adjacent travel lanes by an island, even if the adjacent lanes at the intersection are controlled by a highway traffic control signal or by a STOP sign.
C. At an intersection where a special problem exists and where engineering judgment indicates the problem to be susceptible to correction by the use of the YIELD sign.

D. On an approach to an intersection where the only permissible movement is a right-turn movement with an intersection geometry similar to a channelized right-turn lane or an approach to a roundabout.

Support. YIELD signs are generally not to be installed at entrance ramps on MoDOT freeways or expressways where an acceleration lane is provided. The intention is for drivers to accelerate to improve merging traffic operation. YIELD signs may cause drivers to decelerate, thus negatively impacting merging traffic operation. For cloverleaf interchanges, the loop entrance ramps can result in low speeds on ramps and short weave sections. Therefore, YIELD signs are installed at cloverleaf interchanges.

Standard. YIELD signs shall be used at a cloverleaf interchange where the in-loop traffic merges with the acceleration and deceleration traffic movement.

Option. YIELD signs may be installed facing the entering roadway for a merge-type movement if engineering judgment indicates that control is needed because acceleration geometry and/or sight distance is not adequate for merging traffic operation. The design criteria contained in Section 10.9.6.5 of the "AASHTO Green Book – A Policy on Geometric Design Of Highways and Streets," 7th Edition, 2018, AASHTO should be used to evaluate acceleration lane geometry. (See Figure 903.15.23).

Standard. A YIELD sign shall be used to require road users to yield the right-of-way to other traffic at the entrance to a roundabout. YIELD signs at roundabouts shall be used to control the approach roadways and shall not be used to control the circulatory roadway.

YIELD signs shall not be placed on all of the approaches to an intersection, except at roundabouts.

903.2.10 Minor Road Stop Control (MUTCD Section 2B.11)

Standard. All city street and county road access to the state highway system shall be controlled by a stop sign except as described in EPG 903.2.9 and EPG 902.

903.2.11 All-Way Stop Control (MUTCD Section 2B.12)

Support. The provisions in the following sections describe warrants for the recommended engineering study to determine all-way stop control. Warrants are not a substitute for engineering judgment. The fact that a warrant for a particular traffic control device is met is not conclusive justification to install or not install all-way stop control. Because each intersection will have unique characteristics that affect its operational performance or safety, it is the engineering study for a given intersection that is ultimately the basis for a decision to install or not install all-way stop control.

All-way stop controls at intersections with substantially differing approach volumes can reduce the effectiveness of these devices for all roadway users.

Guidance. The decision to establish all-way stop control at an unsignalized intersection should be based on an engineering study. The engineering study for all-way stop control should include an analysis of factors related to the existing operation and safety at the intersection, the potential to improve these conditions, and the applicable factors contained in the following all-way stop control warrants:

A. All-Way Stop Control Warrant A: Crash Experience (see EPG 903.2.12)
B. All-Way Stop Control Warrant B: Sight Distance (see EPG 903.2.13)
C. All-Way Stop Control Warrant C: Transition to Signal Control or Transition to Yield Control at a Circular Intersection (see EPG 903.2.14)
D. All-Way Stop Control Warrant D: 8-Hour Volume (Vehicles, Pedestrians, Bicycles) (see EPG 903.2.15)
E. All-Way Stop Control Warrant E: Other Factors (see EPG 903.2.16)

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Standard. The satisfaction of an all-way stop control warrant or warrants shall not in itself require the installation of all-way stop control at an unsignalized intersection.

903.2.12 All-Way Stop Control Warrant A: Crash Experience (MUTCD Section 2B.13)

Option. All-way stop control may be installed at an intersection where an engineering study indicates that:

> A. For a four-leg intersection, there are five or more reported crashes in a 12-month period or six or more reported crashes in a 36-month period that were of a type susceptible to correction by the installation of all-way stop control.
> B. For a three-leg intersection, there are four or more reported crashes in a 12-month period or five or more reported crashes in a 36-month period that were of a type susceptible to correction by the installation of all-way stop control.

903.2.13 All-Way Stop Control Warrant B: Sight Distance (MUTCD Section 2B.14)

Option. All-way stop control may be installed at an intersection where an engineering study indicates that sight distance on the minor-road approaches controlled by a STOP sign is not adequate for a vehicle to turn onto or cross the major (uncontrolled) road.

Support. At such a location, a road user, after stopping, cannot see conflicting traffic and is not able to negotiate the intersection unless conflicting cross traffic is also required to stop.

903.2.14 All-Way Stop Control Warrant C: Transition to Signal Control or Transition to Yield Control at a Circular Intersection (MUTCD Section 2B.15)

Option. All-way stop control may be installed at locations where all-way stop control is an interim measure that can be installed to control traffic while arrangements are being made for the installation of a traffic control signal (see EPG 902.3) at the intersection or for the installation of yield control at a circular intersection.

903.2.15 All-Way Stop Control Warrant D: 8-Hour Volume (Vehicles, Pedestrians, Bicycles) (MUTCD Section 2B.16)

Option. All-way stop control may be installed at an intersection where an engineering study indicates:

> A. The combined motor vehicle, bicycle, and pedestrian volume entering the intersection from the major-street approaches is at least 300 units per hour for each of any 8 hours of a typical day; and
> B. The combined motor vehicle, bicycle, and pedestrian volume entering the intersection from the minor-street approaches is at least 200 units per hour for each of any of the same 8 hours.

If the 85th-percentile approach speed of the major-street traffic exceeds 40 mph, the minimum vehicular volume warrants may be reduced to 70 percent of the values given in Items A and B in the preceding paragraph.

903.2.16 All-Way Stop Control Warrant E: Other Factors (MUTCD Section 2B.17)

Option. All-way stop control may be installed at an intersection where an engineering study indicates that all-way stop control is needed due to other factors not addressed in the other all-way stop control warrants. Such other factors may include, but are not limited to, the following:

A. The need to control left-turn conflicts,
B. An intersection of two residential neighborhood collector (through) streets of similar design and operating characteristics where all-way stop control would improve traffic operational characteristics of the intersection, or
C. Where pedestrian and/or bicyclist movements support the installation of all-way stop control.

903.2.17 STOP Sign or YIELD Sign Placement (MUTCD Section 2B.18)

Standard. The STOP or YIELD sign shall be installed on the near side of the intersection on the right-hand side of the approach to which it applies. When the STOP or YIELD sign is installed at this required location and the sign visibility is restricted, a Stop Ahead sign (see EPG 903.2.29) shall be installed in advance of the STOP sign or a Yield Ahead sign (see EPG 903.2.29) shall be installed in advance of the YIELD sign.

The STOP or YIELD sign shall be located as close as practicable to the intersection it regulates, while optimizing its visibility to the road user it is intended to regulate.

STOP signs and YIELD signs shall not be mounted on the same post.

Support. EPG 903.1.5 contains information about mounting signs back-to-back with a STOP or YIELD sign.

Guidance. STOP or YIELD signs should not be placed farther than 50 feet from the edge of the pavement of the intersected roadway (see Drawing F in Figure 903.1.13).

Supplemental plaques used in conjunction with a STOP or YIELD sign should be limited to those specified for such use in the EPG.

Standard. Where drivers proceeding straight ahead must yield to traffic approaching from the opposite direction, such as at a one-lane bridge, a TO ONCOMING TRAFFIC (R1-2aP) plaque shall be mounted below the YIELD sign. See Figure 903.2.53.2 and Figure 903.2.53.3 in EPG 903.2.53.

Support. Figure 903.1.13 shows examples of some typical placements of STOP signs and YIELD signs.

EPG 903.1.13 contains additional information about separate and combined mounting of other signs with STOP or YIELD signs.

Guidance. Stop lines that are used to supplement a STOP sign should be located as described in EPG 620.2.18. Yield lines that are used to supplement a YIELD sign should be located as described in EPG 620.2.18.

Where there is a marked crosswalk at the intersection, the STOP sign should be installed in advance of the edge of the crosswalk that is nearest to the approaching traffic.

Except at roundabouts and channelized right-turn lanes, where there is a marked crosswalk at the intersection, the YIELD sign should be installed in advance of the edge of the crosswalk that is nearest to the approaching traffic.

Where two roads intersect at an acute angle, the STOP or YIELD sign should be positioned at an angle, or shielded, so that the legend is out of view of traffic to which it does not apply.

At a roundabout intersection, to prevent circulating vehicles from yielding unnecessarily, the face of the YIELD sign is not to be visible from the circulatory roadway.

If a raised splitter island is available on the left-hand side of a multi-lane roundabout approach, an additional YIELD sign should be placed on the left-hand side of the approach.

Option. If a raised splitter island is available on the left-hand side of a single-lane roundabout approach, an additional YIELD sign may be placed on the left-hand side of the approach.

At wide-throat intersections or where two or more approach lanes of traffic exist on the signed approach, an additional STOP or YIELD sign may be installed on the left-hand side of the road and/or a stop or yield line may be used to improve observance of the right-of-way control. At channelized intersections or at divided roadways separated by a median or divisional island (painted or physical), the additional STOP or YIELD sign may be placed on a channelizing island, or in the median or on the divisional island.

Standard. More than one STOP sign or more than one YIELD sign shall not be placed on the same support facing in the same direction.

903.2.18 Yield Here To Pedestrians Signs (R1-5 Series) (MUTCD Section 2B.19)



R1-5



R1-5d

Support. The R1-5 series signs are intended to mitigate the scenario that can place pedestrians at risk by blocking other drivers' view of pedestrians and by blocking the pedestrians' view of the vehicles approaching in the adjacent lanes.

Standard. Yield Here to Pedestrians (R1-5, R1-5a, R1-5c, and R1-5d) signs shall be used if yield lines are used in advance of a marked crosswalk only where it crosses an uncontrolled multi-lane approach. The legend STATE LAW shall not be displayed on the R1-5 series signs.

Guidance. If yield lines and Yield Here to Pedestrians signs are used in advance of a crosswalk that crosses an uncontrolled multi-lane approach, the signs should be placed 20 to 50 feet in advance of the nearest edge of the crosswalk (see EPG 620.2.18 and Figure 620.2.18).

Standard. When used with a School Crossing assembly within school zones (see EPG 908), the R1-5a sign shall be used in place of the R1-5 sign in accordance with the second paragraph of this article.

When used with a Trail Crossing assembly (see EPG 903.3.44), the R1-5d sign shall be used in place of the R1-5 sign in accordance with the second paragraph of this article.

Guidance. When Yield Here to Pedestrians signs are provided in advance of a crosswalk across an multi-lane approach, parking should be prohibited in the area between the yield line and the crosswalk.

Yield lines and Yield Here to Pedestrians signs should not be used in advance of crosswalks that cross an approach to or departure from a roundabout.

Option. A Pedestrian Crossing (W11-2) warning sign may be placed overhead or may be post-mounted with a diagonal downward-pointing arrow (W16-7P) plaque at the crosswalk location where Yield Here to Pedestrians signs have been installed in advance of the crosswalk.

Standard. If a W11-2 sign is post-mounted at the crosswalk location where a Yield Here to Pedestrians sign is used on the approach, the Yield Here to Pedestrians sign shall not be placed on the same post as the W11-2 sign.

Option. An advance Pedestrian Crossing (W11-2) warning sign with an AHEAD or a distance supplemental plaque may be used in conjunction with a Yield Here to Pedestrians sign on the approach to the same crosswalk.

In-Street Pedestrian Crossing signs and Yield Here to Pedestrians signs may be used together at the same crosswalk.

903.2.19 In-Street Pedestrian and Trail Crossing Signs (R1-6 Series) (MUTCD Section 2B.20)



R1-6



R1-6d

Note: The legend STATE LAW is optional

Option. The In-Street Pedestrian Crossing (R1-6) sign, In-Street Trail Crossing (R1-6d) sign, may be used to remind road users of laws regarding right-of-way at an unsignalized crosswalk. The legend STATE LAW may be displayed at the top of the R1-6 series signs if applicable. On the R1-6 series signs, the legend YIELD may be used instead of the appropriate YIELD sign symbol.

MoDOT may develop and apply criteria for determining the applicability of In-Street Pedestrian Crossing signs.

Standard. If used, In-Street Pedestrian or Trail Crossing signs shall only be placed in the roadway at the crosswalk location on a raised island.

The In-Street Pedestrian or Trail Crossing sign shall not be post-mounted on the left-hand or right-hand side of the roadway.

Support. EPG 620.8.2 contains information about the use of tubular markers to provide additional emphasis for a pedestrian crossing.

Standard. When used at an uncontrolled crossing, the In-Street Pedestrian Crossing sign shall be used only as a supplement to a Pedestrian Crossing (W11-2) warning sign with a diagonal downward-pointing arrow (W16-7P) plaque at the crosswalk location.

When used at an uncontrolled crossing, the In-Street Trail Crossing sign shall be used only as a supplement to a Trail Crossing (W11-15) warning sign with a diagonal downward-pointing arrow (W16-7P) plaque at the crosswalk location.

An In-Street or Trail Crossing sign shall not be placed in advance of the crosswalk to educate road users about the State law prior to reaching the crosswalk, nor shall it be installed as an educational display that is not near any crosswalk.

Option. In-Street Pedestrian or Trail Crossing signs may be mounted back-to-back on a raised island in the median of an undivided roadway.

Standard. The In-Street Pedestrian or Trail Crossing sign shall not be used at crosswalks on approaches controlled by a traffic control signal, pedestrian hybrid beacon, or an emergency-vehicle hybrid beacon.

Option. The In-Street Pedestrian or Trail Crossing sign may be used at intersections or midblock pedestrian crossings with flashing beacons.

Support. The provisions of EPG 903.1.15 concerning mounting height are not applicable for the In-Street Pedestrian Crossing sign. EPG 903.1.18 contains information about sign mounting methods.

Standard. The top of an In-Street Pedestrian or Trail Crossing sign placed in an island shall be a maximum of 4 feet above the island surface.

Option. The In-Street Pedestrian Crossing or Trail Crossing signs may be used seasonally to prevent damage in winter because of plowing operations, and may be removed at night if the pedestrian activity at night is minimal.

903.2.20 Speed Limit Sign (R2-1) (MUTCD Section 2B.21)



R2-1

Support. In general, the maximum speed limits applicable to roads are established:

A. Statutorily – a maximum speed limit applicable to a particular class of road, such as freeways or city streets, that is established by State law; or
B. As speed zones – based on engineering studies.

State statutory limits restrict the maximum speed limit that can be established on a particular road, notwithstanding what an engineering study might indicate. Maximum speed limits in Missouri are governed by the Missouri Revised Statutes, Section 304.010.

MoDOT can establish non-statutory speed limits or designate reduced speed zones using an engineering study. Setting appropriate speed limits is especially important to ensure safety for all road users in varying types of contexts, particularly on roadways where adjacent land use suggests that trips could be served by varied modes. These situations include urban and suburban non-freeway arterials or rural arterials that serve as main streets in smaller communities, consistent with the context classifications of urban core, urban, suburban, and rural towns found in "A Policy on Geometric Design of Highways and Streets," 2018 Edition, AASHTO. When setting a speed limit, a range of factors such as land-use context, pedestrian and bicyclist activity, crash history, intersection spacing, driveway density, roadway geometry, roadside conditions, roadway functional classification, traffic volume, and observed speeds can influence the speed limit determined in the engineering study. The engineering study will determine which of the recommended factors will prevail in setting the speed limit.

MoDOT can use speed limit setting tools and methods such as expert systems and those consistent with the safe system approach as part of the required engineering study for a non-statutory speed limit. As speed limit setting tools vary, practitioners needs to be aware of their limitations and advantages, possible variation between the tools and the need to explore gaps or weaknesses of tools, and weigh the output accordingly in consideration of setting speed limits.

To achieve desired operating speeds, agencies often implement other speed management strategies concurrently with setting speed limits, such as traffic calming measures, geometric design features, and increased enforcement. See EPG 905.2.14 for more information regarding speed limit guidelines.

Standard. Speed zones (other than statutory speed limits) shall only be established on the basis of an engineering study that has been performed in accordance with traffic engineering practices. The engineering study shall consider the roadway context.

Guidance. Among the factors that should be considered when conducting an engineering study for establishing or reevaluating speed limits within speed zones are the following:

A. Roadway environment (such as roadside development, number and frequency of driveways and access points, and land use), functional classification, public transit volume and location or frequency of stops, parking practices, and pedestrian and bicycle facilities and activity;
B. Roadway characteristics (such as lane widths, shoulder condition, grade, alignment, median type, and sight distance);
C. Geographic context (such as an urban district, rural town center, non-urbanized rural area, or suburban area), and multi-modal trip generation;
D. Reported crash experience for at least a 12-month period;
E. Speed distribution of free-flowing vehicles including the pace, median (50th-percentile), and 85th-percentile speeds; and
F. A review of past speed studies to identify any trends in operating speeds.

When the 85th-percentile speed is appreciably greater than the posted speed limit, and the roadway context does not support setting a higher speed limit, the engineering study should consider whether changes to geometric features, enforcement, and/or other speed-reduction countermeasures might improve compliance with the posted speed limit. A similar approach should be used if the results of past speed studies indicate that the 85th-percentile speed has consistently increased.

On urban and suburban arterials, and on rural arterials that serve as main streets through developed areas of communities, the 85th-percentile speed should not be used to set speed limits without consideration of all factors described in the first Guidance paragraph of this article.

On a freeway, expressway, or rural highway (outside urbanized locations or conditions), the speed limit that is posted within a speed zone should be within 5 mph of the 85th-percentile speed of free-flowing motor-vehicle traffic under the following conditions:

A. All factors described in the first Guidance paragraph of this article have been considered and determined to be non-mitigating, and
B. The measures described in the second Guidance paragraph of this article have been considered to the extent practicable.

See EPG 905.2.14 for additional information regarding setting speed limits

MoDOT should conduct engineering studies to reevaluate non-statutory speed limits on segments of their roadways that have undergone significant changes since the last review (such as changes to roadway context, the addition or elimination of parking or driveways, changes in the number of travel lanes, changes in the configuration of bicycle lanes, changes to road geometrics, changes in traffic control signal coordination, or significant changes in traffic volumes).

Speed studies for signalized intersection approaches should be taken outside the influence area of the traffic control signal, which is generally considered to be approximately ½ mile, to avoid obtaining skewed results for the speed distribution. If the signal spacing is less than 1 mile, the speed study should be at approximately the middle of the segment.

Standard. The Speed Limit (R2-1) sign shall display the limit established by law, ordinance, regulation, or as adopted by the authorized agency based on an engineering study. The speed limits displayed shall be in multiples of 5 mph.

Speed Limit (R2-1) signs, indicating speed limits for which posting is required by law, shall be located at the points of change from one speed limit to another.

At the downstream end of the section to which a particular speed limit applies, a Speed Limit sign showing the next speed limit shall be installed.

Speed Limit signs indicating the statutory speed limits shall be installed at entrances to Missouri and at city limits, where appropriate.

Guidance. Additional Speed Limit signs should be installed beyond interchanges and major intersections and at other locations where it is necessary to remind road users of the speed limit that is applicable.

Speed Limit signs should not be located at curves or other locations where the legal speed limit is greater than the safe operating speed. If Speed Limit signs are installed on the same sign supports and above a City Limit sign, the sign supports should be sized to properly support both signs.

The following are recommended locations for posting a Speed Limit sign:

A. Downstream from all acceleration ramps on the freeway/expressway system, posted after the route confirmation marker, if space allows;
B. Downstream from major intersections such as state system junctions, signalized intersections, and major county road junctions;
C. Where it is necessary to remind road users of the speed limit that is applicable;
D. In each direction of travel for road users leaving the Interstate system onto a state route. The sign should be located, if practical, approximately 400 ft. beyond the route confirmation assembly. If the crossroad is not located on the state system, the proper jurisdiction should be notified; or
E. When the speed limit is reduced on the freeway/expressway, an additional sign should be posted in the median.

Support. The “Traffic Control Devices Handbook – 2nd Edition, 2013, ITE.” contains suggested criteria on the spacing of speed limit signs.

EPG 903.3.32 contains information about the use of speed zone signs to inform road users of a reduced or variable speed zone to provide advance notice to comply with the posted speed limit ahead.

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Option. If a W3-5b sign is posted to provide notice of a variable speed zone, an END VARIABLE SPEED LIMIT (R2-13) sign may be installed at the downstream end of the zone to provide notice to road users of the termination of the speed zone.

Advance traffic control warning signs (see EPG 903.2.29), intersection warning signs (see EPG 903.3.33), and/or other traffic control devices are appropriate warning prior to a signalized intersection. A Speed Limit sign should not be used for this purpose.

Guidance. An advisory speed plaque (see EPG 903.3.59) mounted below a warning sign should be used to warn road users of an advisory speed for a roadway condition. A Speed Limit sign should not be used for this purpose.

Option. A variable speed limit sign that changes the speed limit for traffic and ambient conditions may be installed provided that the appropriate speed limit is displayed at the proper times and locations in accordance with the third and fourth Guidance paragraphs of this article.

Standard. The variable speed limit sign legend "SPEED LIMIT" shall be a black legend on a white retroreflective background. The variable speed limit legend shall be displayed in white LEDs on an opaque black background.

Support. EPG 903.3.13 contains information about the use of a Vehicle Speed Feedback plaque mounted below a Speed Limit sign that displays to approaching drivers the speed at which they are traveling.

Advisory speed signs and plaques are discussed in EPG 903.3.12 and 903.3.59. Temporary traffic control zone speed signs are discussed in EPG 616. The WORK ZONE (G20-5aP) plaque intended for installation above a Speed Limit sign is discussed in EPG 616.7.7. School Speed Limit signs are discussed in EPG 908.2.5.

903.2.21 Combined Maximum and Minimum Speed Limits Sign (R2-4a) (MUTCD Section 2B.24)



R2-4a

Standard. Combined Maximum and Minimum Speed Limits (R2-4a) signs shall be installed only on interstate routes in lieu of Speed Limit (R2-1) signs to designate the maximum and minimum speed limits that apply.

Guidance. The Combined Maximum and Minimum Speed Limits sign should be located in the same manner as Speed Limit signs (See EPG 903.2.9). Additionally, the R2-4a sign should be installed on interstate routes at entrances to Missouri and where interstate routes cross county lines.

903.2.22 Speed Limit XX Except Where Posted Sign (R2-5d)



R2-5d

Standard. The SPEED LIMIT XX EXCEPT WHERE POSTED (R2-5d) sign shall be installed only at locations where it has been requested and is required by an enabling ordinance.

Guidance. The SPEED LIMIT XX EXCEPT WHERE POSTED sign should be placed immediately to the right of the City Limit sign on its own post.

Option. The SPEED LIMIT XX EXCEPT WHERE POSTED sign may be used on all state highways and outer roads except the Interstate system.

903.2.23 Higher Fines Signs and Plaque (MUTCD Section 2B.25)

Support. See EPG 907.3 for information on Travel Safe Zones.

903.2.24 Movement Prohibition Signs (R3-1 through R3-4, R3-18, and R3-27) (MUTCD Section 2B.26)


R3-1


R3-2



R3-3


R3-4


R3-18


R3-27

Standard. Movement Prohibition signs shall be installed where specific movements are prohibited at an intersection approach except as provided in the second Option and fourth Standard paragraphs of this article.

Support. Missouri Statute 304.341, which governs U-turn Movements at signalized intersections, states: It shall be unlawful for the driver of any vehicle to turn such vehicle so as to proceed in the opposite direction at any intersection controlled by a traffic signal or police officer; nor shall such turn be made at any place unless the

movement can be made in safety and without interfering with other traffic.

Missouri Statute 304.120 allows municipalities, by ordinance, to make additional rules of the road or traffic regulations to meet their needs and traffic conditions, which would allow U-turn Movements to be permitted at certain unsignalized intersections.

Guidance. Movement Prohibition signs should only be used to prohibit a turn or through movement from an entire approach and should not be used to designate movements that are required or permitted from a specific lane or lanes on a multi-lane approach.

Movement Prohibition signs should be placed where they will be most easily seen by road users who might be intending to make the movement.

If a No Right Turn (R3-1) sign is used, at least one should be placed either over the roadway or at a right-hand corner of the intersection.

If a No Left Turn (R3-2) sign is used, at least one should be placed over the roadway, at the far left corner of the intersection, on a median, or in conjunction with the STOP sign or YIELD sign located on the near right corner.

Except as provided in Item C of the third Standard paragraph of this article for signalized locations, if a NO TURNS (R3-3) sign is used, two signs should be used, one at a location specified for a No Right Turn sign and one at a location specified for a No Left Turn sign.

If a No U-Turn (R3-4) sign or a combination No U or Left Turn (R3-18) sign is used, at least one should be used at a location specified for a No Left Turn sign.

The No U-Turn sign (R3-4) should be used sparingly and only where a specific problem has been documented and not as standard practice for median breaks. If used, these signs should be placed at or between intersections to indicate where U-turns are prohibited.

If both left turns and U-turns are prohibited, the combination No U or Left Turn (R3-18) sign should be used instead of separate R3-2 and R3-4 signs.

Standard. The No U-Turn sign shall be installed above the AUTHORIZED AND EMERGENCY VEHICLES ONLY (R5-29) sign (See EPG 903.2.36).

Support. EPG 903.2.25 through EPG 903.2.28 contain information regarding lane control signs that indicate the required or permitted movements from individual lanes.

Guidance. If a No Straight Through (R3-27) sign is used, at least one should be placed either over the roadway or at a location where it can be seen by road users who might be intending to travel straight through the intersection.

If turn prohibition signs are installed in conjunction with traffic control signals:

A. The No Right Turn sign should be installed adjacent to a signal face viewed by road users in the right-hand lane.
B. The No Left Turn (or No U-Turn or combination No U or Left Turn) sign should be installed adjacent to a signal face viewed by road users in the left-hand lane.
C. A NO TURNS sign should be placed adjacent to a signal face viewed by all road users on that approach, or two signs should be used.

Option. If turn prohibition signs are installed in conjunction with traffic control signals, an additional turn prohibition sign may be post-mounted to supplement the sign mounted overhead.

Where ONE WAY signs are used (see EPG 903.2.40), No Left Turn and No Right Turn signs may be omitted.

Where the movement restriction applies to certain vehicle classes, signs incorporating a supplementary legend, modified as appropriate, may be used to indicate the specific vehicle class restriction or exception. When the movement restriction applies during certain time periods only, the following Movement Prohibition signing alternatives may be used and are listed in order of preference:

A. A blank-out or changeable message sign (see Chapter 2L) that displays the prohibited movement only during the time that the movement prohibition is applicable, especially at signalized intersections.
B. Permanently-mounted signs incorporating a supplementary legend showing the hours and days during which the prohibition is applicable. Contact the Highway Safety and Traffic Division for the design of supplementary legends and plaques.
C. Portable signs, installed by proper authority, located off the roadway at each corner of the intersection. The portable signs are only to be used during the time that the movement prohibition is applicable.

Standard. The blank-out part-time electronic-display Movement Prohibition sign shall consist of a red circle and diagonal with a white prohibited movement on an opaque black background.

Option. Movement Prohibition signs may be omitted at a ramp entrance to an expressway or a channelized intersection where the design is such as to indicate clearly the one-way traffic movement on the ramp or turning lane.

Standard. The No Left Turn (R3-2) sign, the No U-Turn (R3-4) sign, and the combination No U or Left Turn (R3-18) sign shall not be used at approaches to roundabouts to prohibit drivers from turning left onto the circulatory roadway of a roundabout.

Support. At roundabouts, the use of R3-2, R3-4, or R3-18 signs to prohibit left turns onto the circulatory roadway might confuse drivers about the possible legal turning movements around the roundabout. ONE WAY (R6-1 or R6-2) signs are appropriate to indicate the travel direction within a roundabout.

903.2.25 Intersection Lane Control Signs (R3-5 through R3-8) (MUTCD Section 2B.27)

Standard. Intersection Lane Control signs, if used, shall require road users in certain lanes to turn, shall permit turns from a lane where such turns would otherwise not be permitted, shall require a road user to stay in the same lane and proceed straight through an intersection, or shall indicate permitted movements from a lane.

Intersection Lane Control signs shall not be used in lieu of turn prohibition signs, such as No Right-Turn (R3-1).

Support. Intersection Lane Control signs have three applications:

A. Mandatory Movement Lane Control (R3-5 series and R3-7 series) signs,
B. Optional Movement Lane Control (R3-6 series) signs, and
C. Advance Intersection Lane Control (R3-8 series) signs.

Guidance. When Intersection Lane Control signs are mounted overhead, each sign used should be placed over the lane or a projection of the lane to which it applies.

On signalized approaches where through lanes that become mandatory turn lanes, multiple-lane turns that include shared lanes for through and turning movements, ramps with two or more lanes or other lane-use regulations are present that would be unexpected by unfamiliar road users, overhead Intersection Lane Control

signs should be installed approximately 250 ft. in advance of the stop bar over the appropriate lanes. A one-arm cantilever tubular truss to support these signs should be used to eliminate an obstacle on one side of the roadway.

Option. A signal mast arm design (without signal head) may be used to mount Intersection Lane Control signs, which allows a longer arm than standard one or two arm tubular sign supports. The upright post may be placed on either side of the roadway, and if possible, placed so that roadway geometrics draw traffic away from the post and footing.

Guidance. The Left Only (R3-5L) sign should be installed on the back side of the mast arms over the left turn lanes where practical.

Where overhead mounting on the approach is impracticable for the Advance and/or Intersection Lane Control signs, one of the following alternatives should be employed:

A. At locations where through lanes become mandatory turn lanes, a Mandatory Movement Lane Control (R3-7) sign should be post-mounted on the left-hand side of the roadway where a through lane is becoming a mandatory left-turn lane on a one-way street or where a median of sufficient width for the signs is available, or on the right-hand side of the roadway where a through lane is becoming a mandatory right-turn lane.
B. At locations where a through lane is becoming a mandatory left-turn lane on a two-way street where a median of sufficient width for the signs is not available, and at locations where multiple-lane turns that include shared lanes for through and turning movements are present, an Advance Intersection Lane Control (R3-8 series) sign should be post-mounted in a prominent location in advance of the intersection, and consideration should be given to the use of an oversized version in accordance with Table 903.2.3.

Use of an overhead sign for one approach lane should not require installation of overhead signs for the other lanes of that approach.

Option. Intersection Lane Control signs may be omitted where:

A. A turn bay has been provided by physical construction or pavement markings, and
B. Only the road users using such turn bays are permitted to make a turn in that direction.

Standard. Except as provided in the last paragraph of this article, at roundabouts, Intersection Lane Control (R3-5, R3-6, and R3-8 series) signs shall display curved-stem arrow symbols as shown in Figure 903.2.25.

Option. Normal-stem arrow symbol options may be displayed on Intersection Lane Control (R3-5, R3-6, and R3-8 series) signs at roundabouts where they more effectively indicate road geometry based on engineering judgment.

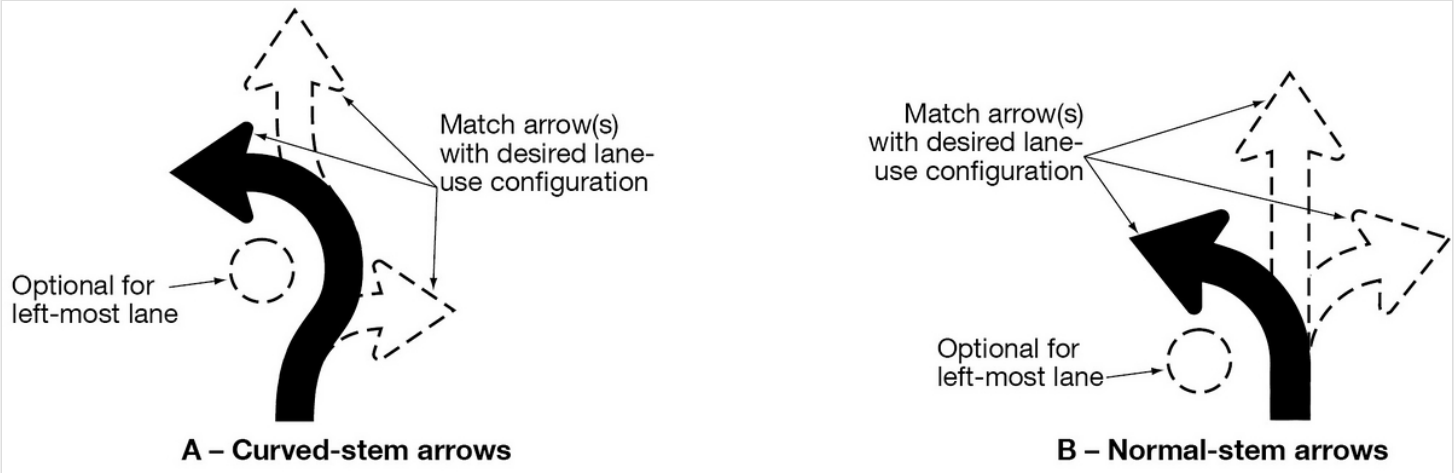


Figure 903.2.25 Intersection Lane Control Signal Arrow Options for Roundabouts

903.2.26 Mandatory Movement Lane Control Signs (R3-5, R3-5a, and R3-7) and Plaques (MUTCD Section 2B.28)



R3-5



R3-5a



R3-7L



R3-7R

Standard. Mandatory Movement Lane Control (R3-5, R3-5a, and R3-7) signs, if used, shall indicate only the single vehicle movement that is required from the lane.

The Mandatory Movement Lane Control (R3-5 and R3-5a) symbol signs shall include the legend ONLY and shall be mounted overhead over the specific lanes to which they apply (see EPG 903.2.25). The R3-7 sign shall be for post-mounting only. The R3-7 sign shall not be mounted at the far side of the intersection.

If used, the Mandatory Movement Lane Control (R3-7) sign shall be located in advance of the intersection, such as near the upstream end of the mandatory movement lane, and/or at the near side of the intersection where the regulation applies.

The use of the Mandatory Movement Lane Control (R3-7) word message sign shall be limited to only locations where through lanes approaching an intersection become mandatory turn lanes.

Mandatory Movement Lane Control Signs shall not be used on roadways with speed limits 50 mph or greater. Contact Highway Safety and Traffic Division for alternatives when speed limits are 50 mph or greater.

Guidance. Mandatory Movement Lane Control signs should be accompanied by lane-use arrow markings, especially where traffic volumes are high, where there is a high percentage of commercial vehicles, or where other distractions exist.

Option. The Through Only (R3-5a) sign may be used to require a road user in a particular lane to proceed straight through an intersection.

On an approach to a mandatory turn lane where traffic regularly enters the shoulder to access the turn lane inappropriately, creating safety or operational issues, a DO NOT DRIVE ON SHOULDER (R4-17) sign (see EPG 903.2.35) may be used to supplement the standard Mandatory Movement Lane Control (R3-5 and/or R3-7 series) signs.

903.2.27 Optional Movement Lane Control Signs (R3-6 Series) (MUTCD Section 2B.29)



R3-6



R3-6a



R3-6b

Standard. Optional Movement Lane Control (R3-6, R3-6a and R3-6b) signs, if used, shall be used for two or more movements from a specific lane or to emphasize permitted movements. The Optional Movement Lane Control sign shall be mounted overhead over the specific lane to which it applies.

If used, the Optional Movement Lane Control signs shall indicate all permissible movements from specific lanes.

Because more than one movement is permitted from the lane, the word message ONLY shall not be used on an Optional Movement Lane Control sign.

Optional Movement Lane Control signs shall be used for two or more movements from a specific lane where a movement, not allowed by State statute or local ordinance, is permitted.

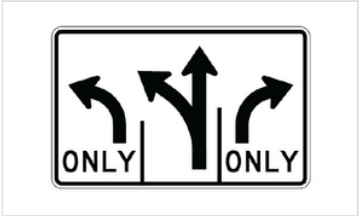
The Optional Movement Lane Control signs shall not be used alone to effect a turn prohibition.

Guidance. If used, the Optional Movement Lane Control sign should be located overhead in advance of the intersection, such as near the upstream end of an adjacent mandatory movement lane, and/or overhead at the intersection where the regulation applies.

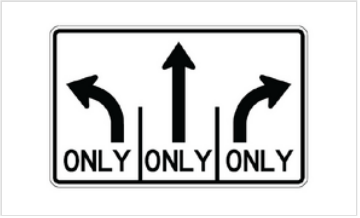
903.2.28 Advance Intersection Lane Control Signs (R3-8 Series) (MUTCD Section 2B.30)



R3-8



R3-8a



R3-8b



R3-8xa



R3-8xb



R3-8xc

Option. Advance Intersection Lane Control (R3-8, R3-8a, and R3-8b) signs may be used to indicate the configuration of all lanes ahead.

The word message ONLY or the bicycle symbol, may be used within the border in combination with the arrow symbols of the R3-8 sign series.

Where a bicycle lane is between two general-purpose lanes the R3-8 series signs may be modified to show the bicycle lane with a white legend on a black background in accordance with designs of the R3-8x series signs (see EPG 914.2.2).

Guidance. When used, an Advance Intersection Lane Control sign should be placed at an adequate distance in advance of the intersection, either along the lane tapers or at the beginning of the turn lane so that road users can select the appropriate lane.

Option. An Advance Intersection Lane Control sign may be repeated closer to the intersection along the approach for additional emphasis.

Standard. An Advance Intersection Lane Control (R3-8 series) sign shall not be mounted at the far side of an intersection to which it applies.

Where three or more approach lanes are available to traffic, Advance Intersection Lane Control (R3-8 series) signs, if used, shall be post-mounted in advance of the intersection and shall not be mounted overhead.

903.2.29 Two-Way Left-Turn-Only Signs (R3-9a and R3-9b) and Plaques (MUTCD Section 2B.32)



R3-9a



R3-9b

Support. Missouri Statute 300.215, which governs two-way left turn lane movements states:

Designated two-way left turn lanes: Where a special lane for making left turns by drivers proceeding in opposite directions have been indicated by official traffic control devices:

A. A left turn shall not be made from any other lane;

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B. A vehicle shall not be driven in the lane except when preparing for or making a left turn from or into the roadway or when preparing for or making a U-turn when otherwise permitted by law;

C. A vehicle shall not be driven in the lane for a distance more than five hundred feet.

Standard. Two-Way Left Turn Only (R3-9a) signs shall be used for overhead installation only. Center Lane Only (R3-9b) signs shall be post mounted installations.

Guidance. A Two-Way Left-Turn-Only (R3-9a or R3-9b) sign should be used in conjunction with the required pavement markings where a non-reversible lane is reserved for the exclusive use of left-turning vehicles in either direction and is not used for passing, overtaking, or through travel.

Option. The post-mounted R3-9b sign may be used as an alternate to or a supplement to the overhead R3-9a sign

Additional R3-9b signs may be installed after major intersections, or in situations that require additional emphasis of the proper use of this lane.

Support. Signing is especially helpful to drivers in areas where the two-way left-turn-only maneuver is new, in areas subject to environmental conditions that frequently obscure the pavement markings, and on peripheral streets with two-way left-turn-only lanes leading to an extensive system of routes with two-way left-turn-only lanes.

903.2.30 Jughandle Signs (R3-23, R3-24, R3-25, and R3-26 Series) (MUTCD Section 2B.35)

Guidance. There are limited cases where these signs are applicable to the MoDOT system. Any use of these signs requires authorization from the Highway Safety and Traffic Division.

903.2.31 DO NOT PASS Sign (R4-1) (MUTCD Section 2B.36)



R4-1

Option. The DO NOT PASS (R4-1) sign may be used in addition to pavement markings (see EPG 620.2.3) to emphasize the restriction on passing. The DO NOT PASS sign may be used at one-lane bridges and work zones. Any other use of this sign requires authorization from the Highway Safety and Traffic Division.

Support. Standards for determining the location and extent of no-passing zone pavement markings are set forth in EPG 620.2.3.

Standard. PASS WITH CARE (R4-2) signs shall be used in conjunction with the DO NOT PASS sign.

903.2.32 PASS WITH CARE Sign (R4-2) (MUTCD Section 2B.37)



R4-2

Guidance. The PASS WITH CARE (R4-2) sign should be installed at the downstream end of a no-passing zone if a DO NOT PASS sign has been installed at the upstream end of the zone.

Standard. The PASS WITH CARE sign shall be the same size and shall be erected in the same manner as the DO NOT PASS (R4-1) sign.

903.2.33 KEEP RIGHT EXCEPT TO PASS Sign (R4-16) and SLOWER TRAFFIC KEEP RIGHT Sign (R4-3) (MUTCD Section 2B.38)



R4-3



R4-16

Option. The KEEP RIGHT EXCEPT TO PASS (R4-16) sign may be used on roadways where there are two lanes in one direction of travel to direct drivers to stay in the right-hand lane except when they are passing another vehicle.

Guidance. If used, the KEEP RIGHT EXCEPT TO PASS sign should be installed at or just beyond the beginning of a two-lane section of roadway and at selected locations along two-lane roadways where additional emphasis is needed.

Option. The SLOWER TRAFFIC KEEP RIGHT (R4-3) sign may be used on multi-lane through roadways to improve capacity or reduce unnecessary lane changing due to the presence of slower vehicles that impede the normal flow of traffic.

Standard. The SLOWER TRAFFIC KEEP RIGHT (R4-3) sign shall be required for climbing lanes.

Guidance. If used, the SLOWER TRAFFIC KEEP RIGHT sign should be installed at or just beyond the beginning of a multi-lane roadway section or at the beginning of an extra lane provided for trucks and/or other slow-moving traffic, and at selected locations where there is a tendency on the part of some road users to drive in

the left-hand lane(or lanes) below the normal speed of traffic. These signs should not be used on the approach to an interchange or through an interchange area where traffic is entering or exiting, or along deceleration or acceleration lanes.

If an extra lane has been provided for trucks and other slow-moving traffic, a Lane Ends sign (see EPG 903.3.39) should be installed in advance of the point where the extra lane ends. Appropriate pavement markings should be installed at both the upstream and downstream ends of the extra lane (see EPG 620.2.14 and Figure 620.2.14).

903.2.34 Keep Right and Keep Left Signs (R4-7 Series and R4-8 Series) (MUTCD Section 2B.39)


R4-7

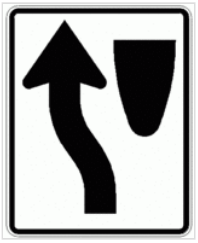


R4-7a



R4-7b


R4-7c


R4-8



R4-8a



R4-8b


R4-8c

Option. The Keep Right (R4-7) sign may be used at locations where it is necessary for traffic to pass only to the right-hand side of a roadway feature or obstruction. The Keep Left (R4-8) sign may be used at locations where it is necessary for traffic to pass only to the left-hand side of a roadway feature or obstruction.

Guidance. At locations where it is not readily apparent that traffic is required to keep to the right, a Keep Right sign should be used.

Standard. If Keep Right signs are installed at the start of a median or at a median opening, they shall be placed as close as practicable to the approach ends of the medians, and shall be visible to traffic on the divided highway.

Guidance. If used, the Keep Right sign should be mounted on the face of or just in front of a pier or other obstruction separating opposite directions of traffic in the center of the highway such that traffic will have to pass to the right-hand side of the sign.

Where the approach end of the island channelizes traffic away from the approach direction, the word legend (R4-7a, R4-7b, R4-8a, or R4-8b) signs should be used instead of the symbol (R4-7 or R4-8) signs to emphasize the degree of curvature away from the approach direction (see Figure 903.2.34.1).

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Where a two-lane, two-way highway transitions to a divided highway, the KEEP RIGHT (R4-7b) sign should be installed within 50 ft. of the gore point, if possible. The edge of the sign should be a minimum of 6 ft. from the curb or shoulder point.

Standard. The Keep Right (Left) sign shall not be installed on the right-hand (left-hand) side of the roadway in a position where traffic must pass to the left-hand (right-hand) side of the sign.

Option. The Keep Right sign may be omitted at intermediate ends of divisional islands and medians.

A narrow Keep Right (R4-7c) sign may be installed on the approach end of a median island that is less than 4 feet wide at the point where the sign is to be located.

Standard. A narrow Keep Right (R4-7c) sign shall not be installed on a median island that has a width of 4 feet or more at the point where the sign is to be located.

Option. The Keep Right sign may be installed in the median of a divided highway crossing that functions as a single intersection such that it is visible to traffic on the divided highway as shown in Figure 903.2.41.3 and Figure 903.2.41.4 .

Support. EPG 903.2.40 provides more information about the use of the Keep Right sign in combination with or in lieu of ONE-WAY signs at divided highway crossings.

Standard. The KEEP RIGHT (R4-7b) sign shall be installed as close to the median nose as possible where an undivided highway transitions into a divided highway.

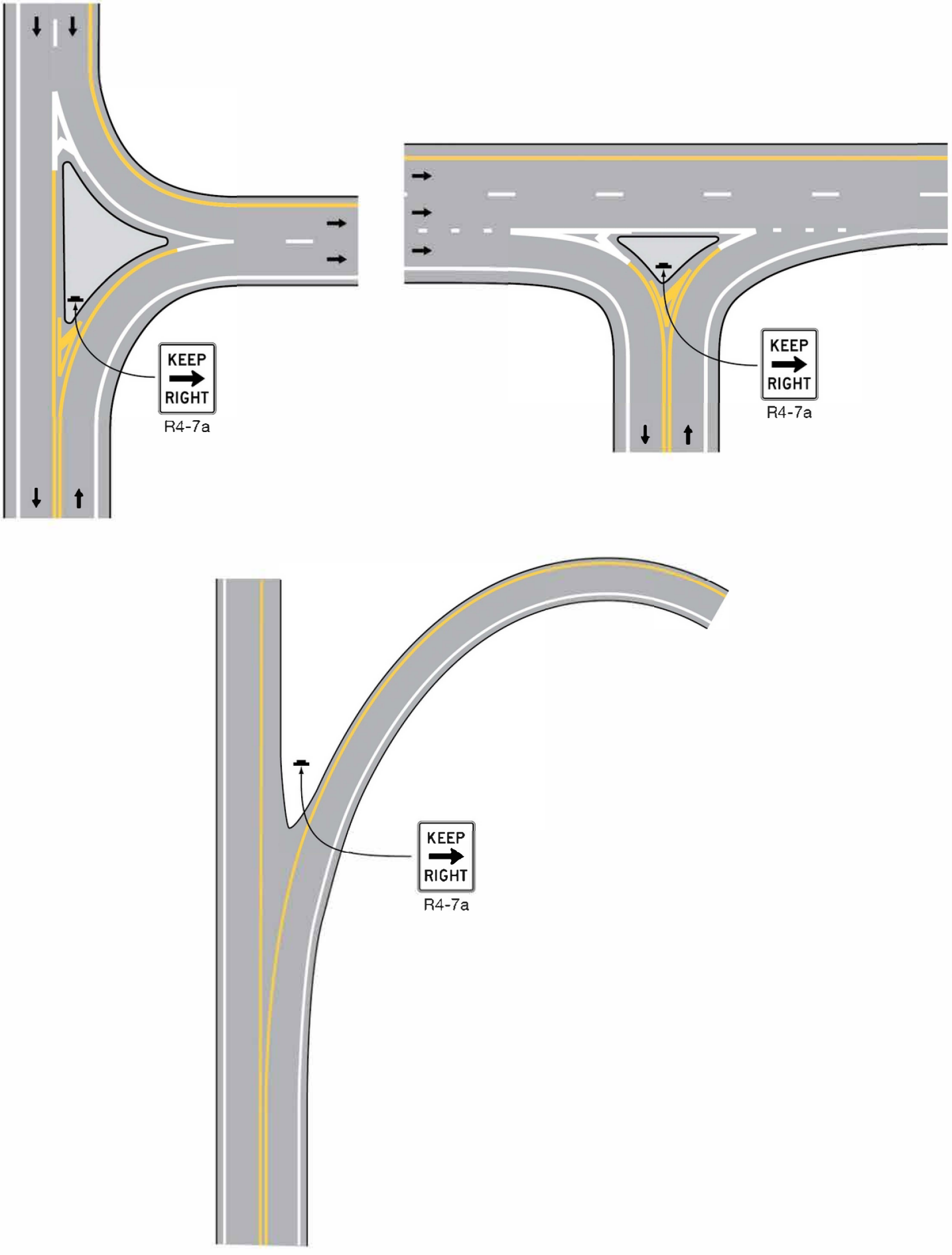
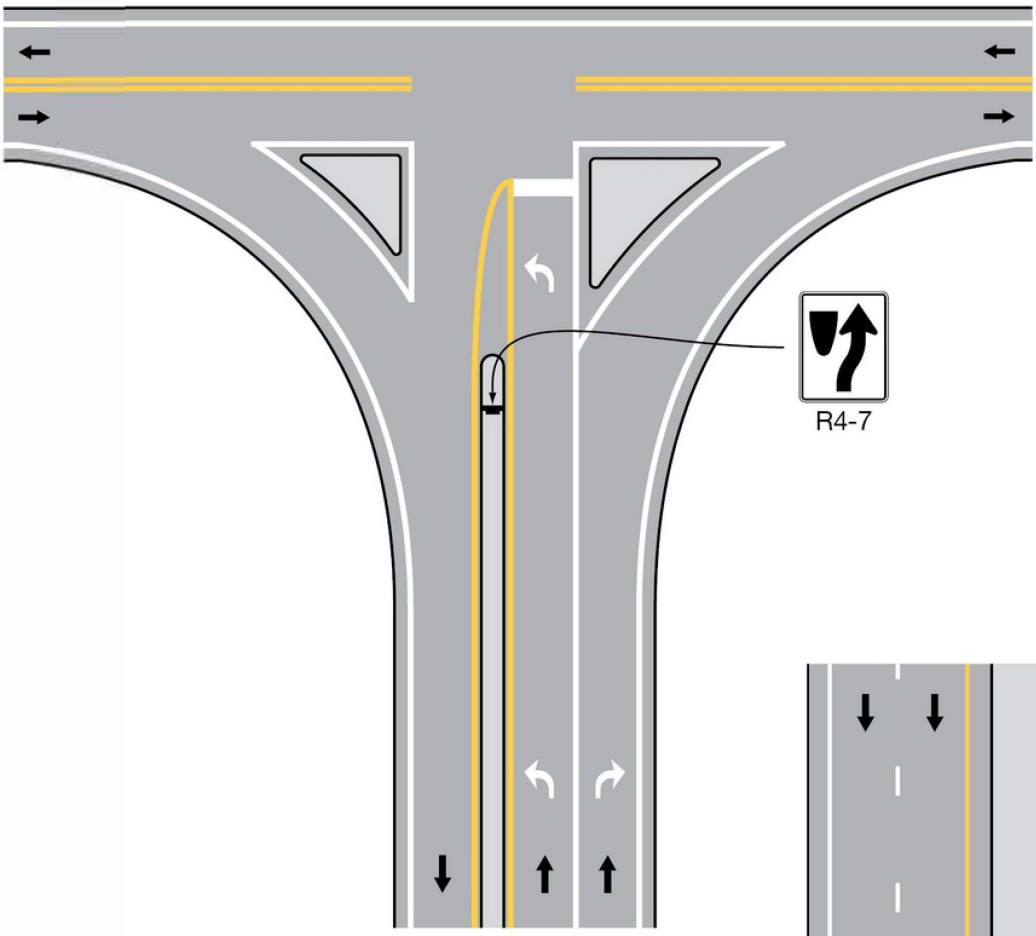
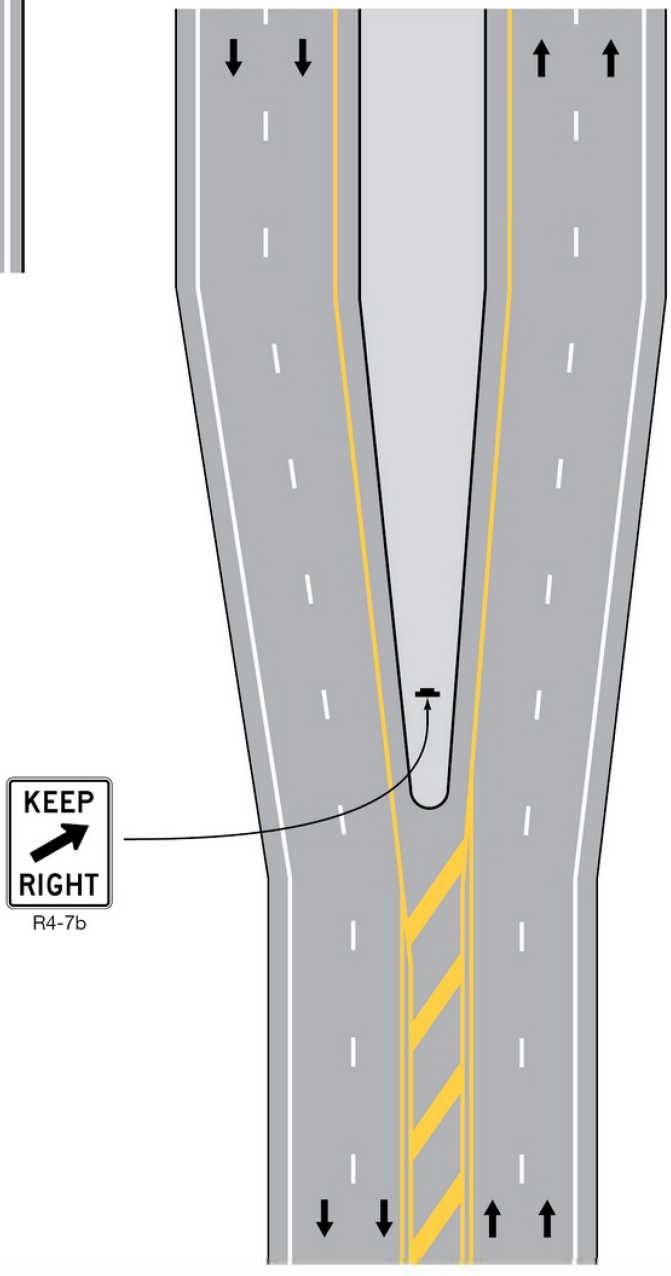

KEEP
RIGHT
R4-7a
KEEP
RIGHT
R4-7a
KEEP
RIGHT
R4-7a

Figure 903.2.34.1 Examples of Keep Right and Keep Left Sign Placement *(Sheet 1 of 2)*



R4-7



R4-7b



Figure 903.2.34.2 Examples of Keep Right and Keep Left Sign Placement *(Sheet 2 of 2)*

903.2.35 DO NOT DRIVE ON SHOULDER Sign (R4-17) (MUTCD Section 2B.43)



R4-17

Option. The DO NOT DRIVE ON SHOULDER (R4-17) sign may be installed to inform road users that using the shoulder of a roadway as a travel lane is prohibited.

Guidance. The DO NOT DRIVE ON SHOULDER (R4-17) sign should be considered for special conditions if there is a need determined by district traffic engineering staff. The sign should be considered as a temporary tool to aid in the enforcement of the condition. After it appears the problem has been corrected, these signs should be removed.

Support. The R4-17 sign is to be used only where necessary. MoDOT does not want to set driver expectations for general use of this sign.

903.2.36 Selective Exclusion Signs and Plaques (MUTCD Section 2B.45)



R5-2



R5-2aP



R5-25



R5-29

Option. Selective Exclusion signs may be used to provide notice to road users that State or local statutes or ordinances exclude designated types of traffic from using particular roadways or facilities.

Standard. Selective Exclusion signs shall clearly indicate the type of traffic that is excluded.

Support. Typical exclusion messages include:

A. No Trucks (R5-2),
B. No Pedestrian Crossing (R9-3),
C. EXCEPT LOCAL DELIVERY (R5-2aP) plaque.
D. NO VENDING (R5-24)
E. NO FISHING FROM BRIDGE (R5-25)
F. AUTHORIZED AND EMERGENCY VEHICLES ONLY (R5-29)

Guidance. If an exclusion is governed by vehicle weight, a Weight Limit sign (see EPG 903.2.53) should be used instead of a Selective Exclusion sign.

The Selective Exclusion sign should be placed on the right-hand side of the roadway at an appropriate distance from the intersection so as to be clearly visible to all road users turning into the roadway that has the exclusion. The No Pedestrian Crossing (R9-3) sign (see EPG 903.2.46) should be installed so as to be clearly visible to pedestrians who are at a location where an alternative route is available.

Option. The No Pedestrian Crossing (R9-3) sign may also be used at underpasses or elsewhere where pedestrian facilities are not provided.

The EXCEPT LOCAL DELIVERY (R5-2aP) plaque may be mounted below the R5-2 sign.

The NO VENDING (R5-24) sign may be used at locations where vending is taking place within the right-of-way.

Standard. When used, the NO FISHING FROM BRIDGE (R5-25) sign shall be mounted at or near the bridge ends.

Option. The NO FISHING FROM BRIDGE (R5-25) sign may be used at locations where fishing from a bridge creates a safety hazard.

Guidance. The AUTHORIZED AND EMERGENCY VEHICLES ONLY (R5-29) sign should be used at emergency crossovers to prohibit vehicles from using the emergency crossover unless they have special permission (such as law enforcement vehicles or emergency vehicles) or are performing official business (such as highway agency vehicles).

The No U Turn sign should be installed above the AUTHORIZED AND EMERGENCY VEHICLES ONLY sign.

Signing for both directions of traffic should be provided on one post with the signs being installed 90 degrees to the roadway. The signs should be mounted back to back. The post should be located approximately in the middle of the median. If median width is greater than 60 ft., consideration should be given to install separate signs.

903.2.37 DO NOT ENTER Sign (R5-1) (MUTCD Section 2B.46)



R5-1

Standard. The DO NOT ENTER (R5-1) sign shall be used at the following locations:

A. Where a two-way roadway becomes a one-way roadway;
B. The intersection of an interchange exit ramp with a crossroad as specified in EPG 903.2.39 (see Figure 903.2.39.1);
C. The intersection of a channelized or turning roadway with a two-way undivided crossroad; and
D. Except as provided in the fourth paragraph of this article, an intersection with a divided highway (see Figure 903.2.37).

If the DO NOT ENTER sign is mounted behind a STOP or YIELD sign:

A. 36 x 36 inch DO NOT ENTER sign shall be used behind a 48 x 48 inch STOP sign; and
B. 30 x 30 inch. DO NOT ENTER sign shall be used behind a 60 x 60 inch YIELD sign.

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Guidance. A DO NOT ENTER sign should be installed at other locations where additional emphasis is needed where wrong-way movements are prominent or where the intersecting angle of roadways is such that the visibility of ONE WAY signs alone does not sufficiently convey the restriction.

Option. A DO NOT ENTER sign may be omitted on a low-speed urban street that is a divided highway at a crossing that functions as two separate intersections.

Guidance. The DO NOT ENTER sign, if used, should be placed directly in view of a road user at the point where a road user could wrongly enter a divided highway, one-way roadway, or ramp. The sign should be mounted facing traffic that might enter the roadway or ramp in the wrong direction.

At a crossing with a divided highway; the sign, if used, should be placed on the outside edge side of the roadway facing traffic that might enter the roadway in the wrong direction.

If the DO NOT ENTER sign would be visible to traffic to which it does not apply, the sign should be turned away from, or shielded from, the view of that traffic.

A second DO NOT ENTER sign should be used, particularly where traffic approaches from an intersecting roadway (Figure 903.2.37).

EPG 903.1.12 contains the provisions for the use of continuously-operated or actuated LEDs to enhance the conspicuity of signs.

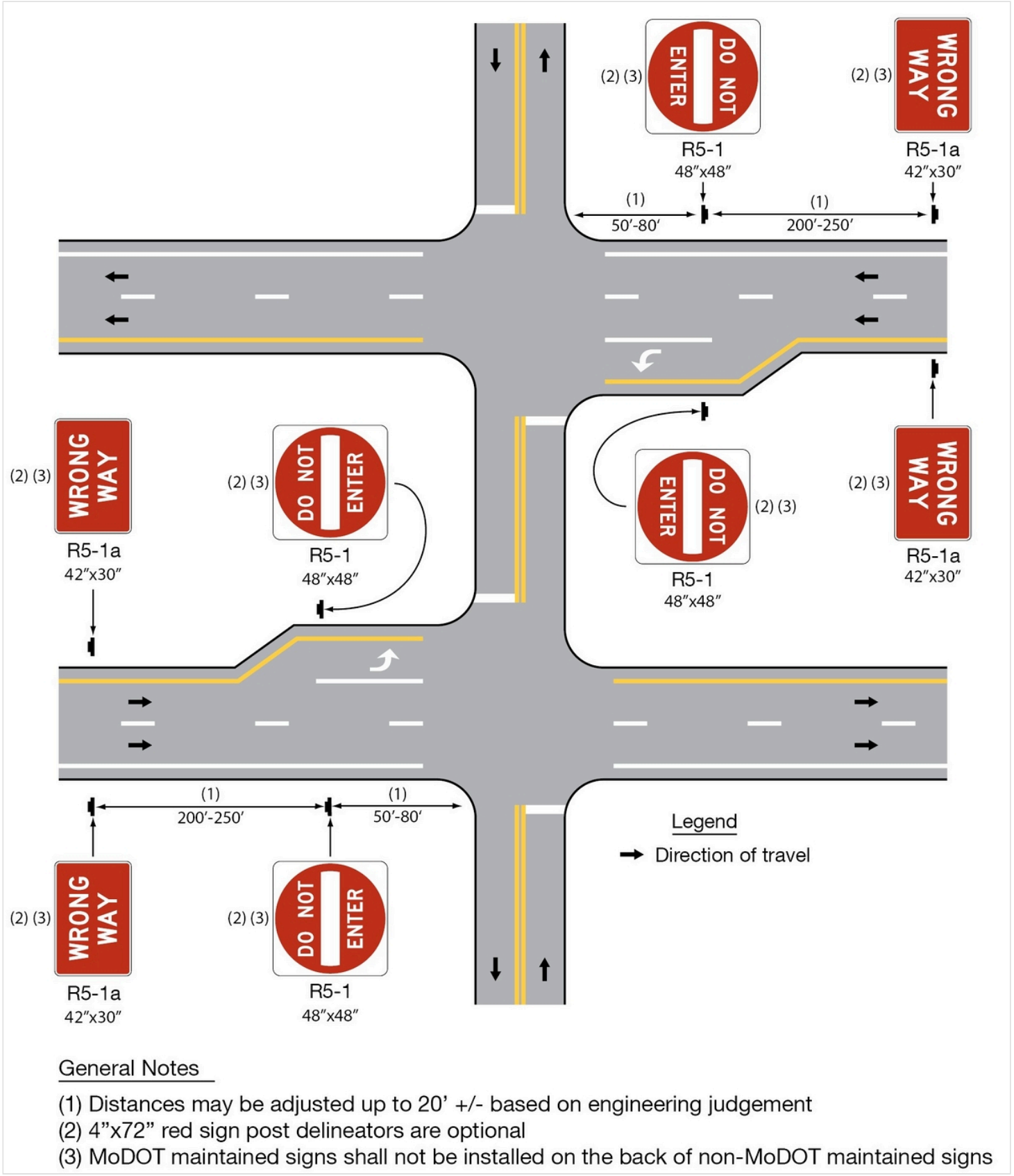


Figure 903.2.37 Locations of DO NOT ENTER and WRONG WAY Signing for Divided Highway Crossings that Function as Two Separate Intersections

903.2.38 WRONG WAY Sign (R5-1a) (MUTCD Section 2B.47)



R5-1a

Option. The WRONG WAY (R5-1a) sign may be used as a supplement to the DO NOT ENTER sign where a crossroad intersects a one-way roadway in a manner that does not physically discourage or prevent wrong-way entry (see Figure 903.2.37).

Guidance. If used, the WRONG WAY sign should be placed at a location along the one-way roadway farther from the crossroad than the DO NOT ENTER sign (see EPG 903.2.37).

The WRONG WAY sign should be placed on the same side of the road as the DO NOT ENTER sign.

Support. EPG 903.1.12 contains the provisions for the use of continuously-operated or actuated LEDs to enhance the conspicuity of signs.

903.2.39 Wrong-Way Traffic Control at Interchange Ramps (MUTCD Section 2B.48)

Standard. At interchange exit ramp terminals where the ramp intersects a crossroad in such a manner that wrong-way entry could inadvertently be made, the following signs shall be used (see Figure 903.2.39.1):

A. At least one ONE WAY sign for each direction of travel on the crossroad shall be placed where the exit ramp intersects the crossroad.
B. At least one DO NOT ENTER sign shall be conspicuously placed near the downstream end of the exit ramp in positions appropriate for full view of a road user starting to enter wrongly from the crossroad.
C. At least one WRONG WAY sign shall be placed on the exit ramp facing a road user traveling in the wrong direction.

Guidance. In addition, the following pavement markings should be used (see Figure 903.2.39.1):

A. On two-lane paved crossroads at interchanges, solid double yellow lines should be used as a center line for an adequate distance on both sides approaching the ramp intersections.
B. Where crossroad channelization or ramp geometrics do not make wrong-way movements difficult, a lane-use arrow should be placed in each lane of an exit ramp near the crossroad terminal where it will be clearly visible to a potential wrong-way road user.

Option. The following traffic control devices may be used to supplement the signs and pavement markings described in the first and second paragraphs of this article:

A. Additional ONE WAY signs may be placed, especially on two-lane rural crossroads, appropriately in advance of the ramp intersection to supplement the required ONE WAY sign(s).
B. Additional WRONG WAY signs may be used.
C. Slender, elongated wrong-way arrow pavement markings (see Figure 620.2.22.1) intended primarily to warn wrong-way road users that they are traveling in the wrong direction may be placed upstream from the ramp terminus (see Figure 903.2.39.1) to indicate the correct direction of traffic flow. Wrong-way arrow pavement markings may also be placed on the exit ramp at appropriate locations near the crossroad junction to indicate wrong-way movement.
D. Lane-use arrow pavement markings may be placed on the exit ramp and crossroad near their intersection to indicate the permissive direction of flow.
E. Lane control signs or movement prohibition signs may be used on the approaches to the exit ramp.
D. A Keep Right (R4-7 or R4-7c) may be used on a ramp median nose for wrong-way traffic control.

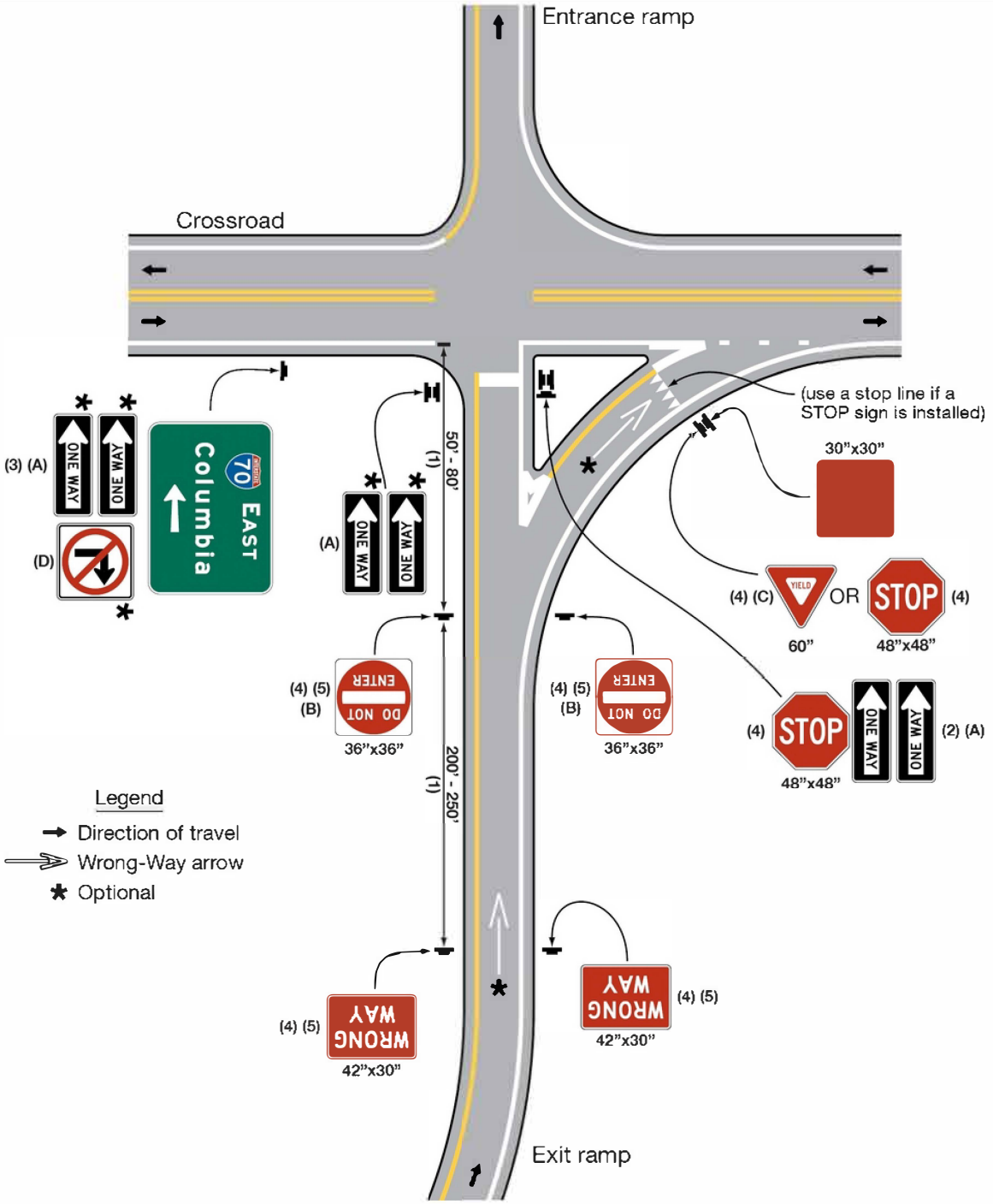
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Guidance. On interchange entrance ramps where the ramp merges with the through roadway and the design of the interchange does not clearly make evident the direction of traffic on the separate roadways or ramps, a ONE WAY sign visible to traffic on the entrance ramp and through roadway should be placed on each side of the through roadway near the entrance ramp merging point.

Option. On interchange entrance ramps where the ramp merges with the through roadway and the design of the interchange does not clearly make evident the direction of traffic on the separate roadways or ramps a No Left Turn (R3-2) sign may be located on the left-hand side of the entrance ramp at the gore. If a No Left Turn (R3-2) sign is located on the left-hand side, a supplemental R3-2 sign may be installed on the right-hand side of the entrance ramp.

On interchange entrance ramps where the ramp merges with the through roadway and the design clearly indicates the direction of flow, a ONE WAY sign may be placed visible to traffic on the entrance ramp and/or a NO TURNS (R3-3) sign may be placed visible to traffic on the entrance ramp and through roadway at the gore area.

Support. EPG 903.2.37, EPG 903.2.38, and EPG 903.2.40 contain further information on signing to avoid wrong-way movements at at-grade intersections on expressways.



General Notes

(1) Distances may be adjusted up to 20' +/- based on engineering judgement
(2) When signals are present, ONE WAY signs may be mounted to signal posts
(3) ONE WAY signs may be installed back to back below crossroad guide signs located <50' from ramp
(4) 4"x72" red sign post delineators are optional
(5) MoDOT maintained signs shall not be installed on the back of non-MoDOT maintained signs

Sign Size Notes

(A) ONE WAY signs should be 36"x12" (single lane crossroad) or 54"x18" (multi-lane crossroad)
(B) DO NOT ENTER signs may be 48"x48" based on engineering judgement
(C) When installed back to back, YIELD signs shall be 60" and DO NOT ENTER signs shall be 30"x30"
(D) NO RIGHT TURN signs should be 30"x30" (single lane crossroad) or 36"x36" (multi-lane crossroad)

Figure 903.2.39.1. Example of Application of Regulatory Signing and Pavement Markings at an Exit Ramp Termination to Deter Wrong-Way Entry

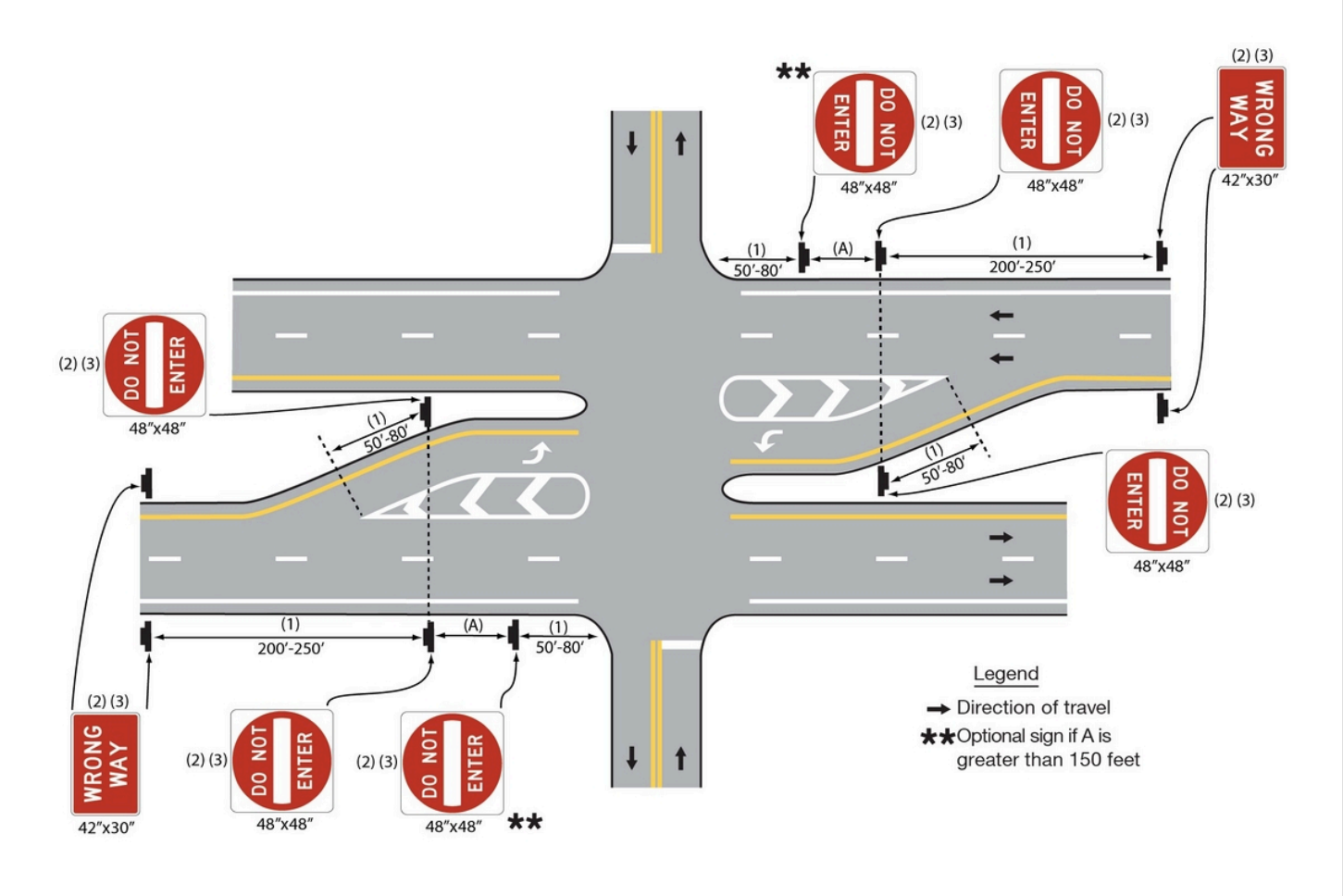


Figure 903.2.39.2. Locations of Wrong-Way signing for Divided Highways with Offset Left Turn Lanes

Notes:

1. Distances may be adjusted up to 20’ +/- based on engineering judgement
2. 4”x72” red sign post delineators are optional
3. MoDOT maintained signs shall not be installed on the back of non-MoDOT maintained signs
4. See Figure 903.2.41.4 for ONE WAY signing for Divided Highways with Offset Left Turn Lanes

903.2.40 ONE WAY Signs (R6-1 and R6-2) (MUTCD Section 2B.49)



R6-1



R6-2

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Standard. Except as provided in the sixth paragraph of this article, the ONE WAY (R6-1 or R6-2) sign shall be used to indicate streets or roadways upon which vehicular traffic is allowed to travel in one direction only.

ONE WAY signs shall be placed parallel to the one-way street at all alleys and roadways that intersect one-way roadways.

At the crossing of a roadway with a divided highway that functions as two separate intersections, ONE WAY signs shall be placed, visible to each crossroad approach, on the near right and far left corners of each intersection with the directional roadways (see Figures 903.2.41.1 and 903.2.41.2).

At the crossing of a roadway with a divided highway that functions as a single intersection Keep Right (R4-7) signs (see EPG 903.2.34) and/or ONE WAY signs shall be installed (see Figure 903.2.41.3 and Figure 903.2.41.4). If Keep Right signs are installed, they shall be placed as close as practicable to the approach ends of the medians and shall be visible to traffic on the divided highway as shown in Figure 903.2.41.3 and Figure 903.2.41.4. If ONE WAY signs are installed, they shall be placed on the near right and far left corners of the intersection and shall be visible to each crossroad approach.

Option. At the crossing of a roadway with a divided highway, regardless of function as a single or separate intersections, ONE WAY signs may also be placed on the far right corner of the intersection as shown in Figure 903.2.41.1, Figure 903.2.41.2, Figure 903.2.41.3 and Figure 903.2.41.4.

ONE WAY signs may be omitted on the one-way roadways of divided highways, where the design of interchanges indicates the direction of traffic on the separate roadways.

Support. EPG 903.2.39 contains information for the placement of ONE WAY signs at a crossroad with an interchange.

Standard. If used at unsignalized intersections with one-way streets, ONE WAY signs shall be placed on the near right and the far left corners of the intersection facing traffic entering or crossing the one-way street.

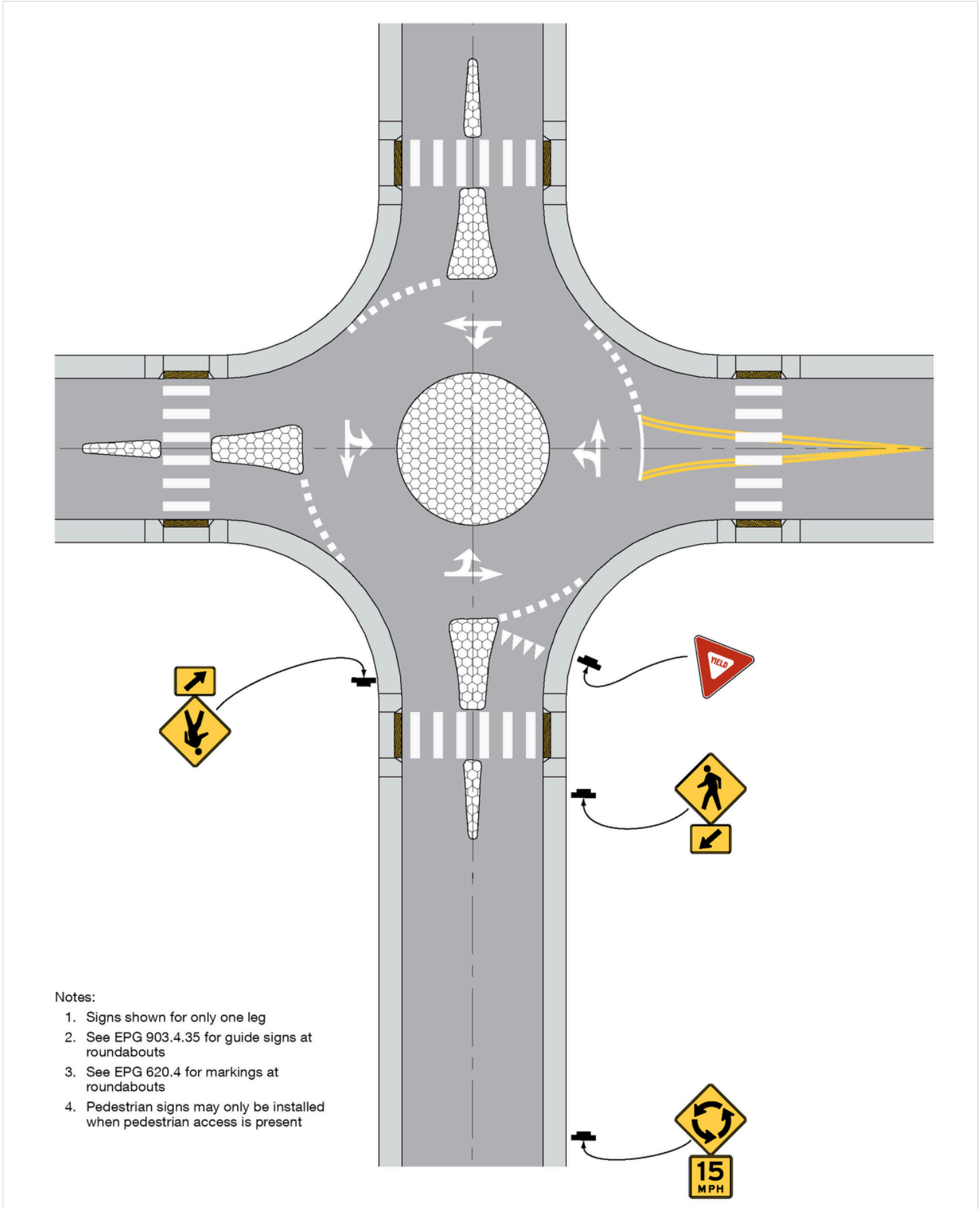
If used at signalized intersections with one-way streets, ONE WAY signs shall be placed near the appropriate signal faces, on the poles holding the traffic signals, on the mast arm or span wire holding the signals, or at the locations specified for unsignalized intersections.

At unsignalized T-intersections where the roadway at the top of the T-intersection is a one-way roadway, ONE WAY signs shall be placed on the near-right and the far side of the intersection facing traffic on the stem approach.

ONE WAY (R6-2) signs may be used in lieu of ONE WAY (R6-1) signs on mast arms for signals or where lateral space is limited.

Where the central island of a roundabout allows for the installation of signs, ONE WAY signs may be used to direct traffic counter-clockwise around the central island (see Figure 903.2.40.2 and Figure 903.2.40.3).

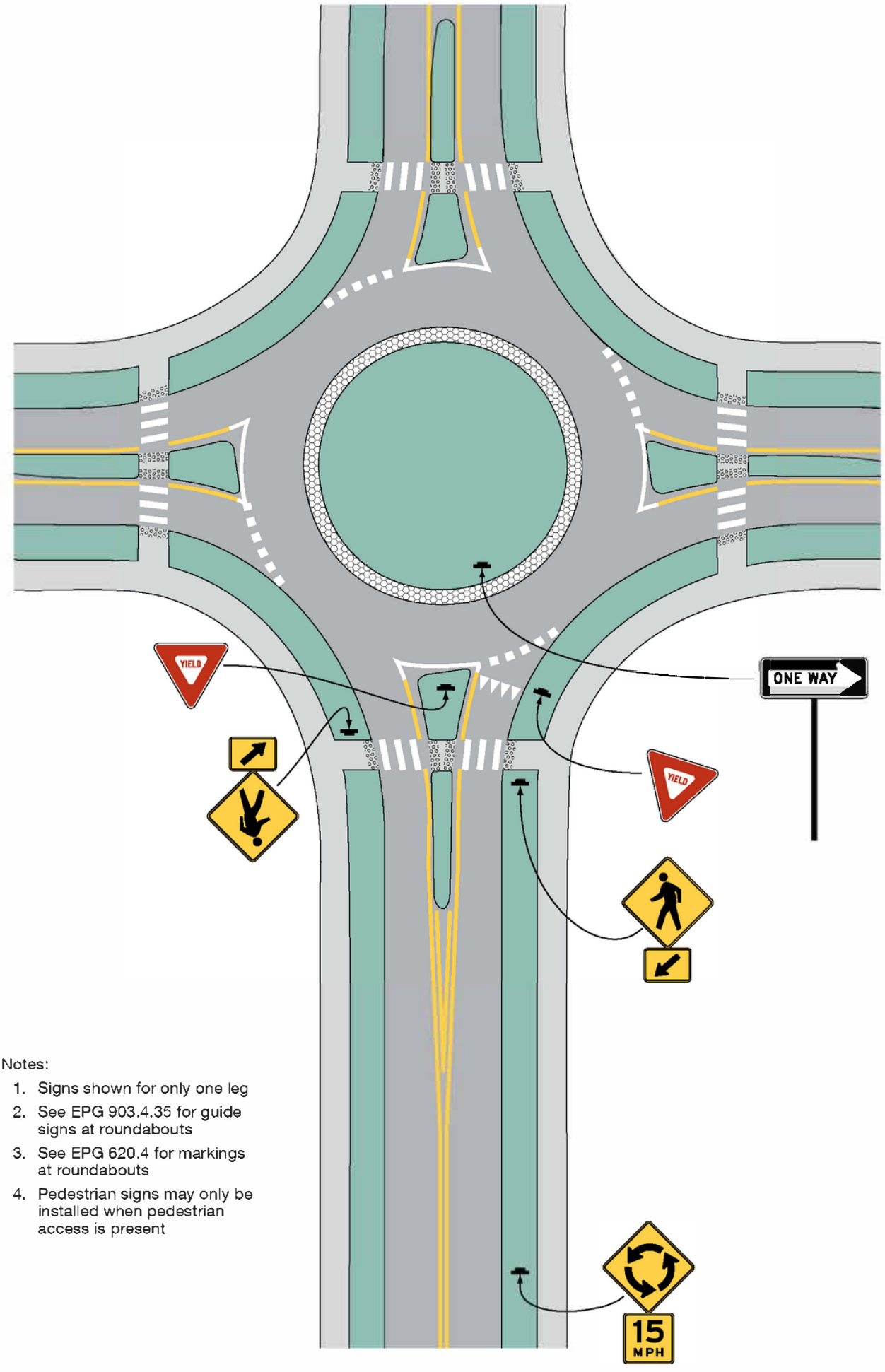
Guidance. Where used on the central island of a roundabout, the mounting height of a ONE WAY sign should be at least 4 feet, measured vertically from the bottom of the sign to the elevation of the near edge of the traveled way.



Notes:

1. Signs shown for only one leg
2. See EPG 903.4.35 for guide signs at roundabouts
3. See EPG 620.4 for markings at roundabouts
4. Pedestrian signs may only be installed when pedestrian access is present

Figure 903.2.40.1 Example of Regulatory and Warning Signs for a Mini-Roundabout



Notes:

1. Signs shown for only one leg
2. See EPG 903.4.35 for guide signs at roundabouts
3. See EPG 620.4 for markings at roundabouts
4. Pedestrian signs may only be installed when pedestrian access is present

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Figure 903.2.40.2 Example of Regulatory and Warning Signs for a One-Lane Roundabout

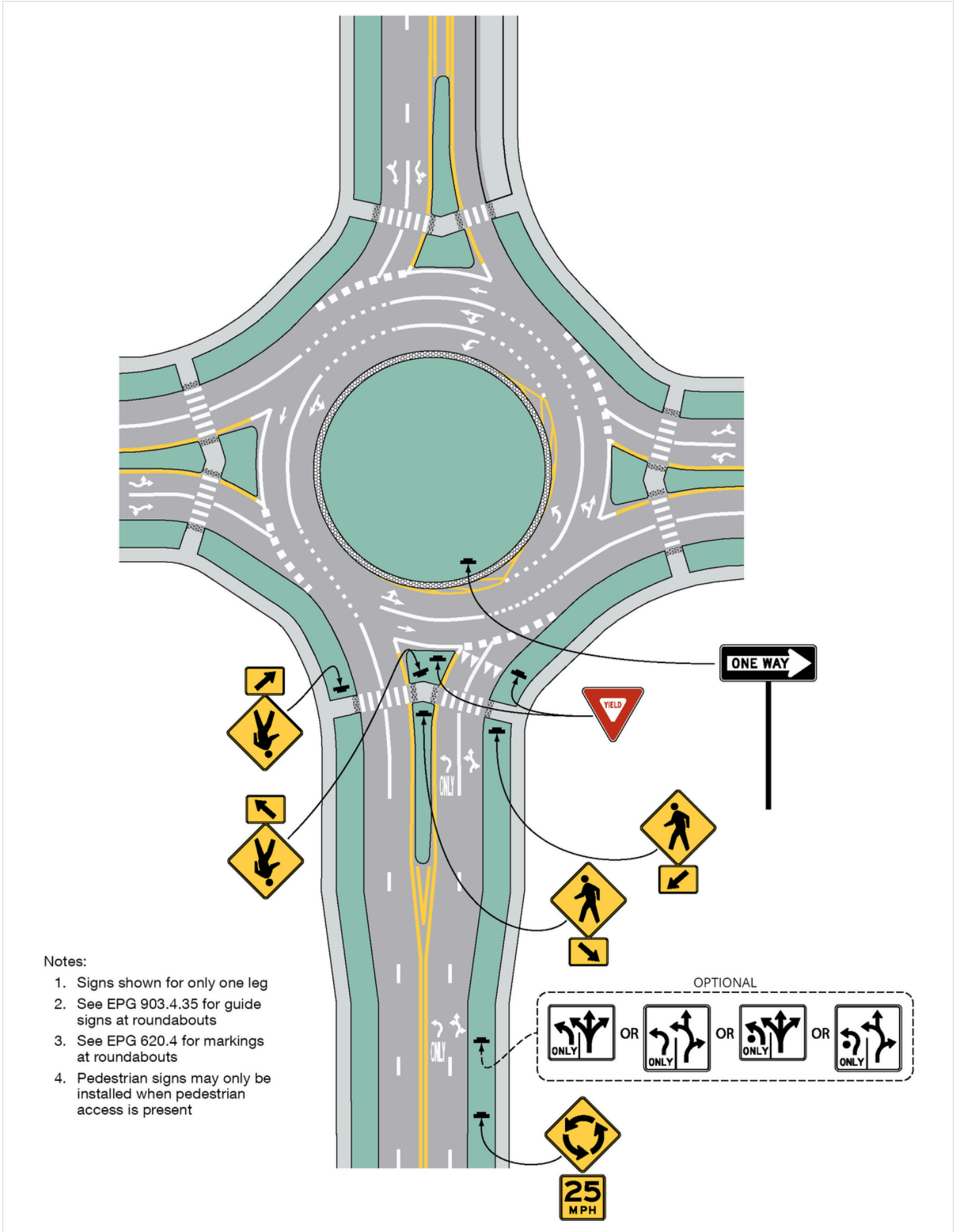


Figure 903.2.40.3 Example of a Regulatory and Warning Signs for a Two-Lane Roundabout with Consecutive Double lefts

903.2.41 Divided Highway Crossing Signs (R6-3 and R6-3a) (MUTCD Section 2B.50)



R6-3



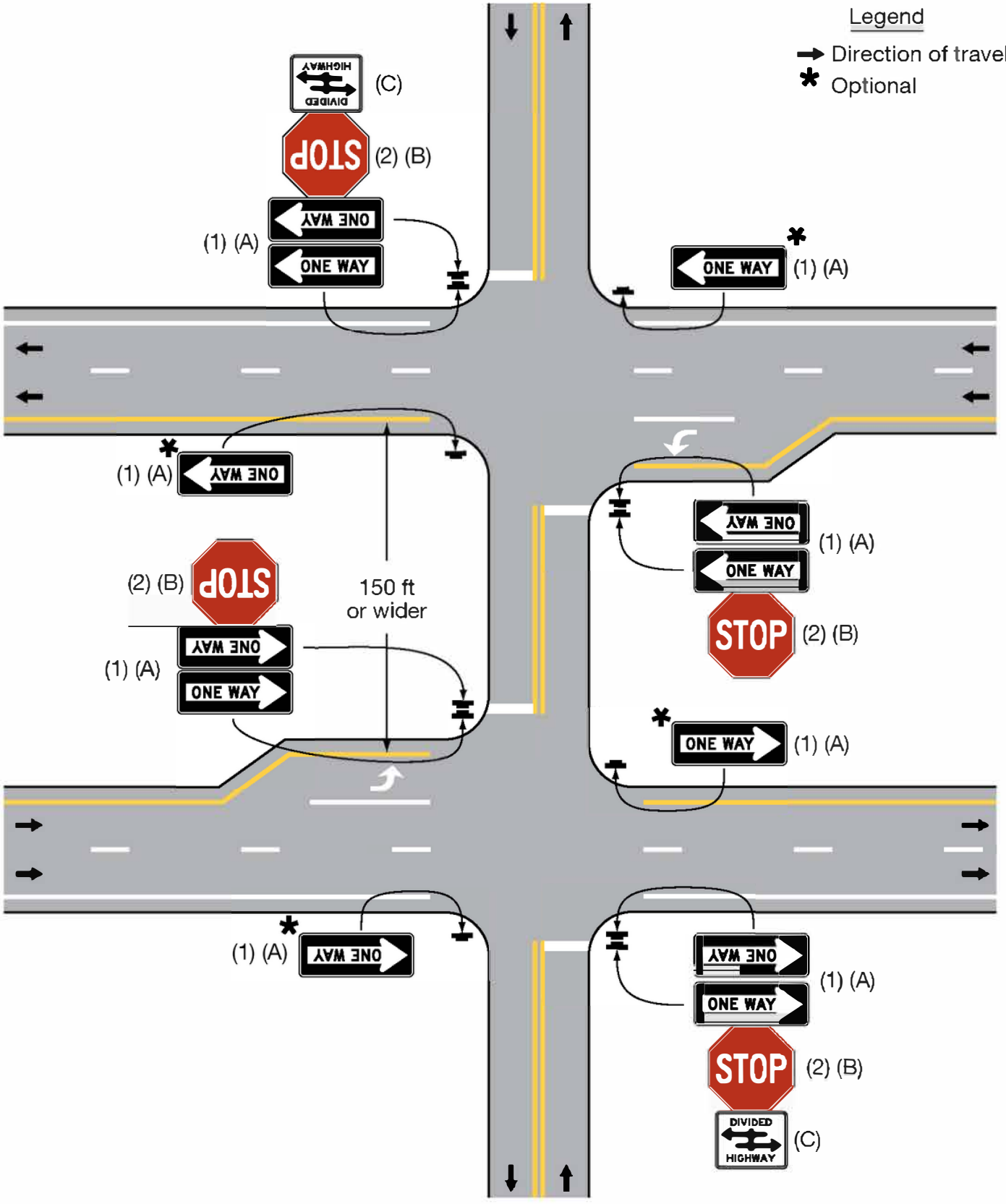
R6-3a

Standard. On unsignalized minor-street approaches from which both left turns and right turns are permitted onto a divided highway at a crossing that functions as two separate intersections (see EPG 903.1.23), a Divided Highway Crossing (R6-3 or R6-3a) sign shall be used to advise road users that they are approaching an intersection with a divided highway (see Figure 903.2.41.1 and Figure 903.2.41.2).

If a Divided Highway Crossing sign is used at a four-leg intersection, the R6-3 sign shall be used. If used at a T-intersection, the R6-3a sign shall be used.

The Divided Highway Crossing sign shall be located on the near right corner of the intersection, mounted beneath a STOP or YIELD sign or on a separate support.

The DIVIDED HIGHWAY (R6-3b) sign may be used in situations where the R6-3 or R6-3a Divided Highway Crossing signs may be confusing.



General Notes

(1) When signals are present, ONE WAY signs may be mounted on signal post
(2) 4"x72" red sign post delineators are optional
(3) See Figure 903.2.37 for examples of placing DO NOT ENTER and WRONG WAY signing

Sign Size Notes

(A) ONE WAY signs should be 36"x12" for a single lane crossroad (54"x18" may be used based

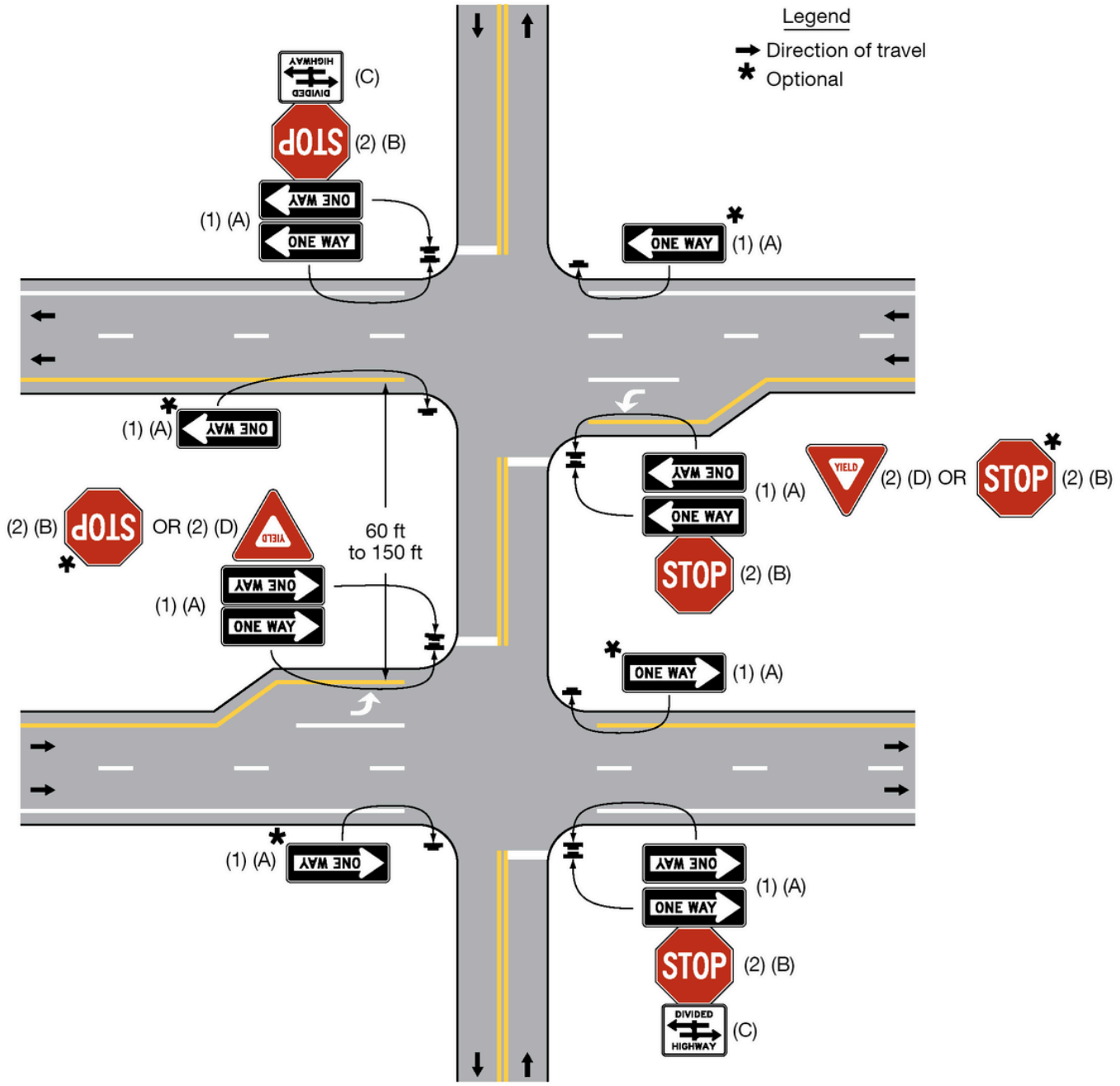
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on engineering judgement), and 54”x18” for a multi-lane crossroad.

(B) STOP signs should be 36”x36” for a single lane crossroad (48”x48” may be used based on engineering judgement), and 48”x48” for a multi-lane crossroad.

(C) DIVIDED HIGHWAY signs should be 30”x24” for all crossroads.

Figure 903.2.41.1 ONE WAY Signing for Divided Highways with Median Widths Greater than 150 Feet



General Notes

(1) When signals are present, ONE WAY signs may be mounted on signal post

(2) 4"x72" red sign post delineators are optional

(3) See Figure 903.2.37 for examples of placing DO NOT ENTER and WRONG WAY signing

Sign Size Notes

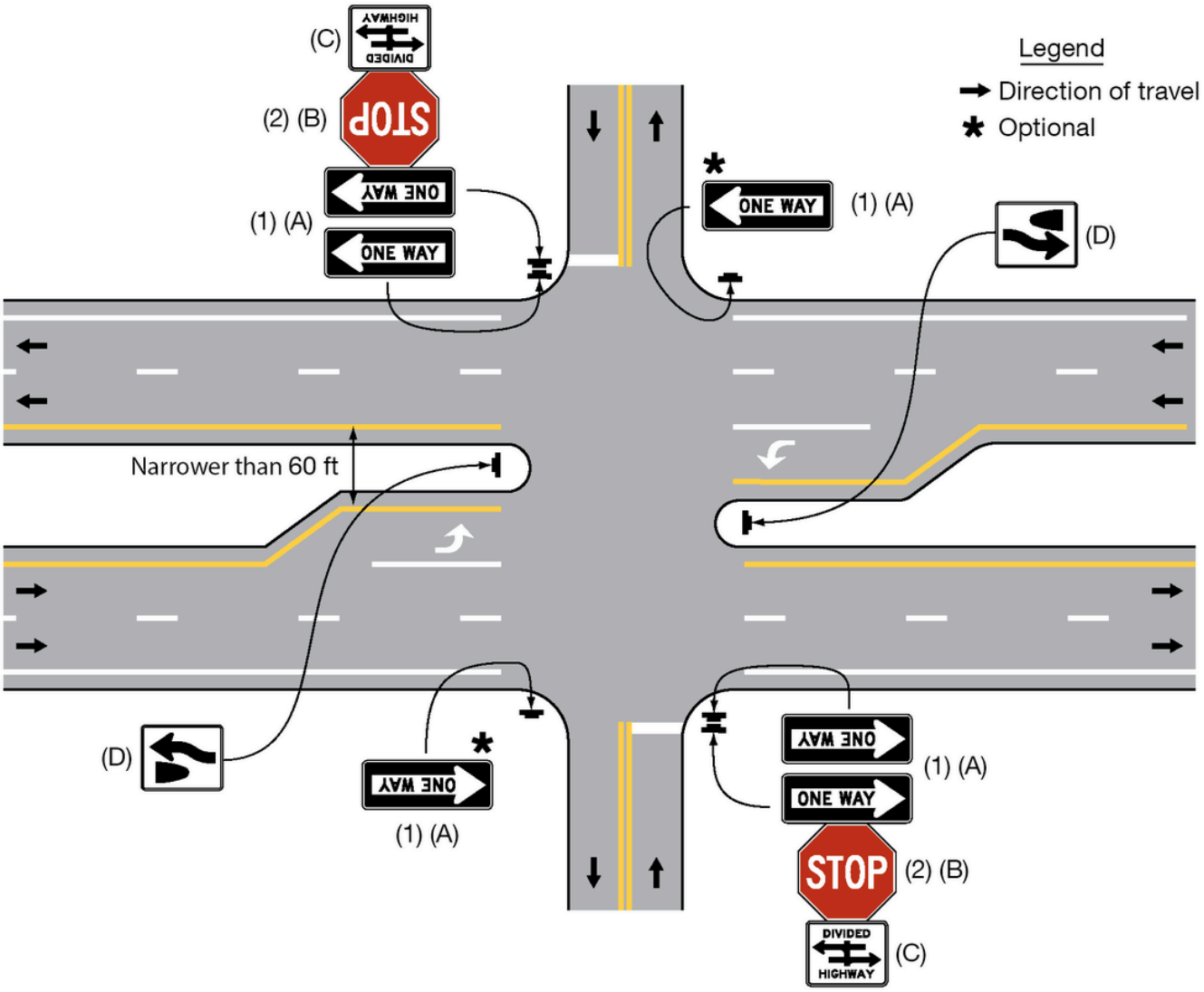
(A) ONE WAY signs should be 36"x12" for a single lane crossroad (54"x18" may be used based on engineering judgement), and 54"x18" for a multi-lane crossroad.

(B) STOP signs should be 36"x36" for a single lane crossroad (48"x48" may be used based on engineering judgement), and 48"x48" for a multi-lane crossroad.

(C) DIVIDED HIGHWAY signs should be 30"x24" for all crossroads.

Figure 903.2.41.2 ONE WAY Signing for Divided Highways with Median Widths of 60 Feet to 150 Feet

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General Notes

(1) When signals are present, ONE WAY signs may be mounted on signal post

(2) 4"x72" red sign post delineators are optional

(3) See Figure 903.2.37 for examples of placing DO NOT ENTER and WRONG WAY signing

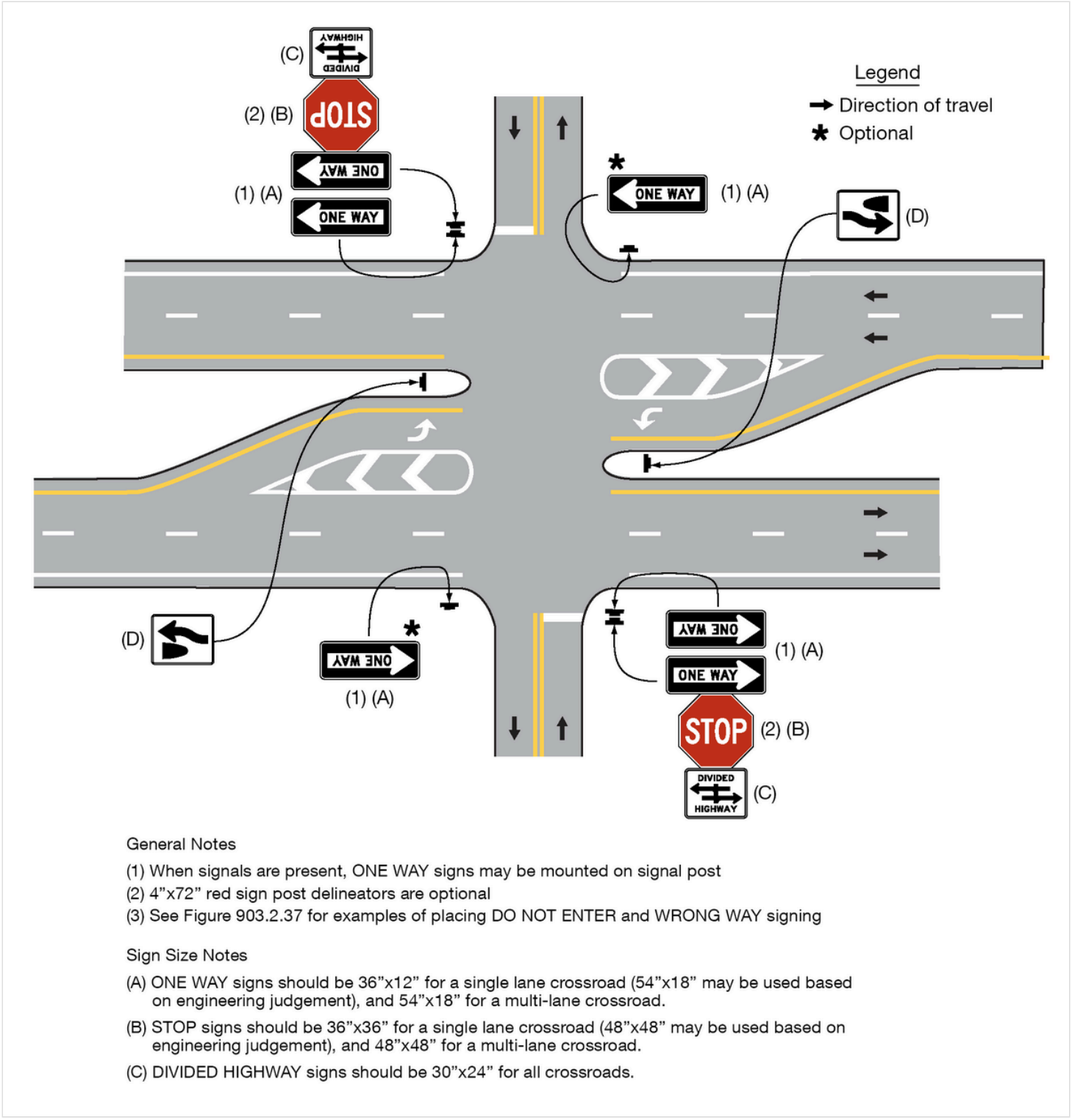
Sign Size Notes

(A) ONE WAY signs should be 36"x12" for a single lane crossroad (54"x18" may be used based on engineering judgement), and 54"x18" for a multi-lane crossroad.

(B) STOP signs should be 36"x36" for a single lane crossroad (48"x48" may be used based on engineering judgement), and 48"x48" for a multi-lane crossroad.

(C) DIVIDED HIGHWAY signs should be 30"x24" for all crossroads.

Figure 903.2.41.3 ONE WAY Signing for Divided Highways with Median Widths Narrower Than 60 Feet



General Notes

(1) When signals are present, ONE WAY signs may be mounted on signal post

(2) 4"x72" red sign post delineators are optional

(3) See Figure 903.2.37 for examples of placing DO NOT ENTER and WRONG WAY signing

Sign Size Notes

(A) ONE WAY signs should be 36"x12" for a single lane crossroad (54"x18" may be used based on engineering judgement), and 54"x18" for a multi-lane crossroad.

(B) STOP signs should be 36"x36" for a single lane crossroad (48"x48" may be used based on engineering judgement), and 48"x48" for a multi-lane crossroad.

(C) DIVIDED HIGHWAY signs should be 30"x24" for all crossroads.

Figure 903.2.41.4 ONE WAY Signing for Divided Highways with Offset Left Turn Lanes

903.2.42 Parking, Standing, and Stopping Signs (R7 and R8 Series) (MUTCD Section 2B.52)

Support. Parking signs pertain to the parking, standing, and stopping of vehicles along the roadway and in designated parking areas. They cover a wide variety of regulations, and only general guidance can be provided here. The word "standing" when used on the R7 and R8 series of signs refers to the practice of a driver keeping the vehicle in a stationary position while continuing to occupy the vehicle. The word "stopping" when used on the

R7 and R8 series signs refers to any vehicle, occupied by a driver or not, that stops other than to avoid conflict with other traffic or to comply with official direction. Other types of activities such as active loading, active passenger loading, and/or waiting might be established in State or local codes for use on R7 and R8 series signs.

Parking signs are categorized as either (1) prohibiting parking or (2) permitting parking with restrictions on how parking is allowed.

The types of parking, standing, or stopping prohibitions that might be encountered include, but are not limited to:

A. Prohibited at all times;
B. Prohibited only at certain times of the day and/or days of the week;
C. Prohibited with exceptions, such as for bus stops, loading/unloading zones, persons with disabilities, or electric vehicle charging stations; or
D. Prohibited under certain conditions, such as Snow Emergency Routes.

Permissive parking signs allowing parking with restrictions include, but are not limited to:

A. Parking only allowed for limited time duration (such as 30 minutes or for 1 hour);
B. Metered parking requiring payment at an individual or a multi-space parking meter, or through electronic means such as by telephone or mobile application.;
C. Parking only for specific persons (such as those with disabilities or patrons or employees of a business) or specific vehicle types (such as electric vehicles, police/government vehicles, motorcycles, bicycles, or taxis);
D. Angled or back-in angled parking when it is not commonly used in the area;
E. Parking programs such as neighborhood/residential permits, school areas, or special events; and
F. Emergency parking or stopping only.

The District Engineer is authorized to act on requests for parking restrictions within incorporated areas upon receipt of a city ordinance requesting the same.

Option. The District Engineer may authorize parking restrictions after completion of a study by the district staff and review by county and local law enforcement.

Within interchange areas and on ramps the standard NO PARKING ANYTIME (R7-1) sign may be used.

Guidance. Local law enforcement agencies should be consulted when determining if there is a need for no parking signs to be installed.

903.2.43 Design of Parking, Standing, and Stopping Signs (MUTCD Section 2B.53)



R7-1



R7-108



R7-111



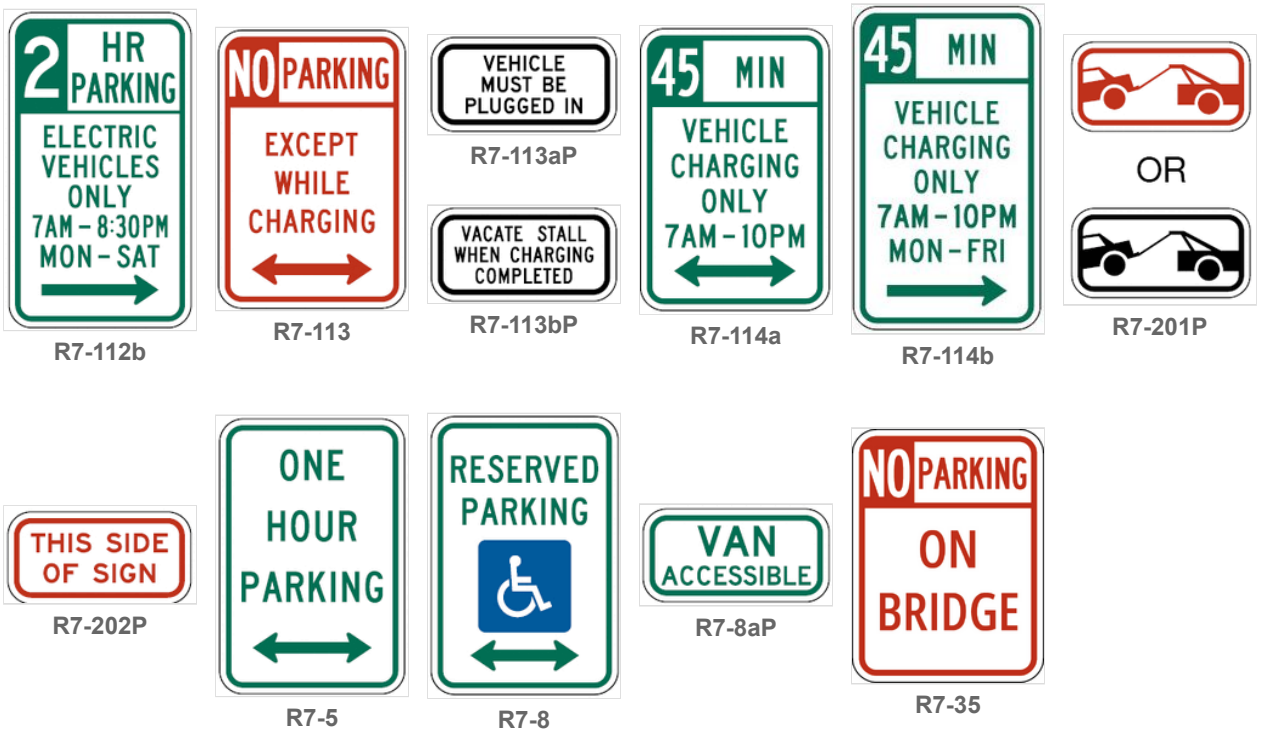
R7-111a



R7-112



R7-112a



Standard. Parking, standing, or stopping signs shall be rectangular.

Public agencies shall follow established law (State law, local ordinance, or regulation) as adopted by the authorized agency regarding what messages are allowed on parking signs.

The legend on parking signs shall state applicable regulations. Parking signs shall comply with the standards of shape, color, and location.

Prohibitive parking signs shall be used where parking is prohibited at all times or at specific times. Except as otherwise provided in this article, parking signs shall have a red legend and border on a white background and, when the parking prohibition symbol is used, the symbol “P” shall be black.

Permissive parking signs shall be used where only time-limited parking or parking in a particular manner is allowed. Permissive parking signs shall have a green legend and border on a white background.

Guidance. Parking information, should be displayed from top to bottom of the sign, as applicable, in the following order:

A. The restriction or prohibition;
B. The times of the day that it is applicable, if not all hours;
C. The days of the week that it is applicable, if not every day;
D. Qualifying or supplementary information;
E. Exemptions to the restriction of prohibition; and
F. Any tow-away message or symbol.

If the parking regulation applies to a limited area or zone, the limits of the regulation should be shown by arrows or supplemental plaques. If arrows are used and if the sign is at the end of a parking zone, there should be a single-headed arrow pointing in the direction that the regulation is in effect. If the sign is at an intermediate point in a zone, there should be a double-headed arrow pointing both ways. When a single sign is used at the transition point between two parking zones, it should display a right arrow and a left arrow pointing in the direction that the respective regulations apply.

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Standard. The times and days for which the parking regulations are in effect shall be posted if they are not in effect at all times of day or all days of the week.

Option. As an alternate to the use of arrows to show designated restriction zones, the following word messages may be used: BEGIN, END, HERE TO CORNER, HERE TO ALLEY, and THIS SIDE OF SIGN.

Standard. Where parking spaces are reserved for persons with disabilities, the Accessible Parking (R7-8) sign shall be used to designate the space and shall display the official International Symbol of Accessibility.

Where parking spaces that are reserved for persons with disabilities are designed to accommodate wheelchair vans, a VAN ACCESSIBLE (R7-8aP) plaque shall be mounted below the R7-8 sign.

The RESERVED PARKING for Persons with Disabilities (R7-8) sign shall be installed in rest area parking lots 10 ft. to 16 ft. from the edge of the handicap ramp.

Support. The R7-8L has a left arrow and the R7-8R a right arrow. The R7-8 does not have an arrow.

Guidance. Where parking spaces are designated for parking of electric vehicles, an Electric Vehicle Parking (R7-111 series, R7-112 series, and R7-113) sign should be installed adjacent to the designated spaces. Where there is no time limit, the R7-111 series sign should be used. Where parking is subject to a time limit, the R7-112 series sign should be used.

Where parking spaces are only designated for charging of electric vehicles, an R7-113 sign or R7-114 series sign should be installed adjacent to the designated spaces.

Where additional restrictions apply while a vehicle occupies the designated space, the R7-113P series plaques should be installed below the R7-113 sign or the R7-114 series signs.

Option. A Tow-Away Zone (R7-201P or R7-201aP) plaque may be mounted below any parking prohibition sign. The word legend TOW-AWAY ZONE may be incorporated into the parking prohibition sign in lieu of using a separate plaque.

The R7-201P plaque may have a black or red symbol and border on a white background.

Guidance. When a legend other than that on the standard parking signs is necessary, letter height, symbol size, and basic sign layout should be consistent with the those shown on the standard parking signs as detailed in the FHWA “Standard Highway Signs” publication (see EPG 911 (MUTCD Section 1A.05)).

In general, the letter height of the principal legend on parking signs sized for urbanized applications should be at least 2 inches.

The NO PARKING ON BRIDGE sign (R7-35) should be used at bridge ends or on bridges where motorists tend to block or endanger through traffic by parking on the bridge.

903.2.44 Placement of Parking, Standing, and Stopping Signs (MUTCD Section 2B.54)

Support. The efficacy of parking, standing, and stopping signs, when used on conventional roads in urbanized or developed environments, depends on their visibility and consistent placement along a street or within a particular block. It is often impracticable for the entire legend to be legible from similar distances as for other types of signs. Therefore, it is important that their conventional form be recognizable from an adequate distance such that the road user can obtain the information upon closer inspection.

Guidance. When signs with arrows are used to indicate the extent of the restricted zones, the signs should be set at an angle of not less than 30 degrees nor more than 45 degrees with the line of traffic flow in order to be visible to approaching traffic.

When signs are placed at the head of perpendicular parking stalls, the signs should be parallel to the roadway facing the parking stall.

Spacing of signs should be based on legibility, conspicuity, and sign orientation.

If the zone is long, signs should be used at intermediate points within the zone.

If the signs are mounted at an angle of 90 degrees to the curb line, two signs should be mounted back to back at the transition point between two parking zones, each with an appended THIS SIDE OF SIGN (R7-202P) supplemental plaque.

If the signs are mounted at an angle of 90 degrees to the curb line, signs without any arrows or appended plaques should be used at intermediate points within a parking zone, facing in the direction of approaching traffic. Otherwise, the standards of placement should be the same as for signs using directional arrows.

Option. Blanket parking regulations that apply to an entire jurisdiction may, if legal, be posted in the vicinity of the jurisdictional boundary lines. Blanket parking regulations that apply to a posted zone or district may, if legal, be posted at the entry points to the zone or district.

903.2.45 Emergency Restriction Signs (R8-7) (MUTCD Section 2B.55)



R8-7

Standard. Emergency Restriction signs shall be rectangular and shall have a black legend and border on a white background.

Option. The EMERGENCY STOPPING ONLY (R8-7) sign may be used to discourage or prohibit shoulder parking on the interstate and other freeway highway systems based on the Missouri Revised Statutes, Section 304.024.

Guidance. The use of the EMERGENCY STOPPING ONLY sign should be held to a minimum and not erected unless there is a specific problem.

Support. EPG 913.2.7 contains information for the use of the DO NOT STOP ON TRACKS (R8-8) sign to discourage or prohibit parking or stopping on railroad or light rail transit tracks.

903.2.46 Pedestrian Crossing Signs (R9-3) (MUTCD Section 2B.57)



R9-3



R9-3a

Option. Pedestrian Crossing signs may be used to limit pedestrian crossing to specific locations.

Standard. If used, Pedestrian Crossing signs shall be installed to face pedestrian approaches.

Option. The No Pedestrian Crossing (R9-3) sign may be used to prohibit pedestrians from crossing a roadway at an undesirable location or in front of a school or other public building where a crossing is not designated.

The NO PEDESTRIAN CROSSING (R9-3a) word message sign may be used as an alternate to the R9-3 symbol sign.

Support. Pedestrians with vision disabilities might need features other than traffic control devices to provide effective communication of the prohibition of pedestrian crossing.

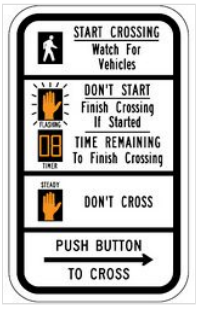
903.2.47 Traffic Signal Pedestrian and Bicyclist Actuation Signs (R10-3b, R10-3d, R10-3e, R10-4, and R10-25) (MUTCD Section 2B.58)



R10-3b



R10-3d



R10-3e



R10-4



R10-25

Standard. Where manual actuation of a traffic signal is required for pedestrians or bicyclists to call a signal phase to cross the roadway, traffic signal signs applicable to pedestrian actuation or bicyclist actuation shall be mounted immediately above or incorporated into the push button detector units (see EPG 902.9.5).

Support. Traffic signal signs applicable to pedestrians include:

A. Push Button for Walk Signal (R10-3 series), and
B. Push Button for Green Signal (R10-4 series).

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Option. If the signalized intersection has push buttons but no pedestrian heads the PUSH BUTTON FOR GREEN SIGNAL (R10-4) sign may be used instead of the R10-3e and R10-3j signs.

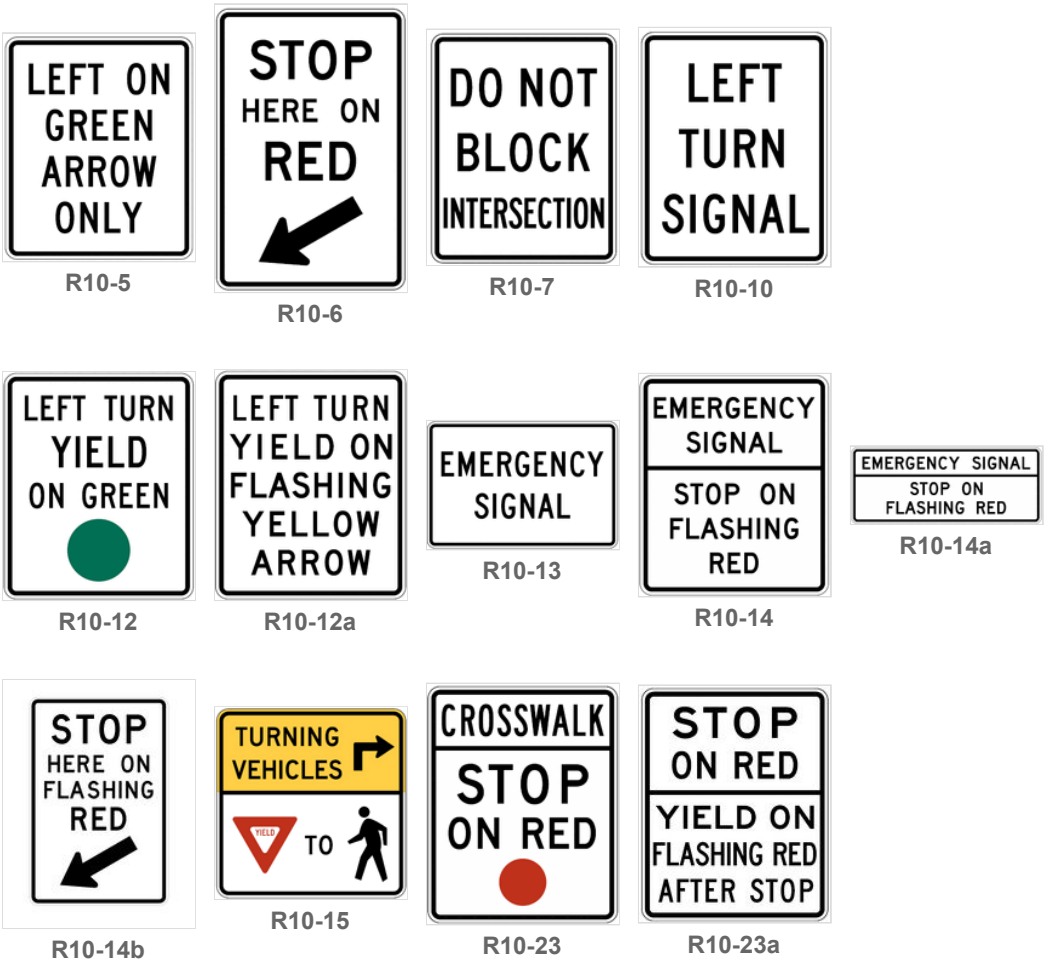
Guidance. The finger in the push button symbol on the R10-4 sign should point in the same direction as the arrow on the sign.

Option. Where symbolic pedestrian signal indications are used, an educational sign (R10-3b) may be used at signalized intersections. The R10-3d educational sign may be used to inform pedestrians that the pedestrian clearance time is sufficient only for the pedestrian to cross to the median at locations where pedestrians cross in two stages using a median refuge island. The R10-3e educational sign may be used where countdown pedestrian signals have been provided.

The R10-3e sign shall be used with pre-timed pedestrian signals. For actuated pedestrian signal, the R10-3eL and R10-3eR shall be mounted immediately above or incorporated in pedestrian pushbutton units.

The R10-25 sign may be used where a push button detector has been installed for pedestrians to activate In-Roadway Warning Lights (see EPG 902.20) or flashing beacons that have been added to the pedestrian warning signs.

903.2.48 Traffic Signal Signs and Plaques (R10-5 through R10-23a) (MUTCD Section 2B.59)



Option. To supplement traffic signal control, traffic signal (R10-5 through R10-30) signs may be used to regulate road users.

Traffic signal signs may be installed at certain locations to clarify signal control. Among the legends that may be used for this purpose are:

A. LEFT (RIGHT) ON GREEN ARROW ONLY (R10-5),
B. STOP HERE ON RED (R10-6) for observance of stop lines,
C. DO NOT BLOCK INTERSECTION (R10-7) for avoidance of traffic obstructions,
D. LEFT (RIGHT) TURN SIGNAL (R10-10),
E. U TURN SIGNAL (R10-10a) for exclusive control of a U-turn movement,
F. LEFT (RIGHT) TURN YIELD ON GREEN (symbolic circular green) (R10-12), and
G. LEFT (RIGHT) TURN YIELD ON FLASHING YELLOW ARROW (R10-12a).

Guidance. If used, the LEFT ON GREEN ARROW ONLY sign, the LEFT TURN SIGNAL sign, the LEFT TURN YIELD ON GREEN (symbolic circular green) sign, or the LEFT TURN YIELD ON FLASHING YELLOW ARROW sign should be located adjacent to the left-turn signal face.

Standard. The LEFT TURN SIGNAL (R10-10L) sign has been discontinued by MoDOT. These signs shall remain in place until the circular red indication is replaced with a red left arrow (see EPG 902.6.6 Signal Indications for Protected Only Mode Left-Turn Movements in a Separate Signal Face).

If an existing R10-10L is at the end of its service life, it shall be removed, and the circular red indication shall be replaced with a red left arrow.

Guidance. If used, the RIGHT ON GREEN ARROW ONLY sign, the RIGHT TURN SIGNAL sign, or the RIGHT TURN YIELD ON FLASHING YELLOW ARROW sign should be located adjacent to the right-turn signal face.

Option. If used, a U TURN SIGNAL (R10-10a) sign may be installed adjacent to the signal face that exclusively controls a U-turn movement.

Standard. The CROSSWALK—STOP ON RED (symbolic circular red) (R10-23) and STOP ON RED-YIELD ON FLASHING RED AFTER STOP (R10-23a) signs shall only be used in conjunction with pedestrian hybrid beacons (see EPG 902.10.2).

The EMERGENCY SIGNAL (R10-13) sign shall be used in conjunction with emergency-vehicle traffic control signals (see EPG 902.13.2).

The EMERGENCY SIGNAL—STOP ON FLASHING RED (R10-14 or R10-14a) sign shall be used in conjunction with emergency-vehicle hybrid beacons (see EPG 902.14.2).

Option. If needed for extra emphasis, a STOP HERE ON FLASHING RED (R10-14b) sign may be installed with an emergency-vehicle hybrid beacon.

Standard. The Left Turn Yield to Bicycles (R10-12b) sign shall be limited to applications where the conflicting bicyclist movement would be unexpected in direction, location, or similar condition that would tend to violate the expectation of a turning motorist.

Guidance. The Left Turn Yield to Bicycles sign should be located adjacent to the left-turn signal face.

Currently the R10-12b sign is not used by MoDOT. Contact the Highway Safety and Traffic division when considering the use of this sign.

Where conditions might warrant additional emphasis to drivers turning at a signalized intersection where potential pedestrian conflicts might not be readily apparent, a Turning Vehicles Yield to Pedestrians (R10-15) sign may be used.

The R10-15 series signs, where used, should be placed as follows:

A. On the near right corner of the signalized intersection for right-turning vehicles.
B. On the far left corner of the signalized intersection for the left-turning vehicles onto a two-way street.
C. On the near left corner of the signalized intersection for left-turning vehicles from a one-way street onto a one-way street.

903.2.49 No Turn on Red Signs (R10-11 and R10-30a) (MUTCD Section 2B.60)



R10-11

Standard. Where a right turn on a circular red signal indication (or a left turn on a circular red signal indication from a one-way street to a one-way street) is to be prohibited, a NO TURN ON RED (R10-11) word message sign shall be used.

The NO TURN ON RED (R10-11) sign shall be used to prohibit a right turn on red.

Guidance. If used, the No Turn on Red sign should be installed near the appropriate signal head.

A No Turn on Red sign should be considered when an engineering study finds that one or more of the following conditions exists:

A. Inadequate sight distance to vehicles approaching from the left (or right, if applicable);
B. Geometrics or operational characteristics of the intersection that might result in unexpected conflicts;
C. An exclusive pedestrian or bicycle phase;
D. An unacceptable number of conflicting pedestrian movements with right-turn-on-red maneuvers, especially involving children, older pedestrians, or persons with disabilities;
E. More than three right-turn-on-red crashes reported in a 12-month period for the particular approach; or
F. The skew angle of the intersecting roadways creates difficulty for drivers to see traffic approaching from their left (or right, if applicable).

Standard. If an R10-11 sign with conventional road size as shown in Table 903.2.3 is used on an approach on the far side of the intersection and the distance between the stop line and the sign is greater than 120 feet, then a duplicate sign shall be located on the near side of the intersection to supplement the sign on the far side of the intersection.

Except as provided by the option below, if right turn on red (RTOR) is restricted, then the NO TURN ON RED (R10-11) sign shall be used in lieu of the RIGHT TURN SIGNAL sign.

Guidance. If used, the NO TURN ON RED sign should mounted adjacent to the far right signal indication. Refer to EPG 902.6.13 to determine when a NO TURN ON RED sign should be considered.

Option. Where space is limited, the square-shaped NO TURN ON RED (R10-11b) sign may be used instead of the R10-11 sign.

When a no-turn-on-red restriction applies during certain time periods only, the following alternatives may be used:

> A Movement Prohibition (R3-1, R3-2, R3-4, R3-18, and R3-27) signs or NO TURN ON RED signs displayed by using a blank-out sign for the time period or one or more portion(s) of a particular cycle of the traffic control signal during which the prohibition is applicable; or

White LEDs may be used in the border and activated during periods of turn prohibition to enhance the sign conspicuity.

A RIGHT TURN ON RED MUST YIELD TO U-TURN (R10-30) sign may be installed to remind road users that they must yield to conflicting U-turn traffic on the street or highway onto which they are turning right on a red signal after stopping.

A RIGHT TURN MUST YIELD TO U-TURN (R10-30a) sign may be installed under a yield sign to remind road users that they must yield to conflicting U-turn traffic on the street or highway on to which they are turning right controlled by a yield sign.

903.2.50 Ramp Metering Signs (R10-28 and R10-29) (MUTCD Section 2B.61)



R10-28



R10-29

Option. When ramp control signals (see EPG 902.16) are used to meter traffic on a freeway or expressway entrance ramp, regulatory signs with legends appropriate to the control may be installed adjacent to the ramp control signal faces.

For entrance ramps with only one controlled lane, an XX VEHICLE(S) PER GREEN (R10-28) sign may be used to inform road users of the number of vehicles that are permitted to proceed during each short display of the green signal indication. For entrance ramps with more than one controlled lane, an XX VEHICLE(S) PER GREEN EACH LANE (R10-29) sign may be used to inform road users of the number of vehicles that are permitted to proceed from each lane during each short display of the green signal indication.

Support. EPG 903.12 contains provisions for the use of blank-out or changeable message signs when the metering is limited by time, day, or condition.

903.2.51 KEEP OFF MEDIAN Sign (R11-1) (MUTCD Section 2B.62)



R11-1

Option. The KEEP OFF MEDIAN (R11-1) sign may be used to prohibit driving into or parking on the median.

Guidance. The KEEP OFF MEDIAN sign should be installed on the left-hand side of the roadway within the median at random intervals as needed wherever there is a tendency for encroachment.

Support. A median is the area between two roadways of a divided highway measured from edge of travel way to edge of travel way or the area between a highway and an outer road.

903.2.52 ROAD CLOSED Sign (R11-2) and LOCAL TRAFFIC ONLY Signs (R11-3 and R11-4) (MUTCD Section 2B.63)



R11-2



R11-3



R11-4

Guidance. The ROAD CLOSED (R11-2) sign should be installed where roads have been closed to all traffic (except authorized vehicles).

ROAD CLOSED—LOCAL TRAFFIC ONLY (R11-3) or ROAD CLOSED TO THRU TRAFFIC (R11-4) signs should be used where through traffic is not permitted, or for a closure some distance beyond the sign, but where the highway is open for local traffic up to the point of closure.

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Standard. The Road Closed (R11-2, R11-3, and R11-4) signs shall be designed as horizontal rectangles. These signs shall be preceded by the applicable Advance Road Closed warning sign with the secondary legend AHEAD and, if applicable, an Advance Detour warning sign (see EPG 616.8.4).

903.2.53 Weight Limit Sign (R12-1) (MUTCD Section 2B.64)



R12-1

Support. In 2022, a new load posting policy was implemented by MoDOT in the EPG. This new policy resulted from a plan of corrective action with FHWA. With this new policy, all structures on the national bridge inventory will be categorized under this new policy within the next 10 years. There are 10,387 structures on the state system. 270 of these structures are major or unusual structures and these will be categorized over the next 10 years. The remaining 10,117 structures consist of 6,940 normal bridges and 3,177 culverts. The normal bridges will be categorized in the next 4 years and the culverts will be reviewed in the last 3 years of the 10 year timeline of the plan. The R12-1 sign remains in use, with the remaining MoDOT bridge posting signs being replaced by one of three new bridge posting signs in this article.

Standard. Weight limit signs shall be used to indicate a structure that has a vehicle weight restriction.

Guidance. The units shown on any weight limit sign should be tons.

Standard. Weight limit signs shall be installed in accordance with the new bridge posting classifications once completed.

A weight limit sign shall be located at the applicable structure in accordance with (see Table 903.2.53 and Figures 903.2.53.1 to 903.2.53.3).

An additional weight limit sign, with an advisory distance or directional legend, shall be located in advance of the applicable section of highway or structure so that prohibited vehicles can detour or turn around prior to the limit zone.

In commercial zones, bridges with the capacity of more the 65 tons shall not be posted, as normally loads in excess of 65 tons will not occur.

Once a bridge has been categorized, the bridge posting signs shall be updated within 30 days of the bridge posting reclassification. This includes installing the correct sign and configuring the sign locations to match the appropriate bridge posting figure (see Figures 903.2.53.1 to 903.2.53.3).

Support. If existing weight limit signs need to be replaced prior to a bridge being categorized, contact Highway Safety and Traffic Division, Signing Section, for guidance.

Table 903.2.53, Listing of Bridge Posting Categories

Statewide Legal Load Posting Gross Weight Categories					
Classification	**Category**	**Description**	**Sign Verbiage**	**Sign**	**Figure**
Normal Legal	SW-1	No Posting Required	N/A	N/A	N/A
Normal Legal	SW-2	General Gross Weight Limit	Weight Limit XX Tons	R12-1	903.5.36.1
Normal Legal	SW-3	Single Unit Vehicle Gross Weight Limit	Weight Limit Single Unit XX Tons	R12-12	903.5.36.1
Normal Legal	SW-4	Combination Vehicle Gross Weight Limit	Weight Limit Combination XX Tons	R12-13	903.5.36.1
Normal Legal	SW-5	Single Unit Vehicle and Combination Vehicle Gross Weight Limits	Weight Limit Single Unit XX Tons Combination XX Tons	R12-14	903.5.36.1
Statewide Legal Load Posting Centerline Restriction with Gross Weight Categories					
Classification	**Category**	**Description**	**Sign Verbiage**	**Sign**	**Figure**
Lane Restricted	LR-1	Lane Restriction Only	N/A	N/A	903.5.36.3
Lane Restricted	LR-2	Lane Restriction with General Gross Weight Limit	Weight Limit XX Tons	R12-1	903.5.36.2
Lane Restricted	LR-3	Lane Restriction with Single Unit Vehicle Gross Weight Limit	Weight Limit Single Unit XX Tons	R12-12	903.5.36.2
Lane Restricted	LR-4	Lane Restriction with Combination Vehicle Gross Weight Limit	Weight Limit Combination XX Tons	R12-13	903.5.36.2
Lane Restricted	LR-5	Lane Restriction with Single Unit Vehicle and Combination Vehicle Gross Weight Limits	Weight Limit Single Unit XX Tons Combination XX Tons	R12-14	903.5.36.2
Commercial Zone Areas Gross Weight Categories					
Classification	**Category**	**Description**	**Sign Verbiage**	**Sign**	**Figure**
Commercial Zone	CZ-1	No Posting Required	N/A	N/A	N/A
Commercial Zone	CZ-2	General Gross Weight Limit	Weight Limit XX Tons	R12-1	903.5.36.1
Commercial Zone	CZ-3	Single Unit Vehicle Gross Weight Limit	Weight Limit Single Unit XX Tons	R12-12	903.5.36.1
Commercial Zone	CZ-4	Combination Vehicle Gross Weight Limit	Weight Limit Combination XX Tons	R12-13	903.5.36.1
Commercial Zone	CZ-5	Single Unit Vehicle and Combination Vehicle Gross Weight Limits	Weight Limit Single Unit XX Tons Combination XX Tons	R12-14	903.5.36.1
Other Miscellaneous Load Posting Categories					
Classification	**Category**	**Description**	**Sign Verbiage**	**Sign**	**Figure**
Fire Truck	FT-1	General Gross Weight Limit for Emergency Vehicles Included in the FAST Act, Federal Reauthorization Bill	Weight Limit XX Tons	R12-1	903.5.36.1
Closed Bridge	K-CD	Closed to All Traffic	N/A	N/A	N/A

Closed Bridge	K-CIF	Closed to All Traffic as the Result of a Critical Inspection Finding	N/A	N/A	N/A
Other	OT-1	For Local Agency Bridges that have Signage that Doesn't Fit the Normal Legal, Lane Restricted, or Commercial Zone Categories	N/A	N/A	N/A

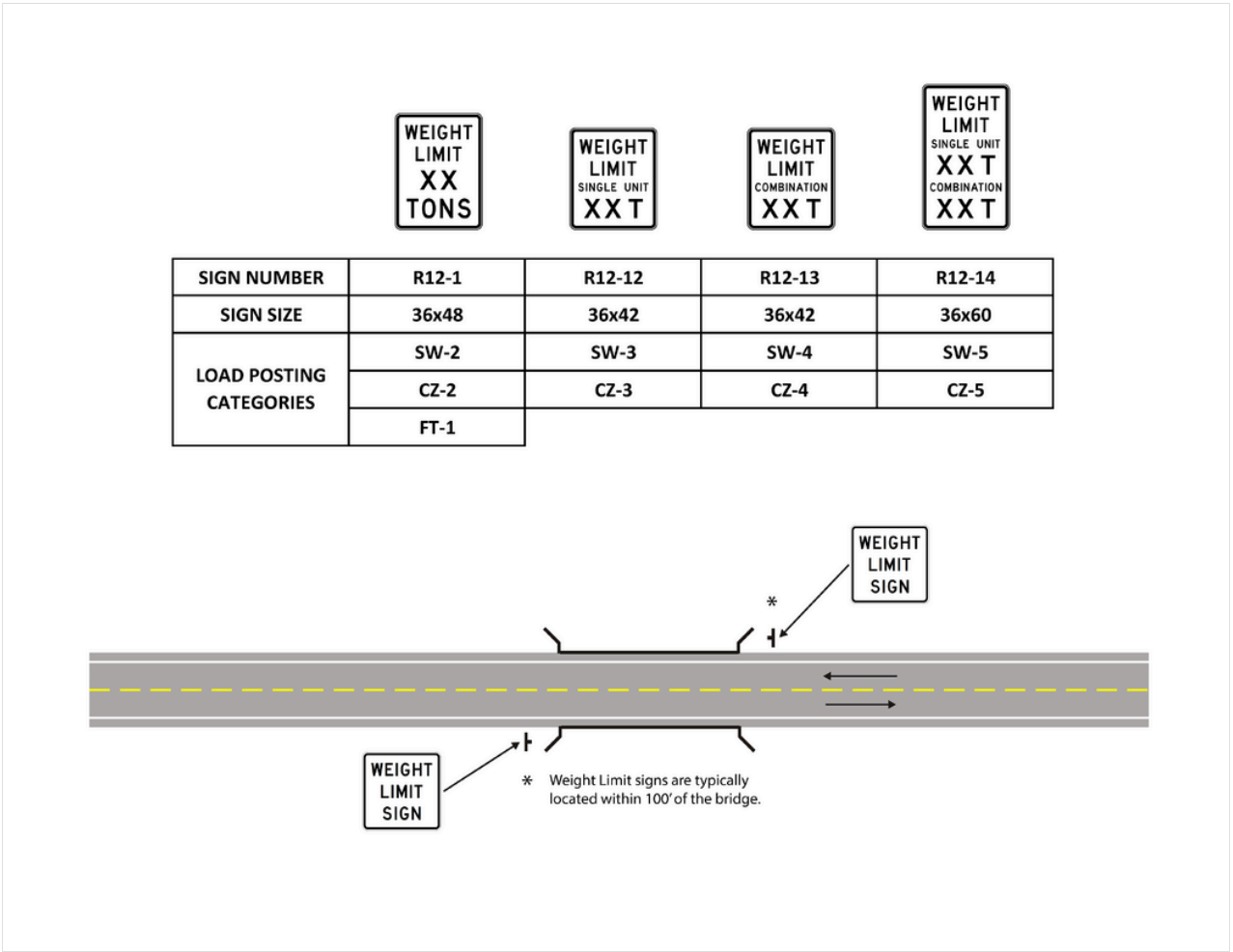
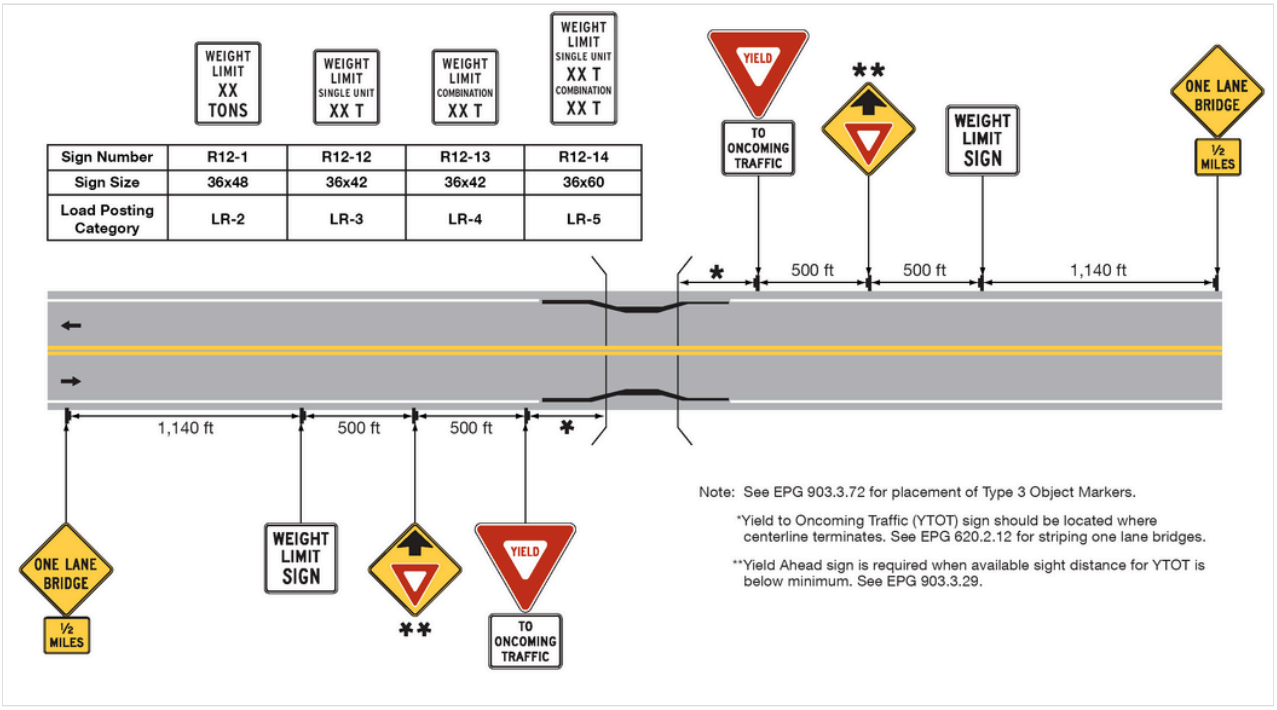


Figure 903.2.53.1 Weight Limit Restrictions



Sign Number	R12-1	R12-12	R12-13	R12-14
Sign Size	36x48	36x42	36x42	36x60
Load Posting Category	LR-2	LR-3	LR-4	LR-5

Figure 903.2.53.2 One Lane Bridge Weight and Width Restrictions

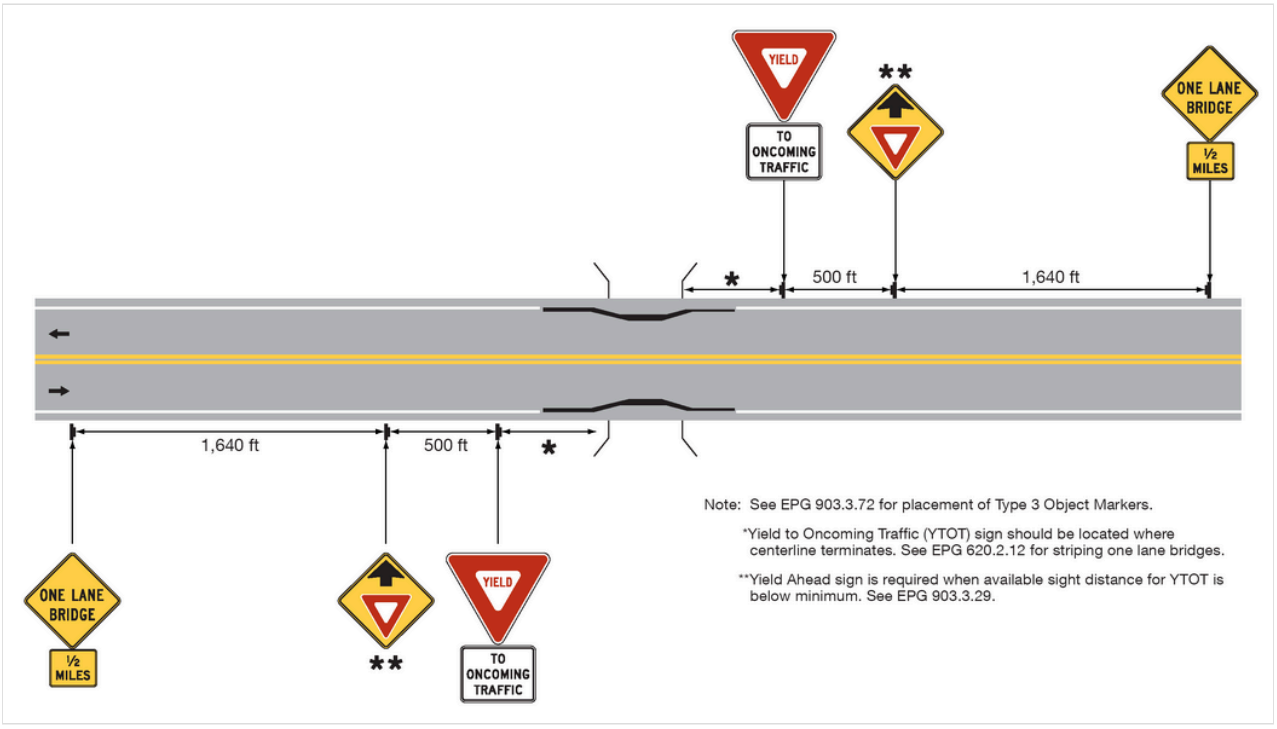


Figure 903.2.53.3 One Lane Bridge Width Restrictions

903.2.54 Weigh Station Sign (R13 Series) (MUTCD Section 2B.65)



R13-11



R13-15P



R13-16

Standard. The BUSES WEIGH sign (R13-11) should be used at all weigh stations to supplement the standard weigh station signing.

Guidance. The OPEN-CLOSED plaque (R13-15P) should be installed below all WEIGH STATION RIGHT LANE signs whenever an automatic OPEN-CLOSED sign has not been provided.

The BEFORE PULLING ON SCALE (R13-16) sign should be installed just to the right of the weigh scale and immediately in front thereof. A 30 in. STOP sign should be mounted above the sign.

903.2.55 TRUCK ROUTE Sign (R14-1) (MUTCD Section 2B.66)



R14-1

Guidance. The TRUCK ROUTE (R14-1) sign should be used to mark a route that has been designated to allow truck traffic.

903.2.56 Photo Enforced Signs and Plaques (R10-18a and R10-19P) (MUTCD Section 2B.69)



R10-18a


R10-19P

Option. A Signal Ahead (W3-3) sign and a Traffic Signal Photo Enforced (R10-18a) sign may be used on the same approach provided that they are on separate supports.

A Photo Enforced (R10-19P) plaque may be mounted below a regulatory sign to advise road users that the regulation is being enforced by photographic equipment.

Standard. The Traffic Signal Photo Enforced (R10-18a) sign shall be used on approaches to signalized locations where red-light cameras are present.

The Traffic Signal Photo Enforced (R10-18a) sign shall not be installed on approaches to signalized locations where red-light cameras are not present on any of the approaches to the signalized location.

A Traffic Signal Photo Enforced (R10-18a) sign shall not be installed on the same support in combination with a Signal Ahead (W3-3) sign.

If used below a regulatory sign, the Photo Enforced (R10-19P) plaque shall be a rectangle with a black legend and border on a white background.

Support. For more information about photo enforcement requirements, see EPG 950.

903.2.57 STATE LAW MOVE OVER OR SLOW DOWN FOR STOPPED EMERGENCY VEHICLES Sign (R16-25) (MUTCD Section 2B.71)



R16-25

Support. The STATE LAW MOVE OVER OR SLOW DOWN FOR STOPPED EMERGENCY VEHICLES (R16-25) sign is used to inform motorists of Missouri Revised Statutes 304.022, which requires motorists to drive with caution when approaching stopped emergency vehicles.

Guidance. The STATE LAW MOVE OVER OR SLOW DOWN FOR STOPPED EMERGENCY VEHICLES sign should be installed on Interstates entering the state at the state line. The location of the sign should be as close to the state line as possible and placed at the discretion of MoDOT.

Option. Additional STATE LAW MOVE OVER OR SLOW DOWN FOR STOPPED EMERGENCY VEHICLES signs may be installed on U.S. routes entering the state where there are no adjacent interstates and rest areas at the request of the Missouri State Highway Patrol.

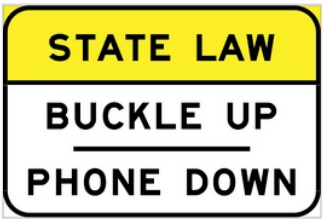
Standard. Requests for additional signs shall be forwarded to the appropriate district engineer for approval. These signs shall only be installed on divided highways. The installation of this sign shall not interfere with or detract from any other regulatory, warning, or guide signs.

903.2.58 Headlight Use Signs (R16-5a) (MUTCD Section 2B.73)

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Support. The HEADLIGHTS ON WHEN WIPERS ARE REQUIRED (R16-5a) sign, supported by RSMo 307.020 in 2004, was developed to inform motorists of the new law directing them to turn on headlights when wipers are on and during inclement weather. The use of these signs has been discontinued as the law has been in place for more than 15 years and many vehicles come equipped with headlights that turn on when wipers are activated. Existing signs are to be removed at the end of their sign life.

903.2.59 Seat Belt Symbol (MUTCD Section 2B.74)



R16-30

Guidance. The seat belt symbol should not be used alone. If used, the seat belt symbol should be incorporated into regulatory sign messages for mandatory seat belt use.

Support. The seat belt symbol is illustrated in the FHWA "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)).

Guidance. The R16-2, R16-3, R16-24, R16-27, and R16-27a seatbelt signs have been discontinued. These signs should remain in place to the end of their service life.

The STATE LAW BUCKLE UP PHONE DOWN (R16-30) sign should be installed at the end of the on ramp of rest areas and Missouri Welcome Centers on the interstate system. The STATE LAW BUCKLE UP PHONE DOWN (R16-30a) sign should be installed on Interstate and U.S. Routes at the state line entering Missouri. Neither sign should be installed at any other location along a roadway.

Support. A growing number of cities and counties are passing local ordinances to make seat belt usage a primary law in their communities. To promote the use of seat belts a PRIMARY SEAT BELT CITY / COUNTY - ORDINANCE sign may be installed by MoDOT upon request.

Standard. If a city/county has an established primary seat belt ordinance, MoDOT will install PRIMARY SEAT BELT CITY / COUNTY - ORDINANCE signs upon request once a copy of the ordinance has been received. When the PRIMARY SEAT BELT CITY / COUNTY - ORDINANCE is installed they shall be mounted to the right of the city limit sign or the entering county line sign.

Option. If insufficient space is available to mount the assembly to the right of these signs, the assembly shall be installed 200 ft. downstream of the city limit or county line signs at the appropriate sign spacing.

903.2.60 Barricades (MUTCD Section 2B.75)

Option. Barricades may be used to mark any of the following conditions:

A. The end of a roadway,
B. A ramp or lane that is closed for operational purposes, or
C. The permanent or semi-permanent closure or termination of a roadway.

Standard. When used to warn and alert road users of the terminus of a roadway, other than in temporary traffic control zones, barricades shall meet the design criteria of EPG 616.11.7 for a Type 3 Barricade, except that the colors of the stripes shall be retroreflective white and retroreflective red.

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Option. An end-of-roadway marker or markers may be used as described in EPG 903.3.73.

Guidance. Appropriate advance warning signs (see EPG 903.3) should be used.

903.2.61 NO PARKING ALL TRAILERS AND TRUCKS OVER 6 TONS (R7-36)



R7-36

Standard. NO PARKING ALL TRAILERS AND TRUCKS OVER 6 TONS (R7-36) signs shall be placed in each commuter parking lot. A sign shall be installed at or near each entrance of the commuter parking lot.

Support. This parking restriction is necessary because commuter lots have been used by commercial trailers and trucks for extended periods of parking.

903.2.62 STOP FOR SCHOOL BUS SIGN (R16-26)

Standard. The STOP FOR SCHOOL BUS (R16-26) sign has been discontinued. MoDOT shall no longer provide STOP FOR SCHOOL BUS (R16-26) signs. Existing STOP FOR SCHOOL BUS (R16-26) signs shall be left in place until they reach the end of their service life.

903.2.63 Other Regulatory Signs

Option. Regulatory word message signs other than those classified and specified in the EPG and the federal Standard Highway Signs and Markings book may be developed to aid the enforcement of other laws or regulations.

Except for symbols on regulatory signs, minor modifications in the design may be permitted provided that the essential appearance characteristics are met.

Standard. Special regulatory signs shall be approved by the State Highway Safety and Traffic Engineer.

903.2.64 Engine Brake Muffler Required Signing



R5-23

History. MoDOT once had a NOISE ORDINANCE ENFORCED policy which was developed to address cities' requests to install NO JAKE BRAKE signing. These requests were generated when a community experienced excessive noise related to improperly installed/operated engine braking systems on commercial vehicles. Jake brakes, or engine braking systems, are safety features of commercial vehicles. MoDOT was not willing to post

signs on state routes which prohibited the use of these safety devices. However, to address the increasing requests for signing, MoDOT did permit the installation of NOISE ORDINANCE ENFORCED signs if a city passed an appropriate ordinance. This program was replaced with the current ENGINE BRAKE MUFFLERS REQUIRED signing in January 2022. This change was designed to address shortcomings of the noise ordinance signing program, which included difficulty in enforcing a noise level and noise ordinances which did not contain language relevant to engine braking noise levels. The current program is based on the direction other states have taken, focusing on the physical equipment on a commercial vehicle which can be more easily inspected and evaluated for deficiencies. This signing program is also targeting the primary concern of excessive noise from engine braking.

Support. Commercial vehicles are commonly equipped with an engine braking system. These systems supplement the vehicle's mechanical brakes aiding in slowing these heavy vehicles safely. These safety systems, when not properly installed, can create excessive noise which many communities find objectionable. MoDOT does not permit regulatory signs which prohibit the use of these safety devices, however, the ENGINE BRAKE MUFFLERS REQUIRED signing conveys to truck drivers they must use these safety devices in an appropriate manner.

Option. If a community experiences issues with excessive noise from improperly used and installed engine braking systems on commercial vehicles, they can pass an ordinance and request MoDOT to install ENGINE BRAKE MUFFLERS REQUIRED signing at their city limit sign locations. MoDOT will install and maintain these signs with only a copy of the ordinance for our records, no fee or contract is involved. A jurisdiction can pass an ordinance specifically related to engine braking or include the language as part of another ordinance, such as a noise ordinance.

Standard. Before MoDOT will install ENGINE BRAKE MUFFLERS REQUIRED signing, a city must pass an appropriate ordinance which will be approved and kept on file by CO Highway Safety and Traffic. The ordinance shall include the following language:

Engine compression braking devices on any commercial vehicle, as defined in Missouri Revised Statute RSMo Section 301.010, may only be used within the city limits of [CITY NAME] if the truck is equipped with an adequate muffler (factory muffler or equivalent aftermarket muffler) which is properly maintained to prevent any excessive or unusual noise. If the truck's exhaust system is equipped with a muffler cut-off, bypass, or similar device, that device shall not be activated when the engine brake is being utilized. Unmuffled engine braking system shall only be utilized within the city limits by commercial motor vehicles in emergency situations to protect life or property. Engine braking systems on rescue vehicles, city and state vehicles are exempt from this ordinance if used in the performance of official duties.

ENGINE BRAKE MUFFLER REQUIRED signing shall only be installed at the city limit location.

ENGINE BRAKE MUFFLER REQUIRED signing shall not be installed on freeways or expressways within the city limits where the posted speed limit is 45 mph or greater due to the critical need for the device at higher speeds.

Existing NOISE ORDINANCE ENFORCED signs shall be removed at the end of the signs' service life, with no new NOISE ORDINANCE ENFORCED signs being installed after January 2022.

Individual sign installation locations can be denied by MoDOT if engineering judgement determines the prohibition would negatively impact safety, such as on long steep grades or abrupt/unexpected approaches to intersections.

Option. If the city limit on a freeway or expressway is within a posted speed limit of 45 mph or greater and the posted speed limit on that route drops to 40 mph or less, the ENGINE BRAKE MUFFLER REQUIRED sign may be installed adjacent to the speed limit sign where the speed limit drops below 45 mph.

At the end of a NOISE ORDINANCE ENFORCED sign's life, or before, a city may request the new ENGINE BRAKE MUFFLER REQUIRED signing once the appropriate ordinance is passed.

If there is insufficient space to the right of the city limit sign to place the ENGINE BRAKE MUFFLER REQUIRED sign, it may be installed 200 ft. downstream of the city limit sign.

903.2.65 Regulatory Signs For Trash/Dumping (R5-26, R5-28)



R5-28

Standard. The NO DUMPING sign (R5-28) shall be erected only at locations where the Department of Natural Resources has given us written notice that solid waste is being disposed of on highway right of way. NO MORE TRASH signs (R5-26) are not typically installed along MoDOT roadways. NO MORE TRASH signs (R5-26) should only be installed at commuter lots, rest areas or roadside parks. NO MORE TRASH signs shall only be installed along the roadway if a major liter issue has been identified and the sign is needed for enforcement purposes. Existing NO MORE TRASH signs (R5-26) shall be left in place until they reach the end of their service life.

903.2.66 Regulation Signs For Roadside Parks and Commuter Parking Lots (R20-1)



R20-1

Support. Regulation signs are displayed at MoDOT maintained roadside parks and commuter parking lots to convey the rules and regulations pertaining to each type of facility.

Guidance. A minimum of one regulation sign should be installed at each MoDOT maintained roadside park and commuter parking lot, with the sign(s) being installed in centralized location(s) where the sign will be within normal sight of visitors once they leave their vehicles.

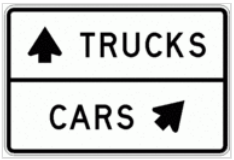
903.2.67 Rest Area Regulatory Signing (R20-2, R20-3, R20-4)



R20-2



R20-3



R20-4

Guidance. The REST AREA MAINTAINED BY (R20-3) sign should be installed in a prominent area along the entrance ramp to the rest area, preferably in the gore area separating truck / car traffic.

Standard. The TRUCKS-CARS (R20-4) sign shall be installed at the gore point inside the rest area to direct various vehicles to the appropriate parking lot.

A minimum of three REST AREA REGULATIONS (R20-2) signs shall be installed at each rest area.

The REST AREA MAINTAINED BY (R20-3) sign shall be installed at all rest areas to inform the public who is responsible to maintain the facility prior to the gore point.

903.2.68 Access Management Signing (R21-1 through R21-5)

Standard. ACCESS MANAGEMENT (R22-1 through R22-5) signs have been discontinued. MoDOT shall no longer provide ACCESS MANAGEMENT (R22-1 through R22-5) signs. Existing ACCESS MANAGEMENT (R22-1 through R22-5) signs shall be left in place until they reach the end of their service life.

903.2.69 Trucks and Buses 300 Ft Interval Sign (R4-30)

Standard. TRUCKS AND BUSES (R4-30) signs have been discontinued. MoDOT shall no longer provide TRUCKS AND BUSES (R4-30) signs. Existing TRUCKS AND BUSES (R4-30) signs shall be left in place until they reach the end of their service life.

903.2.70 FINES DOUBLED ENDS Sign (R2-20)



R2-20

Support. The FINES DOUBLED ENDS (R2-20) sign is not to be used on a system-wide basis. It is part of a signing package intended for special use at locations where severe crashes are occurring. There is a requirement for regional support to focus a safety campaign involving local law enforcement and public information efforts to reduce the number and severity of crashes within the travel safe zone (see EPG 907.3.2).

Standard: A FINES DOUBLED ENDS sign shall be used to mark the end of a designated travel safe zone. This sign is installed in conjunction with the TRAVEL SAFE ZONE – FINES DOUBLED (W26-1) sign.

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903.3 Warning Signs and Object Markers (MUTCD Chapter 2C)

903.3.1 Application of Warning Signs (MUTCD Section 2C.01)

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903.3.22 Low Clearance Signs (W12-2, and W12-2a) (MUTCD Section 2C.25)

903.3.23 BUMP and DIP Signs (W8-1 and W8-2) (MUTCD Section 2C.26)

903.3.24 PAVEMENT ENDS Sign (W8-3) (MUTCD Section 2C.28)

903.3.25 Slippery When Wet Sign (W8-5) (Section 2C.30)

Standard. The use of warning signs shall be based on an engineering study or on engineering judgment.

903.3.26 FALLEN ROCKS Signs (W8-14)

903.3.27 Warning Signs and Plaque for Motorcyclists (W8-15, W8-15aP, and W8-16) (MUTCD Section 2C.31)

903.3.28 IMPASSABLE WHEN WATER OVER ROAD Sign (MUTCD Section 2C.34)

903.3.29 Advance Traffic Control Signs (W3-1, W3-2, W3-3, and W3-4) (MUTCD Section 2C.35)

903.3.30 Advance Ramp Control Signal Signs (W3-7 and W3-8) (MUTCD Section 2C.37)

903.3.31 WATCH FOR STOPPED TRAFFIC Sign (W26-1) (MUTCD Section 2C.39)

903.3.32 Reduced Speed Limit Ahead and Speed Zone Signs (W3-5) (MUTCD Section 2C.40)

903.3.33 Intersection Warning Signs (W2-1 through W2-8) (MUTCD Section 2C.41)

903.3.34 Advance Intersection Signs (W2-10a and W2-11a)

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903.3.42 Two-Way Traffic Sign (W6-3) (MUTCD Section 2C.51)

903.3.43 NO PASSING ZONE Sign (W14-3) (MUTCD Section 2C.53)

903.3.44 Vehicular Traffic Warning Signs (MUTCD Section 2C.54)

903.3.45 Bicycle Warning (W11-1) Sign

903.3.46 Combined Bicycle/Pedestrian Crossing (W11-15) Sign

903.3.47 Trail Crossing (W11-15a) Sign

903.3.48 Horse-Drawn Vehicle (W11-14) Sign

903.3.49 TRUCK CROSSING (W8-6) Sign

903.3.50 Truck Entrance (W11-10) Sign

903.3.51 Farm Equipment (W11-5) Warning Sign

903.3.52 Emergency Vehicle (W11-8) Sign

903.3.53 Non-Vehicular Warning Signs (W11-2, W11-3, W11-4, and W11-7) (MUTCD Section 2C.55)

903.3.54 FERRY CROSSING AHEAD Sign (W3-18)

903.3.55 Passing Lane Warning Signs (W6-5, W6-5a, W6-6aP, W6-16, and W6-17)

903.3.56 TRAVEL SAFE ZONE – FINES DOUBLED Sign (W27-1)

Warning signs shall be retroreflective.

903.3.57 Use of Supplemental Warning Plaques (MUTCD Section 2C.57)

903.3.58 Design of Supplemental Warning Plaques (MUTCD Section 2C.58)

903.3.59 Advisory Speed Plaque (W13-1P) and Confirmation Advisory Speed Plaque (W13-1aP) (MUTCD Section 2C.59)

903.3.60 Distance Plaques (W16-2P, W16-3P, W16-4P, and W7-3aP) (MUTCD Section 2C.61)

903.3.61 Supplemental Arrow Plaques (W16-5P and W16-6P) (MUTCD Section 2C.62)

903.3.62 Diagonal Downward-Pointing Arrow Plaques (W16-7P and W16-7aP) (MUTCD Section 2C.63)

903.3.63 Hill-Related Plaques (W7-3 Series) (MUTCD Section 2C.64)

903.3.64 Advance Street Name Plaques (W16-8P and W16-8aP) (MUTCD Section 2C.65)

903.3.65 Traffic Does Not Stop Plaques (W4-4P Series) (MUTCD Section 2C.66)

903.3.66 IN ROAD and IN STREET Plaques (W16-1P) (MUTCD Section 2C.67)

903.3.67 NOTICE Plaque (W16-18p)

903.3.68 Exception Plaques (W16-23P and W16-24P)

903.3.69 Warning Signs Provided for Other Agencies

903.3.70 Object Marker Design and Placement Height (MUTCD Section 2C.70)

903.3.71 Object Markers for Obstructions Within the Roadway (MUTCD Section 2C.71)

903.3.72 Object Markers for Obstructions Adjacent to the Roadway (MUTCD Section 2C.72)

903.3.73 Object Markers for Ends of Roadways (MUTCD Section 2C.73)

903.3.74 Shoulder Barricade Assembly

Guidance. The use of warning signs should be kept to a minimum as the unnecessary use of warning signs tends to breed disrespect for all signs. In situations where the condition or activity is seasonal or temporary, the warning sign should be removed or covered when the condition or activity does not exist.

Support. The decision to use most warning signs is based on prevailing conditions. The items to be considered when determining the need for a warning sign are stopping sight distance and prevailing speed. Prevailing speed is determined by using either the posted or 85th percentile speed on the facility. Stopping sight distance is the distance a driver requires to perceive, react, and respond to a condition. The prevailing speed affects the amount of sight distance required for a condition.

It is recommended to use Table 903.3.1 to determine the stopping sight distance needed when considering the use of most warning signs. If the stopping sight distance is less than that in Table 903.3.1, a sign might be needed.

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Table 903.3.1 Stopping Sight Distance Requirements

Prevailing Speed (mph)	Distance (ft.)
30	200
35	250
40	305
45	360
50	425
55	495
60	570
65	645
70	730
Note: Based on "A Policy on Geometric Design of Highways and Streets", 2018 Edition, AASHTO, Table 3-1, Stopping Sight Distance	

903.3.2 Design of Warning Signs (MUTCD Section 2C.02)

Standard. Except as provided in the following Option paragraph or unless specifically designated otherwise, all warning signs shall be diamond-shaped (square with one diagonal vertical) with a black legend and border on a fluorescent yellow background. Warning signs shall be designed in accordance with the sizes, shapes, colors, and legends contained in the FHWA “Standard Highway Signs” publication (see EPG 911 (MUTCD Section 1A.05)).

Option. A warning sign that is larger than the size shown in the Oversized column in Table 903.3.3 for that particular sign may be diamond-shaped or may be rectangular or square in shape.

Support. The use of a shape other than diamond-shaped is typical for overhead installations. EPG 903.1.5 contains information on allowable methods to accommodate a diamond-shaped warning sign where the lateral space available in which to install a diamond-shaped warning sign is constrained, such as in urban locations, when mounting on a narrow median barrier or adjacent to a retaining wall, including the display of the standard legend in a vertically oriented rectangle.

The use of LEDs in the border and legend of warning signs is described in EPG 903.1.12.

Option. Word message warning signs other than those provided in the EPG may be developed and installed by MoDOT for conditions otherwise not addressed by standard signs (see EPG 903.1.4).

Support. MoDOT uses the fluorescent yellow-green (FYG) color exclusively for school signs. The only application where MoDOT would use the FYG color for bicycle or pedestrian signs is if a state route and local street intersected and the local jurisdiction utilized FYG color signs on their legs of the intersection. This would only be done to be in compliance with the MUTCD requirement that FYG and yellow shall not be intermixed in an application.

There are two primary reasons MoDOT has chosen not to use FYG color for bicycle or pedestrian signs. The first reason involves the MUTCD requirement that FYG color signs shall not be intermixed with other yellow color signs. A transition to FYG color signs would result in the premature replacement of all signs in an area when just one sign reached the end of its life or was damaged, resulting in wasted resources. The second reason, and most important, is to reserve FYG color signs for school signing to make these signs stand out from other signing, as school children are especially vulnerable road users.

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In response to repeated requests by a local jurisdiction for MoDOT to use the FYG color for bicycle and pedestrian signs, MoDOT initiated a research study to determine if there were any documented safety benefits for using the FYG color for these signs. Having previously adopted fluorescent orange for all work zone signs, MoDOT made the transition from standard yellow to fluorescent yellow (FY) for all warning signs as there was documentation to support this change in sheeting color. However, no documentation could be found to indicate that the FYG sign color provides any safety benefits when compared to the FY sign color. The research study surveyed other state DOTs as well as local MPOs to determine if they made a change to the FYG color, how they made the decision to do so, and if they could provide any research documentation which would support FYG to be safer than FY. The study showed there was no conclusive evidence to demonstrate that FYG sign color had any safety benefit compared to the FY sign color that MoDOT was already using. Most agencies who adopted FYG did so based on engineering judgement and not based on the results of research.

Standard. Warning signs regarding conditions associated with school buses and schools and their related supplemental plaques shall have a black legend and border on a fluorescent yellow-green background (see EPG 908.2.1).

Option. Consistent with the provisions of EPG 902.18.3, a Warning Beacon may be used in combination with a standard warning sign.

903.3.3 Size of Warning Signs and Plaques (MUTCD Section 2C.03)

Standard. Except as provided in EPG 903.1.7, the sizes for warning signs shall be as shown in Table 903.3.3.

Support. EPG 903.1.7 contains information regarding the applicability of the various columns in Table 903.3.3.

Option. Signs and plaques larger than those shown in Table 903.3.3 may be used (see EPG 903.1.11) for special applications where speed, volume or other factors result in conditions where increased emphasis, improved recognition or increased legibility would be desirable, with approval from the MoDOT Highway Safety and Traffic Division.

Guidance. The minimum size for all diamond-shaped warning signs facing traffic on exit and entrance ramps at interchanges should be the size identified in Table 903.3.3 for the mainline roadway classification (Freeway/Expressway).

Table 903.3.3 Warning Sign and Plaques Sizes

Sign or Plaque	Sign Designation	EPG Article	Conventional Road (in. x in.)		Freeway/Expressway (in. x in.)
			Standard	Oversized	Mainline & Ramps
Turn	W1-1	903.3.7	36 X 36	48 X 48	48 X 48
Curve	W1-2	903.3.7	36 X 36	48 X 48	48 X 48
Reverse Turn	W1-3	903.3.7	36 X 36	48 X 48	48 X 48
Reverse Curve	W1-4	903.3.7	36 X 36	48 X 48	48 X 48
Winding Road	W1-5	903.3.7	36 X 36	48 X 48	48 X 48
One-Direction Large Arrow	W1-6	903.3.10	48 X 24	72 X 36	72 X 36
Two-Direction Large Arrow	W1-7	903.3.35	48 X 24	72 X 36	72 X 36
Chevron	W1-8	903.3.8	18 X 24	30 X 36	30 X 36
Combination Horizontal Alignment/Intersection	W1-10 Series	903.3.9	36 X 36	48 X 48	48 X 48
Hairpin Curve	W1-11	903.3.7	36 X 36	48 X 48	48 X 48
Truck Rollover	W1-13	903.3.11	-	-	48 X 48
270° Curve	W1-15	903.3.7	-	-	48 X 48
Cross road	W2-1	903.3.33	36 X 36	48 X 48	48 X 48
Side Road	W2-2	903.3.33	36 X 36	48 X 48	48 X 48
Side Road (45°)	W2-3, 3a	903.3.33	36 X 36	48 X 48	48 X 48
T Intersection	W2-4	903.3.33	36 X 36	48 X 48	48 X 48
Y Intersection	W2-5	903.3.33	36 X 36	48 X 48	48 X 48
Circular Intersection	W2-6	903.3.33	36 X 36	48 X 48	48 X 48
Offset Side Road	W2-7	903.3.33	36 X 36	48 X 48	48 x 48
Double Side Roads	W2-8	903.3.33	36 X 36	48 X 48	48 X 48
Watch for Entering Traffic	W2-10a	903.3.34	36 X 36	48 X 48	48 X 48
Watch for Approaching Traffic	W2-11a	903.3.34	36 X 36	48 X 48	48 X 48
Stop Ahead	W3-1	903.3.29	36 X 36	48 X 48	48 X 48
Yield Ahead	W3-2	903.3.29	36 X 36	48 X 48	48 X 48
Signal Ahead	W3-3	903.3.29	36 X 36	48 X 48	48 X 48
Be Prepared to Stop	W3-4	903.3.29	36 X 36	48 X 48	48 X 48
Reduced Speed Ahead	W3-5	903.3.32	36 X 36	48 X 48	48 X 48
Ramp Meter Ahead	W3-7	903.3.30	36 X 36	-	-
Ramp Metered When Flashing	W3-8	903.3.30	36 X 36	-	-
Ferry Crossing Ahead	W3-18	903.3.54	36 X 36	48 X 48	-
Merge	W4-1	903.3.37	36 X 36	48 X 48	48 X 48
Lane Ends	W4-2	903.3.39	36 X 36	48 X 48	48 X 48
Added Lane	W4-3	903.3.38	36 X 36	48 X 48	48 X 48
Cross Traffic Does Not Stop (plaque)	W4-4P	903.3.37	24 X 12	36 X 18	36 X 18
Traffic From Left Does Not Stop (plaque)	W4-4aPL	903.3.37	24 X 12	36 X 18	36 X 18

Traffic From Right Does Not Stop (plaque)	W4-4aPR	903.3.37	24 X 12	36 X 18	36 X 18
Oncoming Traffic Does Not Stop (plaque)	W4-4bP	903.3.37	24 X 12	36 X 18	36 X 18
Entering Roadway Merge	W4-5	903.3.37	36 X 36	48 X 48	48 X 48
Entering Roadway Added Lane	W4-6	903.3.38	36 X 36	48 X 48	48 X 48
Single Lane Transition	W4-8	903.3.40	36 X 36	48 X 48	48 X 48
ROAD NARROWS	W5-1	903.3.15	36 X 36	48 X 48	48 X 48
NARROW BRIDGE	W5-2	903.3.16	36 X 36	48 X 48	48 X 48
ONE LANE BRIDGE	W5-3	903.3.17	36 X 36	48 X 48	-
Divided Highway	W6-1	903.3.18	36 X 36	48 X 48	-
Divided Highway Ends	W6-2	903.3.19	-	-	48 X 48
Two-Way Traffic	W6-3	903.3.42	36 X 36	48 X 48	-
Two-Way Traffic (2-Lane)	W6-5	903.3.55	36 X 36	48 X 48	-
Two-Way Traffic (3-Lane)	W6-5a	903.3.55	36 X 36	48 X 48	
Passing Lane (plaque)	W6-6aP	903.3.55	42 X 12	-	-
Passing Lane Ends	W6-16	903.3.55	36 X 36	-	-
Watch for Left-Turning Traffic in Passing Lane	W6-17	903.3.55	72 X 48	-	-
Hill	W7-1	903.3.14	36 X 36	48 X 48	48 X 48
Uphill	W7-1c	903.3.14	36 X 36	48 X 48	48 X 48
Percent Grade	W7-3P	903.3.63	24 X 18	30 X 24	30 X 24
Next _ Miles (plaque)	W7-3aP	903.3.63	24 X 18	30 X 24	30 X 24
Bump	W8-1	903.3.23	36 X 36	48 X 48	48 X 48
Dip	W8-2	903.3.23	36 X 36	48 X 48	48 X 48
Pavement Ends	W8-3	903.3.24	36 X 36	-	-
Slippery When Wet	W8-5	903.3.25	36 X 36	48 X 48	48 X 48
Truck Crossing	W8-6	903.3.49	36 X 36	48 X 48	48 X 48
Fallen Rocks	W8-14	903.3.26	36 X 36	48 X 48	48 X 48
Road May Flood	W8-18	903.3.28	36 X 36	48 X 48	48 X 48
Impassable During High Water	W8-34	903.3.28	36 X 36	48 X 48	48 X 48
Left (Right) Lane Ends	W9-1	903.3.39	36 X 36	48 X 48	48 X 48
Lanes Merge	W9-4	903.3.40	36 X 36	48 X 48	48 X 48
Right (Left) Lane Exit Only	W9-7	903.3.41	132 X 70	-	132 X 70
Bicycle	W11-1	903.3.45	36 X 36	-	-
Pedestrian	W11-2	903.3.53	36 X 36	48 X 48	-
Cattle	W11-4	903.3.53	36 X 36	48 X 48	
Farm Vehicle	W11-5	903.3.51	36 X 36	-	-
Equestrian	W11-7	903.3.53	36 X 36	-	-
Emergency Vehicle	W11-8	903.3.52	36 X 36	48 X 48	48 X 48
Truck Entrance	W11-10	903.3.50	36 X 36	48 X 48	48 X 48

Emergency Signal Ahead (plaque)	W11-12P	903.3.52	36 X 30	-	36 X 30
Horse-Drawn Vehicle	W11-14	903.3.48	36 X 36	48 X 48	48 X 48
Bike / Ped	W11-15	903.3.46	36 X 36	48 X 48	48 X 48
Trail Crossing	W11-15a	903.3.47	36 X 36	-	-
Double Arrow	W12-1	903.3.20	30 X 30	36 X 36	36 X 36
Low Clearance Advance	W12-2	903.3.22	36 X 36	48 X 48	48 X 48
Low Clearance (overhead)	W12-2a	903.3.22	84 X 24	-	84 X 24
Advisory Speed	W13-1P	903.3.33	24 X 24	30 X 30	30 X 30
Advisory Speed (plaque)	W13-1aP	903.3.33	48 X 15	-	48 X 15
Advisory Exit Speed	W13-2	903.3.12	-	-	48 X 60
Advisory Ramp Speed	W13-3	903.3.12	-	-	48 X 60
Advisory Exit Speed with 270° Loop Arrow	W13-6	903.3.12	-	-	48 X 84
Advisory Ramp Speed with 270° Loop Arrow	W13-7	903.3.12	-	-	48 X 84
Advisory Exit Speed with 180° Hairpin Arrow	W13-8	903.3.12	-	-	48 X 84
Advisory Ramp Speed with 180° Hairpin Arrow	W13-9	903.3.12	-	-	48 X 84
Advisory Exit Speed with 90° Turn Arrow	W13-10	903.3.12	-	-	48 X 72
Advisory Ramp Speed with 90° Turn Arrow	W13-11	903.3.12	-	-	48 X 72
Advisory Exit Speed with Truck Rollover	W13-12	903.3.12	-	-	48 X 84
Advisory Ramp Speed with Truck Rollover	W13-13	903.3.12	-	-	48 X 84
Vehicle Speed Feedback Sign	W13-20	903.3.13	30 X 36	-	48 X 60
Vehicle Speed Feedback (plaque)	W13-20aP	903.3.13	30 X 24	-	48 X 36
Dead End	W14-1	903.3.21	36 X 36	36 X 36	-
No Outlet	W14-2	903.3.21	36 X 36	36 X 36	-
No Passing Zone (pennant)	W14-3	903.3.43	-	-	-
Road Ends	W14-13	903.3.21	36 X 36	36 X 36	-
In Road (plaque)	W16-1P	903.3.66	24 X 18	-	24 X 18
XX FEET (plaque)	W16-2P	903.3.60	24 X 18	30 X 24	30 X 24
XX MILES (plaque)	W16-3P	903.3.60	24 X 18	30 X 24	30 X 24
NEXT _ FEET (plaque)	W16-4P	903.3.60	24 X 18	30 X 24	30 X 24
Directional Arrow (plaque)	W16-5P	903.3.61	30 X 21	-	30 X 21
Advance Turn Arrow (plaque)	W16-6P	903.3.61	30 X 21	-	30 X 21
Downward Diagonal Arrow (plaque)	W16-7P	903.3.62	30 X 21	-	30 X 21
Dual Downward Diagonal Arrow (plaque)	W16-7aP	903.3.62	30 X 21	-	30 X 21
Two Line Street Name (plaque)	W16-8aP	903.3.64	Varies X 15	Varies X 24	Varies X 24
Advance Street Name (plaque)	W16-8P	903.3.64	Varies X 8	Varies X 12	Varies X 12

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Ahead (plaque)	W16-9P	903.3.44, 903.3.53	30 X 18	-	30 X 18
Notice (plaque)	W16-18P	903.3.68	36 X 12	48 X 18	48 X 18
Except to Turn (plaque)	W16-23P	903.3.68	48 X 30	-	-
Except to Exit (plaque)	W16-24P	903.3.68	48 X 30	-	-
Double Reverse Curve Left - 1 Lane	W24-1L	903.3.7	36 X 36	-	36 X 36
Double Reverse Curve Left - 2 Lanes	W24-1aL	903.3.7	36 X 36	-	36 X 36
Double Reverse Curve Left - 3 Lanes	W24-1bL	903.3.7	36 X 36	-	36 X 36
Oncoming Traffic Has Extended Green	W25-1	903.3.36	24 X 30	-	-
Oncoming Traffic May Have Extended Green	W25-2	903.3.36	24 X 30	-	-
Watch for Stopped Traffic	W26-1	903.3.31	36 X 36	48 X 48	48 X 48
Travel Safe Zone	W27-1	903.3.56	36 X 48	48 X 60	48 X 60

903.3.4 Placement of Warning Signs (MUTCD Section 2C.04)

Support. Information on the placement of warning signs is contained in EPG 903.1.13 through 903.1.18.

The time needed for detection, recognition, decision, and reaction is called the Perception-Response Time (PRT). Table 903.3.4 is provided as an aid for determining warning sign location. The distances shown in Table 903.3.4 can be adjusted for roadway features, other signing, and to improve visibility.

Guidance. Warning signs should be placed so that they provide an adequate PRT. The distances contained in Table 903.3.4 should be applied with engineering judgment.

Minimum spacing between warning signs with different messages should be based on the estimated PRT for driver comprehension of and reaction to the second sign.

The effectiveness of the placement of warning signs should be periodically evaluated. This is typically accomplished during routine sign inspection cycles. EPG 903.1.19 contains information regarding MoDOT's sign maintenance program.

Standard. When any part of a warning sign assembly (post, sign, plaque, etc.) is replaced, maintained or modified, the placement of the sign shall be reviewed based on Table 903.3.4. Additionally, mounting height shall be reviewed for conformance with EPG 903.1.15.

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Table 903.3.4 Guidelines for Advance Placement of Warning Signs

Posted or 85th-Percentile Speed	Advance Placement Distance[1]								
	Condition A: Speed reduction and lane changing in heavy traffic[2]	Condition B: Deceleration to the listed advisory (mph) for the condition							
		0[3]	10[4]	20[4]	30[4]	40[4]	50[4]	60[4]	70[4]
20 mph	225 ft	115 ft	N/A[5]	—	—	—	—	—	—
25 mph	325 ft	155 ft	N/A[5]	N/A[5]	—	—	—	—	—
30 mph	460 ft	200 ft	N/A[5]	N/A[5]	—	—	—	—	—
35 mph	565 ft	250 ft	N/A[5]	N/A[5]	N/A[5]	—	—	—	—
40 mph	670 ft	305 ft	100 ft[6]	100 ft[6]	N/A[5]	—	—	—	—
45 mph	775 ft	360 ft	125 ft	100 ft[6]	100 ft[6]	N/A[5]	—	—	—
50 mph	885 ft	425 ft	200 ft	175 ft	125 ft	100 ft[6]	—	—	—
55 mph	990 ft	495 ft	275 ft	225 ft	200 ft	125 ft	N/A[5]	—	—
60 mph	1100 ft	570 ft	350 ft	325 ft	275 ft	200 ft	100 ft[6]	—	—
65 mph	1200 ft	645 ft	450 ft	400 ft	350 ft	275 ft	200 ft	100 ft[6]	—
70 mph	1250 ft	730 ft	525 ft	500 ft	450 ft	375 ft	275 ft	150 ft	—
75 mph	1350 ft	820 ft	625 ft	600 ft	550 ft	475 ft	375 ft	250 ft	100 ft[6]

Note 1 — For Advanced Placement Distance — General

- The distances are adjusted for a sign legibility distance of 180 feet for Condition A.
- The distances for Condition B (with the exception of the potential stop condition) have been adjusted for a sign legibility distance of 250 feet, which is appropriate for an alignment warning symbol sign.
- For Conditions A and B, warning signs with less than 6-inch legend or more than four words, a minimum of 100 feet should be added to the advance placement distance to provide adequate legibility of the warning sign.

Note 2 — For Condition A — Speed Reduction and Lane Change Conditions

- Typical conditions are locations where the road user must use extra time to adjust speed and change lanes in heavy traffic because of a complex driving situation or reduce to a new posted speed.
- Typical signs are Merge, Right Lane Ends, and Reduced Speed Ahead.
- The distances are determined by providing the driver a PRT of 14.0 to 14.5 seconds for vehicle maneuvers (2018 AASHTO Policy, Table 3-3, Decision Sight Distance, Avoidance Maneuver E) and adjusted for a legibility distance of 180 feet for the appropriate sign.

Note 3 — For Condition B — Stop Condition

- Typical condition is the warning of a potential stop situation.
- Typical signs are Stop Ahead, Yield Ahead, Signal Ahead, and Intersection Warning signs.
- The distances are based on the 2018 AASHTO Policy, Table 3-1, Stopping Sight Distance, providing a PRT of 2.5 seconds, a deceleration rate of 11.2 feet/second^2.

Note 4 — For Condition B — Reduced Speed Conditions

- Typical conditions are locations where the road user must decrease speed to maneuver through the warned condition.
- Typical signs are Turn, Curve, Reverse Turn, Reverse Curve, or Reduced Speed Ahead.
- The distance is determined by providing a 2.5 second PRT, a vehicle deceleration rate of 10 feet/second2, and adjusted for a sign legibility distance of 250 feet.

Note 5 — For Condition B — N/A Values

- No suggested distances are provided for these speeds, as the placement location is dependent on site conditions and other signing.
- An alignment warning sign may be placed anywhere from the point of curvature up to 100 feet in advance of the curve.
- However, the alignment warning sign should be installed in advance of the curve and at least 100 feet from any other signs.

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Note 6 — For Condition B — for shortest distance values per posted speed

- The minimum advance placement distance is listed as 100 feet to provide adequate spacing between signs.

General Note:

Warning signs that advise road users about conditions that are not related to a specific location can be installed in an appropriate location, based on engineering judgment.

903.3.5 Horizontal Alignment Warning Signs – General (MUTCD Section 2C.05)

Support. A variety of horizontal alignment warning signs, pavement markings (see EPG 620.2), and delineation (see EPG 620.6) can be used to advise motorists of a change in the roadway alignment. Uniform application of these traffic control devices with respect to the amount of change in the roadway alignment conveys a consistent message establishing driver expectancy and promoting effective roadway operations. The design and application of horizontal alignment warning signs to meet those requirements are addressed in EPG 903.3.5 through 903.3.12.

The following list identifies treatments that might be used in advance of or within a change in horizontal alignment:

A. Horizontal alignment (Turn (W1-1), Curve (W1-2, W1-10 series, W1-11, W1-13, W1-15), Reverse Turn (W1-3), Reverse Curve (W1-4), Winding Road (W1-5), Exit Speed (W13-2), Ramp Speed (W13-3), and Combination Horizontal Alignment (Advisory Exit or Ramp Speed W13-6 through W13-11)) signs (see EPG 903.3.7, 903.3.9, and 903.3.12)
B. Advisory Speed (W13-1P) plaque (see EPG 903.3.59)
C. Chevron Alignment (W1-8) signs (see EPG 903.3.8)
D. One Direction Large Arrow (W1-6) sign (see EPG 903.3.10)
E. Sign or marking conspicuity enhancements (see EPG 903.1.11)
F. Longitudinal rumble strips (see EPG 620.10.1)
G. Vehicle Speed Feedback Sign (see EPG 903.3.13)

In addition, considerations other than traffic control devices, such as improved surface friction (high friction surface treatments), pavement edge treatments, lighting improvements, increased superelevation, and longitudinal rumble strips, might be used in advance of or within a change in horizontal alignment.

Guidance. Except as provided in EPG 903.3.6, the selection of traffic control devices used to warn road users of a change in horizontal alignment or to provide guidance in navigating the change in horizontal alignment should be based on consideration of one or more of the following factors:

A. The speed of traffic on the approach to the change in horizontal alignment
B. The recommended advisory speed for the change in horizontal alignment
C. The difference between the speed limit and the advisory speed, or the speed differential for the change in horizontal alignment
D. Daily traffic volumes on the roadway
E. The typical mix of vehicle types on the roadway
F. Sight distance throughout the change in horizontal alignment
G. Other types of traffic control devices that are used in advance of and within the change in horizontal alignment on the same roadway segment
H. The crash history of the change in horizontal alignment

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I. The presence of driveways or intersections within the curve radius

903.3.6 Device Selection for Changes in Horizontal Alignment (MUTCD Section 2C.06)

Standard: Table 903.3.6 shall be used to specify the type(s) of warning signs to be used in advance of, and/or along, a horizontal curve, except as provided in following Option paragraph. The speed differential shall be the difference between the horizontal curve's advisory speed and the roadway's posted speed limit on the approach to the curve.

Option. A One Direction Large Arrow (W1-6) sign may be used to supplement Chevron Alignment (W1-8) signs when:

A. Site conditions limit the number of Chevron Alignment signs that are visible; or

B. The number of Chevron Alignment signs that can be installed within the change in horizontal alignment is less than the number determined by the spacing specified in EPG 903.3.8.

Additional or supplemental devices may be used for a change in horizontal alignment on the basis of engineering judgment.

If engineering judgment indicates the need for the horizontal alignment sign for a curve that can be driven at or above the posted speed limit, horizontal alignment signs may be installed with the Advisory Speed Plaque (W13-1P) displaying an advisory speed equal to the posted speed limit.

Warrants for center lines and edge lines are provided in EPG 620.2.2 and 620.2.11, respectively.

Provisions for delineators are contained in EPG 620.6.

Provisions for Advisory Speed (W13-1P) plaques are contained in EPG 903.3.59.

Table 903.3.6 Application of Warning Signs for Changes in Horizontal Alignment

Speed Differential[1]	Warning Signs Required
5 to 10 mph	Horizontal Alignment warning sign[2] Advisory Speed plaque[3]
15 mph or more	Horizontal Alignment warning sign[2] Advisory Speed plaque[3] Chevron Alignment signs[4]

1. Speed differential shall be the difference between the horizontal curve's advisory speed and the roadway's posted speed limit.
2. Provisions for the use of Horizontal Alignment warning signs are contained in EPG 903.3.6.
3. Provision for Advisory Speed (W13-1P) plaques are contained in EPG 903.3.59.
4. EPG 903.3.6 contains information about the use of a One Direction Large Arrow (W1-6) sign in place of or to supplement chevron alignment signs.

903.3.7 Horizontal Alignment Signs (W1-1 through W1-5, W1-11, W1-15, W24-1) (MUTCD Section 2C.07)



Standard. When a horizontal alignment sign is required as provided in EPG 903.3.6 the sign installed in advance of the curve shall be a Curve (W1-2) sign unless a different sign is recommended or allowed by the provisions of this Article.

A Turn (W1-1) sign shall be used instead of a Curve (W1-2) sign in advance of a horizontal curve that has an advisory speed of 30 mph or less.

Guidance. Where there are two changes in roadway alignment in opposite directions that are separated by a tangent distance of less than 600 feet, the Reverse Turn (W1-3) sign should be used instead of multiple Turn (W1-1) signs or the Reverse Curve (W1-4) sign should be used instead of multiple Curve (W1-2) signs.

Support. Figures 903.3.7.1 and 903.3.7.2 provide examples of warning signs used for turns and curves.

Option. A Winding Road (W1-5) sign may be used instead of multiple Turn (W1-1) or Curve (W1-2) signs where there are three or more changes in roadway alignment each separated by a tangent distance of less than 600 feet.

A NEXT XX MILES (W7-3aP) supplemental distance plaque (see EPG 903.3.60) may be installed below the Winding Road sign where continuous roadway curves exist for a specific distance.

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If the curve has a change in horizontal alignment of 135 degrees or more, the Hairpin Curve (W1-11) sign may be used instead of a Turn or Curve sign.

If the curve has a change of direction of approximately 270 degrees, such as on a cloverleaf interchange ramp, the 270-degree Loop (W1-15) sign may be used instead of a Turn or Curve sign.

Guidance. When the Hairpin Curve sign or the 270-degree Loop sign is installed, either a One-Direction Large Arrow (W1-6) sign or Chevron Alignment (W1-8) signs should be installed on the outside of the turn or curve.

Option. A double reverse left sign (W24-1L) and advisory speed plaque may be used on the crossroad approaches to a Diverging Diamond Interchange (DDI) when the difference between the speed limit and the advisory speed is 5 mph or greater. The need for this signing is based on engineering judgment if speeding through a DDI is a concern. An Advisory speed plaque is typically installed where the posted speed on the crossroad of the DDI is 40 mph or greater.

Standard. If used with an advisory speed plaque, the W24-1L sign shall display the number of double reverse arrows which indicates the number of lanes on the crossroad going through the DDI in the direction of travel where the sign is observed.

Support. See EPG 903.3.59 for information regarding Advisory Speed Plaques (W13-1P).

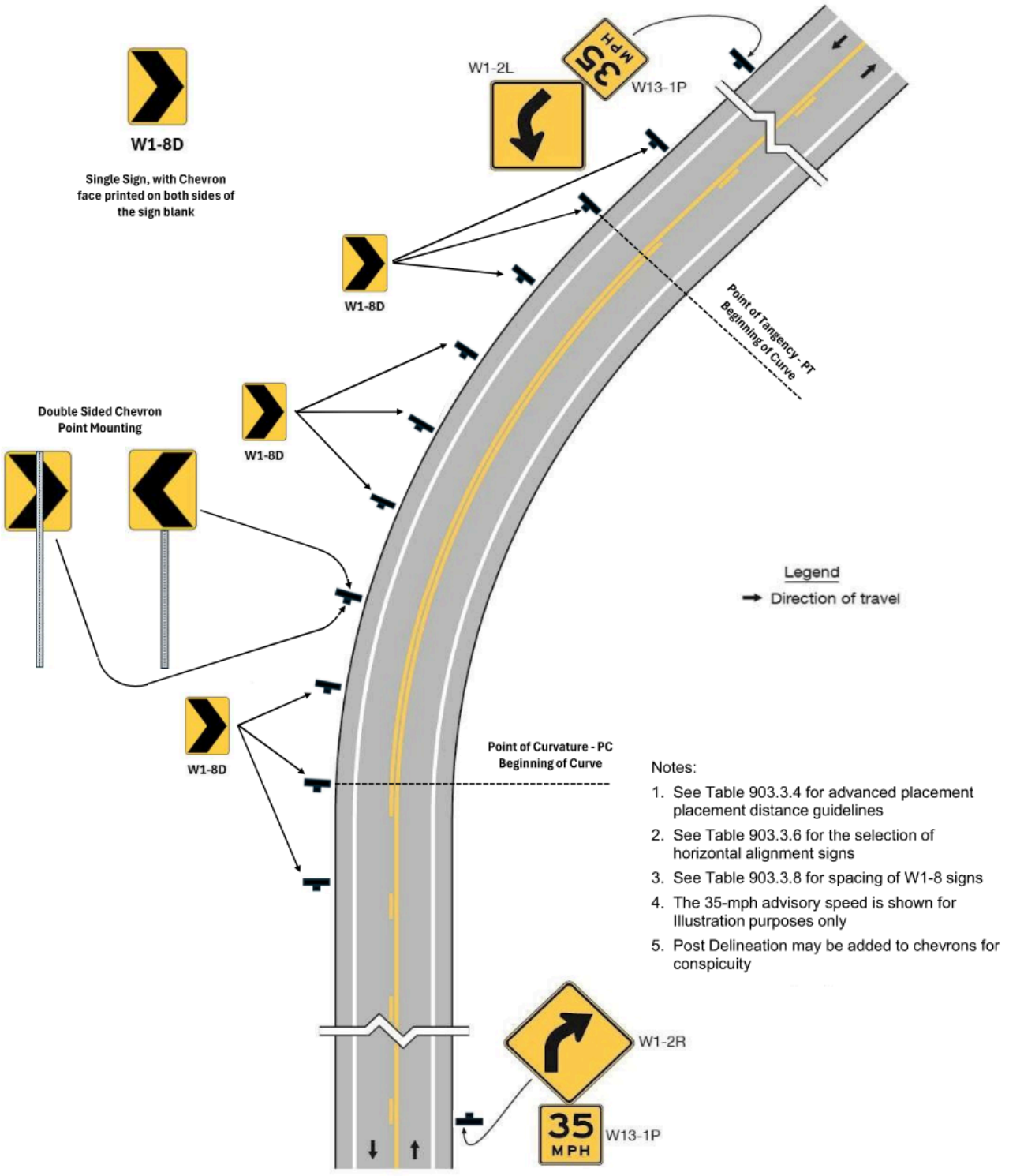


Figure 903.3.7.1 Examples of Warning Signs for Changes in Horizontal Alignment *(Sheet 1 of 2)*

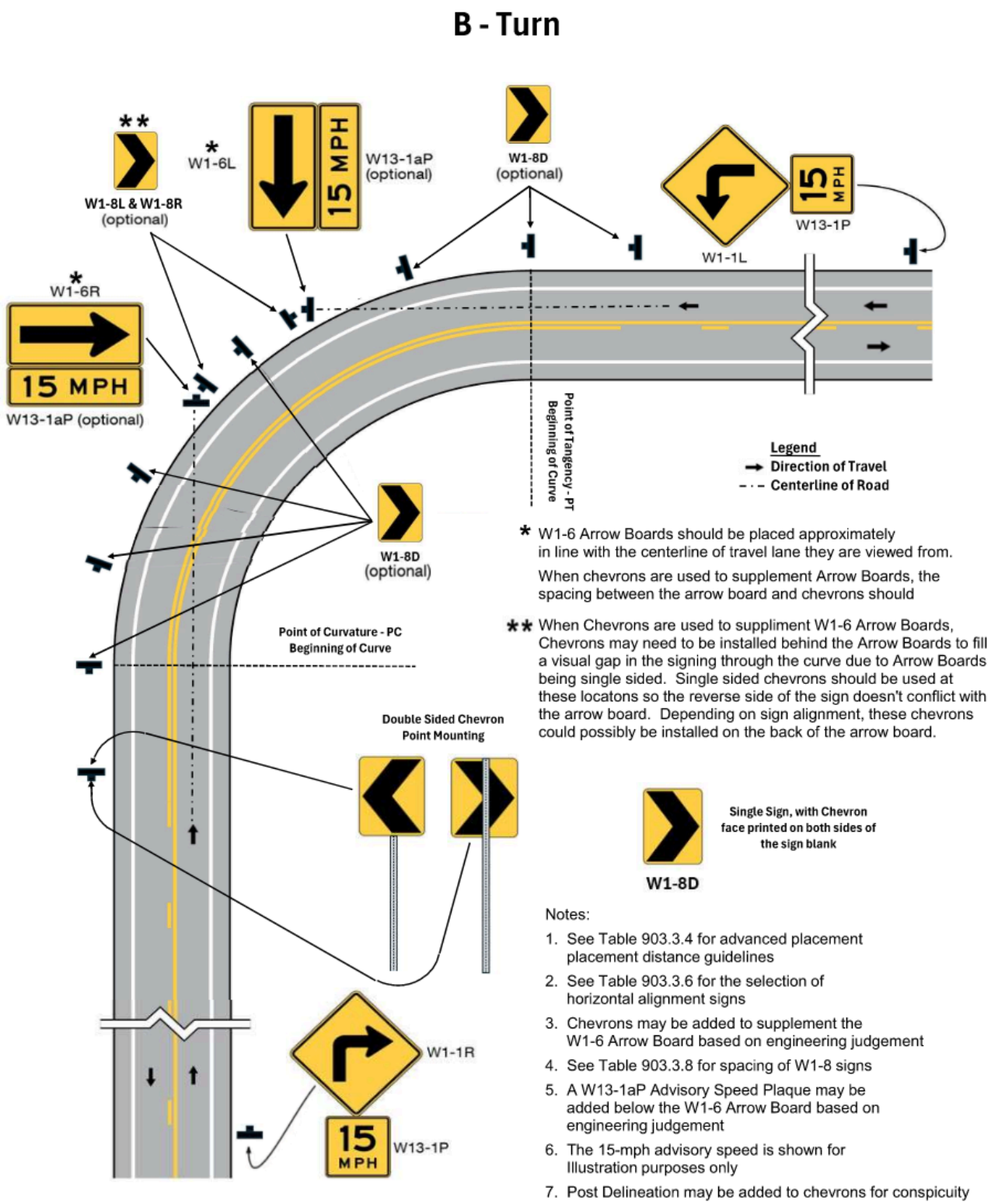


Figure 903.3.7.2 Examples of Warning Signs for Changes in Horizontal Alignment *(Sheet 2 of 2)*

903.3.8 Chevron Alignment Sign (W1-8) (MUTCD Section 2C.08)



W1-8

Support. Examples of when to use Chevron signs include locations where there is a crash history, evidence of drivers losing control on a curve or turn, a sharp change in horizontal alignment not readily visible to the driver, or as a systemic curve improvement program.

The majority of fatal and serious injury crashes are attributed to lane departure crashes (State Strategic Highway Safety Plan). Chevrons are a highly cost-effective way to reduce lane departure crashes in curves and turns.

Implementation of the 2009 MUTCD requirements for chevron deployments resulted in a statewide reduction in severe lane departure crashes in horizontal curves. To maintain this observed safety benefit, MoDOT has established standards based on the 2009 MUTCD criteria, which is above the minimum requirements in the 11th Edition of the MUTCD. For more details on the safety benefits of chevrons, contact the Highway Safety and Traffic Division.

Standard. The use of the Chevron Alignment (W1-8) sign (see Figure 903.3.7.2) to provide additional emphasis and guidance for a change in horizontal alignment shall be in accordance with the information provided in EPG 903.3.6.

The Chevron Alignment sign shall be a vertical rectangle. No border shall be used on the Chevron Alignment sign.

If used, Chevron Alignment signs shall be installed on the outside of a turn or curve, in line with and at approximately a right angle to approaching traffic. Chevron Alignment signs shall be installed at a minimum height of 4 feet, measured vertically from the bottom of the sign to the elevation of the near edge of the traveled way, which will locate the sign at approximately the driver's eye height.

Guidance. The approximate spacing of Chevron Alignment signs on the turn or curve measured from the point of curvature (PC) should be as shown in Table 903.3.8.

In addition to the Chevron Alignment signs placed throughout the curve, there should be one sign in advance of the PC and one after the PT. These signs should be spaced the same as the Chevron Alignment signs in the curve.

Option. The values in Table 903.3.8 are typical and variances for driveways, public roads, and other signs may alter the spacing. Engineering judgment may also be used to modify the spacing as long as road users always have at least two Chevron Alignment signs in view until the change in alignment eliminates the need for the signs.

Based on engineering judgement, chevron alignment signs may be omitted within incorporated city limits.

Guidance. The Chevron Alignment signs should be visible for a sufficient distance to provide the road user with adequate time to react to the change in alignment.

The single-sided Chevron sign should only be used where only one direction of travel is impacted, such as on an expressway. The double-side Chevron (W1-8D) should be used on two-lane, two-way roads.

At the end of a four-lane divided highway, where the traffic reduces to two lanes, chevrons should be used to direct traffic from the dual lanes that are ending and being redirected to the two-lane roadway.

Option. Chevron Alignment signs may also be used on any other roadways based on engineering judgment.

Chevron Alignment signs may be used in addition to the One-Direction Large Arrow (W1-6) sign on turns posted at 30 mph or less.

Guidance. As chevrons are installed, all horizontal alignment signing (chevrons, curve and turn signing, advisory speed plaques and arrow boards) on a corridor should be evaluated to ensure the installations meet current standards. Aspects of existing horizontal alignment signs to look at should include spacing of existing chevrons, offset and mounting heights of any horizontal alignment sign as well as the distance advanced warning signs are installed from the curve/turn. The need for curve/turn signs should be reevaluated if the ball banking measurements from when the signs were installed are out of date due to roadway/pavement improvements or due to changes in vehicle performance.

Option. LEDs may be used to enhance the conspicuity of Chevron Alignment signs (see EPG 903.1.12).

Standard. The LEDs used in the Chevron Alignment sign shall consist of yellow LEDs outlining the chevron symbol.

Chevron Alignment signs shall not be placed on the far side of a T-intersection facing traffic on the stem approach to warn drivers that a through movement is not physically possible, as this is the function of a Two-Direction (or One-Direction) Large Arrow sign.

Chevron Alignment signs shall not be used to mark obstructions within or adjacent to the roadway, including the beginning of guardrails or barriers, as this is the function of an object marker (see EPG 903.3.70).

Chevron Alignment signs directing traffic to the right shall not be used in the central island of a roundabout or a neighborhood traffic circle.

Table 903.3.8 Typical Spacing of Chevron Alignment Signs on Horizontal Curves

Advisory Speed	Curve Radius	Sign Spacing
15 mph or less	Less than 200 feet	40 feet
20 to 30 mph	200 to 400 feet	60 feet
35 to 45 mph	401 to 700 feet	80 feet
50 to 60 mph	701 to 1,250 feet	100 feet
more than 60 mph	More than 1,250 feet	140 feet
Note: The relationship between curve radius and the advisory speed shown in this table should not be used to determine the advisory speed.		

903.3.9 Combination Horizontal Alignment/Intersection Signs (W1-10 Series) (MUTCD Section 2C.09)



Option. The Turn (W1-1) sign, the Curve (W1-2) sign, and the Reverse Curve (W1-4) sign may be combined with the Cross Road (W2-1) sign or the Side Road (W2-2 or W2-3) sign to create a combination Horizontal Alignment/Intersection (W1-10 series) sign that depicts the condition where an intersection occurs within or immediately adjacent to a turn or curve.

Support. EPG 903.2.64 contains information about the use of an advance street name plaque to identify an intersecting road.

Guidance. Elements of the combination Horizontal Alignment/Intersection sign related to horizontal alignment should comply with the provisions of EPG 903.3.7, and elements related to intersection configuration should comply with the provisions of EPG 903.3.33. The symbol design should approximate the configuration of the intersecting roadway(s). No more than one Cross Road or two Side Road symbols should be displayed on any one combination Horizontal Alignment/Intersection sign.

A layout of the proposed sign should be included when ordering or when including the sign in design plans.

Standard. The use of the combination Horizontal Alignment/Intersection sign shall be in accordance with the provisions of EPG 903.3.7 for the appropriate Turn or Curve sign.

If used, a W1-10L sign designation shall indicate a curve to the left, while a W1-10R sign designation shall indicate a curve to the right.

903.3.10 One-Direction Large Arrow Sign (W1-6) (MUTCD Section 2C.10)



W1-6

Standard. A One-Direction Large Arrow sign shall be used to delineate a change in horizontal alignment where the advisory speed is 30 mph or lower.

The One-Direction Large Arrow sign shall be a horizontal rectangle with an arrow pointing to the left or right.

If used, the One-Direction Large Arrow sign shall be installed on the outside of a turn or curve in line with and at approximately a right angle to approaching traffic.

The One-Direction Large Arrow sign shall not be used where there is no alignment change in the direction of travel, such as at the beginnings and ends of medians or at center piers.

The One-Direction Large Arrow sign directing traffic to the right shall not be used in the central island of a roundabout.

Guidance. The One-Direction Large Arrow sign should be visible for a sufficient distance to provide the road user with adequate time to react to the change in alignment.

If Chevron Alignment signs are used to supplement the One-Direction Large Arrow sign, chevrons, and arrow signs should be installed so they do not visually block each other.

903.3.11 Truck Rollover Sign (W1-13) (MUTCD Section 2C.11)



W1-13

Option. A Truck Rollover (W1-13) sign may be used as a supplement to a horizontal alignment warning sign to warn drivers of vehicles with a high center of gravity, such as trucks, tankers, and recreational vehicles, of a curve or turn where there are:

A. Past incidents of truck rollovers at the specific location,
B. High volumes of trucks, or
C. A speed differential (see EPG 903.3.6) that might pose a greater risk for vehicles with high centers of gravity.

Guidance. Where engineering judgment determines the need for the installation of a Truck Rollover (W1-13) sign, it should be located downstream of the horizontal alignment warning sign in advance of the curve.

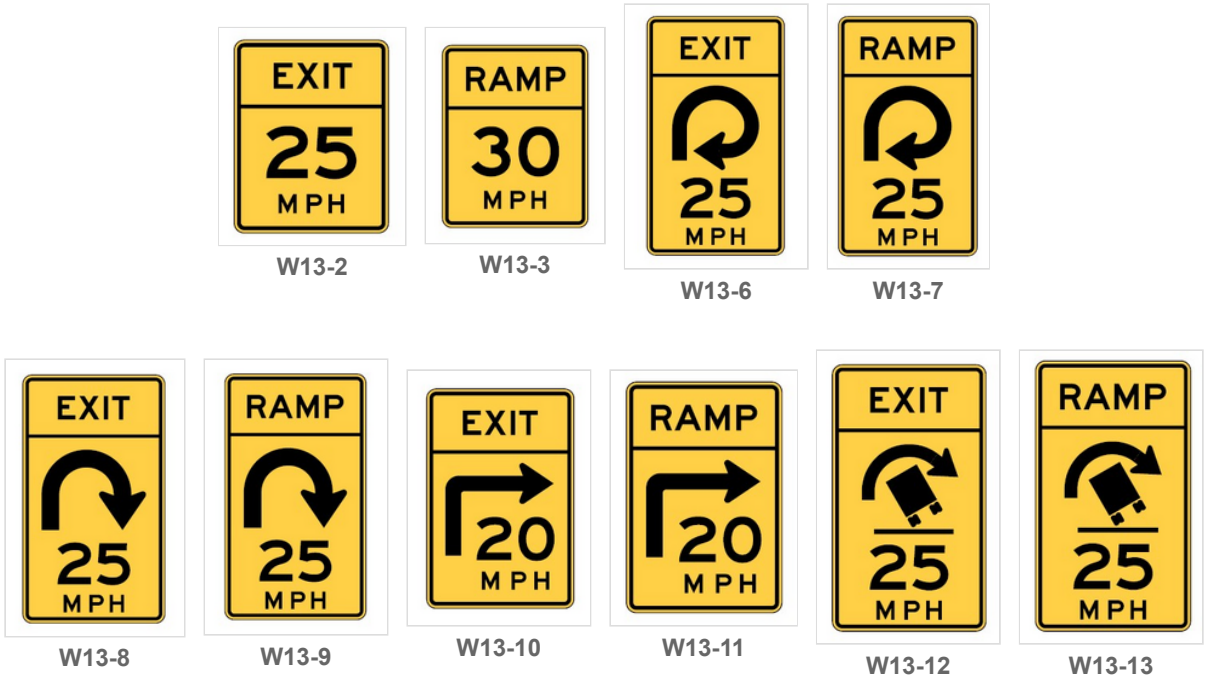
Standard. If a Truck Rollover (W1-13) sign is used, it shall be accompanied by an Advisory Speed (W13-1P) plaque indicating the recommended speed for vehicles with a higher center of gravity.

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Option. The Truck Rollover sign may include conspicuity enhancements, or may be a blank-out sign, activated by the detection of an approaching vehicle with a high center of gravity that is traveling in excess of the recommended speed for the condition.

Support. The curved arrow on the Truck Rollover sign shows the direction of roadway curvature. The truck tips in the opposite direction.

903.3.12 Advisory Exit and Ramp Speed Signs (W13-2 and W13-3) and Combination Horizontal Alignment/Advisory Exit and Ramp Speed Signs (W13-6 through W13-13) (MUTCD Section 2C.12)



Standard. Where an advisory speed is posted in advance of a freeway or expressway exit, the Advisory Exit Speed (W13-2) sign shall be used.

Where an advisory speed is posted in advance of a conventional road ramp or to another roadway or roadside facility, the Advisory Ramp Speed (W13-3) sign shall be used.

An Advisory Exit Speed or Advisory Ramp Speed sign shall be used when the difference between the mainline roadway speed limit and the exit or ramp advisory speed in the vicinity of the departure is 20 mph or greater.

Guidance. An Advisory Exit Speed or Advisory Ramp Speed sign should be used when the difference between the mainline roadway speed limit and the exit or ramp advisory speed in the vicinity of the departure is 15 mph.

Option. An Advisory Exit Speed or Advisory Ramp Speed sign may be used based on engineering judgment when the difference between the mainline roadway speed limit and the exit or ramp advisory speed in the vicinity of the departure is 10 mph or less.

The Combination Horizontal Alignment/Advisory Exit Speed (W13-6, W13-8, and W13-10) signs may be used in lieu of the Advisory Exit Speed (W13-2) sign, and the combination Horizontal Alignment/Advisory Ramp Speed (W13-7, W13-9, and W13-11) signs may be used in lieu of the Advisory Ramp Speed (W13-3) sign.

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The Combination Truck Rollover/Advisory Exit Speed and Truck Rollover/Advisory Ramp Speed (W13-12 and W13-13) signs may be used in lieu of the W13-2 and W13-3 signs respectively if the tip over condition is in the vicinity of the gore.

Standard. Roadway geometrics represented on the Combination Horizontal Alignment/Advisory Exit and Combination Horizontal Alignment/Advisory Ramp Speed signs shall be limited to the standard signs shown in the EPG.

Guidance. If used, the Advisory Exit Speed sign or the Combination Horizontal Alignment/Advisory Exit Speed sign should be installed along the deceleration lane. The Advisory Exit Speed or the Combination Horizontal Alignment/Advisory Exit Speed signs should be visible in time for the road user to decelerate and make an exiting maneuver.

Regulatory Speed Limit signs (see EPG 903.3.20) should not be located in the vicinity of exit ramps or deceleration lanes, particularly where they will conflict with the advisory speed displayed on the Advisory Exit or Ramp Speed signs.

Support. EPG 903.3.6 contains provisions for the determination of the displayed advisory speed.

Table 903.3.4 lists recommended advance sign placement distances for deceleration to various advisory speeds.

Option. Where there is a need to remind road users of the recommended advisory speed, a horizontal alignment warning sign with an advisory speed plaque displaying the same advisory speed may be installed at a downstream location along the ramp.

Guidance. If the ramp curvature changes to the extent that it warrants a lower advisory speed, a horizontal alignment warning sign with the new advisory speed should be displayed in advance of the change in curvature.

Option. The One-Direction Large Arrow (W1-6) sign may be installed beyond the exit gore on the outside of the curve to provide additional warning of an immediate change in curvature. When used in conjunction with the exit speed, the One-Direction Large Arrow (W1-6) sign may be supplemented with a Confirmation Advisory Speed (W13-1aP) plaque when the plaque is not used with the Exit Gore (E5-1 series) sign.

Guidance. The horizontal alignment symbol displayed on the Combination Horizontal Alignment/Advisory Exit and Ramp Speed signs should be consistent with the horizontal geometry of the ramp.

Support. Examples of advisory speed signing for exit ramps are shown in Figure 903.3.12.

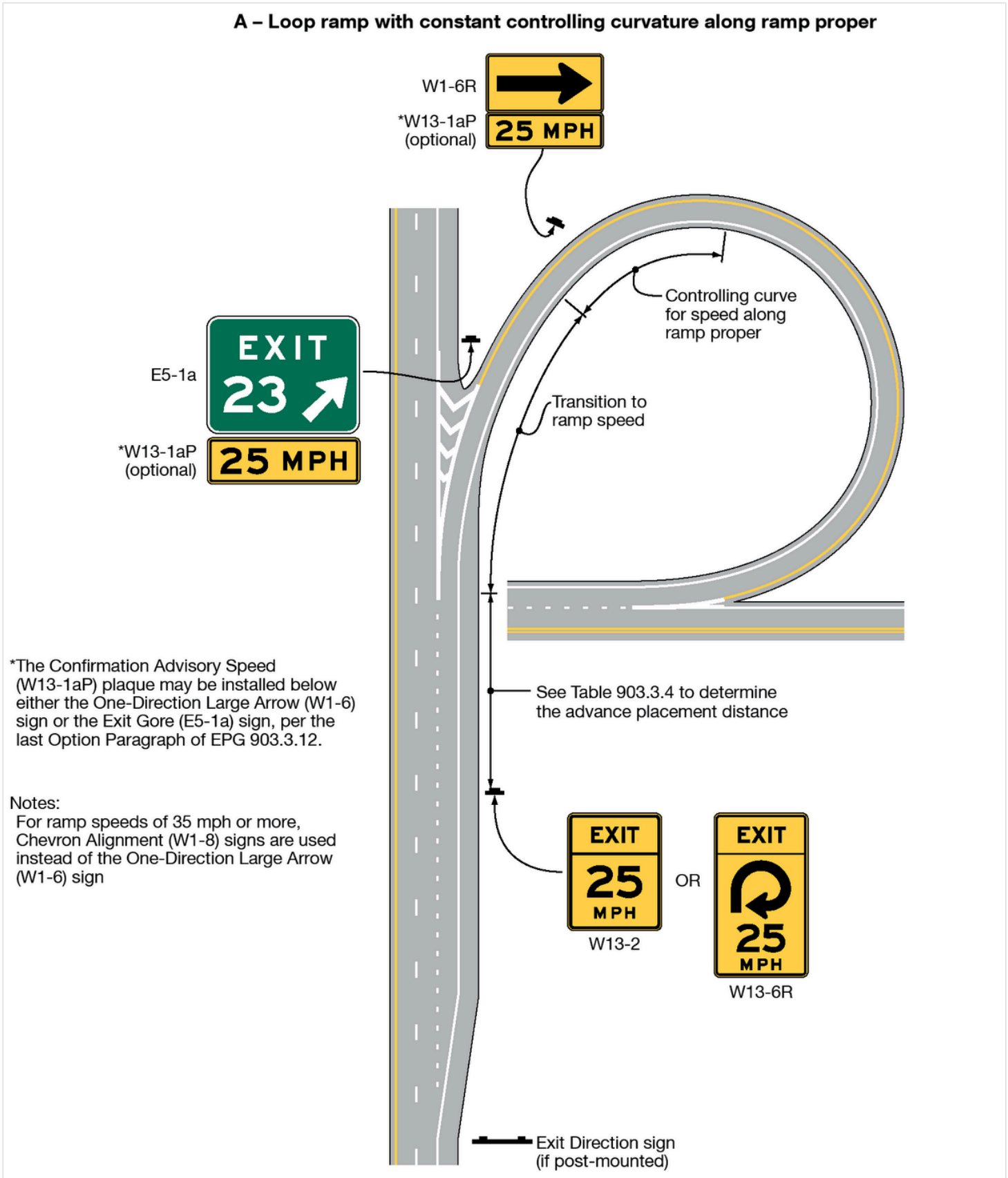


Figure 903.3.12 Examples of Exit Ramp Advisory Speed and Other Warning Signs

903.3.13 Vehicle Speed Feedback Sign and Plaque (W13-20 and W13-20aP) (MUTCD Section 2C.13)

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Option. A Vehicle Speed Feedback (W13-20) sign or (W13-20aP) plaque (see Figure 903.3.13) that displays the speed of an approaching vehicle to the vehicle operator may be used to provide warning to drivers of their speed in relation to either a speed limit (R2-1) sign or a horizontal alignment warning sign assembly with a posted advisory speed.

Standard. When used to display the speed of an approaching vehicle in relation to the posted speed limit, the Vehicle Speed Feedback (W13-20aP) plaque shall be mounted below a Speed Limit (R2-1) sign (see EPG 903.2.20).

The Vehicle Speed Feedback assembly shall not be installed at a location where the posted speed limit on the route changes. Vehicle Speed Feedback assemblies shall be placed anywhere downstream of a speed limit change but shall be a minimum of 200 feet downstream of a speed limit change on conventional routes and a minimum of 400 feet downstream of a speed limit change on expressways of freeways. Vehicle Speed Feedback assemblies shall be installed in accordance with the Vehicle Speed Feedback Typical Application (https://epg.modot.org/forms/general_files/TS/TA_Your_Speed_Feedback_Assembly.pdf).

When used to supplement a horizontal alignment warning sign advisory speed, the Vehicle Speed Feedback (W13-20) sign shall be an independent installation near the point of curvature of a horizontal curve (see EPG 903.3.6).

The legend YOUR SPEED shall be a black legend on a yellow retroreflective background, except as provided in EPG 616.8.1 and 908.2.1. The changeable legend displaying the speed of the approaching vehicle shall be a yellow luminous legend on a black opaque background. The vehicle speed displayed on the changeable portion of the sign shall be displayed as an integer. The Vehicle Speed Feedback sign and plaque shall not flash, strobe, change color, or use other animated elements integrated into the changeable legend display. When no vehicles are approaching, the changeable display shall not display a legend.

Vehicle Speed Feedback sign equipment shall not have the capability to collect, store or transmit personally identifiable information of any type.

Guidance. The changeable portion of the Vehicle Speed Feedback legend should be approximately the same height, width, and stroke of those on the Speed Limit sign it supplements or is mounted below.

When a W13-20aP plaque is used with a Speed Limit sign it should be approximately the same width as the Speed Limit sign it is mounted below.

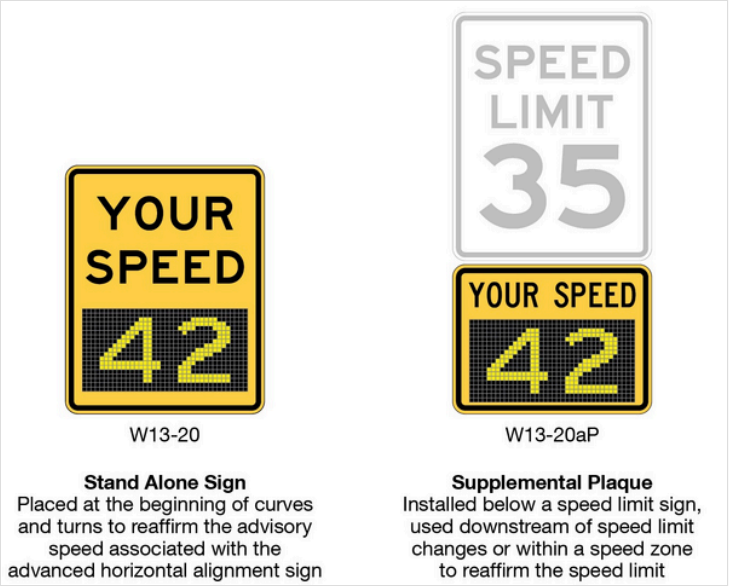
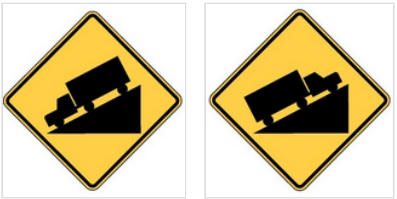


Figure 903.3.13 Vehicle Speed Feedback Sign and Plaque

903.3.14 Hill Signs (W7-1 and W7-1c) (MUTCD Section 2C.14)



Guidance. The Hill (W7-1) sign should be used in advance of a downgrade where the length, percent of grade, horizontal curvature, and/or other physical features require special precautions on the part of road users.

The Hill sign and supplemental grade (W7-3P) plaque (see EPG 903.3.63) used in combination, or the W7-1a sign used alone, should be installed in advance of downgrades for the following conditions:

A. 5% grade that is more than 3,000 feet in length,
B. 6% grade that is more than 2,000 feet in length,
C. 7% grade that is more than 1,000 feet in length,
D. 8% grade that is more than 750 feet in length, or
E. 9% grade that is more than 500 feet in length.

These signs should also be installed for steeper grades or where crash experience and field observations indicate a need.

Supplemental plaques (see EPG 903.3.57 and 903.3.63) and larger signs should be used for emphasis or where special hill characteristics exist. On longer grades, the use of the Hill sign with a distance (W7-3aP) plaque at periodic intervals of approximately 1-mile spacing should be considered.

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Support. The Uphill (W7-1c) sign is also available by special request.

903.3.15 ROAD NARROWS Sign (W5-1) (MUTCD 2C.17)



W5-1

Guidance. A ROAD NARROWS (W5-1) sign should be used in advance of a transition on two-lane roads where the pavement width is reduced abruptly to a width such that vehicles traveling in opposite directions cannot simultaneously travel through the narrow portion of the roadway without reducing speed.

Option. Additional emphasis may be provided by the use of object markers and delineators (see EPG 903.3.70 through EPG 903.3.73 and EPG 620.6). The Advisory Speed (W13-1P) plaque (see EPG 903.3.59) may be used to indicate the recommended speed.

903.3.16 NARROW BRIDGE Sign (W5-2) (MUTCD Section 2C.18)



W5-2

Guidance. A NARROW BRIDGE (W5-2) sign should be used in advance of any bridge or culvert having a two-way roadway horizontal clearance of 16 to 18 feet, or any bridge or culvert having a roadway horizontal clearance less than the width of the approach travel lanes.

Additional emphasis should be provided by the use of object markers, delineators, and/or pavement markings.

Option. A NARROW BRIDGE sign may be used in advance of a bridge or culvert on which the approach shoulders are narrowed or eliminated.

903.3.17 ONE LANE BRIDGE Sign (W5-3) (MUTCD Section 2C.19)



W5-3

Guidance. A ONE LANE BRIDGE (W5-3) sign should be used on two-way roadways in advance of any bridge or culvert:

A. Having a roadway horizontal clearance of less than 16 feet, or
B. Having a roadway horizontal clearance of less than 18 feet when commercial vehicles constitute a high proportion of the traffic, or

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C. Having a roadway horizontal clearance of 18 feet or less where the sight distance on the approach is less than that shown in Condition A of Table 903.3.4.

Additional emphasis should be provided by the use of object markers, delineators, and/or pavement markings.

Option. STOP (R1-1) or YIELD (R1-2) signs (see EPG 903.2.4 and 903.2.5) and related pavement markings (see EPG 620.2.20 and 620.2.21) may be used when conditions A, B, or C in the first Guidance paragraph of this Article apply.

903.3.18 Divided Highway Sign (W6-1) (MUTCD Section 2C.20)



W6-1

Guidance. A Divided Highway (W6-1) sign should be used on the approaches to a section of highway (not an intersection or junction) where the opposing flows of traffic are separated by a median or other physical barrier.

Standard. The Divided Highway (W6-1) sign shall not be used instead of a Keep Right (R4-7 series) sign on the approach end of a median island.

903.3.19 Divided Highway Ends Sign (W6-2) (MUTCD Section 2C.21)



W6-2

Guidance. A Divided Highway Ends (W6-2) sign should be used in advance of the end of a section of physically divided highway (not an intersection or junction) as a warning of two-way traffic ahead.

The Two-Way Traffic (W6-3) sign (see EPG 903.3.42) should be used to give warning and notice of the transition to a two-lane, two-way section.

903.3.20 Double Arrow Sign (W12-1) (MUTCD Section 2C.23)



W12-1

Option. The Double Arrow (W12-1) sign may be used to advise road users that traffic is permitted to pass on either side of an island, obstruction, or gore in the roadway. Traffic separated by this sign may either rejoin or change directions.

Guidance. If used on an island, the Double Arrow sign should be mounted near the approach end (see EPG 903.3.13).

If used in front of a pier or obstruction, the Double Arrow sign should be mounted on the face of, or just in front of, the pier or obstruction. Where stripe markings are used on the pier or obstruction, they should be discontinued to leave a 3-inch space around the outside of the Double Arrow sign.

903.3.21 DEAD END, NO OUTLET, and ROAD ENDS Signs (W14-1, W14-2, and W14-13) (MUTCD Section 2C.24)



W14-1 W14-2 W14-13

Option. DEAD END (W14-1) sign may be used at the entrance to a single road or street that terminates without intersecting another street. The NO OUTLET (W14-2) sign may be used at the entrance to a road or road network from which there is no other exit.

The ROAD ENDS (W14-13) sign may be used to warn of a roadway which has no outlet and which terminates in a dead end and may be used in place of the DEAD END or NO OUTLET sign where the use of the DEAD END and NO OUTLET signs would have a negative effect on traffic generators or public perceptions due to the negative connotation of the message.

Guidance. When the W14-1, W14-2, or W14-13 sign is used, the sign should be posted as near as practicable to the entry point or at a sufficient advance distance to permit the road user to avoid the dead end or no outlet condition by turning at the nearest intersecting street.

Standard. The W14-1, W14-2, or W8-26 sign shall not be used in place of the ROAD CLOSED (R11-2) sign for temporary conditions, such as high water, bridge out, etc.

Support. Information about the use of Type 4 object markers to mark the end of the road or street is contained in EPG 903.3.73.

903.3.22 Low Clearance Signs (W12-2, and W12-2a) (MUTCD Section 2C.25)



W12-2 W12-2a

Support. MoDOT is responsible for installing and maintaining overhead low clearance signs mounted on all structures passing over MoDOT routes as well as installing and maintaining overhead low clearance signs mounted all MoDOT structures passing over non-MoDOT routes (this does not include MoDOT structures passing over rail lines). MoDOT has developed specific provisions for the use of Low Clearance signs.

Standard. Low Clearance signing shall be installed to display vertical clearances available under structures within specified limits of statutory maximum vehicle heights.

The clearance displayed on the Low Clearance (W12-2 and W12-2a) signs shall be 2 inches less than the measured clearance to account for possible packed snow and ice. For example, a measured vertical clearance of 15 ft. shall be posted as 14 ft. 10 in. All clearance measurements shall be rounded down to the nearest full inch. For example, a measured vertical clearance of 14 ft. 9 ½ in. would be rounded down to 14 ft. 9 in. and posted as 14 ft. 7 in.

The statutory maximum vehicle heights and vertical clearances are as follows:

A. Within Commercial Zones = 15 ft. statutory maximum vehicle height (16’ 0” maximum posting).
B. On Interstate and designated highway network routes and on all routes within 10 miles of Interstate and designated highway network routes = 14 ft. statutory maximum vehicle height (15’ 0” maximum posting).
C. On routes greater than 10 miles from Interstate and designated highway network routes = 13 ft. 6 in. statutory maximum vehicle height (15’ 0” maximum posting).

Support. For specific details on commercial zone limits and designated highway network routes, see Missouri Vehicle Route Map.

Standard. The MoDOT posting requirements for Low Clearance signs are as follows:

A. Case I – Two Signs Required: Where the measured vertical clearance is 15 ft. 2 in. or less, but more than 13 ft. 8 in., two signs shall be used. First, a Low Clearance Overhead (W12-2a) sign shall be installed on the structure, and second, a ground-mounted Low Clearance Advance (W12-2) sign shall be placed approximately 750 ft. in advance of the structure. When an interchange is involved, the ground-mounted Low Clearance (W12-2) sign shall be located approximately 750 ft. in advance of the off-ramp.
B. Case II – Three Signs Required: Where the measured vertical clearance is 13 ft. 8 in. or less, three signs shall be used. First, a Low Clearance Overhead (W12-2a) sign shall be installed on the structure, second, a ground-mounted Low Clearance Advance (W12-2) sign shall be placed approximately 750 ft. in advance of the structure, and third, an additional Low Clearance Advance (W12-2) sign with a Distance Ahead (W16-2P or W16-3P) plaque below the sign shall be placed at the nearest intersecting road or wide point in the road at which a vehicle can detour or turn around.
C. Case III – One Sign: Where the measured vertical clearance is 15 ft. 2 in. or less and where the bridge is state maintained but the road beneath is not, a Low Clearance Overhead (W12-2a) sign shall be installed on the structure, but the ground-mounted Low Clearance Advance (W12-2) sign shall not be installed by MoDOT. The Low Clearance Advance sign may be installed and maintained by the local jurisdiction.
D. Case IV – Commercial Zones: Vertical clearance signing shall be provided for structures within commercial zones (see Section 304.190 of the Revised Statutes of Missouri). Any structure with a measured vertical clearance of 16 ft. 2 in. or less within the commercial zone limits shall be posted. For measured vertical clearances greater than 15 ft. 2 in. and equal to or less than 16 ft. 2 in. within commercial zones a Low Clearance Overhead (W12-2a) sign shall be installed on the structure. The signing for measured vertical clearances of 15 ft. 2 in. or less within commercial zones shall be as described for Case I or Case II.

In the case of an arch structure or a structure which has a sloping span resulting in different vertical clearances per lane, one Low Clearance Overhead (W12-2a) sign shall be centered over each lane displaying the vertical clearance available for that lane. One sign per lane shall be applied if the difference in vertical clearance between adjacent lanes is 6 inches or greater or when the vertical clearance between the far-right lane and far-left lane is 12 inches or greater.

Guidance. Clearances should be evaluated periodically to verify the displayed clearances are accurate and to determine if additional low clearance signing is necessary, particularly when resurfacing operations have occurred, on routes onto which over-height vehicles are normally directed under the permit process, and structures that are susceptible to catastrophic failure when struck by over-height vehicles. The information should be updated in the TMS.

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Where there is a need to warn of a low clearance on an intersecting road or off a freeway or expressway exit, a rectangular warning sign with an appropriate word legend should be used rather than a W12-2 sign.

Option. When only one Overhead Low Clearance (W12-2a) sign is required and mounting one sign centered over the roadway is not practical, two W12-2a signs may be installed with one sign installed to the right of the travel lanes and one sign installed to the left of the travel lanes.

Guidance. The clearance shown on the Low Clearance Advance (W12-2) sign should match the clearance on the W12-2a sign or, if there are multiple W12-2a signs, should match the lowest clearance.

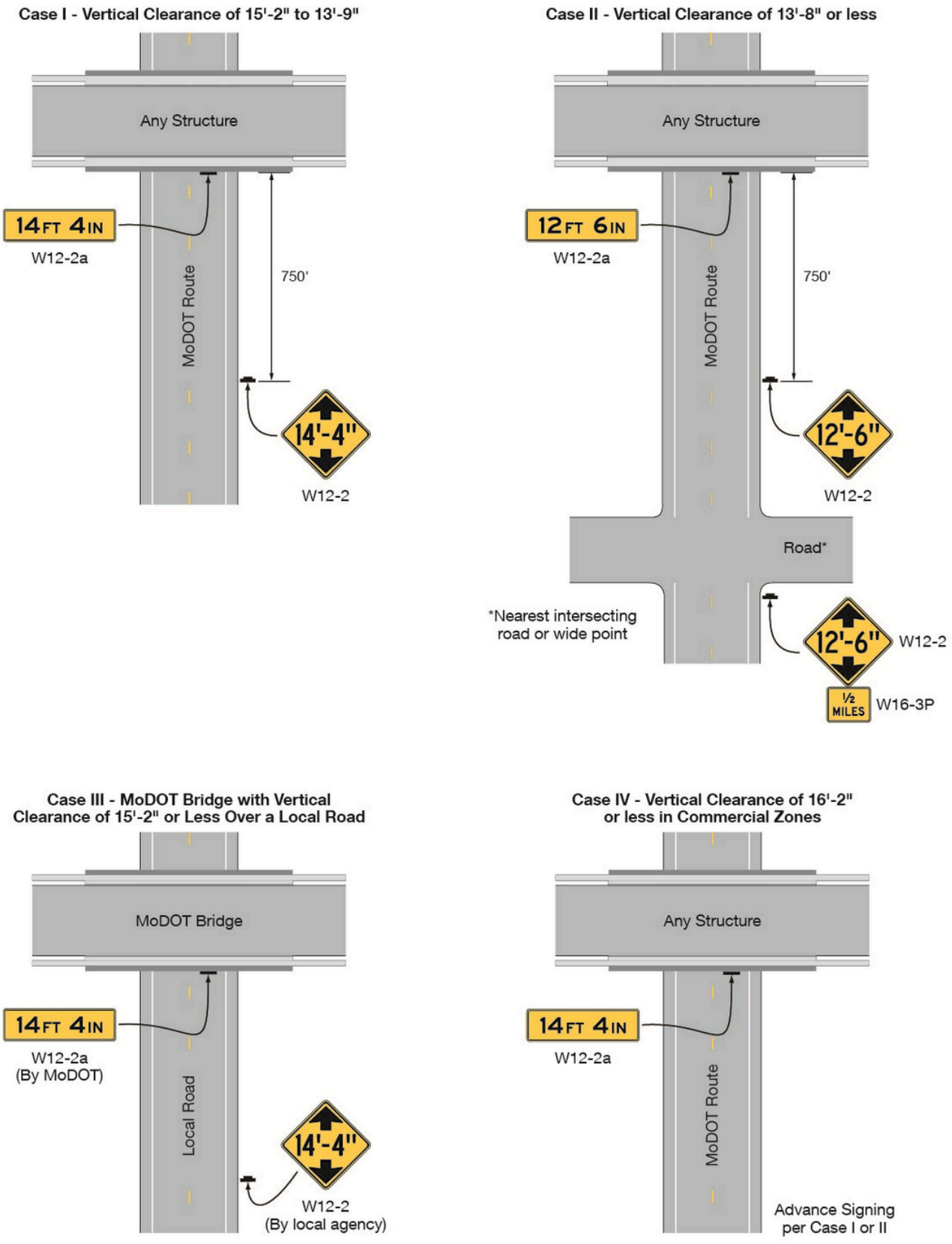


Figure 903.3.22 Examples of Low Clearance Signs

903.3.23 BUMP and DIP Signs (W8-1 and W8-2) (MUTCD Section 2C.26)



W8-1



W8-2

Support. BUMP and DIP signs (W8-1, W8-2) are limited use signs, only being used for locations where the condition cannot be corrected, such as low water crossings or highway-rail grade crossings.

See EPG 913.2.14 for low ground clearance conditions at highway-rail grade crossings.

Guidance. BUMP (W8-1) and DIP (W8-2) signs should be used in advance of a sharp rise or depression in the profile of the road.

Option. These signs may be supplemented with an Advisory Speed plaque (see EPG 903.3.59).

Guidance. The DIP sign should not be used in advance of a short stretch of depressed alignment that might momentarily hide a vehicle.

A short stretch of depressed alignment that might momentarily hide a vehicle should be treated as a no-passing zone when center line striping is provided on a two-lane or three-lane road (see EPG 620.2.3).

Option. BUMP and DIP signs may be used as temporary traffic control signs (WO8-1, WO8-2) for locations where the condition is temporary and/or where the condition can be corrected in the future (See EPG 616.6.50).

903.3.24 PAVEMENT ENDS Sign (W8-3) (MUTCD Section 2C.28)



W8-3

Guidance. A PAVEMENT ENDS (W8-3) sign should be used where a paved surface changes to either a gravel treated surface or an earth road surface.

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Option. An Advisory Speed plaque (see EPG 903.3.59) may be used when the change in roadway condition requires a reduced speed.

903.3.25 Slippery When Wet Sign (W8-5) (Section 2C.30)



W8-5

Guidance. The Slippery When Wet sign (W8-5) is a limited use sign that should not be installed for locations where the condition can be corrected. Existing Slippery When Wet (W8-5) signs should be left in place until the condition is corrected.

Option. The Slippery When Wet (W8-5) sign may be used to warn of unexpected slippery conditions.

Guidance. When used, Slippery When Wet signs should be placed in advance of the beginning of the affected section (see Table 903.3.4), and additional signs should be placed at appropriate intervals along the road where the condition exists.

Option. The Slippery When Wet sign may be used as a temporary traffic control sign (WO8-5) for locations where the condition is temporary and/or where the condition can be corrected in the future (See EPG 616.6.50).

903.3.26 FALLEN ROCKS Signs (W8-14)



W8-14

Option. The FALLEN ROCKS (W8-14) sign may be used in advance of an area that is adjacent to a hillside, mountain, or cliff where rocks frequently fall onto the roadway.

Guidance. When used, FALLEN ROCKS signs should be placed in advance of the beginning of the affected section (see Table 903.3.4), and additional signs should be placed at appropriate intervals along the road where the condition exists.

Standard. The district shall perform an evaluation of the FALLEN ROCKS site to determine whether existing installations of the FALLEN ROCKS sign is still necessary. If it is determined that the sign is not necessary, the sign will not be replaced at the end of the service life.

903.3.27 Warning Signs and Plaque for Motorcyclists (W8-15, W8-15aP, and W8-16) (MUTCD Section 2C.31)

Support. MoDOT does not install permanent W8-15, W8-15aP, and W8-16 signs and plaques. For temporary applications, see EPG 616.16.

903.3.28 IMPASSABLE WHEN WATER OVER ROAD Sign (MUTCD Section 2C.34)



W8-18 WO20-3 W8-34a WO8-33 D2-1 and R11-3a R5-22

Support. When a road goes underwater, MoDOT requires the road to be closed to traffic regardless of the depth of water over the road. This closure is accomplished by following TA-8W. This TA displays two figures; the first figure applies to locations which do not flood on a frequent basis and uses standard work zone signs to close the road. The second figure applies to roads that frequently go under water and utilize permanently installed signs. These permanent signs provide critical guidance to motorists between the time the road begins to flood to the time maintenance crews can physically close the road.

MoDOT has discontinued the use of the LOW WATER CROSSING (W8-35) sign, low water crossings are designed for water to routinely flow over the roadway while traffic passes through the water. MoDOT no longer maintains low water crossings on State routes, and MoDOT's direction is to close any road covered in any depth of water. MoDOT has discontinued the use of the WATER GAUGE (W8-19a). Water gauges are intended to indicate the depth of the water over a road to allow motorists to judge if it is safe to proceed, however, MoDOT no longer supports motorists driving through any depth of water and closes any road which is covered by water.

Standard. Any roadway location which goes underwater shall be closed to traffic as soon as possible. Any location, regardless of flooding frequency, shall be closed using the signing package in the first figure of TA-8W.

Guidance. Any roadway which historically floods one or more times per year should have the permanent signing package found in the second figure of TA-8W installed. This applies to locations where streams and rivers rise and flood the road surface, but not in urban areas where a road floods due to blocked or overwhelmed storm drains. This signing package, which includes the DO NOT ENTER WHEN WATER OVER ROAD (R5-22) sign, provides motorists with advanced information on how they need to react to the flooded road before maintenance crews can get to the location and physically close the roadway. The flip signs allow for an expedited closure with the work zone signs already in place, only needing to flip them from the warning sign message to the work zone message upon arriving at the location, as well as deploying the barricades and ROAD CLOSED (R11-2) sign.

Existing LOW WATER CROSSING (W8-35) signs should be removed at the earliest convenience; the presence of these signs may encourage motorists to enter a flooded road if they see the depth of water and incorrectly believe it is shallow enough to safely pass.

Option. The signing package in the second figure of TA-8W may be installed at any location that may flood less than one time per year to facilitate quicker road closures.

903.3.29 Advance Traffic Control Signs (W3-1, W3-2, W3-3, and W3-4) (MUTCD Section 2C.35)



W3-1 W3-2 W3-3 W3-4

Standard. The Stop Ahead (W3-1), Yield Ahead (W3-2), and Signal Ahead (W3-3) Advance Traffic Control signs shall be installed on an approach to a primary traffic control device that is not visible for a sufficient distance to permit the road user to respond to the device (see Table 903.3.4). The visibility criteria for a traffic control signal shall be based on having a continuous view of at least two signal faces for the distance specified in Table 902.4.6.

Guidance. Where intermittent obstructions occur, engineering judgment should determine the treatment to be implemented.

The minimum visibility distance of a signal for a facility with a speed limit above 60 mph should be determined by summing the stopping sight distance (see Table 903.3.1) and the assumed queue length. The assumed queue length should be determined by engineering judgment.

If an advance traffic control sign is warranted for an approach at an intersection of a MoDOT maintained road and non-MoDOT maintained road, the agency responsible for the maintenance of the non-MoDOT road should be notified of the condition.

Support. Permanent obstructions causing the limited visibility might include roadway alignment or structures. Intermittent obstructions might include foliage or parked vehicles.

Option. An Advance Traffic Control sign may be used for additional emphasis of the primary traffic control device, even when the visibility distance to the device is satisfactory.

Signal Ahead (W3-3) signs may be posted on the right- and left-hand sides of the road on a high speed divided approach.

Support. EPG 903.3.64 contains information about the use of an advance street name plaque to identify an intersecting road.

Option. A BE PREPARED TO STOP (W3-4) sign may be used to warn of stopped traffic caused by a traffic control signal in advance of a section of roadway that regularly experiences traffic congestion, history of crashes, or based on engineering judgement.

A Warning Beacon (see EPG 902.18.3) may be used with an Advance Traffic Control or BE PREPARED TO STOP (W3-4) sign. If a warning beacon is used, the beacon(s) may be activated before the start of the yellow change interval referred to as lead flash, which is the time before the onset of yellow at which the warning beacon(s) begin to flash. Recommended values for lead flash in accordance with the posted speed limit are specified in Table 903.3.29.

Table 903.3.29 Design Parameters for Advance Warning System

Posted Speed (mph)	Distance Between Warning Sign and Stop Line (ft)	Lead Flash, Advance Warning Before End of Green (sec)
70	871 to 975 max**	8
70	730 min* to 870	7
65	811 to 905 max**	8
65	645 min* to 810	7
60	661 to 745 max**	7
60	570 min* to 660	6
55	606 to 685 max**	7
55	495 min* to 605	6
50	476 to 550 max**	6
50	425 min* to 475	5
45	426 to 495 max**	6
45	360 min* to 425	5

*The advance traffic control sign shall not be installed less than this minimum distance.
**The sign placement distance can exceed the "max" distance. The lead flash time should be determined by coordinating with the MoDOT Highway Safety and Traffic Division.

Standard. When a BE PREPARED TO STOP (W3-4) sign is used in advance of a traffic control signal, it shall be used in addition to a Signal Ahead sign and shall be placed a minimum of 200 feet downstream from the Signal Ahead sign. The BE PREPARED TO STOP (W3-4) sign shall be installed as specified in Table 903.3.4 (See Figure 903.3.29.1).

A BE PREPARED TO STOP (W3-4) sign with a warning beacon shall not be considered for intersection approaches with a posted speed limit of 40 mph or less.

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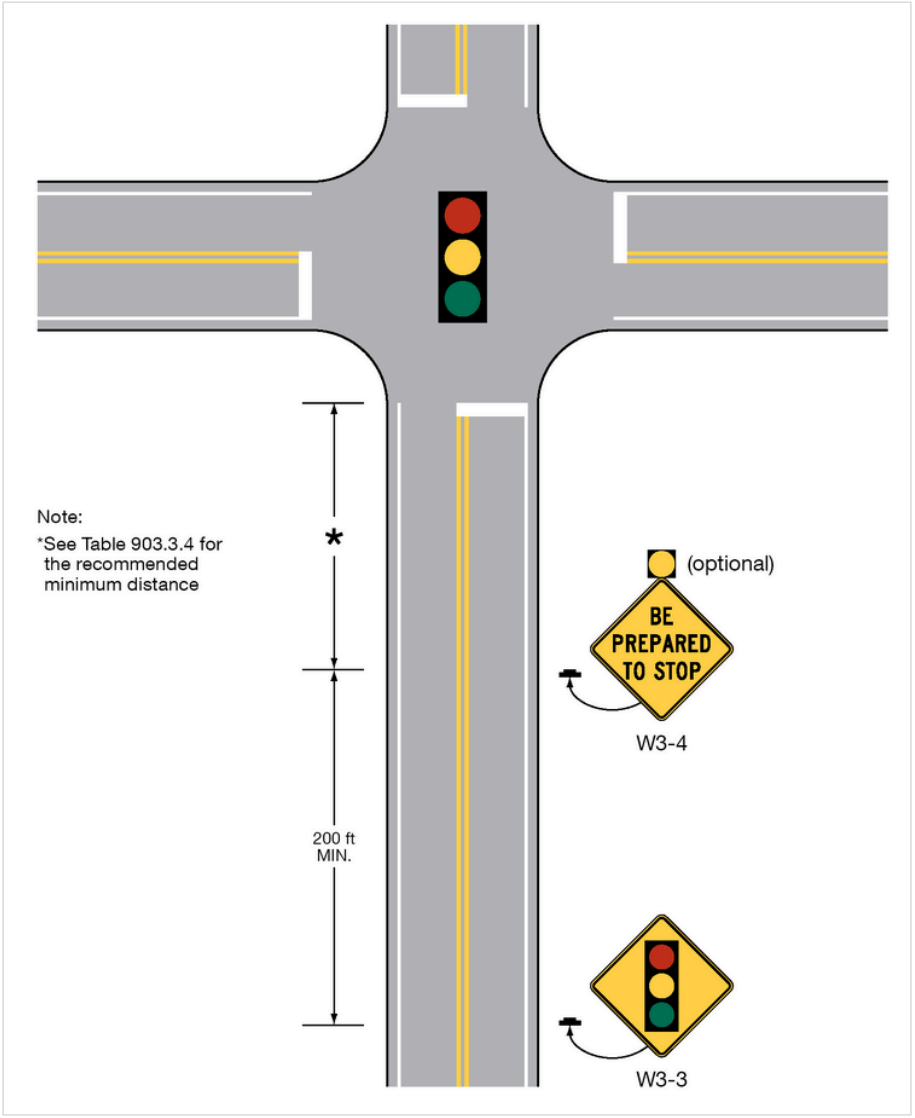


Figure 903.3.29.1 Example for Placement of BE PREPARED TO STOP Sign

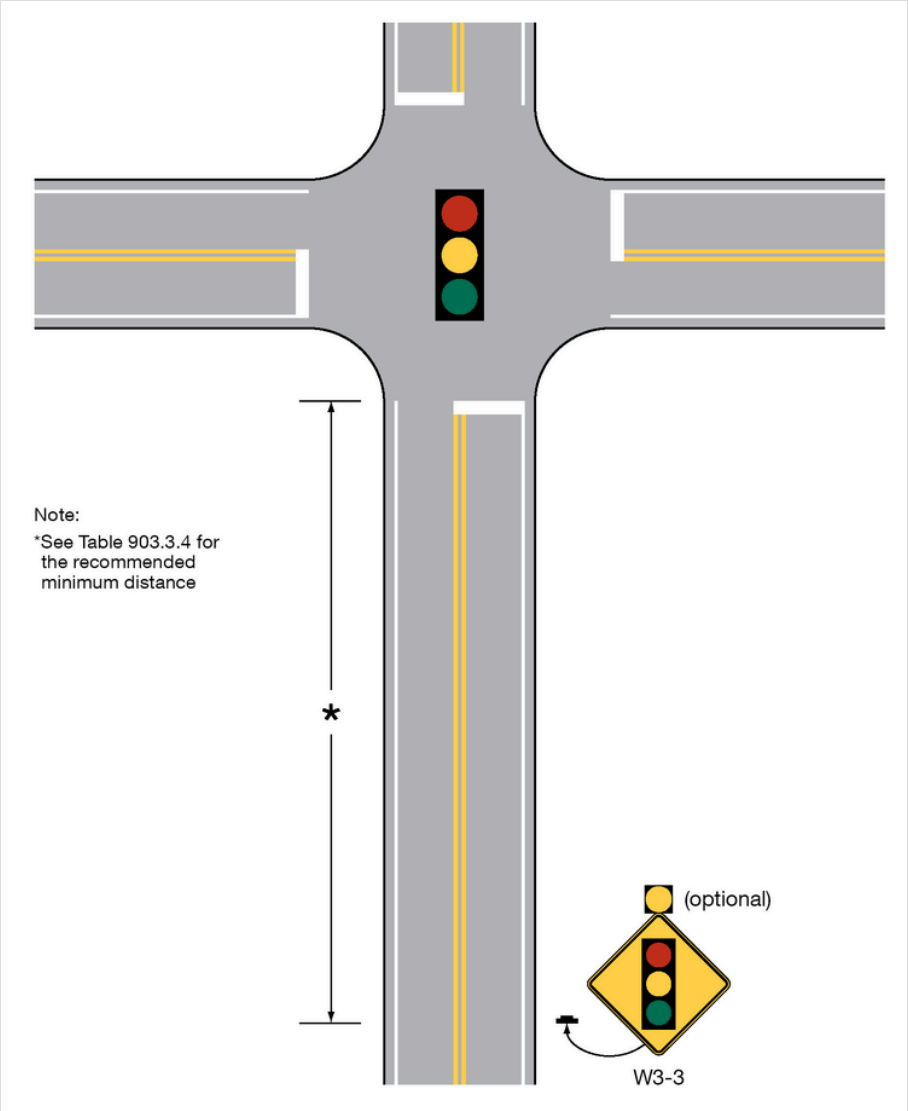


Figure 903.3.29.2 Example for Placement of Signal Ahead Sign

903.3.30 Advance Ramp Control Signal Signs (W3-7 and W3-8) (MUTCD Section 2C.37)



W3-7 W3-8

Option. A RAMP METER AHEAD (W3-7) sign may be used to warn road users that a freeway entrance ramp is metered and that they will encounter a ramp control signal (see EPG 902.16).

Guidance. When the ramp control signals are operated only during certain periods of the day, a RAMP METERED WHEN FLASHING (W3-8) sign should be installed in advance of the ramp control signal near the entrance to the ramp, or on the arterial on the approach to the ramp, to alert road users to the presence and operation of ramp meters.

Standard. The RAMP METERED WHEN FLASHING sign shall be supplemented with a Warning Beacon (see EPG 902.18.3) that flashes when the ramp control signal is in operation.

903.3.31 WATCH FOR STOPPED TRAFFIC Sign (W26-1) (MUTCD Section 2C.39)



W26-1

Option. The WATCH FOR STOPPED TRAFFIC (W26-1) sign may be used to warn road users of the possibility of vehicles stopping abruptly in the travel lane due to recurring congested conditions.

903.3.32 Reduced Speed Limit Ahead and Speed Zone Signs (W3-5) (MUTCD Section 2C.40)



W3-5

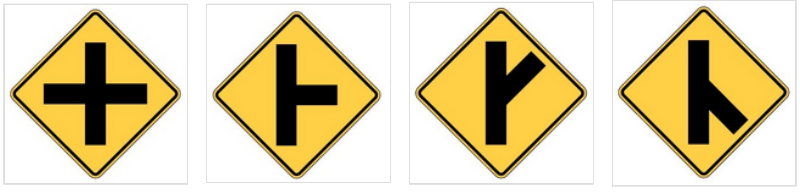
Standard. A Reduced Speed Limit Ahead (W3-5) sign shall be used to inform road users of a reduced speed zone where the speed limit is being reduced by more than 10 mph.

Option. A Reduced Speed Limit Ahead (W3-5) sign may be used to inform road users of a reduced speed zone where the speed limit is being reduced by 10 mph or less based if engineering judgment indicates the need for advance notice to comply with the posted speed limit ahead.

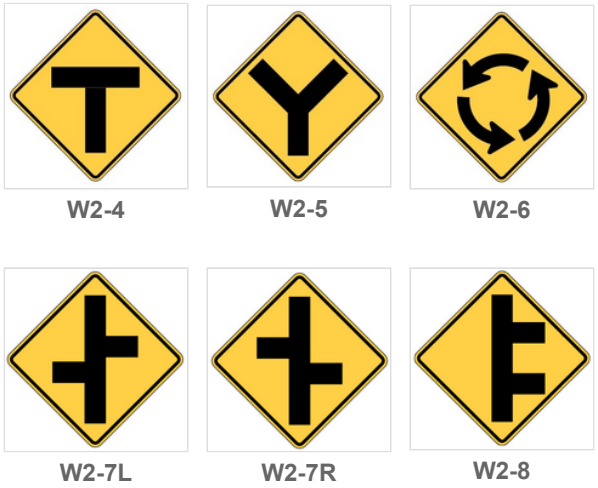
Standard. If used, a Reduced Speed Limit Ahead sign shall be followed by a Speed Limit (R2-1) sign (see EPG 903.3.20), installed at the beginning of the zone where the speed limit applies.

The speed limit displayed on the W3-5 sign shall be identical to the speed limit displayed on the subsequent Speed Limit sign.

903.3.33 Intersection Warning Signs (W2-1 through W2-8) (MUTCD Section 2C.41)



W2-1 W2-2 W2-3 W2-3a



Support. Intersection Warning Signs are used when there is limited stopping sight distance, history of crashes, or based on engineering judgment.

Option. A Cross Road (W2-1), Side Road (W2-2, W2-3, or W2-3a), T-Intersection (W2-4), or Y-Intersection (W2-5) sign may be used in advance of an intersection to indicate the presence of an intersection and the possibility of turning or entering traffic.

Standard. The Circular Intersection (W2-6) sign shall be installed in advance of roundabout intersections. The appropriate Advisory Speed supplemental plaque (W13-1P) shall be installed below the Circular Intersection sign.

Option. If other circular intersections exist, that would not be classified as roundabouts, the Circular Intersection (W2-6) sign may be used.

Support. EPG 903.2.64 contains information about the use of an advance street name plaque to identify an intersecting road.

Guidance. The Intersection Warning sign should illustrate and depict the general configuration of the intersecting roadway, such as a cross road, side road, T-intersection, or Y-intersection.

Intersection Warning signs, other than the Circular Intersection (W2-6) sign, the T-intersection (W2-4) sign, and the Grade Crossing and Intersection Advance Warning (W10-2, W10-3, and W10-4) signs (see EPG 913.2.6) should not be used on approaches controlled by STOP signs, YIELD signs, or signals.

If an Intersection Warning sign is used where the side roads are not opposite of each other, the Offset Side Roads (W2-7) sign should be used instead of the Cross Road sign.

If an Intersection Warning sign is used where two closely-spaced side roads are on the same side of the highway, the Double Side Roads (W2-8) sign should be used instead of the Side Road sign.

No more than two side roads should be depicted on the same side of the highway on a W2-7 or W2-8 sign, and no more than three side roads should be depicted on a W2-7 or W2-8 sign.

903.3.34 Advance Intersection Signs (W2-10a and W2-11a)



W2-10a



W2-11a

Support. Advance Intersection signs are typically associated with restricted sight distance and gap selection at stop controlled intersections.

Option. The WATCH FOR ENTERING TRAFFIC (W2-10a) sign may be used on the uncontrolled through roadway approach to a side or cross road stop controlled intersection to warn of entering traffic from the side or cross road.

The WATCH FOR APPROACHING TRAFFIC (W2-11a) sign may be used on the side road stop controlled approach to warn of traffic approaching on the uncontrolled through road.

903.3.35 Two-Direction Large Arrow Sign (W1-7) (MUTCD Section 2C.43)



W1-7

Standard. The Two-Direction Large Arrow (W1-7) sign shall be a horizontal rectangle.

If used, the Two-Direction Large arrow sign shall be installed on the far side of a T-intersection in line with, and at approximately a right angle to, traffic approaching from the stem of the T-intersection.

The Two-Direction Large Arrow sign shall not be used where there is no change in the direction of travel such as at the beginnings and ends of medians or at center piers.

Guidance. The Two-Direction Large Arrow sign should be visible for a sufficient distance to provide the road user with adequate time to react to the intersection configuration.

903.3.36 Traffic Signal Oncoming Extended Green Signs (W25-1 and W25-2) (MUTCD Section 2C.44)



W25-1



W25-2

Standard. At locations where either a W25-1 or a W25-2 sign is required based on the provisions in EPG 902.6.1, the W25-1 or W25-2 sign shall be installed near the left-most signal face for the approach.

903.3.37 Merge Signs and Plaque (W4-1 and W4-5) (MUTCD Section 2C.45)



W4-1



W4-5

Guidance. The Merge (W4-1) sign should be installed on the side of the major roadway where merging traffic will be encountered and in such a position as to not obstruct the road user's view of entering traffic.

When a Merge sign is installed on a major roadway, the symbol should be oriented right or left as appropriate to depict the side from which the merge occurs, with the arrow representing the major roadway and the curved stem representing the entering roadway.

When a Merge sign is to be installed on an entering roadway that curves before merging with the major roadway, such as a ramp with a curving horizontal alignment as it approaches the major roadway, the Entering Roadway Merge (W4-5) sign should be used to better portray the actual geometric conditions to road users on the entering roadway.

Where two roadways of approximately equal importance converge and merging movements are required, a Merge sign should be placed on each roadway.

The Merge sign should not be used where two roadways converge and merging movements are not required.

Standard. The Merge sign shall not be used in place of a Lane Ends (W4-2) sign (see EPG 903.3.39) where lanes of traffic moving on a single roadway must merge because of a reduction in the actual or usable pavement width.

Support. Examples of the use of Merge (W4-1) signs are shown in Drawing A in Figure 903.3.37.

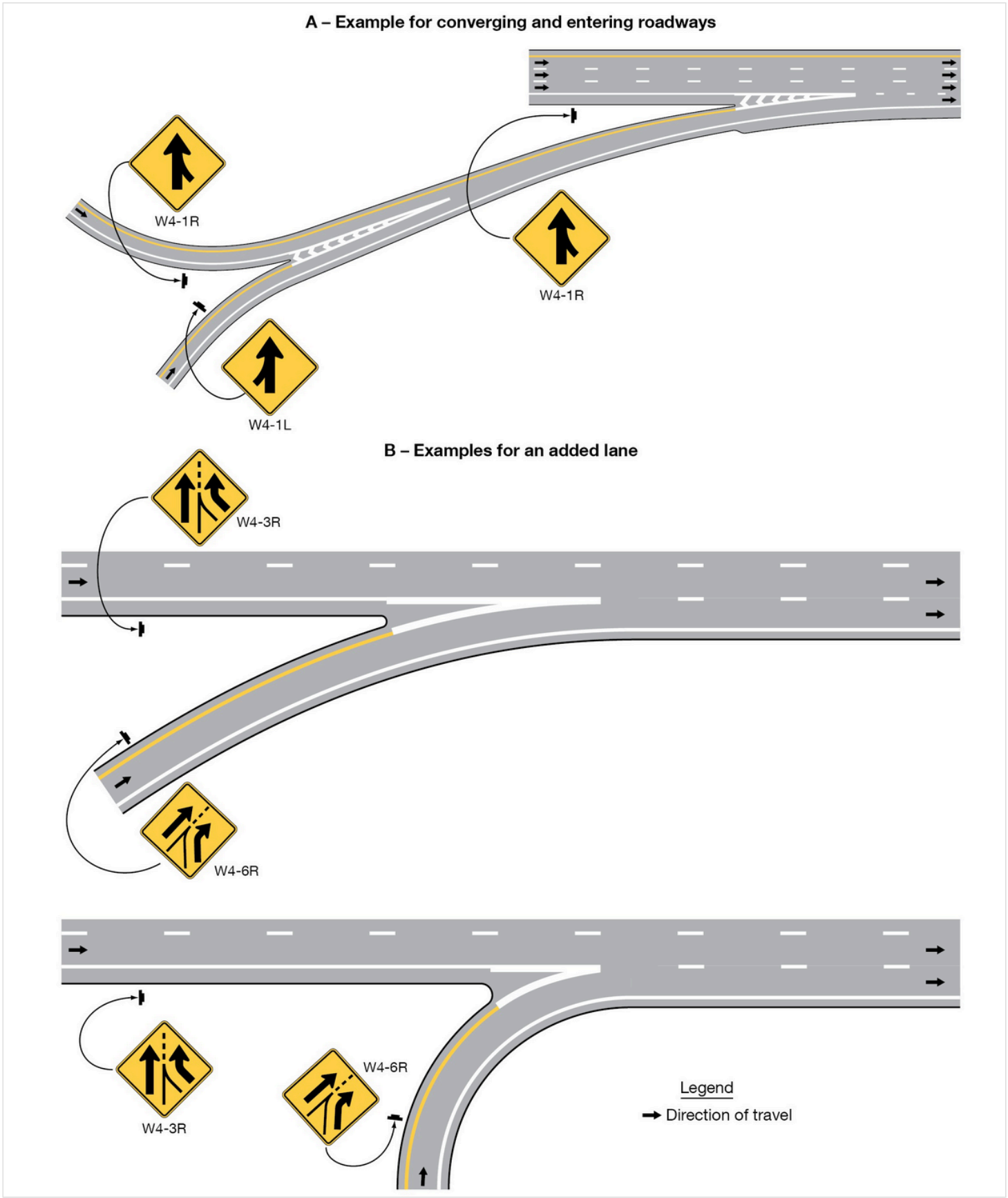


Figure 903.3.37 Examples of Merge and Added Lane Sign Placement for Entering and Converging Roadways

903.3.38 Added Lane Signs (W4-3 and W4-6) (MUTCD Section

2C.46)



W4-3



W4-6

Guidance. The Added Lane (W4-3) sign should be installed in advance of a point where two roadways converge and merging movements are not required. When possible, the Added Lane sign should be placed such that it is visible from both roadways; if this is not possible, an Added Lane sign should be placed on the side of each roadway.

When an Added Lane (W4-3) sign is installed on a major roadway, the symbol should be oriented right or left as appropriate to depict the side from which the entering roadway converges, with the straight arrow representing the major roadway and the curved arrow representing the entering roadway. The sign should be located on the side of the major roadway from which the entering roadway converges.

When an Added Lane sign is to be installed on a roadway that curves before converging with another roadway that has a tangent alignment at the point of convergence, the Entering Roadway Added Lane (W4-6) sign should be used to better portray the actual geometric conditions to road users on the curving roadway.

Support. Examples of the use of Added Lane (W4-3) and Entering Roadway Added Lane (W4-6) signs are shown in Drawing B in Figure 903.3.37.

903.3.39 Lane Ends Signs (W4-2 and W9-1) (Section 2C.47)



W4-2



W9-1

Support. The Lane Ends (W4-2) and RIGHT (LEFT) LANE ENDS (W9-1) signs are used to warn of the reduction in the number of traffic lanes in the direction of travel.

The sequence of the W4-2 and W9-1 signs is illustrated in Figures 903.3.39.1 to 903.3.39.5

Guidance. The Lane Ends (W4-2) sign should be installed at the advance placement distance in accordance with Table 903.3.4.

A RIGHT (LEFT) LANE ENDS (W9-1) sign should be installed in advance of the Lane Ends sign, at the advance placement distance in accordance with Table 903.3.4, to provide additional warning that a lane is ending and that a merging maneuver will be required.

If a W9-1 sign is installed, a Distance (W16-2P series or W16-3P series) plaque (see EPG 903.3.59) should be installed below the W9-1 sign.

On one-way streets or on divided highways where the left-hand lane is ending and the width of the median will permit, the W9-1 and W4-2 signs should be placed facing approaching traffic on the left-hand side or median.

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Option. Where a lane ends a distance beyond the intersection that is less than the advance placement distance indicated in Table 903.3.4, the W4-2 sign may be located at the far side of the intersection (see Figure 903.3.39.4).

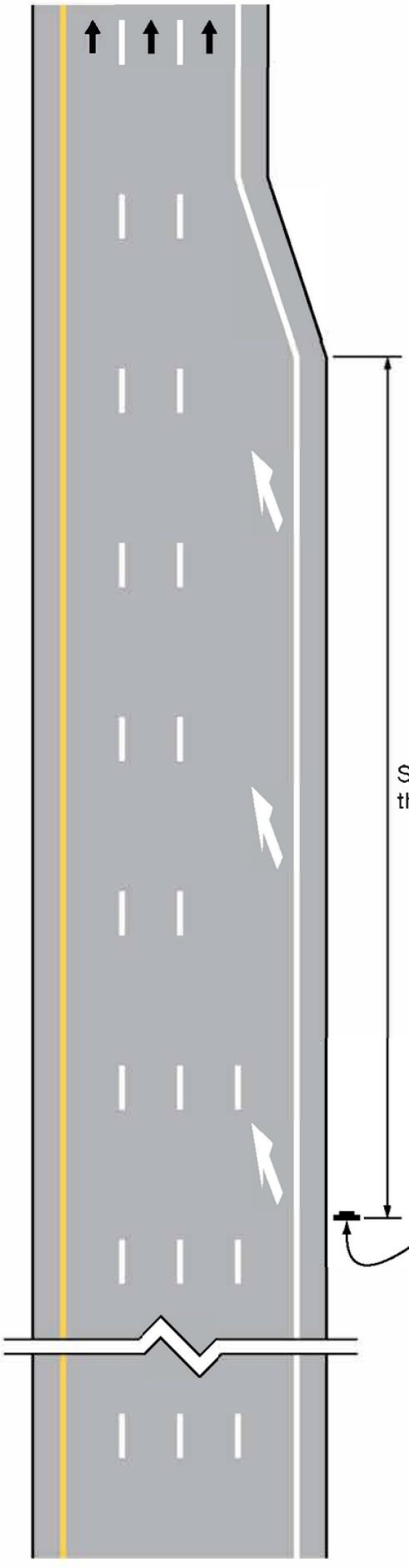
Guidance. When the W4-2 sign is located at the far side of the intersection in accordance with the Option paragraph above, the W9-1 sign should be placed upstream of the intersection with the appropriate distance plaque.

Support. EPG 620.2.14 contains information regarding the use of pavement markings in conjunction with a lane reduction.

Guidance. Lane Ends signs should not be installed in advance of the downstream end of an acceleration lane.

Standard. The W4-2 and W9-1 signs shall not be used in dropped lane situations. In dropped lane situations on conventional roads at intersections, regulatory signs (see EPG 903.2.26) shall be used to inform road users that a through lane becomes a mandatory turn lane.

A – Freeway or expressway - lane ends



Legend

➡ Direction of travel

See Table 903.3.4 to determine the advance placement distance



W4-2R

Note: See EPG 620.2.14 for lane-reduction pavement markings and EPG 620.2.22 for merge arrows



W9-1R

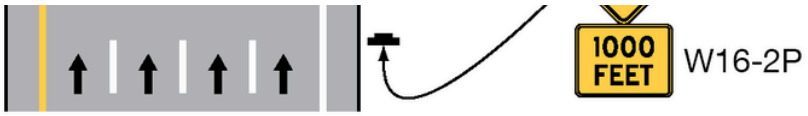


Figure 903.3.39.1 Example Sequences for Lane Ends and Lane Merge Signs *(Sheet 1 of 5)*

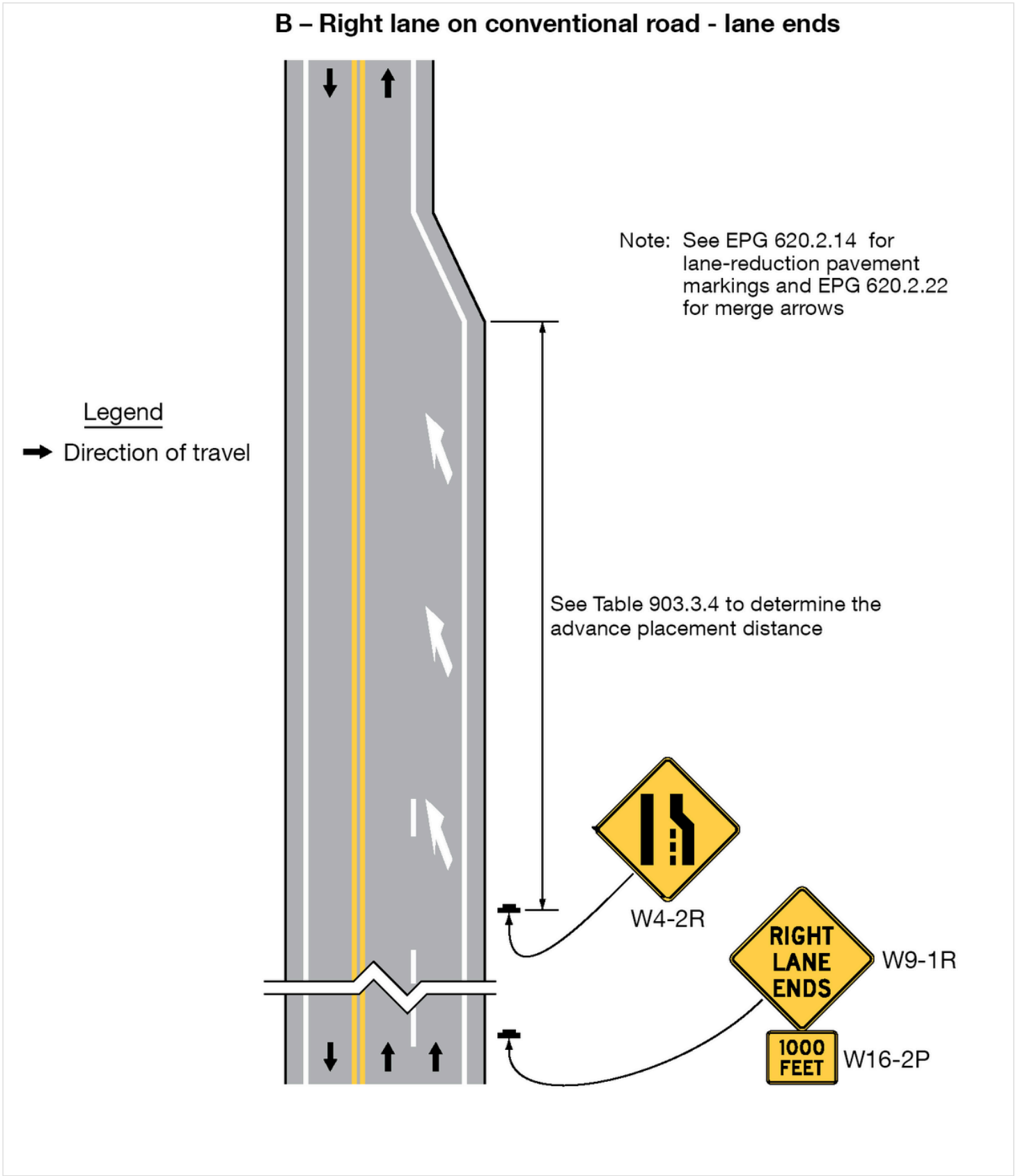


Figure 903.3.39.2 Example Sequences for Lane Ends and Lane Merge Signs *(Sheet 2 of 5)*

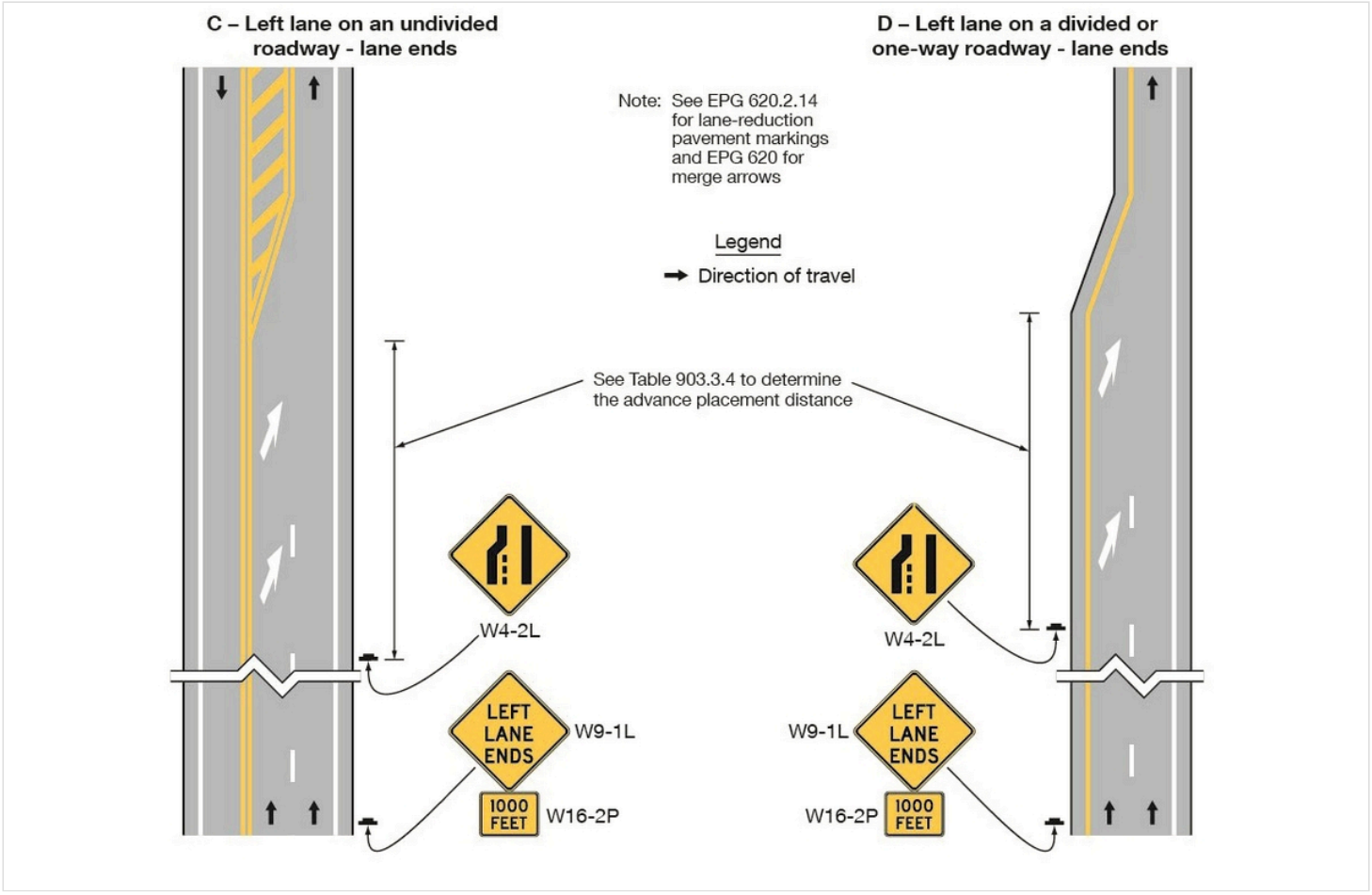


Figure 903.3.39.3 Example Sequences for Lane Ends and Lane Merge Signs *(Sheet 3 of 5)*

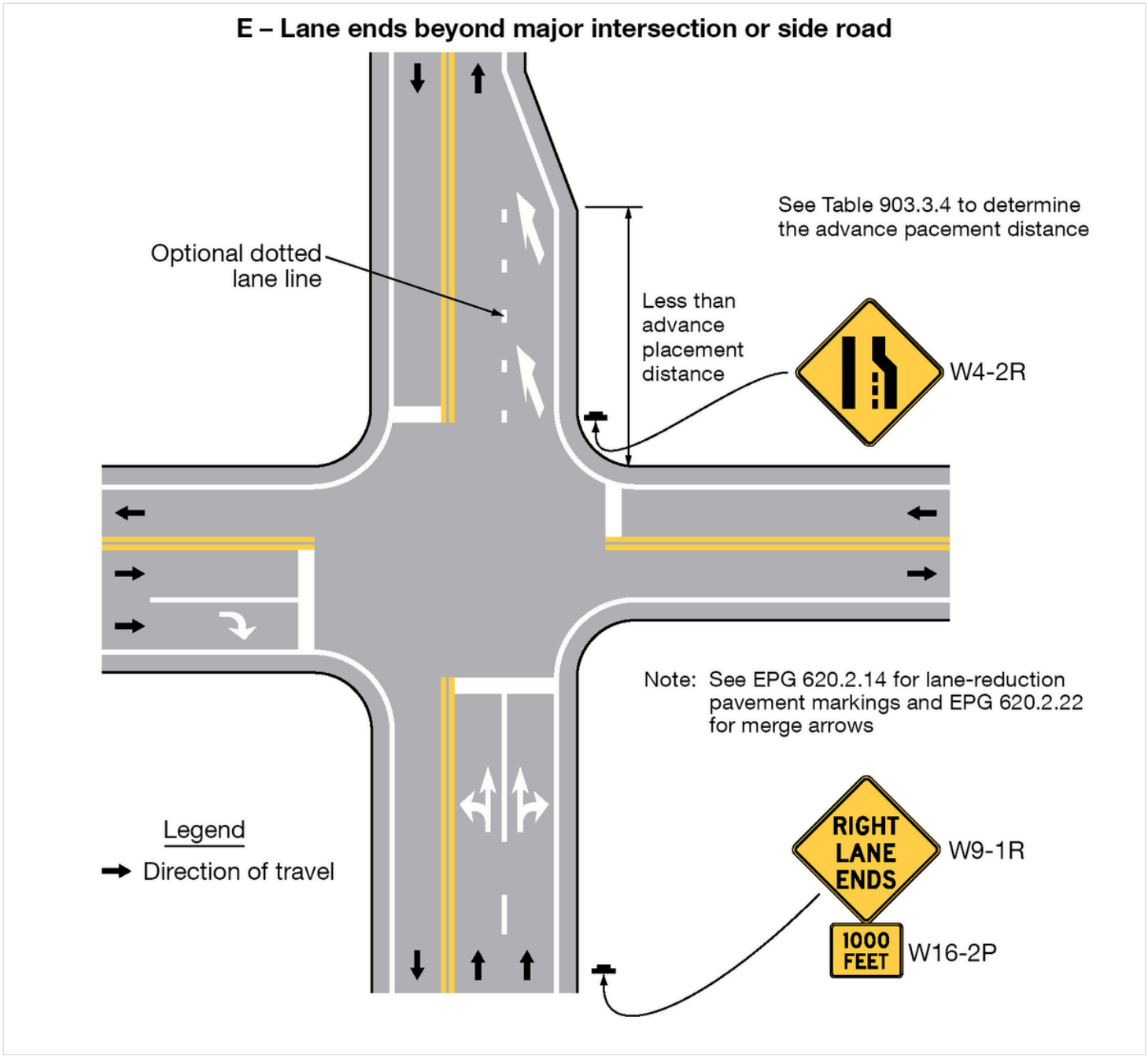


Figure 903.3.39.4 Example Sequences for Lane Ends and Lane Merge Sign *(Sheet 4 of 5)*

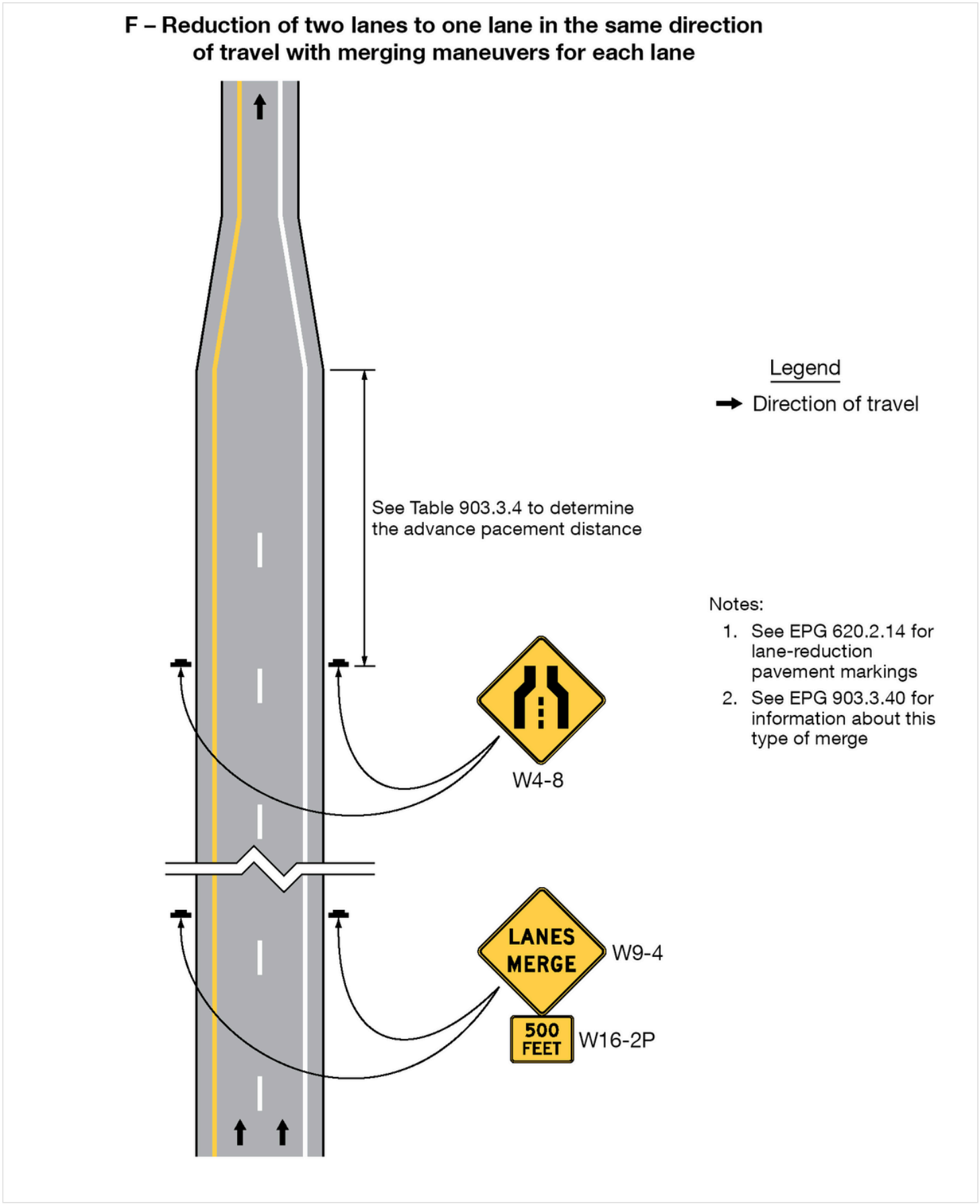


Figure 903.3.39.5 Example Sequences for Lane Ends and Lane Merge Signs *(Sheet 5 of 5)*

903.3.40 Lanes Merge Signs (W9-4 and W4-8) (MUTCD Section

2C.48)


W4-8



W9-4

Support. The LANES MERGE (W9-4) and Single-Lane Transition (W4-8) signs are used to warn of a merge of two lanes to one in the same direction of travel with a merging maneuver required for each lane (see Figure 903.3.39.5). This type of merge is for a geometric condition where both approach lanes merge into a single lane, not where one lane merges into the other. EPG 618.8.8 contains information about the use of the late merge sign.

Guidance. The Single-Lane Transition (W4-8) sign should be located at the advance placement distance in accordance with Table 903.3.4.

The Lanes Merge (W9-4) sign should be used in advance of the W4-8 sign to provide additional warning that both lanes form a single lane and that a merging maneuver is needed for the traffic in each lane.

903.3.41 RIGHT (LEFT) LANE EXIT ONLY Sign (W9-7) (MUTCD Section 2C.50)



W9-7

Option. The RIGHT (LEFT) LANE EXIT ONLY (W9-7) sign may be used to provide advance warning to road users that traffic in the right-hand (left-hand) lane of a roadway will be required to depart the roadway at the next exit.

Guidance. If used, the W9-7 sign should be installed upstream from the first overhead guide sign that contains an EXIT ONLY sign panel or upstream from the first RIGHT (LEFT) LANE MUST EXIT (R3-33) regulatory sign, if used, whichever is farther upstream from the exit.

903.3.42 Two-Way Traffic Sign (W6-3) (MUTCD Section 2C.51)


W6-3

Guidance. A Two-Way Traffic (W6-3) sign should be used to warn road users of a transition from a multi-lane divided section of roadway to a two-lane, two-way section of roadway.

A Two-Way Traffic (W6-3) sign with an AHEAD (W16-9P) plaque (see EPG 903.3.57) should be used to warn road users of a transition from a one-way street to a two-lane, two-way section of roadway.

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Option. The Two-Way Traffic sign may be used to supplement the Divided Highway (Road) Ends (W6-2) sign discussed in EPG 903.3.19.

903.3.43 NO PASSING ZONE Sign (W14-3) (MUTCD Section 2C.53)

Support. The NO PASSING ZONE (W14-3) sign is not to be used on a system-wide basis. It is intended for special use as a measure to reduce crashes at locations where there is a history of crashes related to passing maneuvers.

Standard. The NO PASSING ZONE (W14-3) sign shall be a pennant-shaped isosceles triangle with its longer axis horizontal and pointing to the right. When used, the NO PASSING ZONE sign shall be installed on the left-hand side of the roadway at the beginning of no-passing zones identified by pavement markings or DO NOT PASS signs or both (see EPG 903.2.31 and 620.2.3).

The use of the NO PASSING ZONE sign shall be approved by the State Highway Safety and Traffic Engineer.

903.3.44 Vehicular Traffic Warning Signs (MUTCD Section 2C.54)

Option. Vehicular Traffic Warning signs may be used to alert road users to locations where unexpected entries into the roadway by trucks, bicycles, farm vehicles, emergency vehicles, golf carts, horse-drawn vehicles, or other vehicles might occur.

Guidance. Vehicular Traffic Warning signs should be used only at locations where the road user's sight distance is restricted, or the condition, activity, or entering traffic would be unexpected.

If the condition or activity is seasonal or temporary, the Vehicular Traffic Warning sign should be removed or covered when the condition or activity does not exist.

Before advanced warning signs are installed, all efforts to correct the sight distance issues should be made as this will be far more effective to improve safety compared to installing a sign. Roadway alignments cannot be corrected easily, but removal of vegetation on and off the state right of way that blocks sight distance can address sight distance issues.

Option. Supplemental plaques (see EPG 903.3.57) with legends such as AHEAD, XX FEET, NEXT XX MILES, IN STREET, or IN ROAD may be mounted below Vehicular Traffic Warning signs to provide advance notice to road users of unexpected entries.

Standard. A Vehicular Traffic Warning sign assembly shall not be installed on an approach controlled by a STOP or a YIELD sign, except as provided in the following two Option paragraphs.

Option. The Vehicular Traffic Warning sign assembly may be installed on an approach to a circular intersection controlled by a YIELD sign where the crosswalk is at least 20 feet in advance of the yield point at the entrance to the circulatory roadway.

At a signalized or stop-controlled intersection the Vehicular Traffic Warning sign assembly may be installed on an approach to a channelized right-turn lane controlled by a YIELD sign where the crosswalk is at least 20 feet in advance of the yield point.

A Warning Beacon (see EPG 902.18.3) may be used with any Vehicular Traffic Warning sign to indicate specific periods when the condition or activity is present or is likely to be present, or to provide enhanced sign conspicuity.

903.3.45 Bicycle Warning (W11-1) Sign



W11-1

Guidance. Bicycle Warning (W11-1) signs should be used only at locations where the road user's sight distance is restricted, and the condition, activity, or entering traffic would be unexpected.

Option. Bicycle Warning (W11-1) signs may be used to alert road users to locations where unexpected entries into the roadway by cyclists might occur.

Support. Bicycle warning (W11-1) signs with a diagonal downward-pointing arrow (W16-7P) plaques are used to alert road users of locations where bicyclists routinely cross state highways.

Standard. If a post-mounted W11-1 sign is placed at the location of a bicycle crossing, a diagonal downward pointing arrow (W16-7P) plaque shall be mounted below the sign. The bicycle crossing warning sign with diagonal arrow supplemental plaque should be placed immediately in advance of, as near as possible, the crossing in both directions of travel. If the W11-1 sign is mounted overhead, the W16-7P supplemental plaque shall not be used.

Guidance. Bicycle crossing warning signs should be installed at locations where an established independent bicycle path crosses a state route. Bicycle crossing warning signs should not be installed where an established "US Bike Route" crosses a state route or where cyclists riding on the public roadways cross a state route.

Option. A Bicycle Warning (W11-1) sign with an AHEAD (W16-9P) supplemental plaque may be added in advance of the bicycle crossing if engineering judgement determines a need based on limited sight distance of the crossing.

Bicycle Warning (W11-1) signs with an In Road (W16-1P) plaque may be used to alert road users to locations where cyclists riding on the roadway might occur.

Standard. When bicycle warnings signs are installed to warn motorists of bicycle activity along a state highway, the IN ROAD (W16-1P) plaque shall be installed below the Bicycle Warning (W11-1) sign and shall match the color of the warning sign.

Support. Bicycle warning signs with the IN ROAD supplemental plaques (IN ROAD plaque replaces the SHARE THE ROAD plaque) are used to alert road users where bicyclists routinely ride along specific sections of state highways, in the travel lane or on the shoulder of the roadway.

Guidance. The use of Bicycle warning signs to warn road users of cyclist activity along specific sections of roadway should be based on identifiable, routine and/or frequent cyclist activity. Indications bicycle warnings signs should be installed should be based on conditions, such as, but not limited to:

A. Requests received by bicycle groups, or clubs, who indicate the state highways which are part of their group's frequent cycling routes.

B. Requests from Amish, Mennonite or other communities who utilize bicycles as one of their primary modes of routine transportation, indicating the state highways which service their community's cycling needs.
C. Sections of a state route where an established bicycle trail overlaps the state route for some length, using the roadway and not a dedicated bike lane, before returning to the independent trail again.
D. Cycling activity occurs a minimum of 3 days per week, 6 months per year.

Bicycle warning signs should not be installed along routes for the following conditions:

A. For the purpose of promoting cycling or conveying a bicycle friendly organization when there is no routine cycling activity on that route,
B. When cyclists have access to a dedicated bicycle lane along the route,
C. Where cyclists have access to a parallel bike facility, or multi-use path, or
D. In response to a request from an individual without verifying the need as described in this article.

Bicycle warning signs used to notify drivers of bicycle traffic on the state route should only be ground-mounted installations. Signs should be installed at the point on the route the activity begins and downstream of major public road entry points onto the state route.

Option. Additional bicycle warning signs may be installed based on engineering judgement if the distance between major road intersections is excessive or if there are areas with limited sight distance which may obscure bicycle traffic.

A NEXT XX MILES (W7-3aP) plaque (See EPG 903.3.60) may be installed below the IN ROAD plaque if engineering judgement determines the need to notify road users of the length of roadway over which unexpected cyclists riding along the road may occur.

903.3.46 Combined Bicycle/Pedestrian Crossing (W11-15) Sign



W11-15

Option. Combined Bicycle/Pedestrian Crossing (W11-15) signs may be used to alert road users to locations where unexpected entries into the roadway by cyclists and pedestrians might occur.

Guidance. Combined Bicycle/Pedestrian warning signs should be installed at locations where an established shared use path crosses a state route.

Support. The combined Bicycle/Pedestrian (W11-15) sign is used where both bicyclists and pedestrians might be crossing the roadway at intersections with a shared-use path and state routes. A shared-use path is defined as a paved or gravel path, 8-10 foot wide, dedicated to bike and pedestrian traffic which is an independent facility from the roadway.

Standard. If a post-mounted W11-15 sign is placed at the location of the combined Bicycle/Pedestrian crossing, a diagonal downward pointing arrow (W16-7P) plaque shall be mounted below the sign. The Bicycle/Pedestrian warning sign with diagonal downward pointing arrow plaque shall be placed immediately in advance of, as near as possible, the crossing in both directions of travel. If the W11-15 sign is mounted overhead, the W16-7P supplemental plaque shall not be used.

Option. An advanced Bicycle/Pedestrian warning sign with an AHEAD (W16-9P) supplemental plaque may be added in advance of the Bicycle/Pedestrian crossing if engineering judgement determines a need based on limited sight distance of the crossing.

903.3.47 Trail Crossing (W11-15a) Sign



W11-15a

Option. TRAIL CROSSING (W11-15a) signs may be used to alert road users to locations where unexpected entries into the roadway by cyclists, pedestrians or equestrian activity might occur.

Support. The TRAIL CROSSING sign is used to warn of a rustic trail where pedestrian, bicyclist, or equestrian activities, might be crossing the state highway. A rustic trail would typically be an unpaved trail of an undefined width, but one that is visible and identifiable by a motorist as it crosses the right of way.

Guidance. TRAIL CROSSING signs should be installed at locations where an established rustic trail used by pedestrians, bicyclists, and equestrian activities crosses a state route.

Standard. If a post-mounted W11-15a sign is placed at the location of the rustic trail crossing, a diagonal downward pointing arrow (W16-7P) plaque shall be mounted below the sign. The W11-15a sign with diagonal downward pointing arrow plaque shall be placed immediately in advance of, as near as possible, the crossing in both directions of travel. If the W11-15a sign is mounted overhead, the W16-7P supplemental plaque shall not be used.

Option. A TRAIL CROSSING warning sign with an AHEAD (W16-9P) supplemental plaque may be added in advance of the trail crossing if engineering judgement determines a need based on limited sight distance of the crossing.

903.3.48 Horse-Drawn Vehicle (W11-14) Sign



W11-14

Option. Horse-Drawn Vehicle (W11-14) signs may be used to alert road users to locations where unexpected horse-drawn vehicles are traveling along the roadway might occur.

Guidance. W11-14 signs should be used only at locations where the road user's sight distance is restricted, and the condition, activity, or entering traffic would be unexpected.

Support. Horse-Drawn Vehicle warning signs with the IN ROAD (W16-1P) supplemental plaque (IN ROAD plaque replaces the SHARE THE ROAD plaque) are used to alert road users where horse-drawn vehicle traffic is routinely traveling along specific sections of state highways, in the travel lane or on the shoulder of the roadway.

Standard. When Horse-drawn vehicle warnings signs are installed to warn motorists of Horse-drawn vehicle activity along a state highway, the IN ROAD (W16-1P) plaque shall be installed below the Horse-drawn vehicle warning sign and shall match the color of the warning sign.

Guidance. The use of Horse-Drawn Vehicle signs to warn road users of horse-drawn vehicle activity along specific section of roadway should be based on identifiable, routine and/or frequent horse-drawn vehicle activity. The application of horse-drawn vehicle warning signs is limited to the Amish, Mennonite or other communities who utilize horse-drawn vehicles as one of their primary modes of routine transportation. The district should work with community leadership to determine the state routes their communities utilize on a routine basis to determine the most appropriate sign installation locations.

Horse-Drawn Vehicle signs used to notify drivers of horse-drawn vehicle traffic on the state route should only be ground-mounted installations. Signs should be installed at the point on the route the activity begins and downstream of each major public road entry points onto the state route.

Option. Additional Horse-Drawn Vehicle signs with IN ROAD plaques may be installed based on engineering judgement if the distance between major road intersections is excessive or if there are areas with limited sight distance which may obscure horse-drawn vehicle traffic.

A NEXT XX MILES (W7-3aP) plaque may be added below the IN ROAD plaque if engineering judgement determines the need to notify drivers of the length of roadway affected by the warning sign.

903.3.49 TRUCK CROSSING (W8-6) Sign



W8-6

Option. Truck Crossing (W8-6) signs may be used to alert road users to locations where unexpected entries into the roadway by trucks crossing the road might occur.

Guidance. W8-6 signs should be used only at locations where the road user's sight distance is restricted, and the condition, activity, or entering traffic would be unexpected.

Support. The W8-6 sign is used to alert road users to locations where trucks are routinely crossing a state highway at a commercial entrance intersection. A typical example would be a company with facilities on either side of a highway where raw materials, finished goods, etc. are routinely moved sites. In these cases, warning signs with fluorescent yellow backgrounds are installed in a permanent installation.

Option. For cases involving temporary truck crossings, such as haul roads moving earth or quarry materials, a TR12 Truck crossing agreement (see EPG 153.21) may be used to install a temporary traffic control sign with a fluorescent orange background.

Guidance. W8-6 signs should be installed at locations where there is consistent and routine truck traffic crossing a state route where the road user's sight distance is restricted, and the crossing would be unexpected based on engineering judgement.

The truck crossing for which the warning sign is being installed should be recognizable by the presence of a on premise business marquee sign, business name on structures or other indicators to allow drivers to associate the warning sign to the entrance/site where tucks could be crossing the state highway.

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Standard. If used, the TRUCK CROSSING sign shall be placed in accordance with Table 903.3.4.

The TRUCK CROSSING sign shall only be installed for the direction of travel where the road user's sight distance is restricted.

The TRUCK CROSSING sign shall not be used on state highways at intersections with city streets or county roads, to address issues at these types of intersections other warning signs, such as Intersection Warning signs are more appropriate.

903.3.50 Truck Entrance (W11-10) Sign



W11-10

Option. Truck Entrance (W11-10) signs may be used to alert road users to locations where unexpected entries into the roadway by trucks might occur.

Guidance. Truck Entrance signs should be used only at locations where the road user's sight distance is restricted, and the condition, activity, or entering traffic would be unexpected.

Support. The W11-10 sign is used to alert road users to locations where trucks are routinely entering and leaving a state highway at a non-public roadway intersection, commercial entrance. A typical example would be trucks entering and exiting a quarry entrance which has direct access to the state route. In these cases, warning signs with fluorescent yellow backgrounds are installed in a permanent installation.

Option. For cases involving a temporary truck entrance, such as logging trucks entering and leaving a timber harvest location, a TR12 Truck crossing agreement (see EPG 153.21) may be used to install a temporary traffic control sign with a fluorescent orange background.

Guidance. Truck Entrance signs should be installed at locations where there is consistent and routine truck traffic entering and leaving a state route where the road user's sight distance is restricted, and the crossing would be unexpected based on engineering judgement.

The truck entrance for which the sign is being installed should be recognizable by the presence of a on premise business marquee sign, building with the business name or some other form of marking to allow drivers associate the warning sign to the site where trucks could be entering or leaving the highway.

Standard. If used, the Truck Entrance sign shall be placed in accordance with Table 903.3.4.

The Truck Entrance sign shall only be installed for the direction of travel where the road user's sight distance is restricted.

The truck entrance warning sign shall not be used on state highways at intersections with city streets or county roads, to address issues at these types of intersections other warning signs, such as Intersection Warning signs are more appropriate.

903.3.51 Farm Equipment (W11-5) Warning Sign



W11-5

Option. Farm Equipment Warning (W11-5) signs may be used to alert road users to locations where unexpected entries into the roadway by farm equipment crossing the road might occur.

Guidance. W11-5 signs should be used only at locations where the road user's sight distance is restricted, and the condition, activity, or entering traffic would be unexpected.

Support. The Farm Equipment (W11-5) sign is used to alert road users to locations where slow-moving farm vehicles are routinely entering or crossing the state highway (immediately across or a short transition down the road to a different entrance) if the highway splits the farm. A typical example would be a dairy farm where these crossings take place daily. In these cases, fluorescent yellow warning signs are installed in a permanent installation.

Farm Equipment signs are not installed to warn of farm equipment traveling along a state highway. This warning is the responsibility of the farmer and can be addressed by displaying the appropriate warning lights and signs on the equipment as well as having the appropriate lead and/or trailing vehicles escorting the equipment.

Option. For cases involving a temporary farm equipment access entrance, such as during planting or harvest season, a TR12 Truck Crossing agreement (see EPG 153.21) may be used to install a temporary traffic control sign with a fluorescent orange background.

Guidance. Farm Equipment signs should be installed at locations where there is consistent and routine farm equipment entering and leaving a state route where the road user's sight distance is restricted, and the crossing would be unexpected based on engineering judgement.

The farm vehicle entrance for which the warning sign is being installed should be recognizable by the presence of a on-premise business marquee sign, presence of farm equipment, farm structures or other indicators to allow drivers to associate the warning sign to the site where farm vehicles could be crossing/entering the highway.

Standard. If used, the Farm Equipment warning sign shall be placed in accordance with Table 903.3.4.

The Farm Equipment warning sign shall only be installed for the direction of travel where the road user's sight distance is restricted.

903.3.52 Emergency Vehicle (W11-8) Sign



W11-8



W11-12P

Option. Emergency Vehicle (W11-8) signs may be used to alert road users to locations where unexpected entries into the roadway by emergency vehicles might occur.

Guidance. Emergency Vehicle signs should be used only at locations where the road user's sight distance is restricted, and the condition, activity, or entering traffic would be unexpected.

Support. The Emergency Vehicle sign is used to alert road users to locations where emergency vehicles are routinely entering and leaving a state highway at dedicated emergency vehicle facility entrances.

Guidance. Emergency Vehicle signs should be installed at a state route where the road user's sight distance is restricted, and the crossing would be unexpected based on engineering judgement.

The emergency vehicle entrance for which the warning sign is being installed should be recognizable by the presence of a on premise marquee sign, building with the emergency agency name displayed or some other form of marking to allow drivers to associate the warning sign to the site/entrance where emergency vehicles could be entering or leaving the state highway.

Standard. If used, the Emergency Vehicle warning sign shall be placed in accordance with Table 903.3.4.

The Emergency Vehicle warning sign shall only be installed for the direction of travel where the road user's sight distance is restricted.

When measuring sight distance for emergency vehicle entrances, the sight distance shall be determined using a 3.5 ft. eye height and an 8 ft. object height in the same method use to evaluate school bus stop sight distances (see EPG 908.2.4).

The Emergency Vehicle sign with the EMERGENCY SIGNAL AHEAD (W11-12P) supplemental plaque shall be placed in advance of all emergency-vehicle traffic control signals (see EPG 902.13).

903.3.53 Non-Vehicular Warning Signs (W11-2, W11-3, W11-4, and W11-7) (MUTCD Section 2C.55)



W11-2



W11-4 (Cattle)



W11-7

Option. Non-Vehicular Warning (W11-2, W11-4, and W11-7) signs may be used to alert road users in advance of locations where unexpected entries into the roadway might occur.

Support. These conflicts might be relatively confined or might occur randomly over a segment of roadway.

Guidance. If used in advance of a pedestrian or equestrian crossing, the W11-2 and W11-7, signs should be supplemented with plaques (see EPG 903.3.59) with the legend AHEAD or XX FEET to inform road users that they are approaching a point where crossing activity might occur.

Standard. If a post-mounted W11-2 or W11-7 sign is placed at the location of the crossing point where pedestrians or equestrians might be crossing the roadway, a diagonal downward-pointing arrow (W16-7P) plaque (see EPG 903.3.62) shall be mounted below the sign. If the W11-2 or W11-7 sign is mounted overhead, the W16-7P plaque shall not be used.

A Non-Vehicular Warning sign assembly shall not be installed on an approach controlled by a STOP or a YIELD sign, except as provided in the first two Option paragraphs below.

Equestrian (W11-7) warning signs shall only be installed at Public Equestrian Trail Crossings. Existing Equestrian (W11-7) Crossing signs that do not meet the Public Equestrian Trail Crossing criteria shall be left in place until they reach the end of their service life.

The use of the Deer (W11-3) warning signs has been discontinued by MoDOT due to studies proving these signs provide little or no safety benefit. Existing W11-3 signs shall be removed at the end of their service life.

The Cattle (W11-4) sign shall be issued to an individual only when the Application for Sign at Cattle Crossings contract (TR09) is fully executed. See EPG 153.21 for the TR09 Agreement.

Option. The Non-Vehicular Warning sign assembly may be installed on an approach to a circular intersection controlled by a YIELD sign where the crosswalk is at least 20 feet in advance of the yield point at the entrance to a circulatory roadway.

At a signalized or stop-controlled intersection the Non-Vehicular Warning sign assembly may be installed on an approach to a channelized right-turn lane controlled by a YIELD sign where the crosswalk is at least 20 feet in advance of the yield point.

A Pedestrian Crossing (W11-2) sign may be placed overhead or may be post-mounted with a diagonal downward-pointing arrow (W16-7P) plaque at the crosswalk location where Yield Here To Pedestrians signs (see EPG 903.2.18) have been installed in advance of the crosswalk.

Standard. If a W11-2 sign has been post-mounted at the crosswalk location where a Yield Here To Pedestrians sign is used on the approach, the Yield Here To Pedestrians sign shall not be placed on the same post as the W11-2 sign.

Option. An advance Pedestrian Crossing (W11-2) sign with an AHEAD or a distance supplemental plaque may be used in conjunction with a Yield Here To Pedestrians sign on the approach to the same crosswalk.

The crossing location identified by a W11-2 or W11-7 sign may be defined with crosswalk markings (see EPG 620.3).

Standard. The W11-2 sign and related supplemental plaques shall only have a fluorescent yellow-green background with a black legend and border if the signs are installed within a school area as described in the fifth Support paragraph of EPG 903.3.2.

Guidance. When a fluorescent yellow-green background is used, a systematic approach featuring one background color within a zone or area should be used. The mixing of standard yellow and fluorescent yellow-green backgrounds within a selected site area should be avoided.

Option. A Warning Beacon (see EPG 902.18.3) may be used with any Non-Vehicular Warning sign to indicate specific periods when the condition or activity is present or is likely to be present, or to provide enhanced sign conspicuity.

903.3.54 FERRY CROSSING AHEAD Sign (W3-18)



W3-18

Option. The FERRY CROSSING AHEAD (W3-18) sign may be installed for a ferry crossing. A STOP (R1-1) sign at the ferry crossing may be used as a supplement.

903.3.55 Passing Lane Warning Signs (W6-5, W6-5a, W6-6aP, W6-16, and W6-17)



W6-6aP



W6-16



W6-17

Support. Alternating passing lanes may be provided on rural, two-lane highways to provide motorists with an opportunity to pass slower vehicles without crossing the centerline. Where passing lanes are provided, operations and safety may be improved by giving motorists advance information about the location of passing lanes. Providing motorists with advance notice of passing lanes may reduce the number of passing maneuvers.

Standard. The PASSING LANE ENDS (W6-16), WATCH FOR LEFT-TURNING TRAFFIC IN PASSING LANE (W6-17), and PASSING LANE PLAQUE (W6-6aP) signs shall be black legend and fluorescent yellow background and shall only be used in alternating passing lane sections.

The PASSING LANE ENDS sign shall be used prior to the end of the passing lane to warn motorists the passing lane in that direction of travel is ending and merging back to a single lane. The sign shall be placed in advance of the LANE ENDS MERGE RIGHT (W9-2) sign at a distance determined by Table 903.3.4.

Option. The WATCH FOR LEFT TURNING TRAFFIC IN PASSING LANE sign may be used at locations in a passing lane segment where left turns are common, such as at a county road. This sign may be installed at the judgement of the engineer.

The Two-Way Traffic on a Three-Lane Roadway (W6-5 and W6-5a) signs may be installed along three-lane roadways with two lanes in one direction and one in the opposing direction.

903.3.56 TRAVEL SAFE ZONE – FINES DOUBLED Sign (W27-1)



W27-1

Support. The TRAVEL SAFE ZONE - FINES DOUBLED (W27-1) sign is not to be used on a system-wide basis. It is intended for special use at locations where severe crashes are occurring. There is a requirement for regional support to focus a safety campaign involving local law enforcement and public information efforts to reduce the number and severity of crashes within the travel safe zone (see EPG 907.3).

Standard. A TRAVEL SAFE ZONE – FINES DOUBLED sign shall be used to mark the beginning of a designated travel safe zone. This sign is installed in conjunction with the FINES DOUBLED ENDS (R2-20) sign (see EPG 903.2.70).

903.3.57 Use of Supplemental Warning Plaques (MUTCD Section 2C.57)

Option. A supplemental warning plaque may be displayed with a warning or regulatory sign when engineering judgment indicates that road users require additional warning information beyond that contained in the main message of the warning or regulatory sign.

Standard. Supplemental warning plaques shall be used only in combination with and installed on the same post(s) as warning or regulatory signs. They shall not be mounted alone or displayed alone.

Unless otherwise provided in the EPG for a particular plaque, supplemental warning plaques shall be mounted below the sign they supplement.

903.3.58 Design of Supplemental Warning Plaques (MUTCD Section 2C.58)

Standard. A supplemental warning plaque used with a warning sign shall have the same legend, border, and background color as the warning sign with which it is displayed. A supplemental warning plaque used with a regulatory sign shall have a black legend and border on a yellow background.

Supplemental warning plaques shall be square or rectangular.

903.3.59 Advisory Speed Plaque (W13-1P) and Confirmation Advisory Speed Plaque (W13-1aP) (MUTCD Section 2C.59)



W13-1P



W13-1aP

Option. The Advisory Speed (W13-1P) plaque may be used to supplement an advance warning sign to indicate the advisory speed for a condition.

The Confirmation Advisory Speed (W13-1aP) plaque may be used to supplement a One-Direction Large Arrow (W1-6) sign on the outside of a turn or curve in line with and at approximately a right angle to approaching traffic.

Standard. The use of the Advisory Speed and Confirmation Advisory Speed plaques for horizontal curves shall be in accordance with EPG 903.3.6. The Advisory Speed plaque shall also be used where an engineering study indicates a need to advise road users of the advisory speed for other roadway conditions.

The speed displayed on the Advisory Speed and Confirmation Advisory Speed plaques shall be a multiple of 5 mph. The maximum advisory speed posted shall never be more than the posted speed limit.

Except in emergencies or when the condition is temporary, an Advisory Speed or Confirmation Advisory Speed plaque shall not be installed until the advisory speed has been determined by an engineering study.

The Advisory Speed plaque shall only be used to supplement an advance warning sign. The Advisory Speed plaque or the Confirmation Advisory Speed plaque shall not be installed as a separate sign installation.

Guidance. The Advisory Speed plaque, if used with a sign that is also supplemented with another plaque, such as an Advance Street Name plaque (see EPG 903.3.64), should be mounted immediately below the primary warning sign with any other plaque mounted below the Advisory Speed plaque.

Standard. The Confirmation Advisory Speed plaque shall only be used to supplement a One-Direction Large Arrow (W1-6) sign (see EPG 903.3.10) or an Exit Gore (E5-1 series) sign (see EPG 903.5.26) and shall not be installed as a separate sign installation.

The advisory speed shall be determined by an engineering study that follows established engineering practices.

Guidance. The advisory speed should be determined based on free-flowing traffic conditions.

Because changes in conditions, such as roadway geometrics, surface characteristics, or sight distance, might affect the advisory speed, each location should be evaluated periodically or when conditions change.

Support. Among the established engineering practices that are appropriate for the determination of the recommended advisory speed for a horizontal curve are the following:

A. Accelerometer method
B. 10 degrees of ball bank for all speeds

Engineering Study for Ball-Banking

The procedure to determine the safe speed on a curve or turn is a ball-bank study. To correctly use the ball-bank indicator, the ball-bank indicator should be mounted on the dashboard of a passenger car and adjusted to read "0" when the car is stationary on a level grade with the ball-bank indicator being in a vertical plane. When adjusting the indicator, all personnel who are to be in the car while testing should be in their seats and all four tires should have the same pressure. It is usually best for at least two persons to be in the car while taking the ball-bank reading: one for driving, the other for observation and recording.

The 10-degree reading that can be maintained the complete length of a curve is the appropriate safe speed for that curve. Care must be taken to maintain the car in its proper lane and to maintain a smooth, consistent speed throughout the curve. It will occasionally be found that a curve will have a higher safe speed in one direction than the other. In such cases, the lower safe speed should be used for both directions. Only increments of 5 mph are used on the Advisory Speed Plaque, therefore the curve shall be posted to the nearest 5 mph speed from the survey.

903.3.60 Distance Plaques (W16-2P, W16-3P, W16-4P, and W7-3aP) (MUTCD Section 2C.61)



W16-2P



W16-3P



W16-4P



W7-3aP

Option. The Distance Ahead (W16-2P and W16-3P) plaques may be used to inform the road user of the distance to the condition indicated by the warning sign.

The Next Distance (W7-3aP and W16-4P) plaques may be used to inform road users of the length of roadway over which the condition indicated by the warning sign exists.

Standard. Distances shall be shown in ¼ mile or 100 ft. increments. If the distance is less than a ½ mile then feet shall be used.

903.3.61 Supplemental Arrow Plaques (W16-5P and W16-6P) (MUTCD Section 2C.62)


W16-5P


W16-6P

Guidance. If the condition indicated by a warning sign is located on an intersecting road and the distance between the intersection and condition is not sufficient to provide adequate advance placement of the warning sign, a Supplemental Arrow (W16-5P or W16-6P) plaque should be used below the warning sign.

Standard. Supplemental Arrow plaques shall have the same legend design as the Advance Turn Arrow and Directional Arrow auxiliary signs (see EPG 903.4.22 and 903.4.24) except that they shall have a black legend and border on a fluorescent yellow or fluorescent yellow-green background, as appropriate.

903.3.62 Diagonal Downward-Pointing Arrow Plaques (W16-7P and W16-7aP) (MUTCD Section 2C.63)



W16-7P W16a-7P

Support. Diagonal downward-pointing arrow (W16-7P and W16-7aP) plaques are used with certain Vehicular Traffic Warning signs and certain Non-Vehicular Warning signs (see EPG 903.3.53), and School Crossing signs (see EPG 908.2.3) to indicate the specific location of a crossing point.

The W16-7P plaque contains a single arrow pointing diagonally down to the right or left, toward the roadway, depending on which side of the roadway it is located.

Option. A W16-7aP plaque may be used with a single crossing sign located on a narrow median separating two roadways with traffic in the same direction where the crossing traverses both roadways.

903.3.63 Hill-Related Plaques (W7-3 Series) (MUTCD Section 2C.64)



W7-3P W7-3aP

Guidance. Hill-Related (W7-3 series) plaques (see EPG 903.3.14) or other appropriate legends and larger signs should be used for emphasis or where special hill characteristics exist.

On longer grades, the use of a distance (W7-3aP) plaque (see EPG 903.3.14) at periodic intervals of approximately 1-mile spacing should be considered.

903.3.64 Advance Street Name Plaques (W16-8P and W16-8aP) (MUTCD Section 2C.65)



W16-8P

W16-8aP

Support. Advance street name signing can provide valuable information to the motorist. Intersections that are signed with Intersection Warning (W2 series) or Advance Traffic Control (W3 series) signs typically have inherent sight distance concerns. The addition of the street name to the warning sign can aid a motorist in making decisions in a timely manner.

Option. An Advance Street Name (W16-8P or W16-8aP) plaque may be used with any Intersection (W1-10 series, W2 series, W10-2, W10-3, or W10-4) or Advance Traffic Control (W3 series) sign to identify the name of the intersecting street.

If the side road being signed is maintained by a public agency, the addition of the street name sign may be considered on request.

Standard. The lettering on Advance Street Name plaques shall be composed of a combination of lower-case letters with initial upper-case letters.

If two street names are used on the Advance Street Name plaque, a directional arrow pointing in the direction of the street shall be placed next to each street name. Arrows pointing to the left shall be placed to the left of the street name, and arrows pointing to the right shall be placed to the right of the street name.

The street name used on an Advance Street Name supplemental sign shall be the approved name used by either the local agency or the Emergency 911 Coordinator.

When used, the Advance Street Name supplemental plaque shall only be mounted below the W2 or W3 series warning sign or the Advisory Speed plaque on the same post.

The Advance Street Name supplemental plaque for a 36 in. x 36 in. warning sign shall be a maximum of 36 in. wide and for a 48 in. x 48 in. warning sign shall be a maximum of 48 in. wide.

Guidance. If two street names are used on the Advance Street Name plaque, the street names and associated arrows should be displayed in the following order:

A. For a single intersection, the name of the street to the left should be displayed above the name of the street to the right; or
B. For two sequential intersections, such as where the plaque is used with an Offset Side Roads (W2-7) or a Double Side Road (W2-8) sign, the name of the first street encountered should be displayed above the name of the second street encountered, and the arrow associated with the second street encountered should be an advance arrow, such as the arrow shown on the W16-6P arrow plaque (see EPG 903.3.61).

903.3.65 Traffic Does Not Stop Plaques (W4-4P Series) (MUTCD Section 2C.66)



W4-4P W4-4aP W4-4bP

Option. The CROSS TRAFFIC DOES NOT STOP (W4-4P) plaque may be used in combination with a STOP sign when engineering judgment indicates that conditions are present that are causing or could cause road users to misinterpret the intersection as an all-way stop.

The TRAFFIC FROM LEFT (RIGHT) DOES NOT STOP (W4-4aP) or ONCOMING TRAFFIC DOES NOT STOP (W4-4bP) plaque may be used when such messages more accurately describe the traffic controls established at the intersection.

Guidance. The W4-4aP and W4-4bP plaques should be used at intersections where STOP signs control all but one approach to the intersection, unless the only non-stopped approach is from a one-way street.

Standard. If a W4-4P series plaque is used, it shall be mounted below the STOP sign.

903.3.66 IN ROAD and IN STREET Plaques (W16-1P) (MUTCD Section 2C.67)



W16-1P

Option. In situations where there is a need to warn drivers to watch for other slower forms of transportation traveling along the highway, such as bicycles or horse-drawn vehicles, an IN ROAD (W16-1P) plaque may be used.

Standard. The background color of the W16-1P plaque shall match the background color of the warning sign with which it is displayed. If a W16-1P plaque is used, it shall be mounted below a Bicycle (W11-1) or Horse-Drawn Vehicle (W11-14) warning signs and shall not be mounted alone.

Support. EPG 914.2.6 contains information about the use of a Bicycles Allowed Use of Full Lane (R9-20) sign to inform drivers of the presence of bicycles in the roadway or where bicyclists are expected or preferred to use the full lane.

903.3.67 NOTICE Plaque (W16-18p)



W16-18P

Support. It is sometimes necessary to enhance the conspicuity of a regulatory sign to attract drivers' attention to the message the sign is conveying. This may be necessary to help notify drivers to a speed limit reduction, turning movement prohibition, or bridge weight restriction. The NOTICE (W16-18P) plaque is an alternate to the use of red flags (see EPG 903.1.11).

Standard. The NOTICE (W16-18P) plaque shall not be used alone.

When used, the NOTICE plaque shall be installed directly above the regulatory sign it is enhancing.

Guidance. The use of the NOTICE (W16-18P) plaque should be based on engineering judgment and not systematically applied to a specific sign unless otherwise specified in the EPG.

903.3.68 Exception Plaques (W16-23P and W16-24P)



W16-23P



W16-24P

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Support. The EXCEPT TO TURN (W16-23P) supplemental warning plaque is used with the NO TRUCKS LEFT LANE (R5-32) regulatory sign (see EPG 903.2.36) in locations where trucks are not allowed to drive in the left lane, but are allowed to enter the left lane in order to make a turn. The EXCEPT TO EXIT (W16-24P) supplemental warning plaque is used with the NO TRUCKS LEFT LANE (R5-32) regulatory sign in locations where trucks are not allowed to drive in the left lane, but trucks are allowed to enter the left lane in order to exit the highway.

Standard. When used, the EXCEPT TO TURN (W16-23P) and EXCEPT TO EXIT (W16-24P) supplemental warning plaques shall only be installed in conjunction with the FINES DOUBLED ENDS (R2-20) sign (see EPG 903.2.70).

903.3.69 Warning Signs Provided for Other Agencies

Support. MoDOT will provide, if requested by the appropriate local traffic authority, warning signs for conditions beyond the end of state-maintained right of way.

If the location for placement of an advance warning sign for a curve, turn, paved road, stop condition or other condition deemed appropriate falls on state-maintained right of way, MoDOT will place and maintain the traffic control device on state-maintained right-of-way at the request of the local traffic authority.

Standard. The placement of all traffic control devices on the state highway system shall be governed by the Engineering Policy Guide. MoDOT is responsible for the placement and maintenance of all signs on state-maintained right-of-way.

903.3.70 Object Marker Design and Placement Height (MUTCD Section 2C.70)

Support. Types 1, 2, and 3 object markers are used to mark obstructions within or adjacent to the roadway. Type 4 object markers are used to mark the end of a roadway.

Standard. When used, object markers (see Figure 903.3.70) shall not have a border and shall consist of an arrangement of one or more of the following types:

Type 1—a diamond-shaped sign, at least 18 inches on a side, consisting of an all-yellow retroreflective sign (OM1-3).

Type 2—an all-yellow horizontal or vertical retroreflective sign (OM2-2V or OM2-2H), measuring 6 x 12 inches.

Type 3—a striped marker, 12 x 36 inches, consisting of a vertical rectangle with alternating black and retroreflective yellow stripes sloping downward at an angle of 45 degrees toward the side of the obstruction on which traffic is to pass. The minimum width of the yellow and black stripes shall be 3 inches.

Type 4—a diamond-shaped sign, at least 18 inches on a side, consisting of an all-red retroreflective sign (OM4-3).

Support. Type 3 object markers with stripes that begin at the upper right side and slope downward to the lower left side are designated as right object markers (OM3-R). Object markers with stripes that begin at the upper left side and slope downward to the lower right side are designated as left object markers (OM3-L). Object markers with chevron stripes that slope downward to both the lower left and lower right sides are designated as center object markers (OM3-C).

Guidance. When used for marking obstructions within the roadway or obstructions that are 8 feet or less from the shoulder or curb, the minimum mounting height, measured from the bottom of the object marker to the elevation of the near edge of the traveled way, should be 4 feet.

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When used to mark obstructions more than 8 feet from the shoulder or curb, the clearance from the ground to the bottom of the object marker should be at least 4 feet.

Object markers should not present a vertical or horizontal clearance obstacle for pedestrians.

Option. When object markers or markings are applied to an obstruction that by its nature requires a lower or higher mounting, the vertical mounting height may vary according to need.

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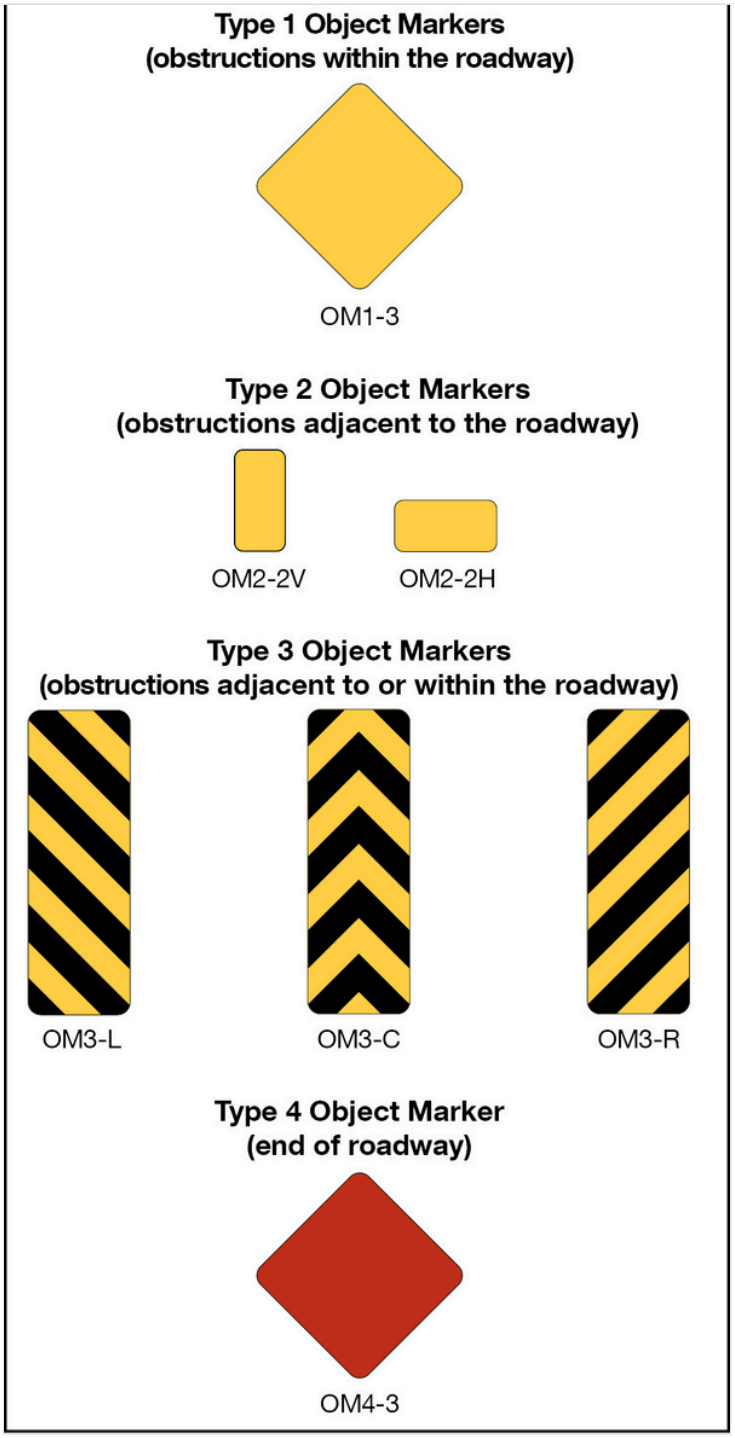


Figure 903.3.70 Object Markers

903.3.71 Object Markers for Obstructions Within the Roadway (MUTCD Section 2C.71)

Standard. Obstructions within the roadway shall be marked with a Type 1 or Type 3 object marker. In addition to markers on the face of the obstruction, warning of approach to the obstruction shall be given by appropriate pavement markings (see EPG 620.2.15).

Option. To provide additional emphasis, a Type 1 or Type 3 object marker may be installed at or near the approach end of a median island.

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To provide additional emphasis, large surfaces such as bridge piers may be painted with diagonal stripes, 12 inches or greater in width, similar in design to the Type 3 object marker.

Standard. The alternating black and retroreflective yellow stripes (OM3-L, OM3-R) shall be sloped down at an angle of 45 degrees toward the side on which traffic is to pass the obstruction. If traffic can pass to either side of the obstruction, the alternating black and retroreflective yellow stripes (OM3-C) shall form chevrons that point upwards.

Option. Appropriate signs (see EPG 903.2.34 and 903.3.20) directing traffic to one or both sides of the obstruction may be used instead of the object marker.

903.3.72 Object Markers for Obstructions Adjacent to the Roadway (MUTCD Section 2C.72)

Support. Obstructions not actually within the roadway are sometimes so close to the edge of the road that they need a marker. These include underpass piers, bridge abutments, handrails, ends of traffic barriers, utility poles, and culvert headwalls. In other cases there might not be a physical object involved, but other roadside conditions exist, such as narrow shoulders, drop-offs, gores, small islands, and abrupt changes in the roadway alignment, that might make it undesirable for a road user to leave the roadway, and therefore would create a need for a marker.

Standard. Type 3 object markers shall be used to mark all obstructions within 3 feet of the edge of the travel lane or edge of the shoulder when shoulders are present (paved or aggregate). Type 3 object markers shall not be used to mark obstructions located beyond 8 feet of the edge of the travel lane or edge of the shoulder. See Figures 903.3.72.1 and 903.3.72.2 for standard applications of Type 3 object markers.

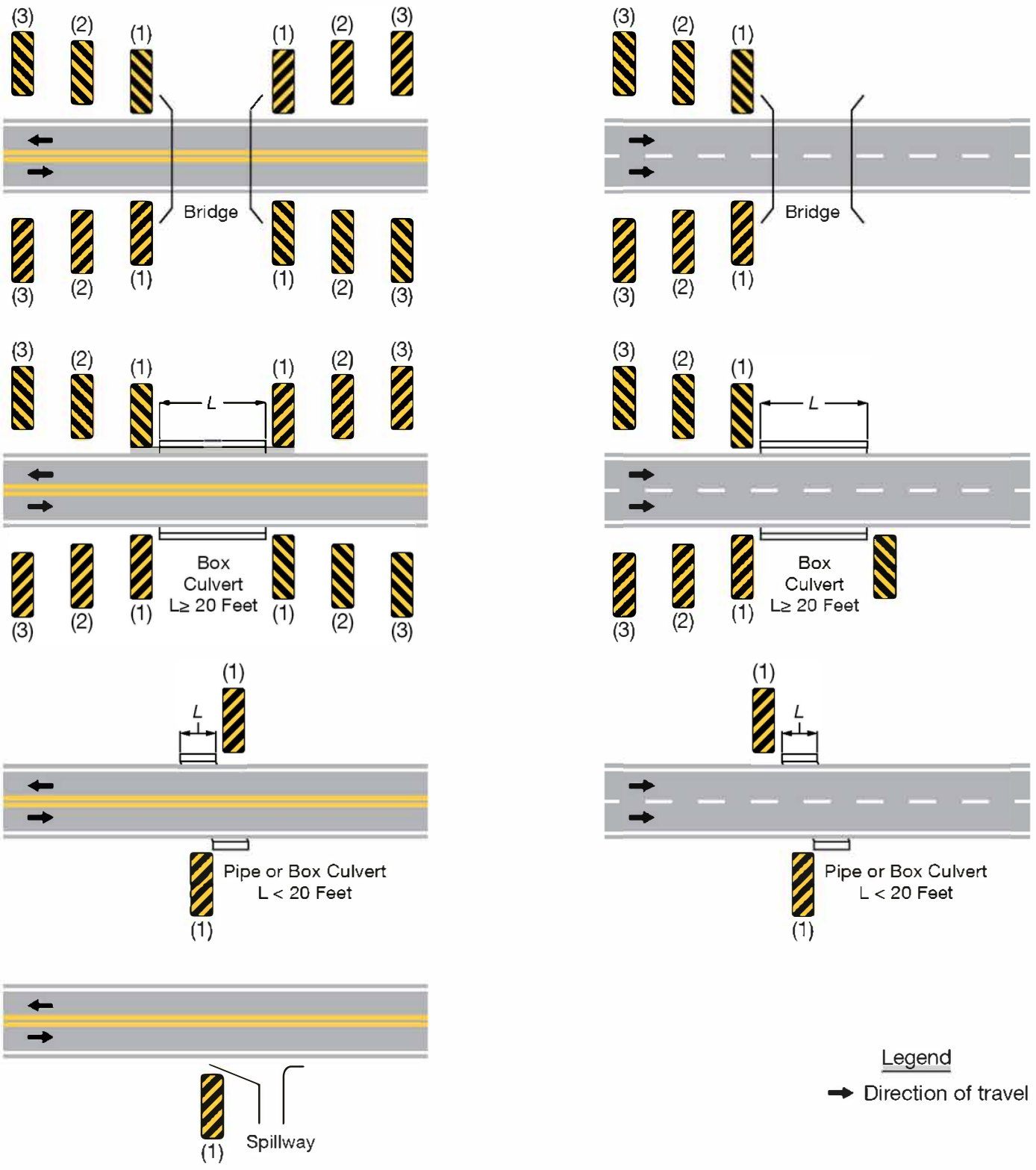
Option. Type 3 object markers may be used to mark obstructions located 3 feet to 8 feet from the edge of the travel lane or edge of the shoulder based on engineering judgment. See Figures 903.3.72.1 and 903.3.72.2 for standard applications of Type 3 object markers.

Guidance. If a Type 2 or Type 3 object marker is used to mark an obstruction adjacent to the roadway, the edge of the object marker that is closest to the road user should be installed in line with the closest edge of the obstruction.

When a marker is applied to the approach ends of guardrail or crash cushion terminals it should have the appearance of a Type 3 object marker and should be directly affixed, without a substrate, to the approach end of the guardrail or crash cushion and generally conform to the size and shape of the approach end of the guardrail or crash cushion.

Standard. Type 1 and Type 4 object markers shall not be used to mark obstructions adjacent to the roadway.

Guidance. Standard warning signs in this Chapter should also be used where applicable.



Type 3 object marker installation
(1) Placed as near the obstruction as possible and set to line up with inside edge of obstruction.
(2) Placed 1.5 feet off the edge of pavement and 20 feet from the end of the obstruction.
(3) Placed 3.0 feet off the edge of pavement and 40 feet from the end of the obstruction.

See Figure 903.3.72.2 for standard mounting height details for Type 3 object markers.

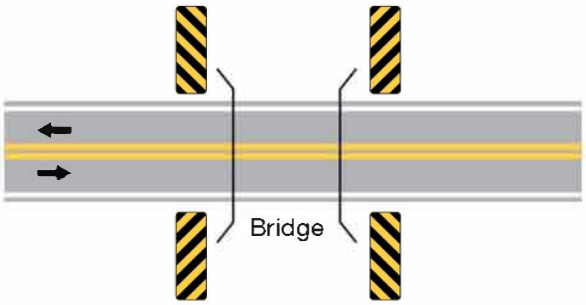
In areas where there is high agricultural equipment impacts with object markers the mounting height may be adjusted
- Object marker (1) mounted at ground level.
- Object marker (2) mounted at 1/2 standard height.

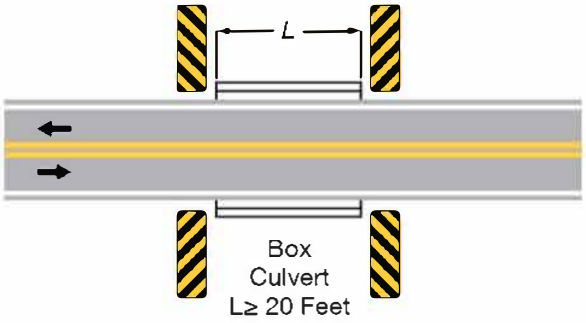
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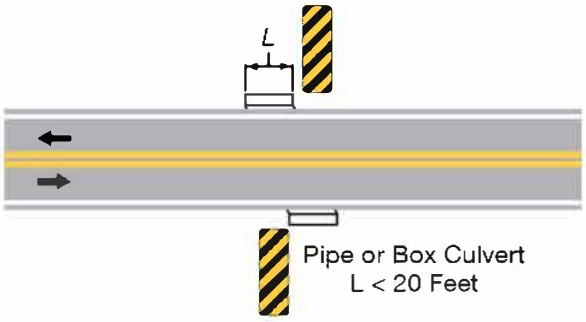
- Object marker (3) mounted at standard height.

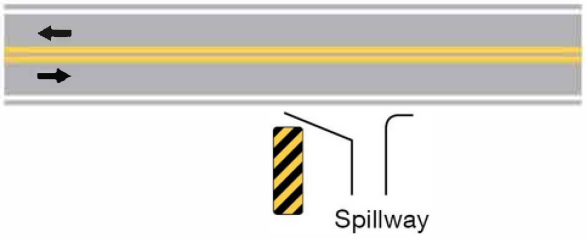
Figure 903.3.72.1 Standard Application of Type 3 Object Markers Objects 2' or Less From Edge of Travel Lane/Shoulder

2-Lane - 2-Way Highway

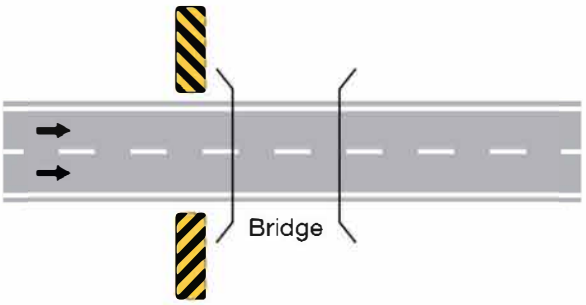


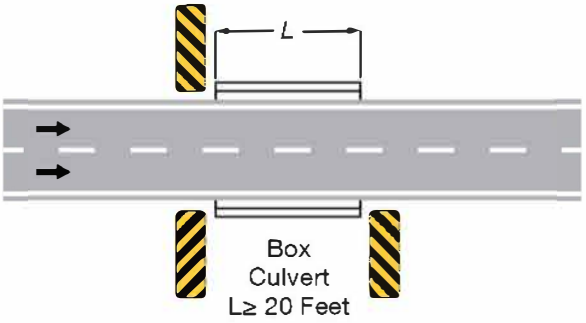


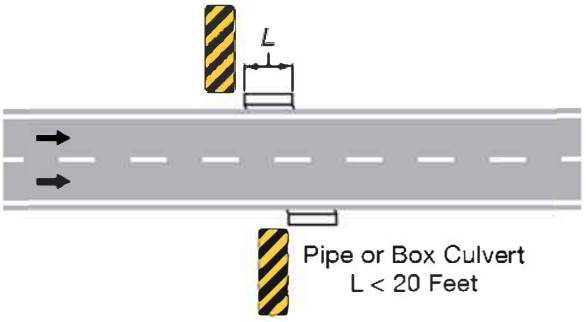




Divided Highway



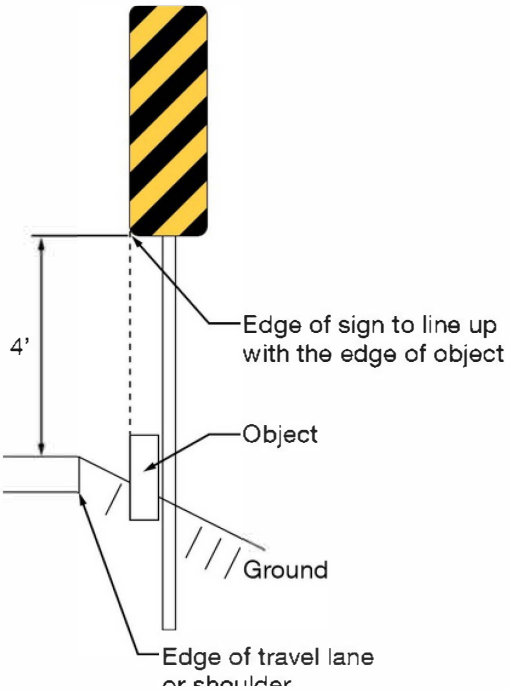




Legend

→ Direction of travel

Mounting Height and Offset
Type 3 Object Marker Installation



of shoulder

Figure 903.3.72.2 Standard Application of Type 3 Object Markers Objects Greater Than 2' From Edge of Travel Lane/Shoulder

903.3.73 Object Markers for Ends of Roadways (MUTCD Section 2C.73)

Support. The Type 4 object marker is used to warn and alert road users of the end of a roadway in other than construction or maintenance areas.

Standard. If an object marker is used to mark the end of a roadway, a Type 4 object marker shall be used. See (Section 903 of the Missouri Standard Plans for Highway Construction (https://www.modot.org/media/51221)) for installation details.

Option. The Type 4 object marker may be used in instances where there are no alternate vehicular paths.

Standard. The minimum mounting height, measured vertically from the bottom of a Type 4 object marker to the elevation of the near edge of the traveled way, shall be 4 feet.

Guidance. Appropriate advance warning signs in EPG 903.3 should be used.

903.3.74 Shoulder Barricade Assembly



GB-1

Option. Shoulder barricades may be used for added emphasis of standard warning sign installations at the direction of the engineer.

Standard. The shoulder barricade assembly shall consist of three horizontal boards (GB-1L or GB-1R) marked with reflective diagonal stripes and a 48-inch standard warning sign and a 48 in. standard warning sign with the appropriate 30-inch advisory plaque. See Figure 903.3.74 for typical construction.

GB-1R shoulder barricades shall be installed on the right side of the roadway and have diagonal stripes sloping downward from the right to the left.

GB-1L shoulder barricades shall be installed on the left side of the roadway and have diagonal stripes sloping downward from the left to the right.

Option. Supplemental signs may be installed on the shoulder barricade at the direction of the engineer.

Guidance. Shoulder Barricades should be installed on the appropriate size on wide flanged structural steel posts.

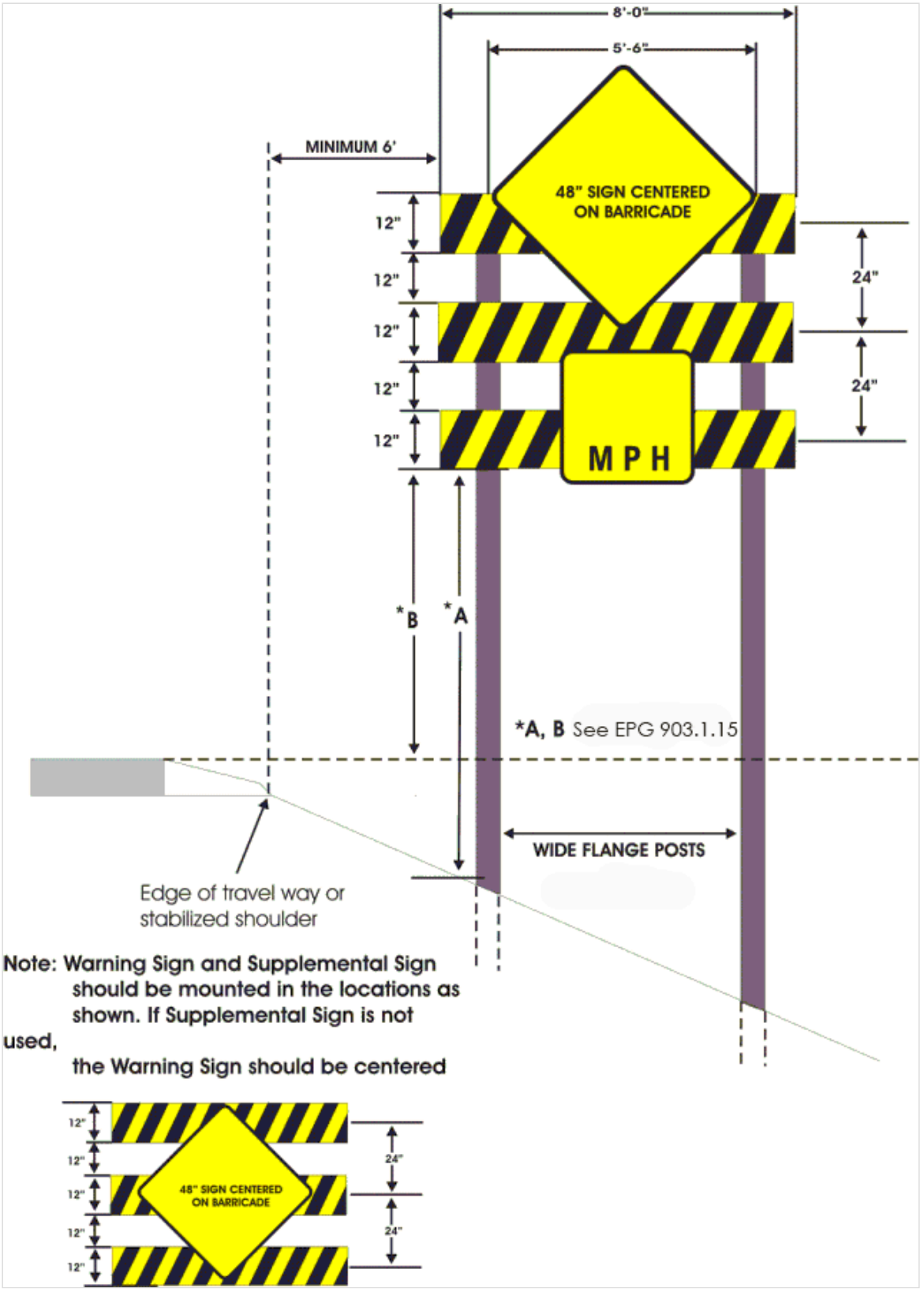


Figure 903.3.74 Shoulder Barricade Assembly

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903.4 Guide Signs—Conventional Roads (MUTCD Chapter 2D)

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903.4.50 State-Designated Scenic Byway, Historic Trail, and Auto Tour Route Signs (MUTCD Section 2D.58)
903.4.51 Corridor Designations
903.4.52 MoDOT Maintenance Signs (M19-2)

Standard. The provisions of EPG 903.4 shall apply to any road or street other than expressways and freeways, except as otherwise provided in the EPG.

Support. Guide signs direct road users along streets and highways; inform them of intersecting routes; direct them to cities, towns, villages, or other important destinations; identify nearby rivers and streams, parks, forests, and historical sites; and provide information that will help them along their way in the most simple and direct manner possible.

Guidance. The selection of primary or control destinations (those displayed consistently over longer distances along a route) displayed on guide signs should be meaningful to road users in navigation and orientation. The destinations selected should be identifiable on official maps.

Support. EPG 903.1 addresses placement, location, and other general criteria for signs.

903.4.2 Color, and Retroreflection, and Illumination (MUTCD Section 2D.02)

Support. Requirements for illumination, retroreflection, and color are stated under the specific headings for individual guide signs or groups of signs. General provisions are given in EPG 903.1.6, 903.1.21, and 903.1.22.

Standard. Except as otherwise provided in the EPG for individual signs or groups of signs, guide signs on streets and highways shall have a white message and border on a green background. All messages, borders, and legends shall be retroreflective and all backgrounds shall be retroreflective.

Support. Color coding is sometimes used to help road users distinguish between multiple potentially confusing destinations. Examples of valuable uses of color coding include guide signs for roadways approaching or inside an airport property with multiple terminals serving multiple airlines, and community wayfinding guide signs for various traffic generator destinations within a community or area.

Standard. Except as otherwise provided in the EPG, different color sign backgrounds shall not be used to provide color coding of destinations. The color coding shall be accomplished by the use of different colored square or rectangular sign panels on the face of the guide signs (see Figure 903.4.2).

Option. The different colored sign panels on the face of a sign may include a black or white (whichever provides the better contrast with the panel color) letter, numeral, or other appropriate designation to identify an airport terminal or other destination.

Support. EPG 903.4.48 contains specific provisions regarding Community Wayfinding guide signs.



Figure 903.4.2 Examples of Color-Coded Destination Guide Signs

903.4.3 Size of Signs (MUTCD Section 2D.03)

Standard. Except as provided in EPG 903.1.7, the minimum sizes of conventional road guide signs that have standardized designs shall be as shown in Table 903.4.3.

Support. EPG 903.1.7 contains information regarding the applicability of the various columns in Table 903.4.3.

Option. Signs larger than those shown in Table 903.4.3 may be used (see EPG 903.1.7) for special applications where speed, volume or other factors result in conditions where increased emphasis, improved recognition or increased legibility would be desirable, with approval from the MoDOT Highway Safety and Traffic Division.

Support. For other guide signs, the legends are so variable that a standardized design or size is not appropriate. The sign size is determined primarily by the length of the message, and the size of lettering and spacing necessary for proper legibility.

Option. Reduced letter height, reduced interline spacing, and reduced edge spacing may be used on guide signs if sign size must be limited by factors such as lane width or vertical or lateral clearance.

Guidance. Reduced spacing between the letters or words on a line of legend should not be used as a means of reducing the overall size of a guide sign, except where determined necessary by engineering judgment to meet unusual lateral-space constraints. In such cases, the legibility distance of the sign legend should be the primary

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consideration in determining whether to reduce the spacing between the letters or the words or between the words and the sign border, or to reduce the letter height.

When a reduction in the prescribed size is necessary, the design used should be as similar as possible to the design for the standard size.

Table 903.4.3. Conventional Road Guide Sign and Plaque Sizes

Sign or Plaque	Sign Designation	EPG Article	Conventional Road (in. x in.)			Freeway/Expressway (in. x in.)
			Standard	Oversized	Special	Mainline & Ramps
Interstate Route (1 or 2 digits)	M1-1, M1-1a	903.4.11	Varies X 24	Varies X 24	-	Varies X 24
Interstate Route (3 digits)	M1-1, M1-1a	903.4.11	Varies X 30	Varies X 30	-	Varies X 30
Off-Interstate Route (1 or 2 digits)	M1-2	903.4.11	Varies X 24	Varies X 24	-	Varies X 24
Off-Interstate Route (3 digits)	M1-2	903.4.11	Varies X 30	Varies X 30	-	Varies X 30
U.S. Route (1 or 2 digits)	M1-4	903.4.11	Varies X 24	Varies X 24	-	Varies X 24
U.S. Route (3 digits)	M1-4	903.4.11	Varies X 30	Varies X 30	-	Varies X 30
State Route (1 or 2 digits)	M1-5	903.4.11	Varies X 24	Varies X 24	-	Varies X 24
State Route (3 digits)	M1-5	903.4.11	Varies X 30	Varies X 30	-	Varies X 30
State Route (Letter)	M1-5a	903.4.11	Varies X 24	Varies X 24	-	Varies X 24
Junction (plaque)	M2-1P	903.4.13	21 X 15	21 X 15	-	21 X 15
North (plaque)	M3-1P	903.4.14	24 X 12	24 X 12	-	24 X 12
East (plaque)	M3-2P	903.4.14	24 X 12	24 X 12	-	24 X 12
South (plaque)	M3-3P	903.4.14	24 X 12	24 X 12	-	24 X 12
West (plaque)	M3-4P	903.4.14	24 X 12	24 X 12	-	24 X 12
Alternate (plaque)	M4-1P	903.4.16	24 X 12	24 X 12	-	24 X 12
Spur (plaque)	M4-1bP	903.4.17	24 X 12	24 X 12	-	24 X 12
Business (plaque)	M4-3P	903.4.18	24 X 12	24 X 12	-	24 X 12
To (plaque)	M4-5P	903.4.19	24 X 12	24 X 12	-	24 X 12
End (plaque)	M4-6P	903.4.20	24 X 12	24 X 12	-	24 X 12
Advance Turn Arrow (90° Left/Right)	M5-1P	903.4.22	21 X 15	21 X 15	-	21 X 15
Advance Turn Arrow (45° Left/Right)	M5-2P	903.4.22	21 X 15	21 X 15	-	21 X 15
Advance Turn Arrow (Curved Stem)	M5-3P	903.4.22	21 X 15	21 X 15	-	21 X 15
Lane Designation (Left)	M5-4P	903.4.23	24 X 18	24 X 18	-	24 X 18
Lane Designation (Center)	M5-5P	903.4.23	24 X 18	24 X 18	-	24 X 18
Lane Designation (Right)	M5-6P	903.4.23	24 X 18	24 X 18	-	24 X 18
Directional Arrow (Left/Right)	M6-1P	903.4.24	21 X 15	21 X 15	-	21 X 15
Directional Arrow (45° Left/Right)	M6-2P	903.4.24	21 X 15	21 X 15	-	21 X 15
Directional Arrow (Straight)	M6-3P	903.4.24	21 X 15	21 X 15	-	21 X 15
Directional Arrow (Two-Way)	M6-4P	903.4.24	21 X 15	21 X 15	-	21 X 15

Directional Arrow (Two-Way 45° Left/Right)	M6-5P	903.4.24	21 X 15	21 X 15	-	21 X 15
Directional Arrow (Up & Left/Right)	M6-6P	903.4.24	21 X 15	21 X 15	-	21 X 15
Directional Arrow (Up & 45° Left/Right)	M6-7P	903.4.24	21 X 15	21 X 15	-	21 X 15
Auto Tour	M-17 Series	903.4.50	Varies	Varies	-	Varies
MoDOT Maintenance Ends	M19-2	903.4.52	18 X 12	-	-	-
Destination (1 line)	D1-1	903.4.32	Varies	Varies	-	Varies
Destination (2 lines)	D1-2	903.4.32	Varies	Varies	-	Varies
Destination (3 lines)	D1-3	903.4.32	Varies	Varies	-	Varies
Destination and Distance (1 line)	D1-1a	903.4.32	Varies	Varies	-	Varies
Destination and Distance (2 lines)	D1-2a	903.4.32	Varies	Varies	-	Varies
Destination and Distance (3 lines)	D1-3a	903.4.32	Varies	Varies	-	Varies
Circular Intersection Destination (1 line)	D1-1d	903.4.35	Varies	Varies	-	Varies
Circular Intersection Departure Guide	D1-1e	903.4.35	Varies	Varies	-	Varies
Circular Intersection Destination (2 lines)	D1-2d	903.4.35	Varies	Varies	-	Varies
Circular Intersection Destination (3 lines)	D1-3d	903.4.35	Varies	Varies	-	Varies
Distance (1 line)	D2-1	903.4.38	Varies	Varies	-	Varies
Distance (2 lines)	D2-2	903.4.38	Varies	Varies	-	Varies
Distance (3 lines)	D2-3	903.4.38	Varies	Varies	-	Varies
Street Name (1 line)	D3-1	903.4.40	Varies	Varies	-	-
Street Name (2 lines)	D3-1b	903.4.40	Varies X 18	Varies X 18	-	-
Advance Street Name	D3-2	903.4.41	Varies	Varies	-	Varies
Parking Area	D4-1	903.4.42	30 X 24	30 X 24	-	-
Commuter	D4-1P	903.4.42	30 X 6	30 X 6	-	-
Commuter Parking	D4-1a	903.4.42	60 X 36	60 X 36	-	-
Park - Ride	D4-2	903.4.43	30 X 36	30 X 36	-	-
Missouri Scenic Byway	D6-4b	903.4.50	Varies	Varies	-	Varies
Missouri Scenic Byway Confirmation	D6-4c	903.4.50	Varies	Varies	-	Varies
Point of Interest	D6-4d	903.4.50	Varies	Varies	-	Varies
Advance Weigh Station Distance	D8-1	903.4.45	48 X 48	48 X 48	-	108 X 84
Weigh Station Advance Direction	D8-2	903.4.45	-	-	-	120 X 72
Weigh Station Entrance Direction	D8-3	903.4.45	48 X 48	48 X 48	-	84 X 72

Combination Lane Use/Destination	D15-1	903.4.34	Varies X 96	Varies X 96	-	Varies X 96
Next Truck Lane	D17-1	903.4.46	42 X 48	42 X 48	-	60 X 66
Advance Truck Lane	D17-2	903.4.46	42 X 42	42 X 42	-	60 X 54
Next Passing Lane	D17-3	903.4.47	42 X 48	42 X 48	-	60 X 66
Advance Passing Lane	D17-4	903.4.47	42 X 42	42 X 42	-	60 X 54
Alternating Passing Lanes	D17-4a	903.4.47	84 X 36	84 X 36	-	-

903.4.4 Lettering Style (MUTCD Section 2D.04)

Standard. The design of upper-case letters, lower-case letters, numerals, route shields, and spacing shall be as provided in the EPG articles and FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)).

The lettering for names of places, streets, and highways on conventional road guide signs shall be a combination of lower-case letters with initial upper-case letters (see EPG 903.1.8). The nominal loop height of the lower-case letters shall be ¾ the height of the initial upper-case letter. When a mixed-case legend letter height is specified referring only to the initial upper-case letter, the height of the lower-case letters that follow shall be determined by this proportion. When the height of a lower-case letter is referenced, the reference is made to the nominal loop height. The height of the initial upper-case letter shall also be determined by this proportion.

All other word legends on conventional road guide signs shall be in upper-case letters.

The unique letter forms for each of the Standard Alphabet series shall not be stretched, compressed, warped, or otherwise manipulated. Modifications to the length of a word for a given letter height and series shall be accomplished only by the methods described in EPG 903.4.3 and shall be approved by the MoDOT Highway Safety and Traffic Division.

903.4.5 Size of Lettering (MUTCD Section 2D.05)

Support. Sign legibility is a direct function of letter size and spacing. Legibility distance has to be sufficient to give road users enough time to read and comprehend the sign. Under optimum conditions, a guide sign message can be read and understood in a brief glance. The legibility distance takes into account factors such as inattention, blocking of view by other vehicles, unfavorable weather, inferior eyesight, or other causes for delayed or slow reading. Where conditions permit, repetition of guide information on successive signs gives the road user more than one opportunity to obtain the information needed.

Standard. Design layouts for conventional road guide signs shall be provided by the MoDOT Highway Safety and Traffic Division.

Except as otherwise provided in the EPG, the principal legend on post-mounted guide signs shall be in letters and numerals at least 6 inches in height for all upper-case letters, or a combination of 6 inches in height for upper-case letters and 4.5 inches in nominal loop height (see EPG 903.4.4) for lower-case letters.

Except as otherwise provided in the EPG, the principal legend on overhead guide signs shall be in letters and numerals at least 6 inches in height for all upper-case letters, or a combination of 6 inches in height for upper-case letters and 4.5 inches in nominal loop height (see EPG 903.4.4) for lower-case letters.

Guidance. Lettering sizes should be consistent on any particular class of highway.

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The minimum lettering and numeral sizes provided in the EPG (see Table 903.4.5.1) should be exceeded where conditions indicate a need for greater legibility.

Table 903.4.5.1 Typical Minimum Letter and Numeral Sizes for Conventional Road Guide Signs

Type of Sign	D1 & D2 Series 55 mph and less	D1 & D2 Series/D3-2 60 mph and greater	E8 Series	E1-1 Series
A. Intersection or Interchange Advance Guide Signs and entrance Direction Guide Signs				
Interstate or Off-Interstate Business Route signs				
Numerals**	6	9	9	14
1- or 2-Digit Shields	18 X 18	24 X 24	24 X 24	36 X 36
3-Digit shields	22.5 X 18	30 X 24	30 X 24	45 X 36
U.S. or State Route Signs				
Numerals	9	12	12	18
1- or 2-Digit Shields	18 X 18	24 X 24	24 X 24	36 X 36
3-Digit shields	22.5 X 18	30 X 24	30 X 24	45. X 36
County Route Signs				
Numerals	6	8	8	10
1- 2-, or 3-Digit Shields	18 X 18	24 X 24	24 X 24	36 X 36
U.S. or State Text identification (Examples: U S 56, Md 2)				
Numerals & Letters	8	12	12	15
Cardinal Directions (NORTH, SOUTH, EAST, WEST)				
First Letter - Upper-Case	6	8	10	10
Rest of Word - Upper-Case	5	6	8	8
Auxiliary and Alternative Route Legends (Examples: JCT, TO, ALT, BUSINESS)				
Words- Upper-Case	5	6	8	8
Names of Destinations or Roads (Examples: Springfield, Main St, 2nd Ave)				
Leading Upper-Case Letter or Numerals	6	8	10.67	13.33
Following Lower-Case Letters or Ordinals**	4.5	6	8	10
Distance or Action Messages (Examples: 2 MILES, 1/2 MILE, KEEP RIGHT)				
Distance Numerals	6	6	8	10
Distance Fraction Numerals	4.5	4.5	6	8
Distance Words - Upper-Case	4.5	4.5	6	8
Action Message Words - Upper-Case	6	6	8	10
B. Destination and Other Guide Signs				
Names of Destinations or Roads (Examples: Springfield, Main St, 2nd Ave)				
Leading Upper-Case Letter or Numerals	4	6	8	10.67
Following Lower-Case Letters or Ordinals**	3	4.5	6	8
Distance or Action Messages (Examples: 2 MILES, 1/2 MILE, KEEP RIGHT)				
Distance Numerals	5	6	8	8
Distance Fraction Numerals	4	4.5	6	6
Distance Words - Upper-Case	4	4.5	6	6
Action Message Words - Upper-Case	5	6	8	8

Table 903.4.5.2 Typical Overhead Letter and Number Sizes for Conventional Overhead Road Guide Signs for complex intersections (Multi-Lane Roundabouts, DDIs, Ramp Terminals, etc.)

Type of Sign	
A. Intersection or Interchange Advance Guide Signs and Entrance Direction Guide Signs	
Interstate, or Off-Interstate Business Route Signs	
Numerals**	9
1- or 2-Digit Shields	24 X 24
3-Digit shields	30 X 24
U.S. or State Route Signs	
Numerals	12
1- or 2-Digit Shields	24 X 24
3-Digit Shields	30 X 24
County Route Signs	
Numerals	8
1- 2-, or 3-Digit Shields	24 X 24
U.S. or State Text identification (Examples: U S 56, Md 2)	
Numerals & Letters	12
Cardinal Directions (NORTH, SOUTH, EAST, WEST)	
First Letter - Upper-Case	10
Rest of Word - Upper-Case	8
Auxiliary and Alternative Route Legends (Examples: JCT, TO, ALT, BUSINESS)	
Words- Upper-Case	8
Names of Destinations or Roads (Examples: Springfield, Main St, 2nd Ave)	
Leading Upper-Case Letter or Numerals	10.67 (des.)
Following Lower-Case Letters or Ordinals**	8 (des.)
Distance or Action Messages (Examples: 2 MILES, 1/2 MILE, KEEP RIGHT)	
Distance Numerals	8 (des.)
Distance Fraction Numerals	6 (des.)
Distance Words - Upper-Case	6 (des.)
Action Message Words - Upper-Case	8 (des.)
B. Destination and Other Guide Signs	
Names of Destinations or Roads (Examples: Springfield, Main St, 2nd Ave)	
Leading Upper-Case Letter or Numerals	10.67 (des.)
Following Lower-Case Letters or Ordinals**	8 (des.)
Distance or Action Messages (Examples: 2 MILES, 1/2 MILE, KEEP RIGHT)	
Distance Numerals	8 (des.)
Distance Fraction Numerals	6 (des.)
Distance Words - Upper-Case	6 (des.)
Action Message Words - Upper-Case	8 (des.)

* Except as provided otherwise in the EPG

** Minimum size listed for 3-digit shields. Larger numeral sizes used for 1-digit, some 2 digit, and some 3-digit shields. See the FHWA Standard Highways Signs publication for more information on Route Sign numeral heights and Standard Alphabet series.

*** Lower-case letter height (loop height) is determined by the initial upper-case letter height (see EPG 903.1.8)

Notes:

1. Sizes are shown in inches and where applicable as width x height.
2. For Street Name (D3-1 Series) signs, see Table 903.4.40.
3. The 18-inch route shield size is not for independent use, such as in Directional or Confirmation Assemblies.

903.4.6 Amount of Legend (MUTCD Section 2D.06)

Support. The longer the legend on a guide sign, the longer it will take road users to recognize and comprehend it, regardless of letter size.

Guidance. Except where otherwise provided in the EPG, guide signs should be limited to no more than three lines of destinations, which include place names, route numbers, street names, and cardinal directions. Where two or more signs are included in the same overhead display, the amount of legend should be further minimized. Where appropriate, a distance message or action information, such as an exit number, NEXT RIGHT, or directional arrows, should be provided on guide signs in addition to the destinations.

903.4.7 Abbreviations (MUTCD Section 2D.07)

Support. The use of commonly recognized abbreviations for certain words can be useful in reducing the reading time and improve quicker comprehension of a sign message. Descriptors and directional or quadrant orientations for street names and destinations, such as Boulevard (Blvd), North (N), and Southwest (SW), are some examples of commonly recognized abbreviations. Examples of the use of some guide sign abbreviations are shown in Figure 903.4.7.

Standard. The words NORTH, SOUTH, EAST, and WEST shall not be abbreviated when used to indicate cardinal directions of numbered or named highways on guide signs.

Guidance. Abbreviations should be kept to a minimum; however, they are useful when complete destination messages produce excessively long signs. If used, abbreviations should be unmistakably recognized by road users (see EPG 911 (MUTCD Section 1D.08)). Longer commonly used words that are not part of a proper name and are readily recognizable, such as street name descriptors (such as Street, Boulevard, or Avenue), should be abbreviated as provided in Table 903.4.7.1 to expedite recognition of the sign legend by reducing the amount and complexity of the legend. Shorter street name descriptors, such as those shown in Table 903.4.7.2, should not be abbreviated.

Periods, apostrophes, question marks, ampersands, or other punctuation or characters that are not letters, numerals, or hyphens should not be used in abbreviations, unless necessary to avoid confusion.

The solidus is intended to be used for fractions only and should not be used to separate words on the same line of legend. Instead, a hyphen should be used for this purpose, such as “TRUCKS – BUSES.”

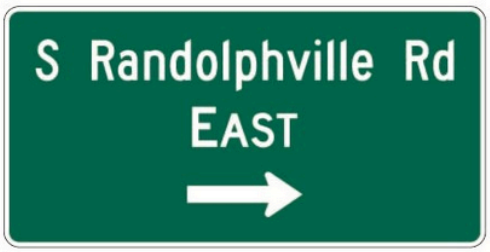
A – Cardinal directions and orientations



"South" is the street name and shall not be abbreviated.

"EAST" is the cardinal direction of travel and shall not be abbreviated.

"Avenue" is the street name descriptor with a recognizable abbreviation* and should be abbreviated.



"South" is a pre-directional designation and may be abbreviated.

"EAST" is the cardinal direction of travel and shall not be abbreviated.

"Road" is the street name descriptor with a recognizable abbreviation* and should be abbreviated.

B – Quadrant and cardinal directions



"Southeast" is a quadrant cardinal orientation and should be abbreviated.

"Boulevard" is the street name and shall not be abbreviated.



"Southeast" is the street name and shall not be abbreviated.

"Boulevard" is the street name descriptor with a recognizable abbreviation* and should be abbreviated.

C – Other descriptors within proper names



"Peak" is a geographical feature as a descriptor within a proper name. When a geographical feature descriptor does not have a recognizable abbreviation, it shall not be abbreviated.



"Mount" is a geographical feature as a descriptor within a proper name. When a geographical feature descriptor has a recognizable abbreviation, it may be abbreviated.

Figure 903.4.7 Examples of Uses of Abbreviations on Guide Signs

Table 903.4.7.1 Acceptable Abbreviations for Street Name Descriptors

Descriptor	Standard Abbreviation
Avenue	Ave
Boulevard	Blvd
Bypass	Byp
Causeway	Cswy
Circle	Cir
Corner	Cor
Court	Ct
Crescent	Cres
Drive	Dr
East	E*
Expressway	Expwy
Extension	Ext
Freeway	Fwy
Highway	Hwy
Lane	La, Ln
Landing	Lndg
North	N*
Northeast	NE*
Northwest	NW*
Parkway	Pkwy
Place	Pl
Plaza	Plz
Road	Rd
Route	Rte
South	S*
Southeast	SE*
Southwest	SW*
Square	Sq
Street	St
Terrace	Ter
Thruway	Thwy
Trafficway	Trfway
Trail	Tr
Turnpike	Tpk
West	W*
*** For pre-directional or post-directional designations or cardinal orientations, such as E Main St or 3rd St SW**	

Table 903.4.7.2 Street Name Descriptors Not Acceptable for Abbreviation

Descriptor
Alley
Belt
Beltway
Close
Cove
Edge
Gate
Green
Grove
Hill
Loop
Mews
Oval
Pass
Passage
Path
Ridge
Row
Run
Trace
Turn
View
Vista
Walk

903.4.8 Arrows (MUTCD Section 2D.08)

Support. Arrows are used for lane assignment and to indicate the direction toward designated routes or destinations. Figure 903.4.8 shows the various standard arrow designs that have been approved for use on guide signs. Detailed drawings for these arrows will be provided by the MoDOT Highway Safety and Traffic Division.

Standard. Except for Overhead Arrow-per-Lane signs (see EPG 903.4.33), on overhead signs where it is desirable to indicate a lane to be followed, a down arrow shall be positioned over the approximate center of the lane and shall point vertically downward toward the approximate center of that lane. Down arrows shall be used only on overhead guide signs that restrict the use of specific lanes to traffic bound for the destination(s) and/or route(s) indicated by these arrows. Down arrows shall not be used unless an arrow can be located over and pointed to the approximate center of each lane that can be used to reach the destination displayed on the sign.

If down arrows are used, having more than one down arrow pointing to the same lane on a single overhead sign (or on multiple signs on the same overhead sign structure) shall not be permitted.

Where a roadway is leaving the through lanes, a directional arrow shall point upward at an angle that approximates the alignment of the exit roadway in the vicinity of the point of departure.

The Type E directional arrow for circular intersections shall not be used on any sign that is not associated with a circular intersection.

Guidance. The Type A directional arrow should be used on guide signs on freeways, expressways, and conventional roads to indicate the direction to a specific destination or group of destinations, except as otherwise provided in this Article and in EPG 903.5.17.

When a directional arrow in a vertical, upward-pointing orientation is placed to the side of a group of destinations to indicate a through movement, the Type A directional arrow should be used. When a directional arrow in a vertical, upward-pointing orientation is placed to the side of a single destination or under a destination or group of destinations, the Type B directional arrow should be used.

The Type B directional arrow should be used on guide signs on conventional roads when placed at any angle to the side of a single destination or when placed in a horizontal orientation to the side of a group of destinations.

The Type C advance turn directional arrow should be used on conventional road guide signs placed in advance of an intersection where a turn must be made to reach a posted destination or group of destinations.

The Type D directional arrow should be used primarily for sign applications other than guide signs, except as provided in the fourth Option paragraph below.

If the Type E directional arrow is used, the principles set forth in EPG 903.4.22 through 903.4.25 should be followed.

Option. The Type A-Extended directional arrow may be used on guide signs where additional emphasis regarding the direction is needed relative to the amount of legend on the sign.

The Type C directional arrow may be used to the side of the legend of an overhead guide sign to accentuate a sharp turn exit maneuver from a mainline roadway (see EPG 903.5.25 for additional information regarding Exit Direction signs for low advisory ramp speeds).

On conventional roads on the approach to an intersection where the Combination Lane-Use/Destination overhead guide sign (see EPG 903.4.24) is not used, the Type C advance turn directional arrow may be used beneath the legend of an overhead guide sign to indicate the fact that a turn must be made from a mandatory movement lane over which the sign is placed to reach the destination or destinations displayed on the sign.

The Type D directional arrow may be used on post-mounted guide signs on conventional roads with lower operating speeds if the height of the text on the sign is 8 inches or less. Type D arrows may be used on a Street Name (D3-1 only) sign displaying two street names to indicate the different direction of travel for each street.

The Type E directional arrow may be used on guide signs on approaches to circular intersections to represent the intended driver paths to destinations involving left-turn movements around the circulatory island.

The directional and down arrows shown in Figure 903.4.8 may be used on signs other than guide signs for the purposes of providing directional guidance and lane assignment.

Guidance. Arrows used on guide signs to indicate the directions toward designated routes or destinations should be pointed at the appropriate angle to clearly convey the direction to be taken. A horizontally-oriented directional arrow design should be used at right-angle intersections.

On a post-mounted guide sign, a directional arrow for a straight-through movement should point upward. For a turn, the arrow on a guide sign should point horizontally or at an upward angle that approximates the sharpness of the turn.

At an exit, an arrow should be placed at the side of the sign that will reinforce the movement of exiting traffic. The directional arrow design should be used.

Standard. If used, the Type C advance turn directional arrow shall display a right or left arrow, the shaft of which is bent at a 90-degree or oblique angle.

Option. Arrows may be placed below the principal sign legend or on the appropriate side of the legend that is consistent with the direction of the movement.

On a post-mounted sign at an exit where placement of the arrow to the side of the legend farthest from the roadway would create an unusually wide sign that limits the road user's view of the arrow, the directional arrow may be placed at the bottom portion of the sign, centered under the legend.

Guidance. The width across the arrowhead for the Types A, B, and C directional arrows should be between 1.5 and 1.75 times the height of the upper-case letters of the principal legend on the sign. The width across the arrowhead for the Type D directional arrow should be at least equal to the height of the upper-case letters of the principal legend on the sign. For down arrows used on overhead signs, the width across the arrowhead should be approximately 2 times the height of the upper-case letters of the principal legend on the sign.

Support. EPG 903.4.33 contains the provisions for arrows used in Overhead Arrow-per-Lane signs on approaches to conventional road intersections.

The FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)) and Standard Plan 903.01 (https://www.modot.org/media/16919) contains design details and standardized sizes of the various arrows based on ranges of letter heights of principal legends.

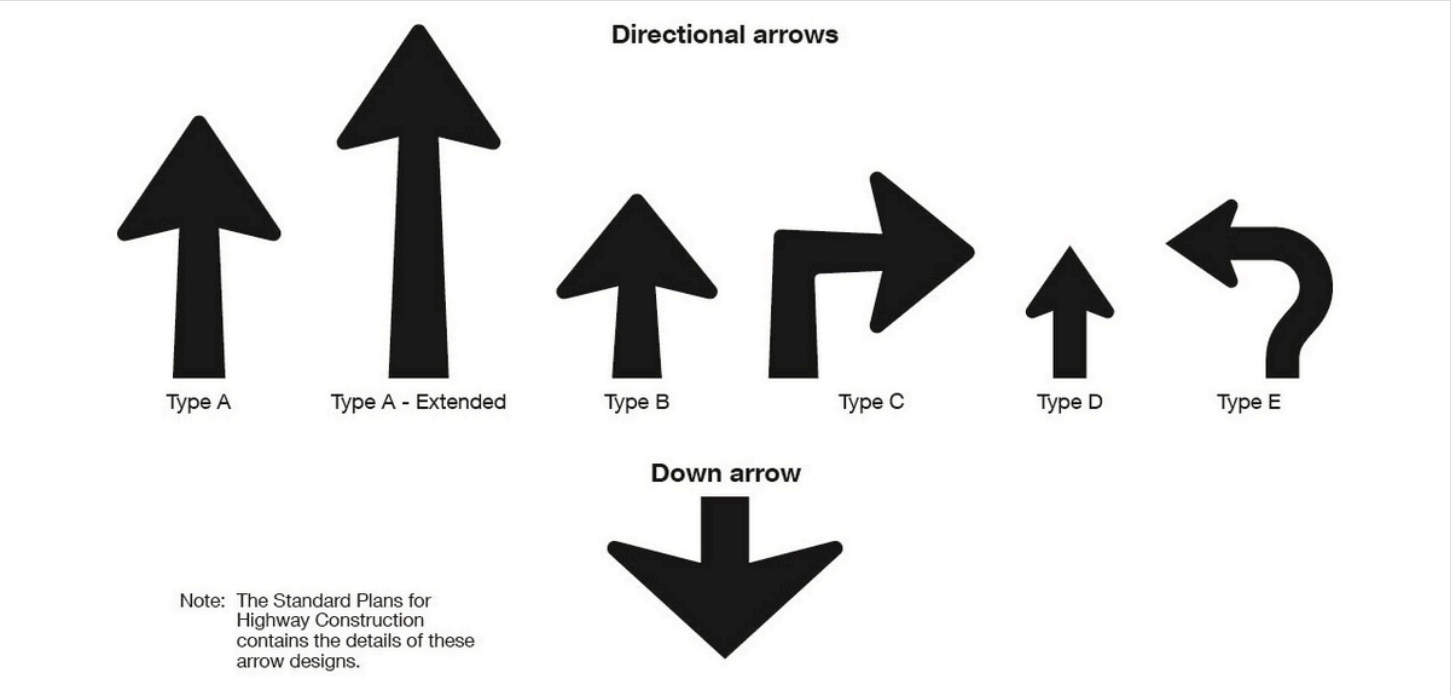


Figure 903.4.8 Arrows for Use on Guide Signs

903.4.9 Numbered Highway Systems (MUTCD Section 2D.09)

Support. The purpose of numbering and signing highway systems is to identify routes and facilitate travel.

The Interstate and United States (U.S.) highway systems are numbered by the American Association of State Highway and Transportation Officials (AASHTO) upon recommendations of the State highway organizations because the respective States own these systems. State and county road systems are numbered by the appropriate authorities.

The basic policy for numbering the Interstate and U.S. highway systems is contained in the following Purpose and Policy statements published by AASHTO:

A. “Establishment and Development of United States Numbered Highways,” and

B. “Establishment of a Marking System of the Routes Comprising the National System of Interstate and Defense Highways.”

Guidance. The principles of these policies should be followed in establishing the highway systems described in the preceding paragraph and any other systems, with effective coordination between adjacent jurisdictions. Care should be taken to avoid the use of numbers or other designations that have been assigned to Interstate, U.S., or State routes in the same geographic area. Overlapping numbered routes should be kept to a minimum.

Standard. Route systems shall be given preference in this order: Interstate, United States, State, and county. The preference shall be given by installing the highest-priority route number on the top or the left of the sign, except as provided in the Option paragraph below.

Interstate route numbering shall be approved by the FHWA.

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Option. The prioritization of route systems may be modified when a different prioritization would better accommodate the expectancy of the road user and provide more effective direction, such as for separate decision points for routes that are encountered in a particular order.

903.4.10 Route Signs and Auxiliary Plaques (MUTCD Section 2D.10)

Standard. Except as provided in the third Option paragraph of 903.4.25, all numbered highway routes shall be identified by route signs and auxiliary plaques.

The signs for each system of numbered highways, which are distinctive in shape and color, shall be used only on that system and the approaches thereto.

Option. Route signs and auxiliary plaques may be proportionally enlarged where greater conspicuity or legibility is needed.

Support. Route signs are typically mounted in assemblies with auxiliary plaques.

EPG 903.4.49 contains information regarding the signing for National Scenic Byways.

EPG 903.4.50 contains information regarding the signing for Missouri Scenic Byways, historic trails, and auto tour routes.

903.4.11 Design of Route Signs (MUTCD Section 2D.11)



M1-1



M1-2



M1-4



M1-5



M1-5a

Standard. The design of standard route signs shall conform to the designs provided in the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)). The design of other route signs shall be established by the authority having jurisdiction and shall be in general conformance with the designs provided in the FHWA's "Standard Highway Signs" publication.

The Interstate Route (M1-1) sign shall be used on all Interstate routes and in connection with Route Sign assemblies on intersecting highways.

Except as otherwise provided in the EPG, a 24 x 24-inch minimum sign size shall be used for Interstate route numbers with one or two digits, and a 30 x 24-inch minimum sign size shall be used for Interstate route numbers having three digits.

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The Off-Interstate Business Route (M1-2) sign shall consist of a cutout shield displaying the number of the connecting Interstate route and the words BUSINESS and LOOP in upper-case letters. The legend and border shall be white on a green background, and the shield shall be the same shape and dimensions as the Interstate Route sign. In no instance shall the word INTERSTATE appear on the Off-Interstate Business Route sign.

Option. The Off-Interstate Business Route sign may be used on a major highway that is not a part of the Interstate system, but one that serves the business area of a city from an interchange on the system.

Standard. U.S. Route signs shall consist of black numerals on a white shield surrounded by a rectangular black background without a border. This sign shall be used on all U.S. routes and in connection with Route Sign assemblies on intersecting highways.

A 24 x 24-inch minimum sign size shall be used for U.S. route numbers with one or two digits, and a 30 x 24-inch minimum sign size shall be used for U.S. route numbers having three digits.

State Numbered Route (M1-5) signs shall consist of black numerals on a white representation of the State of Missouri surrounded by a rectangular black background without a border. This sign shall be used on all state numbered routes and in connection with route sign assemblies on intersecting highways.

A 24 in. x 24-inch minimum sign size shall be used for state numbered route numbers with one or two digits, and a 30 in. x 24 in. minimum sign size shall be used for state numbers having three digits.

The legend on State Route signs shall conform to the Standard Alphabets contained in the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)).

Guidance. Where U.S. or State Route signs are used as components of guide signs, only the distinctive shape of the shield itself and the route numerals within should be used. The rectangular background upon which the distinctive shape of the shield is mounted, such as the black area around the outside of the shields on the M1-4 and standard M1-5 signs, should not be included on the guide sign. Where U.S. or State Route signs are used as components of other signs of non-contrasting background colors, the rectangular background should be used so that recognition of the distinctive shape of the shield can be maintained.

Standard. All references to numbered routes in this EPG 903.4 shall be interpreted to also include lettered routes.

State Lettered Route (M1-5a) signs shall be rectangular with the route letter in the center. The legend and border shall be black on a white background.

A 24 in. x 24-inch minimum sign size shall be used for state lettered routes with one letter and a 30 in. x 24-inch minimum sign size shall be used for state lettered routes having two letters.

Guidance. The letters G, I, L, Q and S should not be used on State Lettered Route signs. The letter R should be used on supplemental routes connecting state parks or other recreational facilities.

Support. Usually, but not always, double letter routes are farm to market roads that end at county roads or are former alignments of other highways.

Missouri is the only state to extensively use lettering on its highway system. The 1952 Missouri 10-Year Highway Modernization and Expansion Program (the “Takeover Program”) upgraded 12,000 miles of county roads. The roads became known as supplemental routes. The program provided a state-maintained road within 2 miles of 95% of all rural units, such as farm homes, churches, schools, stores, etc. Missouri opted to use letters to label these routes to avoid confusion with the existing numbered routes.

903.4.12 Design of Route Sign Auxiliary Plaques (MUTCD Section 2D.12)

Standard. Route sign auxiliary plaques displaying word legends, except the Junction (M2-1P) auxiliary plaque, shall have a minimum standard size of 24 x 12 inches. The Junction auxiliary plaque and those auxiliary plaques displaying arrows shall have a minimum standard size of 21 x 15 inches. All route sign auxiliary plaques shall match the color combination of the route sign that they supplement.

Guidance. The background, legend, and border of a route sign auxiliary plaque should have the same colors as those of the route sign with which the auxiliary plaque is mounted in a route sign assembly (see EPG 903.4.25). For a route sign design that uses multiple background colors, such as the Interstate Route sign, the background color of the corresponding auxiliary plaque should be that of the background area on which the route number is placed on the route sign.

Option. A route sign and any auxiliary plaques used with it may be combined on a single sign as a guide sign.

Standard. If a route sign and its auxiliary plaques are combined to form a single guide sign, the background color of the sign shall be green and the design shall comply with the basic principles for the design of guide signs. The auxiliary messages shall be white legends placed directly on the green background. Auxiliary plaques shall not be mounted directly to a guide sign or other type of sign.

903.4.13 Junction Auxiliary Plaque (M2-1P) (MUTCD Section 2D.13)



M2-1P

Standard. The Junction (M2-1P) auxiliary plaque shall display the abbreviated legend JCT and shall be mounted at the top of an assembly (see EPG 903.4.26) directly above the route sign, the sign for an alternative route (see EPG 903.4.17) that is part of the route designation, or the Cardinal Direction auxiliary plaque where access is available only to one direction of the intersected route. The minimum size of the Junction auxiliary plaque shall be 21 x 15 inches for compatibility with auxiliary plaques displaying arrow symbols.

903.4.14 Cardinal Direction Auxiliary Plaques (M3-1P through M3-4P) (MUTCD Section 2D.15)



M3-1P



M3-2P



M3-3P



M3-4P

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Guidance. Cardinal Direction auxiliary plaques displaying the legend NORTH, EAST, SOUTH, or WEST should be used to indicate the general direction of the entire route.

Standard. Cardinal Directions shall not be used with an Off-Interstate Business Route (M1-2) sign or State Letter Route (M1-5a) sign.

To improve the readability and recognition of the cardinal directions, the first letter of the cardinal direction words shall be ten percent larger, rounded up to the nearest whole number size.

If used, the Cardinal Direction auxiliary plaque shall be mounted directly above a route sign or, if used, an auxiliary plaque for an alternative route.

Support. Odd-numbered routes typically run north-south, and even-numbered routes typically run east-west.

903.4.15 Alternative Route Auxiliary Plaques - General (MUTCD Section 2D.16)

Option. Alternative Route auxiliary plaques displaying legends such as ALTERNATE, SPUR, or BUSINESS, may be used to indicate an alternate route of the same number between two points on that route.

Standard. If used, the Alternative Route auxiliary plaques shall be mounted directly above a route sign.

903.4.16 ALTERNATE Auxiliary Plaque (M4-1P) (MUTCD Section 2D.17)



M4-1P

Support. An alternate route branches from the numbered route, follows a separate alignment, and rejoins the numbered route downstream.

Option. The ALTERNATE (M4-1P) auxiliary plaque may be used to indicate an officially designated alternate routing of a numbered route between two points on that route.

Standard. If used, the ALTERNATE auxiliary plaque shall be mounted directly above a route sign.

The M4-1P plaque shall not be used to sign an alternative routing that is not officially designated and incorporated into the numbered highway system, such as alternative routings for incident management or emergency detours.

Guidance. The shorter (time or distance) or better-constructed route should retain the regular route number, and the longer or worse-constructed route should be designated as the alternate route.

903.4.17 SPUR Auxiliary Plaque (M4-1bP)



M4-1bP

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Support. A spur route is a highway that branches from a state numbered route or state letter route to serve a specific area or connect to another highway.

Option. The SPUR (M4-1bP) auxiliary plaque may be used to indicate an officially designated alternate route that branches from a numbered route and does not rejoin the same route.

Standard. If used, the SPUR auxiliary plaque shall be mounted directly above a route sign.

The SPUR auxiliary plaque shall only be used in conjunction with state numbered routes or state letter routes. The SPUR auxiliary plaque shall not be used in conjunction with Interstate or U.S. routes.

903.4.18 BUSINESS Auxiliary Plaque (M4-3P) (MUTCD Section 2D.19)



M4-3P

Option. The BUSINESS (M4-3P) auxiliary plaque may be used to designate an alternate route that branches from a numbered route, passes through the business portion of a city, and rejoins the numbered route beyond that area.

Standard. If used, the BUSINESS auxiliary plaque shall be mounted directly above a route sign.

Cardinal direction auxiliary plaques shall not be used on a sign assembly with a BUSINESS auxiliary plaque.

903.4.19 TO Auxiliary Plaque (M4-5P) (MUTCD Section 2D.21)



M4-5P

Option. The TO (M4-5P) auxiliary plaque may be used to provide directional guidance to a particular road facility from other highways in the vicinity (see EPG 903.4.30).

Standard. If used, the TO auxiliary plaque shall be mounted directly above a route sign or an auxiliary plaque for an alternative route. If a Cardinal Direction auxiliary plaque is also included in the assembly, the TO auxiliary plaque shall be mounted directly above the Cardinal Direction auxiliary plaque.

903.4.20 END Auxiliary Plaque (M4-6P) (MUTCD Section 2D.22)



M4-6P

Guidance. The END (M4-6P) auxiliary plaque should be used where the route being traveled ends, usually at a junction with another route.

The END auxiliary plaque should not be used to indicate the end of a lettered route.

Standard. If used, the END auxiliary plaque shall be mounted either directly above a route sign or above a sign for an alternative route that is part of the designation of the route being terminated.

903.4.21 Temporary Detour Signs and Auxiliary Plaques (MUTCD Section 2D.25)

Support. EPG 616.9 contains information regarding Temporary Detour signs and auxiliary plaques.

903.4.22 Advance Turn Arrow Auxiliary Plaques (M5-1P, M5-2P, and M5-3P) (MUTCD Section 2D.26)



M5-1P M5-2P M5-3P

Standard. If used, the Advance Turn Arrow auxiliary plaque shall be mounted directly below the route sign in Advance Route Turn assemblies, and shall display a right or left arrow, the shaft of which is bent at a 90-degree angle (M5-1P) or at an oblique angle (M5-2P).

If used, the Circular Intersection Advance Turn Arrow (M5-3P) auxiliary plaque shall be used only on the approach to a circular intersection to depict a movement along the circulatory roadway around the central island and to the left, relative to the approach roadway and entry into the intersection.

Guidance. If the M5-3P plaque is used, then this arrow type should also be used consistently on any regulatory lane-use signs (see EPG 903.2), Destination signs (see EPG 903.4.32), and pavement markings (see EPG 620) for a particular destination or movement.

903.4.23 Lane Designation Auxiliary Plaques (M5-4P, M5-5P, and M5-6P) (MUTCD Section 2D.27)

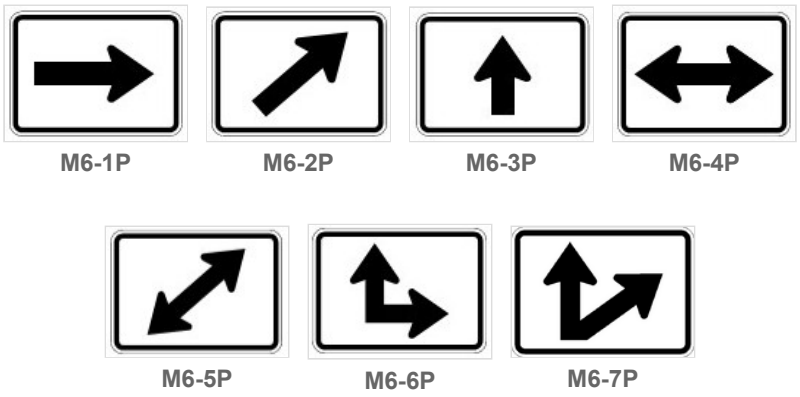


M5-4P M5-5P M5-6P

Option. A Lane Designation (M5-4P, M5-5P, or M5-6P) auxiliary plaque may be mounted directly below the route sign in an Advance Route Turn assembly on multi-lane roadways to allow road users to move into the appropriate lane prior to reaching the intersection or interchange.

Standard. If used, the Lane Designation auxiliary plaques shall be used only where the designated lane is a mandatory movement lane and shall be located adjacent to the full-width portion of the mandatory movement lane. The Lane Designation auxiliary plaques shall not be installed adjacent to a through lane in advance of a lane that is being added or along the taper for a lane that is being added.

903.4.24 Directional Arrow Auxiliary Plaques (M6 Series) (MUTCD Section 2D.28)



Standard. If used, the Directional Arrow auxiliary plaque shall be mounted below the route sign and any other auxiliary plaques in Directional assemblies (see EPG 903.4.25), and shall display a single-headed or double-headed arrow pointing in the general direction that the route follows.

A Directional Arrow auxiliary plaque that displays a double-headed arrow shall not be mounted in any Directional assembly in advance of or at a circular intersection.

Option. The Straight Arrows (M6 Series) may be substituted for the Advance Turn arrows (M5-1 and M5-2) when used near the "on" ramps of tight diamond interchanges to reduce the possibility of motorist confusion about which ramp to enter.

903.4.25 Route Sign Assemblies (MUTCD Section 2D.29)

Standard. A Route Sign assembly shall consist of a route sign and auxiliary plaques that further identify the route and indicate the direction. Route Sign assemblies shall be installed on all approaches to numbered routes that intersect with other numbered routes.

Where two or more routes follow the same section of highway, the route signs for Interstate, U.S., and State routes shall be mounted in that order from the left in horizontal arrangements and from the top in vertical arrangements. Subject to this order of precedence, route signs for lower-numbered routes shall be placed at the left or top.

Within groups of assemblies, information for routes intersecting from the left shall be mounted at the left in horizontal arrangements and at the top or center of vertical arrangements. Similarly, information for routes intersecting from the right shall be at the right or bottom, and for straight-through routes at the center in horizontal arrangements or top in vertical arrangements.

Route Sign assemblies shall be mounted in accordance with the general specifications for signs (EPG 903.1), with the lowest sign in the assembly at the height prescribed for single signs.

Guidance. Assemblies for two or more routes, or for different directions on the same route, should be mounted in groups on a common support.

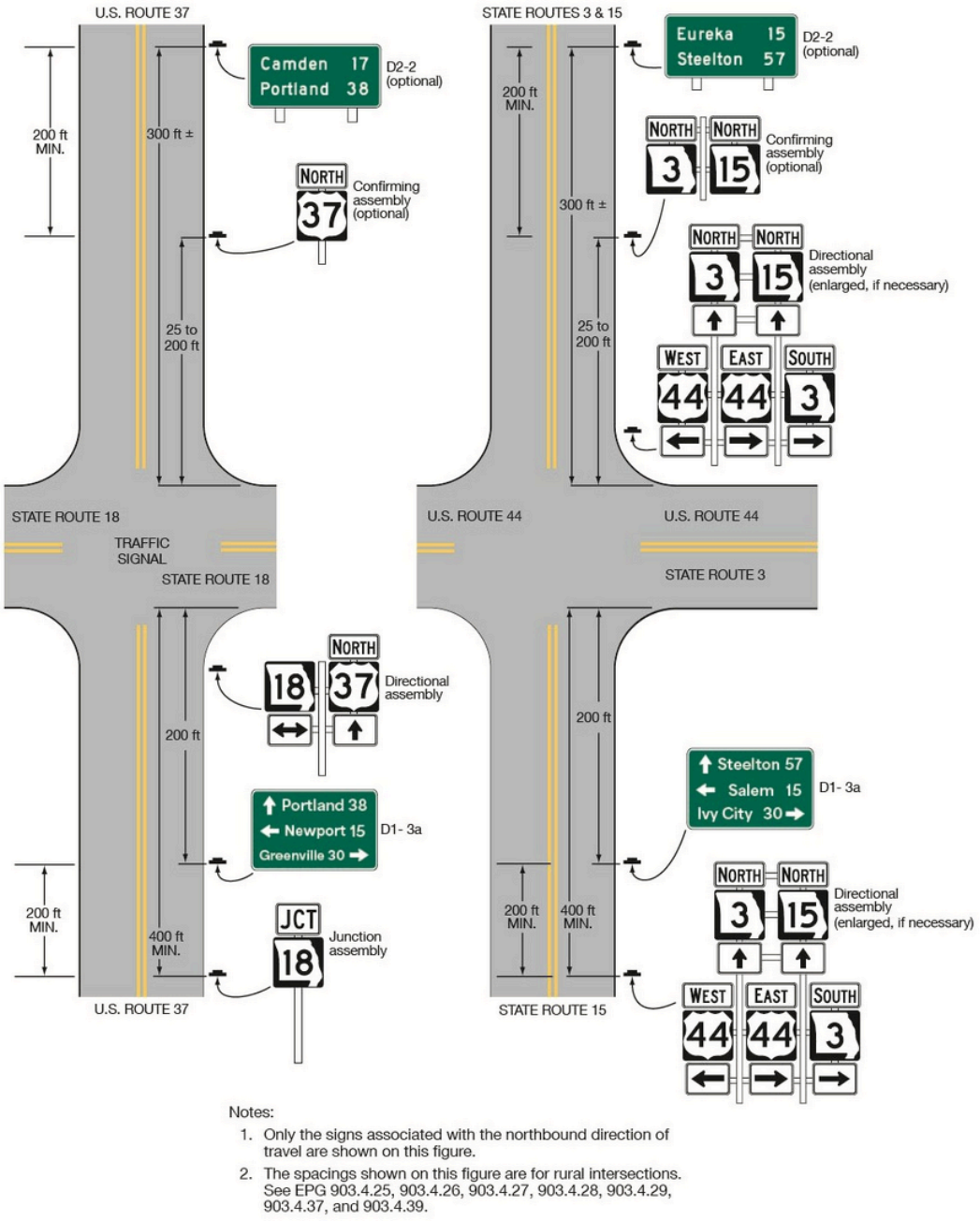
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Option. Route Sign assemblies may be installed on the approaches to numbered routes on unnumbered roads and streets that carry an appreciable amount of traffic destined for the numbered route.

If engineering judgment indicates that groups of assemblies that include overlapping routes or multiple turns might be confusing, route signs or auxiliary signs may be omitted or combined, provided that clear directions are given to road users.

Support. Figures 903.4.25.1 through 903.4.25.3 show typical placements of route signs.

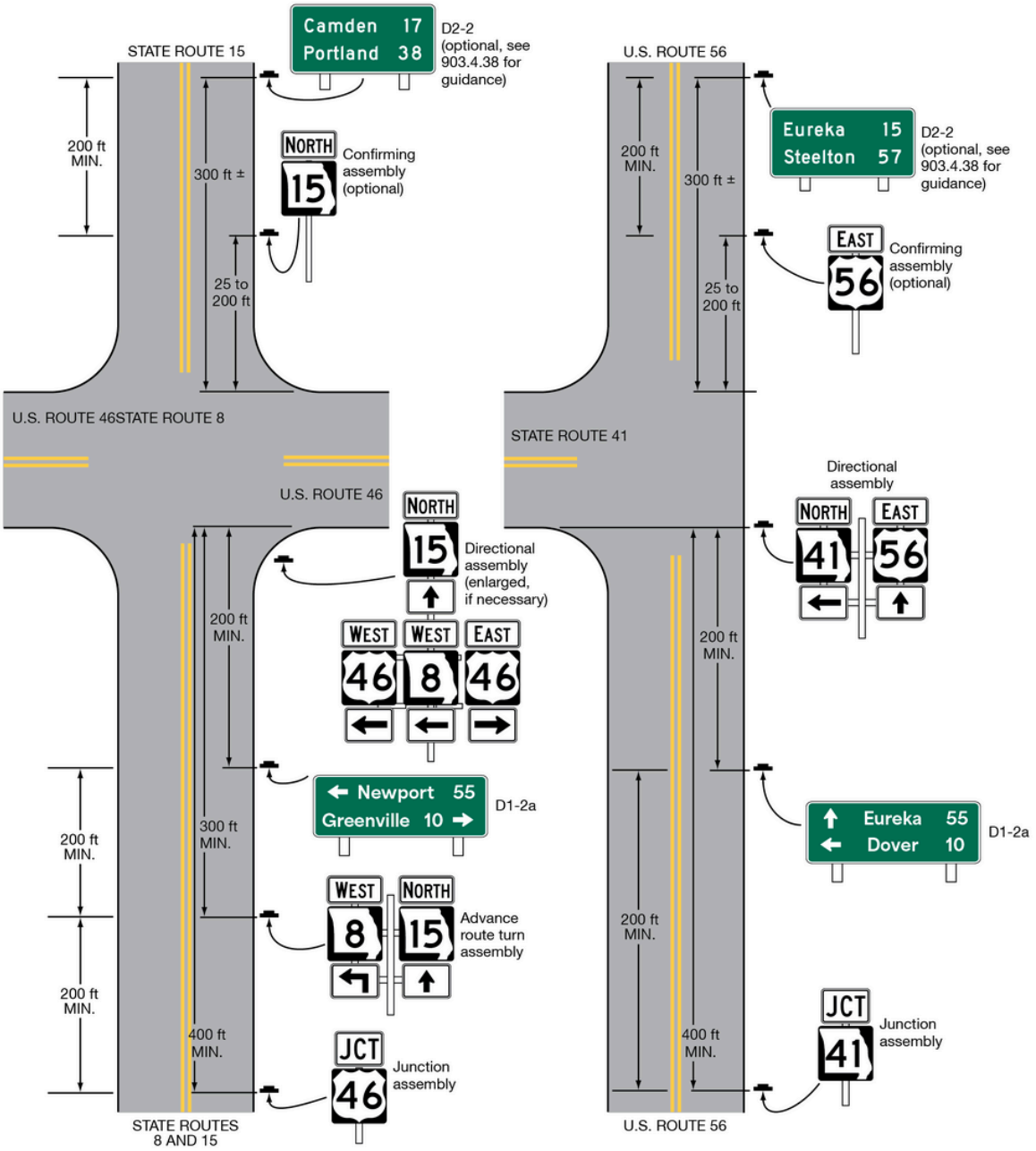
Route sign assemblies are flat sheet signs. For interstate route signs, payment is the same, but these contain blue sheeting. For cardinal directions placed above interstate route signs, a note is placed on Form D-30 to indicate the number of cardinal directions which are interstate design (white on blue), and which are the black on white type. This is also indicated for arrow signs placed below the interstate route signs. For overlapping routes with an interstate and any other type of roadway containing the same cardinal direction, only one cardinal direction is required, and one arrow sign, with the interstate design being used.



Notes:

1. Only the signs associated with the northbound direction of travel are shown on this figure.
2. The spacings shown on this figure are for rural intersections. See EPG 903.4.25, 903.4.26, 903.4.27, 903.4.28, 903.4.29, 903.4.37, and 903.4.39.

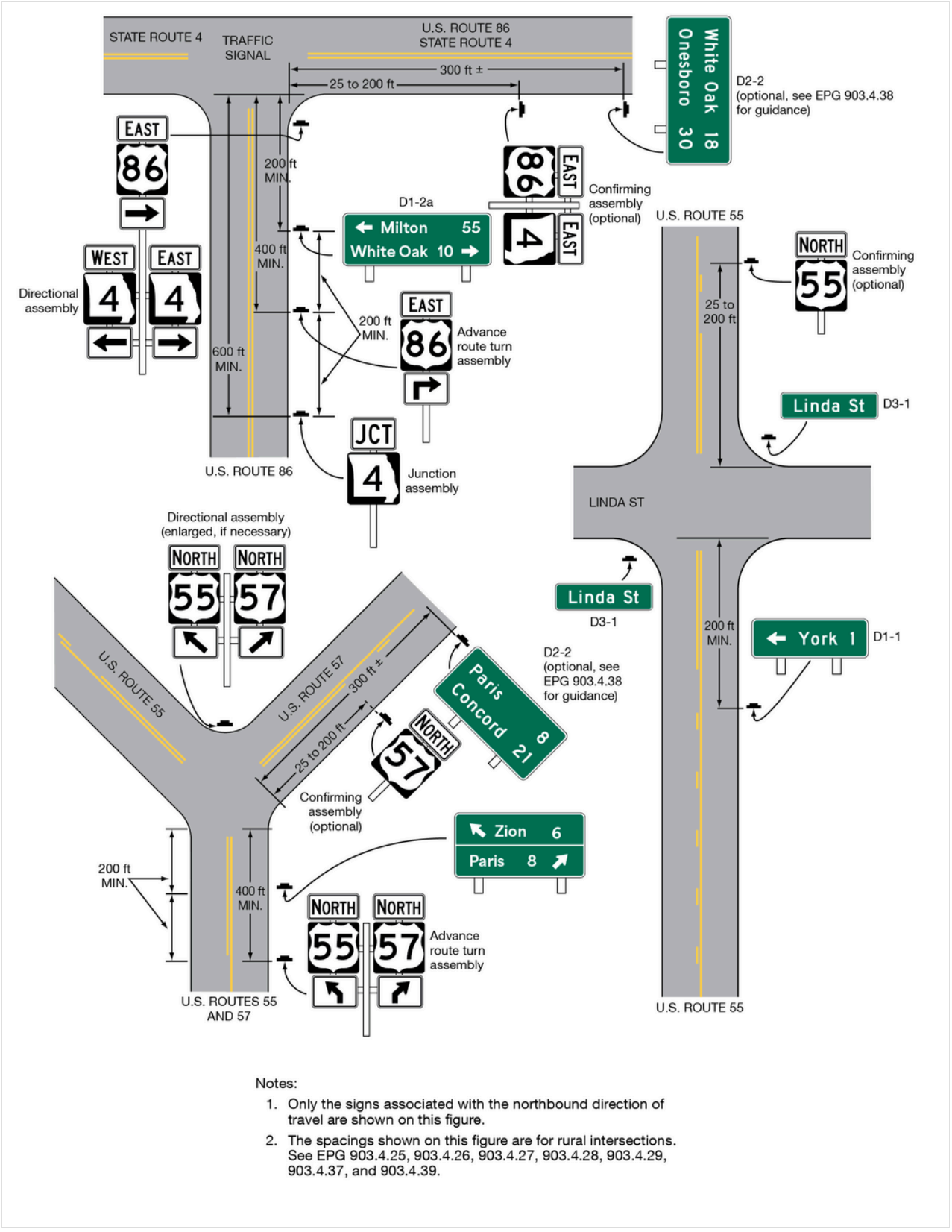
Figure 903.4.25.1 Illustration of Directional Assemblies and Other Route Signs *(Sheet 1 of 3)*



Notes:

1. Only the signs associated with the northbound direction of travel are shown on this figure.
2. The spacings shown on this figure are for rural intersections. See EPG 903.4.25, 903.4.26, 903.4.27, 903.4.28, 903.4.29, 903.4.37, and 903.4.39.
3. Directional assembly may be located on far side of intersection if needed.

Figure 903.4.25.2 Illustration of Directional Assemblies and Other Route Signs *(Sheet 2 of 3)*



Notes:

1. Only the signs associated with the northbound direction of travel are shown on this figure.
2. The spacings shown on this figure are for rural intersections. See EPG 903.4.25, 903.4.26, 903.4.27, 903.4.28, 903.4.29, 903.4.37, and 903.4.39.

Figure 903.4.25.3 Illustration of Directional Assemblies and Other Route Signs *(Sheet 3 of 3)*

903.4.26 Junction Assembly (MUTCD Section 2D.30)

Standard. A Junction assembly shall consist of a Junction auxiliary plaque (see EPG 903.4.13) and a route sign. The route sign shall display the number or letter of the intersected or joined route.

The Junction assembly shall be installed in advance of every intersection where a numbered or lettered route is intersected or joined by another numbered or lettered route.

Guidance. In urban areas, the Junction assembly should be installed in the block preceding the intersection. In urban areas where speeds are low, the Junction assembly should not be installed more than 300 feet in advance of the intersection.

In rural areas, the Junction assembly should be installed at least 400 feet in advance of the intersection. In rural areas, the minimum distance between a Junction assembly and either a Destination sign or an Advance Route Turn assembly should be 200 feet.

Where speeds are high, greater spacings should be used.

Option. Where two or more routes are to be indicated, a single Junction auxiliary plaque may be used for the assembly and all route signs grouped in a single mounting.

903.4.27 Advance Route Turn Assembly (MUTCD Section 2D.31)

Standard. An Advance Route Turn assembly shall consist of a route sign, an Advance Turn Arrow or word message auxiliary plaque, and a Cardinal Direction auxiliary plaque, if needed. It shall be installed in advance of an intersection where a turn must be made to remain on the indicated route.

Option. The Advance Route Turn assembly may be used to supplement the required Junction assembly in advance of intersecting routes.

Guidance. Where a multi-lane highway approaches an interchange or intersection with a numbered route, the Advance Route Turn assembly should be used to provide advance notice so that road users know the correct lane(s) from which to make their turn.

Option. Lane Designation auxiliary plaques (see EPG 903.4.23) may be used in Advance Route Turn Assemblies in place of the Advance Turn Arrow auxiliary plaques where engineering judgment indicates that specific lane information associated with each route is needed and overhead signing is impracticable and the designated lane is a mandatory movement lane. An assembly with the Lane Designation auxiliary plaques may supplement or substitute for an assembly with Advance Turn Arrow auxiliary plaques.

Guidance. In low-speed areas, the Advance Route Turn assembly should be installed not less than 200 feet in advance of the turn. In high-speed areas, the Advance Route Turn assembly should be installed not less than 300 feet in advance of the turn. In rural areas, the minimum distance between an Advance Route Turn assembly and either a Destination sign or a Junction assembly should be 200 feet.

Standard. An assembly that includes an Advance Turn Arrow auxiliary plaque shall not be placed where there is an intersection between it and the designated turn.

Guidance. Sufficient distance should be allowed between the assembly and any preceding intersection that could be mistaken for the indicated turn.

903.4.28 Directional Assembly (MUTCD Section 2D.32)

Standard. A Directional assembly shall consist of a Cardinal Direction auxiliary plaque, if needed; a route sign; and a Directional Arrow auxiliary plaque. The uses of Directional assemblies shall comply with the following:

A. Turn movements (indicated in advance by an Advance Route Turn assembly) shall be marked by a Directional assembly with a route sign displaying the number of the turning route and a single-headed arrow pointing in the direction of the turn.

B. The beginning of a route (indicated in advance by a Junction assembly) shall be marked by a Directional assembly with a route sign displaying the number of that route and a single-headed arrow pointing in the direction of the route.

C. An intersected route (indicated in advance by a Junction assembly) on a crossroad where the route is designated on both legs shall be designated by:

1. Two Directional assemblies, each with a route sign displaying the number of the intersected route, a Cardinal Direction auxiliary plaque, and a single-headed arrow pointing in the direction of movement on that route; or

2. A Directional assembly with a route sign displaying the number of the intersected route and a double-headed arrow, pointing at appropriate angles to the left, right, or ahead.

D. An intersected route (indicated in advance by a Junction assembly) on a side road or on a crossroad where the route is designated only on one of the legs shall be designated by a Directional assembly with a route sign displaying the number of the intersected route, a Cardinal Direction auxiliary plaque, and a single-headed arrow pointing in the direction of movement on that route.

Guidance. Straight-through movements should be indicated by a Directional assembly with a route sign displaying the number of the continuing route and a vertical arrow. A Directional assembly should not be used for a straight-through movement in the absence of other assemblies indicating right or left turns, as the Confirming assembly sign beyond the intersection normally provides adequate guidance.

Directional assemblies should be located on the near right corner of the intersection. At major intersections and at Y or offset intersections, additional Directional assemblies should be installed on the far right or left corner to confirm the near-side assemblies. When the near-corner position is impractical for Directional assemblies, the far right corner should be the preferred alternative, with oversized signs, if necessary, for legibility. Where unusual conditions exist, the location of a Directional assembly should be determined by engineering judgment with the goal being to provide the best possible combination of view and safety.

Support. It is more important that guide signs be readable, and that the information and direction displayed thereon be readily understood, at the appropriate time and place than to be located with absolute uniformity.

Figures 903.4.25.1 through 903.4.25.3 show typical placements of Directional assemblies.

903.4.29 Confirming or Reassurance Assemblies (MUTCD Section 2D.33)

Standard. If used, Confirming or Reassurance assemblies shall consist of a Cardinal Direction auxiliary plaque and a route sign, except as provided in the following paragraph. Where the Confirming or Reassurance assembly is for an alternative route, the appropriate auxiliary plaque for an alternative route (see EPG 903.4.15) shall also be included in the assembly.

Cardinal Direction auxiliary signs shall not be used on Confirming or Reassurance assemblies for lettered routes, off-interstate business routes (business loops), business routes, and spur routes.

A Confirming assembly shall be installed just beyond intersections of state numbered and lettered routes.

Guidance. Confirmation assemblies should be placed 25 to 200 feet beyond the far shoulder or curb line of the intersected highway.

A Confirming assembly should be placed 500 feet beyond the downstream end of interchange acceleration lanes confirming the route(s) the driver is entering onto.

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Option. Confirmation assemblies may be installed downstream of non-state routes based on engineering judgement. Examples of such application may include non-state routes which carry a significant volume of non-local traffic, or where the intersection with the non-state route may be confusing to the motorist as to which direction the state route departs from the intersection.

On freeways with emergency reference markers the confirming route assembly may be omitted only if there is no overlapping route on that portion of the freeway, as the emergency reference marker serves as the confirmation.

Reassurance assemblies may be installed on a route if the distance between state-to-state intersections is 20 miles or greater, with the route markers being installed at the approximate midpoint between the state intersections.

903.4.30 Trailblazer Assembly (MUTCD Section 2D.34)

Support. Trailblazer assemblies provide directional guidance to a particular road facility from other highways in the vicinity. This guidance is accomplished by installing Trailblazer assemblies at strategic locations to indicate the direction to the nearest or most convenient point of access. The use of the word TO indicates that the road or street where the sign is posted is not a part of the indicated route, and that a road user is merely being directed progressively to the route.

Standard. A Trailblazer assembly shall consist of a TO auxiliary plaque (see EPG 903.4.19) or an identification sign for a byway, historic trail, or auto tour route sign (see EPG 903.4.49 and 903.4.50), and a single-headed Directional Arrow auxiliary plaque pointing in the direction leading to the route. Where the Trailblazer assembly is for an alternative route, the appropriate auxiliary plaque for an alternative route (see EPG 903.4.15) shall also be included in the assembly.

Option. A Cardinal Direction auxiliary plaque (see EPG 903.4.14) may be used in a Trailblazer assembly where the direction leading to the route provides access only to one direction of travel for that route.

Guidance. The TO auxiliary plaque, Cardinal Direction auxiliary plaque, and Directional Arrow auxiliary plaque should be of the standard size provided for auxiliary plaques of their respective type. The route sign should be the size provided in EPG 903.4.11.

Option. Trailblazer assemblies may be installed with other Route Sign assemblies, or alone, in the immediate vicinity of the designated facilities.

903.4.31 Destination and Distance Signs (MUTCD Section 2D.35)

Support. In addition to guidance by route numbers, it is desirable to supply the road user information concerning the destinations that can be reached by way of numbered or unnumbered routes. This is done by means of Destination signs and Distance signs.

State abbreviations are not routinely listed in conjunction with the control city of destination, unless the need is determined by the MoDOT Highway Safety and Traffic Division.

Option. Route shields and cardinal directions may be included on the Destination sign with the destinations and arrows.

Guidance. If Route shields and cardinal directions are included on a Destination sign, the height of the Route shields should be at least two times the height of the upper-case letters of the principal legend and not less than 18 inches (15 inches for lettered routes), and the letter height of cardinal directions should be at least the minimum letter height specified for these signs.

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Standard. When a route designation is displayed on a destination sign with legends 8 inches or greater, route shields shall be used to display route names. When the destination has 6-inch legend or less, the route name shall be spelled out with text. State routes, both state numbered and state lettered routes, shall be listed simply as ROUTE XX. The letters "MO" shall not be used for state route designations, however, the letter "I" for interstate routes and "US" for United States routes will be shown.

Support. Control cities are defined for the interstate system in the AASHTO List of Control Cities for Use in Guide Signs on Interstate Highways and Table 903.8.11, Interstate Sign Control Cities (https://epg.modot.org/index.php/903.8_Freeway_and_Expressway_Guide_Signs). Control cities on other systems are determined as the next community located where the route intersects with a U.S. numbered route. A list of routes eligible for distance signing and the appropriate control points is available. The MoDOT Highway Safety and Traffic Division determines the control cities for non-interstate state-maintained routes.

Standard. The distances displayed on destination signs shall be based on the control point of the destination. Control points are typically the intersection of two major routes within the destination, these control points are determined by the MoDOT Highway Safety and Traffic Division. Distances displayed on destination signs are not measured to the jurisdictional boundary of the destination as boundaries change over time.

903.4.32 Destination Signs (D1 Series) (MUTCD Section 2D.36)



D1-1



D1-2



D1-3



D1-1a



D1-2a



D1-3a

Standard. Except on approaches to interchanges (see EPG 903.4.44), the Destination (D1-1 through D1-3) signs, if used, shall be a horizontal rectangle displaying the name of a city or unincorporated community and a directional arrow.

Destinations shall not include traffic generators such as universities, stadiums, amusement parks, or other publicly or privately owned attractions.

Option. The distance (see EPG 903.4.38) to the place named may also be displayed on the Destination (D1-1a through D1-3a) signs. If several destinations are to be displayed at a single point, the several names may be placed on a single sign with an arrow (and the distance, if desired) for each name.

Guidance. Adequate separation should be made between any destinations or group of destinations in one direction and those in other directions by suitable design of the arrow, spacing of lines of legend or separate signs.

Standard. Except as otherwise provided in the EPG, an arrow pointing to the right shall be at the extreme right of the sign, and an arrow pointing left or up shall be at the extreme left. The distance numerals, if used, shall be placed to the right of the destination names.

Guidance. Unless a sloping arrow will convey a clearer indication of the direction to be followed, the directional arrows should be horizontal or vertical.

If several individual name signs are assembled into a group, all signs in the assembly should be of the same horizontal width.

Destination signs should be used:

A. At the intersections of U.S. or State numbered routes with Interstate, U.S., or State numbered routes; and

B. At points where they serve to direct traffic from U.S. or State numbered routes to the business section of towns, or to other destinations reached by unnumbered routes.

Standard. Where a total of three or fewer destinations are displayed on the Advance guide (see EPG 903.5.23) and Supplemental guide (see EPG 903.5.49) signs, no more than three destination names shall be displayed on a Destination sign. Where four destinations are displayed on the Advance guide and Supplemental guide signs, no more than four destination names shall be displayed on a Destination sign.

Option. Unincorporated communities may be displayed on Destination signs at junction of state routes where it is more appropriate than using incorporated communities if that destination meets the qualifications for Unincorporated Community (I5-1) Signs (see EPG 903.9.9 City/County Limit Signs).

Guidance. If space permits, four destinations should be displayed on two separate signs at two separate locations.

Option. Where space does not permit, or where all four destinations are in one direction, a single sign may be used. Where a single sign is used and all destinations are in the same direction, the arrow may be placed below the destinations for the purpose of enhancing the conspicuity of the arrow.

Standard. Where a single four-name sign assembly is used, a heavy line approximating the width of the sign border entirely across the sign or separate signs shall be used to separate destinations by direction.

Guidance. The closest destination lying straight ahead should be at the top of the sign or assembly, and below it the closest destinations to the left and to the right, in that order. The destination displayed for each direction should ordinarily be the next county seat or the next principal city, rather than a more distant destination. In the case of overlapping routes, only one destination should be displayed in each direction for each route.

Standard. If more than one destination is displayed in the same direction, the name of a nearer destination shall be displayed above the name of a destination that is farther away.

Support. Overhead destination guide signs are sometimes helpful on multi-lane conventional roadways with complex or unusual roadway alignments or geometrics at intersecting highways to provide positive direction to destinations and to assign lanes to be used for destinations.

Option. Overhead Destination signs may be used to provide lane assignment and destination information for some or all of the lanes on the approach to a multi-lane intersection. Destination information may include cardinal directions, route numbers, street names, and/or place names.

Overhead signs using the Arrow-per-Lane sign design configuration may be used to provide lane assignments for some or all lane destinations at the approach to a multi-lane intersection (see EPG 903.4.33).

903.4.33 Overhead Arrow-per-Lane Destination Guide Signs (MUTCD Section 2D.37)

Support. Overhead Arrow-per-Lane destination guide signs are sometimes used on multi-lane conventional roadways to provide positive direction to destinations and to indicate lanes to be used for those destinations. These locations typically include complex or unusual roadway alignments or geometrics. Overhead Arrow-per-Lane signs on conventional roads do not always have arrows for every lane. Unlike the Combined Lane-Use/Destination (D15-1) sign (see EPG 903.4.34), Overhead Arrow-per-Lane signs can be used to provide lane assignments where the designated lane is not a mandatory movement lane.

Guidance. Overhead Arrow-per-Lane destination guide signs are not typically used by MoDOT. When used, Overhead Arrow-per-Lane signs should comply with the provisions in this Article.

Option. At complex intersection approaches involving multiple lanes and destinations, an Overhead Arrow-per-Lane destination guide sign may be used to provide destination information for some or all lanes. Destination information may include cardinal direction, route numbers, street names, and/or place names.

Standard. Overhead Arrow-per-Lane signs for conventional roads shall only be used for multi-lane approaches to intersections that have an option lane.

Overhead Arrow-per-Lane guide signs used on conventional roads shall include as a minimum one arrow above each mandatory turn lane and a bifurcated arrow for the option lane from which both the through and turning movements are allowed.

Guidance. Displaying an arrow over each through movement lane that does not allow turning should be considered for providing additional positive guidance.

Standard. Overhead Arrow-per-Lane signs for conventional roads shall be designed in accordance with the following criteria:

A. The shaft of each arrow shall be located over the approximate center of the lane to which it applies.

B. Arrows for continuing through lanes shall be vertically upward-pointing.

C. The arrow for a lane that must turn shall be curved in the direction of the turn and shall be accompanied by a black-on-yellow ONLY (E11-1b) sign panel (see Figure 903.5.28.1) adjacent to the lower end of the arrow shaft.

D. The arrow for an optional exit lane that also carries the through route shall have a single shaft that bifurcates into a vertically upward-pointing arrow and a curving arrow corresponding to the configuration of the through and turn lanes.

E. A vertical white line shall be used to separate the route shields and destinations for the two diverging movements from each other.

F. The number of lanes displayed on a sign shall correspond to the number of lanes being signed for at the location of that sign. An advance sign shall not depict lanes that are added downstream of a sign location.

Guidance. Overhead Arrow-per-Lane guide signs used on conventional roads should be designed in accordance with the following additional criteria:

A. No more than one destination should be displayed for each movement, and no more than three destinations should be displayed per sign.

B. The arrowhead(s) for the diverging movement should be positioned lower on the sign than the arrowhead(s) for the movement that continues straight ahead.

C. Route shields, cardinal directions, and destinations should be positioned on the sign such that they are clearly related to the arrowhead(s) for the movement to which they apply.

E. The vertical white line that is used to separate the route shields and destinations for the two diverging movements from each other should not descend below the top of the arrowheads for the through lanes, and should be positioned approximately halfway between the diverging arrowheads for the optional movement lane.

Destination information should be kept to a minimum necessary to provide positive guidance without overloading the road user.

Standard. The minimum height of arrows on an Overhead Arrow-per-Lane sign used on a conventional road shall be as shown in Table 903.4.33.

Guidance. When letter heights and other sign legend elements are enlarged there should be an corresponding increase in the arrow size used.

Option. Curved-stem arrows may be substituted on Overhead Arrow-per-Lane Signs on multi-lane approaches to a circular intersection with an option lane (see EPG 903.4.35).

Table 903.4.33 Overhead Arrow-per-Lane Arrow Height Based on Principal Legend Letter Height

Principal Legend Letter Height	Straight Arrow	Turn Arrow
10.67	25.5	20.188
Note: Letter and arrow heights are shown in inches.		

903.4.34 Combination Lane-Use/Destination Overhead Guide Sign (D15-1) (MUTCD Section 2D.38)



D15-1

Option. At intersection approaches involving multiple turn lanes and destinations, a Combination Lane-Use/Destination (D15-1) overhead guide sign that combines a lane-use regulatory sign with destination information such as a cardinal direction, a route number, a street name, and/or a place name may be used.

Support. At such locations, the combined information on the D15-1 signs can be even more effective than separate lane-use and guide signs for conveying to unfamiliar drivers which lane or lanes to use for a particular destination.

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Standard. The Combination Lane-Use/Destination (D15-1) overhead guide sign shall be used only where the designated lane is a mandatory movement lane. The D15-1 sign shall not be used for lanes with optional movements.

The D15-1 sign shall have a green background with a white border. The lane-use sign (see EPG 903.2) shall be placed near the bottom of the sign and the destination information shall be placed near the top of the sign. The D15-1 sign shall be located over the approximate center of the lane to which it applies.

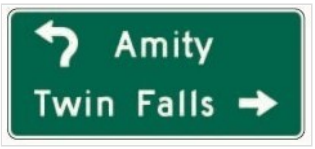
903.4.35 Destination Signs at Circular Intersections (MUTCD Section 2D.39)



D1-1d



D1-1e



D1-2d



D1-3d

Standard. Destination signs that are used at circular intersections shall comply with the provisions of EPG 903.4.32, except as provided in this Article.

Option. Exit Destination (D1-1d and D1-1e) signs with diagonal upward-pointing arrows or Directional assemblies (see EPG 903.4.28) may be used to designate a particular exit from a circular intersection.

Destination (D1-2d and D1-3d) signs with curved-stem arrows may be used on approaches to circular intersections to represent the left-turn movements.

Curved-stem arrows on circular intersection destination signs may point in diagonal directions to depict the location of an exit relative to the approach roadway and entry into the intersection.

An Overhead Arrow-per-Lane Destination sign (see EPG 903.4.33) with curved-stem arrows may be used on multi-lane approaches to circular intersections that have an option lane.

Guidance. If curved-stem arrows are used on destination signs, then this arrow type should also be used consistently on any regulatory lane-use signs (see EPG 903.2), Directional assemblies (see EPG 903.4.28), and pavement markings (see EPG 620) for a particular destination or movement.

Support. Figure 903.4.35.1 shows examples of guide signing for circular intersections.

Standard. Diagrammatic guide signs for circular intersections shall not be used.

Support. EPG 903.2 contains information regarding regulatory signs at circular intersections, EPG 903.3 contains information regarding warning signs at circular intersections, and EPG 620.4 contains information regarding pavement markings at circular intersections.

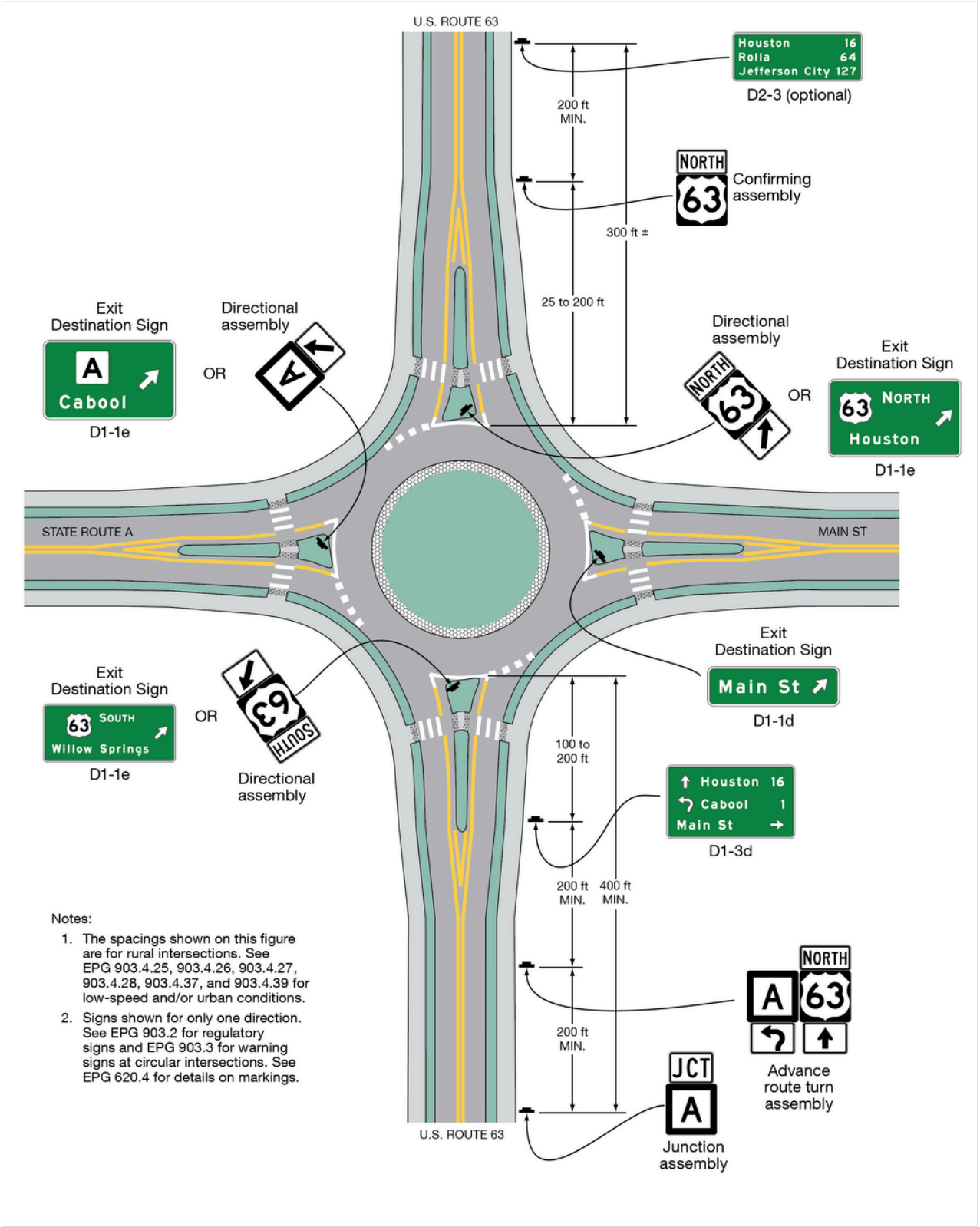


Figure 903.4.35.1 Examples of Guide Signs for Circular Intersections *(Sheet 1 of 2)*

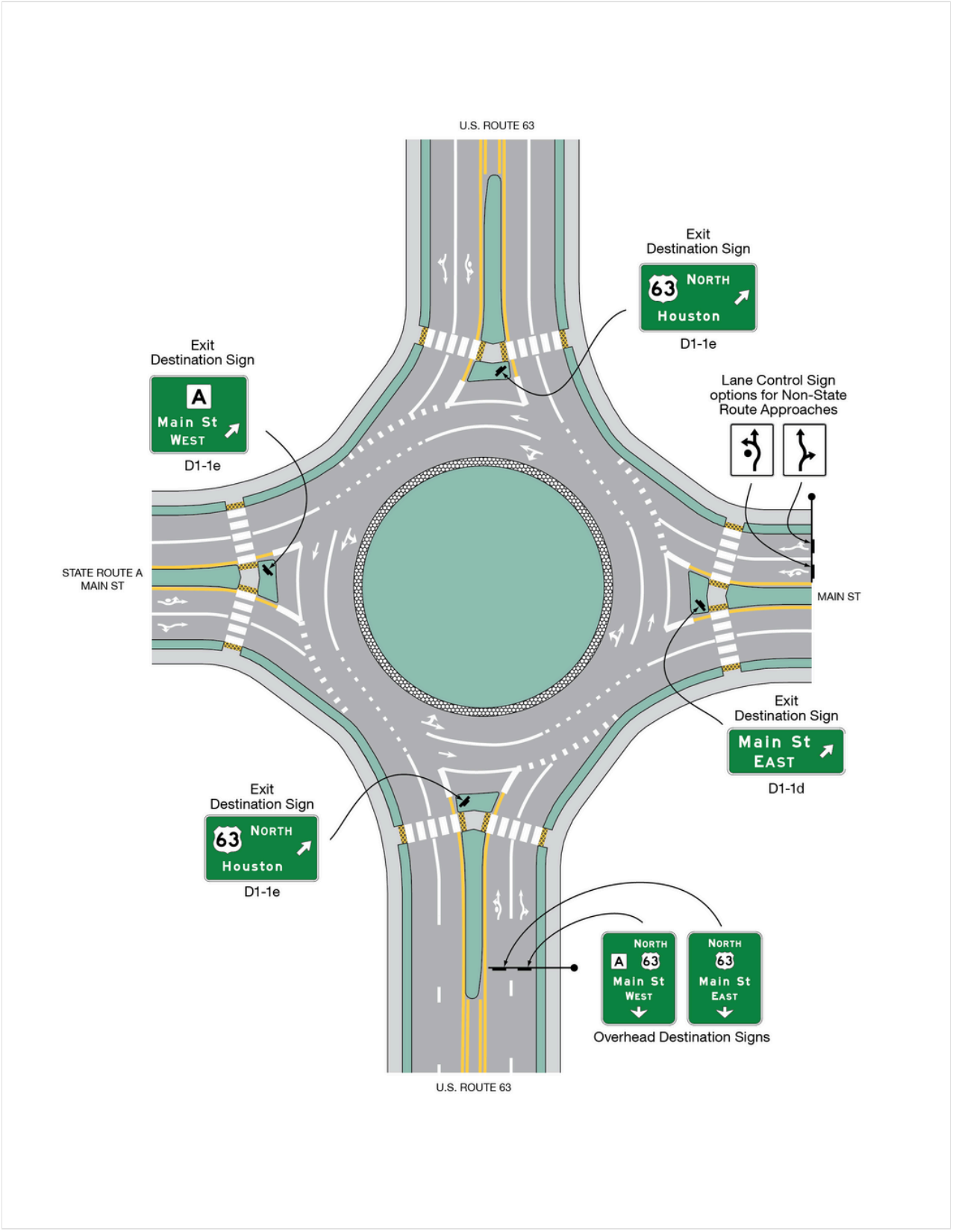


Figure 903.4.35.2 Examples of Guide Signs for Circular Intersections *(Sheet 2 of 2)*

903.4.36 Destination Signs at Intersections with Indirect Turning Movements (MUTCD Section 2D.41)

Guidance. A system of guide signs along with associated lane markings should be used to direct traffic through intersections with indirect turning movements.

903.4.37 Location of Destination Signs (MUTCD Section 2D.42)

Guidance. When used in urban areas or on exit ramps, Destination signs should be located 200 feet or more in advance of the intersection, and following any Junction or Advance Route Turn assemblies that might be required. In rural areas, Destination signs should be located 400 feet or more in advance of the intersection. The minimum distance between a Destination sign and either an Advance Route Turn assembly or a Junction assembly should be 200 feet.

Option. Because the Destination sign is of lesser importance than the Junction, Advance Route Turn, or Directional assemblies, the Destination sign may be eliminated where the distance in which to provide adequate sign spacing is limited.

Support. Figures 903.4.25.1 through 903.4.25.3 show typical placements of Destination signs.

903.4.38 Distance Signs (D2 Series) (MUTCD Section 2D.43)



D2-1



D2-2



D2-3

Standard. If used, the Distance (D2-1 through D2-3) signs shall be a horizontal rectangle of a size appropriate for the required legend, displaying the names of no more than three cities, towns, or junctions, and the distance (to the nearest mile) to those places.

The distance numerals shall be placed to the right of the destination names.

Guidance. The distance displayed should be determined on a case-by-case basis by the MoDOT Highway Safety and Traffic Division when signs are being detailed for fabrication.

The top destination displayed on the Distance sign should be that of the next city or interchange which will be reached while traveling on the route. The second destination displayed on the Distance sign should be the next control city, or significant destination, encountered while traveling on the route. This control city should be displayed on all subsequent destination signs along the route until that city is reached and then replaced with the next control city along the route. The bottom destination displayed on the Distance sign should be that of the significant anchor city or control city for that route. The anchor city should be displayed on all destination signs along the route as a consistent reference of distance traveled.

Option. On a route continuing into another State, destinations in the adjacent State may be displayed.

903.4.39 Location of Distance Signs (MUTCD Section 2D.44)

Guidance. Distance signs should be installed on all state routes leaving municipalities and just beyond intersections of other state routes in rural areas. If used, they should be placed just outside the municipal limits or at the edge of the built-up area if it extends beyond the limits. If a distance sign cannot be installed leaving the intersection, a destination sign with distances should be installed in advance of the intersection providing a destination for each departing leg of the intersection and the distance to the destination.

Where overlapping routes separate a short distance from the municipal limits, the Distance sign at the municipal limits should be omitted. The Distance sign should be installed approximately 300 feet beyond the separation of the two routes.

Where, just outside of an incorporated municipality, two routes are concurrent and continue concurrently to the next incorporated municipality, the top name on the Distance sign should be that of the place where the routes separate; the bottom name should be that of the city to which the greater part of the through traffic is destined.

Support. Figures 903.4.25.1 through 903.4.25.3 show typical placements of Distance signs.

903.4.40 Street Name Signs (D3-1) (MUTCD Section 2D.45)



D3-1



D3-1b

Support. Street Name signs at intersections and along roadways provide road users with important navigation information. EPG 903.8.10 contains information about signs used to identify the names of grade-separated streets, railways, bikeways, or other transportation facilities.

MoDOT does not install street name signs at non-signalized intersections, if installed, this signing is installed and maintained by the local jurisdiction who owns the roadway intersecting the state route, or who has established a street name on an intersecting state route.

Guidance. Street Name (D3-1) signs should be installed at all signalized intersections in both urban and rural areas except as noted in the first Standard paragraph below.

To minimize wrong-way movements onto freeway or expressway exit ramps, Street Name signs should not be used at the intersection of a freeway or expressway exit ramp with the crossroad to display the name of the freeway or expressway to traffic on the crossroad.

Standard. Street Name signs shall not be installed for approaches to fire stations, commercial entrances, schools, or driveways without an official street name.

When used, Street Name signs shall be mounted on a mast arm or between the carrier and tether wires for span wire signals, and shall be mounted a maximum of 12 inches from the center of the upright support (see Standard Plan 902.40R (https://www.modot.org/sites/default/files/documents/90240.pdf)).

Street name signs shall not be installed between signal heads as the signal structures are not designed for the additional wind load at these locations.

Option. For signals with insufficient space to install a street name sign between the upright support and the first signal indication, a D3-1 sign, 12 inches tall and not to exceed 4 feet in width, may be mounted on vertical signal support.

For span wire signals, the maximum distance from the center of the upright support to the street name sign as indicated in the preceding Standard paragraph may be increased if the upright support isn't adjacent to the roadway (see Standard Plan 902.70Q (https://www.modot.org/sites/default/files/documents/90270_2.pdf)).

Standard. The lettering for names of streets and highways on Street Name signs shall be composed of a combination of lower-case letters with initial upper-case letters (see EPG 903.1.8).

Guidance. Letter heights on street name signs should be as shown in Table 903.4.40. Table 903.4.40 should be used by local jurisdictions when fabricating and installing street name sign at state route intersections. MoDOT uses the largest font possible on street name signs at signalized intersections, with the legend size/sign size being controlled by the capacity of the signal structure.

Support. The recommended minimum letter heights for Street Name signs are summarized in Table 903.4.40. The speed limits specified and the recommended minimum letter heights provided in this Article apply to the roadway that each Street Name sign faces rather than to the street that has its name displayed on the Street Name sign. The letter heights specified in Table 903.4.40 are the combination of lower-case letters with the initial upper-case letter of a mixed-case legend.

A minimum upper-case letter height of 10 inches with a lower-case nominal loop height of 8 inches is recommended for all overhead Street Name signs regardless of posted speed limit as Street Name signs generally require greater legibility distances for road users to properly react.

The letter height of the street name descriptor (such as St, Ave, or Rd), the directional legend (such as NW), or any other supplemental legend (such as block or house numbers) on the D3-1 signs may be smaller than that of the street name itself.

Guidance. The letter height of the street name descriptor, the directional legend, or any other supplemental legend on the D3-1 signs should be at least two-thirds of the letter height of the street name itself, but not less than 3 inches for the initial upper-case letters and not less than 2.25 inches for the nominal loop height of the lower-case letters.

Conventional abbreviations (see EPG 911 (MUTCD Section 1D.08)) should be used except for the street name itself. Acceptable abbreviations for street name descriptors such as “Ave” for Avenue and “Blvd” for Boulevard should be as provided in Table 903.4.7.1 (see EPG 903.4.7). The street name descriptors that are provided in Table 903.4.7.2 should not be abbreviated (see EPG 903.4.7).

Option. MoDOT does not display block numbers on street name signs. However, local jurisdictions who elect to install and maintain internally illuminated street name signs on MoDOT signals, under an agreement with MoDOT, may display block numbers as a supplemental legend on a Street Name sign to aid emergency responders and road users in locating addresses.

Guidance. If block numbers are displayed on a Street Name sign where only a single Street Name sign is provided for the crossroad, the block or house numbers for the left and right blocks should be positioned at the left and right sides of the sign, respectively.

If block numbers are displayed on a Street Name sign where two Street Name signs are provided for the crossroad, such as on diagonally opposite corners of an intersection, each Street Name sign should display only the block or house numbers associated with that block of the crossroad.

Option. MoDOT does not display pictographs (see definition in EPG 911 (MUTCD Section 1C.02)) on street name signs. However, local jurisdictions who elect to install and maintain internally illuminated street name signs on MoDOT signals, under an agreement with MoDOT, may display a pictograph representing the municipality, in accordance with the provisions of EPG 903.1.4.

Standard. Pictographs shall not be displayed on Advance Street Name (D3-2) signs (see EPG 903.4.41).

If a pictograph is used on a D3-1 sign, the height and width of the pictograph shall not exceed the upper-case letter height of the principal legend of the sign.

The bicycle symbol shall not be used on a Street Name sign.

Guidance. The pictograph should be positioned to the left of the street name.

Pictographs should not be used on a D3-1 sign that contains directional arrows.

Standard. The Street Name sign shall be retroreflective or illuminated in accordance with the provisions of EPG 903.1.21.

Option. MoDOT only utilizes green as the background color for street name signs. However, MoDOT will consider a city request to use an alternative background color (see the second standard paragraph below) other than the standard guide sign color of green for MoDOT Street Name (D3-1) signs if the city agrees to fund the total cost of the sign replacement project.

Standard. Alternative background colors shall not be used for Advance Street Name (D3-2) signs (see EPG 903.4.41).

The only acceptable alternative background colors for Street Name (D3-1) signs shall be blue, brown, or white. Regardless of whether green, blue, or brown is used as the background color for Street Name (D3-1) signs, the legend (and border, if used) shall be white. For Street Name signs that use a white background, the legend (and border, if used) shall be black.

If a city requests to fund changing the color of a MoDOT street name sign, the following conditions shall be met:

A. MoDOT must first agree to the request and reserves the right to refuse based on engineering judgement.
B. The city shall be responsible for all costs associated with the sign replacement project.
C. The street name signs shall be designed by MoDOT and meet all other MoDOT street name design aspects.
D. Block numbers, pictographs or any other added legend beyond what MoDOT would normally display on the street name shall not be displayed on these street name signs as MoDOT will assume maintenance of the new signs once they are installed.
E. Only those street name signs within the city's jurisdictional boundaries will be permitted to be altered.
F. All street name signs along the state corridor within the city's jurisdiction shall all be upgraded to the alternate color at the same time, no partial upgrades will be permitted.

Option. Cities and counties may install MUTCD compliant Street Name signs on MoDOT right of way at non-signalized intersections, either on an independent post adjacent to and to the right of the STOP sign or installed on the MoDOT post above the STOP sign.

Standard. If a city or county elects to install as street name sign above the MoDOT STOP sign, they shall first contact the local district office to make the request and to have their proposed attachment method approved, no contract or agreement is required. These installations shall meet the following criteria:

A. The installation of street name signs on MoDOT STOP signs must be approved by the appropriate MoDOT district.
B. Street name signs shall have a vertical clearance between 1 inch and 4 inches measured from the bottom of the Street Name sign to the top of the STOP sign.
C. The Street Name sign shall be mounted independently of the STOP sign, attaching only to the sign post and in no way connected to the STOP sign.
D. The installation shall not interfere with the maintenance of the STOP sign.
E. Only one Street Name sign shall be permitted for a side street, no street name sign is permitted for the state route, such installations shall be installed on a separate sign post.
F. Street name signs shall only be mounted above and not below the STOP sign.
G. The maintenance of the Street Name sign shall be the sole responsibility of the city or county, MoDOT will only maintain the sign post and the STOP sign.
H. The maximum width of a Street Name sign placed over a MoDOT STOP sign shall not exceed the width of the STOP sign, MoDOT will not upgrade existing STOP sign posts to allow for larger Street

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Name sign. Wider street name signs shall be installed on a separate sign post.
I. Attachments to MoDOT STOP sign posts shall be accomplished by use of a bracket, U-channel posts stub, or other methods pre-approved by MoDOT.
J. The Street Name sign representing the side street shall be mounted with its face parallel to the street it is naming.
K. If the Stop sign has a ONE WAY signs mounted above it, such as on expressways, a city or county shall install their Street Name sign on a separate sign post.

The installation and maintenance of all street name sign installed on MoDOT right of way by a city or county, either as an independent installation or a street name sign installed over a MoDOT STOP sign shall be the responsibility of the city or county.

Street name signs are the only form of route designation a city or county may install on MoDOT right of way, no other form of route designation is permitted.

Cities and counties are not permitted to install street name signs depicting anything other than the official street name of the roadway used by the US Postal service. Street name signs for alternate street names, such as, honorary, historic or memorial street names shall not be installed on MoDOT right of way.

MoDOT reserves the right to remove and return any street names signs which are not installed correctly or interfere with the visibility of the STOP sign.

Option. At intersection crossroads where the same road has two different street names for each direction of travel, both street names may be displayed on the same Street Name (D3-1) sign along with Type D directional arrows, except where one arrow would point in a direction opposing the flow of traffic on a one-way street or where a turn in the direction of the arrow is not allowed.

Support. Information regarding the use of street names on supplemental plaques for use with intersection-related warning signs is contained in EPG 903.3.64.

Information regarding the identification of overcrossing and undercrossing roadways at grade separations is contained in EPG 903.8.10.

Table 903.4.40 Minimum Letter Heights on Street Name Signs

Type of Mounting	Type of Street or Highway	Speed Limit	Recommended Minimum Letter Height *	
			Initial Upper-Case	Lower-Case
Overhead	All types	All speed limits	10 inches	8 inches
Overhead - Two Line	All Types	All Speed Limits	6 inches	4.5 inches
Signal Column or Pedestal Base	All Types	All Speed Limits	6 inches	4.5 inches

* Letter heights are shown for the street name. Descriptors or other supplementary legend may be displayed in smaller lettering of at least 3 inches.

Notes:

1. MoDOT's overhead street name sign legend controlled by signal structure limitations.
2. MoDOT only installs street name signs at signalized intersections.

903.4.41 Advance Street Name Signs (D3-2 Series) (MUTCD Section 2D.46)



D3-2

Support. Advance Street Name (D3-2) signs identify a downstream intersection. Although this is often the next intersection, it could also be several intersections away in cases where the next signalized intersection is referenced.

Standard. Advance Street Name (D3-2) signs, if used, shall supplement rather than be used instead of the Street Name (D3-1) signs at the intersection.

Option. Advance Street Name (D3-2) signs may be installed in advance of unsignalized intersections within a corridor of signalized intersections which has Advance Street Name signs to provide road users with advance information to identify the name(s) of the next intersecting street to prepare for crossing traffic and to facilitate timely deceleration and/or lane changing in preparation for a turn.

Special consideration may be given to isolated unsignalized intersections where it can be established that safety problems exist, and installation of this type of signing would be beneficial.

Guidance. On arterial highways in rural areas, Advance Street Name signs should be used in advance of all signalized intersections and in advance of all intersections with mandatory turn lanes.

In urban areas, Advance Street Name signs should be used in advance of all signalized intersections on divided highways, major arterial streets, or other routes as determined by the district, except where signalized intersections are so closely spaced that advance placement of the signs is impracticable.

If there is concern that the action message for Advance Street Name signs for unsignalized intersections could be misleading due to other entrances in the area or the sight distance to the intersection is limited, then the action message should be the distance shown to the nearest 100 ft.

Advance Street Name sign placement should be one-half or one-quarter mile in advance of the signal or intersection. In the event of closely spaced signals, this sign should be located immediately beyond the adjacent signalized or unsignalized intersection.

The heights of the letters on Advance Street Name signs should comply with the provisions of EPG 903.4.5.

Standard. If used, Advance Street Name signs shall have a white legend and border on a green background. Alternative background colors shall not be used on Advance Street Name signs.

If used for signalized intersections, Advance Street Name signs shall provide the name(s) of the intersecting street(s) on the top line(s) of the legend and messages such as the abbreviation for junction (JCT) and a route shield if the cross street is a state highway and (or) NEXT SIGNAL.

If used for unsignalized intersections, Advance Street Name signs shall provide the name(s) of the intersecting street(s) on the top lines(s) of the legend and messages such as the abbreviation for junction (JCT) and a route shield if the cross street is a state highway and an action message. The recommended action message for these signs is NEXT INTERSECTION or NEXT ROUNDABOUT. When the Advance Street Name sign is provided for at the junction of a state highway, the Advance Street Name sign shall replace the existing junction assembly.

The installation of an Advance Street Name sign for an unsignalized intersection shall be a supplement to any Street Name signing provided by others.

Pictographs shall not be displayed on Advance Street Name signs.

Option. Directional arrow(s) may be placed to the right or left of the street name or message such as NEXT SIGNAL, as appropriate, rather than on the bottom line of the legend. Curved-stem arrows may be used on Advance Street Name signs on approaches to circular intersections.

For intersecting crossroads where the same road has a different street name for each direction of travel, the different street names may be displayed on the same Advance Street Name sign along with directional arrows.

In advance of two closely-spaced intersections where it is impracticable to install separate Advance Street Name signs, the Advance Street Name sign may include the street names for both intersections along with appropriate supplemental legends for both street names, such as NEXT INTERSECTION, 2ND INTERSECTION, or NEXT LEFT and NEXT RIGHT, or directional arrows.

Guidance. If two street names are used on the Advance Street Name sign, the street names should be displayed in the following order:

A. For a single intersection where the same road has a different street name for each direction of travel, the name of the street to the left should be displayed above the name of the street to the right; or

B. For two closely-spaced intersections, the name of the first street encountered should be displayed above the name of the second street encountered, and the arrow associated with the second street encountered should be an advance arrow, such as the arrow shown on the W16-6P arrow plaque (see EPG 903.3.61).

Option. An Advance Street Name (W16-8P or W16-8aP) plaque (see EPG 903.3.64) with black legend on a yellow background, installed to supplement an Intersection (W2 series) or Advance Traffic Control (W3 series) warning sign may be used instead of an Advance Street Name guide sign.

903.4.42 Parking Area Guide Sign (D4-1, D4-1P, and D4-1a) (MUTCD Section 2D.47)



D4-1



D4-1P



D4-1a

Option. The Parking Area (D4-1) guide sign may be used to show the direction to a nearby public parking area or parking facility.

The sign may also be used in all MoDOT commuter parking lots.

Standard. The parking area shall be owned or operated by a public agency in order to be signed.

The COMMUTER (D4-1P) plaque shall be mounted above the Parking Area sign at commuter parking lots. If used, the sign shall be a horizontal rectangle. The legend and border shall be green on a retroreflectorized white background.

COMMUTER PARKING (D4-1a) signs shall be utilized in each commuter parking area mounted back-to-back. One sign shall face the Interstate and the other will face the parking lot such that the maximum number of motorists on either side of the assembly can read the legend.

In addition, Commuter Parking Lot Restriction signs shall be erected at or near each entrance to the commuter parking lot.

Guidance. If used, the Parking Area (D4-1) guide sign should be installed as 1st order signing to the parking facility and where it can advise drivers of a place to park. The sign should not be used more than four blocks from the parking area.

903.4.43 PARK - RIDE Sign (D4-2) (MUTCD Section 2D.48)



D4-2

Option. A PARK - RIDE (D4-2) sign may be used to direct road users to park-and-ride facilities.

The PARK - RIDE signs may be used in lieu of the Parking sign when a public transit stop is located within the commuter parking lot.

Standard. The signs shall display the word message PARK - RIDE and direction information (arrow or word message).

Option. PARK - RIDE signs may display the local transit pictograph and/or carpool symbol.

Standard. If used, the local transit pictograph and/or carpool symbol shall be located in the top part of the sign above the message PARK - RIDE. In no case shall the vertical dimension of the local transit pictograph and/or carpool symbol exceed 18 inches.

Guidance. If the function of the parking facility is to provide parking for persons using public transportation, the local transit pictograph should be used on the guide sign. If the function of the parking facility is to serve carpool riders, the carpool symbol should be used on the guide sign. If the parking facility serves both functions, both the pictograph and carpool symbol should be used. If used, the public transit pictograph should be of the same design as the local transit authority, however, the local transit authority name should not be a part of this sign.

The COMMUTER (D4-1P) plaque should be mounted below this sign.

Standard. These signs shall have a white legend and border on a rectangular green background. The carpool symbol shall be as shown for the D4-2 sign. The color of the local transit pictograph shall be selected by the local transit authority.

Option. To increase the target value and contrast of the local transit pictograph, and to allow the local transit pictograph to retain its distinctive color and shape, the pictograph may be included within a white border or placed on a white background.

903.4.44 Signing on Conventional Roads on Approaches to Interchanges (MUTCD Section 2D.49)

Support. Because there are a number of different ramp configurations that are commonly used at interchanges with conventional roads, drivers on the conventional road cannot reliably predict whether they will be required to turn left or right in order to enter the correct ramp to access the freeway or expressway in the desired direction of travel. Consistently applied signing for conventional road approaches to freeway or expressway interchanges is highly desirable.

Standard. On multi-lane conventional roads approaching an interchange, guide signs shall be provided to identify which direction of turn is to be made and/or which specific lane to use for ramp access to each direction of the freeway or expressway.

Guidance. The signing of conventional roads with one lane of traffic approaching an interchange should consist of a sequence containing the following signs (see Figure 903.4.44.1):

A. Junction Assembly

B. Destination sign

C. Directional Assembly or Entrance Direction sign for the first ramp

D. Advance Route Turn Assembly or Advance Entrance Direction sign with an advance turn arrow

E. Directional Assembly or Entrance Direction sign for the second ramp

Standard. If used, the Entrance Direction sign shall consist of a white legend and border on a green background. It shall contain the freeway or expressway route shield(s), cardinal direction, and directional arrow(s).

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Option. The Entrance Direction sign may contain a destination(s) and/or an action message such as NEXT RIGHT.

At interchanges where right-of-way is restricted, the following alternate sequence of signs may be used (see Figure 903.4.44.2):

A. Junction Assembly

B. Directional Assembly for the first ramp

C. Directional Assembly for the second ramp

Guidance. On multi-lane conventional roads approaching an interchange, the sign sequence should contain the following signs (see Figures 903.4.44.3 through 903.4.44.5):

A. Junction Assembly

B. Advance Entrance Direction sign(s) for both directions (if applicable) of travel on the freeway or expressway

C. Entrance Direction sign for first ramp

D. Advance Turn Assembly

E. Entrance Direction sign for the second ramp

Support. Advance Entrance Direction signs are used to direct road users to the appropriate lane(s).

Standard. The Advance Entrance Direction sign shall consist of a white legend and border on a green background. It shall contain the freeway or expressway route shield(s) and cardinal direction(s).

Option. The Advance Entrance Direction sign may have destinations, directional arrows, and/or an action message such as KEEP LEFT, NEXT LEFT, or SECOND RIGHT. Signs in this sequence may be mounted overhead to improve visibility as shown in Figures 903.4.44.3 through 903.4.44.5.

Support. A post-mounted Advance Entrance Direction diagrammatic sign (see Figure 903.4.44.6), within the sequence of approach guide signing described in the first and second guidance paragraphs of this Article, might be helpful in depicting the location of a freeway or expressway entrance ramp that is in close proximity to an intervening intersection on the same side of the approach roadway and where signing for only the ramp might cause confusion to road users.

Standard. If used, the post-mounted Advance Entrance Direction diagrammatic sign shall display only the two successive turns from the same side of the roadway, one of which shall be the entrance ramp. The post-mounted Advance Entrance Direction sign shall depict only the successive turns and shall not depict lane use with lane lines, multiple arrow shafts for the approach roadway, action messages, or other representations.

Support. Example guide signing for a transposed-alignment crossroad at a diverging diamond interchange is shown in Figure 903.4.44.7. Example guide signing for a single-point urban intersection at a diamond interchange is shown in Figure 903.4.44.8.



Figure 903.4.44.1 Example of Interchange Crossroad Guide Signing for a One-Lane Approach

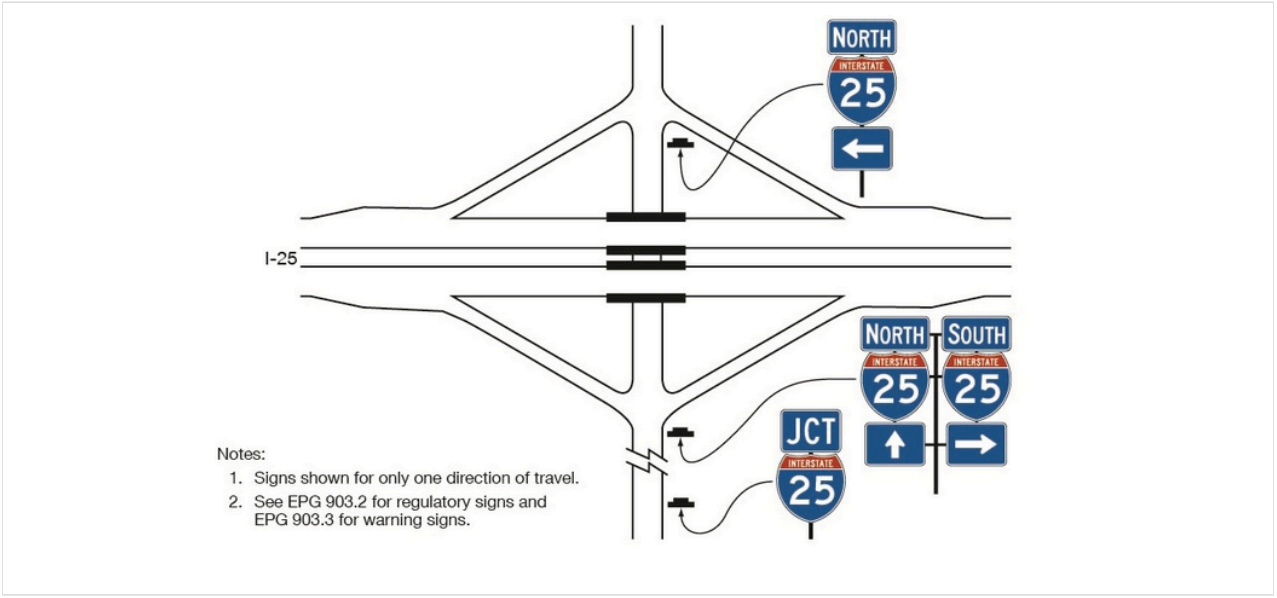


Figure 903.4.44.2 Example of Alternate Interchange Crossroad Guide Signing in Areas with Restricted Right-of-Way

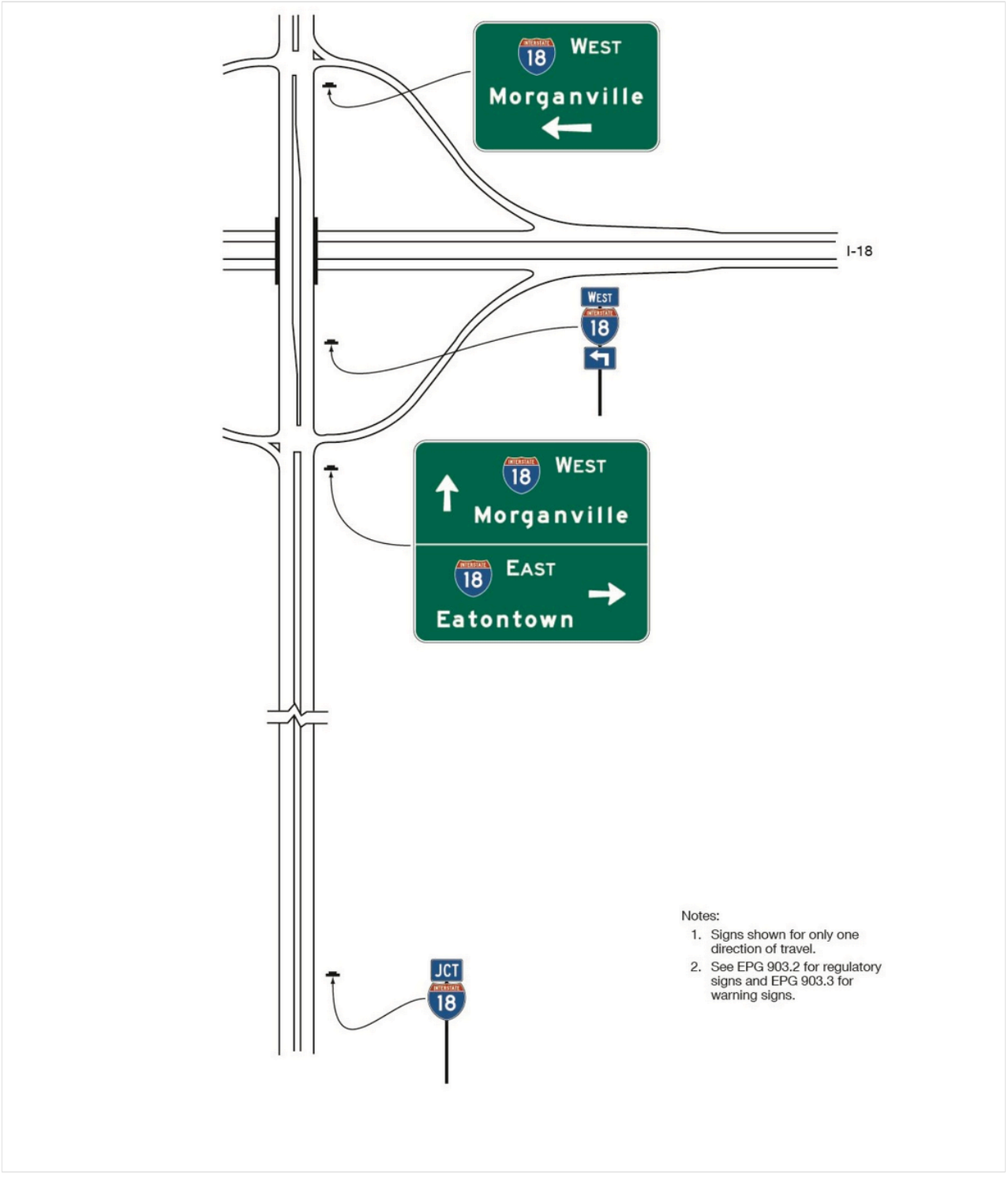


Figure 903.4.44.3 Examples of Multi-Lane Crossroad Guide Signing for a Diamond Interchange

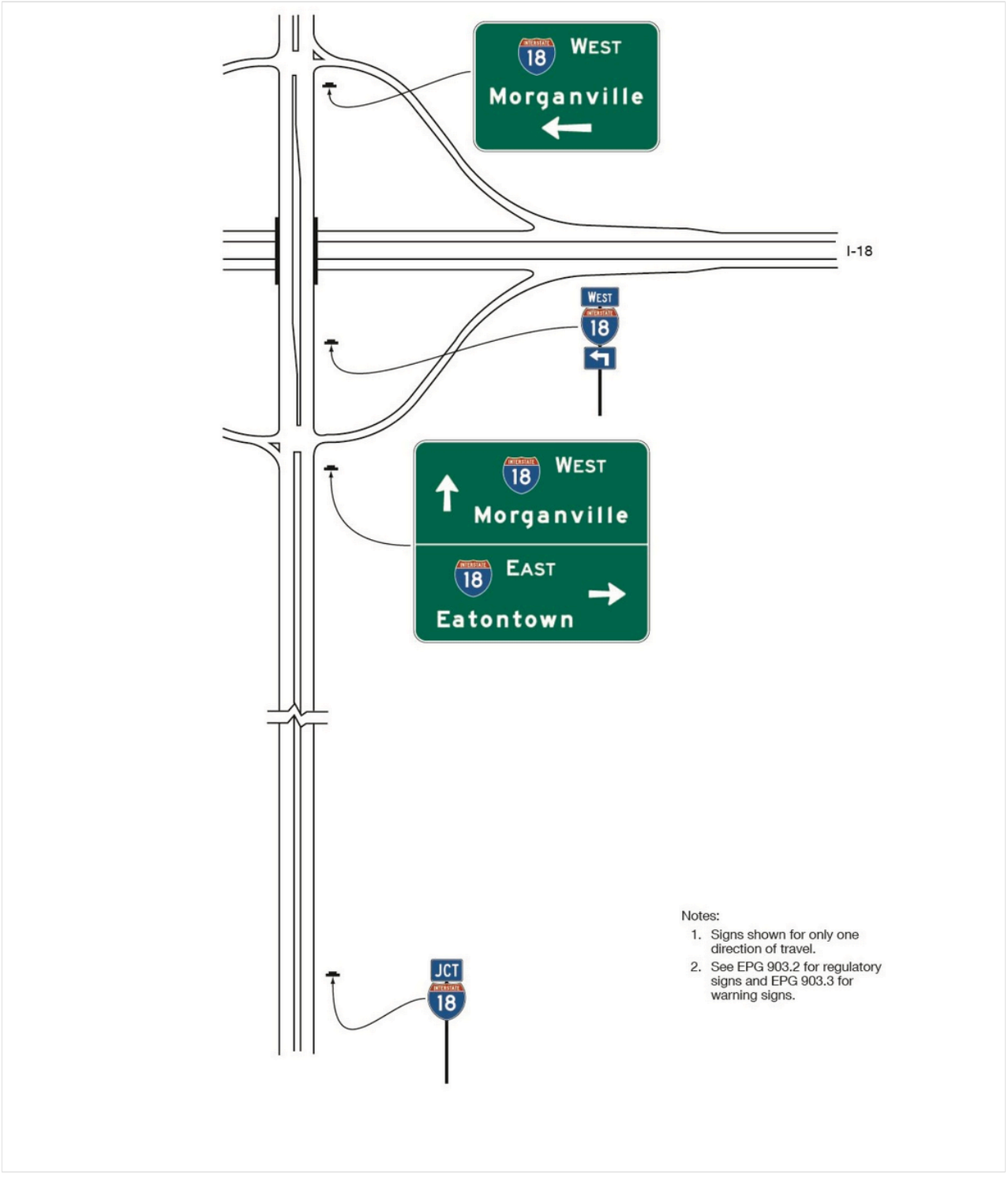


Figure 903.4.44.4 Examples of Multi-Lane Crossroad Guide Signing for a Partial Cloverleaf Interchange

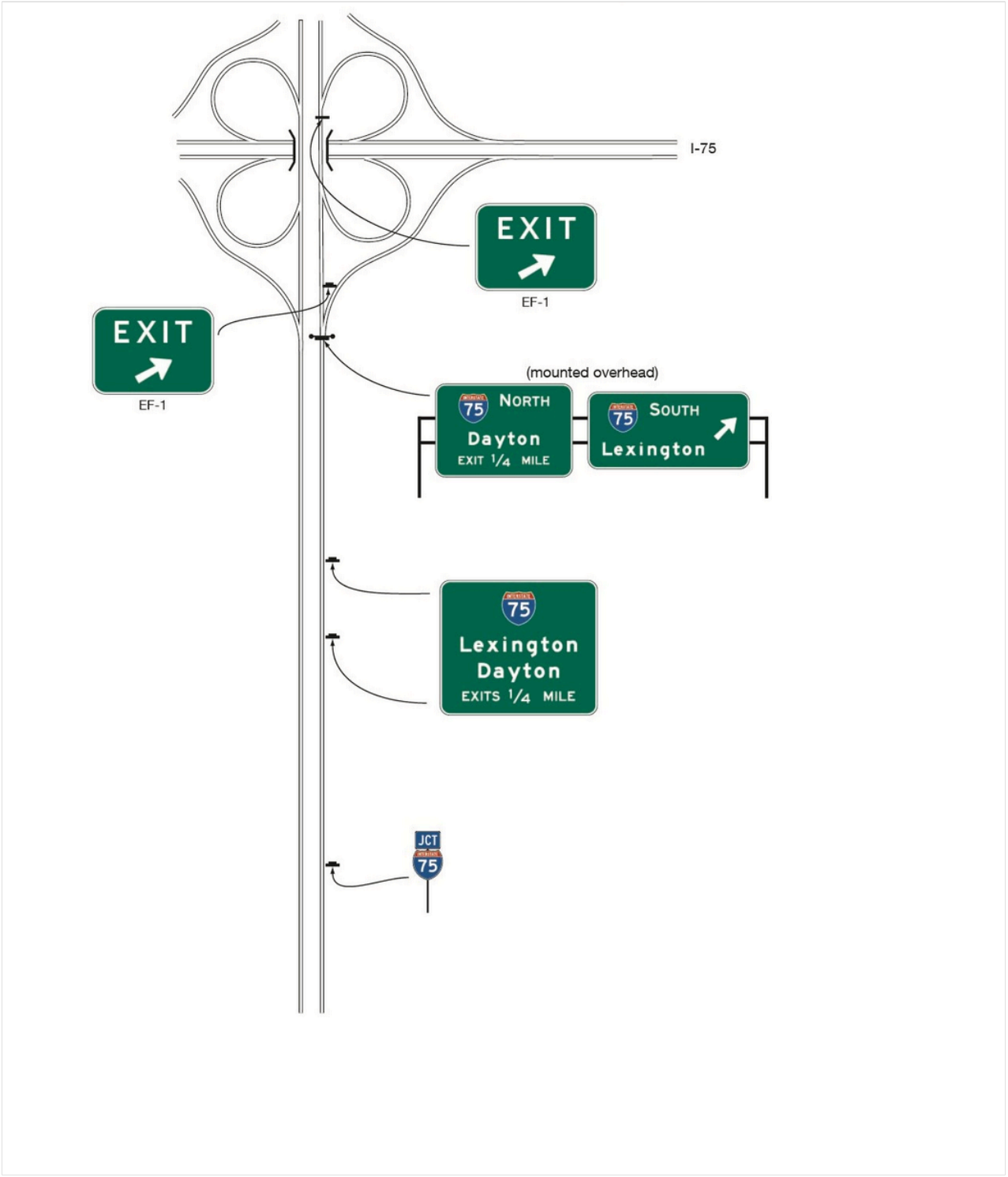


Figure 903.4.44.5 Examples of Multi-Lane Crossroad Signing for a Cloverleaf Interchange

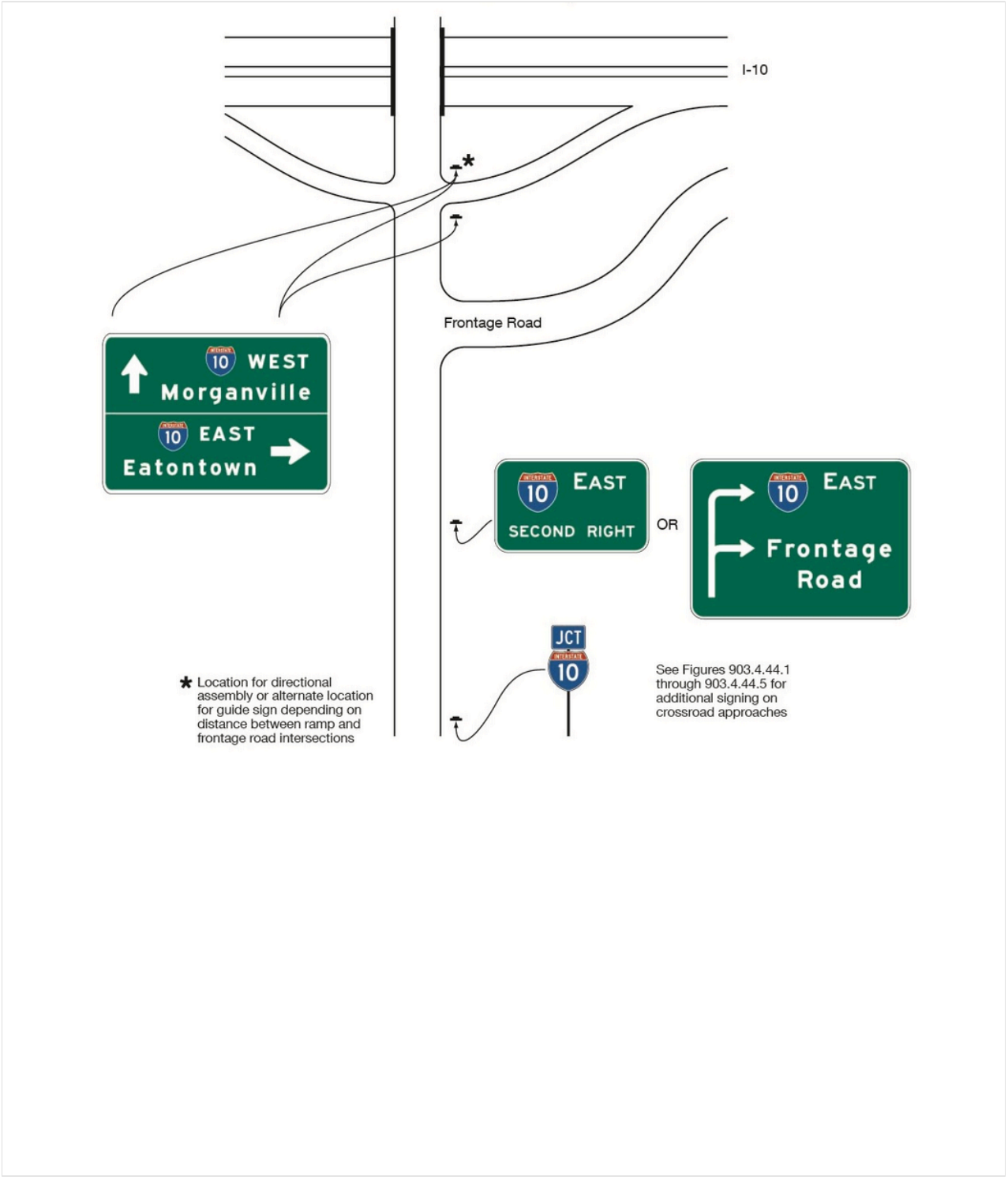


Figure 903.4.44.6 Example of Crossroad Guide Signing for an Entrance Ramp with a Nearby Frontage Road

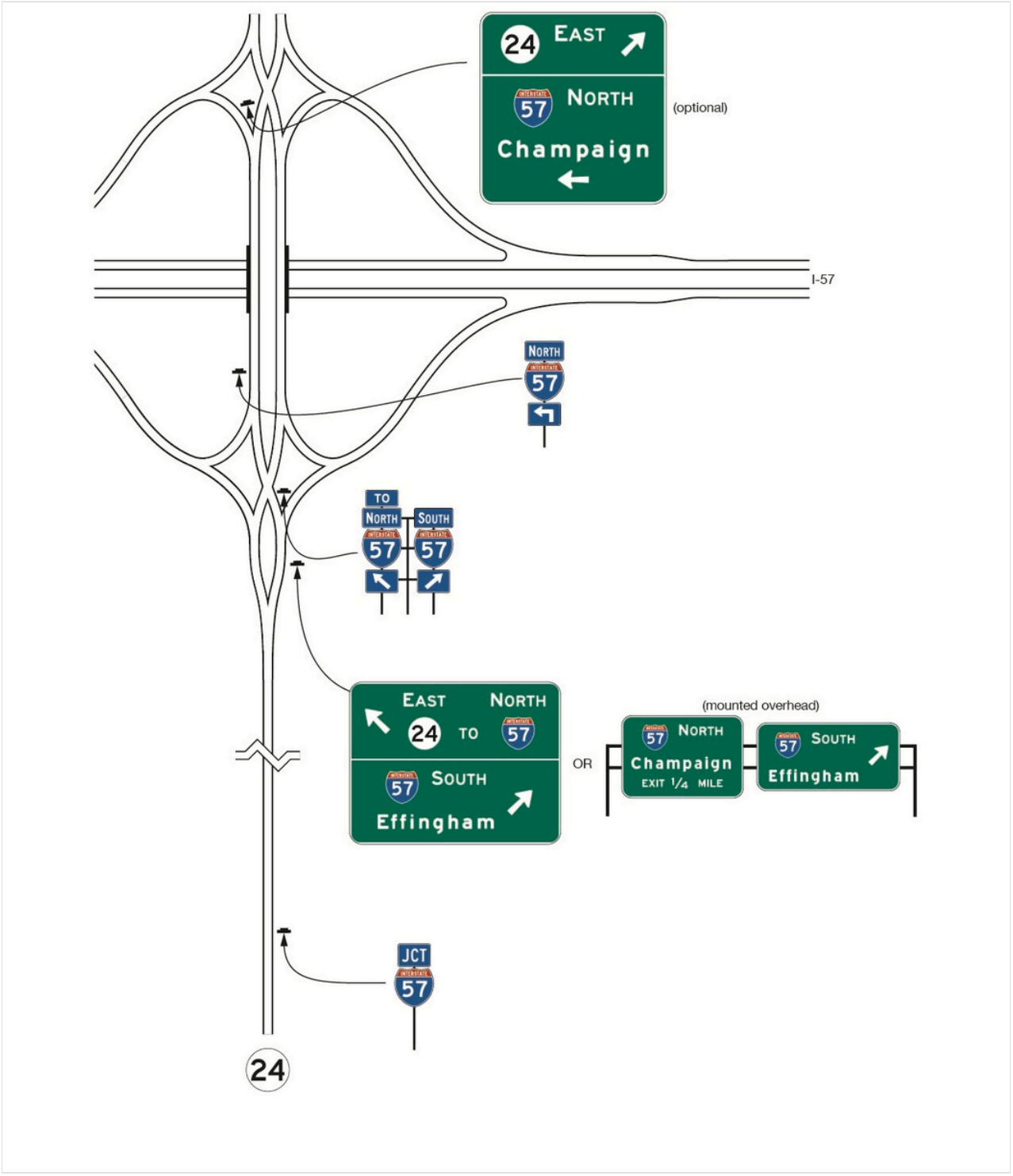


Figure 903.4.44.7 Example of Transposed Alignment Crossroad Guide Signing at a Diverging Diamond Interchange

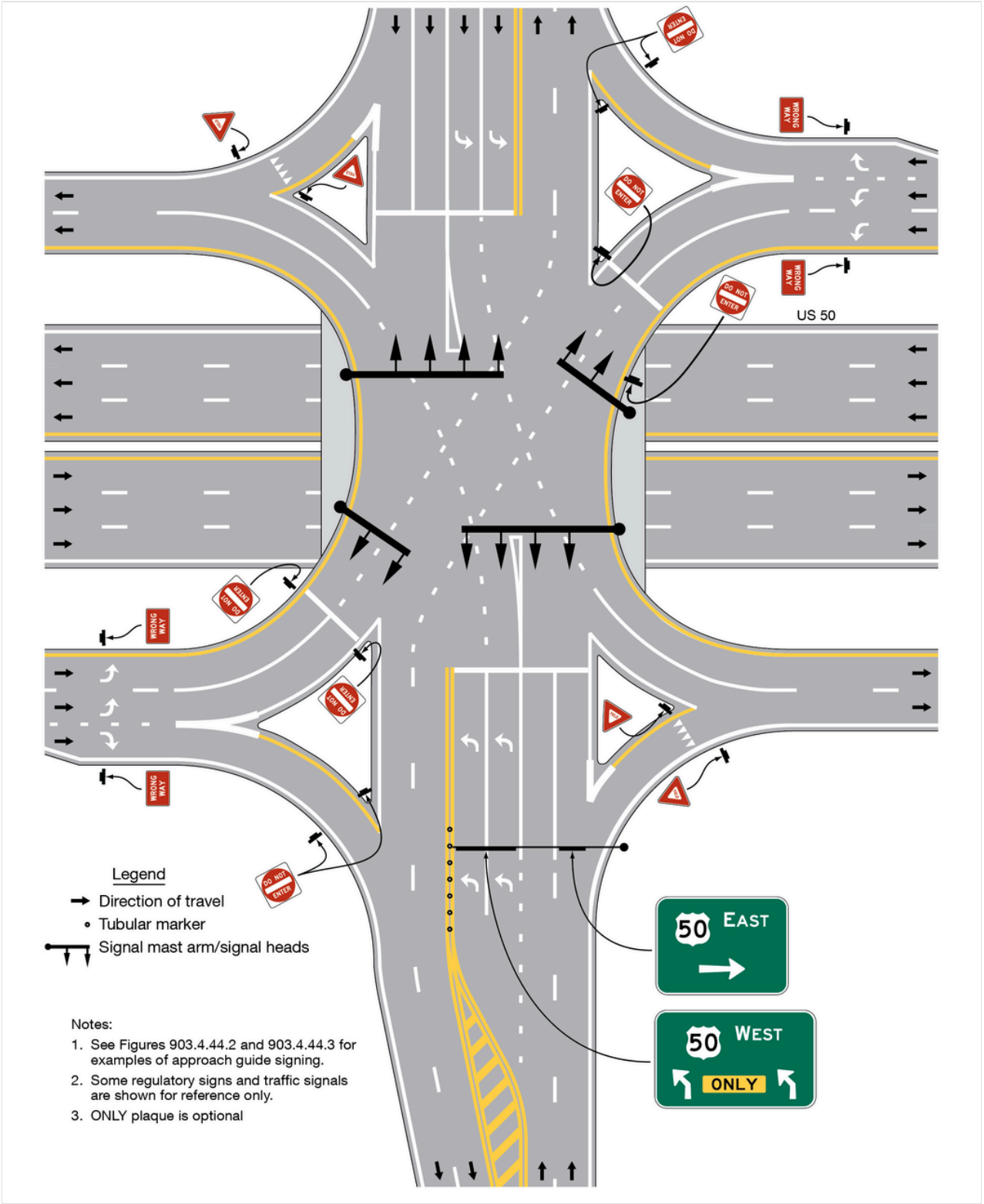


Figure 903.4.44.8 Example of Crossroad Intersection Guide Signs for a Single-Point Urban Interchange

903.4.45 WEIGH STATION Signing (D8 Series) (MUTCD Section

2D.51)



D8-1



D8-2



D8-3

Support. Independent facilities or areas have been added along many highways where certain commercial vehicles are directed to stop to be weighed and/or inspected. These areas are sometimes permanent, such as in a roadside area, or temporary mobile facilities deployed along the roadway.

The general concept for signing permanent Weigh Stations is similar to signing Rest Areas (see EPG 903.9.3) because in both cases traffic using either area remains within the right-of-way.

Standard. The standard sequence of signs for a Weigh Station on a conventional highway shall include three basic signs:

A. Advance Weigh Station Distance (D8-1) sign,

B. Weigh Station Advance Direction (D8-2) sign, and

C. Weigh Station Entrance Direction (D8-3) sign.

If the weigh station uses a preclearance system, a WEIGH STATION PRECLEARANCE – ALL TRUCKS RIGHT LANE sign shall be used.

Guidance. A Gore sign with the same basic legend as the Weigh Station Entrance Direction (D8-3) sign should also be used to emphasize the entrance to the weigh station.

The Weigh Station Advance Direction (D8-2) Sign or the Advance Weigh Station Distance (D8-1) sign should display, either on the sign or on a supplemental plaque or sign panel, the changeable legend OPEN or CLOSED.

903.4.46 Truck and Climbing Lane Signs (D17-1 and D17-2)



D17-1



D17-2

Support. A truck lane, commonly referred to as a climbing lane, is an additional lane added to the right of the travel lane. This added lane gives slow moving trucks and other slow-moving vehicles a dedicated lane to use to climb a steep grade at slower speeds if they are unable to climb the hill at the posted speed limit. At the end of the truck lane, the vehicles in the right lane that is ending must merge back into the normal travel lane. This helps reduce congestion by allowing normal traffic the ability to proceed up the grade unimpeded, in the normal travel lane, at the posted speed limit.

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Truck lanes are typically installed at specific segments of roadway where vehicles commonly have difficulty maintaining the speed limit along an uphill grade and are not are typically not constructed as a series of continuous truck lanes along a corridor. Truck lanes utilize a unique set of regulatory and warnings signs as well as pavement markings to denote the availability of this added lane.

Guidance. If a series of truck lanes is provided along a highway, a Next Truck Lane (D17-1) sign should be installed after each truck lane segment.

Option. Most truck lanes are obvious to drivers and do not require advance notification. If a need to provide advance notification of the upcoming truck lane has been determined based on engineering judgement, one Truck Lane Mile (D17-2) sign may be installed in advance of the truck lane. The Truck Lane Mile (D17-2) sign, if used, is typically placed no more than ½ mile in advance of the beginning of the truck lane.

Support. See EPG 903.3.39 for Lane Ends Signs and EPG 620.2.14 for Lane-Reduction Transition pavement markings and see EPG 616.16 for the typical application for all traffic control devices as they are applied to a truck lane.

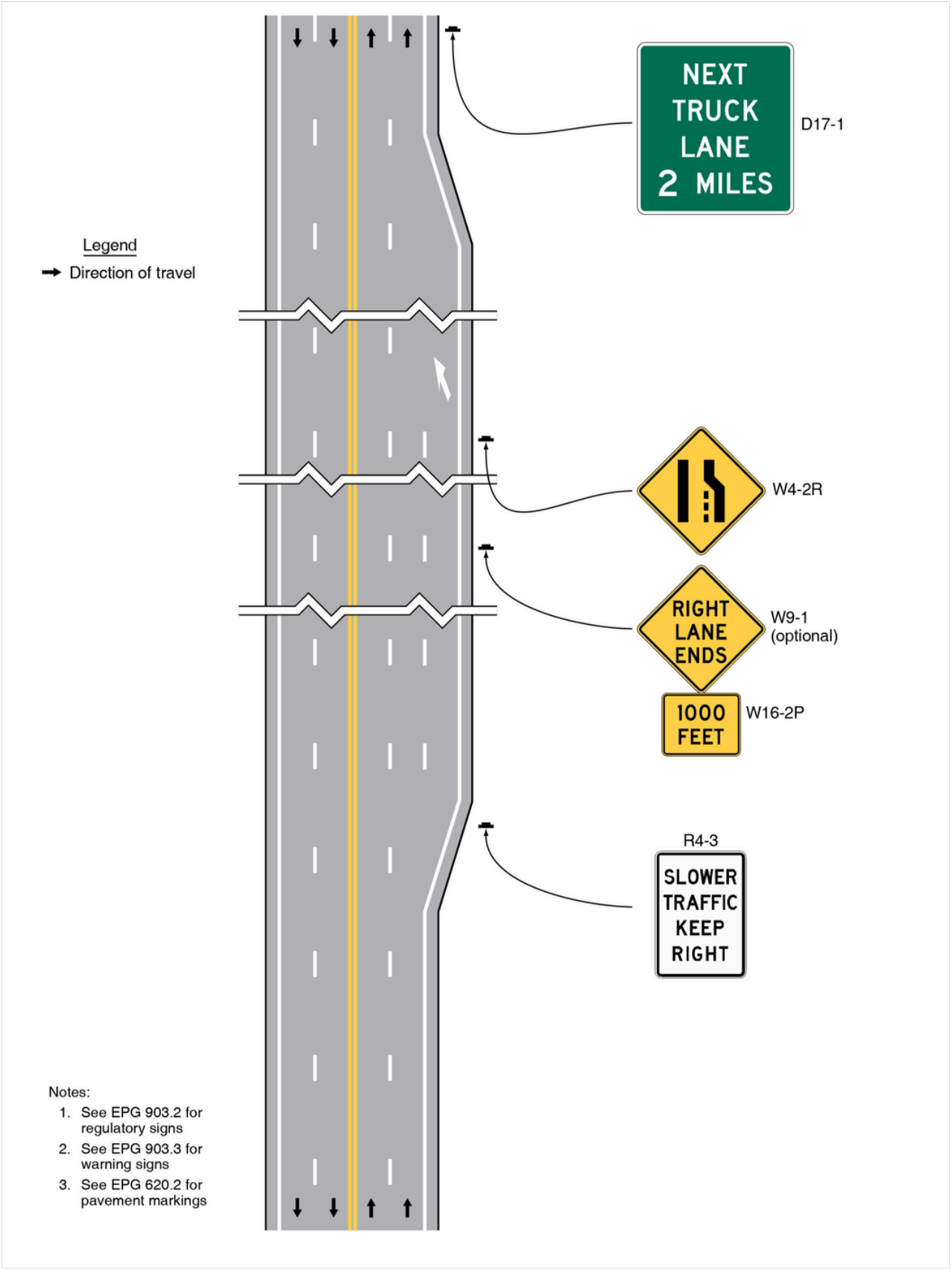


Figure 903.4.46 Example of Signing for a Truck Lane

903.4.47 Passing Lane / Alternating Passing Lane Signs (D17-3,

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D17-4, D17-4a)



D17-3



D17-4



D17-4a

Support. A passing lane is lane added to the left of the normal travel lane. This lane gives drivers the ability to pass slower moving traffic without the need to use the opposing lane of traffic for passing maneuvers. At the end of the passing lane, vehicles in the left lane that is ending must merge back into the normal traffic lane.

In most cases, passing lanes are constructed as a series of passing lane segments in both directions of travel, alternating in availability from one direction of travel to the other along the corridor segment. This application is referred to as alternating passing lanes. This system of passing lanes can provide some of the benefits of a four-lane divided roadway within the right-of-way footprint of a conventional two-lane roadway. Passing lanes utilize a unique set of regulatory, warning and guide signs, as well as pavement markings, to denote the availability of the passing lane.

Guidance. On corridors where alternating passing lanes have been constructed, the ALTERNATING PASSING LANE NEXT XX MILES (17-4a) sign should be installed in advance of the first passing lane at each end of the alternating passing lane along the corridor. This sign notifies the driver that there will be a series of passing lane opportunities over the given distance displayed on the sign.

Option. Advanced notification of single passing lane opportunities is not typically required. If a need to provide advance notification of an upcoming passing lane has been determined to be needed based on engineering judgement, one PASSING LANE (D17-4) sign may be installed in advance of the passing lane. PASSING LANE (D17-4) sign, if used, is typically placed no more than ½ mile in advance of the beginning of the passing lane.

Standard. Each passing lane within an alternating passing lane corridor shall include a NEXT PASSING LANE X MILES (D17-3) sign at the end of passing lane.

Support. See EPG 903.3.39 for Lane Ends Signs and EPG 620.2.14 for Lane-Reduction Transition pavement markings and see EPG 616.16 for the typical application for all traffic control devices as they are applied to a passing lane.

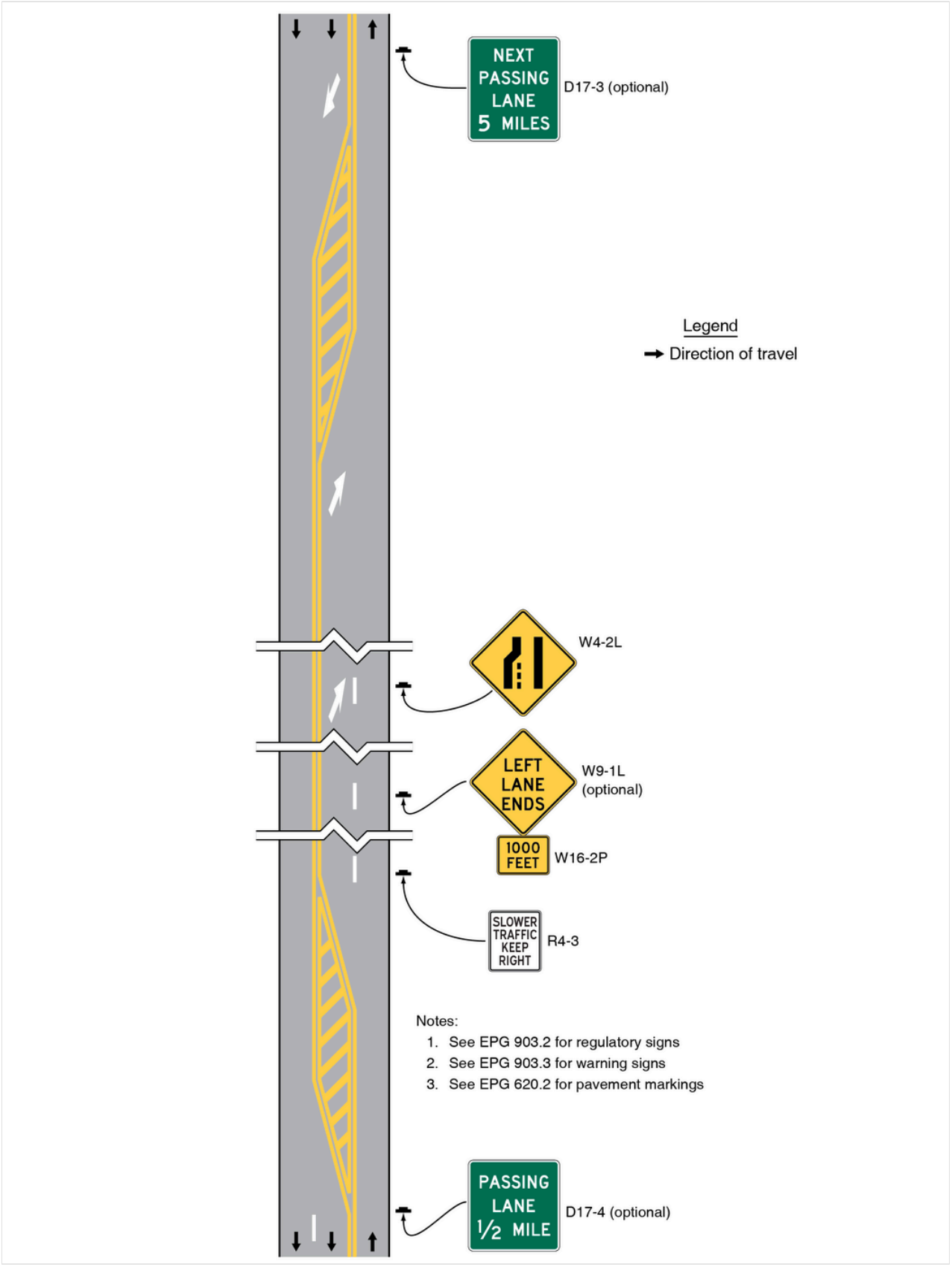


Figure 903.4.47 Example of Signing for an Intermittent Passing Lane

903.4.48 Community Wayfinding Signs (MUTCD Section 2D.55)

Support. Community wayfinding guide signs are part of a coordinated and continuous system of signs that direct tourists and other road users to key civic, cultural, visitor, and recreational attractions and other similar secondary destinations within a city or a local urbanized or downtown area.

Community Wayfinding is a city installed and maintained signing program allowed on MoDOT right of way per this policy. Wayfinding signs are installed as MoDOT permit projects and require a TR47 agreement. MoDOT's only role is to ensure the city program signs meet the requirements of the wayfinding policies and do not interfere with safe operation of the state highway system.

Community wayfinding guide signs are a type of destination guide sign for conventional roads with a common color and/or identification marker for destinations within an overall wayfinding guide sign plan for an area.

Figure 903.4.48 illustrates various examples of the design of community wayfinding guide signs.

Standard. The use of community wayfinding guide signs shall be limited to conventional roads. Community wayfinding guide signs shall not be installed on freeway or expressway mainlines or ramps. Direction to community wayfinding destinations from a freeway or expressway shall be limited to the use of a Supplemental guide sign (see EPG 903.5.49) on the mainline and a Destination sign (see EPG 903.4.32) on the ramp to direct road users to the area or areas within which community wayfinding guide signs are used. A community wayfinding program shall have a minimum of three well defined districts before freeway/expressway signing will be permitted. A well-defined district shall represent a region or area with multiple sites or destinations within it. The individual wayfinding destinations shall not be displayed on the Supplemental guide and Destination signs except where the destinations are in accordance with this policy. Community wayfinding guide signs shall not be used to provide direction to primary destinations or highway routes or streets. Destination or other guide signs shall be used for this purpose as described elsewhere in EPG 903.4 and shall have priority over any community wayfinding sign in placement, prominence, and conspicuity.

Because regulatory, warning, and other guide signs have a higher priority, community wayfinding guide signs shall not be installed where adequate spacing cannot be provided between the community wayfinding guide sign and other higher-priority signs. Community wayfinding guide signs shall not be installed in a position where they would obscure the road users' view of other traffic control devices.

Community wayfinding guide signs shall not be mounted overhead.

Support. Community wayfinding guide signs include boundary markers, welcome to messages or the simple display of a city name on a structure or sign (see EPG 903.17).

Guidance. If used, a community wayfinding guide sign system should be established on a local municipal or equivalent jurisdictional level or for an urbanized area of adjoining municipalities or equivalent that form an identifiable geographic entity that is conducive to a cohesive and continuous system of signs. Community wayfinding guide signs should not be used on a regional or statewide basis where infrequent or sparse placement does not contribute to a continuous or coordinated system of signing that is readily identifiable as such to the road user. In such cases, Destination or other guide signs detailed in EPG 903.4 should be used to direct road users to an identifiable area in which the type of eligible destination described in first Support paragraph of this Article is located.

When a system of community wayfinding guide signs is being considered, the system of existing guide signs should be evaluated for applicability and general compliance with the provisions of the EPG to ensure road user directional guidance is adequately being addressed.

Support. The specific provisions of this Article regarding the design of community wayfinding sign legends apply to vehicular community wayfinding signs and do not apply to those signs that are intended only to provide information or direction to pedestrians or other users of a sidewalk or roadside area.

Guidance. Because pedestrian wayfinding signs typically use smaller legends that are inadequately sized for viewing by vehicular traffic and because they can provide direction to pedestrians that might conflict with that appropriate for vehicular traffic, wayfinding signs designed for and intended to provide direction to pedestrians or other users of a sidewalk or other roadside area should be located to minimize their conspicuity to vehicular traffic. Such signs should be located as far as practicable from the street, such as at the far edge of the sidewalk. Where locating such signs farther from the roadway is impracticable, the pedestrian wayfinding signs should have their conspicuity to vehicular traffic minimized by employing one or a combination of the following methods:

A. Locating signs away from intersections where high-priority traffic control devices are present.

B. Facing the pedestrian message toward the sidewalk and away from the street.

C. Cantilevering the sign over the sidewalk if the pedestrian wayfinding sign is mounted at a height consistent with vehicular traffic signs, removing the pedestrian wayfinding signs from the line of sight in a sequence of vehicular signs.

To further minimize their conspicuity to vehicular traffic during nighttime conditions, pedestrian wayfinding signs should not be retroreflective.

Support. Color coding is sometimes used on community wayfinding guide signs to help road users distinguish between multiple potentially confusing traffic generator destinations located in different neighborhoods or subareas within a community or area.

Option. At the boundaries of the geographical area within which community wayfinding guide signing is used, an informational guide sign may be posted to inform road users about the presence of wayfinding signing and to identify the meanings of the various color codes or pictographs that are being used.

Standard. These informational guide signs shall have a white legend and border on a green background and shall have a design similar to that illustrated in Figure 903.4.2 and shall be consistent with the basic design principles for guide signs. These informational guide signs shall not be installed on freeway or expressway mainlines or ramps.

The color coding or a pictograph of the identification markers of the community wayfinding guide signing system shall be included on the informational guide sign posted at the boundary of the community wayfinding guide signing area. The color coding or pictographs shall apply to a specific, identifiable neighborhood or geographical subarea within the overall area covered by the community wayfinding guide signing. Color coding or pictographs shall not be used to distinguish between different types of destinations that are within the same designated neighborhood or subarea. The color coding shall be accomplished by the use of different colored square or rectangular panels on the face of the informational guide sign, each positioned to the left of the neighborhood or named geographic area to which the color-coding panel applies. The height of the colored square or rectangular panels shall not exceed 2 times the height of the upper-case letters of the principal legend on the sign.

Option. The different colored square or rectangular panels may include either a black or a white (whichever provides the better contrast with the color of the panel) letter, numeral, or other appropriate designation to identify the destination.

Except for the informational guide sign posted at the boundary of the wayfinding guide sign area, community wayfinding guide signs may use background colors other than green in order to provide a color identification for the wayfinding destinations by geographical area within the overall wayfinding guide signing system. Color-coded community wayfinding guide signs may be used with or without the boundary informational guide sign displaying corresponding color-coding panels described in the sixth Support paragraph (beginning with “Color coding is sometimes…”) through the sixth Standard paragraph (beginning with “The color coding or a

pictograph…") of this Article. Except as provided in the following Standard paragraph, in addition to the colors that are approved in the EPG for use on official traffic control signs (see EPG 903.1.6), other background colors may also be used for the color coding of community wayfinding guide signs.

Standard. The standard colors of red, orange, yellow, purple, or the fluorescent versions thereof, fluorescent yellow-green, and fluorescent pink shall not be used as background colors for community wayfinding guide signs, in order to minimize possible confusion with critical, higher-priority regulatory and warning sign color meanings readily understood by road users.

The minimum contrast value of legend color to background color for community wayfinding guide signs shall be at least 0.70 (or 70%).

All messages, borders, legends, and backgrounds of community wayfinding guide signs and any identification markers shall be retroreflective (see EPG 903.1.21 and 903.1.22).

Community wayfinding guide signs, exclusive of any identification marker used, shall be rectangular in shape.

Guidance. Simplicity and uniformity in design, position, and application as described in EPG 903.1.4 are important and should be incorporated into the community wayfinding guide sign design and location plans for the area.

Community wayfinding guide signs should be limited to three destinations per sign (see EPG 903.4.6).

Abbreviations (see EPG 911 (MUTCD Section 1D.08)) should be kept to a minimum, and should include only those that are commonly recognized and understood.

Horizontal lines of a color that contrasts with the sign background color should be used to separate groups of destinations by direction from each other.

Support. The basic requirement for all highway signs, including community wayfinding signs, is that they be legible to those for whom they are intended and that they be understandable in time to permit a proper response. EPG 903.1.4 contains additional information on the design of signs, including desirable attributes of effective designs.

Guidance. Word messages should be as brief as practical and the lettering should be large enough to provide the necessary legibility distance.

Standard. The minimum specific ratio of letter height to legibility distance shall comply with the provisions of EPG 903.1.8. The size of lettering used for destination and directional legends on community wayfinding signs shall comply with the provisions of minimum letter heights as provided in EPG 903.4.5.

Interline and edge spacing shall comply with the provisions of EPG 903.4.5.

Except as provided in the Option paragraph below, the lettering style used for destination and directional legends on community wayfinding guide signs shall comply with the provisions of EPG 903.4.4.

The lettering for destinations on community wayfinding guide signs shall be a combination of lower-case letters with initial upper-case letters (see EPG 903.4.4). All other word messages on community wayfinding guide signs shall be in all upper-case letters.

Guidance. Except as provided in the Option and Standard paragraphs below, letters, numerals, and other characters should be composed of the Standard Alphabets as detailed in the "Standard Highway Signs" publication EPG 911 (MUTCD Section 1A.05)).

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Option. A lettering style other than the Standard Alphabets provided in the "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)) may be used on community wayfinding guide signs if an engineering study determines that the legibility and recognition values for the chosen lettering style meet or exceed the values for the Standard Alphabets for the same legend height and stroke width.

Standard. If a lettering style other than the Standard Alphabets is used, the alternative lettering style shall be conventional in form. The letters, numerals, and other characters shall not be italic, oblique, script, highly decorative, or of other unusual forms.

In accordance with EPG 903.1.4, except for signs that are designed and located with the intent to be viewed only by pedestrians, bicyclists stopped out of the flow of traffic, or occupants of parked vehicles, Internet and e-mail addresses, including domain names and uniform resource locators (URL), and scanning graphics for the purpose of obtaining information (see EPG 903.1.4), shall not be displayed on any community wayfinding guide sign or sign assembly.

The arrow location and priority order of destinations shall follow the provisions described in EPG 903.4.8 and 903.4.32. Arrows shall be of the designs provided in EPG 903.4.8.

Option. Pictographs (see definition in EPG 911 (MUTCD Section 1C.02)) may be used on community wayfinding guide signs.

Standard. If a pictograph is used, its height shall not exceed 2 times the height of the upper-case letters of the principal legend on the sign.

Except for pictographs, symbols that are not approved in the EPG for use on guide signs shall not be used on community wayfinding guide signs.

Business logos, commercial graphics, or other forms of advertising (see EPG 911 (MUTCD Section 1D.07)) shall not be used on community wayfinding guide signs or sign assemblies.

Option. Other graphics that specifically identify the wayfinding system, including identification markers, may be used on the overall sign assembly and sign supports.

Support. An identification marker consists of a shape, color, and/or pictograph that is used as a visual identifier for the community wayfinding guide signing system for an area. Figure 903.4.48 shows examples of identification marker designs that can be used with community wayfinding guide signs.

Option. An identification marker may be used in a community wayfinding guide sign assembly, or may be incorporated into the overall design of a community wayfinding guide sign, as a means of visually identifying the sign as part of an overall system of community wayfinding signs and destinations.

Standard. The sizes and shapes of identification markers shall be smaller than the community wayfinding guide signs themselves. Identification markers shall not be designed to have an appearance that could be mistaken by road users as being a traffic control device.

Guidance. The area of the identification marker should not exceed ⅕ of the area of the community wayfinding guide sign with which it is mounted in the same sign assembly.



Figure 903.4.48 Examples of Community Wayfinding Guide Signs

903.4.49 National Scenic Byways Sign and Plaque (M10-1 and M10-1aP) (MUTCD Section 2D.57)

Support. Certain roads have been designated by the U.S. Secretary of Transportation as National Scenic Byways or All-American Roads based on their archeological, cultural, historic, natural, recreational, or scenic qualities.

Table 903.4.49 lists the approved National Scenic Byways that follow state-maintained routes.

Table 903.4.49 Approved National Scenic Byways in Missouri

National Scenic Byways in Missouri
Crowley's Ridge Parkway (https://fhwaapps.fhwa.dot.gov/bywaysp/StateMaps/Show/byway/2588)
Little Dixie Highway of the Great River Road (https://www.fhwa.dot.gov/infrastructure/back0406.cfm)

Option. MoDOT may install the National Scenic Byways (M10-1) sign or (M10-1aP) plaque (see Figure 903.4.49) at entrance points to a route that has been recognized by the U.S. Secretary of Transportation as a National Scenic Byway or an All-American Road. The M10-1 sign may be installed as independent Directional (see EPG 903.4.28) or Confirming (see EPG 903.4.29) assemblies at periodic intervals along the designated route and near intersections where the designated route turns or follows a different numbered highway. The M10-1aP plaque may be installed below a route sign in a Confirming assembly. At locations where roadside features have been developed to enhance the traveler's experience such as rest areas, historic sites, interpretive facilities, or scenic overlooks, the National Scenic Byways sign or plaque may be placed on the associated sign assembly to inform travelers that the site contributes to the byway travel experience.

Guidance. Where the byway is identified only by the National Scenic Byways sign, the Directional assembly should consist of the M10-1 sign and an M5 series or M6 series auxiliary plaque when indication of a turn is necessary to remain on the byway route.

Where the name of the byway is to be displayed on identification signs or plaques along the byway route, the name should be displayed in a Directional or Confirming assembly.

The size of the National Scenic Byways (M10-1) sign and (M10-1aP) plaque should be consistent with that specified for route signs (see EPG 903.4.10) for the roadway classification.

Where the name of the byway is to be displayed along the byway route as provided in the fifth paragraph of this Article, the byway Directional or Confirming assemblies should be located separately from any route Sign assemblies or Destination guide signs.

Standard. When a National Scenic Byways sign is installed on a National Scenic Byway or an All-American Road, the design shown for the M10-1 sign or M10-1aP plaque in Figure 903.4.49 shall be used. Use of this design shall be limited to routes that have been designated as a National Scenic Byway or All-American Road by the U.S. Secretary of Transportation.

If used, the M10-1 sign or M10-1aP plaque shall be placed such that the highway route signs have primary visibility for the road user.

The M10-1 sign or the M10-1aP plaque shall not be installed as sign panels on a guide sign or as part of a guide sign assembly.

The National Scenic Byway signs shall be paid for by the group or association responsible for byway.

Any additional signing, other than that provided by MoDOT, shall be located off of state maintained right of way.

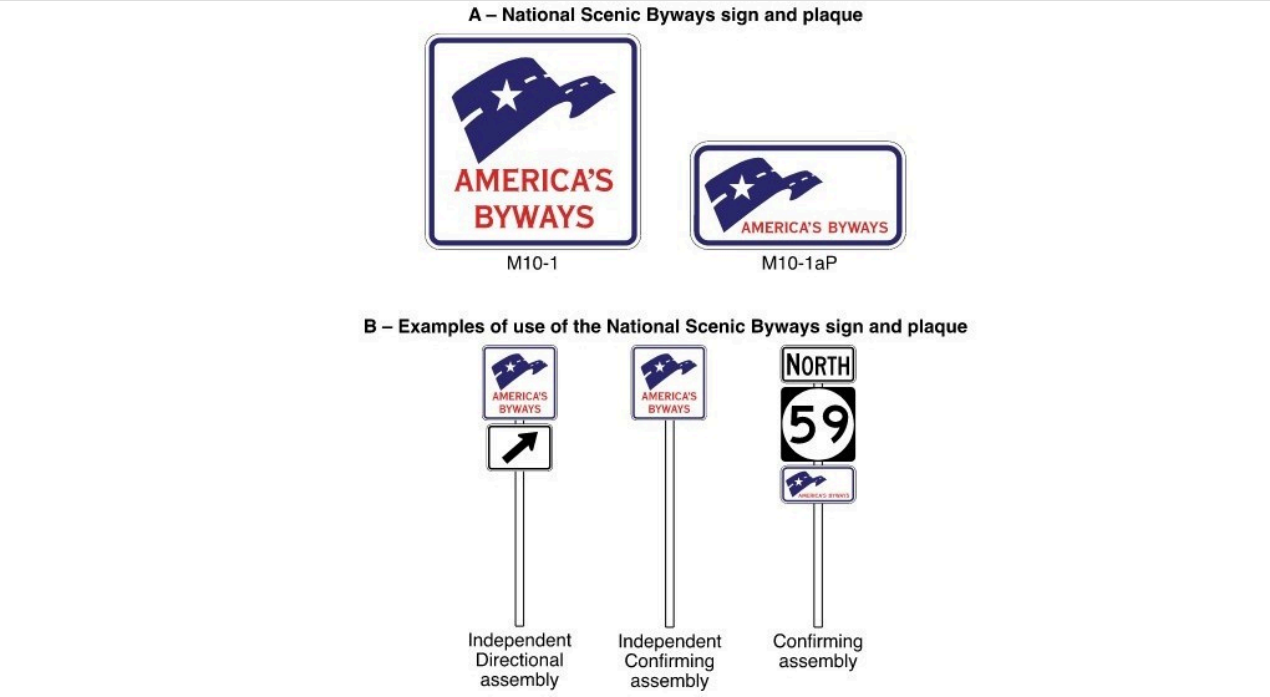


Figure 903.4.49 National Scenic Byways Sign and Plaque, and Examples of Use

903.4.50 State-Designated Scenic Byway, Historic Trail, and Auto Tour Route Signs (MUTCD Section 2D.58)



D6-4b



D6-4c



D6-4d



M17-1



M17-2



M17-3



M17-4



M17-5



M17-8



M17-8a



M17-10



M17-11

Support. Signing for State-designated scenic byways, historic trails, and auto tour routes, is similar in concept to that for National Scenic Byways as provided in EPG 903.4.49.

Table 903.4.50 lists the approved Missouri Scenic Byways that follow state-maintained routes.

Table 903.4.50 Approved Missouri Scenic Byways

Missouri Scenic Byway
Cliff Drive (http://kcparks.org/park/cliff-drive/)
Crowley's Ridge Parkway (https://fhwaapps.fhwa.dot.gov/bywaysp/StateMaps/Show/byway/2588)
Historic Route 66 Byway (https://missouri66.org/)
Little Dixie Highway of the Great River Road (https://www.fhwa.dot.gov/infrastructure/back0406.cfm)
Old Trails Road (https://www.visitmo.com/things-to-do/old-trails-road-scenic-byway)
Ozark Mountain High Road (https://scenicbyways.info/byway/73303.html)
Ozark Mountain Parkway (https://scenicbyways.info/byway/64978.html)
Sho-Me Santa Fe Trail (https://scenicbyways.info/byway/73302.html)
Spirit of Kansas City (https://scenicbyways.info/byway/73301.html)
Stars and Stripes Historical/Cultural Byway (https://scenicbyways.info/byway/73304.html)

Named highways are officially designated and shown on official maps and serve the purpose of providing route guidance, primarily on unnumbered highways, and property addresses. A highway designated as a trail, auto tour route, or byway is not considered to be a highway name for the purposes of highway signing or road user navigation and orientation.

EPG 911 (MUTCD Section 1D.09) provides information on the authority for placement of traffic control devices within the highway right-of-way.

Guidance. Route Sign assemblies and Destination guide signs should have priority in visibility and location over signing related to historic trails, auto tour routes, and byways.

Standard. When a Missouri Scenic Byways sign is installed on state-maintained routes, the design shown for the D6-4b or D6-4c sign shall be used. Use of this design shall be limited to routes that have been designated as a Missouri Scenic Byway by the Commission.

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The Missouri Scenic Byway (D6-4b) signs shall be installed at the beginning of the byway and shall include the byway name at the bottom of the sign.

Missouri Scenic Byways (D6-4c) Confirmation signs shall be installed above route turn assemblies and at intersections where the designated route turns or follows a different numbered highway.

If used, the D6-4b or D6-4c sign shall be placed such that the roadway signs have primary visibility for the road user.

Any additional signing, other than that provided by MoDOT, shall be located off state maintained right of way.

Option. The end of the byway may be marked with the Missouri Scenic Byways (D6-4c) Confirmation sign with the END (M4-6) auxiliary sign mounted below.

At locations where roadside features have been developed to enhance the traveler's experience, the Missouri Scenic Byways Point of Interest (D6-4d) plaque may be placed below the Missouri Scenic Byway (D6-4b) sign to inform travelers that the site contributes to the byway travel experience.

Support. In some instances, a Missouri Scenic Byway will receive National Scenic Byway status in which case the byway is eligible for additional signing to denote this designation and is eligible for first order signing.

Standard. If a Missouri Scenic Byway receives National Scenic Byway status, the National Scenic Byways (M10-1) sign shall be mounted below the Missouri Scenic Byway (D6-4b) sign or the Missouri Scenic Byways (D6-4c) Confirmation sign.

Support. If a Missouri Scenic Byway receives National Scenic Byway status it is eligible for first order signing.

Standard. First order signing for at grade intersections shall consist of a Public Use Area (D7-10) sign containing the byway name, the National Scenic Byway logo and a directional arrow and a distance, if applicable, to the beginning of the byway if less than one mile.

Option. For grade-separated interchanges, supplement guide signs and ramp signing may be installed to direct traffic to the byway.

Standard. The mainline signs shall be white on brown and contain the America's Byway logo, the name of the byway and NEXT RIGHT. The ramp sign will be of the same design as the first order at grade signing.

The location of these signs shall be identical to that found on a normal Missouri Scenic Byway. The costs associated with the National Scenic Byways designation shall be the responsibility of the group or association responsible for byway.

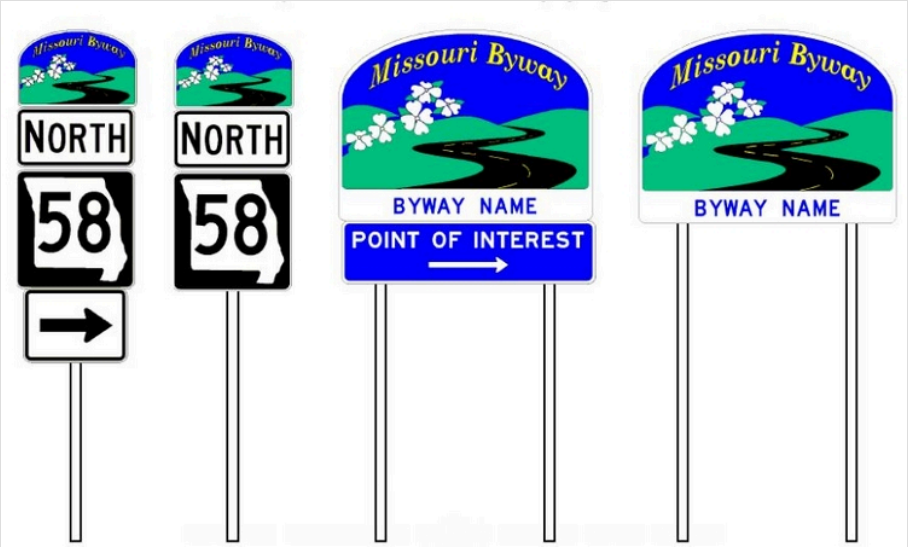


Figure 903.4.50.1 Examples of the Use of Missouri Scenic Byways Sign

Support. An auto tour route is a path along a historic route or a historic trail with the auto tour route traversing existing roadways. The roadway the auto tour route traverses may be the actual historic road or represent the exact location of a historic trail, however, it is more common the auto tour route traverses existing roadways which represent the closest approximation of where the historic route or trail originally existed.

MoDOT does not typically initiate auto tour routes, this action is typically initiated by historical organizations like the National Park Service or private organizations like the Historic Route 66 Association of Missouri who have an interest in preserving the history of a historic route or trail. These organizations are the technical experts on the history of the historic route or trail.

Auto tour signing is expensive to install and maintain and these costs are generally borne by the sponsoring organization requesting the signing. One of the primary issues with auto tour routes is they traditionally rely on signs to guide motorists along the path. If just one sign is stolen or damaged and taken out of service, the path is broken, and motorists can lose their way. In today's technology and GPS guidance, there may be better more cost-effective ways of guiding motorists along an auto tour route. A sponsoring organization may want to consider instead of signing, such as a navigational map app for smart phone or GPS system. These types of apps are cheaper, can be easily updated, and are not as susceptible to failures like physical signs.

Standard. The Commission will consider marking an auto tour trail if the historic route or historic trail meets these minimum qualifications:

A. The road has been designated historic in one of the following ways:

1. The route is listed on the National Park Service's National Register of Historic Places.
2. The route is a National Park Service National Historic Trail
3. The route has been designated as historic through state legislation or congressional action.

B. An organization shall exist who sponsors the historic route and who shall be responsible for determining the exact path of the historical road.
C. The historic route shall be a minimum of 50 miles long and contiguous in length.

Once a historic route or trail has been determined to qualify for auto tour signing, there are additional conditions and terms which must be met before signs can be installed on Commission right of way:

A. There shall be an agreement between the sponsoring organization and the Commission to define the responsibilities of each party. The agreement will have a 10-year term with options to renew the agreement. A new agreement will be executed as part of the renewal period. Any changes to the agreement during the 10-year period will void the agreement.

B. The sponsoring organization shall be responsible for paying a fee for the auto tour trail signing placed on Commission right of way. The fee shall be determined by the Commission and will cover the cost for initial sign installations as well as the estimated maintenance costs for the life of the 10-year agreement. If at the end of the 10-year term the sponsoring organization wishes to renew the agreement, the organization will be responsible for paying a renewal fee to cover the estimated maintenance costs for the subsequent 10 years. If a renewal is not executed with the Commission following the end date of the previous agreement the auto tour trail signing will no longer be maintained and will be removed from Commission right of way.
C. Historic route signs located on MoDOT right of way shall be installed and maintained by MoDOT per the agreement. These signs will always remain the property of the Commission and at the end of their life span will be disposed of as scrap material.
D. The Commission shall approve the path of the historic route prior to execution of the agreement.
E. The design of the sign used to mark the historic route shall be approved by the Commission as well as the Federal Highway Administration. The size of the sign shall not be larger than 24” x 30".
F. The Commission shall coordinate the fabrication of the approved historic route signs for both state route and non-state route portions of the historic route or path to assure uniformity in signing.
G. The installation of signs on Commission right of way shall be in accordance with MoDOT standards and specifications and approved by MoDOT prior to the execution of an agreement. The sign installations on routes outside of the Commission’s current right of way shall match the sign design and sign placement established for the state right of way, with the post selection meeting the approval of the local jurisdiction who owns the right of way the signs are being installed on.
H. If the path of the historic route travels on roadways outside of the Commission’s current highway system, the sponsoring organization shall acquire written commitments from local jurisdictions to allow the historic route’s path to traverse the local jurisdiction’s routes prior to the execution of the agreement with the Commission. These written commitments must also address how the signs will be initially installed along the local jurisdiction’s route as well as the commitments for the long-term maintenance of the signs. If these commitments cannot be obtained the historic route signing cannot be installed.
I. The auto tour path for the historic route shall be installed in a single phase within a year or less.
J. Any part of the Commission-maintained system shall be limited to a maximum of three concurrent historic route and/or trail designations.
K. The approved auto tour path shall be marked using trailblazer assemblies and confirmation assemblies installed on their own independent sign supports. The trailblazing assemblies shall comprise of one approved auto tour sign and the appropriate directional arrow. The confirmation assembly shall be comprised of only the approved auto tour sign. The confirmation assemblies shall be placed in advance of an intersection where the auto tour route makes a directional change, the confirmation assembly shall be installed downstream of the intersection where the auto tour route made the directional change. No other signs shall be installed along the route unless approved by the Commission. The Commission will work with the sponsoring organization to establish the sign installation plan identifying sign installation locations.
L. Cardinal Direction plaques shall not be used with auto tour route signing.
M. The AUTO TOUR (M17-1) auxiliary sign was an educational plaque, it is no longer used. All existing signs shall be removed from assemblies at the end of their life cycle.

The TR15 agreement for the auto tour route signing for sponsoring organizations who are not state or federal agencies shall contain the following provisions:

A. The sponsoring organization for the historic route shall provide a detailed map and description for the path of the historic route to be included in the agreement between the sponsoring organization and the Commission.
B. The sponsoring organization shall have the funding for the installation and 10 years of maintenance in place before the agreement will be executed.
C. If the historic road crosses a state line, there must be agreement with the adjoining state or states on the signing and the routing of the historic route. If agreements with the other states cannot be reached the historic signing shall end at the last intersection in Missouri.
D. If approved, Auto Tour Route signs shall not be installed on freeways or expressways, except as necessary to provide continuity between disconnected segments of conventional roadways that are designated as auto tour routes, for which the freeway or expressway provides the only connection between the segments. If installed on freeways or expressways, Auto Tour Route signs shall be installed as independent trailblazer assemblies and shall not be installed with other Route signs or confirmation assemblies or on guide signs. If installed on freeways or expressways, Auto Tour Route trailblazer assemblies shall be installed at less frequent intervals than route confirmation assemblies.

Support. Historic trail signing with state or federal sponsorship are typically installed under a memorandum of understanding (MOU), that is drafted specifically for each trail.

The Mississippi River Trail (MRT), while listed here, is a US Bike route which was established through the AASHTO Route Marking process. The MRT Trail is a designated bicycle and pedestrian trail that traverses the shores of the Mississippi River in the United States. The trail extends from the headwaters at Lake Itasca in Minnesota to near the mouth of the river in Venice, Louisiana. Much of the trail's 3,000 miles (4,800 km) follows roadways used by motor vehicles, although some of the route is on multi-use trails.

There are several approved historic routes and trails that follow state-maintained routes which include:

A. Lewis and Clark Trail (http://www.nps.gov/lecl/index.htm) (M17-2)
B. Historic 66 (http://www.missouri66.org/) (M17-8, M17-8a)
C. Santa Fe Trail (http://www.nps.gov/safe/index.htm) (M17-4)
D. Oregon Trail (http://www.nps.gov/oreg/index.htm) (M17-3)
E. Trail of Tears (http://www.nps.gov/trte/index.htm) (M17-5)
F. Pony Express (http://www.nps.gov/poex/) (M17-10)
G. California Trail (http://www.nps.gov/cali/index.htm) (M17-11)
H. Mississippi River Trail (MRT) bike trail / US Bike Route 45 (M17-7)

Option. Exclusive to the Lewis and Clark Trail (M17-2) marker, signing may be placed on the Guide Signs to provide guidance along the approved path on freeways and expressways. If there is insufficient space on the guide sign to display the Lewis and Clark Trail, the trail sign may be hung below the guide sign in accordance with MoDOT Standards and Specifications.

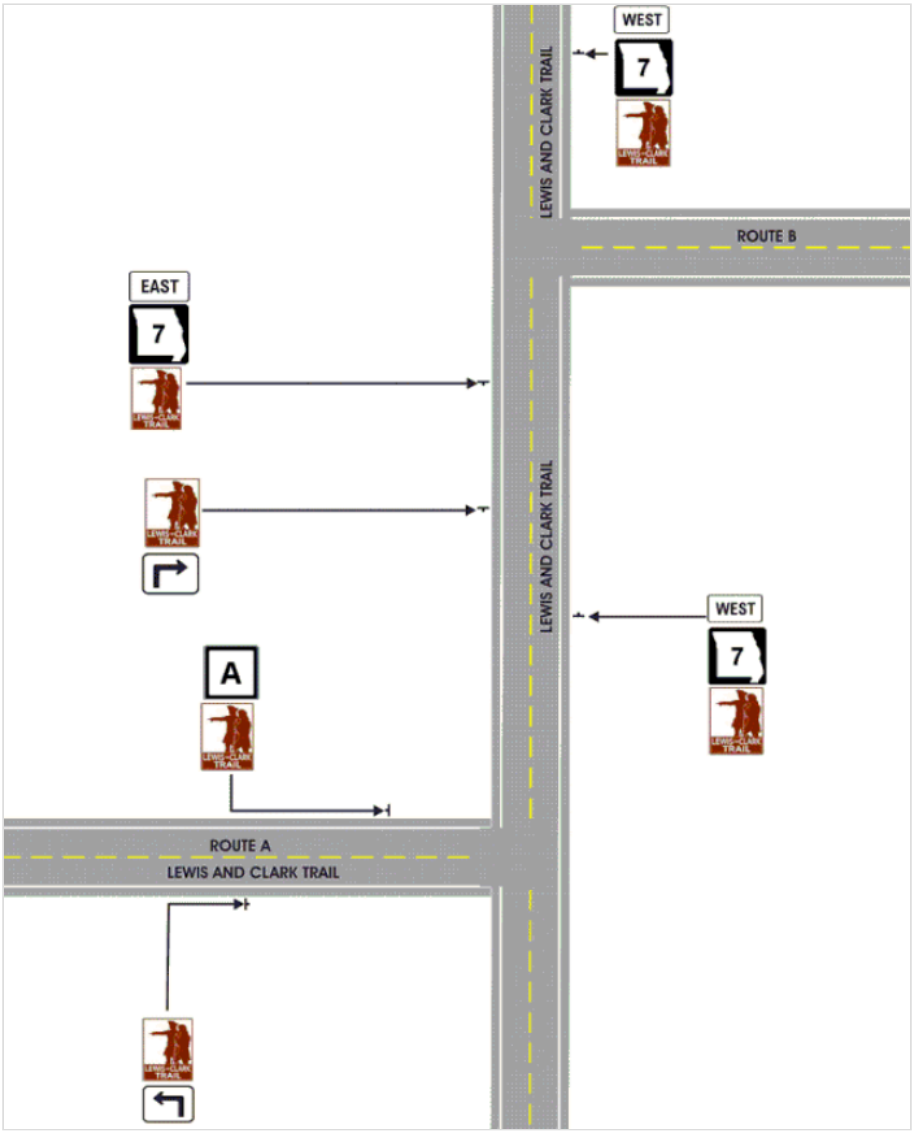


Figure 903.4.50.2 Standard Application of Trail Signing

903.4.51 Corridor Designations



M17-9



M17-12

Support. Corridor designations are typically multi-state route names established and/or implemented by neighboring state DOTs. In Missouri, the adoption of corridor designations was accomplished through Commission action.

There are two approved corridor designations currently in the state:

Avenue of the Saints (https://www.modot.org/us-route-61avenue-saints) (M17-9) - The Avenue of the Saints was the concept of businessman Ernest Hayes of Mount Pleasant, Iowa who in the 1980s envisioned a four-lane highway between St. Paul and St. Louis. It was named by Gary Smith, who at the time was Executive

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Director of the Southeast Iowa Regional Planning Commission. Smith and Hayes convened a group of area business and political leaders, who organized an effort to convince the Iowa Department of Transportation to study the idea, which they did in 1988.

In 1990 the FHWA chose its route for the Avenue of the Saints: the signed highway would follow the existing Interstate 35 from St. Paul to a point south of Clear Lake, Iowa; U.S. Route 18 to Charles City, Iowa; U.S. Route 218 to Cedar Falls, Iowa; U.S. Route 20 and Iowa Highway 58 around Cedar Falls and Waterloo, Iowa; Interstate 380 from Waterloo through Cedar Rapids to Interstate 80 near Coralville, Iowa and Iowa City, Iowa; U.S. Route 218 to Donnellson, Iowa; Iowa Highway 394 and Route B to Wayland, Missouri; and Interstate 64 and U.S. Route 61 from Wayland to St. Louis. The Intermodal Surface Transportation Efficiency Act of 1991 made the Avenue of the Saints an official "high-priority corridor," and signs were put along the route by the end of the year.

On July 25, 2008, the final nine miles (14 km) of highway between the Lewis—Clark county line and Wayland, Missouri, was open to four-lane traffic. A ceremony was held at the intersection of US 61 and Route 27 to commemorate the completion of the four-lane highway in Missouri. The Avenue of the Saints is now complete from St. Paul to suburban St. Louis.

Chicago - Kansas City Expressway (CKC) – The Chicago–Kansas City Expressway is a highway that runs between Chicago, Illinois, and Claycomo, Missouri. The road is known as Route 110 in Missouri and Illinois Route 110 (IL 110) in Illinois. The Illinois Route 110 was created through legislation on May 27, 2010, as the designated route for the Illinois portion of the Chicago–Kansas City Expressway.

Missouri Route 110 and the Chicago-Kansas City Expressway designations were established through the actions of the Missouri Highways and Transportation Commission on January 4, 2012.

903.4.52 MoDOT Maintenance Signs (M19-2)



M19-2

Standard. The MAINTENANCE ENDS (M19-2) sign shall be erected at the end of MoDOT maintenance on all marked highways except at a state line.

The MAINTENANCE BEGINS (M19-1) sign has been discontinued for normal use. MoDOT shall no longer provide MAINTENANCE BEGINS signs. Existing MAINTENANCE BEGINS signs shall be left in place until they reach the end of their service life.

Option. When state maintenance begins and ends at multiple locations along a route's length as it enters and exits various municipalities, a MAINTENANCE BEGINS (M19-1) sign may be used to mark the boundaries of MoDOT maintenance responsibilities.

Guidance. The MAINTENANCE ENDS signs are not to be placed to mark the maintenance responsibilities for crossroads, such as within interchange limits unless there is a specific problem.

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903.5 Guide Signs - Freeways and Expressways (MUTCD Chapter 2E)

903.5.1 Scope of Freeway and Expressway Guide Sign Standards (MUTCD Section 2E.01)

Support. The provisions of EPG 903.5 provide a uniform and effective system of signing for high-volume, high-speed motor vehicle traffic on freeways and expressways. The requirements and specifications for expressway signing exceed those for conventional roads (see EPG 903.4), but are less than those for freeway signing. Since there are many geometric design variables to be found in existing roads, a signing concept commensurate with prevailing conditions is the primary consideration. EPG 911 (MUTCD Section 1C.02) includes definitions of freeway and expressway.

Guide signs for freeways and expressways are primarily identified by the name of the sign rather than by an assigned sign designation. Guidelines for the design of guide signs for freeways and expressways are provided in the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)).

Standard. The provisions of EPG 903.5 shall apply to any highway that meets the definition of freeway or expressway facilities.

903.5.2 Freeway and Expressway Signing Principles (MUTCD Section 2E.02)

Support. The development of a signing system for freeways and expressways is approached on the premise that the signing is primarily for the benefit and direction of road users who are unfamiliar with the route or area. The signing furnishes road users with clear instructions for orderly progress to their destinations. Sign installations are an integral part of the facility and, as such, are best planned concurrently with the development of highway

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location and geometric design. For optimal results, plans for signing are analyzed during the earliest stages of preliminary design, and details are correlated as final design is developed. The excessive signing found on many major highways usually is the result of using a multitude of signs that are too small and that are poorly designed and placed to accomplish the intended purpose.

Freeway and expressway signing is to be considered and developed as a planned system of installations. An engineering study is sometimes necessary for proper solution of the problems of many individual locations, but, in addition, consideration of an entire route is necessary.

Guidance. Road users should be guided with consistent signing on the approaches to interchanges, when they drive from one State to another, and when driving through rural or urban areas. Because geographical, geometric, and operating factors regularly create significant differences between urban and rural conditions, the signing should take these conditions into account.

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Guide signs on freeways and expressways should serve distinct functions as follows:

A. Give directions to destinations, or to streets or highway routes, at intersections or interchanges;
B. Furnish advance notice of the approach to intersections or interchanges;
C. Direct road users into appropriate lanes in advance of diverging or merging movements;
D. Identify routes and directions on those routes;
E. Show distances to destinations;
F. Indicate access to general motorist services, rest, scenic, and recreational areas; and
G. Provide other information of navigational value to the road user.

903.5.3 Guide Sign Classification (MUTCD Section 2E.03)

Support. Freeway and expressway guide signs are classified and addressed as follows:

A. Interchange signs (see EPG 903.5.21 through 903.5.23 and EPG 903.5.25 through 903.5.42);
B. Interchange Sequence signs (see EPG 903.5.24);
C. Post-Interchange signs (see EPG 903.5.45 and 903.5.46);
D. Community Interchanges Identification signs (see EPG 903.5.50);
E. Next Exits signs (see EPG 903.5.51);
F. Weigh Station signs (see EPG 903.5.52);
G. Route signs and Trailblazer Assemblies (see EPG 903.5.53);
H. General Information signs (see EPG 903.8);
I. Emergency Reference Markers (see EPG 903.8.11);
J. General Service signs (see EPG 903.9);
K. Rest and Scenic Area signs (see EPG 903.9.3);
L. Tourist Information and Welcome Center signs (see EPG 903.9.4);
M. Carpool and Ridesharing signs (see EPG 903.9.6);
N. Specific Service signs (see EPG 903.10); and
O. Recreational and Cultural Interest Area signs (see EPG 903.13).

903.5.4 Characteristics of Urban Signing (MUTCD Section 2E.04)

Support. Urban conditions are characterized not so much by city limits or other arbitrary boundaries as by the following features:

A. Mainline roadways with more than two lanes in each direction;
B. High traffic volumes on the through roadways;
C. High volumes of traffic entering and leaving interchanges;
D. Interchanges that are closely spaced;
E. Roadway and interchange lighting;
F. Three or more interchanges serving the major city;
G. A loop, circumferential, or spur route serving a sizable portion of the urban population; and
H. Visual clutter from roadside development.

Operating conditions and road geometrics on urban freeways and expressways usually make special sign treatments desirable, including:

A. Use of Interchange Sequence signs (see EPG 903.5.24);
B. Use of sign spreading to the maximum extent possible (see EPG 903.5.41);
C. Reduction to a minimum of post-interchange signs (see EPG 903.5.45);
D. Display of advance signs at distances closer to the interchange, with appropriate adjustments in the legend (see EPG 903.5.23);
E. Use of overhead signs on roadway structures and independent sign supports (see EPG 903.5.19);
F. Use of Overhead Arrow-per-Lane guide signs in advance of interchanges with option lanes (see EPG 903.5.39); and
G. Frequent use of street names as the principal message in guide signs.

Lower speeds, which are often characteristic of urban operations, do not justify lower signing standards. Typical traffic patterns are more complex for the road user to negotiate, and large, easy-to-read legends are, therefore, just as necessary as on rural highways.

903.5.5 Characteristics of Rural Signing (MUTCD Section 2E.05)

Support. Rural areas ordinarily have greater distances between interchanges, which permits adequate spacing for the sequences of signs on the approach to and departure from each interchange. However, the absence of traffic in adjoining lanes and on entering or exiting ramps often adds monotony or inattention to rural driving. This increases the importance of signs that call for decisions or actions.

Guidance. Where there are long distances between interchanges and the alignment is relatively unchanging, signs should be positioned for their best effect on road users. The tendency to group all signing in the immediate vicinity of rural interchanges should be avoided by considering the entire route in the development of signing plans. Extra effort should be given to the placement of signs at natural target locations to command the attention of the road user, particularly when the message requires an action by the road user.

903.5.6 Designation of Destinations (MUTCD Section 2E.07)

Standard. The direction of a freeway and the major destinations or control cities along it shall be clearly identified through the use of appropriate destination legends (see EPG 903.4.31). Successive freeway guide signs shall provide continuity in destination names and consistency with available map information. At any decision point, a given destination shall be indicated by way of only one route.

Guidance. Control city legends should be used in the following situations along a freeway:

A. At interchanges between freeways;
B. At separation points of overlapping freeway routes;
C. On directional signs on intersecting routes, to guide traffic entering the freeway;
D. On Pull-Through signs; and
E. On the bottom line of post-interchange distance signs.

In a limited number of locations, the use of the name of a neighboring state or adjacent county might be more relevant than the control city. These identifiers should be used sparingly and only if such a designation is in the best interest of the motorists in that region.

Support. Continuity of destination names is also useful on expressways serving long-distance or intrastate travel.

The determination of major destinations or control cities is important to the quality of service provided by the freeway. Control cities on freeway guide signs are selected by the States and are contained in the “Guidelines for the Selection of Supplemental Guide Signs for Traffic Generators Adjacent to Freeways, 5th Edition/Guide Signs, Part II: Guidelines for Airport Guide Signing/Guide Signs, Part III: List of Control Cities for Use in Guide Signs on Interstate Highways,” published by and available from the American Association of State and Highway Transportation Officials. Central Office Highway Safety and Traffic Division selects and maintains control cities for each route to maintain consistency in signing across the state, see Table 903.5.7.

Table 903.5.7 Interstate Sign Control Cities

Interstate	Cities
29	Kansas City, St. Joseph, Council Bluffs, Sioux City, Fargo, Grand Forks, Winnipeg
35 NB	Laredo, San Antonio, Austin, Waco, Dallas–Fort Worth, Oklahoma City, Wichita, Kansas City, Ames, Mason City, Albert Lea, St. Paul–Minneapolis, Duluth
35 SB	Duluth, St. Paul–Minneapolis, Albert Lea, Mason City, Ames, Des Moines, Kansas City, Oklahoma City, Dallas–Fort Worth, Waco, Austin, San Antonio, Laredo
44	Wichita Falls, Lawton, Oklahoma City, Tulsa, Joplin, Springfield, Rolla, St. Louis
49	Joplin, Kansas City
55	New Orleans, Hammond, McComb, Jackson, Grenada, Memphis, Blytheville, Sikeston, Cape Girardeau, St. Louis, Chicago
57 NB	Sikeston, Charleston, Cairo, Chicago
57 SB	Chicago, Cairo, Charleston, Sikeston, Memphis
64 EB	St. Louis, Louisville, Lexington, Ashland, Huntington, Charleston, Beckley, Lewisburg, Lexington, Staunton, Richmond, Norfolk, Chesapeake
64 WB	Richmond, Staunton, Lexington, Lewisburg, Beckley, Charleston, Huntington, Ashland, Lexington, Louisville, St. Louis, Wentzville
70 EB	I-15, Grand Junction, Denver, Limon, Hays, Salina, Topeka, Kansas City, Columbia, Wentzville, St. Louis, Indianapolis, Columbus, Wheeling, Washington (PA), New Stanton, Breezewood, Hancock, Hagerstown, Washington D.C., Baltimore
70 WB	Baltimore, Washington D.C., Frederick, Hagerstown, Breezewood, Wheeling, Columbus, Indianapolis, St. Louis, Wentzville, Columbia, Kansas City, Topeka, Salina, Hays, Limon, Denver, Grand Junction, I-15

903.5.7 General (MUTCD Section 2E.08)

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Support. Effective signs are legible to road users approaching them, and are readable and comprehensible in the viewing time provided to permit proper responses. Desired design characteristics include: (a) long visibility distances; (b) large lettering, symbols, and arrows; and (c) short legends.

903.5.8 Color of Guide Signs (MUTCD Section 2E.09)

Standard. Guide signs on freeways and expressways, except as otherwise provided in the EPG, shall have white letters, symbols, arrows, and borders on a green background.

In the case of "EXIT ONLY" sign panels or other legends that require extra emphasis, the legend shall be black on fluorescent-yellow background.

Support. Color requirements for route signs and trailblazers; for signs with blank-out or changeable messages; for signs for services, rest areas, park and recreational areas; and for certain miscellaneous signs are provided in the individual Sections dealing with the particular sign or sign group.

903.5.9 Retroreflection or Illumination (MUTCD Section 2E.10)

Standard. Letters, numerals, symbols, arrows, and borders of all guide signs shall be retroreflective. The background of all guide signs that are not independently illuminated shall be retroreflective.

Support. Where there is no serious interference from extraneous light sources, retroreflective post-mounted signs usually provide adequate nighttime visibility.

On freeways and expressways where much driving at night is done with low-beam headlights, the amount of headlight illumination incident to an overhead sign display is relatively small.

Option. Overhead sign lighting may be installed based on engineering judgement.

Guidance. Overhead sign lighting should be limited to signs located in tunnels or under structures.

903.5.10 Interchange Classification (MUTCD Section 2E.11)

Support. For signing purposes, MoDOT does not classify interchanges as major, intermediate, or minor with regard to signage.

903.5.11 Size of Signs and Letters (MUTCD Section 2E.12)

Standard. Except as provided in EPG 903.1.7, the sizes of freeway and expressway guide signs that have standardized designs shall be as shown in Table 903.5.11.1.

Support. EPG 903.1.7 contains information regarding the applicability of the various columns in Table 903.5.11.1.

Option. Signs larger than those shown in Table 903.5.11.1 may be used (see EPG 903.1.7).

Standard. The nominal loop height of the lower-case letters shall be ¾ of the height of the initial upper-case letter (see the second Standard paragraph of EPG 903.4.5 for additional information on the specification of letter heights). Other word legends such as cardinal directions, action messages, and special characters shall be composed of all upper-case letters with a minimum letter height of 8 inches. Interline and edge spacing shall be as provided in EPG 903.5.12.

For all freeway and expressway signs that do not have a standardized design, the message dimensions shall be determined first, and the outside sign dimensions secondarily. Minimum numeral and letter sizes for expressway guide signs shall be as shown in Table 903.5.11.2. Minimum numeral and letter sizes for freeway guide signs shall be as shown in Table 903.5.11.3.

All names of places, streets, and highways on freeway and expressway guide signs shall be composed of lower-case letters with initial upper-case letters. The letters and the numerals used shall be FHWA Standard Alphabet Series E (modified) as provided in the FHWA's "Standard Highway Signs" publication (see EPG 911 (Section 1A.05)).

Lettering size on freeway and expressway signs shall be the same for both rural and urban conditions.

Support. Sign size is determined primarily in terms of the length of the message and the size of the lettering necessary for proper legibility. Letter style and height, and arrow design have been standardized for freeway and expressway signs to assure uniform and effective application.

Designs for upper-case and lower-case FHWA Standard Alphabets, together with tables of recommended letter spacing, are shown in the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)).

Table 903.5.11.1 Freeway or Expressway Guide Sign and Plaque Sizes

Sign or Plaque	Sign Designation	EPG Article	Conventional Road			Freeway/Expressway
			Standard	Oversized	Special	(in. x in.)
Interchange Advance Guide (1 destination)	E1-1	903.5.23	-	-	-	Varies
Interchange Advance Guide (2 destinations)	E1-2	903.5.23	-	-	-	Varies
Interchange Advance Guide (3 destinations)	E1-3	903.5.23	-	-	-	Varies
Exit Number (plaque)						
1-, 2-Digit Exit Number	E1-5P	903.5.23	-	-	-	Varies X 30
3-Digit Exit Number	E1-5aP	903.5.23	-	-	-	Varies X 30
1-, 2-Digit Exit Number (with single-letter suffix)	E1-5bP	903.5.23	-	-	-	Varies X 30
3-Digit Exit Number (with single-letter suffix)	E1-5cP	903.5.23	-	-	-	Varies X 30
1-, 2-Digit Exit Number (with dual-letter suffix)	E1-5dP	903.5.23	-	-	-	Varies X 30
3-Digit Exit Number (with dual-letter suffix)	E1-5eP	903.5.23	-	-	-	Varies X 30
Left Exit Number (plaque)						
1-, 2-Digit Exit Number	E1-5fP	903.5.23	-	-	-	Varies X 30
3-Digit Exit Number	E1-5gP	903.5.23	-	-	-	Varies X 30
1-, 2-Digit Exit Number (with single-letter suffix)	E1-5hP	903.5.23	-	-	-	Varies X 30
3-Digit Exit Number (with single-letter suffix)	E1-5iP	903.5.23	-	-	-	Varies X 30
1-, 2-Digit Exit Number (with dual-letter suffix)	E1-5jP	903.5.23	-	-	-	Varies X 30
3-Digit Exit Number (with dual-letter suffix)	E1-5kP	903.5.23	-	-	-	Varies X 30
Left (plaque)	E1-5mP	903.5.23	-	-	-	72 X 30
Next Exit (plaque)	E2-1P, E2-1aP	903.5.44	-	-	-	Varies X 36
Supplemental	E3-1, E3-2	903.5.49	-	-	-	Varies
Exit Gore	E5-1	903.5.26	-	-	-	72 X 60
Exit Gore (with exit number)	E5-1a	903.5.26	-	-	-	Varies X 72
1-, 2-Digit Exit Number	E5-1a	903.5.26	-	-	-	Varies X 72
3-Digit Exit Number	E5-1a	903.5.26	-	-	-	Varies
3-Digit Exit Number (with single-letter suffix)	E5-1a	903.5.26	-	-	-	Varies
3-Digit Exit Number (with dual-letter suffix)	E5-1a	903.5.26	-	-	-	Varies
Pull-Through	E6-1 - E6-2a	903.5.27	-	-	-	Varies
Pull-Through (Destination)	E6-1a	903.5.27	-	-	-	Varies
Pull Through (Down Arrows)	E6-2	903.5.27	-	-	-	Varies
Pull Through (Destination, Down Arrows)	E6-2a	903.5.27	-	-	-	Varies
Post-Interchange Distance (1 line)	E7-1	903.5.46	-	-	-	Varies X 24
Post-Interchange Distance (2 line)	E7-2	903.5.46	-	-	-	Varies X 48
Post-Interchange Distance (3 line)	E7-3	903.5.46	-	-	-	Varies X 60
Interchange Sequence	E9-1, E9-2	903.5.24	-	-	-	Varies
Next Exits	E9-3, E9-3a	903.5.51	-	-	-	Varies
Community Interchanges	E9-4, E9-5	903.5.50	-	-	-	Varies
Exit Only (with arrow)	E11-1, 1d	903.5.28	-	-	-	Varies
Exit	E11-1a	903.5.28	-	-	-	Varies
Only	E11-1b	903.5.28	-	-	-	Varies
Exit Only	E11-1c	903.5.28	-	-	-	Varies
Exit Only (with two arrows)	E11-1e, 1f	903.5.28	-	-	-	Varies
Exit Direction Advisory Speed (panel)	E13-2	903.5.25				162 X 64
Interstate Route (1, 2 digits)	M1-1	903.5.53	-	-	-	24 X 24
Interstate Route (3 digits)	M1-1	903.5.53	-	-	-	30 X 24
Interstate Loop (1, 2 digits)	M1-2	903.5.53	-	-	-	24 X 24
Interstate Loop (3 digits)	M1-2	903.5.53	-	-	-	30 X 24
U.S. Route (1, 2 digits)	M1-4	903.5.53	-	-	-	24 X 24
U.S. Route (3 digits)	M1-4	903.5.53	-	-	-	30 X 24
State Route (1 or 2 digits)	M1-5	903.4.11	-	-	-	24 X 24
State Route (3 digits)	M1-5	903.4.11	-	-	-	30 X 24
State Route (Letter)	M1-5a	903.4.11	-	-	-	Varies X 24
Junction (plaque)	M2-1P	903.4.13	-	-	-	21 X 15

North (plaque)	M3-1P	903.4.14	-	-	-	24 X 12
East (plaque)	M3-2P	903.4.14	-	-	-	24 X 12
South (plaque)	M3-3P	903.4.14	-	-	-	24 X 12
West (plaque)	M3-4P	903.4.14	-	-	-	24 X 12
Alternate (plaque)	M4-1P	903.4.16	-	-	-	24 X 12
Spur (plaque)	M4-1bP	903.4.17	-	-	-	24 X 12
Business (plaque)	M4-3P	903.4.18	-	-	-	24 X 12
To (plaque)	M4-5P	903.4.19	-	-	-	24 X 12
Advance Turn Arrow (90° Left/Right)	M5-1P	903.4.22	-	-	-	21 X 15
Advance Turn Arrow (45° Left/Right)	M5-2P	903.4.22	-	-	-	21 X 15
Advance Turn Arrow (Curved Stem)	M5-3P	903.4.22	-	-	-	21 X 15
Lane Designation (Left)	M5-4P	903.4.23	-	-	-	24 X 18
Lane Designation (Center)	M5-5P	903.4.23	-	-	-	24 X 18
Lane Designation (Right)	M5-6P	903.4.23	-	-	-	24 X 18
Directional Arrow (Left/Right)	M6-1P	903.4.24	-	-	-	21 X 15
Directional Arrow (45° Left/Right)	M6-2P	903.4.24	-	-	-	21 X 15
Directional Arrow (Straight)	M6-3P	903.4.24	-	-	-	21 X 15
Directional Arrow (Two-Way)	M6-4P	903.4.24	-	-	-	21 X 15
Directional Arrow (Two-Way 45° Left/Right)	M6-5P	903.4.24	-	-	-	21 X 15
Directional Arrow (Up & Left/Right)	M6-6P	903.4.24	-	-	-	21 X 15
Directional Arrow (Up & 45° Left/Right)	M6-7P	903.4.24	-	-	-	21 X 15
Destination (1 line)	D1-1	903.4.32	-	-	-	Varies
Destination (2 lines)	D1-2	903.4.32	-	-	-	Varies
Destination (3 lines)	D1-3	903.4.32	-	-	-	Varies
Destination and Distance (1 line)	D1-1a	903.4.32	-	-	-	Varies
Destination and Distance (2 lines)	D1-2a	903.4.32	-	-	-	Varies
Destination and Distance (3 lines)	D1-3a	903.4.32	-	-	-	Varies
Circular Intersection Destination (1 line)	D1-1d	903.4.35	-	-	-	Varies
Circular Intersection Departure Guide	D1-1e	903.4.35	-	-	-	Varies
Circular Intersection Destination (2 lines)	D1-2d	903.4.35	-	-	-	Varies
Circular Intersection Destination (3 lines)	D1-3d	903.4.35	-	-	-	Varies
Distance (1 line)	D2-1	903.4.38	-	-	-	Varies
Distance (2 lines)	D2-2	903.4.38	-	-	-	Varies
Distance (3 lines)	D2-3	903.4.38	-	-	-	Varies
Street Name (1 line)	D3-1	903.4.40	-	-	-	Varies
Street Name (2 lines)	D3-1b	903.4.40	-	-	-	Varies
Advance Street Name	D3-2	903.4.41	-	-	-	Varies
Parking Area	D4-1	903.4.42	-	-	-	30 X 24
Commuter	D4-1P	903.4.42	-	-	-	30 X 6
Commuter Parking	D4-1a	903.4.42	-	-	-	60 X 36
Advance Weigh Station Distance	D8-1	903.4.45	-	-	-	108 X 84
Weigh Station Advance Direction	D8-2	903.4.45	-	-	-	120 X 72
Weigh Station Entrance Direction	D8-3	903.4.45	-	-	-	84 X 72
Combination Lane Use/Destination	D15-1	903.4.34	-	-	-	Varies X 96
Advance Passing Lane	D17-4	903.4.47	-	-	-	Varies

Table 903.5.11.2 Minimum Letter and Numeral Sizes for Expressway Guide Signs

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Type of Sign	Minimum Size	Overhead
A. Advance Guide, Exit Direction, and Overhead Guide Signs		
Exit Number Plaques		
Words	10	10
Numerals & Letters	15	15
Interstate Route Signs		
Numerals	14*	14*
1- or 2-Digit Shields	36 X 36	36 X 36
3-Digit Shields	45 X 36	45 X 36
U.S. or State Route Signs		
Numerals	18	18
1- or 2-Digit Shields	36 X 36	36 X 36
3-Digit Shields	45 X 36	45 X 36
U.S. or State Route Text Identification (Example: US 56)		
Numerals & Letters	18	15
Cardinal Directions		
First Letters	18	15
Rest of Word	15	12
Auxiliary and Alternative Route Legends (Examples: JCT, TO, ALT, BUSNIESS)		
Words	15	12
Names of Destinations		
Upper-Case Letters	20	16
Lower-Case Letters	15	12
Distance Numbers	18	15
Distance Fraction Numerals	12	10
Distance Words	10	10
B. Gore Signs		
Words	10	-
Numerals & Letters	12	-

Type of Sign	Minimum Size
C. Pull-Through Signs	
Destinations - Upper-Case Letters	13.33
Destinations - Lower-Case Letters	10
Route Signs	
Numerals	14*
1- 2-Digit Shields	36 X 36
3-Digit Shields	45 X 45
Cardinal Directions - First Letters	12
Cardinal Directions - Rest of Word	10
D. Supplemental Guide Signs	
Exit Number - Words	8
Exit Number - Numerals and Letters	12
Place Names - Upper-Case Letters	10.67
Place Names - Lower-Case Letters	8
Action Messages	8
Route Signs	
Numerals	9*
1- 2-Digit Shields	24 X 24
3-Digit Shields	30 X 24

Type of Sign	Minimum Size
E. Interchange Sequence or Community Interchanges Identification Signs	
Words - Upper-Case Letters	10.67
Words - Lower-Case Letters	8
Numerals	10.67
Fraction Numerals	8
Route Signs	
Numerals	9*
1- 2-Digit Shields	24 X 24
3-Digit Shields	30 X 24
F. Next XX Exits Sign	
Place Names - Upper-Case Letters	10.67
Place Names - Lower-Case Letters	8
Next XX EXITS - Words	8
NEXT XX EXITS - Number	12
G. Distance Signs	
Words - Upper-Case Letters	8
Words - Lower-Case Letters	6
Numerals	8
Route Signs	
Numerals	6*
1- 2-Digit Shields	18 X 18
3-Digit Shields	22.5 X 18
H. General Service Signs (see EPG 903.9)	
Exit Number - Words	8
Exit Number - Numerals and Letters	12
Services	8
I. Rest Area, Scenic Area, And Roadside Area Signs (see EPG 903.9)	
Words	10
Distance Numerals	12
Distance Fraction Numerals	8
Distance Words	8
Action Message Words	10
J. Reference Location Signs (see EPG 903.8)	
Words	4
Numerals	10
K. Boundary and Orientation Signs (see EPG 903.8)	
Words - Upper-Case Letters	8
Words - Lower-Case Letters	6
L. Next Exit and Next Services Signs	
Words and Numerals	8
M. Exit Only Signs	
Words	12
N. Overhead Arrow-per-Lane Signs	
See Table 903.5.11.3	

* Minimum size listed for 3-digit shields. Larger numeral sizes used for 1-digit, some 2-digit, and some 3-digit shields. See the Standard Highways Signs publication for more information on Route Sign numeral heights and Standard Alphabet series.

Note: Sizes are shown in inches and where applicable are shown as width x height

Guidance. Freeway lettering sizes (see Table 903.5.11.3) should be used when expressway geometric design is comparable to freeway standards.

Other sign letter size requirements not specifically identified elsewhere in the EPG should be guided by these specifications. Abbreviations should be kept to a minimum, except as provided in EPG 903.5.15.

Support. A sign mounted over a particular roadway lane to which it applies might have to be limited in horizontal dimension to the width of the lane, so that another sign can be placed over an adjacent lane. The necessity to maintain proper vertical clearance might also place a further limitation on the size of the overhead sign and the legend that can be accommodated.

Overhead signs are subject to truss capacity and spacing limitations. Using 20-inch legends increases panel width and can prevent the placement of multiple lane-specific signs within available structure limits.

Table 903.5.11.3 Minimum Letter and Numeral Sizes for Freeway Guide Signs

Type of Sign	Minimum Size	Overhead*
A. Advance Guide, Exit Direction, and Overhead Guide Signs		
Exit Number Plaques		
Words	10	10
Numerals & Letters	15	15
Interstate Route Signs		
Numerals	14*	14*
1- or 2-Digit Shields	36 X 36	36 X 36
3-Digit Shields	45 X 36	45 X 36
U.S. or State Route Signs		
Numerals	18	18
1- or 2-Digit Shields	36 X 36	36 X 36
3-Digit Shields	45 X 36	45 X 36
U.S. or State Route Text Identification (Example: US 56)		
Numerals & Letters	18	15
Cardinal Directions		
First Letters	18	15
Rest of Word	15	12
Auxiliary and Alternative Route Legends (Examples: JCT, TO, ALT, BUSNIESS)		
Words	15	12
Names of Destinations		
Upper-Case Letters	20	16
Lower-Case Letters	15	12
Distance Numbers	18	15
Distance Fraction Numerals	12	10
Distance Words	12	10
Action Message Words	12	10
B. Gore Signs		
Words	12	-
Numerals & Letters	18	-

Type of Sign	Minimum Size
C. Pull-Through Signs	
Destinations - Upper-Case Letters	16
Destinations - Lower-Case Letters	12
Route Signs	
Numerals	14*
1- 2-Digit Shields	36 X 36
3-Digit Shields	45 X 36
Cardinal Directions - First Letters	15
Cardinal Directions - Rest of Word	12
D. Supplemental Guide Signs	
Exit Number - Words	10
Exit Number - Numerals and Letters	15
Place Names - Upper-Case Letters	13.33
Place Names - Lower-Case Letters	10
Action Messages	8
Route Signs	
Numerals	9*
1- 2-Digit Shields	24 X 24
3-Digit Shields	30 X 24
E. Interchange Sequence or Community Interchanges Identification Signs	
Words - Upper-Case Letters	13.33
Words - Lower-Case Letters	10
Numerals	13.33
Fraction Numerals	10
Route Signs	
Numerals	9*
1- 2-Digit Shields	24 X 24
3-Digit Shields	30 X 24
F. Next XX Exits Sign	
Place Names - Upper-Case Letters	13.33
Place Names - Lower-Case Letters	10
Next XX EXITS - Words	10
NEXT XX EXITS - Number	15

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Type of Sign	Minimum Size
G. Distance Signs	
Words - Upper-Case Letters	8
Words - Lower-Case Letters	6
Numerals	8
Route Signs	
Numerals	6*
1- 2-Digit Shields	18 X 18
3-Digit Shields	22.5 X 18
H. General Service Signs (see EPG 903.9)	
Exit Number - Words	10
Exit Number - Numerals and Letters	15
Services	10
I. Rest Area, Scenic Area, And Roadside Area Signs (see EPG 903.9)	
Words	12
Distance Numerals	15
Distance Fraction Numerals	10
Distance Words	10
Action Message Words	12
J. Reference Location Signs (see EPG 903.8)	
Words	4
Numerals	10
K. Boundary and Orientation Signs (see EPG 903.8)	
Words - Upper-Case Letters	8
Words - Lower-Case Letters	6
L. Next Exit and Next Services Signs	
Words and Numerals	8
M. Exit Only Signs	
Words	12
N. Overhead Arrow-per-Lane Signs**	
Arrowhead (Type D Directional Arrow)	21
Arrow Shaft Width	7.75
Arrow Height	
Through	40
Left Only	30
Right Only	30
Optional-Diverge (Through with Left or Right)	40
Optional-Split (Left and Right)	33.33
Vertical Separator Width	2
Vertical Space between Vertical Separator and Top of Nearest Arrow	5.0
Horizontal Space between Vertical Separator and Top of Nearest Through Arrow	9
Horizontal Space between Arrow Shaft and EXIT and ONLY Panels	12
EXIT and ONLY Panels	54 X 18

* Minimum size listed for 3-digit shields. Larger numeral sizes used for 1-digit, some 2-digit, and some 3-digit shields. See the Standard Highways Signs publication for more information on Route Sign numeral heights and Standard Alphabet series.

** Overhead Arrow-per-Lane sign example layouts and design elements sizing are provided in the Standard Highway Sign publication. Only 16-inch legends are used on Overhead Arrow-per-Lane signs.

Note: Sizes are shown in inches and where applicable are shown as width x height.

903.5.12 Interline and Edge Spacing (MUTCD Section 2E.13)

Guidance. Horizontal spacing between words should be 1.5 times the lower-case letter height. For legends with only upper-case letters, the spacing should be 1.5 times the upper-case letter height.

Horizontal and vertical spacing between the overall legend and the outside sign edge should be approximately equal to the largest upper-case letter height that appears on the sign. Odd amounts of space should be placed on the two outside spaces between the sign edge and the extreme limit of the legend.

For upper-case letters that are 13.33 in. and taller, spacing around arrows and shields should be a minimum of 12 in. to words or any other arrow or shield.

Vertical spacing between lines is equal to the larger of the lower-case letter height of the two lines. If all letters are upper-case, the spacing equals 3/4 of the larger upper-case letter height of the two lines.

Support. Odd spacing widths may occur due to rounding the overall sign width and height to even 12 in. increments. For other letter heights spacing around arrows and shields may be narrowed depending on the amount of legend, letter sizes and sign appearance.

903.5.13 Sign Borders (MUTCD Section 2E.14)

Guidance. For guide signs larger than 120 x 72 inches, the border should have a width of 2 inches. For smaller guide signs, a border width of 1.25 inches should be used. On unusually large signs with oversized letter heights, route shields, or other legend elements, the border should be 2.5 inches wide and should not exceed 3 inches in width. In all cases, the width of the border should not exceed the stroke width of the lettering of the principal legend on the sign.

Corner radii of sign borders should be approximately ⅛ of the minimum sign dimension on guide signs, except that the radii should not exceed 12 inches on any sign.

Support. The FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)) contains detailed information on border widths and corner radii for ranges of sign sizes.

Option. The sign material in the area outside of the corner radius may be trimmed.

903.5.14 Amount of Legend on Guide Signs (MUTCD Section 2E.15)

Guidance. No more than two destination names or street names should be displayed on any Interchange Advance Guide sign or Exit Direction sign. A city name and street name on the same sign should be avoided. Where two or three signs are placed on the same supports, destinations or street names should be limited to one per sign, or to a total of three in the display. Sign legends should not exceed three lines of copy, exclusive of the exit number and action or distance information.

For urban interchanges of freeways and conventional routes the address block number of the intersecting street should not be displayed unless multiple interchanges between the same two roadways exist.

For isolated rural interchanges, each interchange should be identified by either the name of its community or by the nearest control communities on the intersecting route. If the interchange is the junction of a freeway with a state-maintained route outside of any community, it is possible to use only the intersecting route shields as the identifier.

Option. The public often reference MoDOT routes by street name instead of the official MoDOT route identification number or letter. If this is the case, the street name may be used in conjunction with the MoDOT route shield. The route shield and, if required, the cardinal direction appear on the first line of copy, and the second line indicates the street name. All street names include the appropriate designation such as street (St), boulevard (Blvd), road (Rd), avenue (Ave), or drive (Dr).

Support. Where only one interchange serves a community, the intersecting street name is generally superfluous to the city name on the Interchange Advance guide and Exit Direction signs. Where a community is served by multiple interchanges, the city name is typically displayed on either a Community Interchanges Identification sign (see EPG 903.5.50) or a Next Exits sign (see EPG 903.5.51). Each interchange is then identified by its intersecting roadway name on the Interchange Advance guide and Exit Direction signs rather than by the city name.

Typically, interchanges between freeways and conventional routes within an urban area identify the exit by the intersecting street on the guide signing rather than using control points, control cities, or other community names.

903.5.14.1 Street Names on Guide Signs

Guidance. Using a route shield, a control city and a route name on the same sign should be avoided whenever possible. Some situations require a route shield, a control city and a street name, with the street name being a separate roadway or exit than the MoDOT route. For this condition, the order should be route shield, control city (or major destination) and then the street name as the third line of copy, regardless of roadway geometrics.

903.5.15 Abbreviations (MUTCD Section 2E.16)

Standard. The use of abbreviations on freeway and expressway guide signs shall comply with the provisions of EPG 903.4.7.

903.5.16 Symbols (MUTCD Section 2E.17)

Support. Symbols are not normally displayed on freeway and expressway guide signs. One exception is the PARK - RIDE Supplemental guide sign (see EPG 903.5.49), which displays the Carpool symbol. In some cases, General Information symbols (see EPG 903.8) might be included in the legend of a guide sign to shorten an unusually lengthy legend on the sign.

Guidance. When a General Information symbol is incorporated into the legend of a guide sign, all components of the legend should be balanced in size and arrangement for maximum legibility. The General Information (I series) sign, rather than the symbol alone, should be placed as a sign panel within the guide sign so that adequate recognition of the symbol is provided by the border. The General Information sign panel should be positioned to the left of the legend to which it applies. The size of the General Information sign panel should be similar in size to that specified for a route shield for the type of guide sign on which it is displayed.

903.5.17 Arrows for Interchange Guide Signs (MUTCD Section 2E.18)

Standard. Arrows used on interchange guide signs shall be of the types shown in Figure 903.4.8 and shall comply with the provisions of this Article and EPG 903.4.8.

Except on Overhead Arrow-per-Lane guide signs (see EPG 903.5.39) and on Exit Direction signs for lane drops (see EPG 903.5.28), and except as provided in the second Standard paragraph below, directional arrows on all overhead and post-mounted Exit Direction signs shall point diagonally upward at a 45-degree angle. Directional arrows on overhead Exit Direction signs shall be located on the side of the sign consistent with the direction of the exiting movement. Directional arrows on post-mounted Exit Direction signs shall be located at the bottom portion of the sign and centered under the legend.

Option. On overhead Exit Direction signs that are located fully over the tapered portion of the exit ramp at the theoretical gore, and where a directional arrow to the side of the legend farthest from the roadway might create an unusually wide sign that limits the road user's view of the arrow, the directional arrow may be placed at the bottom portion of the sign, centered under the legend.

Standard. Directional arrows on guide signs for multi-lane exits shall be positioned below the legend over the approximate center of each lane to which the arrow applies (see Figure 903.5.39.4).

Down arrows shall only be used on overhead signs to indicate a lane to be followed and shall be positioned over the approximate center of each lane pointing vertically downward toward the approximate center of that lane. Down arrows shall be used only on overhead guide signs that restrict the use of specific lanes to traffic bound for the destination(s) and/or route(s) indicated by these arrows. Down arrows shall not be used unless an arrow can be located over and pointed to the approximate center of each lane that can be used to reach the destination displayed on the sign.

If down arrows are used, having more than one down arrow pointing to the same lane on a single overhead sign (or on multiple signs on the same overhead sign structure) shall not be permitted.

Support. Directional and down arrows for use on guide signs are shown in Figure 903.4.8 Detailed drawings and standardized sizes based on ranges of letter heights for these arrows are provided in the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)). Information on the dimensions for arrows used in Overhead Arrow-per-Lane signing is provided in the FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)).

903.5.18 Cardinal Directions

Standard. Cardinal directions are the words NORTH, SOUTH, EAST and WEST. Cardinal directions shall be used on all guide signs when the ramp being signed does not provide access to both directions of travel on the intersecting route or cross street. In the case where both directions of travel on the cross-street are accessed directly by the same ramp, the cardinal directions for the intersecting route or cross street shall not be used. This does not apply if the words "north", "south", "east" or "west" are a part of the official name of the cross street.

Cardinal directions shall be upper case with the first letter being the next letter size taller than the others.

Guidance. For cardinal directions, which modify route shields, the cardinal direction should be placed on the left side of the route shield for left exits and on the right side of the shield for right exits. The cardinal direction is not to appear on top of the shield, and the top of the first letter of the direction should vertically align with the top of the route shield. Similar placement should be used for guide signs on the intersecting route guiding motorists where to turn for entry to an expressway or freeway. Cardinal directions are not to be used next to shields for business routes.

For the purpose of sign design, a shield/cardinal direction combination should be considered one "unit". For guide signs at the exit gore with a Type A arrow and destination line of copy, this "unit" should be centered over the destination line, not centered on the width of the sign. If the "unit" is wider than the destination, the destination should be centered under the "unit". This is also true for shields with no cardinal direction. See the example in the standard plans.

No cardinal direction should be used for exits that access both directions of a route. The directions should be shown near the ramp terminal on a supplemental guide or route marker assembly. No cardinal direction is required on advance guide signs for routes that begin (or end) at an interchange, or for routes which are continued through an interchange ramp. For this condition, a control city (see Table 903.5.7) or major destination should accompany a route shield.

Since lettered routes are not designated as being strictly North/South or East/West, the shield does not normally carry a cardinal direction with it. An exception is with a lettered route that has two exits, which would occur at a cloverleaf interchange. The cardinal direction used in this case should be the direction physically associated with the route.

Multiple shields for overlapping roadways should be arranged in the following order of importance: interstate, interstate business, U.S. Routes, U.S. business, Missouri numbered and Missouri lettered. Multiple shields for the same roadway type (i.e. I-35 and I-70, or U.S. 34 and U.S. 67) should be arranged in numerical order starting with the lowest numbered route. For lettered routes, the shields should be arranged in alphabetical order.

When several routes end at a ramp terminal, all guide sign shields should be arranged as the traveler views the routes at the ramp terminal, from left to right. Cardinal directions are not required.

Cardinal directions for two shields that designate the same roadway and have the same direction should be placed on the right or left hand side of the two shields. Only one direction is required.

Cardinal directions for two and three shields that designate the same roadway, but have different directions, should be vertically stacked with the appropriate cardinal direction next to each shield or shields. The shields should be listed in the order previously noted. Also, multiple control cities are ordered respectively with shield order.

For roads not on the state system, cardinal directions should follow the roadway name and appear on a line of copy by itself. A direction should be indicated only if the exit accesses one direction of the side road. Directions should be indicated only for a roadway with multiple exits from a state route.

Support. An example of proper cardinal direction letter size is 15 in./12 in. upper case for a sign with a 16 in./12 in. destination/name.

An example of how to sign without the use of a cardinal direction for an interchange: Route 350 begins at the interchange and Route 50 follows the interchange off ramp. The advance guide sign for westbound Route I-470 shows the Route 50 shield first since this exit is first, and the first destination shown is for Route 50. The exit guide for Route 50 would show no cardinal direction and would only have the Route 50 shield, destination and appropriate arrow. The guide signs for Route 350 are similar to the Route 50 guide signs. Once the driver is on the route, route marker assemblies confirm the route with a cardinal direction.

An example of how to sign without the use of a cardinal direction for multiple shields, at a directional ramp split: to the left is Route U and to the right are overlapping Routes A and U.S. Route 47. On the first line of copy, the guide sign shows the Route U shield first, then the U.S. Route 47 shield next to the Route A shield. This impresses upon the motorists to turn left for Route U. The space between the U.S. Route 47 and the Route A shields may be narrowed from the standard 12 in. to as low as 6 in. to give the impression of unity. The space between the Route U shield and the U.S. Route 47 shield is a minimum of 24 in. to give the impression of separation.

An example of how to use a cardinal direction for multiple shields: an exit to the right for overlapping Routes I-64 and Route 40 is ordered as I-64, Route 40, with one cardinal direction "EAST" placed to the right of the Route 40 shield.

903.5.19 Overhead Sign Installations (MUTCD Section 2E.19)

Support. Specifications for the design and construction of structural supports for signs have been standardized by the American Association of State Highway and Transportation Officials (AASHTO). Overcrossing structures can often serve for the support of overhead signs, and might in some cases be the only practical location that will provide adequate viewing distance. Use of these structures as sign supports will eliminate the need for additional sign supports along the roadside. Conditions that might warrant the installation of overhead signs are given in EPG 903.1.14 and throughout EPG 903.5. Vertical clearance of overhead signs is discussed in EPG 903.1.15.

903.5.20 Lateral Offset (MUTCD Section 2E.20)

Standard. Except where shielded by a rigid traffic barrier, the minimum lateral offset outside the usable roadway shoulder for post-mounted freeway and expressway signs or for overhead sign supports, either to the right-hand or left-hand side of the roadway, shall be 6 feet. This minimum clearance shall also apply outside of a curb. All signs, regardless of location along right-of-way shall be mounted on crashworthy supports (see definition in EPG 911 (MUTCD Section 1C.02)).

Guidance. Where practicable, a sign should not be less than 12 feet from the edge of the nearest traffic lane.

Where an expressway median is 12 feet or less in width, consideration should be given to spanning both roadways without a center support.

Standard. Overhead sign supports shall have a barrier or crash cushion to shield them if they are within the right-of-way.

Butterfly-type sign supports and other overhead non-crashworthy sign supports shall not be installed in gores or other unshielded locations within the clear zone.

Option. Lesser clearances, but not generally less than 6 feet, may be used on connecting roadways or ramps at interchanges.

903.5.21 Interchange Guide Signs (MUTCD Section 2E.21)

Standard. The signs at interchanges and on their approaches shall include Advance Interchange guide signs and Exit Direction signs. Consistent destination messages shall be displayed on these signs.

Guidance. New destination information should not be introduced into the major sign sequence for one interchange, nor should destination information be dropped.

Guide signs placed in advance of an interchange deceleration lane should be spaced at least 800 feet apart.

Use of Supplemental guide signing should be minimized as provided in EPG 903.5.49.

Support. Figure 903.5.21 shows a typical sequence of interchange guide signs.

In some instances the interchange that provides the most direct or preferred access to a destination might be different in opposing directions of travel due to circumstances such as the configuration of the crossroads, or the fact that an interchange is a partial interchange.

Guidance. For each direction of travel, guide signing to a destination should be via the exit with the most direct or preferred access, even when this results in a destination being served by different interchanges for opposing directions of travel.

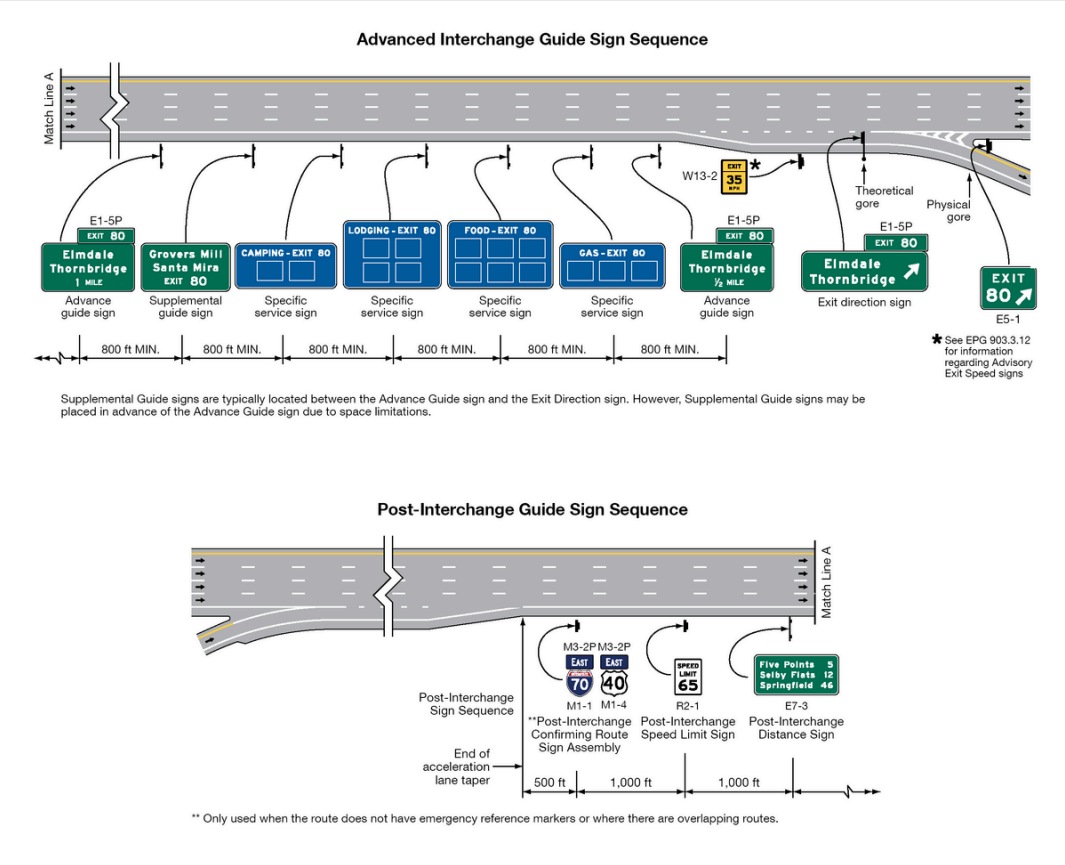


Figure 903.5.21 Typical Sequence of Interchange Guide Signs

903.5.22 Interchange Exit Numbering (MUTCD Section 2E.22)

Standard. Interchange exit numbering shall use the reference location sign exit numbering method. The consecutive exit numbering method shall not be used. The exit numbers shall correspond to the posted Reference Location or Enhanced Reference Location signs.

Support. Reference location sign exit numbering assists road users in determining their destination distances and travel mileage, assists road users in reporting their location in the event of an incident or breakdown, assists responders in responding to incidents, and assists highway agencies because the exit numbering sequence does not have to be changed if new interchanges are added to a route.

Interchange exit numbering provides valuable orientation for the road user on a freeway. The feasibility of numbering interchanges or exits on an expressway will depend largely on the extent to which grade separations are provided.

Standard. Interchange exit numbering shall be used in signing each freeway interchange exit departure point. Exits are numbered for the interstate system only and coincide with mileposts. Interchange exit numbers shall be displayed with each Interchange Advance Guide sign, Exit Direction sign, and Exit Gore sign. The exit number shall be displayed on a separate plaque on top of the Interchange Advance Guide or Exit Direction sign. The Exit Number (E1-5P series) plaque (see Figure 903.5.23) shall include the word EXIT(S) and the appropriate exit number(s) in a single-line format.

Since exits are numbered on the interstate system, the terms NEXT LEFT, NEXT RIGHT, or SECOND LEFT, SECOND RIGHT and NEXT EXIT shall not be used, with the exception of supplemental signs. The exit number shall always be referred to on the exit number panel that is placed above the main guide sign. For interstate guide signs, the term EXIT XX MILES shall not be used.

If a guide sign exit number panel refers to two exits, the exit number letters shall appear in the same order as the driver approaches them.

Suffix letters shall only be used to supplement exit numbers where there is more than one exit associated with the reference mile points of the freeway. Suffix letters shall not be used for an exit ramp for the purpose of identifying a downstream ramp split providing access to multiple highways or different directions on the same highway. The suffix letter shall also be included on the Exit Number plaque and shall be separated from the exit number by a space having a width of between ½ and ¾ of the height of the suffix letter. The suffix letters assigned shall be in ascending alphabetical order starting with the letter A for ramps in the direction of travel with increasing exit numbers, and in descending alphabetical order ending in the letter A in the opposite direction of travel. Exit numbers shall not include the cardinal direction initials corresponding to the directions of the cross route. The minimum numeral and letter sizes shall be as given in Tables 903.5.11.2 and 903.5.11.3.

Where suffix letters are used for exit numbering, an exit of the same number without a suffix letter shall not be used on the same route in the same direction. For example, if an exit is designated as EXIT 256 A, then there shall not be an exit designated as EXIT 256 on the same route in the same direction.

Guidance. To the extent practical, exit numbering should be determined based upon the location of the crossroad with respect to reference location signs as given in the following examples:

A. If a crossroad intersects the mainline approximately at or after Mile 15 and before Mile 16, the interchange should be designated as EXIT 15 (see Drawings A and B in Figure 903.5.22.1).
B. If the interchange crossroad is split into two roadways by direction where one direction of the crossroad is downstream of Mile 18 and the other direction is upstream of Mile 18, the interchange exit number should be EXIT 18 (see Drawings A and B in Figure 903.5.22.1).
C. If there are three closely-spaced interchanges, such as less than 1 mile apart, starting before Mile 16 and ending near or at Mile 17, the interchanges should be designated as EXIT 15, EXIT 16, and EXIT 17.
D. If there are multiple interchanges so closely spaced together that it is impracticable to designate the exit numbers by the freeway mainline reference mile numbers, suffix letters should be used as provided in this Section (see Drawings C and D in Figure 903.5.22.1).

Option. Exit numbers may also be used with Supplemental guide signs in compliance with the provisions of EPG 903.5.49, and Motorist Service signs in compliance with the provisions of EPG 903.9 and EPG 903.10.

Standard. Where exit suffix letters are used and the number of exits is not equal in both directions of travel, the exit suffix lettering for each direction shall be based on the number of exits in that direction. For example, if in the northbound direction of a freeway there are three exits for Mile 25 and two exits in the southbound direction, the exit numbers northbound shall be EXIT 25 A, EXIT 25 B, and EXIT 25 C; and the exit numbers southbound shall be EXIT 25 B followed by EXIT 25 A (see Drawing D in Figure 903.5.22.1).

Except as provided in EPG 903.5.35 for Collector-Distributor Roadways or as otherwise provided for in EPG 903.5, exit numbers and suffix letters shall only be used to designate individual exit departure points directly from the freeway mainline. Exit numbers and suffix letters shall not be used for designating ramp splits into two ramps after leaving the mainline.

The Exit Number (E1-5P) plaque shall be positioned above the top right-hand edge of the sign for an exit to the right (see Figure 903.5.23).

Because road users might not expect an exit to the left and might have difficulty in maneuvering to the left, a Left Exit Number (E1-5fP through E1-5kP) plaque (see Figure 903.5.23) shall be added above the top left-hand edge of the sign for all numbered left-hand exits (see Figure 903.5.28.2 and Figure 903.5.37). The word LEFT on the Left Exit Number plaque shall be a black legend on a yellow rectangular sign panel and shall be centered above the word EXIT.

Support. Example Exit Number plaque designs are shown in Figure 903.5.23. The incorporation of Exit Number plaques on guide signs is illustrated in EPG 903.5.23, 903.5.25, and 903.5.39.

Figure 903.5.22.2 provides an example of Interstate route loops and spurs around major metropolitan areas. The general plan for numbering interchange exits is shown in Figures 903.5.22.3 through 903.5.22.6. Figure 903.5.22.3 shows a circumferential route, which is a route that makes a complete circle around a city or town and usually has two interchanges (one on each side of the city or town) with each of the mainline routes that travel through the city or town. Figure 903.5.22.4 shows a loop route, which is a route that departs from a mainline route and then rejoins the same mainline route at a subsequent point downstream. For the purpose of Interstate route numbering, a three-digit Interstate route that provides connectivity between two different Interstate routes is also defined as a loop (see Figure 903.5.22.2). Figure 903.5.22.5 shows a spur route, which is a route that departs from a mainline route and never rejoins the same mainline route. Figure 903.5.22.6 shows two mainline routes that overlap each other.

Standard. Regardless of whether a mainline route originates within a State or crosses into the State from an adjacent State, the southernmost or westernmost terminus within that State shall be the beginning point for interchange exit numbering.

For circumferential routes, interchange exit numbering shall be in a clockwise direction. The numbering shall begin with the first interchange west of the south end of an imaginary north-south line bisecting the circumferential route, at a radial freeway or other Interstate route, or some other conspicuous landmark in the circumferential route near a south polar location (see Figure 903.5.22.3).

The interchange exit numbers on loop routes shall begin at the loop interchange nearest the south or west junction and increase in magnitude toward the north or east junction (see Figure 903.5.22.4).

Spur route interchanges shall be numbered in ascending order starting at the interchange where the spur leaves the mainline route (see Figure 903.5.22.5).

If a circumferential, loop, or spur route crosses State boundaries, the numbering sequence shall be coordinated by the States to provide continuous interchange exit numbering.

Where numbered routes overlap, continuity of interchange exit numbering shall be established for only one of the routes (see Figure 903.5.22.6). If one of the routes is an Interstate and the other route is not an Interstate, the Interstate route shall maintain continuity of exit interchange numbering.

Guidance. The route chosen for continuity of interchange exit numbering should also have reference location sign continuity (see Figure 903.5.22.6).

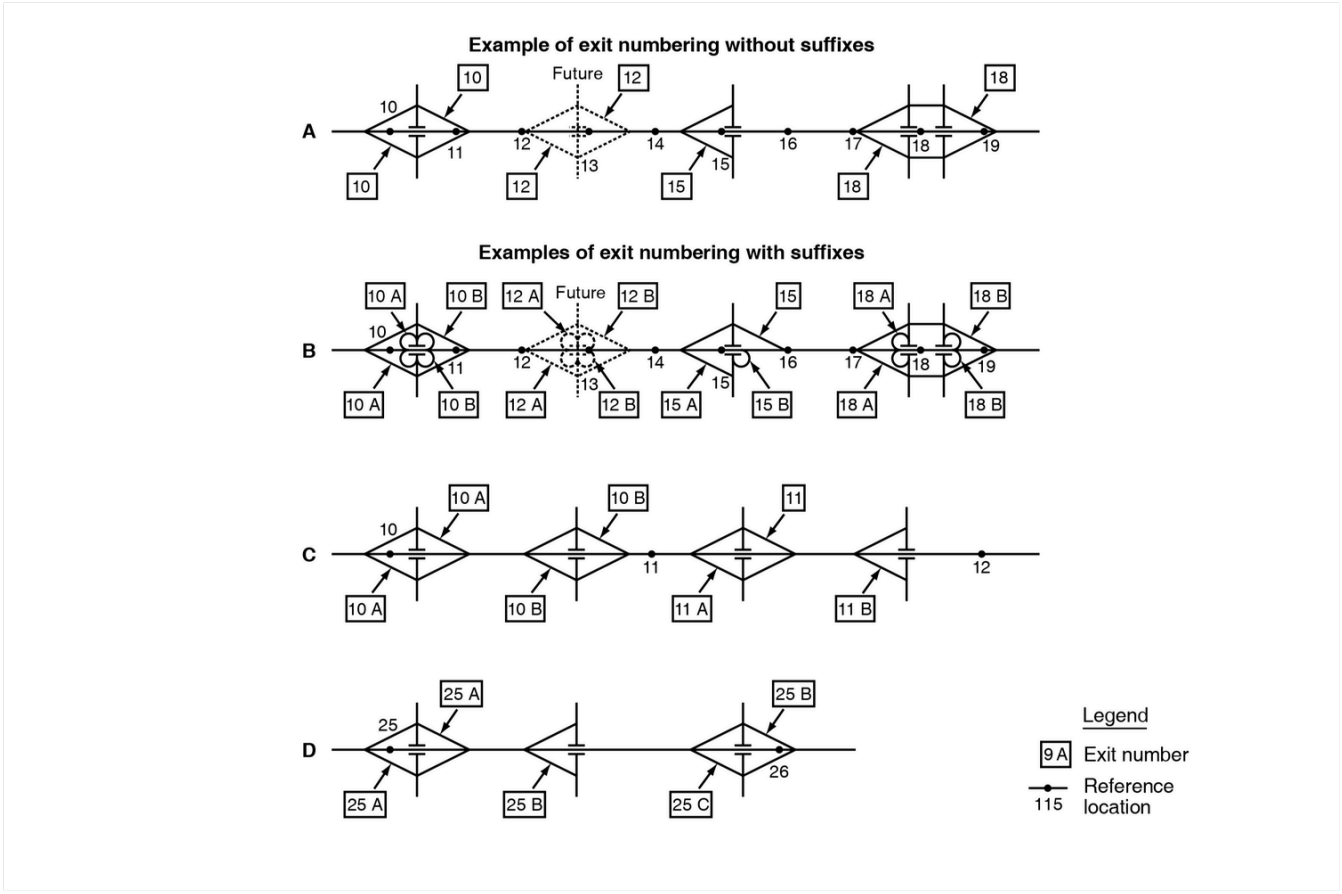


Figure 903.5.22.1 Examples of Interchange Exit Numbering

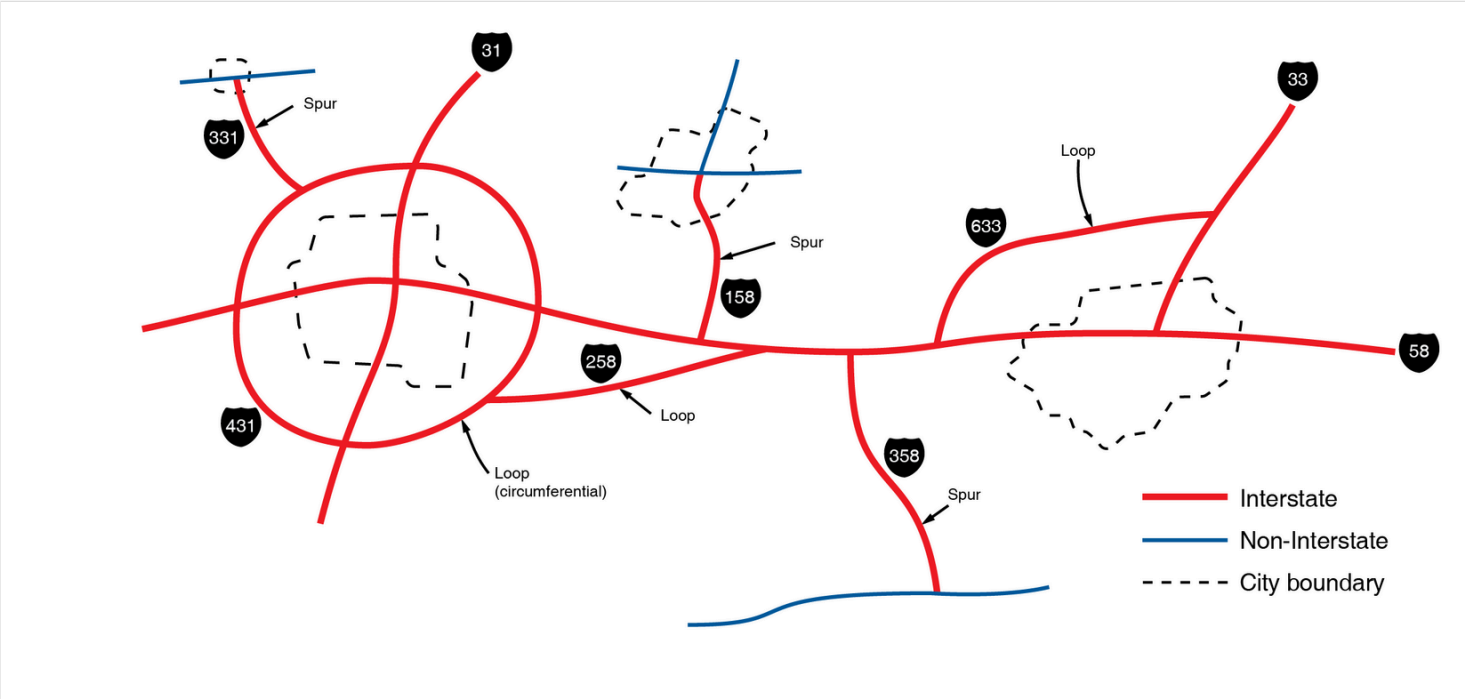


Figure 903.5.22.2 Examples of Interstate Loops and Spurs

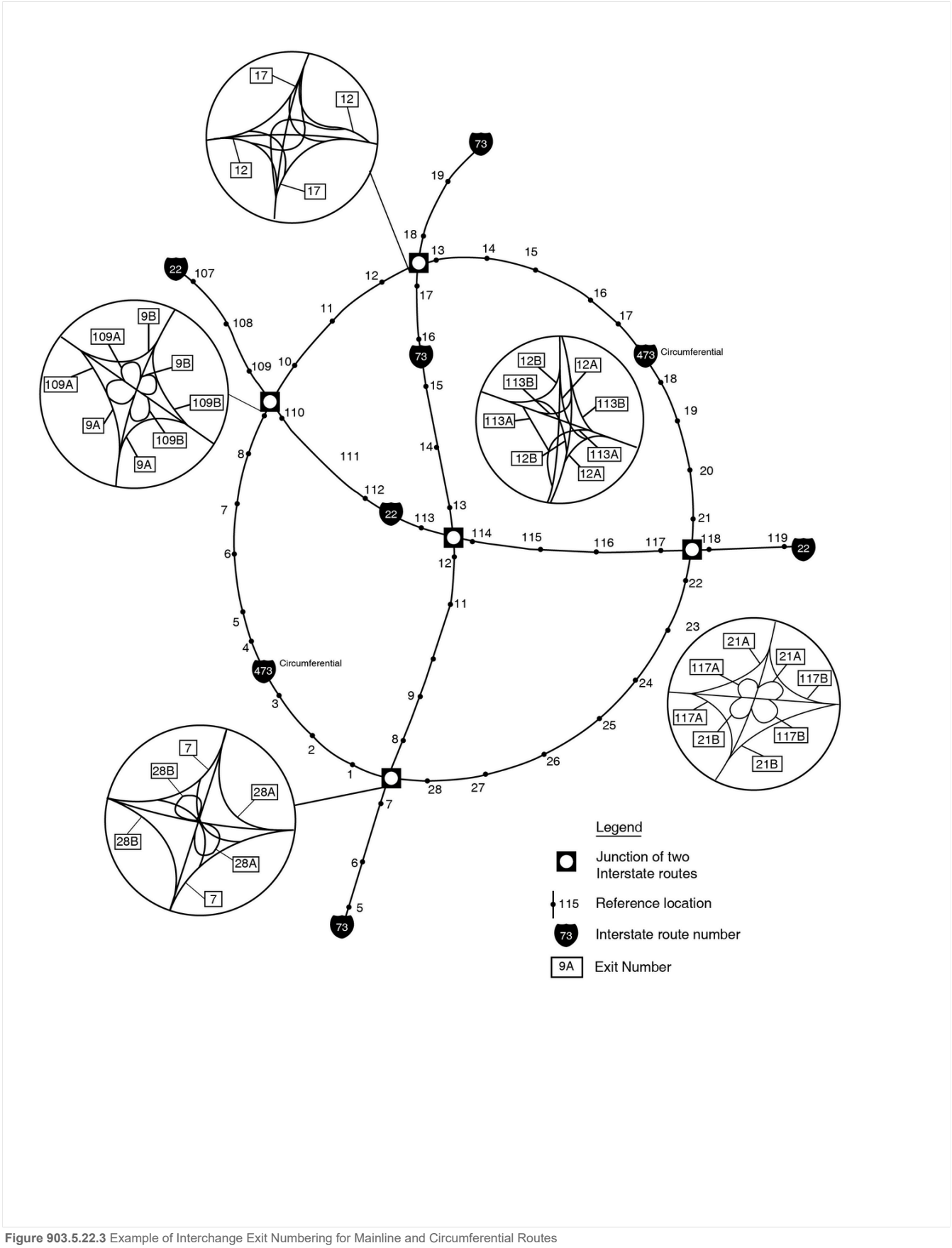
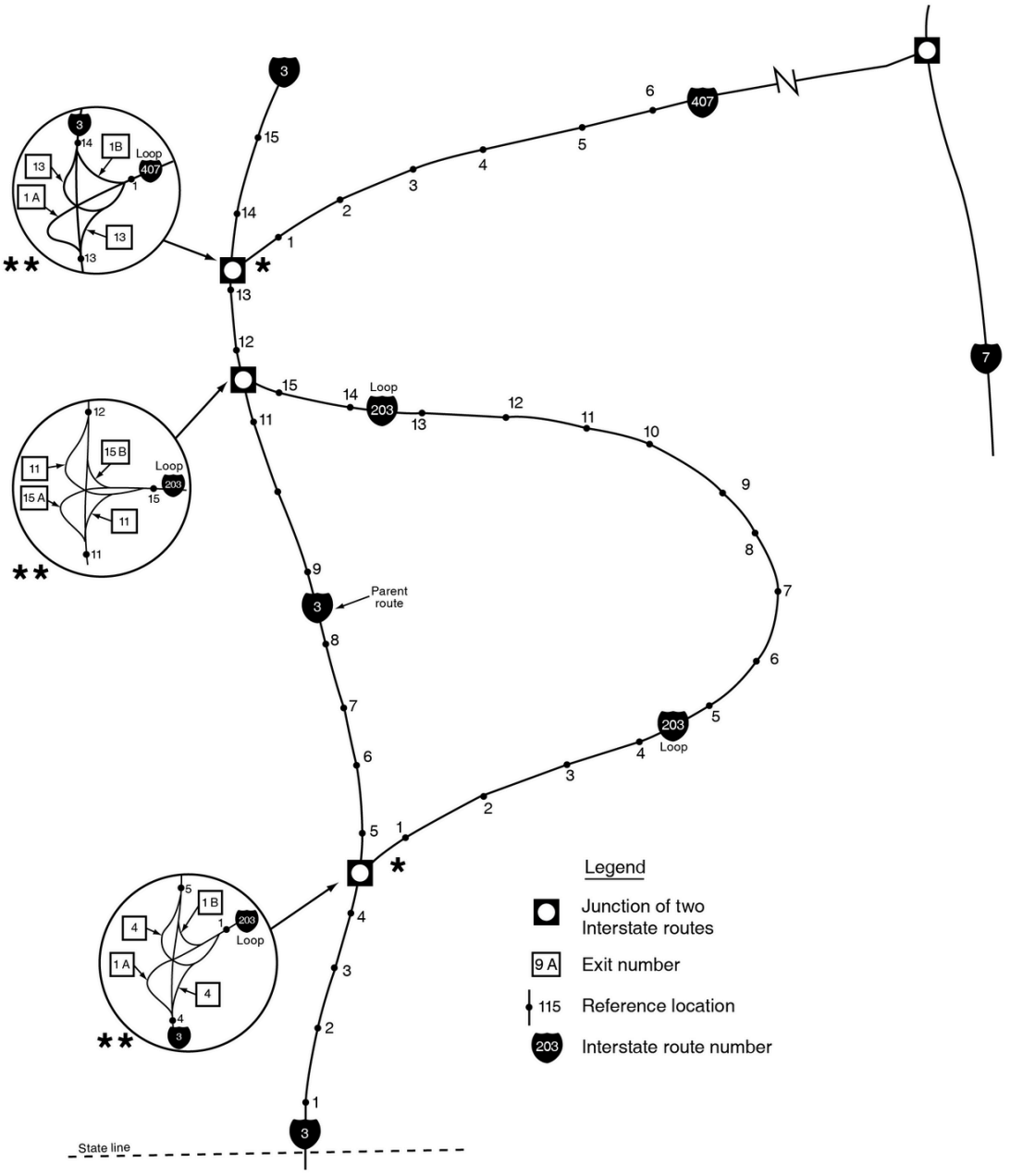


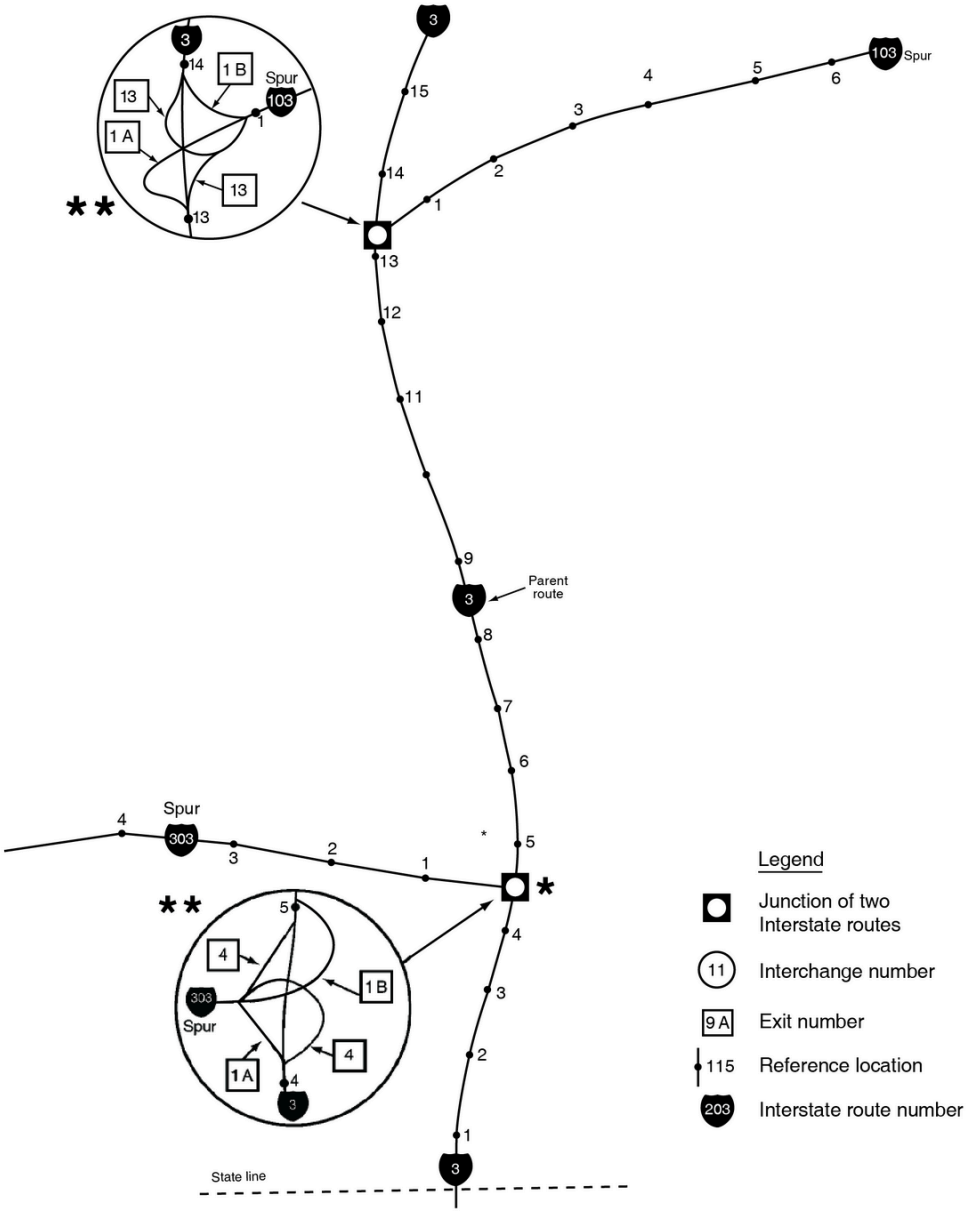
Figure 903.5.22.3 Example of Interchange Exit Numbering for Mainline and Circumferential Routes



* The freeway/freeway interchange where the beginning of the loop or spur route intersects with the mainline route may be called either Exit 1 or Exit 0 on the loop or spur route.

** Exit numbers and suffixes are used at the end of loop routes as these roadways physically end and all traffic must exit and continue on another route. The convention of the suffix "A" being used for the left exit and "B" being used for the right exit at a rout that terminates is similar to the convention of a left destination being listed first over a right destination on a guide sign.

Figure 903.5.22.4 Example of Interchange Exit Numbering for Mainline and Loop Routes



* The freeway/freeway interchange where the beginning of the loop or spur route intersects with the mainline route may be called either Exit 1 or Exit 0 on the loop or spur route.

** Exit numbers and suffixes are used at the end of loop and spur routes as these roadways physically end and all traffic must exit and continue on another route. The convention of the suffix "A" being used for the left exit and "B" being used for the right exit at a rout that terminates is similar to the convention of a left destination being listed first over a right destination on a guide sign.

Figure 903.5.22.5 Example of Interchange Exit Numbering for Mainline and Spur Routes

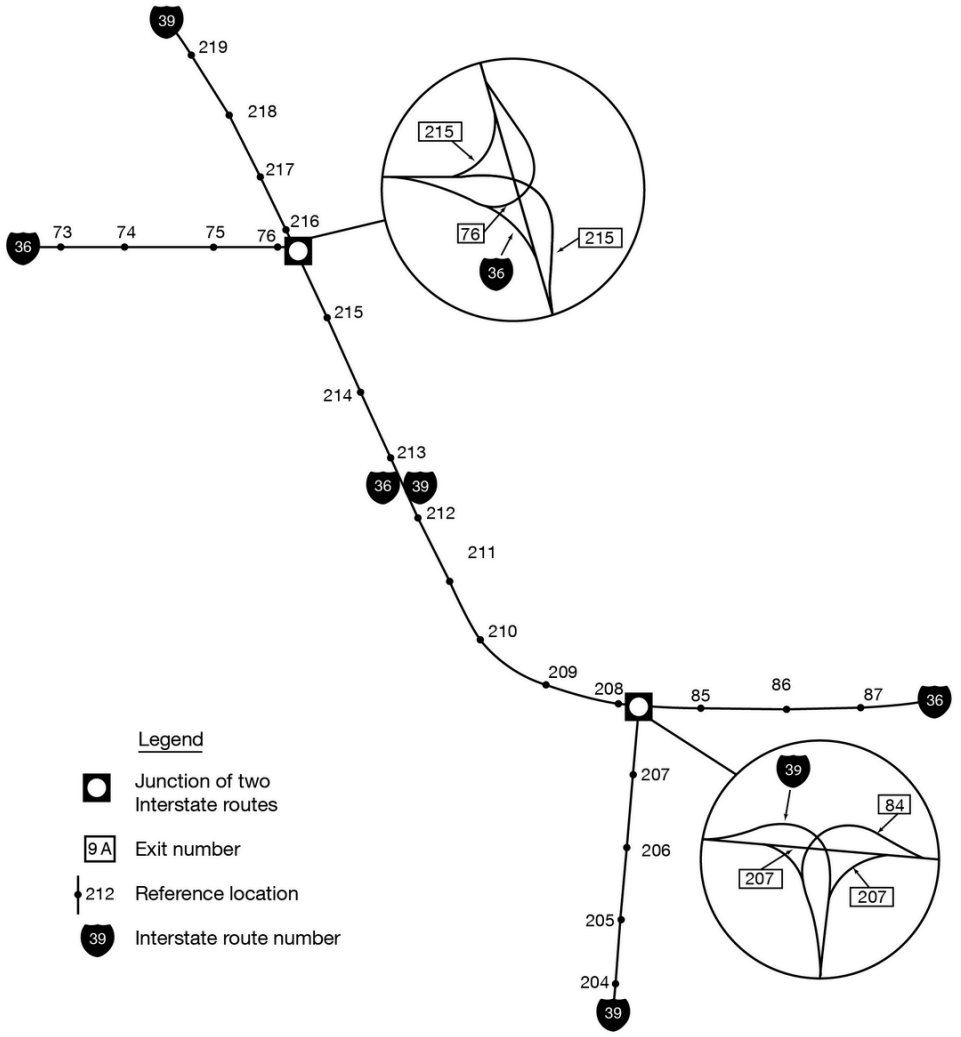


Figure 903.5.22.6 Example of Interchange Exit Numbering for Overlapping Routes

903.5.23 Interchange Advance Guide Signs (E1-1 through E1-3) (MUTCD Section 2E.23)

Support. An Interchange Advance guide sign (see Figure 903.5.23) gives notice well in advance of the exit point of the principal destinations served by the next interchange and the distance to that interchange. In rural areas, this sign will typically be a ground-mount sign. In urban areas, this sign will usually be mounted overhead.

Standard. Except as provided in the fourth Guidance paragraph of this Article, and in the second Option paragraph of EPG 903.5.25, at least one Interchange Advance guide sign shall be used for all interchanges.

Freeway-to-freeway and directional interchanges shall use one additional Advance Guide sign in each direction.

Guidance. Advance guide signs should be placed over the right lane for right hand exits and over the left lane for left hand exits. Two advance guide signs should not be placed side by side.

For interchanges with adequate spacing, Advance Guide signs should be placed 1 mile in advance of the exit gore. When used at freeway-to-freeway or directional interchanges, the additional Advance Guide sign should be located at a distance of 2 miles in advance of the interchange.

Support. EPG 903.5.29 through 903.5.42 contain additional provisions regarding the number, location, and mounting of Interchange Advance guide signs for certain interchange configurations.

Standard. Except as provided in EPG 903.5.28, the legend on Interchange Advance guide signs shall contain the distance message. For each direction of travel, the legend on the Interchange Advance guide signs shall be the same as the legend on the Exit Direction sign, except that the last line shall be the distance message. The distance message shall read XX MILE(S) where exit numbers are used. Where exit numbers are not used, the distance message shall read EXIT XX MILE(S) for an interchange with one exit ramp, and EXITS XX MILE(S) for an interchange with two or more exit ramps.

Guidance. All distances one mile or less should be treated as singular. For example, proper terminology is "1 MILE" and "1 ¼ MILES".

Where an Interchange Advance guide sign is located more than 1,000 feet to ½ mile from the exit, the distance displayed should be to the nearest ¼ mile. Where the distance to be displayed on an Interchange Advance guide sign is 1,000 feet or less, the distance should be displayed in feet, rather than miles, to the nearest 100 feet.

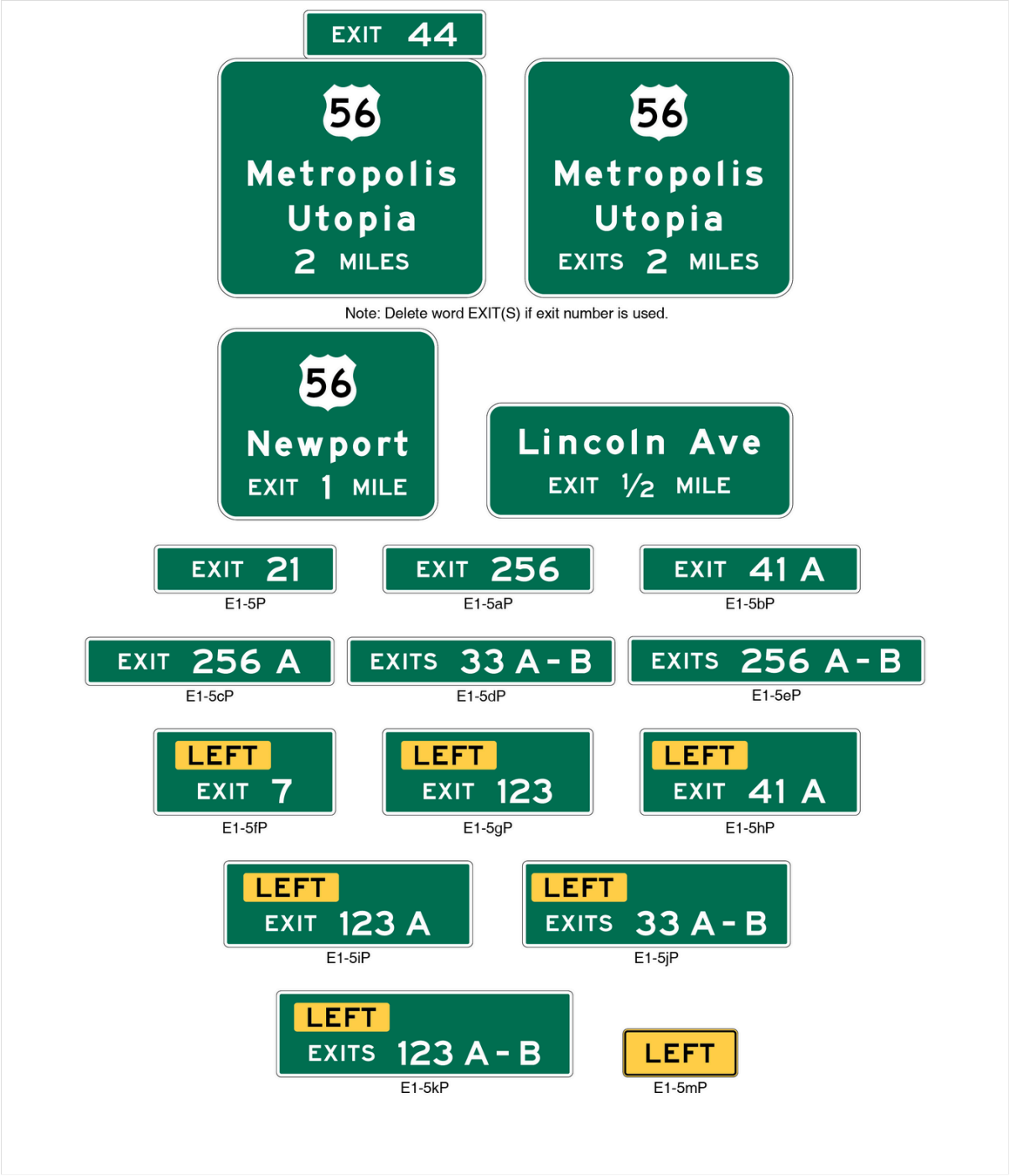


Figure 903.5.23 Examples of Interchange Advance Guide Signs, Exit Number Plaques, and LEFT plaque

Standard. When a distance is displayed in miles, fractions of a mile, rather than decimals, shall be displayed in all cases.

For numbered exits, the exit number used with the Interchange Advance guides signs shall be displayed using an Exit Number plaque above and abutting the Interchange Advance guide sign.

For numbered exits to the right, an Exit Number (E1-5P through E1-5eP) plaque (see Figure 903.5.23) shall be added to the top right-hand edge of the sign.

For numbered exits to the left, a Left Exit Number (E1-5fP through E1-5kP) plaque (see Figure 903.5.23) shall be added above the top left-hand edge of the sign (see Figures 903.5.28.2 and 903.5.37).

For unnumbered exits to the left, a LEFT (E1-5mP) plaque (see Figure 903.5.23) shall be added to the top left-hand edge of the sign, abutting the sign.

Support. EPG 903.5.22 contains additional information regarding exit numbering.

Standard. Interchange Advance guide signs for multi-lane exits having an optional exit lane that also carries the through route at interchanges (see Figures 903.5.39.2 and 903.5.39.3) and for splits with an option lane (see Figure 903.5.39.4) shall be Overhead Arrow-per-Lane signs designed in accordance with EPG 903.5.38 and 903.5.39.

Option. Where the distance between interchanges is more than 1 mile, but less than 2 miles, the first Interchange Advance guide sign may be closer than 2 miles, but not placed so as to overlap the signing for the preceding exit. Duplicate Interchange Advance guide signs or Interchange Sequence Series signs may be placed in the median on the opposite side of the roadway and are not included in the minimum requirements of interchange signing.

Guidance. Where there is less than 800 feet between the theoretical gores of successive interchange entrance or exit ramps, Interchange Sequence Series signs (see EPG 903.5.24) should be used instead of Interchange Advance guide signs for the affected interchanges.

903.5.24 Interchange Sequence Signs (E9-1 and E9-2) (MUTCD Section 2E.24)

Support. Interchanges are sometimes closely spaced, particularly through large urban areas, so that typical guide signs cannot be adequately spaced. In such cases, Interchange Sequence signs identifying the next two (E9-1) or three (E9-2) interchanges can provide the necessary exit destination guidance.

Guidance. Where there is less than 800 feet between the theoretical gores of successive interchange entrance or exit ramps, Interchange Sequence signs should be used instead of Interchange Advance guide signs for the affected interchanges.

If used, Interchange Sequence (E9-1 or E9-2) signs should be used over the entire length of a route in an urban area.

Support. Interchange Sequence signs generally supplement Interchange Advance guide signs. Signing of this type is illustrated in Figure 903.5.24, and is compatible with the sign spreading concept described in the first Support paragraph of EPG 903.5.41.

Standard. Interchange Sequence signs shall be installed in a series. Interchange Sequence signs shall display the next two or three interchanges by name or route number with distances to the nearest ¼ mile.

The first Interchange Sequence sign in the series shall be located in advance of the first Interchange Advance guide sign for the first interchange.

An Interchange Sequence sign shall not be placed on a truss with any other guide sign, unless the sign faces the opposite direction of all other guide signs.

All interchanges shall be listed using the same name that will appear on the Advance Guide and Exit Direction signing for the interchange.

Where the exit direction is to the left, a LEFT (E11-2) sign panel (see Figure 903.5.28.1) shall be displayed on the same line immediately to the right of the interchange name or route number.

Interchange Sequence signs shall not be substituted for Exit Direction signs.

Guidance. The verbiage on the Interchange Sequence sign should appear on the appropriate advance and exit guide signs for sign continuity.

If the intersecting road of a freeway in an urban area is a state-maintained route, the appropriate route shield shall be used in addition to the street name or control communities displayed.

Interchange Sequence signs should be located in the median or placed on a bridge whenever possible. After the first sign of the series, subsequent Interchange Sequence signs should be placed approximately midway between interchanges. This will allow two signs (one for each direction of traffic) to be placed back to back on the same truss. Since the signs are usually back-to-back, a butterfly truss should be installed in the median of divided highways. Barrier protection should be used according to EPG 617.

Standard. Interchange Sequence signs located in the median shall be installed at overhead sign height (see EPG 903.1.14).

Exit numbers shall not be displayed on Interchange Sequence signs.

Option. When conditions arise where back-to-back sequence signs are not practical, an Interchange Sequence sign and truss may be placed on the right-hand side of traffic flow to avoid exposing opposite directions of traffic to a truss pedestal. If exposure to both directions of traffic is not a concern, this sign and truss may be placed at the standard location, on the left-hand side of the traffic flow.

Support. An example of how to use a common street name: Route 67 is commonly referred to as Lindbergh Boulevard. On the advance and exit guide signs, a U.S. Route 67 shield appears with the common name “Lindbergh Boulevard” underneath. The interchange sequence signs would show Lindbergh Blvd and/or shield.

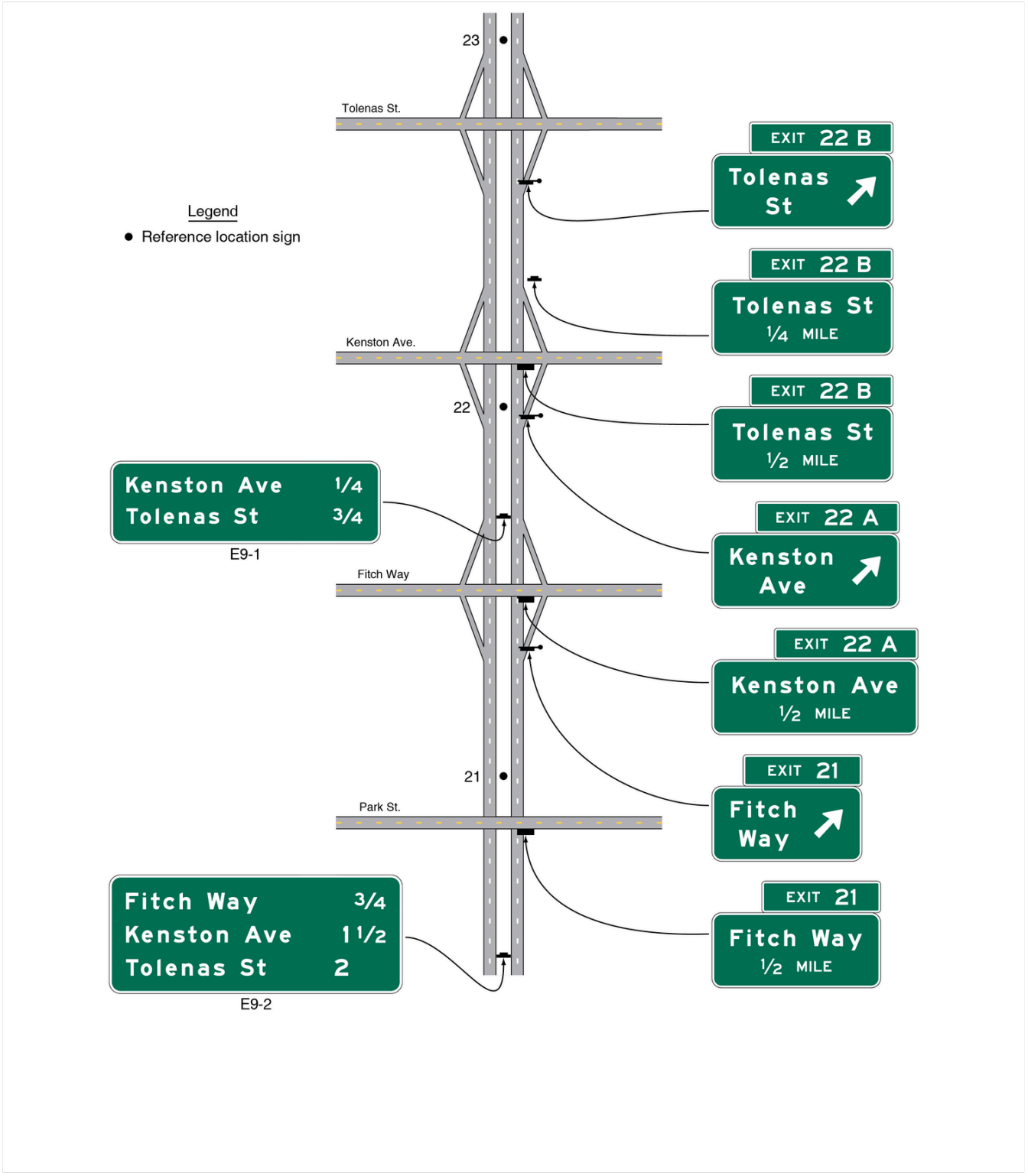


Figure 903.5.24 Example of Using a Series of Interchange Sequence Signs for Closely-Spaced Interchanges

903.5.25 Exit Direction Signs (E4 Series) (MUTCD Section 2E.25)

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Figure 903.5.25.1 Examples of Exit Direction Signs



Figure 903.5.25.2 Example of Exit Direction Sign with Advisory Speed Panel

Support. The Exit Direction sign repeats the route and destination information that was displayed on the Interchange Advance guide sign(s) for the next exit, and thereby assures road users of the destination served and indicates whether they exit to the right or left for that destination.

Standard. Exit Direction signs shall be used at all interchanges. Populations or other similar information shall not be displayed on Exit Direction signs.

Support. EPG 903.5.28, 903.5.30, 903.5.32 through 903.5.34, 903.5.37, and 903.5.39 through 903.5.41 illustrate the use, location, and mounting of Exit Direction signs for certain interchange configurations. The placement location of the Exit Direction sign at the interchange depends on the type of mounting, post-mounted or overhead, and whether there is a deceleration lane (see Figure 903.5.25.3).

Guidance. When post-mounted, the Exit Direction sign should be installed at the beginning of the deceleration lane taper. When mounted overhead, the Exit Direction sign should be installed over the exiting lane in the vicinity of the theoretical gore. If there is less than 300 feet from the beginning of the taper to the theoretical gore, the Exit Direction sign should be installed overhead (see Figure 903.5.25.3).

Standard. Except where Overhead Arrow-per-Lane guide signs are used (see EPG 903.5.39 and the following paragraph of this Article), where a through lane is being terminated (dropped) at an exit, the Exit Direction sign shall be placed overhead at the theoretical gore (see Figures 903.5.28.2, 903.5.28.3, 903.5.36.1 and 903.5.36.2).

Except as provided in the second Standard paragraph of EPG 903.5.39, where Overhead Arrow-per-Lane guide signs are used for the Interchange Advance guide sign(s) for a multi-lane exit having an optional exit lane that also carries the through route or for a split with an option lane (see EPG 903.5.39), an Overhead Arrow-per-Lane guide sign shall also be used instead of the Exit Direction sign and located near, but not downstream from, the point where the outside edge of the dropped lane begins to diverge from the main roadway (see Figures 903.5.39.2 through 903.5.39.4). The Overhead Arrow-per-Lane guide sign shall be designed in accordance with the provisions of EPG 903.5.39.

The following provisions shall govern the design and application of overhead Exit Direction signs:

A. The sign shall display the Exit Number plaque (if exit numbering is used), the route number, cardinal direction, and destination, as applicable, with a diagonally upward-pointing directional arrow (see Figure 903.5.25.1).
B. The message EXIT ONLY in black on a fluorescent yellow sign panel (E11-1d or E11-1e) shall be used on the overhead Exit Direction sign to advise road users of a lane drop situation (see Figures 903.5.28.2 and 903.5.28.3). The sign shall comply with the provisions of EPG 903.5.28.

For numbered exits to the right, an Exit Number (E1-5P through E1-5eP) plaque (see Figure 903.5.23) shall be added above the top right-hand edge of the sign.

For numbered exits to the left, a Left Exit Number (E1-5fP through E1-5kP) plaque (see Figure 903.5.23) shall be added above the top left-hand edge of the sign.

For unnumbered exits to the left, a LEFT (E1-5mP) plaque (see Figure 903.5.23) shall be added above the top left-hand edge of the sign.

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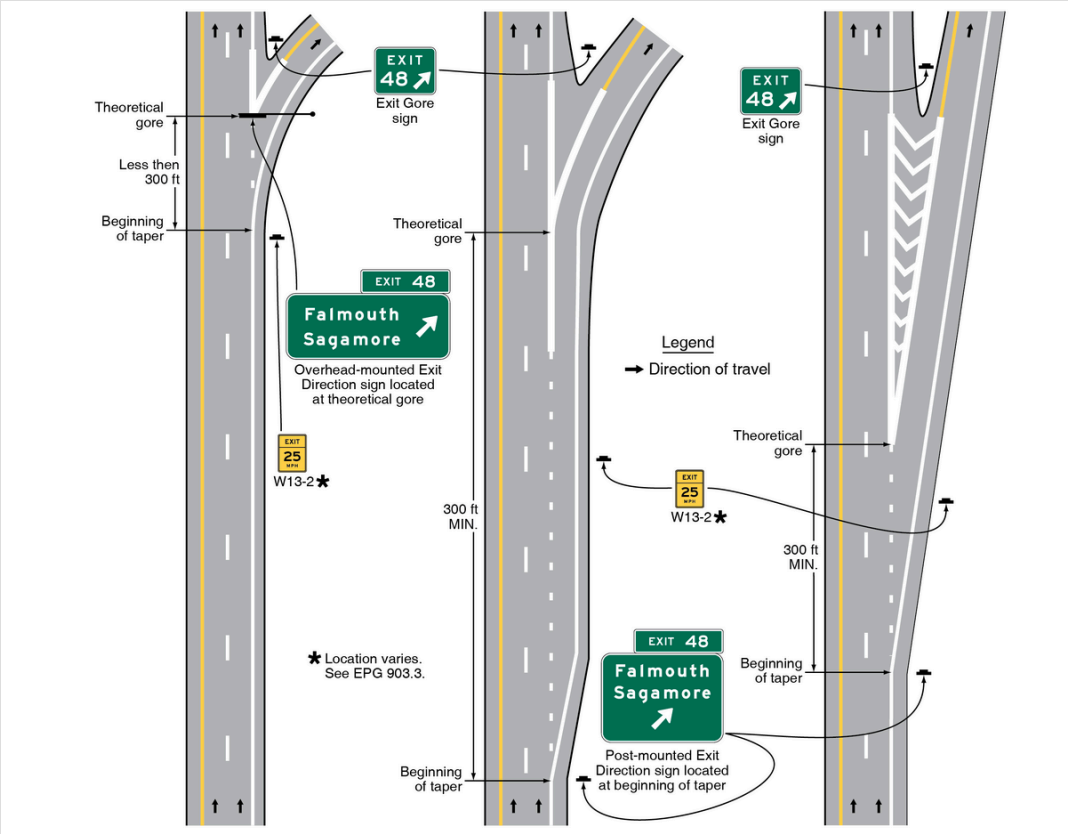


Figure 903.5.25.3 Exit Direction Sign Placement

Support. EPG 903.5.22 contains additional information regarding exit numbering.

Guidance. At multi-exit interchanges, the Exit Direction sign should be located directly over the exiting lane for the first exit, in accordance with this Section. An Interchange Advance guide sign for the second exit should be installed at the same location, normally over the right-hand through lane. Only for those conditions where the through movement is not evident should a confirmatory message be used over the left-hand lane(s) to guide road users traveling through an interchange (see EPG 903.5.41 for additional information on sign spreading).

Where the freeway or expressway is on an overpass, the Exit Direction sign for the second exit should be installed on an overhead support over the exit lane in advance of the gore point, as near as practicable to the theoretical gore. Where the freeway or expressway passes under the crossroad and the exit ramp is located beyond the overcrossing structure, the overhead Exit Direction sign for the second exit should be placed either on the overcrossing structure (see Figures 903.5.32 through 903.5.34) or on a separate structure located immediately in front of the overcrossing structure.

Option. Where extra emphasis of an especially low advisory ramp speed is needed, an Exit Direction Advisory Speed (E13-2) sign panel (see Figure 903.5.25.2) may be placed at the bottom of the Exit Direction sign to supplement, but not to replace, the exit or ramp advisory speed warning signs.

In cases, where sight distance is restricted because of structures or unusual alignment, principally in urban areas, making it impossible to locate the Exit Direction sign without violating the required minimum spacing between major guide signs (see EPG 903.5.23), Interchange Sequence signs (see EPG 903.5.24) may be substituted for an Interchange Advance guide sign.

903.5.26 Exit Gore Signs and Plaque (E5-1 Series) (MUTCD Section 2E.26)



Support. The Exit Gore sign in the gore indicates the exiting point or the place of departure from the main roadway. Consistent application of this sign at each exit is important to provide adequate visibility of the departure of the exit roadway from the main roadway.

Standard. The gore shall be defined as the area located between the main roadway and the ramp just beyond where the ramp branches from the main roadway. An Exit Gore sign shall be located in the gore for each ramp that departs from the main roadway of a freeway or expressway, or departs from a collector-distributor roadway, and shall display the word EXIT (E5-1) if interchange exit numbering is not used or EXIT XX (E5-1a) if interchange exit

numbering is used (only on interstate routes), and an appropriate diagonally upward-pointing arrow. If suffix letters are used for exit numbering at a multi-exit interchange, the suffix letter shall also be included on the Exit Gore (E5-1a) sign shall be separated from the exit number by a space having a width of between ½ and ¾ of the height of the suffix letter. Breakaway or yielding supports shall be used.

The Exit Gore sign shall be placed within the gore area at a location no more than 100 feet beyond the upstream end of the physical gore (See Figure 903.5.26).

Option. A placement distance of approximately 100 feet beyond the beginning of the physical gore is desirable. However, the sign may be placed closer than 100 feet beyond the physical gore, as determined by engineering judgement.

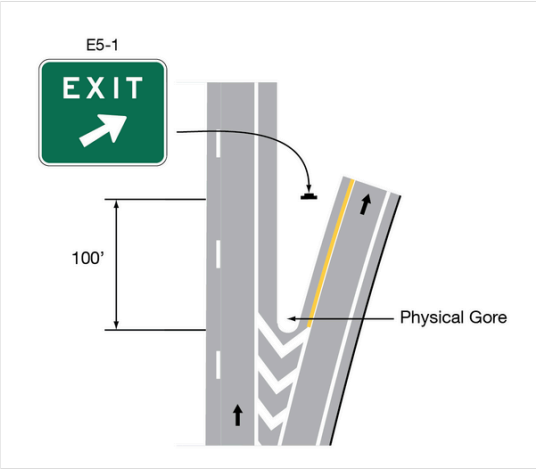


Figure 903.5.26 Example of Exit Gore Sign Location

Guidance. The arrow should be aligned to approximate the angle of departure. Each gore should be treated similarly, whether the interchange has one exit roadway or multiple exits.

Option. Where extra emphasis of an especially low advisory ramp speed is needed, the Confirmation Advisory Speed (W13-1aP) plaque (see EPG 903.3.59) indicating the advisory speed may be mounted below the Exit Gore sign to supplement, but not to replace, the exit or ramp advisory speed warning signs.

To improve the visibility of the gore for exiting drivers, a Type 1 object marker (see EPG 903.3) may be installed 4 feet above the ground line on each sign support below the Exit Gore sign.

903.5.27 Pull-Through Signs (E6-1 Series and E6-2 Series) (MUTCD Section 2E.27)



E6-1



E6-1a

Support. Pull-Through (E6-1 series and E6-2 series) signs are overhead guide signs intended for through traffic.

Guidance. Pull-Through signs should be used where the geometrics of a given interchange are such that it is not clear to the road user as to which is the through roadway, or where additional route guidance is desired. Pull-Through signs with down arrows should be used where the alignment of the through lanes is curved and the exit direction is straight ahead, where the number of through lanes is not readily evident, and at multi-lane exits where there is a reduction in the number of through lanes. Pull-Through signs should not be used at exits with option lanes where full-width Overhead Arrow-per-Lane signs are being used.

Standard. When used, Pull-Through signs shall display the route shield and the cardinal direction for the through route.

Option. Pull-Through signs may display the control city and down arrows (see EPG 903.5.17).

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Support. EPG 903.5.28, EPG 903.5.38, and EPG 903.5.39 contain information regarding the use of Overhead Arrow-per-Lane guide signs at multi-lane exits where there is a reduction in the number of through lanes and a through lane becomes an interior option lane for through or exiting traffic.

903.5.28 Signing for Interchange Lane Drops Without an Optional Exit Lane (MUTCD Section 2E.28)

Standard. The provisions of this Article shall only apply to lane drops at exits that do not have an optional exit lane. At exits that have an optional exit lane in addition to the dropped lane, the provisions of EPG 903.5.38 and 903.5.39 shall apply.

Except as provided in the fourth Guidance paragraph of this Article, major guide signs for all lane drops at interchanges shall be mounted overhead. An EXIT ONLY sign panel shall be used for all interchange lane drops at which the through route is carried on the mainline and when any lane being dropped is a minimum of 1,000 feet in length from full lane width to the theoretical gore.

Option. An EXIT ONLY sign panel may also be used in a situation where the lane being dropped is less than 1,000 feet in length where the terminus of the lane is not visible to the driver.

Standard. Except on Overhead Arrow-per-Lane and Diagrammatic Advance guide signs (see EPG 903.5.38 through 903.5.40), the EXIT ONLY (down arrow) (E11-1 or E11-1f) sign panel (see Figure 903.5.28.1) shall be used on all overhead Advance guide signs of lane drops (see Figures 903.5.28.2, 903.5.28.3, and 903.5.37). The number of arrows on each sign shall correspond to the number of dropped lanes at the location of each sign. Placement of the down arrow shall comply with the provisions of EPG 903.5.17.

For lane drops, the bottom portion of the overhead Exit Direction sign shall be fluorescent yellow with a black border and shall include a diagonally upward-pointing black directional arrow (left or right, as appropriate) for each lane dropped at the exit (see Figures 903.5.28.2 and 903.5.28.3). The sign shall be designed and placed so that each arrow is located over the approximate center of each lane being dropped. Except as provided in the following paragraph, the words EXIT and ONLY shall be positioned to the left and right, respectively, of the arrow on the E11-1d sign panel (see Figure 903.5.28.1) for a single-lane drop. For a two-lane drop, the words EXIT ONLY shall be located between the two arrows on the E11-1e sign panel (see Figure 903.5.28.1). The number of arrows on the sign shall correspond to the number of dropped lanes at the location of the sign.

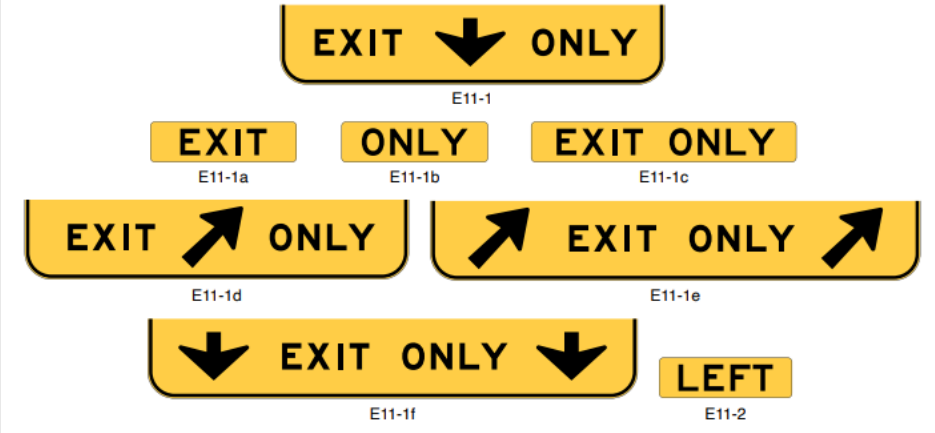


Figure 903.5.28.1 EXIT ONLY and LEFT Sign Panels

Option. Where an existing sign structure length or adjacent signs constrain the width or placement of the Interchange Advance guide sign on that structure, the down arrow may be positioned to the right or left of the words EXIT ONLY, instead of between the words, to allow for the positioning of the arrow over the approximate center of the lane. Where the width of the Exit Direction sign extends over the adjacent lane, the directional arrow may be placed to the right of the words EXIT ONLY for an exit to the right, or to the left of the words EXIT ONLY for an exit to the left, to allow for the positioning of the arrow over the dropped lane.

EXIT ONLY messages of either the combination of E11-1a and E11-1b, or the E11-1c sign panels (see Figure 903.5.28.1) may be used to retrofit existing signing to warn of a lane drop situation ahead.

Standard. If used to retrofit an existing guide sign, the E11-1a and E11-1b sign panels (see Figure 903.5.28.1) shall be placed on either side of a white down arrow on an Interchange Advance guide sign and on either side of a white directional arrow on an Exit Direction sign. The E11-1c sign panel (see Figure 903.5.28.1), if used to retrofit an existing Interchange Advance guide sign, shall be placed between the lower destination message and the white down arrow.

Guidance. Some single exit only lanes develop into dual exit only lanes. An advance EXIT ONLY guide sign should be placed over the single lane before it develops into two, then a second advance EXIT ONLY guide sign should be placed after both lanes are fully developed.

Except as provided in the paragraph below for an auxiliary lane, Interchange Advance guide signs for lane drops within 1 mile of the interchange should not display the distance message.

Where the dropped lane is an auxiliary lane that is provided between successive entrance and exit ramps of two separate interchanges and the distance between the two ramps is less than 1 mile, the first Interchange Advance guide sign in the sequence downstream from the entrance ramp should display the distance message (see Figure 903.5.28.4).

Where the dropped lane carries the through route, signs should be used without the EXIT ONLY sign panel.

Support. Figure 903.5.28.4 shows an example of guide signs for a dropped auxiliary lane between separate interchanges using overhead guide signs. Figure 903.5.22.5 shows guides signs used for an auxiliary lane that is 1,000 feet or longer.

EPG 903.5.38 through 903.5.40 contain information on the signing of lane drops at exits that also have an option lane.

EPG 903.3.41 contains information regarding warning signs that can also be used for freeway lane drop situations.

Guidance. In limited cases in which conditions are so constrained that it is impossible to locate an Interchange Advance guide sign either overhead or partly over the dropped lane, precluding positioning of the down arrow as provided in the third Standard paragraph of this Section, a sign panel displaying the legend RIGHT (LEFT) LANE ONLY in a black legend on a fluorescent yellow background should be substituted for the EXIT ONLY panel on that sign. In such cases, the Interchange Advance guide signs should be alternated with RIGHT (LEFT) LANE EXIT ONLY (W9-7) signs (see EPG 903.3.41).

Where a mainline lane is terminated immediately after an exit ramp, overhead and/or post mounted warning signs should be used to warn traffic as shown in Figure 903.5.22.6.

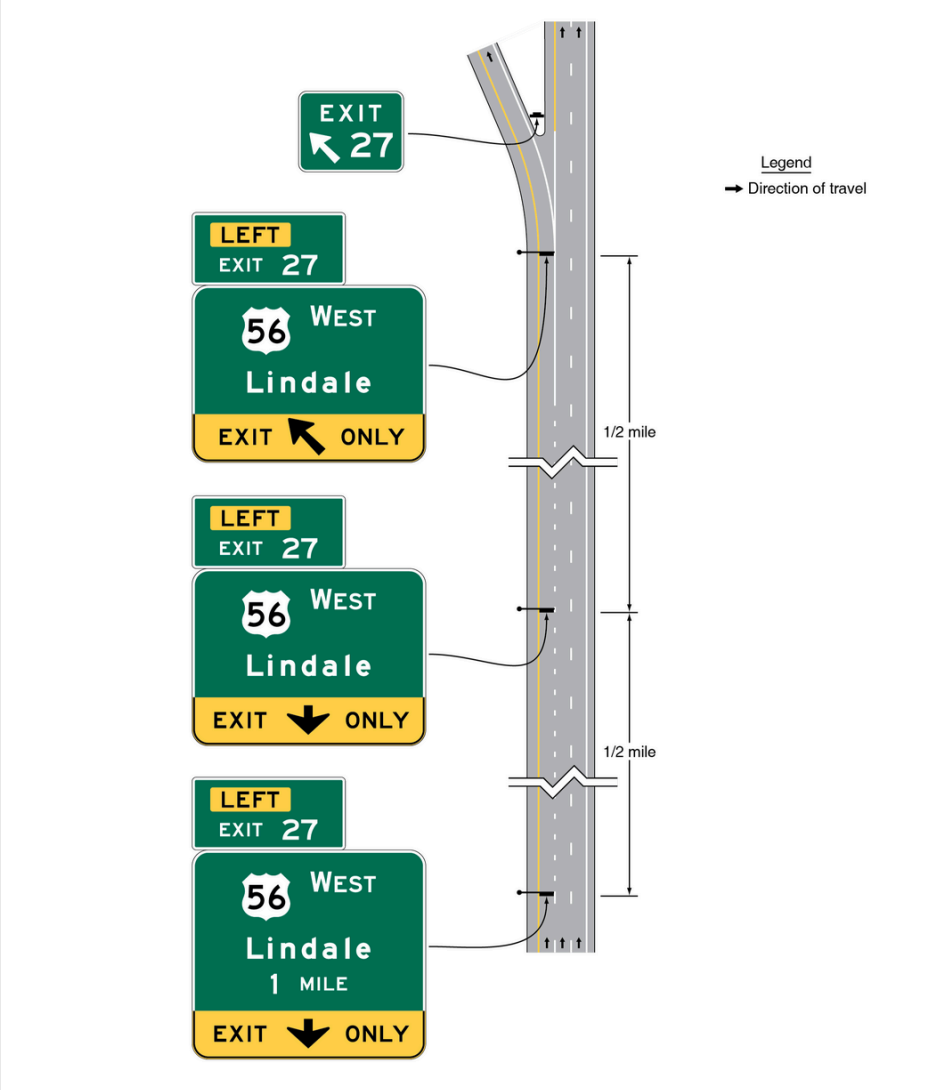


Figure 903.5.28.2 Guide Signs for a Single-Lane Exit to the Left with a Dropped Lane

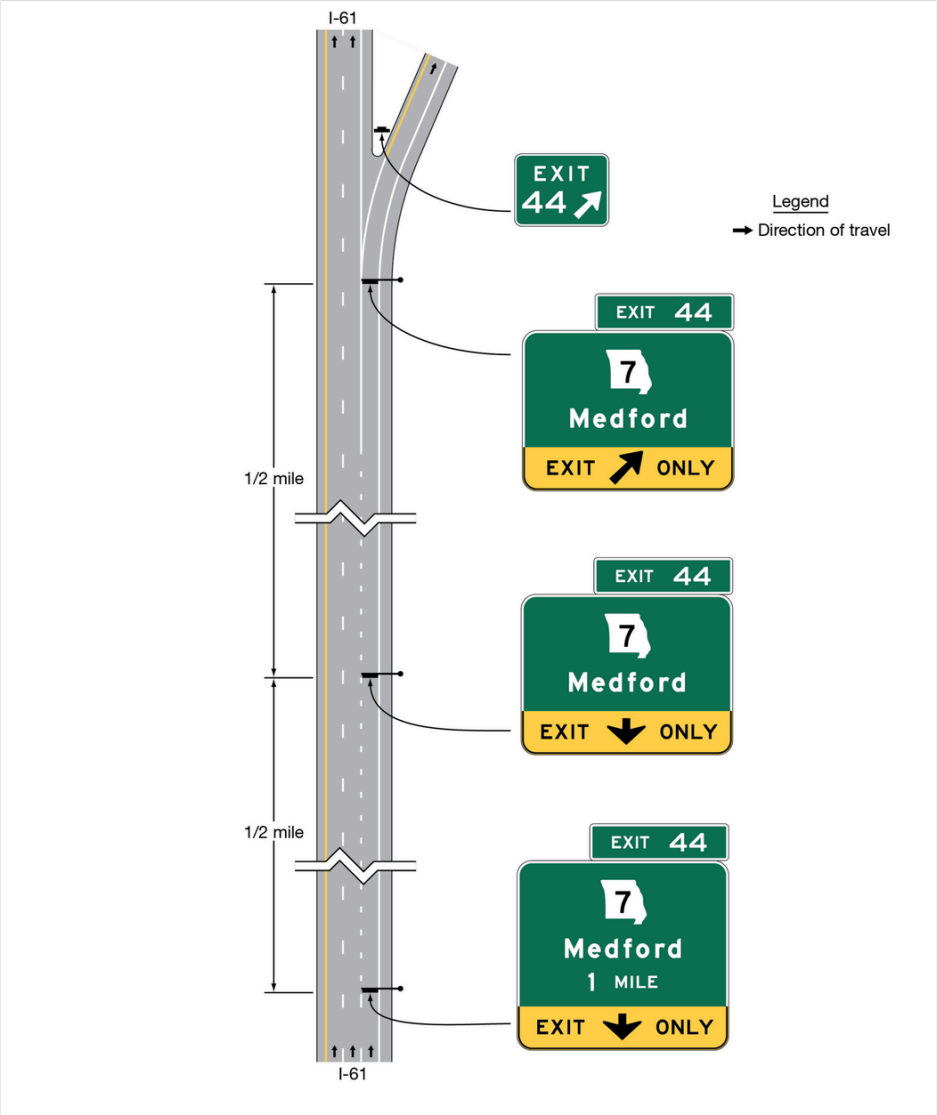


Figure 903.5.28.3 Guide Signs for a Single-Lane Exit to the Right with a Dropped Lane

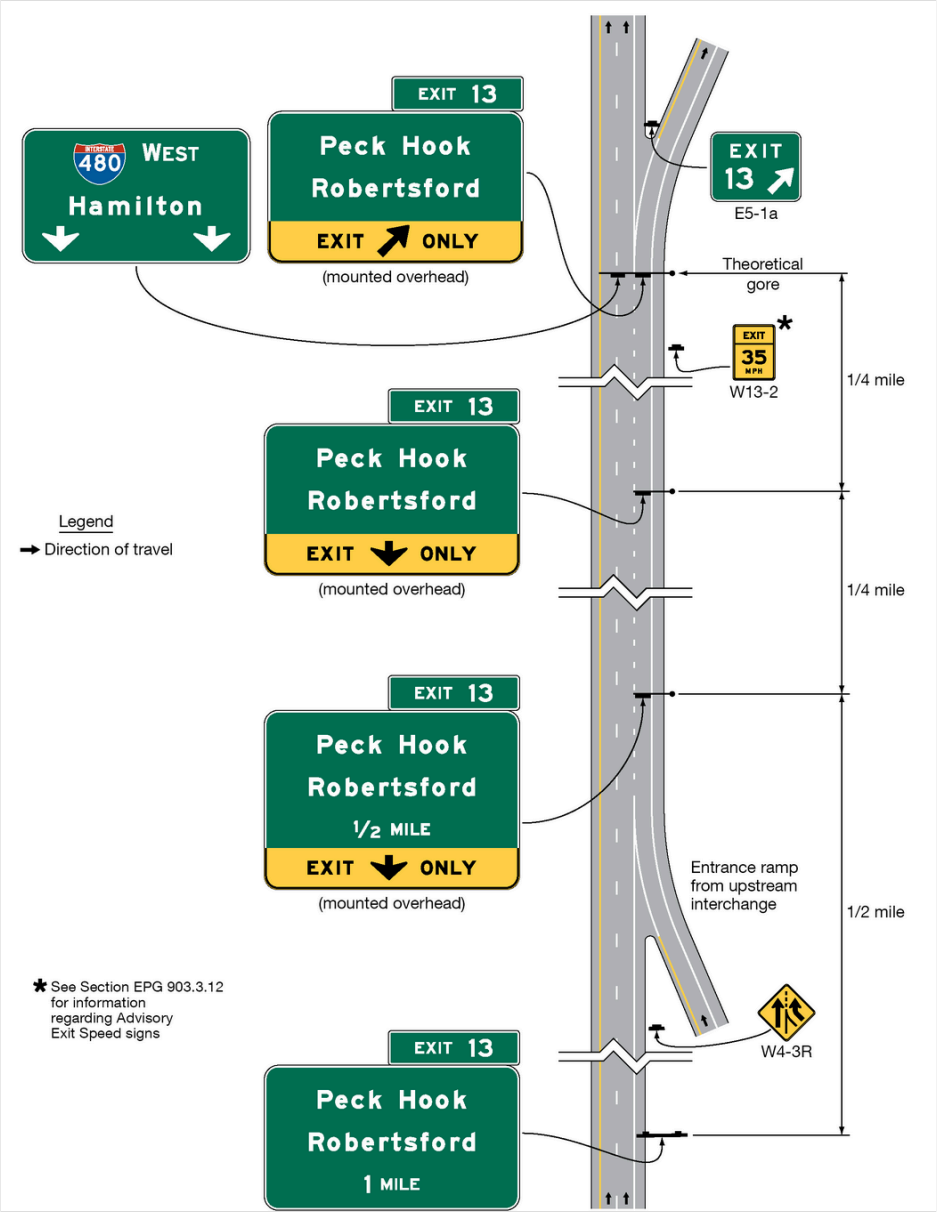


Figure 903.5.28.4 Examples of Overhead Guide Signs for a Dropped Auxiliary Lane between Separate Interchange Ramps

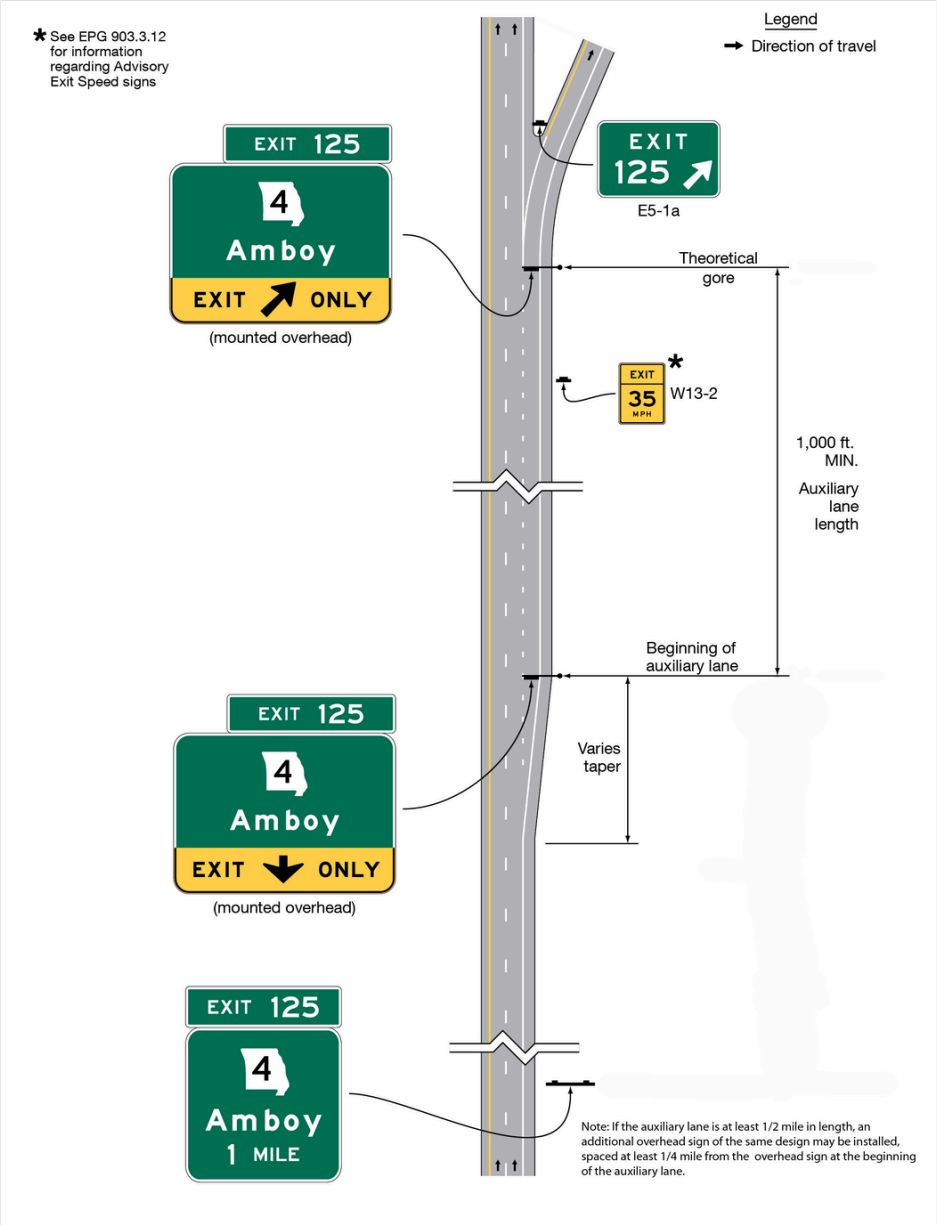


Figure 903.5.28.5 Examples of Guide Signs for an Auxiliary Lane of at Least 1,000 Feet in Length

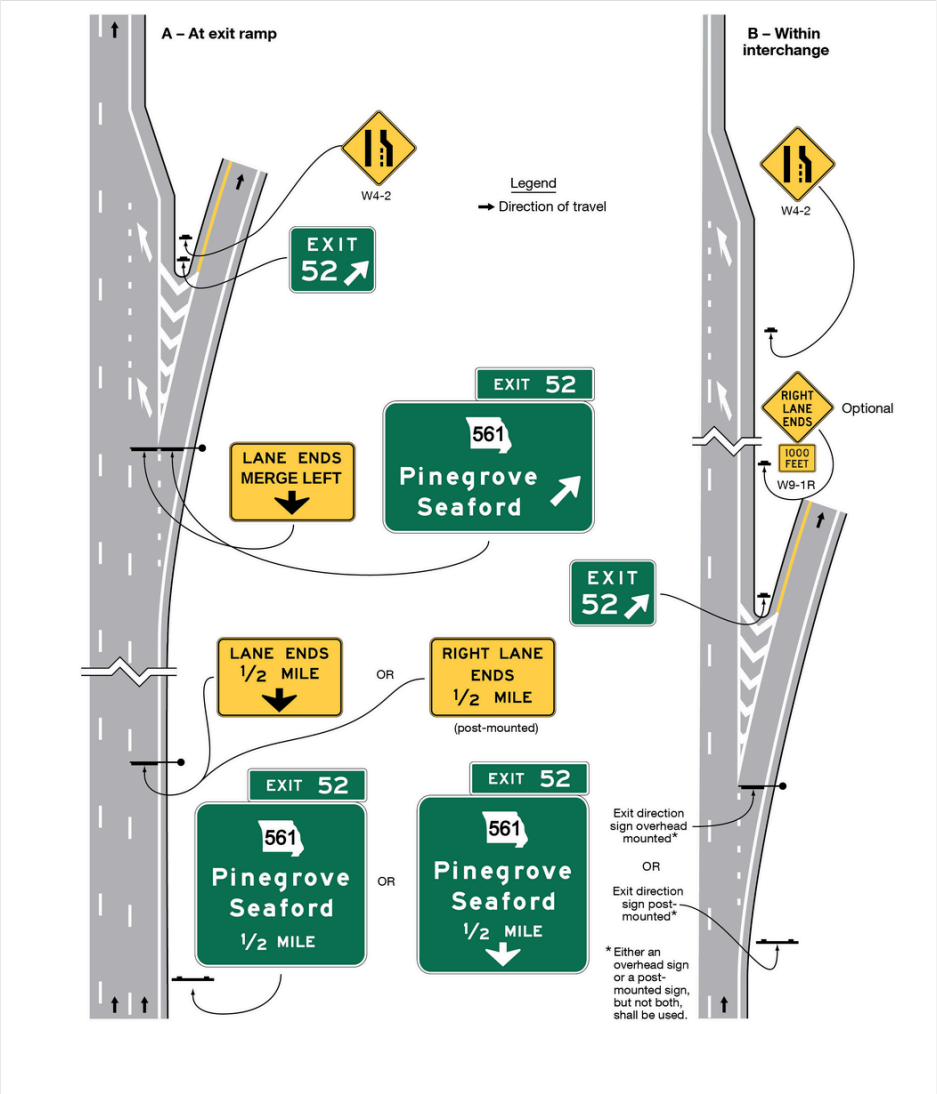


Figure 903.5.28.6 Examples of Signing for Mainline Terminations within an Interchange

903.5.29 Signing by Type of Interchange (MUTCD Section 2E.29)

Support. Road users need signs to help identify the location of the exit, as well as to obtain route, direction, and destination information for specific exit ramps. Figures 903.5.30 through 903.5.36.2 show examples of guide signs for common types of interchanges. The interchange layouts shown in most of the figures illustrate only the major guide signs for one direction of traffic on the freeway and on the exit ramps. EPG 903.4.44 contains information regarding the signing of the crossroad approaches and connecting roadways to freeways and expressways.

Guidance. The signing layout for all interchanges of the same type should be similar. For the purpose of uniform application, the significant features of the signing layout for each of the more frequent types of interchanges (illustrated in Figures 903.5.29.1 through 903.5.36.2) should be followed as closely as possible. Even when unusual geometric features exist, variations in signing layout should be held to a minimum.

Where a single interchange combines a different type of ramp configuration for each direction of travel, the main roadway major guide signing should be determined by the specific interchange type for that direction of travel.

Support. Figures 903.5.29.1 and 903.5.29.2 shows examples of signing for an interchange exit ramp with a downstream split.

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Figure 903.5.29.1 Examples of Signing for an Interchange Exit Ramp with a Downstream Split



Figure 903.5.29.2 Examples of Signing for an Interchange Exit Ramp with a Downstream Split

903.5.30 Diamond Interchange (MUCTD Section 2E.31)

Support. An example of guide signs for a diamond interchange is shown in Figure 903.5.30.

The typical diamond interchange ramp departs from the main roadway such that a speed reduction generally is not necessary in order for a driver to negotiate an exit maneuver from the main roadway onto the ramp roadway. EPG 903.3.12 contains provisions for the use of an Advisory Exit Speed (W13-2) sign for situations where a speed reduction is necessary.

Guidance. When a speed reduction is not necessary, an Advisory Exit Speed sign should not be used.

The Advisory Exit Speed sign, if used, should be located along the deceleration lane or along the ramp such that it is visible to the driver far enough in advance to allow the driver to decelerate before reaching the curve associated with the exiting maneuver. Use and placement of the Advisory Exit Speed sign should otherwise comply with EPG 903.3.12 of the EPG.

Option. A Stop Ahead (W3-1) or Signal Ahead (W3-3) warning sign (see EPG 903.3.29) may be placed, where engineering judgment indicates a need, along the ramp in advance of the crossroad, to give notice to the driver.

Guidance. When used on two-lane ramps, Stop Ahead or Signal Ahead signs should be used in pairs with one sign on each side of the ramp.

Where the exit ramp allows traffic to turn in either direction onto the crossroad, a Destination (D1 series) sign (see EPG 903.4.32) that includes each destination displayed on the Advance, Exit Direction, and Supplemental guide signs along the main roadway for that exit should be placed along the ramp.

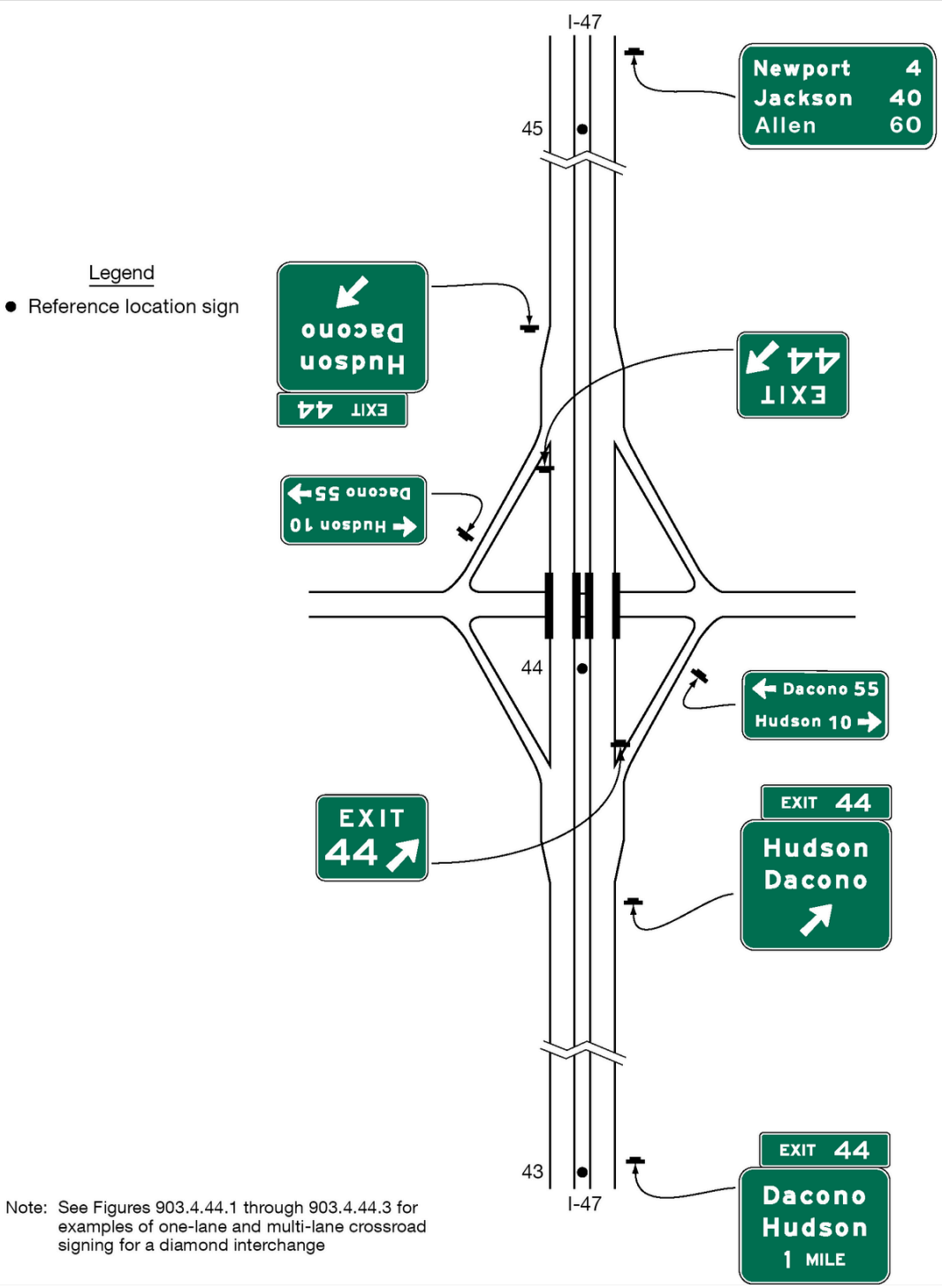


Figure 903.5.30 Example of Guide Signs for a Diamond Interchange

903.5.31 Diamond Interchange in Urban Area (MUTCD Section 2E.32)

Support. An example of guide signs for a diamond interchange in an urban area is shown in Figure 903.5.31. This example includes the use of the Community Interchanges Identification sign (see EPG 903.5.50), which might be useful if two or more interchanges serve the same community.

In urban areas, street names are often displayed as the principal message in destination signs.

Option. If interchanges are too closely spaced to locate the Interchange Advance guide signs at the distances specified in EPG 903.5.23, they may be placed closer to the exit with the distances displayed adjusted accordingly.

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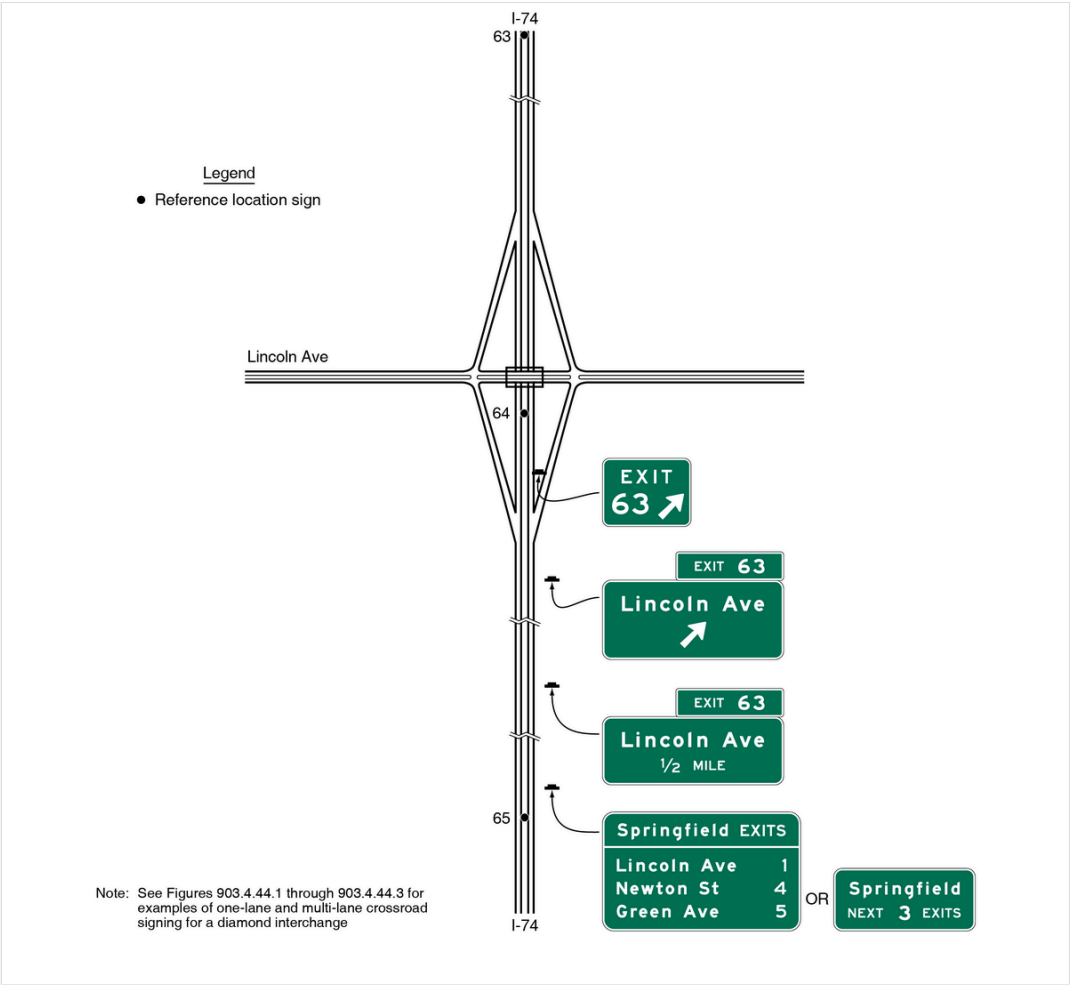


Figure 903.5.31 Example of Guide Signs for a Diamond Interchange in an Urban Area

903.5.32 Cloverleaf Interchange (MUTCD Section 2E.33)

Support. A cloverleaf interchange has two exits for each direction of travel. The exits are closely spaced and have common Advance guide signs. An example of guide signs for a cloverleaf interchange is shown in Figure 903.5.32.

Guidance. The Advance guide signs should include two place names, one corresponding to each exit ramp, with the name of the place served by the first exit on the upper line.

Standard. An overhead guide sign assembly shall be placed at the theoretical gore of the first exit ramp, with an Exit Direction sign for the first exit and an Interchange Advance guide sign for the second exit, as shown in Figure 903.5.32. The second exit shall be indicated by an overhead Exit Direction sign over the auxiliary lane.

Interchanges with more than one exit from the main roadway shall be numbered as described in EPG 903.5.22 with an appropriate suffix.

Guidance. Where the main roadway passes under the crossroad and the exit roadway is located beyond the overcrossing structure, the placement of the overhead Exit Direction sign for the second exit should comply with EPG 903.5.25 (see Figure 903.5.32).

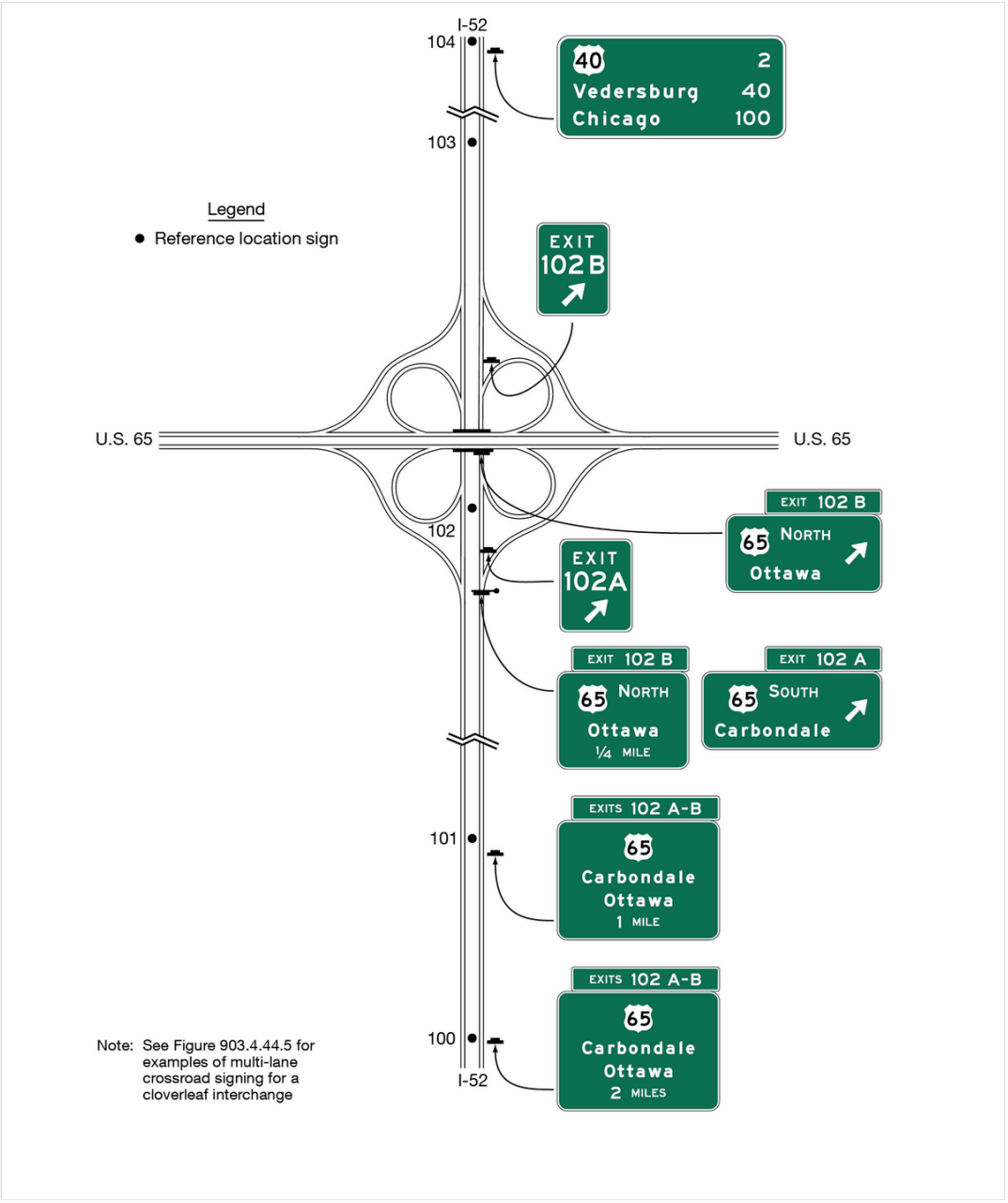


Figure 903.5.32 Example of Guide Signs for a Full Cloverleaf Interchange

903.5.33 Cloverleaf Interchange with Collector-Distributor Roadways (MUTCD Section 2E.34)

Support. An example of guide signs for a full cloverleaf interchange with collector-distributor roadways is shown in Figure 903.5.33.

Guidance. Destination names and route numbers shown on the collector-distributor roadway signing should be the same as those used on the upstream Interchange Advance guide signs on the main roadway.

Standard. Exit Direction signs at exits from the collector-distributor roadways shall be overhead and located at the theoretical gore of the collector-distributor roadway and the exit ramp.

Guidance. Exits from the collector-distributor roadways should be numbered with an appropriate suffix. If the exits from a collector-distributor roadway are numbered, the Interchange Advance guide and Exit Direction signs on the main roadway should include, in addition to two place names, their corresponding exit number and suffixes with the plural EXITS in the Exit Number (E1-5P series) plaque. If only the exit from the main roadway is numbered, the Interchange Advance guide and Exit Direction signs on the main roadway should use the singular EXIT in the Exit Number plaque. If interchange exit numbering is not used, the Interchange Advance guide signs on the main roadway should use the singular EXIT in the distance messages.

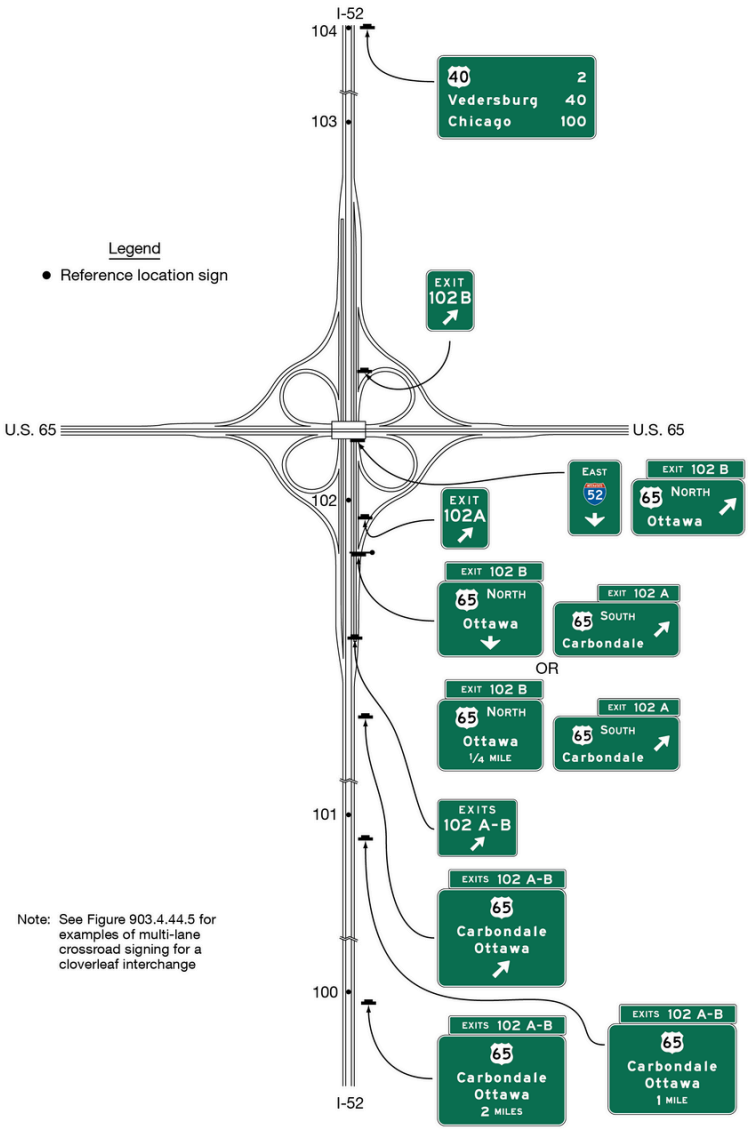


Figure 903.5.33 Example of Guide Signs for a Full Cloverleaf Interchange with Collector-Distributor Roadways

903.5.34 Partial Cloverleaf Interchange (MUTCD Section 2E.35)

Support. An example of guide signs for a partial cloverleaf interchange is shown in Figure 903.5.34.

Guidance. For a partial cloverleaf with only one exit roadway in a direction of travel, where the main roadway passes under the crossroad and the exit roadway is located beyond the overcrossing structure, the overhead Exit Direction sign should be placed either on the overcrossing structure (see Figure 903.5.34) or on a separate structure located immediately in front of the overcrossing structure.

Support. Partial cloverleaf interchanges with successive exit ramps from the same direction of travel are signed the same as cloverleaf interchanges for that direction of travel (see EPG 903.5.32).

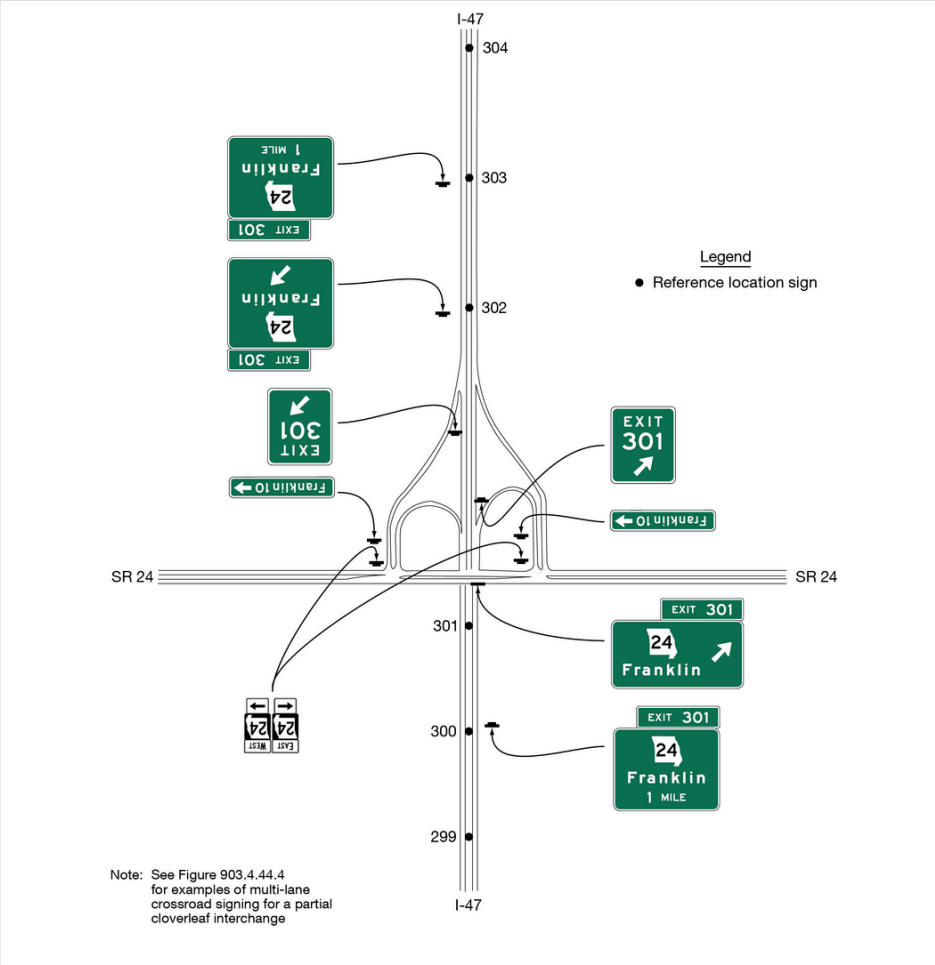


Figure 903.5.34 Example of Guide Signs for a Partial Cloverleaf Interchange

903.5.35 Collector-Distributor Roadways for Successive Interchanges (MUTCD Section 2E.36)

Support. Examples of guide signs for a collector-distributor roadway that provides access to multiple interchanges are shown in Figures 903.5.35.1 and 903.5.35.2. EPG 903.10 contains provisions for General Service and Specific Service signs.

Guidance. Where access to successive interchanges is provided from a single collector-distributor roadway, the number of lines of destination information displayed on the major guide signs on the main roadway approach to the collector-distributor roadway should comply with the provisions of EPG 903.5.14.

Where exit numbering is used, the exit numbers for exits accessed from the collector-distributor roadway should be displayed on the main roadway guide signs.

An Exit Gore sign (see EPG 903.5.26) should be placed in the gore where the collector-distributor roadway departs from the main roadway.

Interchange guide signing along the collector-distributor roadway should comply with the provisions for interchange signing in EPG 903.5.

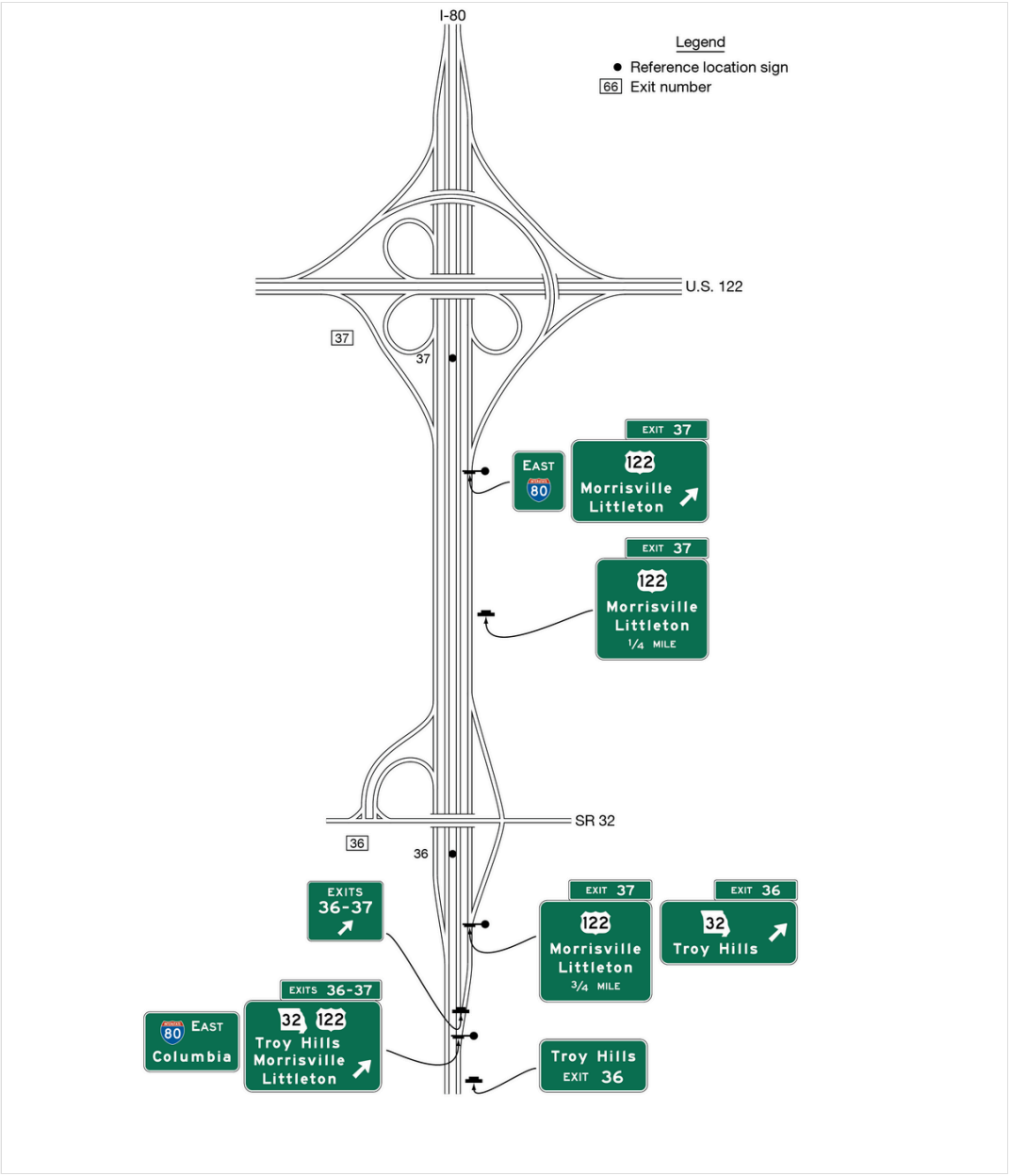


Figure 903.5.35.1 Example of Guide Signs for Successive Interchanges With Collector-Distributor Roadways

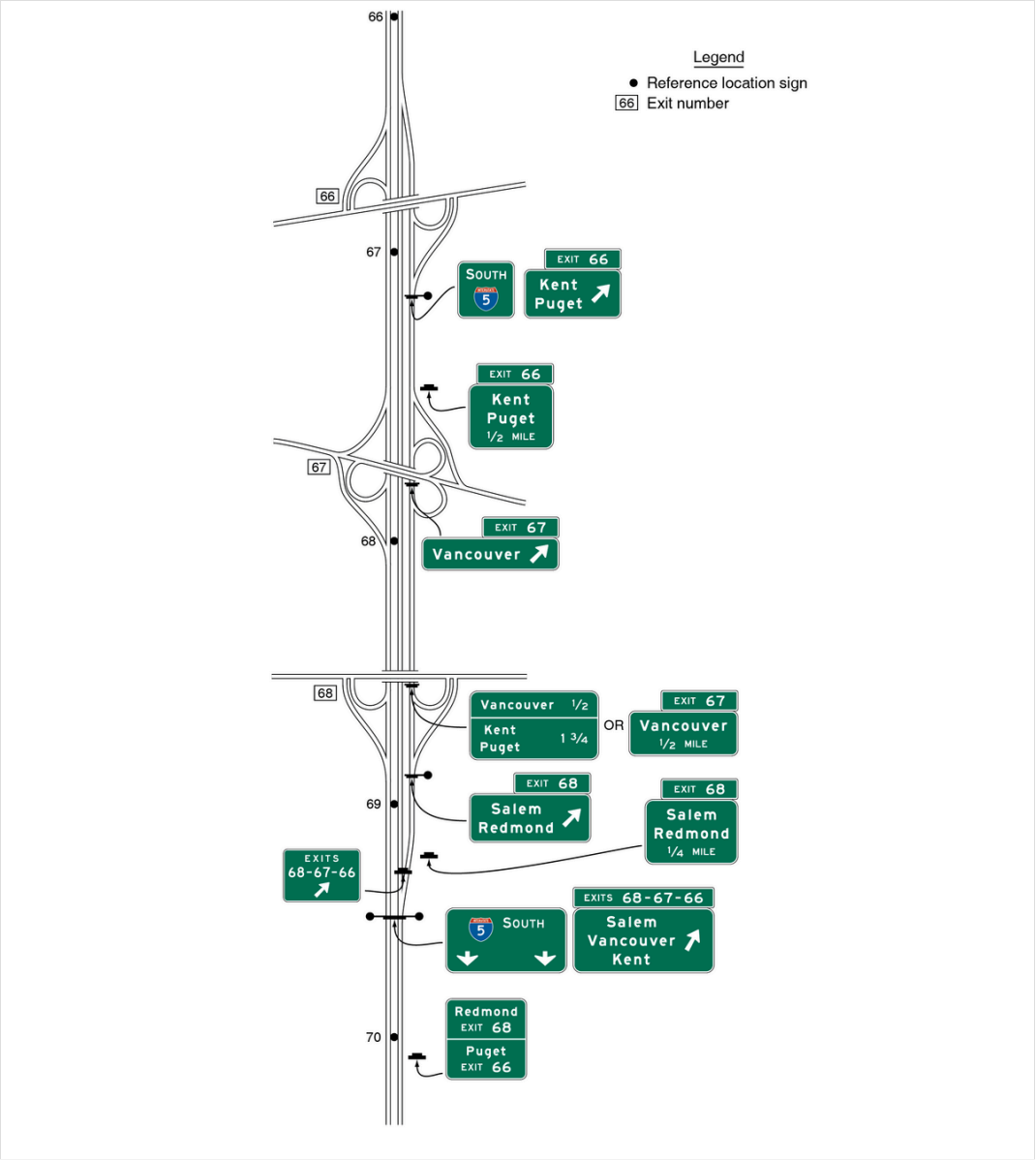


Figure 903.5.35.2 Example of Guide Signs for Successive Interchanges With Collector-Distributor Roadways

903.5.36 Freeway-to-Freeway Interchanges (MUTCD Section 2E.37)

Support. Freeway-to-freeway interchanges are major decision points where the effect of taking a wrong ramp cannot be easily corrected. Reversing direction on the connecting freeway or reentering to continue on the intended course is usually not possible. Examples of guide signs for freeway-to-freeway interchanges are shown in Figures 903.5.36.1 and 903.5.36.2.

Guidance. The sign messages should contain only the route shield, cardinal direction, and the name of the next control city on the route. Arrows should point as indicated in EPG 903.4.8, except where Overhead Arrow-per-Lane signs are used in accordance with the provisions of EPG 903.5.38 and 903.5.39.

Support. An off-route movement is the movement that does not follow the through route. Drivers might not expect the off-route movement to be to the left or an optional lane at a split (see Figure 903.5.39.4). EPG 903.5.22 contains information about the use of the Left Exit Number (E1-5fP through E1-5kP) plaque at splits where the off-route movement is to the left. EPG 903.5.38 and 903.5.39 contain information about the use of Overhead Arrow-per-Lane guide signs for freeway splits with an option lane and for multi-lane freeway-to-freeway exits having an option lane.

Standard. The roadway for the off-route shall be signed as an exit. If exit numbering is used, the signs shall comply with the provisions of EPG 903.5.22. Distance messages on the Advance guide signs shall comply with the provisions of EPG 903.5.23.

Overhead signs shall be used at a distance of 1 mile and at the theoretical gore of each connecting ramp. When Overhead Arrow-per-Lane signs are used, they shall be located in accordance with the provisions of EPG 903.5.39.

Option. The Advance guide signs at the ½-mile and 2-mile locations may also be mounted overhead.

Guidance. An Advisory Exit Speed (W13-2) sign should be used where an engineering study shows that it is necessary to display a speed reduction message for ramp signing (see EPG 903.3.12).

A – Example of signing for a two-lane exit ramp with two dropped lanes and a bifurcation beyond the mainline gore

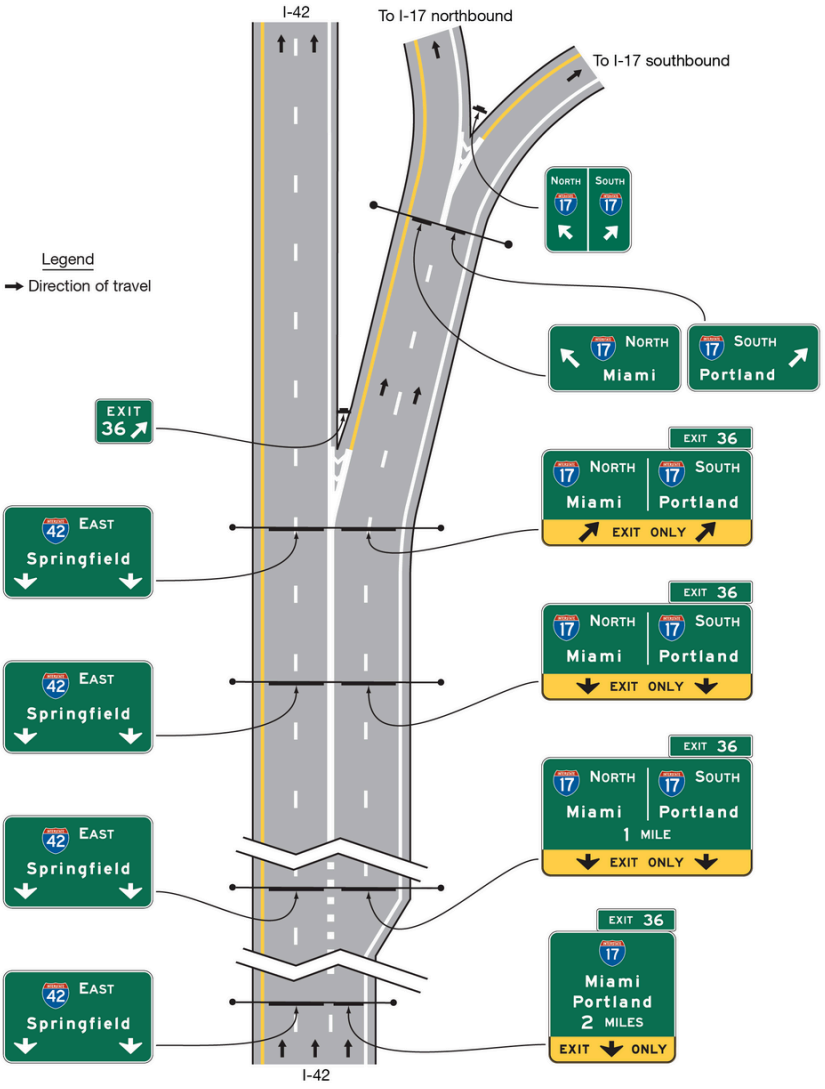


Figure 903.5.36.1 Example of Guide Signs for Freeway-to-Freeway Interchange

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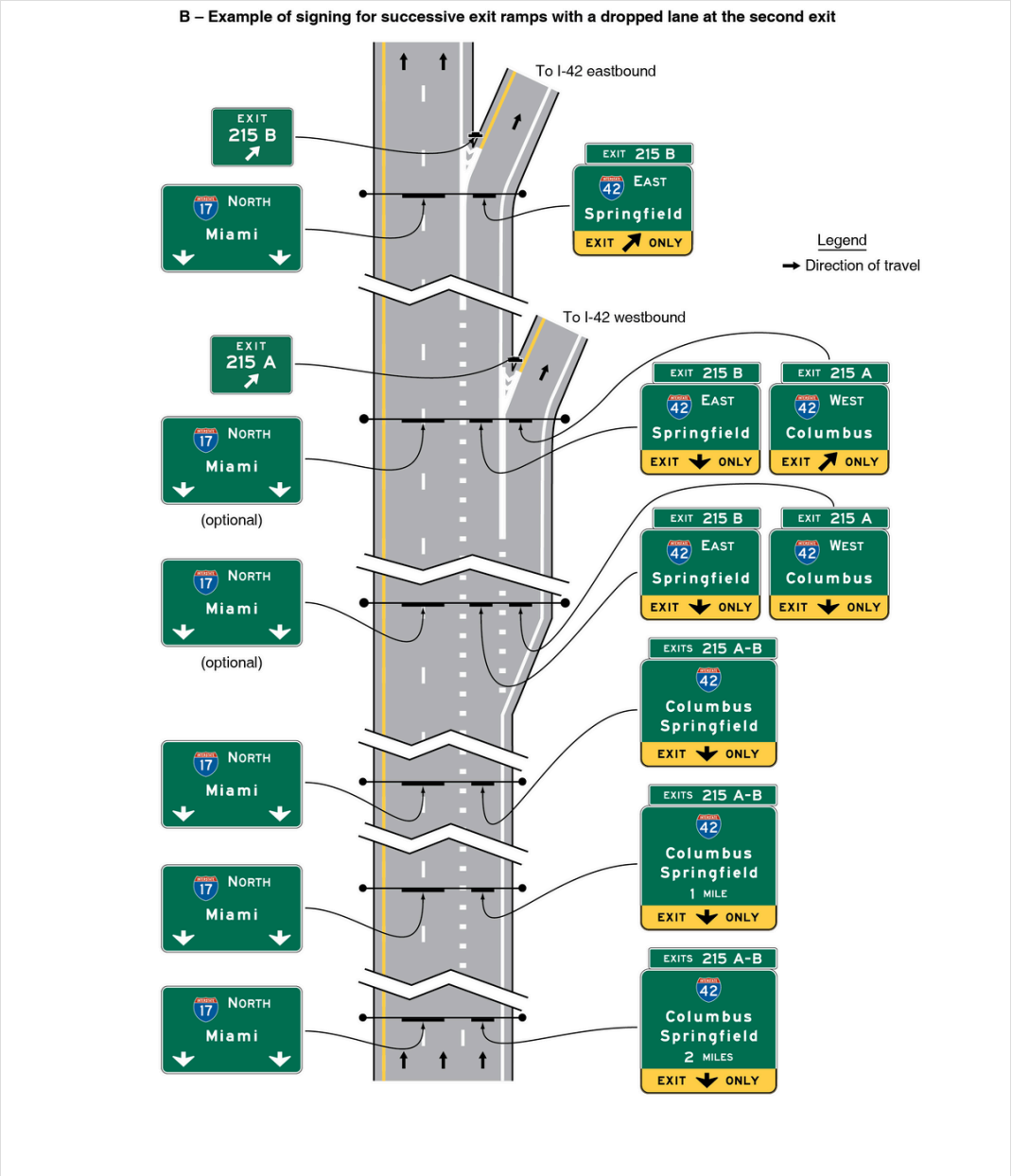


Figure 903.5.36.2 Example of Guide Signs for Freeway-to-Freeway Interchange

903.5.37 Freeway Split with Dedicated Lanes (MUTCD Section 2E.38)

Standard. Signing for freeway splits with dedicated lanes shall use the sign designs shown in Figure 903.5.37.

The arrows on each Interchange Advance guide sign shall match the number of lanes present at the location of the Advance guide sign.

The signs for this application shall be mounted overhead. When arrows are used, each arrow shall be located over the approximate center of the lane to which it applies.

Where one roadway of the split carries the through route, the other roadway of the split shall be signed as an exit. If exit numbering is used, the signs shall comply with the provisions of EPG 903.5.22. Distance messages on the Advance guide signs shall comply with the provisions of EPG 903.5.23.

The number and location of Advance guide signs shall comply with the provisions of EPG 903.5.23.

Guidance. The Exit Direction and Pull-Through signs should be located at the theoretical gore.

The Exit Direction and Pull Through signs should display down arrows if the alignment is straight or diagonal upward-pointing directional arrows if the alignment is curved (see EPG 903.4.8).

Standard. The Exit Direction sign shall contain the EXIT ONLY (E11-1 series) sign panel (see EPG 903.5.28).

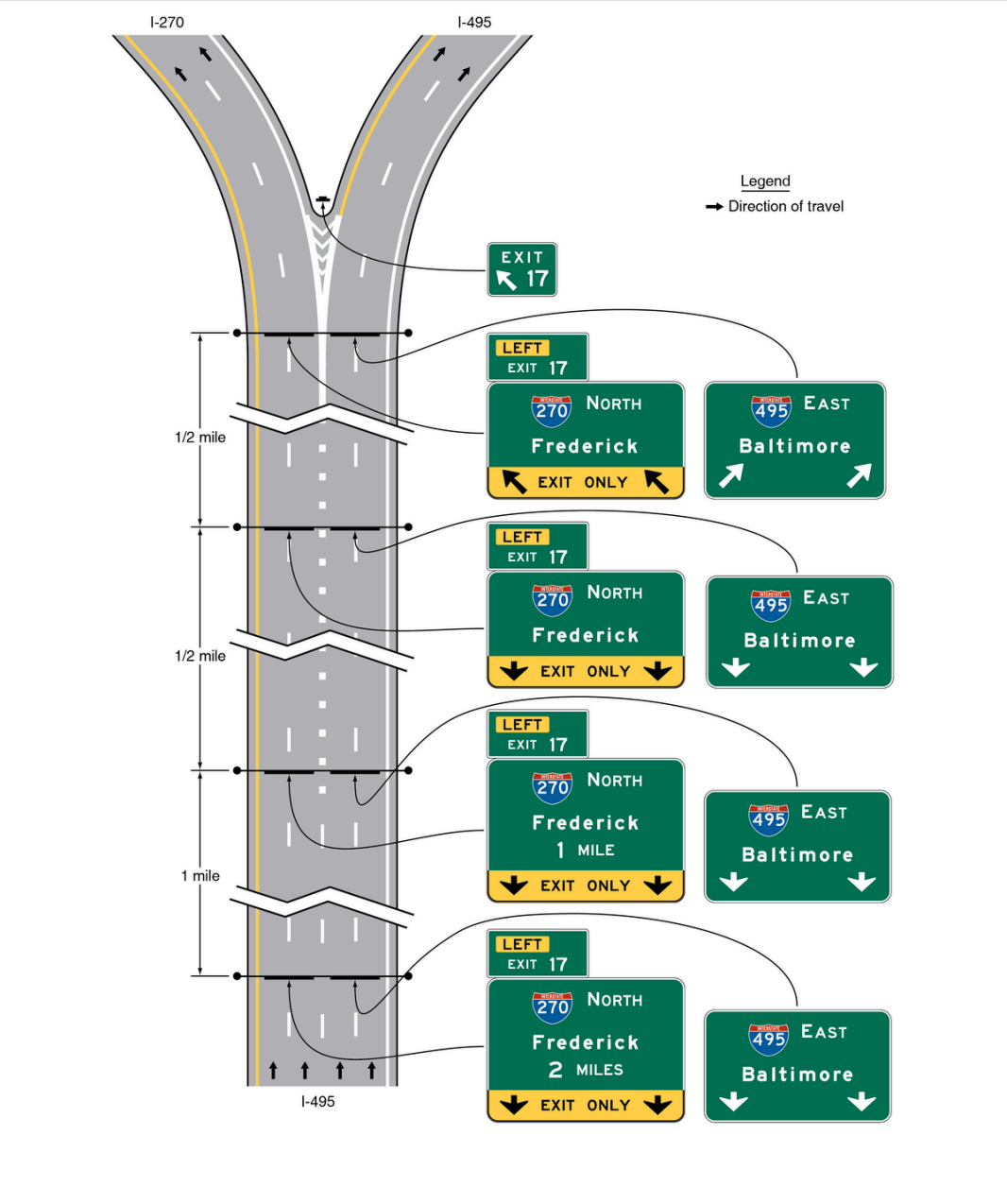


Figure 903.5.37 Example of Guide Signs for a Split with Dedicated Lanes

903.5.38 Signing for Option Lanes at Splits and Multi-Lane Exits (MUTCD Section 2E.39)

Support. Some freeway and expressway splits or multi-lane exit interchanges contain an interior option lane serving both movements in which traffic can either leave the route or remain on the route, or choose either destination at a split, from the same lane.

Standard. On freeways and expressways, Overhead Arrow-per-Lane guide sign designs as provided in EPG 903.5.39 shall be used for all multi-lane exits at interchanges (see EPG 903.5.10) that have an optional exit lane that also carries the through route (see Figures 903.5.39.2 and 903.5.39.3) and for all splits that include an option lane (see Figure 903.5.39.4). Overhead Arrow-per-Lane guide signs shall not be used on freeways and expressways for any other types of exits or splits, including single-lane exits and splits that do not have an option lane.

903.5.39 Design of Overhead Arrow-per-Lane Guide Signs for Option Lanes (MUTCD Section 2E.40)

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Figure 903.5.39.1 Example of an Overhead Arrow-per-Lane Guide Sign for a Multi-Lane Exit with an Option Lane

Support. Overhead Arrow-per-Lane guide signs (see Figure 903.5.39.1) are used where an option lane is present at freeway and expressway multi-lane exit interchanges and splits. They display an upward-pointing arrow above each lane that conveys the direction(s) of travel that the lane serves at the point of departure. At locations where an option lane is present at a multi-lane exit or split, Overhead Arrow-per-Lane guide signs have been shown to be superior to other guide sign designs because they convey positive direction about which destination and direction each approach lane serves, particularly for the option lane, which is otherwise difficult to clearly sign.

Standard. Overhead Arrow-per-Lane guide signs as provided in EPG 903.5.38 shall be used at all new or reconstructed freeway and expressway locations and at freeway and expressway locations where replacement of existing sign support structures is necessitated by reconstruction. The Overhead Arrow-per-Lane guide sign at the exit or split shall be located at or in the immediate vicinity of the point where the exiting lanes begin to diverge from the through lanes or, for a split, at the point where the approach lanes begin to diverge from one another, preserving the relation of the arrows displayed on the sign to their respective lanes. The Overhead Arrow-per-Lane guide sign at the exit shall not be located at or near the theoretical gore.

Option. At existing or non-reconstructed locations where an overhead Exit Direction sign exists at the theoretical gore, and the existing sign support structure is retained, an overhead Exit Direction sign may continue to be used on the existing sign support structure in conjunction with a replacement of the advance signs using the Overhead Arrow-per-Lane guide sign design.

Standard. If an existing Exit Direction sign is being retained at an interchange as provided in the previous paragraph, an Overhead Arrow-per-Lane guide sign shall not be used at the location of the Exit Direction sign at or in the vicinity of the theoretical gore. New installations of Exit Direction and Pull-Through signs shall not be permitted in conjunction with Overhead Arrow-per-Lane guide signs on new or reconstructed facilities.

Guidance. Overhead Arrow-per-Lane guide signs should be located at approximately ½ mile and 1 mile in advance of the exit or split, and at approximately 2 miles in advance of the exit or split where space is available and conditions allow.

Standard. Overhead Arrow-per-Lane guide signs used on freeways and expressways shall be designed in accordance with the following criteria:

A. The sign shall include an upward-pointing (vertical, curved, or bifurcated) arrow for each lane of the approach to the split or exit.
B. The shaft of each arrow shall be located over the approximate center of the lane to which it applies.
C. Arrows for continuing through lanes shall be vertically upward-pointing (see Figure 903.5.39.2) unless the continuing through lanes are on a significantly curved alignment beyond the theoretical gore (see Figure 903.5.39.3).
D. The arrow for a lane that must exit shall be curved in the direction of the exit and shall be accompanied by black-on-fluorescent yellow EXIT (E11-1a) and ONLY (E11-1b) sign panels adjacent to the lower end of the arrow shaft. The E11-1a and E11-1b sign panels shall not be used for a split of two overlapping routes where neither of the diverging routes is designated as an exit. Where the through lanes curve and the exit continues on a straight alignment, upward-pointing vertical arrows shall be used for the exiting movement and curved arrows for the through movement (see Figure 903.5.39.3).
E. The arrow for an optional exit lane that also carries the through route shall have a single shaft that bifurcates into a vertically upward-pointing arrow and a curving arrow corresponding to the configuration of the through and exit lanes.
F. For splits with an option lane, the arrow for the lane from which either direction of the split can be accessed shall have a single shaft that bifurcates into two upward-pointing curving arrows (see Figure 903.5.39.4).
G. A vertical white line shall be used to separate the route shields and destinations for the two diverging movements from each other.
H. The distance to the exit or split shall be displayed below the off-movement destination on the advance signs at the 1-mile and 2-mile locations.
I. The number of lanes displayed on a sign shall correspond to the number of lanes at the location of that sign. An advance sign shall not depict lanes that are added downstream of the sign location.
J. For numbered exits, the Exit Number (E1-5P) or Left Exit Number (E1-5bP) plaque shall be used at the top of the sign in accordance with EPG 903.5.23. For unnumbered exits to the left, a LEFT (E1-5mP) plaque shall be added on the top left-hand edge of and adjacent to the sign.

Guidance. Overhead Arrow-per-Lane guide signs used on freeways and expressways should be designed in accordance with the following additional criteria:

A. No more than one destination should be displayed for each movement, and no more than two destinations should be displayed per sign.
B. The arrowhead(s) for the diverging movement should be positioned lower on the sign than the arrowhead(s) for the movement that continues straight ahead, independent of which movement carries the through route. Where the movements are freeway or expressway splits rather than exits, the arrowheads should be positioned at approximately the same height on the sign.
C. Route shields, cardinal directions, and destinations should be positioned on the sign such that they are clearly related to the arrowhead(s) for the movement to which they apply.
D. The cardinal direction should be placed adjacent to the route shield for exits or splits leading in a single cardinal direction.
E. The vertical white line that is used to separate the route shields and destinations for the two diverging movements from each other should not descend below the top of the arrowheads for the through lanes, and should be positioned approximately halfway between the diverging arrowheads for the optional movement lane (see Figure 903.5.39.1).

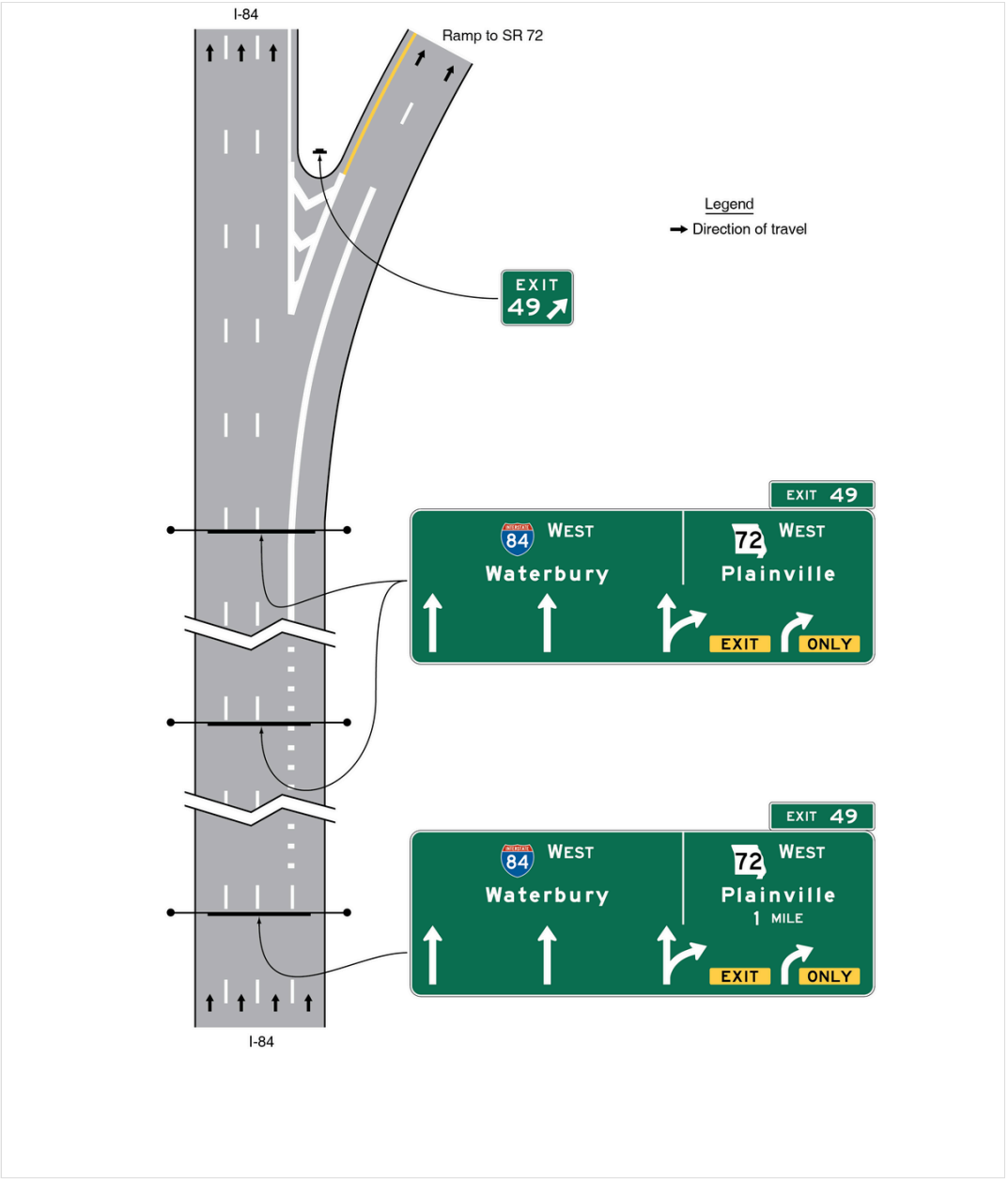


Figure 903.5.39.2 Example of Overhead Arrow-per-Lane Guide Signs for a Two-Lane Exit to the Right with an Option Lane

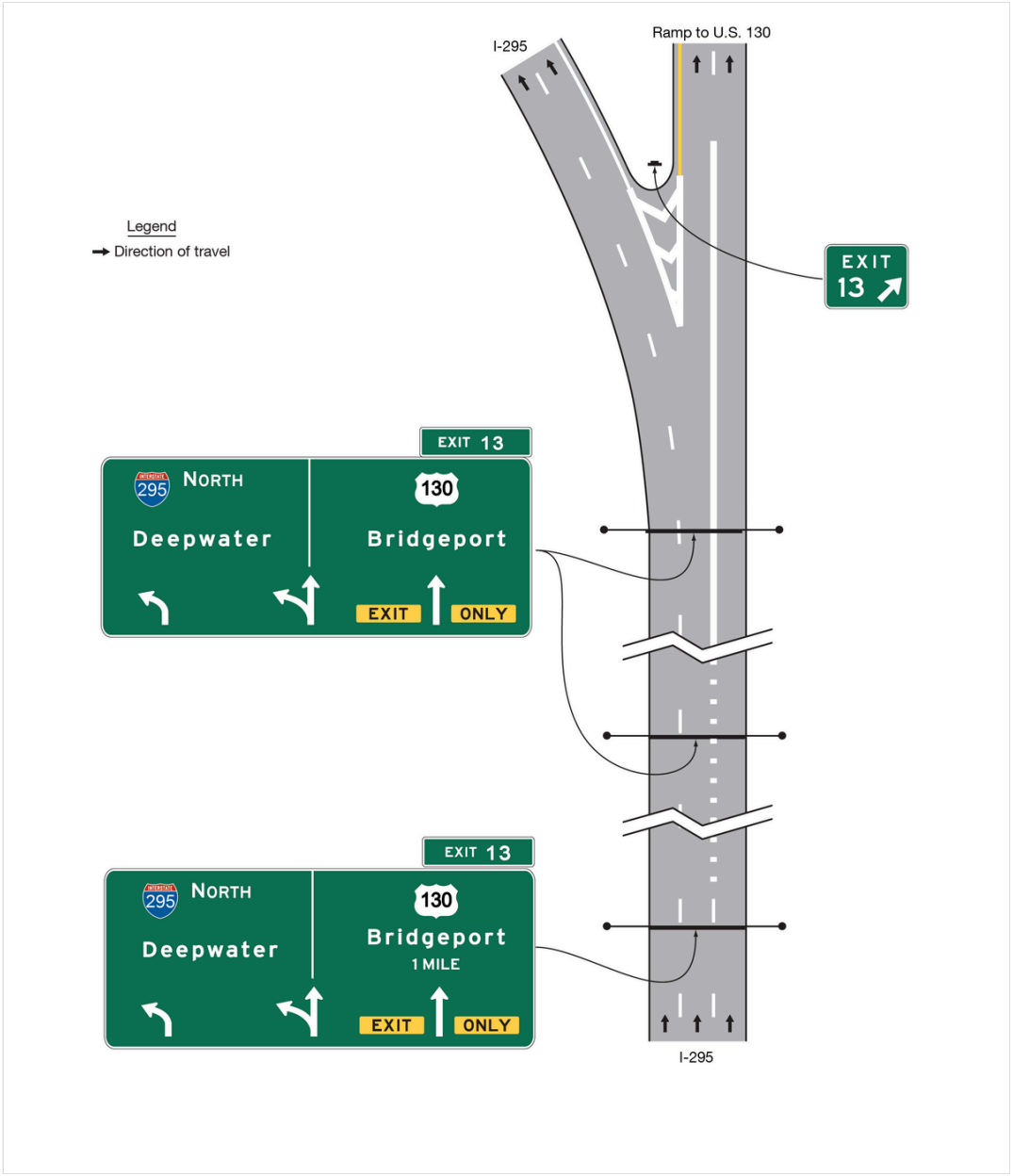


Figure 903.5.39.3 Example of Overhead Arrow-per-Lane Guide Signs for a Two-Lane Exit to the Right with an Option Lane (Through Lanes Curve to the Left)

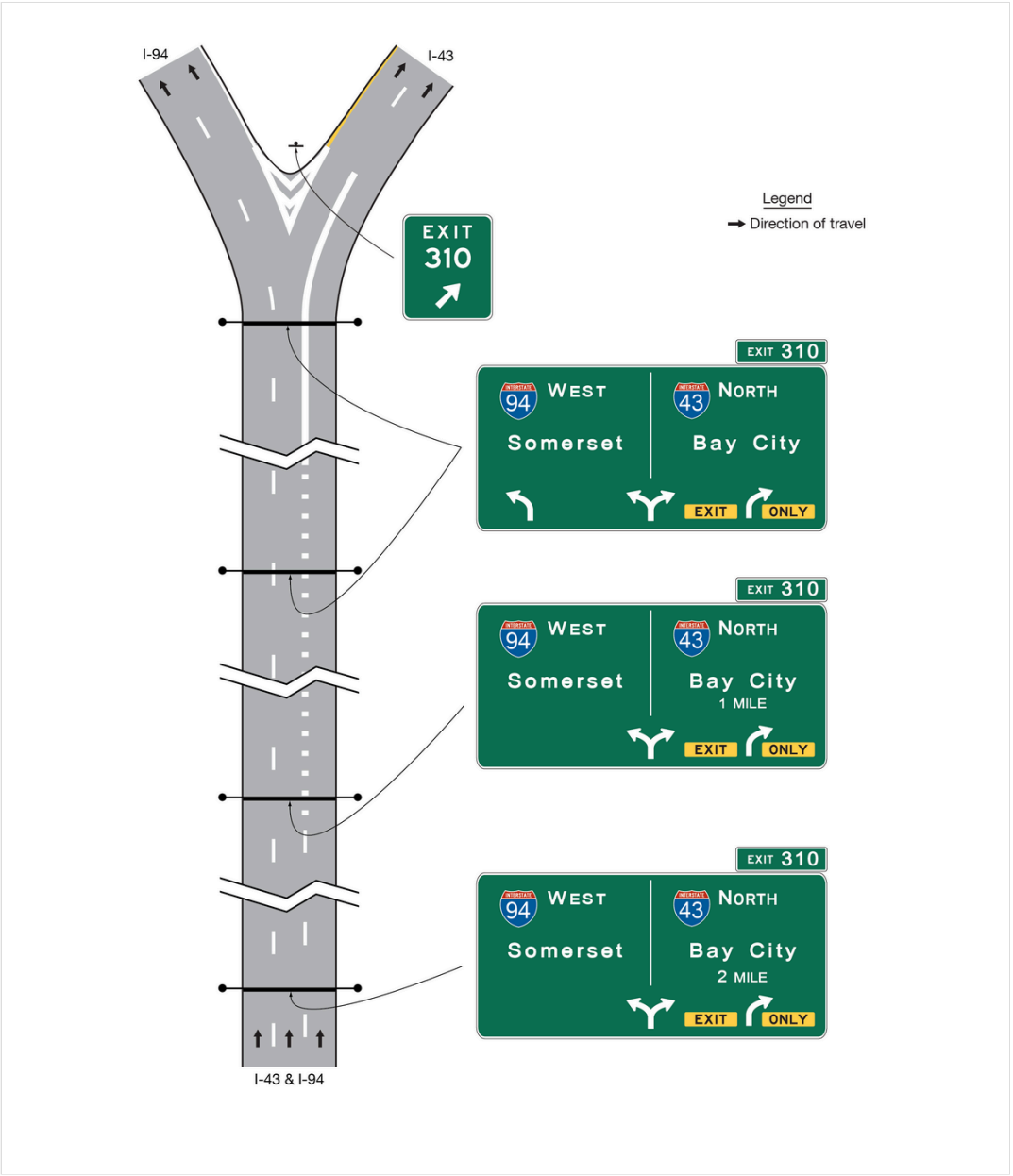


Figure 903.5.39.4 Example of Overhead Arrow-per-Lane Guide Signs for a Split with an Option Lane

Standard. Overhead Arrow-per-Lane guide signs shall not be used to depict a downstream split of an exit ramp on a sign located on the mainline.

Support. Specific detailed design of Overhead Arrow-per-Lane guide signs will be provided by the Highway Safety and Traffic division.

Standard. The arrow heights for Overhead Arrow-per-Lane guide signs on freeways and expressways shall be as shown in Table 903.5.39.

Option. Where extra emphasis of an especially low advisory ramp speed is needed, an EXIT XX MPH (E13-2) sign panel (see Figure 903.5.25.3) may be placed below the applicable destination legend to supplement, but not to replace, the exit or ramp advisory speed warning signs.

Table 903.5.39 Overhead Arrow-per-Lane Arrow Height Based on Principal Legend Letter Height

Principal Legend Letter Height	Through Arrow	Turn Arrow	Through with Turn Arrow	Split Arrow
16 or less	40	30	40	33.33
Note: Letter and arrow heights are shown in inches.				

903.5.40 Design of Freeway and Expressway Diagrammatic Advance Guide Signs (MUTCD Section 2E.41)

Support. MoDOT no longer uses diagrammatic signs for option lanes. Overhead arrow-per-lane guide signs are used exclusively for this purpose.

903.5.41 Number of Signs at an Overhead Installation and Sign Spreading (MUTCD Section 2E.43)

Guidance. If overhead signs are warranted, as set forth in EPG 903.1.13, the number of signs at these locations should be limited to only those essential in communicating pertinent destination information to the road user. Exit Direction signs for a single exit and the Interchange Advance Guide signs should have only one sign with one or two destinations. Regulatory signs, such as speed limits, should not be used in conjunction with overhead guide sign installations. Because road users have limited time to read and comprehend sign messages, there should not be more than three guide signs displayed at any one location either on the overhead structure or its support for one direction of travel.

Option. At overhead locations, more than one sign may be installed to advise of a multiple exit condition at an interchange. If the roadway ramp or crossroad has complex or unusual geometrics, additional signs with confirming messages may be provided to properly guide the road user.

Support. Sign spreading is a concept where major overhead signs are spaced so that road users are not overloaded with a group of signs at a single location.

Guidance. Where overhead signing is used, sign spreading should be used at all single-exit interchanges and to the extent possible at multi-exit interchanges. Sign spreading should be accomplished by use of the following:

A. The Exit Direction sign should be the only guide sign used in the vicinity of the gore (other than the Exit Gore sign). It should be located overhead near the theoretical gore and generally on an overhead sign support structure.
B. The Interchange Advance guide sign to indicate the next interchange exit should be placed near the crossroad location. If the crossroad goes over the mainline, the Interchange Advance guide sign should be placed on the overcrossing structure or on a separate structure immediately in front of the overcrossing structure.

903.5.42 Closely-Spaced Interchanges (MUTCD Section 2E.44)

Support. EPG 903.5.41 contains information regarding sign spreading where the Exit Direction sign and the Interchange Advance guide sign for the next interchange are mounted overhead. Sign spreading is particularly beneficial where interchanges are closely spaced and overhead signing is used in conjunction with Interchange Sequence signs as provided in the following paragraph.

Guidance. Interchange Sequence signs (see EPG 903.5.24) should be used at closely-spaced interchanges. When used, they should identify and show street names and distances for the next two or three exits as shown in Figure 903.5.24.

Standard. Interchange Advance guide signs for closely-spaced interchanges shall show information for only one interchange.

903.5.43 Guide Signing in Tunnels and Similar Structures (MUTCD Section 2E.45)

Support. The application of the provisions for freeway and expressway guide signs in tunnels and other similar structures can present unique challenges not encountered elsewhere due to the extended and continuous distances of constrained vertical and horizontal clearances in which to place signs. The effect of these constraints is particularly evident when there are interchange exit ramps inside the tunnel that require guide signing. As a result, it might not always be possible to use the typical layouts for guide signs inside a tunnel. In addition, interchange guide signs might need to be limited to one destination only, with other destinations displayed separately on Supplemental guide signs (see EPG 903.5.49). Acceptable methods to modify the layout of a sign to fit the space available in a tunnel are provided in the following paragraph.

Option. Overhead-mounted guide signs in tunnels, or in other similar structures with extended constrained vertical and horizontal clearances, may be modified in accordance with the following when needed to accommodate limited vertical clearance available for signs:

A. Some sign legend elements may be arranged side by side, such as by placing route shields to the left of the destination instead of above.
B. The Exit Number plaque (see EPG 903.5.22) may be placed at the right-hand edge of the sign for right exits or at the left-hand edge of the sign for left exits instead of at the top edge of the sign. The legend of the Exit Number plaque may use a reduced letter height of not less than 6 inches for the word EXIT(S) and not less than 12 inches for numerals and suffixes.
C. Destination and roadway names may be displayed in reduced letter heights with an initial upper-case letter of not less than 10.67 inches, when determined acceptable based on consideration of reduced speed and other relevant factors, while maintaining adequate space between the legend and edges of the sign to ensure legibility and quick recognition.
D. Unusually long destination and roadway names that cannot be adequately shortened or otherwise acceptably abbreviated may be displayed using Series D letters in lieu of Series E (modified).

Standard. Applicability of the provisions of the previous paragraph shall be limited to those signs within the limits of the tunnel or other similar structure and shall not be extended to the approaches to or departures from the tunnel.

Support. Unlike typical guide signs that are exposed to rain, guide signs in tunnels accumulate grime and residue quickly. This accumulation can reduce visual contrast between legend and background and reduce the retroreflectivity of the sign sheeting. Therefore, guide signs in tunnels generally need more maintenance.

Guidance. Overhead signs in tunnels should have external or internal sign illumination to ensure adequate visibility between scheduled maintenance and cleanings.

One or more Interchange Sequence signs (see EPG 903.5.24) should be used on the approach to the tunnel entrance to display the distances to the next interchanges that have exit ramps inside the tunnel or immediately following the end of the tunnel.

Supplementary pavement markings, such as word, arrow, and/or route shield markings, should be considered inside the tunnel in addition to the basic lane and edge line markings.

903.5.44 Next Exit Plaques (E2-1P and E2-1aP) (MUTCD Section 2E.46)



E2-1P



E2-1aP

Option. Where the distance to the next interchange is 5 miles or more, a Next Exit (E2-1P or E2-1aP) plaque may be installed to inform road users of the distance to the next interchange.

Guidance. The Next Exit plaque should not be used unless the distance between successive interchanges is more than 5 miles.

Where the Next Exit plaque is used, the E2-1P plaque should be used where the width of the Interchange Advance guide sign is equal to or greater than the width of the E2-1P plaque. The E2-1aP plaque should be used where the width of the E2-1P plaque exceeds the width of the Interchange Advance guide sign.

Standard. The Next Exit plaque shall display the legend NEXT EXIT XX MILES. If the Next Exit plaque is used, it shall be placed below the Interchange Advance guide sign nearest the interchange. It shall be mounted so as to not adversely affect the breakaway feature of the sign support structure.

903.5.45 Post-Interchange Signs (MUTCD Section 2E.47)

Guidance. If space between interchanges permits, as in rural areas, and where undue repetition of messages will not occur, a fixed sequence of signs should be displayed beginning 500 feet beyond the downstream end of the acceleration lane. At this point a Route Sign assembly should be installed followed by a Speed Limit sign and a Distance sign, each at a spacing of 1,000 feet (see Figure 903.5.21).

Option. On interstates, the route confirmation markers may be omitted due to the existence of the emergency reference markers.

Guidance. If space between interchanges does not permit placement of these three post-interchange signs without encroaching on or overlapping the Advance guide signs necessary for the next interchange, or in rural areas where the interchanging traffic is primarily local, one or more of the post-interchange signs should be omitted.

Option. Usually the Distance sign will be of less importance than the other two signs and may be omitted, especially if Interchange Sequence signs are used. If the sign for through traffic on an overhead assembly already contains the route sign, the post-interchange route sign assembly may also be omitted.

903.5.46 Post-Interchange Distance Signs (E7-1 through E7-3) (MUTCD Section 2E.48)



E7-3

Standard. If used, the Post-Interchange Distance sign shall consist of a one-line, two-line, or three-line sign displaying the names of significant destination points and the distances to those points. The top line of the sign shall identify the next meaningful interchange with the name of the community near or through which the route passes, or if there is no community, the route number or name of the intersected highway.

Guidance. Post-Interchange Distance signs should not be used on roadways that use interchange sequence signing.

Support. The minimum sizes of the route shields identifying a significant destination point are prescribed in Tables 903.5.11.2 and 903.5.11.3.

Guidance. If a second line is used, it should be reserved for communities of general interest that are located on or immediately adjacent to the route or for major traffic generators along the route.

Option. The choice of names for the second line, if it is used, may be varied on successive Distance signs to give road users maximum information concerning communities served by the route.

Standard. The third, or bottom line, shall contain the name and distance to a control city (if any) that has national significance for travelers using the route.

Guidance. Distances to the same destinations should not be shown more frequently than at 5-mile intervals. The distances displayed on these signs should be the actual distance to the destination points and not to the exit from the freeway or expressway. The distance displayed for each community should comply with the provisions of EPG 903.4.38.

Support. For interchanges, all guide sign distances are calculated from the advance sign location to the exit gore. Guide signs are located as close to the actual distance as possible. Guide sign distances do not have to be exact, but they need be as close as practical. For intersections, the stop bar or beginning of the crossroad radius is used to set guide sign distances. When referencing to a cloverleaf or another design where the exit ramps for the same route are separated by an appreciable distance, advance guide sign distances refer to the first theoretical gore.

903.5.47 Post-Interchange Travel Time Sign (MUTCD Section 2E.49)

Support. At certain locations, it might be more meaningful to recurrent road users to display the travel time rather than the distance to a destination. Such instances might be areas of adverse roadway conditions due to weather, such as in mountain passes or high elevations, congestion that occurs during peak travel seasons, or recurring congestion.

EPG 903.5.48 contains information on Distance and Travel Time and Comparative Travel Time signs.

Standard. If used, the Post-Interchange Travel Time sign (see Figure 903.5.47) shall replace of the Post-Interchange Distance sign in the series of post-interchange signs (see EPG 903.5.45).

The Post-Interchange Travel Time sign shall comply with the provisions of the first Paragraph of EPG 903.5.45 with the following exceptions:

A. The distance shall be replaced with a changeable message element to display the current travel time to the applicable destination; and
B. The abbreviation MINS shall follow the changeable message element.

Travel times shall not be used on Interchange guide signs (see EPG 903.5.21).



Figure 903.5.47 Example of a Post-Interchange Travel Time Sign

903.5.48 Distance and Travel Time Sign and Comparative Travel Time Sign (MUTCD Section 2E.50)

Support. Some locations might benefit from a travel time message displayed with the distance, or comparative travel times displayed for alternative routes to a common destination. These locations are often in advance of an urbanized area where interchanges become more closely spaced and/or in advance of a circumferential or other alternative route(s) where the road user can decide to divert depending on the destination. Nonetheless, these signs are typically located in advance of a decision point where the road user can divert to an alternate route to avoid recurring congestion.

EPG 903.5.48 contains information on Post-Interchange Travel Time signs.

Standard. The Distance and Travel Time sign (see EPG 903.5.48) shall display a major destination, landmark, or junction; a distance message; and a travel time message, each on a separate line. The distance units shall be displayed in the distance message. The travel time shall be displayed in a changeable message element and the abbreviation MINS shall follow the changeable message element. The Distance and Travel Time sign shall not display distance and time to more than one destination or junction.

The Comparative Travel Time sign (see EPG 903.5.48) shall display a major destination, landmark, or junction, and two alternative routes with travel time messages. Each alternative route and associated travel time message shall be on a separate line. The travel time shall be displayed in a changeable message element and the abbreviation MINS shall follow the changeable message element.

Comparative travel times shall not be used to promote different modes of travel, such as personal vehicle highway travel compared with transit, or different forms of transit.

Guidance. Where used, the Distance and Travel Time sign should be located between interchanges and away from the sequence of interchange guide signs or other major signs. Where used, the Comparative Travel Time sign should be located in advance of the sequence of interchange guide signs to provide adequate time for the road user to decide whether to reroute.

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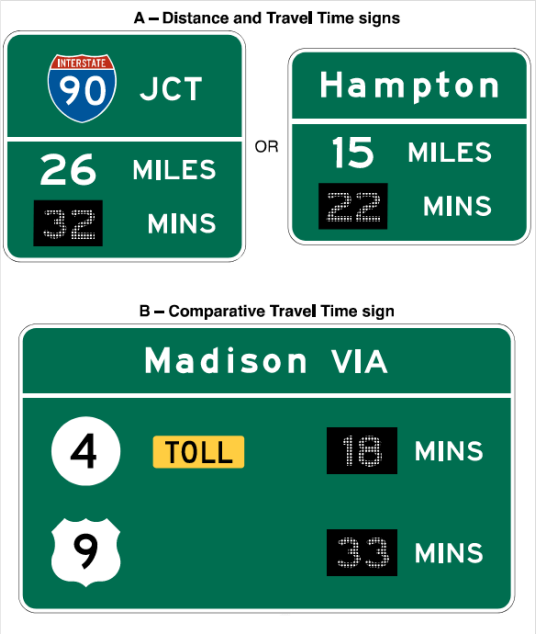


Figure 903.5.48 Example of Travel Time Signs

903.5.49 Supplemental Guide Signs (E3 Series) (MUTCD Section 2E.51)



Figure 903.5.49 Example of Supplemental Guide Signs for a Mult-Exit Interchange

Support. Supplemental guide signs (see Figure 903.5.49) can be used to provide information regarding destinations accessible from an interchange, other than places displayed on the standard interchange signing. However, such Supplemental guide signing can reduce the effectiveness of other more important guide signing because of the possibility of overloading the road user's capacity to receive visual messages and make appropriate decisions. "The AASHTO Guidelines for the Selection of Supplemental Guide Signs for Traffic Generators Adjacent to Freeways" is incorporated by reference in this Article.

This class of sign includes College and Major Traffic Generator signs. Recreational area and historic signs are white on brown. Major traffic generator signs and most other supplemental signs are white on green.

Guidance. Use of Supplemental guide signs should be limited to situations where there is a demonstrated need to sign for more destinations from an interchange than those that are displayed on the Interchange Advance guide and Exit Direction signs.

A Supplemental guide sign should not be installed unless a destination meets the criteria established by MoDOT policy. MoDOT should adopt an appropriate policy for installing Supplemental guide signs using the "AASHTO Guidelines for the Selection of Supplemental Guide Signs for Traffic Generators Adjacent to Freeways." In developing policies for such signing, such items as population, amount of traffic generated, distance from the route, and the significance of the destination, should be taken into account.

Supplemental Guide signs should be post-mounted when adequate space is available, regardless of other guide signs being overhead or post-mounted.

No more than one Supplemental guide sign should be used on each interchange approach.

A Supplemental guide sign should display no more than two destinations and no more than three lines of destination names. Destination names should be followed by the interchange number (and suffix), or if interchanges are not numbered, by the legend NEXT RIGHT or SECOND RIGHT or both, as appropriate. If cloverleaf or closely spaced interchanges exist, the interchange exit number and suffix may be used.

Where two or more Interchange Advance guide signs are used, the Supplemental guide sign should be installed approximately midway between two of the Interchange Advance guide signs. If only one Interchange Advance guide sign is used, the Supplemental guide sign should follow it by at least 800 feet. If the interchanges are numbered, the interchange number should be used for the action message.

Supplemental guide signs should not be installed in the same location with or where it will detract from guide signs for a different interchange.

Standard. Supplemental Guide signs shall be installed as an independent guide sign assembly.

No more than two supplemental traffic generator destinations shall be signed from a single interchange approach and four from a single interchange along the main roadway (see the fourth and fifth Guidance paragraphs of this Article regarding the number of Supplemental guide signs at an interchange and the number of destinations displayed on a Supplemental guide sign).

Supplemental guide signs shall not be placed at the same location as Interchange Advance guide, Exit Direction, or other signs related to an exit or interchange.

Guide signs for recreational or cultural interest destinations (see EPG 903.13) shall be considered as Supplemental guide signs, except where the interchange provides direct access to such a destination and the destination is instead displayed on the Interchange Advance guide and Exit Direction signs.

Option. A pictograph (see definition in EPG 911 (MUTCD Section 1C.02)) may be used on a Supplemental Guide sign in conjunction with a destination that is associated with governmental agencies, military bases, universities, or other government-approved institutions.

Standard. The maximum dimension (height or width) of a pictograph shall not exceed two times the upper-case letter height of the destination legend and shall not exceed the size of a route shield on the guide sign. If used, the pictograph shall be located to the left of the destination legend it represents

A pictograph representing a state, county, or municipal corporation or other incorporated or unincorporated community shall not be displayed on a Supplemental Guide sign.

Pictographs shall otherwise comply with the provisions of EPG 903.1.5.

903.5.50 Community Interchanges Identification Signs (E9-4 and E9-5) (MUTCD Section 2E.52)

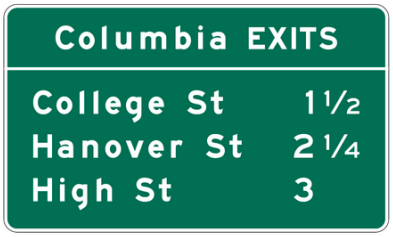


Figure 903.5.50.1 Example of Community Interchanges Identification Sign

Support. For suburban or rural communities served by three or more interchanges, Community Interchanges Identification (E9-4 and E9-5) signs reduce the amount of information displayed on the Interchange Advance guide and Exit Direction signs by eliminating repetition of the same destinations for separate interchanges.

Guidance. In these cases, the name of the community followed by the word EXITS should be displayed on the top line; the lines below should display the destination, road name or route number, and the corresponding distances to the nearest ¼ mile.

The sign should be located in advance of the first Interchange Advance guide sign for the first interchange within the community (see Figure 903.5.50.2).

The legend displayed on the Interchange Advance guide and Exit Direction signs for each interchange should be consistent with the interchange names displayed on the Community Interchanges Identification sign. The name of the community displayed on the Community Interchanges Identification signs should be omitted from the legends of the Interchange Advance guide and Exit Direction signs.

Standard. The amount of destinations listed shall not exceed three.

Interchange exit numbers shall not be shown on Community Interchange Identification signs.

Option. If interchanges are not conveniently identifiable or if there are more than three interchanges to be identified, the Next Exits sign (see EPG 903.5.51) may be used.

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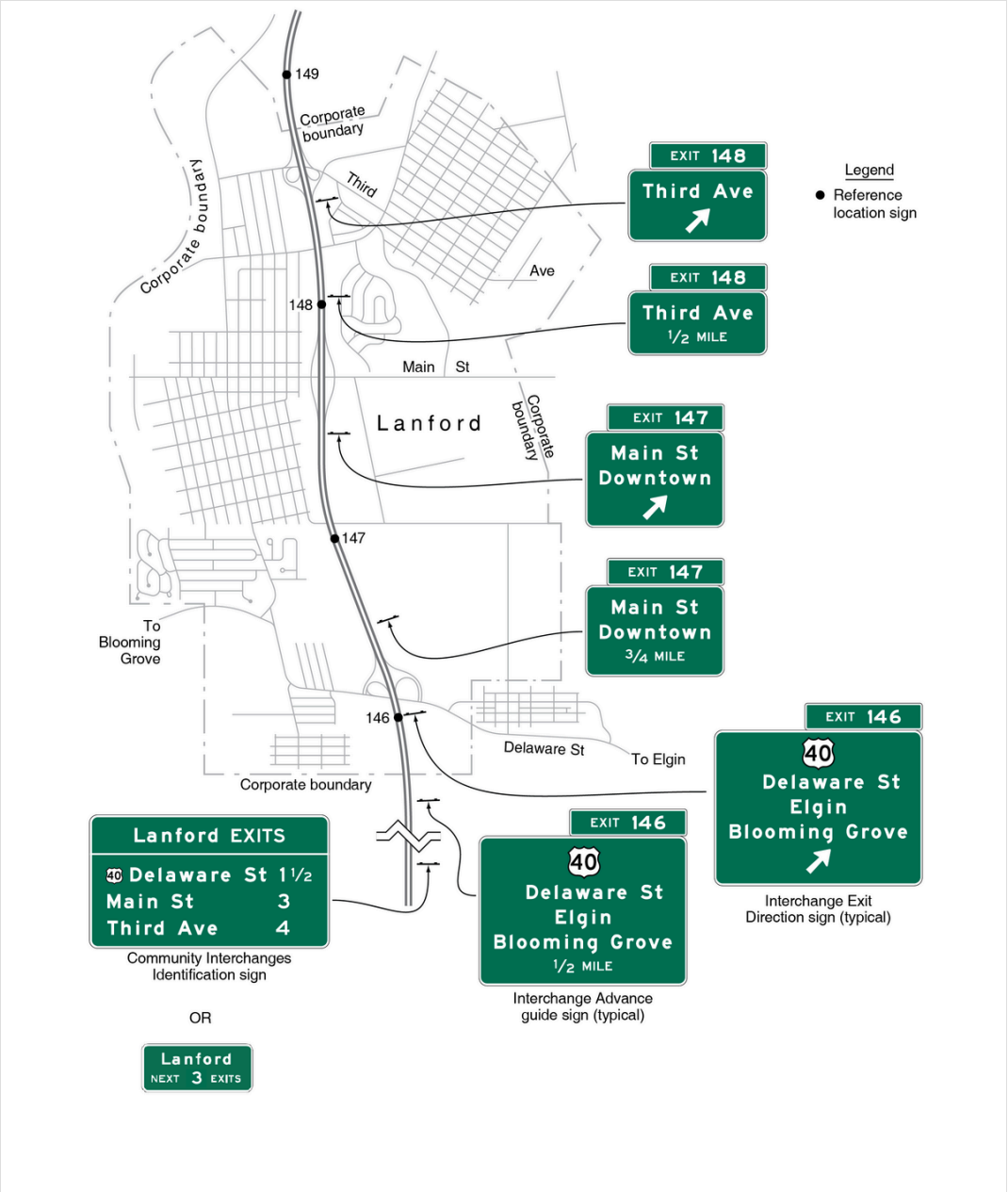


Figure 903.5.50.2 Example of Guide signs at a Community with Three or More Exits

903.5.51 Next Exits Signs (E9-3 and E9-3a) (MUTCD Section 2E.53)



E9-3

Support. Many freeways or expressways pass through historical or recreational regions, or urban areas served by a succession of several interchanges.

Option. Such regions or areas may be indicated by a Next Exits (E9-3 or E9-3a) sign located in advance of the Advance guide sign or signs for the first interchange.

Guidance. The sign legend should identify the region or area followed by the words NEXT XX EXITS.

The legend displayed on the Interchange Advance guide and Exit Direction signs for each interchange should not display the region or area name that is displayed on the Next Exits sign.

903.5.52 Weigh Station Signing (MUTCD Section 2E.54)

Support. Independent facilities or areas have been added along many highways where certain commercial vehicles are directed to stop to be weighed or inspected. These areas are sometimes permanent, such as in a roadside area, or temporary mobile facilities deployed along the roadway.

The general concept for signing permanent Weigh Stations is similar to Rest Area signing (see EGP 903.9.5) because in both cases traffic using either area remains within the highway right-of-way.

Standard. The standard sequence of signs for a Weigh Station on an expressway or freeway shall include four basic signs (see Figure 903.5.52):

A. An Advance Weigh Station Distance (D8-1) sign with the distance 1 MILE displayed,
B. An Advance Weigh Station Distance (D8-1) sign with the distance ½ MILE displayed, or a Weigh Station Advance Direction (D8-2) sign,
C. A Weigh Station Entrance Direction (D8-3) sign, and
D. A Weigh Station Gore sign (with the same legend as the Entrance Direction (D8-3) sign).

If the weigh station uses a preclearance system, a WEIGH STATION PRECLEARANCE – ALL TRUCKS RIGHT LANE sign shall be used.

Option. When spacing of 1 mile and ½ mile are not practical for the D8-1 signs, the 1 MILE and ½ MILE distances on the D8-1 signs may be adjusted to match the spacing determined by engineering judgment.

Standard. A changeable legend display that displays either OPEN or CLOSED shall be included in the signing sequence to indicate when trucks are required to enter the weigh station.

Guidance. The required changeable legend display OPEN or CLOSED describe in the previous paragraph should be displayed within and at the bottom of the Weigh Station Advance Direction (D8-2) sign or the Advance Weigh Station Distance (D8-1) sign, or on a supplemental plaque or sign panel.

Support. An example of weigh station signing for use on freeways and expressways is shown in Figure 903.5.52.

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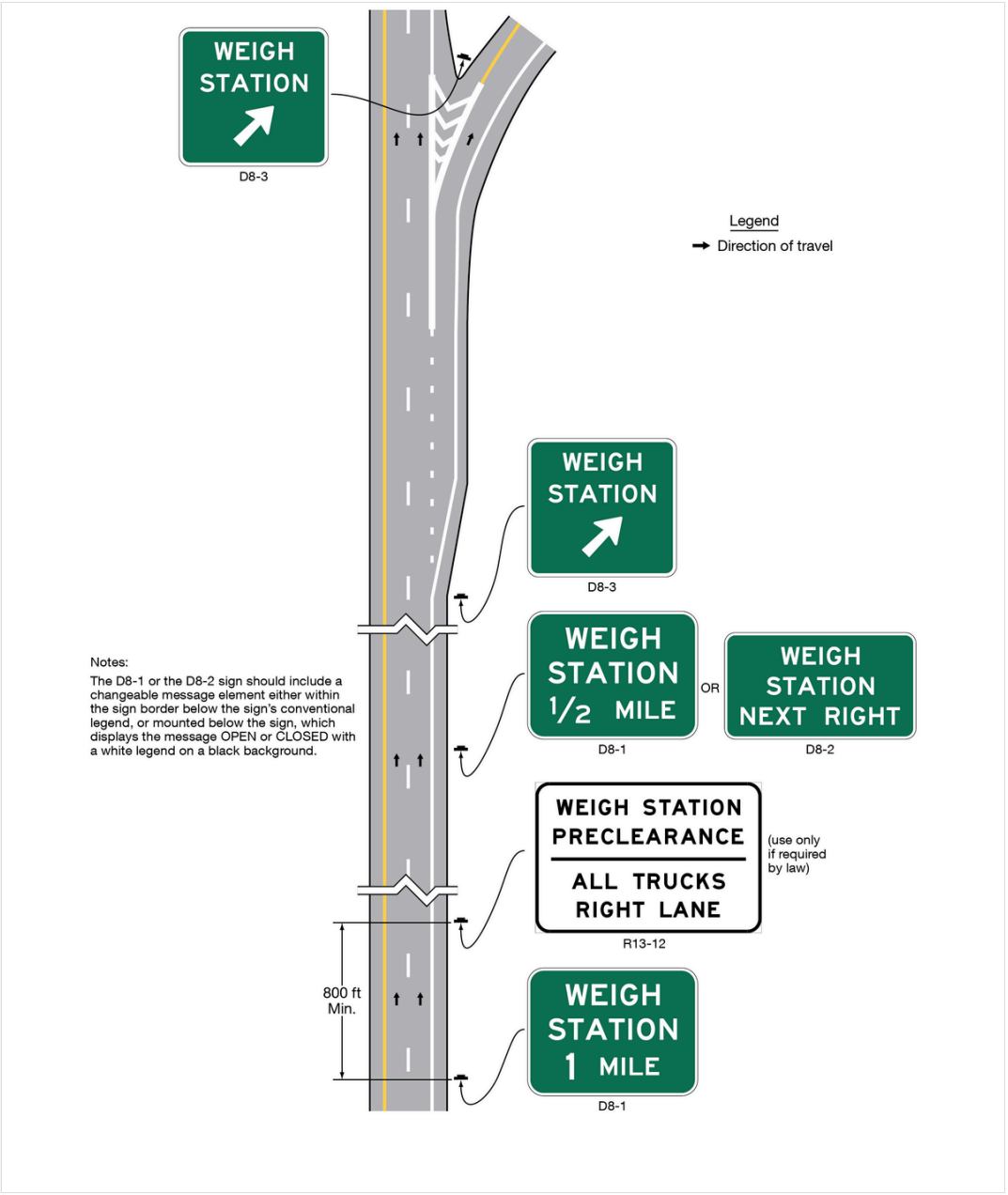


Figure 903.5.52 Example of Weigh Station Signing on Freeways

903.5.53 Route Signs and Trailblazer Assemblies (MUTCD Section 2E.55)

Guidance. Route signs (see Figure 903.5.53) should be incorporated as cut-out shields or other distinctive shapes on large directional guide signs. Where the Interstate shield is displayed in an assembly or on the face of a guide sign with U.S. or State Route signs, the Interstate numeral should be at least equal in size to the numerals on the other Route signs. The use of independent Route signs should be limited primarily to route confirmation assemblies.

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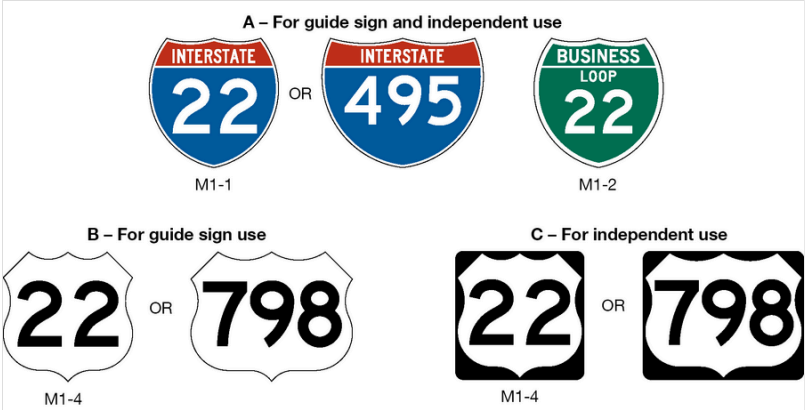


Figure 903.5.53 Interstate, Off-Interstate, and U.S. Route Signs

Route signs and auxiliary plaques showing junctions and turns should be used for guidance on approach roads, for route confirmation just beyond entrances and exits, and for reassurance along the freeway or expressway.

Only standard sizes should be used for guide signs and independent use.

Route shields should be placed before street names and destinations, usually in the first line of the legend.

Support. Shields are detailed in the standard plans. Numbered primary, U.S. and interstate route shields have two widths available for each type of mount: one for two-digit routes and one for three-digit routes.

A business plaque is available in the standard plans for independent use only.

Option. The standard Trailblazer Assembly (see EPG 903.4.30) may be used on roads leading to the freeway or expressway. Component messages of the Trailblazer Assembly may be incorporated into a single sign in accordance with the provisions of EPG 903.4.12. Independently-mounted Route signs may be used instead of Pull-Through signs as confirmation information.

The word "TO" may be used when a guide sign is acting similar to a trailblazer. Some turning movements for roadways may lead to a route, but they may also have other possible destinations.

Standard. The word "TO" shall only be used to trailblaze to a route, not a destination. The word "TO" shall be vertically centered on the shield and shall be placed before the shield to read properly.

When a conflict arises between "TO" and a cardinal direction on the left of a shield, place "TO" first (starting from left hand side), then the shield, then the cardinal direction.

903.5.54 Signing on Conventional Road Approaches and Connecting Roadways (MUTCD Section 2E.58)

Support. EPG 903.4.44 contains information regarding the signing on conventional roads on the approaches to interchanges and the signing on connecting roadways.

903.5.55 Wrong-Way Traffic Control at Interchange Ramps (MUTCD Section 2E.59)

Support. EPG 903.2.39 contains information regarding the use of regulatory signs to deter wrong-way movements at intersections of freeway or expressway ramps with conventional roads, and in the area where entrance ramps intersect with the mainline lanes.

903.5.56 Traffic Generator Signing

Support. MoDOT's policy on signing for traffic generators is defined in the following rules and regulations. These regulations can be found under the Code of State Regulations Title 7, Division 10, Chapter 17 (7 CSR 10-17.010).

Standard. The Traffic Generator Program, along with other supplemental guide sign programs, is managed by a 3rd party contractor. Requests to participate in the Traffic Generator Program shall be forwarded to this 3rd party contractor for processing so they may do site reviews, evaluate eligibility and convey options to the perspective participant.

Support. There are select traffic generator style signs which remain MoDOT's responsibility to install and maintain include:

Signing for Nationally Known / Nationally Prominent Historic Sites (see EPG 903.9.23).

Signing for Lakes over 7,000 acres (see EPG 903.5.57).

903.5.57 Supplemental Guide Signs for Lakes

Standard. For the purposes of interpretation of this policy, major lakes, bodies of water that are over 7,000 surface acres, shall qualify for signing at the Commission's expense, see Table 903.5.57. No signing shall be provided for any individual site, building or event located within a larger signed area.

Table 903.5.57 Missouri Lakes

Non-contractual Lakes
Bull Shoals Lake
Harry S Truman Lake
Lake of the Ozarks
Mark Twain Lake
Norfork Lake
Pomme de Terre Lake
Smithville Lake
Stockton Lake
Table Rock Lake
Thomas Hill Reservoir
Wappapello Lake

The signs shall comply with the provisions of EPG 903.5.49 except as provided below.

The signs shall only be installed on freeways or expressways wherever the direct routes serving the lake intersect, see Figure 903.5.57.

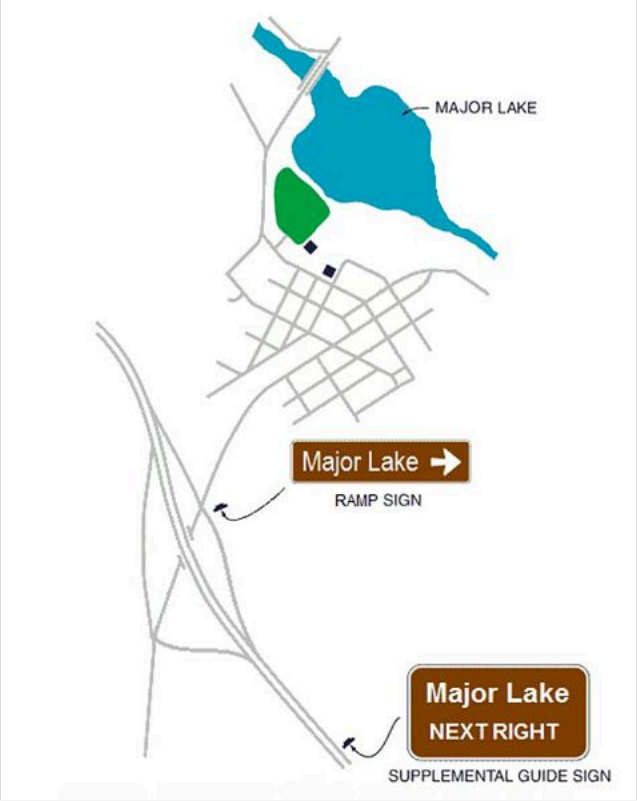


Figure 903.5.57 Example of Supplemental Guide Signs for a Lake on a Freeway or Expressway

The signs shall be rectangular and have a white legend and border on a brown background.

If trailblazing signs are requested, the requesting agency shall be responsible for the participation fee for the trailblazing signs and shall comply with the provisions of EPG 903.13.

No pictograph shall be displayed on the signs.

903.5.58 Lane Reduction

Guidance. When a lane is dropped on a multi-lane, high-volume, high-speed roadway by merging lanes (lane not dropped at an interchange), at least two overhead advance signs should be used. The first sign should indicate the lane that ends and a distance.

The last sign should indicate the lane that ends and an action line.

These signs should be black legend on fluorescent yellow background and placed over the lane that is ending. These signs should have 12 in. series E Modified letters, all upper-case.

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Support. For example, the first line may read RIGHT LANE ENDS. The second line should provide a distance in feet or mileage such as "1000 FT" or "1/2 MILE". When sufficient distance is available, two advance distance signs are provided at 1 mile and 1/2 mile.

Another example, the first line states RIGHT LANE ENDS, and the second line may read "MERGE LEFT".

For typical 4-lane to 2-lane reductions see EPG 903.15.

903.5.59 Signing for Route Termination

Standard. In advance of the termination of any route, a sign shall be installed to indicate the route ends and all traffic must exit. The sign shall include the shield of the route, which terminates with a relevant text message, such as “ALL VEHICLES MUST EXIT”.

903.5.60 Signing for Route Name Change

Standard. In advance of the location where a route name changes, a sign shall be erected indicating “(Rte. XXX) Ends Continue on (Rte. YYY)”.

Guidance. If Route XXX and YYY use different cardinal directions, then they should be included as modifiers to the route shields.

Support. For termination of conventional roads see EPG 903.4.20.

903.5.61 Crossroad Guide Sign

Support. The Crossroad Guide (E8 series) sign is used on a crossroad to provide destination and direction for traffic entering an expressway or freeway.

Guidance. The destination used should be a control city (see Table 903.5.7) for interstate routes.

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903.6 Toll Road Signs (MUTCD Chapter 2F)

Not Currently Used by MoDOT

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903.7 Preferential and Managed Lane Signs (MUTCD Chapter 2G)

Not Currently Used by MoDOT

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903.8 General Information Signs (MUTCD Chapter 2H)

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903.8.21 Community Awareness Signs

903.8.22 Municipal Bus Stop Signing

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Support. General Information signs provide road users with navigational or orientation, geographic, or other information useful for traffic operational purposes. They include such items as Missouri State line (I2-1), City limit (I4-1, I4-1a), unincorporated community signs (I5-1), County line (I6-1), and river names (I3-1). EPG 903.13 contains recreational and cultural interest area symbol signs that are sometimes used in combination with General Information Signs. EPG 911 (MUTCD Section 1D.09) contains information on unnecessary traffic control devices. EPG 903.1.20 contains information on the excessive use of signs and sign clutter.

Option. A General Information (I3-5 and I3-7) symbol sign may be used to provide direction to a transportation (I3 series signs) facility. The symbol sign may be supplemented by an educational plaque where necessary. The name of the facility may be used, if needed, to distinguish between similar facilities in the same area.

The Advance Turn (M5 series) or Directional Arrow (M6 series) auxiliary plaques with white arrows on green backgrounds may be used with General Information symbol signs to create a General Information Directional Assembly.

Guidance. General Information signs should not be installed within a series of guide signs, or at other equally critical locations, unless there are specific reasons for orienting the road user or identifying control points for activities that are clearly in the public interest. On all such signs, the designs should be simple and dignified, devoid of any tendency toward advertising, such as complex graphics or unnecessary messages, and in general compliance with other guide signing.

Standard. Promotional descriptive messages that are not relevant to navigation and orientation, such as “Scenic” or “Historic,” shall not be included in the legends of General Information signs, except as otherwise provided in EPG 903.8 or in cases in which these terms are part of an official name, such as for a Scenic Byway or Historic District.

Except for State Welcome signs (see EPG 903.8.7) and Acknowledgment signs (see EPG 903.8.12), General Information signs shall have white legends and borders on green rectangular-shaped backgrounds.

Standard. When a sign is used to display a safety or transportation-related message, the display format shall not be of a type that would be considered similar to advertising displays. Messages and symbols that resemble any official traffic control device shall not be used on safety or transportation-related message signs.

The Amtrak Station (I3-7) sign shall not be installed if a city will not provide supplemental signing for these locations.

The Amtrak Station and the appropriate M6 series arrow shall be used for ramp signs.

Guidance. The Amtrak Station sign should be compatible with the color and size of existing signing design.

Support. The Amtrak Station sign is a supplemental guide sign of variable size.

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Standard. The “Missouri Train Service – 1-800-USA-RAIL – morail.org” sign has been discontinued. Existing signs shall be removed at the end of their service life.

903.8.2 Sizes of General Information Signs (MUTCD Section 2H.02)

Standard. Except as provided in EPG 903.1.7, the sizes of General Information signs that have a standardized design shall be as shown in Table 903.8.2.

Support. EPG 903.1.7 contains information regarding the applicability of the various columns in Table 903.8.2.

Option. Signs larger than those shown in Table 903.8.2 may be used (see EPG 903.1.7), except where a maximum allowable size is specified.

Table 903.8.2. General Information Sign Sizes

Sign	Sign Designation	EPG Article	Conventional Road (in. X in.)	Freeway/Expressway (in. X in.)
				Mainline & Ramps
Emergency Reference	D10-5	903.8.11	18 X 60	
Sponsor A Highway	I9-1	903.8.12	Varies	Varies
Growing Together	I9-2	903.8.12	Varies	Varies
Airport	D4-10	903.8.3	Var X 36	-
Business District	D4-15	903.8.13	36 X 18	-
Industrial Park	D4-16	903.8.13	48 X 36	-
City Limit	I4-1	903.9.9	Var X 24	Var X 36
City Limit (Logo)	I4-1a	903.8.5	Var X 24	Var X 36
Unincorporated Community	I5-1	903.8.4	Var X 12	Var X 24 (Expressway Only)
County Line	I6-1	903.8.4	Var X 18	Var X 18
County Line (Logo)	I6-1a	903.8.5	Var X 36	Var X 36
Welcome To (Cities)	I2-1	903.8.8	Varies	Varies
Missouri State Line	I2-1	903.8.4	36 X 18	72 X 36
Missouri Welcomes You	I2-2	903.8.7	96 X 48	144 X 72
River and Major Lake	I3-1	903.8.6	Var X 18	Var X 24
Airport (Symbol)	I3-5	903.8.3	24 X 24	30 X 30
Amtrak Station	I3-7	903.8.1	24 X 24	30 X 30
Veterans	-	903.8.15	Varies	Varies
College Signing	-	903.8.16	Varies	Varies
Correction Center	-	903.8.17	Varies	Varies
Lewis and Clark (Historical Marker)	M17-2a	903.8.18	24 X 30	24 X 30

903.8.3 Airport Signs (MUTCD Section 2H.03)



D4-10



I3-5

Support. MoDOT signs for both public general aviation airports and commercial airports. Commercial airports are defined as those facilities which have acquired and continue to maintain FAA 14 CFR Part 139 Certification.

Standard. The Airport (D4-10) sign shall be used to sign general aviation airports and only at the first order sign location (see EPG 903.1.24). If the first order signing location is at an interchange, only ramp terminal signing will be provided. Airport signing shall not be provided for privately owned airports or flying fields.

Supplemental guide signing shall only be used to sign for commercial airports, guide signs shall be provided from the nearest interstate, or other freeway intersection directly to the airport, normally not to exceed 15 miles. Guide signs for commercial service airports shall be provided from the nearest interstate, or other freeway intersection directly to the airport, normally not to exceed 15 miles.

The Airport (I3-5) Symbol sign shall be reserved for guidance to commercial airports.

Option. Signing for St. Louis Lambert International Airport and Kansas City International Airport may have additional guide signing beyond the third order locations and beyond the first interchange due to the fact they draw motorist from all over the state as well as neighboring states.

Airport (I3-5) Symbol sign, with an arrow plaque, may be used as a trailblazer for commercial airports. The Airport (I3-5) Symbol may be included on primary guide signs for exits which lead motorists in the direction of commercial airports.

The Airport (I3-5) symbol sign along with a supplemental plaque may be used to indicate the specific name of the airport. An Airport symbol sign, with or without a supplemental name plaque or the word AIRPORT, and an arrow may be used as a trailblazer.

Standard. Airport pictographs or other graphical representation of the specific airport shall not be used with or in place of the specific airport name on guide signs.

Guidance. If airport guide signs are used, adequate trailblazer signs should be used to provide motorist direction to the airport.

Standard. Adequate trailblazer signs shall be in place prior to installing the airport guide signs.

Support. Location and placement of all airport guide signs depends upon the availability of longitudinal spacing on highways.

903.8.4 Jurisdictional Boundary Signs (I2-1, I4-1, I4-1a, I4-2, I4-2b, I5-1, I6-1, I6-1a) (MUTCD Section 2H.05)



I2-1



I4-1, I4-2



I4-1a



I5-1



I6-1



I6-1a

Guidance. Notices of statutes or local ordinances should be located separately from Jurisdictional Boundary signs using regulatory signs (see EPG 903.2).

Standard. In accordance with EPG 903.8.1, the Jurisdictional Boundary sign shall be rectangular in shape and shall have a white legend on a green background. The sign shall display only the name of the State, county, municipality, Tribal Nation, or other identifiable community, and an appropriate legend such as STATE LINE, County, or the municipal classification.

Names of elected officials or promotional messages, such as notable accomplishments or claims, shall not be displayed on a Jurisdictional Boundary sign or added as a supplemental sign or plaque (see EPG 903.8.14).

The MISSOURI STATE LINE (I2-1) sign shall be erected at the state line on all lettered routes without interfering with higher-priority traffic control devices.

Support. See EPG 903.8.7 for information regarding State Welcome signs as state line signage for interstates and numbered routes.

Standard. The City Limit (I4 series) signs shall be erected at the city limit of each incorporated area, at the point where the city limit crosses the right of way. If there is inadequate space at this location to install a sign, the city limit sign shall be moved to the closest appropriate location within the city limit boundaries without interfering with higher-priority traffic control devices.

County Line (I6 series) signs shall be erected on all state routes at the county line boundary. If there is inadequate space at this location to install a sign, the county line sign shall be moved to the closest appropriate location within the county boundaries without interfering with higher-priority traffic control devices.

City limit and county line signs shall only display the proper name of the incorporated community, or the proper name of the county, these jurisdictional boundary signs are marking, followed by the jurisdictional boundary description of “CITY LIMIT” or “COUNTY LINE” respectively.

Guidance. The County Line sign should not be erected at the state line.

Support. City populations are no longer included on city limit signs. The decision to phase out the display of populations on city limit signs prior to the release of the 11th edition of the MUTCD was due to the pending release of the updated US Census numbers. This was to avoid the significant expenditure of resources to update all existing city limit signs with new populations. Existing city limit signs will continue to display the city population until the end of the sign’s service life with no option to update the display.

See EPG 903.15 for Typical Signing Applications of Jurisdictional Boundary signs.

Option. Unincorporated Community signs (I5-1) may be installed at the approximate entrance of an unincorporated community, similar to a city limit sign. Unincorporated communities eligible for signing are those that the traveling public would view or recognize as an organized community as they pass through the area. These unincorporated communities would typically have businesses, community centers, or other non-residential structures that are visible from the highway, in addition

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to their residential areas. They would also be significant enough to typically justify a reduction in the posted speed limit and/or be considered as a destination on highway signs. Eligible unincorporated communities are typically structured enough to also have some form of governing board or council.

Residential developments or subdivisions are not to be considered unincorporated communities that would qualify for highway signing. Regions that once were recognized by the traveling public as an unincorporated community but now have very little or no community recognizable features would no longer be eligible for signing. Existing Community boards installed for regions that are no longer eligible for signing shall remain in place until the end of their service life.

A Speed Limit sign may be mounted above the Unincorporated Community sign if the speed limit changes at that location.

Guidance. Signs should not be used to identify the boundaries of special-purpose governmental districts, such as school districts, sanitary districts, or improvement districts, as such signs are generally promotional in nature and do not provide navigational or orientation assistance in conjunction with official maps that are available to the general public.

903.8.5 Custom City Limit and Custom County Line Signs (I4-1a, I4-2b, I6-1a)

Support. Many cities and counties want to enhance their identity and presence to the traveling public. A way to do this is by requesting MoDOT to install customized city or county limit signs in lieu of the MoDOT standard jurisdictional boundary signs. Displaying the city or county logo or emblem along with the jurisdictional boundary information is in compliance with MUTCD standards. Custom signs are not required at city or county limits on the state system.

Incorporated communities are permitted to request that custom city limit signs be installed on the state system.

Option. A pictograph representing the jurisdiction (such as a state, county, or municipal corporation) may be displayed on custom city limit or custom county line signs. The display of a pictograph is not a standard application, if a jurisdiction chooses to display a pictograph there is a fee associated with the installation and maintenance of the special signs covered by a MoDOT TR15 signing agreement with the city/county.

Standard. If a pictograph is displayed on the custom city limit or custom county line sign, it shall be the official seal of the jurisdiction and shall comply with the provisions of EPG 903.1.4. The pictograph shall be placed to the left of the legend. The height of the pictograph shall not exceed 2 times the height of the initial upper-case letter of the principal legend.

Any custom sign not conforming to this policy shall be removed.

MoDOT shall fabricate customized signs, for consistency, according to the standards described below. Graphics or messages requested by the city or county shall have the approval of the department prior to fabrication.

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The signs shall be white legend on a green background. The signs shall be made of reflectorized material according to MoDOT standards. Lettering on the signs shall be of the approved size and style as contained in the MUTCD for the type of facility where the signs will go.

When a city or county elects to use a customized limit sign, MoDOT shall replace the standard sign with the custom sign. If there is a need for a speed limit sign, the speed limit sign shall be installed the same as if a standard city limit sign were used.

A participation fee shall be paid for by the city/county which will include all cost for fabrication, installation, and maintenance of the signs. Refer to EPG 903.19 for contract process.

Lighting of these signs shall not be allowed.

Guidance. The TR-15 contract should be executed between the city or county and MoDOT before the sign is installed.

The legend of the sign should be simple, dignified and void of any commercial advertising.

Landscaping around any of these signs should be coordinated and reviewed by the department's roadside management personnel.

903.8.6 River and Major Lake Signs (I3-1) (MUTCD Section 2H.06)

Guidance. If used, the River or Major Lake sign should display only the name of the geographical feature. Additional information that is unnecessary for navigational or orientation purposes, such as watershed or tributary names, should not be displayed on the sign.

River and Major Lake (I3-1) signs should be erected at all bridges on the interstate and numbered routes crossing the river and major lakes listed in Table 903.8.6.

Standard. River and Major Lake Name signs shall not be installed on letter routes. Signs shall only be installed at bridges crossing the rivers and major lakes listed in Table 903.8.6; all other river and lake name signs currently in place shall be removed at the end of their life cycle.

Table 903.8.6 Rivers and Lakes to be Signed

Rivers to be signed with I3-1 Signs	
Big Piney River	Locust Creek
Big River	Meramec River
Black River	Mississippi River
Blackwater River	Missouri River
Bourbeuse River	Moreau River
Cache River	Nishnabotna River
Chariton River	North Fork White River
Cuivre River	Niangua River
Current River	Nodaway River
Des Moines River	North River
Eleven Point River	Osage River
Elk River	Platte River
Fabius River	Pomme de Terre River
Fox River	Sac River
Gasconade River	Salt River
Grand River	South Grand River
Headwater Diversion	Spring River
Jacks Fork River	St. Francis River
James River	Tarkio River
Kansas River	White River
Lamine River	Wyaconda River

Lakes to be signed with I3-1 Signs
Bull Shoals Lake
Harry S Truman Lake
Lake of the Ozarks
Mark Twain Lake
Norfolk Lake
Pomme de Terre Lake
Smithville Lake
Stockton Lake
Table Rock Lake
Thomas Hill Reservoir
Wappapello Lake

Rivers which receive signing are those which drain the major watersheds of the state; however, individual watersheds of any size shall not be signed on MoDOT roadways.

Option. Individual arms of major lakes may be signed on interstate and numbered routes.

903.8.7 State Welcome Signs (I2-2 and I2-3) (MUTCD Section 2H.07)



I2-2



I2-3



I2-3P

Support. The design, placement, and function of State Welcome signs that are used to identify State lines differ from Jurisdictional Boundary (I2-1) signs (see EPG 903.8.4). Because of these differences, it is necessary to distinguish State Welcome signs from State line Jurisdictional Boundary signs.

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Option. A State Welcome sign may be located at or in the vicinity of the State boundary except as prohibited in the first Standard paragraph below.

State Welcome signs may display the State seal or the State flag, the officially-adopted State motto or slogan, and the name of the Governor, in addition to the State name. State Welcome signs may use legend and background colors that provide adequate visual contrast rather than the standard sign colors.

Standard. State Welcome signs shall be located separate from other signs where they will not interfere with or detract from other traffic control devices.

State Welcome signs shall not display changeable or other electronic-display messages (see EPG 903.12). State Welcome signs shall not display messages that emulate promotional advertising of any type. State Welcome signs shall not incorporate Acknowledgment signs or messages (see EPG 903.8.12), or business identification sign panels or logos (see EPG 903.10) into their legends or assemblies. In accordance with EPG 903.1.4, telephone numbers, Internet addresses, and e-mail addresses, including domain names and uniform resource locators (URLs), and scanning graphics for the purpose of obtaining information shall not be displayed in the legends of State Welcome signs or on their supports.

Guidance. State Welcome signs should be located farther from the edge of the roadway than other traffic control devices.

The maximum size of a State Welcome sign should be consistent with the prevailing size of other guide signs based on the roadway type.

Standard. The large MISSOURI WELCOMES YOU (I2-3) sign shall be erected at or near the state line on numbered routes where the traffic volume is 1,000 AADT or greater. The Welcome to Missouri Welcome Center (I2-3P) plaque shall be installed below a Welcome to Missouri (I2-3) sign on interstates when there is a welcome center located downstream from the state line.

The smaller sign (I2-2) shall be erected at or near the state line on numbered routes where the traffic volume is less than 1,000 AADT.

Guidance. At locations where it may be impractical to erect the MISSOURI WELCOMES YOU sign at or near the state line, the MISSOURI STATE LINE sign should be used. At locations where the MISSOURI WELCOMES YOU sign is erected in addition to the MISSOURI STATE LINE sign, the MISSOURI WELCOMES YOU should be installed within ¼ mile of the state line.

Option. The MISSOURI STATE LINE (I2-1) sign may be erected on other routes where it is impractical to use the Welcome to Missouri (I2-2 or I2-3) sign.

903.8.8 Welcome To Signs for Cities

Option. Cities may place Welcome To signs on MoDOT right of way within city limits as a gateway to welcome visitors to their city.

Guidance. Welcome To monuments can be found in EPG 941.5.

Standard. Welcome To signs shall fit on one or two MoDOT breakaway signposts (wood, PSST, pipe, structural) choosing the post type that properly supports the size of sign being installed using the post selection tools in EPG 903.3. MoDOT posts may be painted, but no other alterations may be applied as this can affect the safety performance of the post. The requirements for Welcome To signs include:

- Welcome To signs shall only be installed as ground mounted signs, Welcome To signs shall not be mounted overhead or on bridge structures, i.e. girders, columns abutment walls, etc.
- Welcome To signs shall not be illuminated electrically.
- Welcome To signs shall not contain advertisement of any kind.
- Welcome To signs shall not provide directional guidance by displaying destinations with or without arrows.
- A TR-42 agreement shall be executed and a permit issued (to address traffic control, locate utilities and other aspects of the installation not addressed in the TR42 contract) before a Welcome To sign is installed. A city ordinance is required with the agreement. An ordinance provides evidence of the city's assent to enter into an agreement with the Commission.
- Welcome To sign installation and maintenance shall be completed by a MoDOT approved highway sign installer. This is to assure the signs and their associated breakaway sign supports are installed in accordance with MoDOT standards.

Guidance. Welcome To signs should be installed in a location that does not interfere with normal highway signs and possess the least possible threat to the motorist should they leave the roadway.

Option. The content and design of the sign face is up to the city, design aspects which are optional and permissible include:

- Making the sign retroreflective so they are visible at night and have the same appearance at night as they do during the day.
- The sign can display a city slogan or recognition statement that does not change over time, such as, but limited to:
    - "Sister City To…"
    - "Home of…"
    - The City Population
    - The year the city was established

A city may display city accomplishments below their Welcome To signs, see EPG 903.8.14 for program details and limitations.

Standard. When a Welcome To sign is installed with accomplishment plaques it shall meet the following criteria to permit proper installation expectations

- Installed on two MoDOT Structural #1 I-Beam Posts
- Installed by an approved MoDOT sign installation contractor (see approved list)
- The sign shall be fabricated using extruded aluminum panels (MoDOT specifications) and flat sheet overlay material
    - Extruded panel construction is modular. This allows for a durable structure which is easy to install and to update accomplishment panels
    - See figure for example and construction details

- Welcome To Sign panel shall be a maximum 8 foot wide by 4 foot tall
- The legend on the accomplishment plaques shall be a highly legible font, preferably FHWA Highway Font

Option. Community Awareness signs may be displayed on Welcome To signs and monuments, see EPG 903.8.21



Figure 903.8.8 Example of Welcome To Sign

903.8.9 Project Information Sign (CONST-5) (MUTCD Section 2H.09)



CONST-5

Support. The Project Information (CONST-5) sign provides limited information to road users about a highway construction project on which work is imminently forthcoming or ongoing.

Standard. The Project Information sign legend shall be limited to the following project information:

A. The roadway name or route number,
B. A brief description or title of the project,

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C. The completion date expressed in either a month or season (Spring, Summer, Fall, or Winter), and
D. The agency name.

Option. Project Information signs installed more than one week prior to commencement of work may include a start date.

Standard. Project Information signs shall not be installed more than one month prior to the commencement of work. When installing Project Information signs prior to the commencement of work, the jurisdiction shall have a policy on when the Project Information signs are to be installed. Project Information signs shall be removed at the conclusion of work on the project, even if the final inspection or project closeout has not yet occurred.

The number of Project Information signs shall be limited to one per direction of travel on the roadway on which the project is based. The location of the Project Information sign shall not interfere with the temporary traffic control zone devices.

The Project Information sign shall have a white legend on a green background and shall not display Internet addresses, e-mail addresses, or telephone numbers (see EPG 903.1.4).

Support. See EPG 616.9.5 for additional information.

903.8.10 Grade-Separated Roadway Identification Signs

Standard. Street Identification/Orientation Street Name signs (D-3c) are used to identify roadways that pass over or under a freeway but have no direct access to the freeway. Street Identification/Orientation Street Name signs (D-3c) have been discontinued. MoDOT shall no longer provide Street Identification/Orientation Street Name signs (D-3c). Existing Street Identification/Orientation Street Name signs (D-3c) shall be left in place until they reach the end of their service life.

903.8.11 Emergency Reference Markers (D10-5 and D10-5a)



D10-5

Support. Emergency Reference Markers (D10-5 series) are used to assist travelers in estimating their progress, provide a means for identifying the location of emergency incidents and traffic crashes, and to aid in highway maintenance and servicing. The typical mile marker D10-1 series and intermediate mile marker D10-1a series of signs are not used by MoDOT as they do not provide the same level of information to the driver.

The Directional Ramp Emergency Reference Markers (D10-5a) are placed on long directional ramps to provide motorists a means to report incidents and/or request assistance. These signs help responders identify not only the interchange, but also the specific ramp they need to respond to.

Standard. Emergency Reference Markers (D10-5) shall be placed on all expressway facilities that are located on a route where there is reference location sign continuity.

Emergency Reference Markers (D10-5) shall be placed on Interstates (instead of reference location signs) at two-tenth mile intervals. An Emergency Reference Marker shall not be installed if it cannot be set within 200 ft. of its exact location.

Every attempt shall be made to install Emergency Reference Markers on walls, bridges or concrete median barrier, even if this requires special mounting designs.

Guidance. Directional Ramp Emergency Reference Markers (D10-5a) should be installed on directional ramps. These signs should be spaced approximately every 0.1 mile along the ramp with spacings being adjusted by engineering judgement to adjust for conditions.

Standard. Emergency Reference Markers (D10-5) shall be vertical panels having green backgrounds with white numerals, letters and borders, except for the route shield, which shall be the standard color and shape. The top line shall consist of the cardinal direction for the roadway. The second line shall consist of the applicable route shield for the roadway. The third line shall identify the mile reference for the location and the bottom line of the Emergency Reference Marker shall give the tenth of a mile reference for the location displaying the decimal point.

Directional Ramp Emergency Reference Markers (D10-5a) shall be vertical panels having green backgrounds with white numerals, letters, and borders, except for the route shield, which shall be the standard color and shape. The sign shall display the cardinal direction and route shield of the route being departed followed by “TO” and then display the cardinal direction and route shield of the route being accessed. Only the route shields for the primary routes shall be displayed on these signs, see Standard Plan 903.03 (https://www.modot.org/media/16921) for installation details.

Emergency Reference Markers shall have a minimum mounting height of 4 feet to the bottom of the sign according to the mounting height requirements of and per details found in Standard Plan 903.03.

The distance numbering shall be continuous for each route within the state, except where overlaps occur (see EPG 903.5.22). Where routes overlap, Emergency Reference Marker continuity shall be established for the route of higher classification. If two routes of the same class overlap each other, the route with the lower designation takes precedent unless that route overlaps for only a short segment.

Guidance. The route selected for continuity of distance numbering should also have continuity in interchange exit numbering (see EPG 903.5.22). On a route without Emergency Reference Marker continuity, the first Emergency Reference Marker beyond the overlap should indicate the total distance traveled on the route so that travelers will have a means of correlating their travel distance between Emergency Reference Markers with that shown on their odometer.

Standard. The distance measurement shall increase in the northbound and eastbound directions of travel. Emergency Reference Markers for southbound or westbound roadways shall be set at locations directly opposite to and displaying the same distance measurement as the Emergency Reference Marker for the northbound or eastbound roadways.

Guidance. The zero-distance should begin at the south and west state lines, or at the south and west terminus points where routes begin within a state.

Standard. Except as provided in the option below Emergency Reference Markers shall be installed on the right side of the roadway.

Option. Where conditions limit or restrict the use of Emergency Reference Markers on the right side of the roadway, they may be installed in the median. Emergency Reference Markers may be installed back-to-back if the median location is warranted. Emergency Reference Markers may be installed on non-interstate freeways and expressways under the following conditions:

1. Written support from the local response agency must first be obtained.

2. A logical beginning and ending point must be chosen. Examples of logical beginning or ending points include state boundaries, transitions from two to four lanes, or major intersections. District borders, county lines or construction project limits are not logical beginning and ending points.

3. All districts along the route must be involved in the decision to install Emergency Reference Markers on a route to ensure consistency of application.

Guidance. Emergency Reference markers should not be installed on routes which are likely to change in length due to future realignments. Roadway realignments would require the replacement of Emergency Reference Markers in the future to correct the distance measurement displayed on these signs.

903.8.12 Acknowledgment (Sponsorship) Signs and Plaques (I9-1, I9-2, I9-2P, I9-3, and I9-4) (MUTCD Section 2H.13)



I9-1



I9-2



I9-2P



I9-3

Support. Acknowledgment signs and plaques are a way of recognizing a company, business, or volunteer group that provides or sponsors a highway-related service. Acknowledgment signs include sponsorship signs for sponsor-a-highway litter removal programs, maintenance of a parkway or interchange, and other highway maintenance or beautification sponsorship programs.

Refer to EPG 141.8 for more information on MoDOT's Sponsorship Policy.

Refer to EPG 171 for acknowledgment sign program policy.

Guidance. A State or local highway agency that elects to have a sponsorship acknowledgement program should develop a policy on Acknowledgment signs and plaques. The policy should require that eligible sponsoring organizations comply with State laws prohibiting discrimination based on race, religion, color, age, sex, national origin, and other applicable laws.

Standard. The State or local acknowledgment sign policy shall include all of the provisions regarding placement and design of Acknowledgment signs and plaques that are contained in this Section.

Because regulatory, warning, and guide signs have a higher priority, Acknowledgment signs shall only be installed where adequate spacing is available between the Acknowledgment sign and other higher priority signs. Acknowledgment signs shall not be installed in a position where they would obscure the road users' view of other traffic control devices.

Acknowledgment signs shall not be installed at any of the following locations:

A. On the front or back of, adjacent to, or around any other traffic control device, including traffic signs, highway traffic signals, and changeable message signs;
B. On the front or back of, adjacent to, or around the supports or structures of other traffic control devices, or bridge piers; or
C. At key decision points where a road user's attention is more appropriately focused on other traffic control devices, roadway geometry, or traffic conditions, including exit and entrance ramps, merging or weaving areas, lane terminations, intersections, grade crossings, toll plazas, temporary traffic control zones, and areas of limited sight distance.

Acknowledgment signs and plaques shall have a white legend and border on a blue background. Acknowledgment signs shall be independent post-mounted roadside installations only and shall not be mounted overhead.

Option. An Acknowledgment sign may be used to acknowledge the sponsor of a rest area or welcome center.

Standard. Acknowledgment signs for a rest area, when located on the highway mainline, shall be limited to one sign per direction of travel from which the rest area is accessible, shall be located at least 500 feet from other traffic control devices, and shall not display names or representations of

specific products or services provided by the sponsor within the rest area. Acknowledgment signs for rest areas shall display the legend REST AREA as the program activity, such as REST AREA SPONSORED BY. In accordance with Paragraph 5 of this Section, the Rest Area and Welcome Center Acknowledgment (I20-4 and I20-4a) signs shall not be combined in the same sign assembly with or substitute for the Rest Area General Service guide signs (see EPG 903.9.3).

Option. An additional Acknowledgment sign may be used within the rest area provided that it is not visible from the highway mainline or ramps to and from the rest area.

If a State has officially adopted and is actively promoting a program to encourage the use of safety rest areas through the use of a program name, then that program name may be displayed in smaller lettering below the legend REST AREA on the Rest Area Acknowledgment sign.

Standard. Program names or slogans, as described in the Option paragraph below, shall not be displayed on the Rest Area General Service guide signs or other types of traffic signs.

Guidance. The minimum spacing between Acknowledgment signs and any other traffic control signs, except parking regulation signs, should be:

A. 150 feet on roadways with speed limits of less than 30 mph,
B. 200 feet on roadways with speed limits of 30 to 45 mph, and
C. 500 feet on roadways with speed limits greater than 45 mph.

If the placement of a newly-installed higher-priority traffic control device, such as a higher-priority sign, a highway traffic signal, or a temporary traffic control device, conflicts with an existing Acknowledgment sign, the Acknowledgment sign should be relocated, covered, or removed.

Option. Acknowledgment signs may have their own designs and may also use their own pictograph and/or a brief jurisdiction-wide program slogan as part of any portion of the acknowledgment sign, provided that the signs comply with the provisions for shape, color, and lettering style in this article and in EPG 903.1.

Guidance. Acknowledgment signs should clearly indicate the type of highway services provided by the sponsor.

Standard. Acknowledgment signs and plaques shall comply with the following provisions:

A. Neither the sign or plaque design nor the sponsor acknowledgment name or logo shall contain any contact information, directions, slogans (other than a brief jurisdiction-wide program name, if used), telephone numbers, e-mail or Internet addresses, including domain names and uniform resource locators (URLs), metadata tags (“hash-tags”), or quick-response (QR) codes, bar codes, or similar scanning graphics (see EPG 903.1.4);
B. Except for the sponsor acknowledgment logo, all of the lettering shall be in upper-case letters of the Standard Alphabets as provided in the FHWA’s “Standard Highway Signs” publication (see EPG 911 (MUTCD Section 1A.05));
C. If a logo, instead of a word legend, is used to represent the sponsor, the logo shall be the primary logo that identifies the sponsoring entity. Secondary or alternate logos, slogans, products, mascots, spokespersons, or other items associated with the sponsoring entity’s commercial advertising or marketing shall not be displayed on Acknowledgment signs or plaques;

D. In order to keep the main focus on the highway-related service and not on the sponsor acknowledgment name or logo, the area reserved for the sponsor acknowledgment name or logo shall not be located at the top of the sign or plaque, shall be a maximum of 8 square feet in area, and shall not exceed ⅓ of the total area of the sign;
E. The entire sign display area of an Acknowledgment sign assembly shall not exceed 24 square feet;
F. The sign or plaque shall not contain any messages, lights, symbols, or logos that resemble any official traffic control devices;
G. The sign or plaque shall not contain any external or internal illumination, light-emitting diodes, luminous tubing, fiber optics, luminescent panels, or other flashing, moving, or animated features;
H. The sign or plaque shall not distract from official traffic control messages such as regulatory, warning, or guidance messages;
I. The area of the plaque shall not exceed the lesser of ⅓ the area of the General Service sign below which it is mounted or 24 square feet;
J. The plaque size shall be based on the standard sizes as specified in Table 903.8.2. If the size of the General Service sign is oversized for its application (greater than the size specified for the corresponding roadway application in Table 903.8.2), or if the size of the General Service sign increases due to modification of the sign legend, a corresponding increase in the size of the plaque shall not be allowed; and
K. The sign or plaque shall not display promotional or contact information about the agency's sponsorship program, including if the sign or plaque does not currently display a sponsor.

Option. If a specific outlet of a business with multiple locations in the same area is the sponsoring entity, such as a franchisee, the area reserved for the sponsor acknowledgment name or logo may include the name of the municipality or neighborhood in which the sponsoring entity is located.

Standard. An Acknowledgment plaque shall not be mounted in conjunction with any other sign or traffic control device. An Acknowledgment plaque shall not be used alone.

The general restrictions on the type of content allowed for display on Acknowledgment signs (see the Standard paragraph above) shall apply to the legends of Acknowledgment plaques.

903.8.13 BUSINESS DISTRICT and INDUSTRIAL PARK Signs (D4-15, D4-16)



D4-15



D4-16

Option. The BUSINESS DISTRICT (D4-15) sign may be erected on a highway within the city limits at the principal intersection leading to the central business district.

Standard. If a route passes through the central business district, this sign shall not be used.

If a route passes through the industrial park, this sign shall not be used.

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Option. The INDUSTRIAL PARK (D4-16) sign may be erected on a highway within the city limits at the principal intersection leading to the central industrial park when truck traffic tends to get lost or miss turns.

Guidance. If used, the INDUSTRIAL PARK sign should be installed at first order signing (see EPG 903.1.24) for the most direct path.

903.8.14 City and County Accomplishment Plaques

Support. MoDOT did have a city/county accomplishment program where a city or county could display up to three accomplishments below their jurisdictional boundary sign. This program was discontinued September 1, 2021 in response to pending federal rule changes that would prohibit such displays on jurisdictional boundary signs.

Standard. No new accomplishment plaque requests will be considered after September 1, 2021 to display accomplishments under or in association with a city limit or county line sign. All existing accomplishment plaques shall be maintained for the remainder of the 10-year term in accordance with the latest TR15 contract executed for each installation. No accomplishment contract will be renewed or extended beyond the contract termination date. All existing accomplishments listed on the plaques shall remain unchanged for the remainder of the contract terms. No additions, modifications or updates will be permitted.

Option. If cities have a Welcome To sign (see EPG 903.8.8), they may display accomplishments on these structures. Accomplishments are not recommended on city Welcome To monuments as these structures are farther off the roadway and accomplishment legends would not be legible.

Standard. If accomplishments are installed with a Welcome To sign, the following criteria apply:

1. Accomplishments shall only be updated one time per year under a permit. If accomplishments are school related, they shall be updated at the end of the school year.
2. A maximum of three accomplishments, each displayed on an individual panel, shall be displayed below a city Welcome To sign.
3. Each accomplishment panel shall be no taller than 1 foot and shall be the width of the Welcome To sign they are installed under.
4. The total accomplishment sign area height shall be no taller than the Welcome To sign they are installed under.
5. The addition of the accomplishment plaques will be included in the TR42 agreement for the Welcome To sign they are installed beneath.
6. The size and fabrication method for the Welcome To sign with accomplishments must meet MoDOT specifications for this application of Welcome To sign (see EPG 903.8.8).

Guidance. Care should be taken when considering adding supplemental signs to make sure they do not interfere with or distract from regulatory, warning or guide signs. Sufficient spacing of at least 800 ft. on freeways or expressways should be allowed for drivers to be able to read and comprehend the sign messages.

903.8.14 Missouri Regional Port Authorities

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Support. Signing for port authorities is done in coordination with Multimodal Operations. For more information contact the MoDOT Multimodal Division (https://www.modot.org/railroads-general-information%7C).

903.8.15 Veterans Signing

Standard. MoDOT shall provide signing for veterans cemeteries in Missouri. The cemeteries shall be owned and operated by either the U.S. Department of Veterans Affairs (for national cemeteries) or the Missouri Veterans Commission (http://www.mvc.dps.mo.gov/) (for state cemeteries). First order signing (see EPG 903.1.24), on the state system, shall be provided for all cemeteries that meet the above upon request.

The Missouri Veterans Commission shall pay a participation fee for veterans' home signs for 10 years. After 10 years, the signs will either be removed or renewed for another participation fee. All participation fees are to be determined by Traffic. First order signing, on the state system, shall be provided for all veterans' homes that meet the above upon request.

Option. Second order signing may be considered if there is an intersection of a state route or an interchange within 6 miles of the cemetery or of the veterans' home.

Signing may be allowed for veterans' homes that are owned and operated by the Missouri Veterans Commission.

Support. See EPG 903.9.2 HOSPITAL Signs for signing of Veterans hospitals

903.8.16 College Signing

Support. Effective July 1, 2015 a new Code of State Regulations, 7 CSR Division 10, Chapter 17 – Supplemental Guide Sign Program (https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiQ6qWFw-bsAhUPS60KHXNYDQsQFjAAegQIBxAC&url=https%3A%2F%2Fwww.sos.mo.gov%2Fcmsimages%2Fadrules%2Fcsr%2Fcurrent%2F7csr%2F7c10-17.pdf&usg=AOvVaw0MB3kNkZkj3-ANJUO-dYLG), went into effect that incorporated the rules for college signing.

College signing is now part of the Supplemental Guide Sign Program which is managed by a third party contractor, beginning July 1, 2015.

Standard. The signing programs managed under the Supplemental Guide Sign Program include:

1. Tourist Oriented Directional Signing (TODS)
2. Specific Service Signing (Logos)
3. Traffic Generator Signing for privately owned and operated tourist-oriented activity sites
4. College Signing
5. Signing for State and Federal recreational and historic sites
6. State Correctional Center signing
7. Welcome Center Affiliate signing.

903.8.17 State Correctional Center Signs

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Support. Prior to July 2015, MoDOT's State Correctional Center Signing was managed, installed and maintained by MoDOT. The rules for correctional signing were contained in MoDOT policy in the EPG.

Effective July 1st 2015, a new Code of State Regulations went into effect, 7 CSR Division 10 , Chapter 17 – Supplemental Guide Sign Program, which incorporated the rules for State Correctional Center Signing. State Correctional Center Signing is now part of the Supplemental Guide Sign Program which is managed by a third party contractor, beginning July 1, 2015.

Standard. All requests for State Correctional Center Signing shall be sent to MoDOT's Supplemental Guide Sign Program manager for processing.

903.8.18 Historical Site Signs (M17-2a)



M17-2a

Support. Prior to July 2015, MoDOT's historic signing was accomplished through several different programs, Traffic Generator Signing and State and Federal Historic Site signing, these programs were managed, installed and maintained by MoDOT. In addition, historic sites could also be signed through MoDOT's TODS and Logos program, managed by MoDOT's TODS and Logos third party contract manager. The rules for Traffic generator signing and well as TODS and Logos signing were all contained in individual Codes of State Regulations while the rules for state and federal historic site signing were contained in policy within the EPG.

Effective July 1st 2015, a new Code of State Regulations went into effect, 7 CSR Division 10 , Chapter 17 – Supplemental Guide Sign Program (https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiQ6qWFw-bsAhUPS60KHXNYDQsQFjAAegQIBxAC&url=https%3A%2F%2Fwww.sos.mo.gov%2Fcmsimages%2Fadrules%2Fcsr%2Fcurrent%2F7csr%2F7c10-17.pdf&usg=AOvVaw0MB3kNkZkj3-ANJUO-dYLG), which incorporated the rules for Traffic Generator Signing, TODS, Logos as well as for State and Federal Historic site signing.

These programs are now part of the Supplemental Guide Sign Program which is managed by a third party contractor, beginning July 1, 2015.

Standard. All requests for Historic Site Signing shall be sent to MoDOT's Supplemental Guide Sign Program manager for processing.

Support. There are some historical sites which MoDOT staff still install and maintain signs for, these are sites that have "national prominence" and are "nationally known" and are signed at the Commission's expense. Table 903.8.18 shows the list of sites that are considered to have "national prominence" and are "nationally known" and are the historic sites the Commission deemed to be of

such importance as to justify such signing per Missouri State Statue 226.525 for the signing of natural wonders and historic attractions. Other historic sites have the option for signing under the Supplemental Guide Sign Program.

Table 903.8.18 Nationally Known, Nationally Prominent Sites

Non-contractual Sites
Daniel Boone's Home
General Pershing's Boyhood Home
George Washington Carver Nat'l Monument
Harry S Truman's Birthplace
Mark Twain’s Boyhood Home and Museum
Route 66 State Park
Scott Joplin House
Trail of Tears State Park
Ulysses S. Grant National Historic Site
Wilson's Creek National Battlefield Park
National Churchill Museum

Standard. MoDOT shall provide signing for certified Lewis and Clark historic sites. Signing for sites shall direct motorists from the Lewis and Clark trail to the certified historic site. Signing for a certified site shall be limited to the nearest junction on the trail to the site. Second and third order signing on the trail shall not be allowed. Along the Mississippi River, where there is not an official Lewis and Clark trail, signing shall be provided from the “pseudo-trail” as designated by MoDOT.

Signing shall consist of the Lewis and Clark Historical Marker (M17-2a) sign and an appropriate Advance Turn Arrow placed in advance of the junction where motorists leave the trail. If additional trailblazers on the state system are required, the Lewis and Clark Historical Marker sign with the appropriate Advance Turn Arrow shall be used.

Additional trailblazing off the state system may be required to reach the certified historic site. This signing shall consist of the smaller version of the Lewis and Clark Historical Marker (M17-2a) sign, which is installed and maintained by others. MoDOT shall manufacture the Lewis and Clark Historical Marker signs with the cost of manufacturing reimbursed according to the following subarticles. Signing on the state system shall not be allowed unless the appropriate trailblazer signs off the state system are also installed, if required.

If a Public Area Directional sign does not exist for the facility, signing shall be provided according to the normal Lewis and Clark historic site policy.

Trailblazers shall be reimbursed by the appropriate state agency.

Requests for Lewis and Clark historic signing for a non-state owned location shall only be considered if the location has been certified by the National Park Service.

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Signing for certified sites shall be in accordance with the normal Lewis and Clark historic site policy. The owner of the site shall be responsible for the cost and installation of the trailblazer signs and securing approval from the appropriate local agencies for locating and maintaining the trailblazer signs.

Guidance. The Missouri Department of Natural Resources and the Missouri Department of Conservation have erected special interpretive signs at some of their sites. The advance signs for these sites should be incorporated into any signing that currently exists for the facility by adding it above the existing Public Area Directional sign.

The Lewis and Clark Historical Marker sign should be mounted to either the left or right side of the Public Area Directional sign based on the turn required to reach the site.

Support. Information for certification can be found at:

Lewis & Clark National Historic Trail

1709 Jackson Street

Omaha, NE 68102-2571

https://www.nps.gov/lecl/index.htm (https://www.nps.gov/lecl/index.htm).

Information regarding the trail in Missouri can be found at:

The Missouri Lewis and Clark Bicentennial Commission

100 Jefferson Street, Suite 200

Jefferson City, MO 65101

573-522-9019

https://mostateparks.com/park/lewis-and-clark-state-park (https://mostateparks.com/park/lewis-and-clark-state-park).

Signing for certified sites will normally be from the approved Lewis and Clark trail. There are, however, several sites along the Missouri River in the north part of St. Louis County that are not conveniently located near the Lewis and Clark trail. Any signing provided along these routes will be in accordance with the normal Lewis and Clark historic site policy.

On November 1952, the Commission entered into an agreement with the Missouri Historical Society for the erection of markers along the highways of Missouri at points of great historic interest. These signs are provided by others, normally in a rest area, roadside park or at a specific location of historical interest.

903.8.19 Blue Star Markers (TR42-4)



TR42-4

Option. Blue Star Markers may be placed on the following routes: Route 36, Route 50, Route 67, I-44 and I-70. These signs are normally located in a rest area or roadside park. These signs are provided and maintained by others.

Standard. Approval for signing shall be obtained from the National Garden Clubs, Inc. prior to the erection of any new signs.

903.8.20 Local Reference Signs



Post Office



Library



Recycling Center



Tornado Shelter

Support. Local Reference signs are small informational signs installed and maintained by a city or county on state right of way per the terms of a Roles and Responsibilities document (see EPG 903.19.4.1). These signs provide guidance to city or county owned and maintained community sites which do not qualify for one of MoDOT's supplemental guide sign programs.

Typical examples of sites that would qualify for Local Reference signing include, but are not limited to:

1. City Hall
2. Police Station
3. Courthouse
4. City/County Park
5. City/County Pool
6. Senior Center
7. Recycling Center

Standard. Local Reference signs shall be 24 in. x 24 in. white legend on green guide signs with a directional arrow below the sign legend. The sign legend shall be limited to the generic name of the site, such as CITY PARK, and shall not include the proper name of the facility or the city / county name. Central Office Highway Safety and Traffic shall approve site types being requested for Local Reference signs and shall provide the sign design detail these signs shall be fabricated to match.

Local Reference signs shall only be placed at the first order sign location (see EPG 903.1.24) where motorists leave the state highway system. If the first order location is an interchange, the Local Reference sign shall only be placed at the ramp terminal. Local Reference signs shall not be placed on interstate highways or freeways. These signs shall only be installed on expressways with speed limits of 45 mph or less or on any conventional two-lane route.

A maximum of two Local Reference Signs on a maximum of one post shall be permitted at any given first order location. Local Reference signs shall direct motorists to the site along the most direct path possible. If the most direct path is not the same for the two directions of travel on the state route, the Local Reference signs for each direction shall be placed at two appropriate first order locations.

Local Reference signs and posts shall be provided, installed, and maintained by the city/county per the terms of a Roles and Responsibilities document, and the district shall approve all locations. Local reference signs shall be fabricated to MoDOT's sign design details and shall meet minimum MUTCD (https://mutcd.fhwa.dot.gov/) standards for color and retroreflection. A permit shall be issued by MoDOT to the city/county prior to the installation of Local Reference Signs. These signs shall be installed in accordance with the exhibits included with the Roles and Responsibilities document.

Guidance. Sites receiving Local Reference signing on MoDOT right of way could require additional trailblazer signing on city/county right of way to provide a complete path to the site. This signing is also the responsibility of the city/county to install and maintain. Trailblazer signs should match the same design, color and size as Local Reference signs so they are clearly associated with the first signs they see on MoDOT right of way.

903.8.21 Community Awareness Signs

Support. Many cities/counties participate in programs sponsored by different organizations. Some of these programs provide signs the cities/counties then wish to post with their city limit sign to acknowledge their participation. Cities/counties must achieve the minimum program requirements outlined by each sponsoring organization in order to qualify and/or continue to qualify for one or more of these programs. Signing for the following programs are approved for installation on MoDOT right of way:

A. Storm Ready Program – Administered by National Weather Service program.
B. Disaster Resistant Community Program - Sponsored by FEMA and locally coordinated by SEMA.
C. Missouri Community Betterment Program - Administered by the Missouri Community Betterment Education Fund, Inc.
D. TREE CITY U.S.A. Program – Administered by National Arbor Day Foundation.
E. National Neighborhood Watch Program – Administered by the National Sheriff's Association
F. MADD Program – Administered by Mothers Against Drunk Driving
G. D.A.R.E. Program - Administered by the MSHP in conjunction with local law enforcement

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H. Purple Heart City/County – Administered by the Military Order of the Purple Heart
I. POW-MIA City/County – Administered by the Jefferson Barracks POW-MIA Museum
J. Agri-Ready County - Administered by Missouri Farmers Care / Dept. of Agriculture
K. Firewise USA Program – Administered by the National Fire Protection Association
L. Main Street America – Administered by the Missouri Main Street Connection

Standard. Community Awareness signs shall not detract from, or interfere with, MoDOT signs or maintenance of the roadway. The signs shall look professional and shall not, contain advertising of any kind. These signs shall not be displayed on interstates or freeways. These signs shall only be installed on expressways with speed limits of 45 mph or less or on any conventional two-lane route. No Community Awareness sign shall be mounted to a MoDOT post assembly. Community Awareness signs shall be located 200 feet downstream of the city limit signs.

Cities/counties shall not install signs on MoDOT right of way before signing the Roles and Responsibilities agreement (see EPG 903.19.4.1) and receiving a permit from the local MoDOT district office. The roles and responsibilities agreement contains the guidance for how and where signs are to be installed on MoDOT right of way.

Cities/counties shall be approved by the sign program sponsoring organization before acquiring signs. Cities shall not fabricate their own copies and/or versions of the official community awareness program signs, only those signs provided by the sponsoring organization shall be installed on MoDOT right of way. Signs shall be removed from the right of way if the city/county no longer qualifies for the program the sign represents.

Option. The location of Community Awareness signs may be adjusted as not to interfere with higher-priority traffic control devices.

DARE signs may also be located at the right of way line on routes that pass along school properties.

If a city has a Welcome To sign on MoDOT right of way (see EPG 903.8.8) or a Welcome To monument on right of way (see EPG 941.5), they have the option to install their Community Awareness signs at these locations. However, the city must choose their preferred location for their Community Awareness signs, they cannot be displayed at both their Welcome To sign/monument location and their MoDOT city limit sign location, and the city is still limited to a maximum of two Community Awareness signs per Welcome To sign/monument. If the city elects to install the Community Awareness signs on the city Welcome To sign, they must be installed on the sign posts directly below the city Welcome To sign, one Community Awareness sign per post. If these signs are associated with a city Welcome To monument, the Community Awareness signs must be attached to the monument.

903.8.22 Municipal Bus Stop Signing

Support. Many cities operate public transportation that includes bus service. With many MoDOT routes running through cities and serving as city streets, bus stop locations many times are located on MoDOT routes.

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Guidance. Signing for bus stops should be installed and maintained by municipality forces with standard red on white "No Parking - Bus Stop" signs following enactment of an enabling ordinance either on a blanket or specific location basis.

No other bus system signing, such as trail blazing for bus routes, should be permitted on the state system.

Option. Where a special need exists, the shoulder may be improved for safety and maintenance reasons.

Local bus officials may be permitted to install supplementary plates bearing schedules for the particular stop and other information relating to the bus operation. Distinctive bus system logos may be displayed on the supplementary signs provided they are not distracting to motorists. These supplementary signs should be installed beneath the municipality signs.

Signing for other mass transit systems, including park and ride lots associated with the system, will be allowed under guidelines similar to bus stops.

If the mass transit system has a logo, they may incorporate it into their sign.

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903.9 General Service Signs (MUTCD Chapter 2I)

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903.9.12 EMERGENCY DIAL *55 Sign (D12-4a)

Standard. General Service Signs have been discontinued. MoDOT shall no longer provide General Service Signs. General Service Signs shall be left in place until they reach the end of their service life.

Guidance. The districts should give advanced notice to the entity for which the sign was installed for before removing the signs at the end of their service life. Any General Service Sign which is in place that directs motorists to a location which is no longer providing the service should be removed immediately.

Support. General Service Signing was the motorist service signing system before the adoption of the Logo program in 1991. The Logo program has become the recognized system nationally for directing motorist to the services they wish to find, making the General Service Signing system redundant and not widely used by motorist. This is the reason the program has been eliminated. General Service Signing for Alternate Fuels will be incorporated into the next TODS and Logo contract to supplement these

programs and help direct motorist to available alternate fuels which may be available at normal fuel stations. Alternate fuels will include Blended Ethanol (E85), Biodiesel (B20), Compressed Natural Gas (CNG) and Propane.

903.9.1 Sizes of General Service Signs (MUTCD Section 2I.01)

Standard. Except as provided in EPG 903.1.7, the sizes of General Service signs that have a standardized design shall be as shown in Table 903.9.1.

Table 903.9.1 General Service Signs and Plaque Sizes

Sign	Sign Designation	EPG Article	Conventional Road (in. x in.)	Freeway/Expressway (in. x in.)
				Mainline & Ramps
Rest Area Advance	D5-1		-	132 X 60
Rest Area Advance (Direction)	D5-1a		-	132 X 60
Rest Area Entrance (Direction)	D5-2		-	132 X 60
Rest Area Gore	D5-2a		-	72 X 84
Next Rest Area XX Miles	D5-6		-	-
Safety Break Free Coffee	D5-6c		-	-
Missouri Welcome Center Rest Area 1 Mile	D5-7		-	-
Missouri Welcome Center Rest Area Next Right	D5-7a		-	-
Missouri Welcome Center Rest Area	D5-8		-	-
Car Pool Information	D12-2a		-	-
Rideshare Call	D12-2b		-	-

903.9.2 HOSPITAL Signs (D9-2, D92-2P, D9-27, D9-27P)



D9-2



D9-2P



D9-27



D9-27P

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Option. The commission may provide signs on state right of way for the purpose of directing motorists to a qualified hospital for emergency care including Veterans hospitals.

Hospital signing at a second interchange may be considered.

Supplemental plaques may be added to the Hospital sign and symbolic “H”.

Hospitals, including veterans' hospitals, may purchase a supplemental plaque to be placed below the HOSPITAL sign with the hospital’s name.

Standard. A qualified licensed hospital shall provide continuous emergency care available to the public 24 hours a day, 7 days a week, with a doctor on call at all times, not to exceed third order signing (see EPG 903.1.24). Veterans’ hospital emergency rooms must be open to the general public, and not limited to treating only veterans, to qualify for hospital signing. Medical clinics not meeting these criteria shall not qualify for signing.

On freeways and expressways, the hospital sign shall be kept separate from other service signs due to its unique nature and usage. The HOSIPTAL NEXT RIGHT (D9-27) sign shall be used on the mainline in advance of an interchange and mounted independently.

The symbolic H (D9-2) sign shall be used at the top of the ramp along with the appropriate M series arrow in white on a blue background.

Stand-alone hospital signs shall consist of a sign assembly containing the symbolic H and directional arrow. The intersection for hospital signing shall be at the location where the principal access road to the hospital intersects the state highway system.

Hospital signs shall not be installed until it is determined that the motorist is adequately directed to the hospital once they leave the state highway system. If a hospital is farther than 1 mile from an interchange, a mileage plaque shall be provided with the symbolic H and M series arrow. If two hospitals are located at the same intersection the hospitals shall have a mileage plaque with distances in ¼ mile increments. Trailblazing on the state system shall consist of the symbolic H. Hospital signing shall be provided at the interchange or exit ramps that provide the most direct route to the hospital.

Supplemental plaques shall only be used when the following criteria is met:

A. A maximum of 3 supplemental signs shall be allowed per Hospital sign. Each plaque shall be 132 in. x 12 in. for the Hospital sign and 24 in. x 12 in. for symbolic H,

B. Signs shall be white legend on blue background,

C. All minimum ground clearance and breakaway requirements shall be followed, and

D. No commercial advertising or business logos shall be permitted.

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Guidance. In those instances where the hospital property abuts the MoDOT right of way, the nearest adjacent intersection of two state highways should be eligible. If the hospital is not located on the intersecting street where the state installed signs are located, assurance should be given that responsible local authorities will erect additional signs on the city, street or county highway.

903.9.3 Rest Area and Other Roadside Area Signs (D5-1 through D5-11 Series) (MUTCD Section 2I.05)



D5-1



D5-1a



D5-2



D5-2a



D5-6

Standard. The appropriate roadside feature sign shall be erected in advance of state maintained roadside parks, historic marker, scenic view or roadside table. Any combination of these facilities is to be signed only for the facility appearing first in that order. If a table is provided at a historic marker or scenic view, the Table sign may be mounted below the Historic Marker or Scenic View sign.

Rest Area signs shall have a retroreflective white legend and border on a blue background.

Signs that include the legend REST AREA shall be used only where parking and restroom facilities are available.

Guidance. Rest areas that have tourist information and welcome centers should be signed as provided in EPG 903.9.4.

If a rest area or other roadside area is provided on a conventional road, a D5-1 and/or D5-1a sign should be installed in advance of the rest area or other roadside area to permit the driver to reduce speed in preparation for leaving the highway. A D5-2 sign should be installed at the turn-off point where the driver needs to leave the highway to access the rest area or other roadside area if an exit ramp is provided.

If a rest area or other roadside area is provided on a freeway or expressway, a D5-1 sign should be placed 1 mile and/or 2 miles in advance of the rest area.

Standard. A D5-2a sign shall be placed at the rest area or other roadside area exit gore.

Option. A D5-1a sign may be placed between the D5-1 sign and the exit gore on a freeway or expressway. A second D5-1 sign may be used in place of the D5-1a sign with a distance to the nearest ½ or ¼ mile displayed as a fraction rather than a decimal for distances of less than 1 mile.

To provide the road user with information on the location of succeeding rest areas, a Next Rest Area (D5-6) sign may be installed independently or as a supplemental sign mounted below one of the REST AREA advance guide signs.

Standard. All signs on freeways and expressways for rest and other roadside areas shall have letter and numeral sizes that comply with the minimum requirements of Tables 903.5.11.2 and 903.5.11.3. The sizes for General Service signs that have standardized designs shall be as shown in Table 903.9.1.

903.9.4 Tourist Information and Welcome Center Signs (D5-7 Series and D5-8) (MUTCD Section 2I.08)



D5-7



D5-7a



D5-8

Standard. The Commission shall no longer provide service signing for tourist information centers either privately or publicly owned. The MISSOURI WELCOME CENTER AFFLIATE signs will be the only signing choice for Tourist Information Center requests. See EPG 903.9.5 for additional information. Existing service signing for Tourist Information Centers shall be left in place until they reach the end of their service life.

Support. Tourist Information Centers operated only by the Missouri Division of Tourism are designated as Missouri Welcome Centers.

Guidance. Where Missouri Welcome Centers are located off state owned highways, Missouri Welcome Center (D5-7a) sign should be used (see EPG 903.9.5).

Where Missouri Welcome Centers are located in rest areas the combination signs, Missouri Welcome Center / Rest Area (D5-7 and D5-8) sign, should be used in lieu of the rest area series of signing.

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The number of supplemental sign panels installed with Tourist Information or Welcome Center signs should be limited to a maximum of three so as not to impose an undue informational load on the road user.

Standard. Tourist Information or Welcome Center signs shall have a white legend and border on a blue background. Continuously staffed or unstaffed operation at least 8 hours per day, 7 days per week, shall be required.

903.9.5 Missouri Welcome Center Affiliates

Support. The Missouri Division of Tourism has developed operational guidelines for Missouri Welcome Center Affiliates as detailed in 7 CSR 10-17 Supplemental Guide Sign Program. This program is a means for local chamber/convention and visitor bureaus and institutions of higher education with an established tourism curriculum to promote tourism and increase the number of welcome centers in Missouri without expending state funds. Organizations interested in becoming a Missouri Welcome Center Affiliate should contact the Missouri Division of Tourism via email at tourism@ded.mo.gov or call (573) 751-4133.

Standard. Upon written approval as a Missouri Welcome Center Affiliate by the Missouri Division of Tourism, the affiliate will request signing for the facility through the Missouri supplemental guide sign program contractor. The signing shall be paid for by the affiliate.

Missouri Welcome Center Affiliate signing will be allowed up to the third order signing location (see EPG 903.1.24) or the first interchange encountered traveling away from the affiliate, whichever is encountered first. Signing will be allowed up to a maximum of 6 miles from the affiliate in an rural location and 2 miles in an urban location measured along the roadway path. A maximum of two signs at each sign order location will be allowed, with each sign providing turn guidance for one approach. The mainline and ramp signs for a given direction of travel at an interchange constitute one “sign”. No more than one intersection or interchange may receive signing for each direction on a given route. However, the two signs for a given order of signing may be split between two intersections or interchanges if directional access is better served by different sign locations. Interchange-to-interchange signing is not permitted. If an at-grade intersection is upgraded to an interchange during the affiliate contract period, signing at the farthest interchange will be removed and relocated at the new closer interchange.

Guidance. The number of supplemental sign panels installed with Tourist Information or Welcome Center signs should be limited to three so as not to impose an undue informational load on the road user.

903.9.6 Carpool and Ridesharing Signing (D12-2) (MUTCD Section 2I.14)



D12-2a



D12-2b

Option. In areas having carpool matching services, a Carpool Information (D12-2) sign may be provided adjacent to highways with preferential lanes or along any other highway.

Carpool Information signs may include an Internet domain name or telephone number of more than four characters within the legend.

A Car Pool Information/Ride Share (D12-2a, D12-2b) sign may be installed in those communities where the Department of Natural Resources facilitates this program.

Standard. If a local transit pictograph or carpool symbol is incorporated into the Carpool Information sign, the maximum vertical dimension of the pictograph or symbol shall not exceed 18 inches and the maximum horizontal dimension shall not exceed 30 inches.

903.9.7 Signing for Truck Parking Availability (MUTCD Section 2I.15)

Support. MoDOT does not currently install Truck Parking Availability signs.

903.9.8 Advance Information Signs for Roadside Features

Standard. Advance Information Signs for Roadside Features have been discontinued. MoDOT shall no longer provide Advance Information Signs for Roadside Features. Existing Advance Information Signs for Roadside Features shall be left in place until they reach the end of their service life.

903.9.9 Emergency Service Signs

Option. MoDOT may permit a rural emergency service to install on state right of way a numbering system, which will identify number properties.

Fire hydrant identifying signs may be installed along the state highway system.

Standard. Signs marking the boundaries of fire, ambulance, and law enforcement boundaries shall not be provided nor installed on state roadways. The fire department shall be required to provide, install and maintain fire hydrant identifying signs. These signs shall be 30 in. x 24 in., reflectorized, with a white legend on a blue background. The legend shall include a number that specifically identifies that specific hydrant location for cross-reference. The numbering system used shall be consistent throughout a county or region for ease of identification by mutual-aid departments.

Guidance. The background of fire hydrant identifying signs should have a fire hydrant emblem to indicate the purpose of the signs. These signs should be installed at the edge of the right of way or at the best possible locations for visibility in fill sections. These signs should be installed with the face of the sign parallel to the roadway.

Districts should approve locations based on the following:

A. The fire hydrant or other water source must be accessible from the roadway.
B. The hydrant should be 1/4 mile or less from the roadway centerline.

Support. The purpose of fire hydrant signing should help speed response time for accidents or spills on our roadway system, as well as the roadsides.

Typical numbering schemes for fire hydrant identifying signs would identify the hydrants using the local or regional fire department numbering systems. For example, hydrant number 7301 would be the first hydrant for a fire protection district with the designation “73” in the regional numbering system.

903.9.10 Safety Stop Sign (D5-6c)



D5-6c

Option. Civic organizations may be allowed to dispense free coffee or other refreshments on right of way as a service to motorists during holiday periods. Interstate rest areas, roadside parks and scenic turnouts may be utilized for such activities.

A sign indicating the host organization may be displayed at the serving location.

Standard. Official temporary Safety Stop signs may be erected for such facilities provided the following guidelines are met:

A. Applicant must obtain a permit and reserve a time slot in advance of the event. A copy of this permit must be posted during serving hours.
B. The activity shall be carried on solely within the safety rest area, roadside park, or scenic turnout in locations designated in the permit. Parking or any other activity shall not be permitted on the travel surface, shoulders, ramps, or other surfaces used for the movement of vehicles.
C. The activity shall be conducted for the express purpose of improving the safety of highway travel and not primarily to the advantage of any other organization or activities. No advertising shall be permitted.
D. The applicant must be a nonprofit organization showing a record of concern for automotive, highway or driver safety.
E. The refreshments or any other service offered shall be free of charge to the motorists without the solicitation of contributions or donations or any other benefits to the organization.
F. Solicitation or collection of contributions, donations, etc. is forbidden.
G. Handing out or posting of printed literature is prohibited. Cups or dispensing unit may not carry any advertising. The only exception to this is pre-approved highway safety literature.
H. Participating groups must conduct cleanup of the immediate area, both during and following the activities. All trash is to be placed into bags and placed in the Safety Rest Area trash dumpster or other trash containers located at the facility.

I. Participants are not to interfere with the work of the Safety Rest Area attendants or with the access to the restrooms or drinking fountains for safety breaks conducted at Rest Areas.
J. The serving organization may have two signs showing the service and organization. For example, "Free Coffee, Compliments of _____." Maximum size of these signs shall be 18 in. x 24 inches.
K. Violation of any of the rules may result in cancellation of future reservations for the offending organization.

There have been a number of other safety stops operating adjacent to highway right of way. Signing for such stops shall be placed on state right of way.

The SAFETY BREAK FREE COFFEE (D5-6c) sign shall be used for safety stops at all rest areas on freeways. One sign for each direction of travel shall be mounted beneath the existing advance directional sign for the rest area. This sign shall only be visible to the motorists during the time the facility is in operation and then removed.

Guidance. Special care should be taken before approval is given in roadside parks and scenic turnouts to ensure that adequate parking facilities are available.

Support. A "flip-down" sign is also available.

903.9.11 Ferry Crossing Signs

Option. Directional information signs may be provided for ferry crossings.

Standard. To qualify for signing, a ferry crossing shall meet the following guidelines:

A. The owner of the ferry shall operate the boat weather permitting during the following periods:
    1. Hours of operation are generally sunrise to sunset, five days a week.
    2. Operating season is March 15 through December 15.
    3. The operator should be responsible to notify the Missouri State Highway Patrol or the local district office when conditions will not allow a day or more of normal operation.
B. The ferryboat operation shall be U.S. Coast Guard inspected and certified.

MoDOT shall provide a maximum of third order generic signing (i.e. “Toll Ferry to KY"). The signs shall be considered as a supplemental sign if installed on freeways.

Signs shall be white reflectorized border and legend on a green reflectorized background for all roadway systems.

It shall be the responsibility of the local jurisdiction(s) to provide all supplemental signing over city or county roadways leading to the ferry crossings.

When a ferry is seasonally operated, a Commission furnished sign shall be installed to indicate when the ferry in not in operation for the season.

903.9.12 EMERGENCY DIAL *55 Sign (D12-4a)

Guidance. The EMERGENCY DIAL *55 (D12-4a) signs will no longer be installed along MoDOT roadways.

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Standard. EMERGENCY DIAL *55 signs shall only be installed at Commuter Lots or at locations deemed necessary, at the District Engineers discretion. Existing EMERGENCY DIAL *55 signs shall be left in place until they reach the end of their service life.

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903.10 Specific Service Signs (MUTCD Chapter 2J)



Support. MoDOT's Logo contract signing program began in 1991 and was largely managed internally. In 2010, Tourist Oriented Destination Signing (TODS) was added to the Logo program and they were combined under one contract. Then, in 2015, a Code of State Regulation (7 CSR 10-17) was established which replaced the CSRs for TODS, Logos, Traffic Generator, and College signing, and included rules for State and Federal site signing, Welcome Center Affiliate Signing, and State Correctional Center Signing.

Since 2015, MoDOT's contractor has assumed full responsibility of the program to execute contracts, collect and track revenue, as well as install and maintain all signs with their portion of the revenue. MoDOT receives guaranteed annual revenue from this program which is deposited in the state road fund to help maintain the state's road and bridge network. MoDOT's role under this current program format is limited to site plan reviews for new sign installations, reporting any sign damage to the contractor so they can correct it, and to serve as a resource on MoDOT's policy and Code of State Regulations under which the programs operate.

Standard. All requests for participation in the Logo program shall be forwarded to MoDOT's Supplemental Guide Sign Program contractor for processing. Per the CSR, it is the program manager's responsibility to receive all requests, evaluate eligibility and administer the contract with the applicant.

MoDOT districts' role in the program is to review and approve site plans for new sign installations, assuring the new sign installations do not conflict with existing traffic control devices or create sight distance issues. Another critical responsibility is to identify and report damage and/or deficiencies with any of the signs to the program manager.

Central Office Highway Safety and Traffic Division shall be responsible for managing the Supplemental Guide Sign Program Contract, updating the CSR, and interpreting the intent of the CSR and program contract if there are questions or appeals from prospective applicants. Highway Safety and Traffic Division shall also be responsible for working with Governmental Relations on legislative issues.

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The Logo program shall be managed in accordance with the Code of State Regulations 7 CSR 10-17 Supplemental Guide Sign Program and the Supplemental Guide Sign Program contract between the Commission and MoDOT's third party contractor. The CSR is binding and has the effect of law. Exceptions and/or variations from the CSR are not permitted under normal conditions with the Director having the only authority to authorize such actions.

The rules contained within the CSR are based on, and are in conformance with, the Manual on Uniform Traffic Control Devices and the AASHTO Guidelines for the Selection of Supplemental Guide Signs for Traffic Generators.

Support. Construction project guidance for Relocation of Service Signs is available in EPG 616.23. Also reference "Supplemental Guide Signs" in the General Provisions for contractual requirements.

903.10.1 Application (MUTCD Section 2J.02)

Support. Information in this section supplements the primary guidance contained in 7 CSR 10-17.

Standard. The number of Specific Service signs along an approach to an interchange or intersection, regardless of the number of service types displayed, shall be limited to a maximum of four. In the direction of traffic flow, successive Specific Service signs shall be for attraction, camping, lodging, food, EV charging, and gas services, in that order.

Guidance. The Specific Service signs should be located to avoid visual conflict with other signs within the highway right-of-way.

Where a service type is displayed on two signs, the signs for that service should follow one another in succession.

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903.11 Tourist-Oriented Directional Signs (MUTCD Chapter 2K)



Support. See EPG 903.10 for history of MoDOT's Tourist-Oriented Directional Signs (TODS) program.

Standard. All requests for participation in the TODS program shall be forwarded to MoDOT's Supplemental Guide Sign Program contractor for processing. Per the CSR, it is the program manager's responsibility to receive all requests, evaluate eligibility, and administer the contract with the applicant.

MoDOT districts' role in the program is limited to reviewing and approving site plan reviews for new sign installations to assure these new sign installations are appropriate, looking for items such as, but not limited to, ensuring new installations do not conflict with existing traffic control devices, have sight distance issues, or create an issue for maintaining the right of way. Another critical responsibility is to identify and report damage and/or deficiencies with any of the signs the program manager is responsible for.

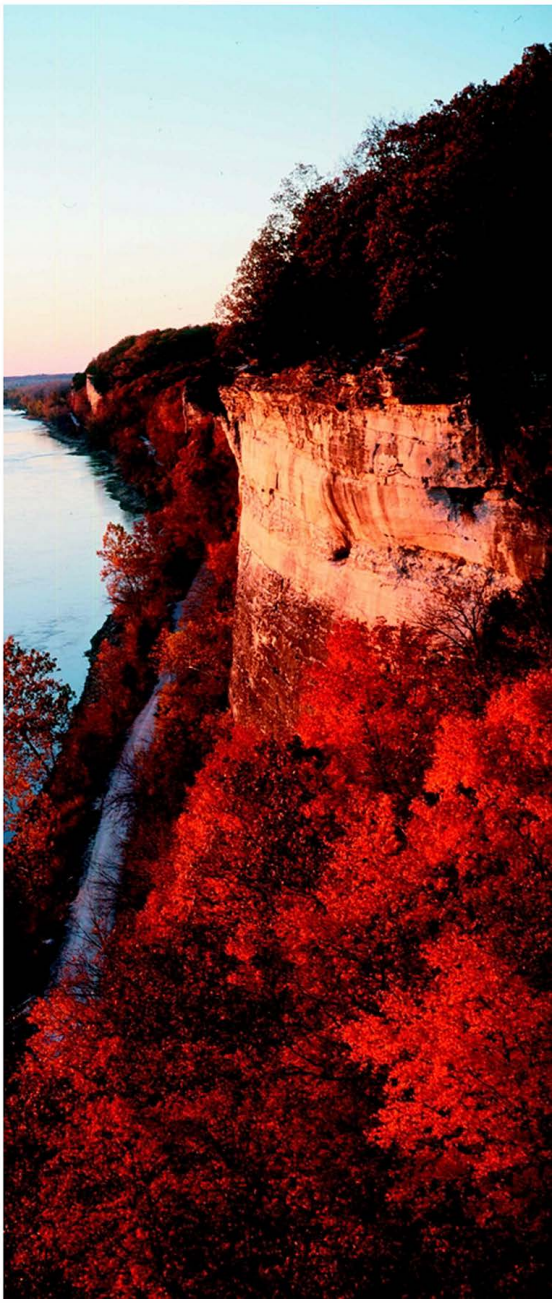
Central Office Highway Safety and Traffic Division shall be responsible for managing the Supplemental Guide Sign Program Contract, updating the CSR, and interpreting the intent of the CSR and the program contract if there are questions or appeals from prospective applicants. Highway Safety and Traffic Division shall also be responsible for working with Governmental Relations on legislative issues.

The TODS program shall be managed in accordance with the Code of State Regulations 7 CSR 10-17 Supplemental Guide Sign Program and the Supplemental Guide Sign Program contract between the Commission and MoDOT's third party contractor. The CSR is binding and has the effect of law. Exceptions and/or variations from the CSR are not permitted under normal conditions with the Director having the only authority to authorize such actions.

The rules contained within the CSR are based on, and are in conformance with, the Manual on Uniform Traffic Control Devices and the AASHTO Guidelines for the Selection of Supplemental Guide Signs for Traffic Generators.

Support. Construction project guidance for Design and Construction is available in EPG 616.23. Also reference "Supplemental Guide Signs" in the General Provisions for contractual requirements.

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903.12 Changeable Message Signs (MUTCD Chapter 2L)

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903.12.8 Permanently-Located Changeable Message Signs (MUTCD Section 2L.08)

903.12.1 Description of Changeable Message Signs (MUTCD Section 2L.01)

Support. A changeable message sign (CMS) is a traffic control device that is capable of displaying one or more alternative messages. Some CMS have a blank mode when no message is displayed, while others display multiple messages with only one of the messages displayed at a time (such as OPEN/CLOSED signs at weigh stations).

Dynamic message signs (DMS) are a type of CMS which are stationary traffic control devices capable of displaying one or more alternative messages that provide travelers with real-time, traffic-related variable messages. DMS are used to warn, regulate, route and manage traffic.

The provisions in EPG 903.12 apply to both permanent and portable changeable message signs with electronic displays or the electronic display portion of an otherwise conventional static sign. Additional provisions that only apply to portable changeable message signs (PCMS) can be found in EPG 616.12.5. Additional MoDOT provisions that apply to permanently-located DMS can be found in EPG 910.3.

The CMS is a traffic control device at all times regardless of the type of message being displayed. Accordingly, the limitations on design, format, and manner of display of a message conveyed on a conventional sign apply to CMS regardless of the type of message being displayed at any given time. Some of the general provisions regarding traffic control devices are reiterated in EPG 903.12. However, EPG 903.12 is not an independent or stand-alone reference for CMS. Users of CMS are expected to consult the other articles in the EPG for criteria on how to develop effective messages that comply with the EPG and that meet the expectancy and limitations of the road user. In this regard, the engineering processes applied to decisions about whether to use a particular sign, for example, are no different for the decisions about the type and content of the message under consideration for display on a CMS. The other limited-use messages allowed on CMS as provided for in EPG 903.12 likewise fall under the same MUTCD provisions as the primary-use traffic operation regulatory, warning, and guidance messages except as stated otherwise in EPG 903.12.

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CMS messaging can be subject to habituation, a phenomenon by which repeated exposure to a stimulus results in diminished response. CMS habituation can occur through repeated exposure to messages, especially those messages that might not be perceived as having relevance to the road user, resulting in diminished responsiveness of the road user to that message. Because messages can be changed or extinguished, the effectiveness of CMS is tied more to the messages displayed thereon, the frequency of displayed messages, and the relevance to the road user, rather than to the installation of the signs themselves.

Guidance. Changeable message signs should be used judiciously to avoid habituation and preserve their effectiveness during the display of real-time messages about traffic conditions or traffic advisories.

Standard. No items other than inventory or maintenance-related information (see EPG 903.1.4) shall be displayed on the front or back of a CMS or portable CMS. Names or logos of the manufacturer, brand, or model shall not be displayed on a CMS or portable CMS, either in the message display itself or on the exterior housing.

Guidance. Blank-out signs that display only single-phase, predetermined electronic-display legends that are limited by their composition and arrangement of pixels or other illuminated forms in a fixed arrangement (such as a blank-out sign indicating a part-time turn prohibition, a blank-out or changeable lane-use sign, or a changeable OPEN/CLOSED sign for a weigh station) should comply with the provisions of the applicable Article for the specific type of sign, provided that the letter forms, symbols, and other legend elements are duplicates of the conventional messages as detailed in the "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)). Because such a sign is effectively an illuminated version of a conventional sign, the size of its legend elements, the overall size of the sign, and the placement of the sign should comply with the applicable provisions for the conventional version of the sign.

903.12.2 Applications of Changeable Message Signs (MUTCD Section 2L.02)

Standard. CMS shall display only traffic operational, regulatory, warning, and guidance information except as otherwise provided in EPG 903.12 and EPG 910.3. Advertising or other messages not related to traffic control shall not be displayed on a CMS or on its supports or other equipment.

Option. CMS may display traffic safety campaign messages (see EPG 903.12.7), transportation-related messages, emergency homeland security messages, and America's Missing: Broadcast Emergency Response (AMBER) and Blue Alert messages, all as provided for in EPG 903.12 and 910.3.

Transportation-related messages for the purpose of improving traffic conditions, such as those providing information on alternative means of transportation, electronic toll collection, or carpooling may be displayed to remind or inform drivers of relevant options or opportunities for transportation.

Support. Messages regarding broader transportation items not related to improving traffic conditions, such as reminders of driver's license or vehicle registration renewal, vehicle recall information, and vehicle maintenance, do not meet the purpose of a transportation-related message.

Examples of transportation-related messages include "STADIUM EVENT SUNDAY, DELAYS NOON TO 4 PM" and "OZONE ALERT—USE TRANSIT."

Guidance. A CMS should not be used to display a transportation-related message if doing so could adversely affect respect for the sign. "CONGESTION AHEAD" or other overly simplistic or vague messages should not be displayed alone. These messages should be supplemented with a message on the location or distance to the congestion or incident, delay and travel time, alternative route, or other similar messages.

CMS should not be used in place of conventional signs for conditions that do not change, except for blank-out type signs used to display regulatory, warning, and guidance information that routinely reoccurs, but only on a part-time basis. Similarly, when only certain elements of a message on a non-changeable sign are subject to change, only those elements of the sign should be in an electronic display.

Support. The purpose of CMS is to provide real-time traffic regulatory, warning, or guidance messages as follows:

A. Incident management and route diversion;
B. Warning of adverse roadway travel conditions due to weather;
C. Special event applications associated with traffic control or conditions;
D. Lane, ramp, and roadway control;
E. Priced or other types of managed lanes;
F. Travel times;
G. Warning situations;
H. Traffic regulations;
I. Speed control or warning;
J. Variable destination guidance;
K. Supporting temporary traffic control; or
L. Active Traffic Management.

CMS provide significant flexibility and capability in communicating many types of real-time traffic control messages to road users. While their intended purpose is the display of traffic regulatory, warning, or guidance information, other limited uses are also allowed under certain conditions, as provided in EPG 903.12. Their integrity as an official traffic control device rests significantly on their judicious use and proper messaging format and content, regardless of the message type being displayed.

Standard. MoDOT shall issue and maintain a policy regarding the use and display of all types of messages to be used on their CMS. The policy shall define the types of messages that will be allowed, the priority of messages, the proper syntax of messages, the timing of messages, and other important messaging elements to ensure messages displayed meet the basic principles that govern the design and use of traffic control devices in general (see EPG 911 (MUTCD Section 1D.01)) and traffic signs in particular as provided for in the EPG.

Guidance. When CMS are used at multiple locations to address a specific situation, the message displays should be consistent along the roadway corridor and adjacent corridors, which might necessitate coordination among different operating agencies.

AMBER and Blue Alerts (see the first option paragraph of this Article), when displayed, should not preempt messages related to traffic or travel conditions. AMBER and Blue Alert messages should be kept as brief as possible and, when possible, direct road users to another source, such as broadcast or highway advisory radio, for detailed information about the alert.

Support. EPG 910.3.2.15 contains procedures for Child Abduction, Blue Alert, and Ozon Alert messages.

Standard. Types of “alert” messages other than AMBER and Blue alerts that are unrelated to traffic or travel conditions shall not be displayed on CMS.

The format of CMS displays shall not be of a type that could be considered similar to advertising or promotional displays.

Support. In times of a declared state of emergency, it might be appropriate to display messages related to evacuation, homeland security, or emergency information. Traffic patterns, movement, or other situations might be atypical due to the emergency, necessitating unique messaging not specifically related to traffic conditions.

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Standard. Homeland security and emergency messages shall only be displayed in declared states of emergency when there is an imminent threat to the general population. Generic security or personal safety messages shall not be displayed when there is no context of a declared state of emergency or known imminent national security threat. Homeland security and emergency messages shall not be promotional or advisory in nature, including the message design, layout, or manner of display.

Guidance. Homeland Security and emergency messages should undergo significant levels of scrutiny prior to being approved for broadcast to ensure accuracy and consistency with emergency conditions. These messages should be designed to convey a clear and simple meaning in a similar format to traffic control messages.

Support. EPG 903.2.20 contains information regarding the design of CMS that are used to display variable speed limits that change based on ambient or operational conditions on the variable Speed Limit (R2-1) sign.

EPG 903.3.13 contains information regarding the design of CMS that are used to display the speed at which approaching vehicles are traveling on the Vehicle Speed Feedback (W13-20 and W13-20aP) sign and plaque.

EPG 912 (MUTCD Section 5B.01) contains provisions for LEDs used in electronic-display signs to accommodate driving automation systems.

903.12.3 Legibility and Visibility of Changeable Message Signs (MUTCD Section 2L.03)

Support. The maximum distance at which a driver can first correctly identify letters and words on a sign is called the legibility distance of the sign. Legibility distance is affected by the characteristics of the sign design and the visual capabilities of drivers. Visual capabilities, and thus legibility distances, vary among drivers.

For the more common types of CMS, the longest measured legibility distances on sunny days occur during mid-day when the sun is overhead. Legibility distances are much shorter when the sun is behind the sign face, when the sun is on the horizon and shining on the sign face, or at night.

Visibility is the characteristic that enables a CMS to be seen. Visibility is associated with the point where the CMS is first detected, whereas legibility is the point where the message on the CMS can be read. Environmental conditions such as rain, fog, and snow impact the visibility of CMS and can reduce the available legibility distances. During these conditions, there might not be enough viewing time for drivers to read the message.

Guidance. CMS used on roadways with speed limits of 55 mph or higher should be visible from ½ mile under both day and night conditions. The message should be designed to be legible from a minimum distance of 600 feet for nighttime conditions and 800 feet for normal daylight conditions. When environmental conditions that reduce visibility and legibility are present, or when the legibility distances stated in the previous sentences in this paragraph cannot be practically achieved, messages composed of fewer units of information should be used and consideration should be given to limiting the message to a single phase (see EPG 903.12.5 for information regarding the lengths of messages displayed on CMS).

The electronic display of standardized regulatory and warning signs used individually or as part of the legend for a larger sign should meet the size and legend requirements for those specific signs in EPG 903.2 and 903.3.

903.12.4 Design Characteristics of Messages (MUTCD Section 2L.04)

Standard. Except as provided in the following paragraph, messages shall not include animation, flashing, dissolving, exploding, scrolling, or other dynamic display elements.

When a portable CMS is used as an arrow board that uses a flashing or sequential display for a lane or shoulder closure, the display and operation shall be considered that of an arrow board and shall comply with the provisions of EPG 616.12.5 and 616.12.6.

Guidance. In developing messages for display on CMS, the provisions of EPG 911 (MUTCD Section 1D.01) should be consulted for the principles of an effective traffic control device.

Standard. All message displays on CMS, whether for traffic operational, regulatory, warning, or guidance information, or for the other allowable message types as defined in EPG 903.12, shall follow the same design and display principles found in the EPG used for other traffic control signs, except as provided elsewhere in EPG 903.12.

Guidance. Except in the case of a limited-legend CMS (such as a blank-out or a part-time regulatory sign display) that is used in place of a conventional regulatory sign or an activated blank-out warning sign that supplements a conventional warning sign at a separate location, the signs should be used as a supplement to and not as a substitute for conventional signs and markings unless otherwise provided for in the EPG.

Support. When CMS are overused for messages not directly associated with real-time driving conditions, road users might pay less attention to the sign, thereby limiting their effectiveness as traffic control devices.

Guidance. Warning Beacons (see EPG 902.18.3) should not be installed on CMS, rather CMS should be used predominately to display messages that are critical to real-time travel conditions. CMS word messages should be limited to no more than three lines, with no more than 20 characters per line.

The spacing between characters in a word should be between 25 and 40 percent of the letter height. The spacing between words in a message should be between 75 and 100 percent of the letter height. Spacing between the message lines should be between 50 and 75 percent of the letter height. Table 903.12.4 contains information for spacing between characters, words, and lines of text.

Table 903.12.4 Spacing between Message Characters, Words, and Lines of Text

Height of Letters Used on CMS	Spacing between Characters in Words	Horizontal Spacing between Words	Vertical Spacing between Lines of Text
12	3 - 5	9 - 12	6 - 9
18	4 ½ - 7	13 ½ - 18	9 - 13 ½
Note: All units are in inches			

Except as otherwise provided in the EPG, word messages on CMS should be composed of all upper-case letters. The minimum letter height should be 18 inches for CMS on roadways with speed limits of 45 mph or higher. The minimum letter height should be 12 inches for CMS on roadways with speed limits of less than 45 mph. When a message is composed of two phases and higher informational load (see EPG 903.12.5), the letter height should be 18 inches, regardless of the speed limit, to optimize legibility distance and available viewing time.

Option. CMS used to replicate a conventional sign may use the character size of the conventional sign being replicated.

Support. Using letter heights of more than 18 inches will not result in proportional increases in legibility distance.

Guidance. The width-to-height ratio of the sign characters should be between 0.7 and 1.0. The stroke width-to-height ratio should be 0.2.

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Support. The width-to-height ratio is commonly accomplished using a minimum font matrix density of five pixels wide by seven pixels high.

Standard. CMS shall automatically adjust their brightness under varying light conditions to maintain legibility.

Guidance. The luminance design of a CMS should meet industry criteria for daytime and nighttime conditions. Luminance contrast design should be between 8 and 12 for all conditions.

Support. CMS maintenance and replacement practices might need to account for the reduction of LED luminance and luminance contrast that occurs naturally over time and might substantially impact legibility.

Guidance. Contrast orientation of CMS should always be positive, that is, with luminous characters on a dark or less-luminous background.

Support. Legibility distances for negative-contrast CMS are likely to be at least 25 percent shorter than those of positive-contrast messages. In addition, the increased light emitted by negative-contrast CMS has not been shown to improve detection distances and might visually overwhelm the darker characters of the sign legend.

Standard. The colors used for the legends and backgrounds on CMS shall be as provided in Table 903.1.6.

Guidance. When displaying color messages use of full background color should be avoided in nighttime conditions. Full background color at night can cause a washout effect of the text or other image being displayed.

Standard. Except as provided for in the following paragraph, if a black background is used, the color used for the legend on a CMS shall match the background color that would be used on a standard sign for that type of legend as specified in Table 903.1.6.

Option. CMS that use only yellow or amber LEDs may display a yellow or amber legend that does not match the background color used on a standard sign for that type of legend as specified in Table 903.1.6.

Standard. If a green background is used for a guide message on a CMS or if a blue background is used for a motorist services message on a CMS, the background color shall be provided by green or blue lighted pixels such that the entire CMS would be lighted, not just the white legend.

Support. Some CMS that employ newer technologies have the capability to display a near duplicate of a standard sign or other sign legend using standard symbols, the Standard Alphabets and letter forms, route shields, and other typical sign legend elements with no apparent loss of resolution or recognition to the road user when compared with a conventional version of the same sign legend. Such signs are of the full-matrix type and can typically display full-color legends. Figure 903.12.4 shows comparative examples of the effects of varying pixel densities on legend form.

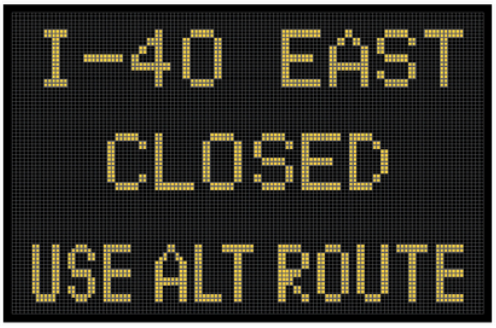
Guidance. If used, the CMS described in the previous paragraph should not display symbols or route shields unless they can do so in the appropriate legend and background color combinations. Where an LED matrix is used to form the changeable legend, signs with pixel spacing greater than 20 millimeters should display only word legends and no symbols or route shields.

For a single-phase message where the Standard Alphabets and other legend elements of standard designs are used, the lettering style, size, and line spacing should comply with the applicable provisions for the type of message displayed as provided elsewhere in the EPG. For two-phase messages, larger legend heights should be used as described previously in this Article because of the need for such messages to be legible at a greater distance. Regardless of the number of phases, the CMS should comply with the legibility and visibility provisions of EPG 903.12.3.

Support. EPG 910.3.2.8.1 includes additional information regarding Design Characteristics of Messages for DMS.



Color full-matrix CMS with pixel pitches of 20 millimeters or less are typically capable of displaying legends nearly identical to conventional sign legends, including route shields and symbols as provided in the EPG.



CMS with insufficient pixel density, typically with pixel pitches greater than 20 millimeters – whether full color or monochrome – are generally not capable of adequately displaying conventional sign legends with sufficient clarity and should only display monochrome word messages.

Figure 903.12.4 Example of Capability to display Sign Legends Based on Pixel Pitch

Notes:

1. Pixel pitch is the distance from the center of a pixel to the center of an adjacent pixel.
2. The pixel pitch is described in Metric units because sign manufacturers only use Metric units.

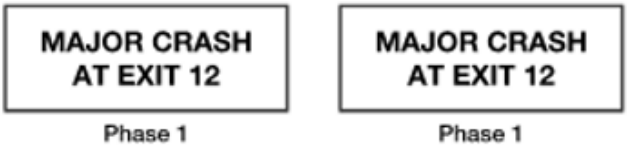
903.12.5 Message Length and Units of Information (MUTCD Section 2L.05)

Guidance. The maximum length of a message should be dictated by the number of units of information contained in the message, in addition to the size of the CMS. A unit of information, which is a single answer to a single question that a driver can use to make a decision, should not be more than four words.

Table 903.12.5 Example of Units of Information

Question	Answer	Number of Information Units
What happened?	MAJOR CRASH	1
Where?	AT EXIT 12	1
Who is the advisory for?	Drivers heading TO NEW YORK	1
What is Advised?	USE ROUTE 46	1

Note: the following is an example of a two-phase message that could be developed from the four information units shown in this table:



Support. In order to illustrate the concept of units of information, Table 903.12.5 shows an example message that is comprised of four units of information.

The maximum allowable number of units of information in a CMS message is based on the principles described in this Article, the current highway operating speed, the legibility characteristics of the CMS, and the lighting conditions.

Standard. Each message shall consist of no more than two phases. A phase shall consist of no more than three lines of text. Each phase shall be understood by itself, and the meaning of the entire message shall be the same, regardless of the sequence in which the phases are read. Each line of legend shall be centered on the sign. If more than one CMS is visible to road users, then only one sign shall display a sequential message at any given time.

Option. A legend on a CMS that replicates a legend on a conventional sign that would not normally be center justified may be left justified or right justified as appropriate, such as a travel time display.

Standard. Abbreviations displayed on CMS shall comply with the provisions of EPG 911 (MUTCD Section 1D.08).

Guidance. When designing and displaying messages on CMS, the following principles should be used:

A. The minimum time that an individual phase is displayed should be based on 1 second per word or 2 seconds per unit of information, whichever produces a lesser value. The display time for a phase should never be less than 2 seconds.
B. The maximum cycle time of a two-phase message should be 8 seconds.
C. The duration between the display of two phases should not exceed 0.3 seconds.
D. No more than three units of information should be displayed in a message phase.
E. No more than four units of information should be in a message when the traffic operating speeds are 35 mph or more.
F. No more than five units of information should be in a message when the traffic operating speeds are less than 35 mph.
G. Only one unit of information should appear on each line of the CMS.

Support. Table 903.12.5 provides an example of the number of units of information in a message.

Option. A unit of information consisting of more than one word may be displayed on more than one line. An additional CMS at a downstream location may be used for the purpose of allowing the entire message to be read twice.

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If more than two phases would be needed to display the necessary information, additional CMS may be used to display this information as a series of two distinct, independent messages with a maximum of two phases at each location, in accordance with the provisions of the first Standard paragraph of EPG 903.12.5.

Support. Figures 913.12.5.1 and 903.12.5.2 provide examples of message construction for CMS. Each example shows the message content, layout, and phasing for a potential message and an improved message. The improved message for each example has been optimized for recognition, comprehension, and effectiveness.

See EPG 910.3.2.8.1 for additional information regarding Message Length and Units of Information for DMS.

Example	Phase	Potential Message	Improved Message	Comments
1	1	EXIT 10	EXIT 10 CLOSED	**Diversionary message:** Each message phase should convey a complete thought independent of the other message phase. The entire message should also make sense regardless of which phase is read first.
	2	CLOSED USE EXIT 12	USE EXIT 12	
2	1	ROADWORK AHEAD	ROAD WORK AHEAD	**Advance warning message:** Condensing ROAD and WORK into single word is not necessary since sign width will accommodate the conventional 2-word message. A general CAUTION message is not specific enough to be actionable by the road user. Message should not be repeated to fill sign. Phase 2 of the improved message can be eliminated without any loss of meaning to Phase 1.
	2	CAUTION CAUTION CAUTION	FINES DOUBLE	
3	1	RIGHT LANE CLOSED	RIGHT LANE CLOSED 1 MILE	**Advance warning message:** Use of single phase message reduces time necessary to read and glances away from the road. Second phase does not provide a complete message.
	2	1 MILE	N/A Single-Phase Message	
4	1	RT LN CLSD 1 MI	RIGHT LANE CLOSED 1 MILE	**Advance warning message:** Less common abbreviations (see EPG 911 (MUTCD Table 1D-2)) are not warranted when the sign can accommodate the full message. Abbreviations in EPG 911 (MUTCD Table 1D-2) should be limited only to portable CMS where the number of characters per line is limited.
	2	N/A Single-Phase Message	N/A Single-Phase Message	
5	1	9TH AVENUE SOUTHWEST KEEP RIGHT	9TH AVE SW KEEP RIGHT	**Directional message:** Conventional abbreviations for street name descriptors (see Table 903.4.7.1) are used for consistency with standard signs to improve recognition and reduce the apparent amount of legend.
	2	N/A Single-Phase Message	N/A Single-Phase Message	
6	1	EXPWY CONGESTED USE 101 FOR AIRPORT	US 19 CONGESTED	**Diversionary message:** Lack of Expressway route number is vague to unfamiliar road user. Adding exit number for diversion route simplifies message. Diversion message is stated in reverse order and requires more words as a result.
	2	N/A Single-Phase Message	AIRPORT USE EXIT 101	
7	1	TRAVEL TIME TO I-89 13 MINUTES	I-89 JCT 12 MILES 13 MINS	**Travel time information:** TRAVEL TIME legend is extraneous and out of context for the distance message. Changing only one line of legend between phases compromises recognition of the message.
	2	TRAVEL TIME TO I-89 12 MILES	N/A Single-Phase Message	
8	1	SEAT BELTS SAVE LIVES	STATE LAW FASTEN SEAT BELTS	**Safety campaign regulatory message:** Slogan-type message does not convey the legal requirement. As an alternative, the STATE LAW legend could be eliminated and the fine for violations displayed on a second phase to convey the regulatory nature of the message.
	2	N/A Single-Phase Message	N/A Single-Phase Message	
9	1	DONT TEXT JUST DRIVE	NO HAND-HELD PHONE BY DRIVER	**Regulatory message.** Slogan-type message does not convey the legal requirement. Phase 2 of the improved message can be eliminated without any loss of meaning to Phase 1.
	2	IT CAN WAIT	$250 FINE AND POINTS	

Figure 903.12.5.1 Examples of Message Construction for CMS

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*Examples shown are for single-color CMS with pixel spacing greater than 20 mm and use all upper-case lettering. Multi-color, fullmatrix CMS with pixel spacing of 20 mm or less should use upper- and lower-case lettering where appropriate and proper legend and background colors.

Example	Phase	Potential Message	Improved Message	Comments
1	1	EXIT 10	EXIT 10 CLOSED	Diversionary message: Each phase conveys a complete thought.
	2	CLOSED USE EXIT 12	USE EXIT 12	
2	1	ROADWORK AHEAD	ROAD WORK AHEAD	Advance warning message: Condensing ROAD and WORK into a single word is unnecessary because the sign width will accommodate the conventional 2-word phrase. A general CAUTION message is not specific enough to be useful to the road user. Message should not be repeated to fill the sign. Phase 2 of the improved message can be eliminated without any loss of meaning to Phase 1.
	2	CAUTION CAUTION CAUTION	FINES DOUBLE	
3	1	RIGHT LANE CLOSED	RIGHT LN CLOSED 1 MILE	Advance warning message: Separation of the message into 2 phases is unnecessary. Second phase does not provide a complete message.
	2	1 MILE	N/A Single-Phase Message	
4	1	RT LN CLSD 1 MI	RIGHT LN CLOSED 1 MILE	Advance warning message: Less common abbreviations (EPG 911 (MUTCD Table 1D-2)) are not warranted when the sign can accommodate the full message.
	2	N/A Single-Phase Message	N/A Single-Phase Message	
5	1	9TH AVENUE SW	9 AVE SW KEEP RIGHT	Directional message: Conventional abbreviations for street name descriptors (see Table 903.4.7.1) are used for consistency with standard signs to improve recognition and reduce the apparent amount of legend.
	2	KEEP RIGHT	N/A Single-Phase Message	
6	1	ROAD WORK	ROADWORK NEXT 3 MILE	Advance warning message: Condensing ROAD and WORK into single word (EPG 911 (MUTCD Table 1D-2)) accommodates a single-phase message.
	2	NEXT 3 MILES	N/A Single-Phase Message	
7	1	SEAT BELTS	FASTEN SEAT BELTS	Safety campaign regulatory message: Slogan-type message does not convey the legal requirement. As an alternative, the STATE LAW legend could be eliminated and the fine for violations displayed on a second phase to convey the regulatory nature of the message. Phase 2 of the improved message can be eliminated without any loss of meaning to Phase 1.
	2	SAVE LIVES	STATE LAW	
8	1	DONT TEXT	NO HAND-HELD PHONE	Regulatory message: Slogan-type message does not convey the legal requirement.
	2	JUST DRIVE	BY DRIVER	

Figure 903.12.5.2 Examples of Message Construction for CMS

*Examples shown are for a portable CMS where the display width is generally limited to 8 characters per line of legend.

903.12.6 Travel Time Messages (MUTCD Section 2L.06)

Support. Travel times provide road users useful information about the level of congestion on segments of highways where motorists experience frequent incidents that slow traffic. Travel times are only helpful to the road user if they have a general understanding of the length of the road segment the travel time is related to so

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that they can compare that to the time it takes them to travel a similar distance on a highway without congestion. However, travel time messages require road users to read and process a significant amount of information and careful consideration is needed to ensure the overall message is not overloading the motorist.

Guidance. Travel times should be tied to the distance to a particular destination or junction so that road users can estimate the level of congestion based on the time to travel that distance. When travel times are displayed on CMS, such as during peak traffic conditions, the message should comply with the provisions of Sections EPG 903.5.47 and 903.5.48. If both a travel time and a distance are displayed, the sign should display only one destination. A distance displayed as part of a travel time message should be rounded to the nearest whole mile.

Option. When comparative travel time displays are used providing travel times on different routes to one destination, distances to that destination may be eliminated.

A reference-location-based exit number (see EPG 903.5.22) may be displayed in lieu of a destination name or junction thereby providing the necessary distance information to the road user. If reference-location-based exit numbers are displayed, then up to two travel times may be displayed provided that the distance to the exit is not also displayed.

Support. EPG 910.3.2.12 includes information regarding Congestion Messages for DMS.

903.12.7 Traffic Safety Campaign Messages (MUTCD Section 2L.07)

Support. An allowable ancillary use of CMS is the display of traffic safety messages in conjunction with a traffic safety campaign that includes other forms of media as the primary communication and education mechanism.

Standard. Traffic control messages shall have priority over traffic safety campaign messages.

Guidance. When a CMS is used to display a traffic safety campaign, the message should be simple, direct, brief, legible, and clear (see EPG 911 (MUTCD Section 1D.01)). Traffic safety campaign messages should be relevant to the road user on the roadway on which the message is displayed. For example, messages regarding school bus stop safety should not be displayed on freeways where school bus stops are not found.

A CMS should not be used to display a traffic safety campaign message if doing so could adversely affect respect for the sign. Messages with obscure or secondary meanings should not be used as they might be misunderstood or understood only by a limited segment of road users and require greater time to process and understand. Similarly, slogan-type messages and the display of statistical information should not be used.

The broad traffic safety campaign marketing message should be appropriately shortened or otherwise modified to comply with the provisions of EPG 903.12.5 when a traffic safety campaign message is displayed on a CMS.

Traffic safety campaign messages should emphasize the applicable regulation or warning and should reference any penalties associated with violations of the regulation. Traffic safety campaigns using CMS should include coordinated enforcement efforts where penalties or enforcement type warnings are part of the message displayed on the CMS.

Traffic safety campaign messages should not be displayed on CMS unless they are part of an active, coordinated safety campaign that uses other media forms as the primary means of outreach. For consistency on a national level, traffic safety campaigns should be coordinated with those on the National Highway Transportation Safety Administration's annual communications calendar or similarly planned sate campaigns.

Support. Examples of traffic safety campaign messages include "UNBUCKLED SEAT BELTS FINE + POINTS" and "IMPAIRED DRIVERS LOSE LICENSE + JAIL."

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EPG 910.3.2.16 includes additional information related to Driver Safety Campaigns.

903.12.8 Permanently-Located Changeable Message Signs (MUTCD Section 2L.08)

Support. See EPG 910.3.2.6 for information regarding Permanently-Located Changeable Message Signs and Dynamic Message Signs (DMS).

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903.13 Recreational, Historic Site, and Cultural Interest Area Signs (MUTCD Chapter 2M)

Support. State and Federal Recreational site, Historic Site, and Cultural Interest Area signing placed on the MoDOT system is a form of traffic generator sign. As such, they are included in the department Supplemental Guide Sign Program. These signs only provide guidance to these recreational and historical sites. Federal and state agencies owning recreational and historical sites are responsible for installing and maintain internal site signing to MUTCD standards. MoDOT only adopts those portions of the National MUTCD that are relevant to state-maintained highways. For this reason, MUTCD content related to signing inside these sites is not included in the EPG. Practitioners should reference the National MUTCD for provisions related to traffic control devices that are not included in the EPG.

Standard. For this signing program, a State or Federal Recreation and Historic Site is defined as a site owned and operated by a Missouri state agency (Missouri Department of Conservation or Missouri Department of Natural Recourse) or a federal agency (National Park Service, National Forest Service, Corps of Engineers, US Fish and Wildlife).

All requests for participation in the State and Federal Recreation and Historic Site Signing program shall be forwarded to MoDOT's Supplemental Guide Sign Program manager for processing. Per the CSR, it is the program manager's responsibility to receive all requests, evaluate eligibility and administer the contract with the applicant.

MoDOT districts' role in the program is to review and approve site plans for new sign installations, assuring the new sign installations do not conflict with existing traffic control devices or create sight distance issues. Another critical responsibility is to identify and report damage and/or deficiencies with any of the signs the for which the program manager is responsible.

Central Office Highway Safety and Traffic Division shall be responsible for managing the Supplemental Guide Sign Program Contract, updating the CSR, and interpreting the intent of the CSR and the program contract if there are questions or appeals from prospective applicants. Highway Safety and Traffic Division shall also be responsible for working with Governmental Relations on legislative issues.

The State and Federal Recreation and Historic Site Signing program shall be managed in accordance with the Code of State Regulations 7 CSR 10-17 Supplemental Guide Sign Program and the Supplemental Guide Sign Program contract between the Commission and MoDOT's third party contractor. The CSR is binding and has the effect of law. Exceptions and/or variations from the CSR are not permitted under normal conditions with the Director having the only authority to authorize such actions.

The rules contained within the CSR are based on, and are in conformance with, the Manual on Uniform Traffic Control Devices and the AASHTO Guidelines for the Selection of Supplemental Guide Signs for Traffic Generators.

Guidance. Recreational and cultural interest symbol signs used on MoDOT right of way are typically limited to those that indicate the availability of camping at a site. These signs are installed as part of state and federal signing in the Supplemental Guide Sign Program managed by MoDOT's third party contractor and their use is based on a site evaluation for eligibility. The design and size of the symbol signs should match MUTCD standards.



Typical Recreational Symbol Signs Used on MoDOT Right of Way

Option. Rustic Signs may be used by state and federal agencies at first order locations, the intersection that leads drivers off the state system or at the entrance of the site when the state route passes through the recreational areas or historic site. Rustic signs do not meet Federal breakaway standards therefore when they are used they shall be placed at or outside of MoDOT's right of way line for safety. These signs will typically replace MoDOT's standard first order signing (see EPG 903.1.24).







903.13.1 Regulatory and Warning Signs (MUTCD Section 2M.03)

Standard. All regulatory and warning signs installed on roads and streets open to public travel within recreational and cultural interest areas shall comply with the requirements in the Manual on Uniform Traffic Control Devices.

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903.14 Emergency Management Signs (MUTCD Chapter 2N)

Not Currently Used by MoDOT

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903.16 Design Aspects of MoDOT Signing

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903.16.5 Signing Plans

903.16.6 Quantity Computations

903.16.1 Scope of Signs and Signing

Standard. The extent of signing by contract on any project is determined early in the project scope. Structural guide signs and supports (overhead or post-mounted) are paid for by contract, regardless of the type of facility. Sheet signs and supports are supplied by contract for all route classifications and project conditions. Unless otherwise agreed to among departments or divisions, the following are general guidelines for the extent of contract signing.

Guidance. Regulatory and warning signs should be used conservatively because these signs tend to lose effectiveness if they are used to excess. If used, route signs and directional signs should be used frequently because they promote reasonably safe and efficient operations by keeping road users informed of their location.

Support. When preparing signing plans, consistency and coordination with existing signing is critical. This does not mean poor signing should be replaced in kind for the sake of consistency. Consistent application of legend styles, abbreviations, control cities, wording, and arrow placement are important for proper driver guidance and expectancy. This is accomplished by routinely applying standards. Signing is basically for the first-time driver, not

repeat traffic. An example of poor signing would be having two advance guide signs for the same exit listing different control cities. Another example would be using local cities for general guidance instead of standard control cities. It is important to have consistent signing throughout the state of Missouri.

Guide sign standards in EPG 903.4, 903.5, and as shown on the standard plans are used whenever possible. Conditions that require deviation from these standards are held to a minimum and justified. Design variances require district justification at the preliminary sign location stage. Signing variances are also noted in the plans. Some deviations from design standards may require approval as outlined in EPG 131.1.

903.16.2 Plan Development Procedure

Standard. The preparation of signing plans requires the cooperation and coordination between the district and Central Office.

When using preexisting structures to accommodate larger new signs, consideration shall be given to the dimensions and load capacity of the existing structure. The larger signs shall properly fit on the existing structure and not exceed the structure's design capacity.

When the need arises to modify the legend of a sign not built to current standards, the entire sign shall be replaced.

Guidance. Bridge Division (https://modotgov.sharepoint.com/sites/br) should be consulted for mounting signs directly on bridges and other structures.

Sign visibility from a distance is critical. Sign locations should be coordinated with other design features that include, but are not limited to bridges, highway lighting, traffic signals, drainage structures, overhead utilities, underground utilities and horizontal and vertical alignments that decrease sign visibility.

The district should prepare proposed sign locations and review the plans for standards and quality control.

When the sign is mounted on a truss, all signs on the truss not built to current standards should be replaced after considering the age, future conditions and detail of the sign.

It is recommended that all non-standard signs be identified, with justification for the non-standard designs.

For preliminary discussions, only the sign location plan showing existing and proposed signing is recommended. Sign details, cross-sections, tabulation sheets, computer generated sign designs or other detailed information should not be completed at this time. Once the preliminary location plan is agreed on, the district is to prepare D-29 (https://www.modot.org/media/16702) and D-30 (https://www.modot.org/media/16703), truss data sheets and template cross-sections for trusses and post-mounted signs. Truss cross-sections should not be drawn on the same sheets as ground mounted sign cross-sections. The districts, or consultants, are responsible for accuracy of the preliminary and final detail design.

The district finalizes the plans and is to submit them to Design with the roadway plans, or as a separate project if so programmed. Typical signing location plans for interchanges are shown in EPG 903.15. Design Division is available for consultation during any part of the plan preparation process.

All non-standard and special signs are detailed by Central Office Highway Safety and Traffic and the district, or consultant, is responsible for incorporating the signs in Form D-31 (https://www.modot.org/media/16704). A Sign Design Order Form (Design Form D-28) (https://epg.modot.org/forms/general_files/DE/RW-LPA/D-28.doc) should be completed for all non-standard and special signs and sent to the signing section of Central Office Highway Safety and Traffic, allowing 30 working days for the review and design to be completed. Each sign

should be identified as an overhead or post-mounted sign. Traffic should be provided with a date the sign designs need to be returned for review. The return date needs to allow enough time to design and quantify the trusses, bases and posts.

Option. Central Office Design or Highway Safety and Traffic Division may provide comments on the preliminary layout at the district's request. It is suggested that districts form review teams from various departments to review plans at the preliminary layout stage, and at final design. After the district reviews plans, Design Division may be consulted for review at the district's discretion.

Two or more segments of alignment may be shown on one sheet. For ease of design, review and construction, sign locations for interchanges are completely shown on one sheet.

In complex areas where many signs exist and will be replaced, proposed signing and existing signing may be shown separately on different plan sheets to avoid clutter and plan confusion; however, combined is preferred, if possible.

Support. Figure 903.16.2.1 and 903.16.2.2 show the steps taken from early plan development to final design.

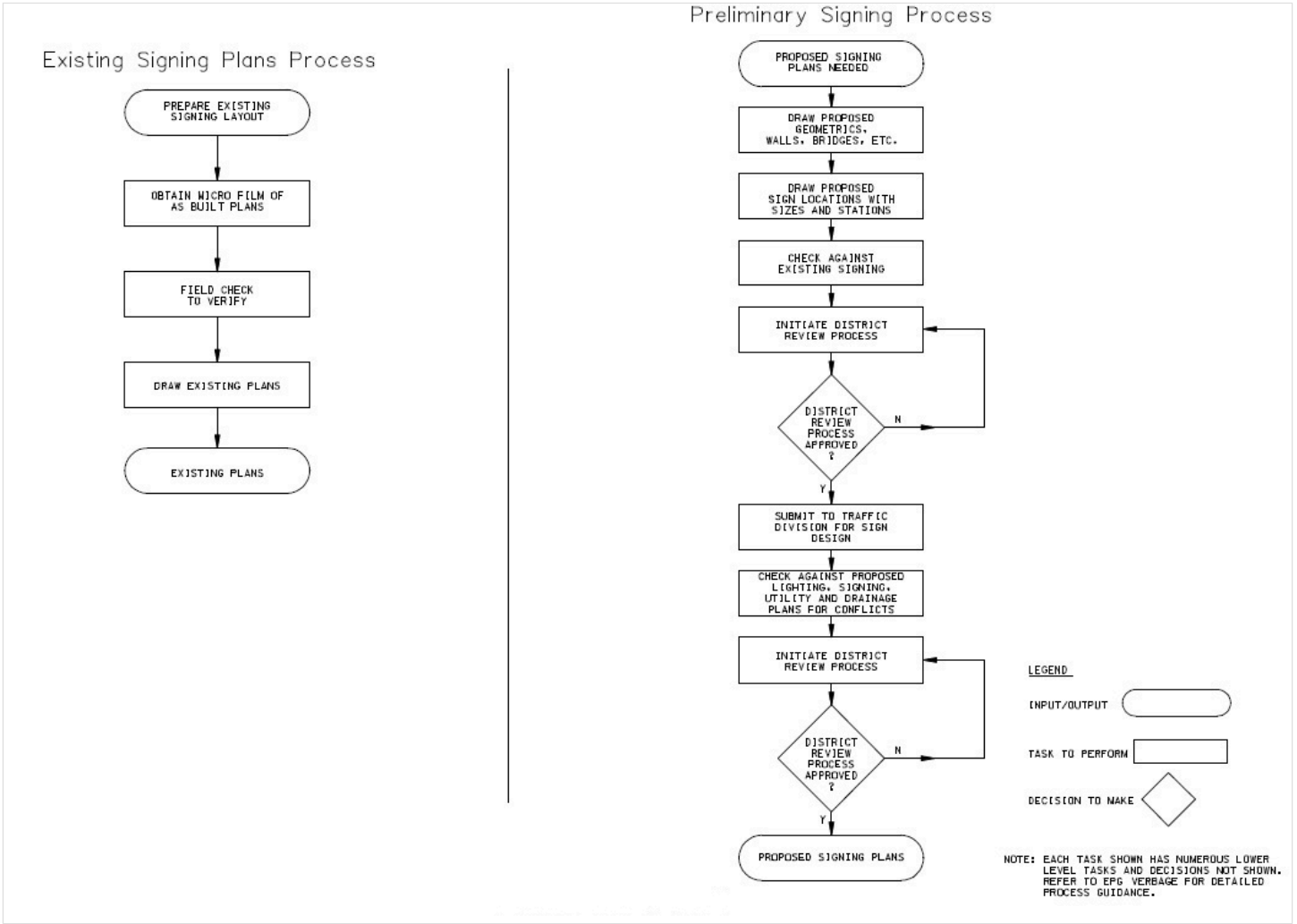


Figure 903.16.2.1 Existing and Preliminary Signing Plans Flowcharts

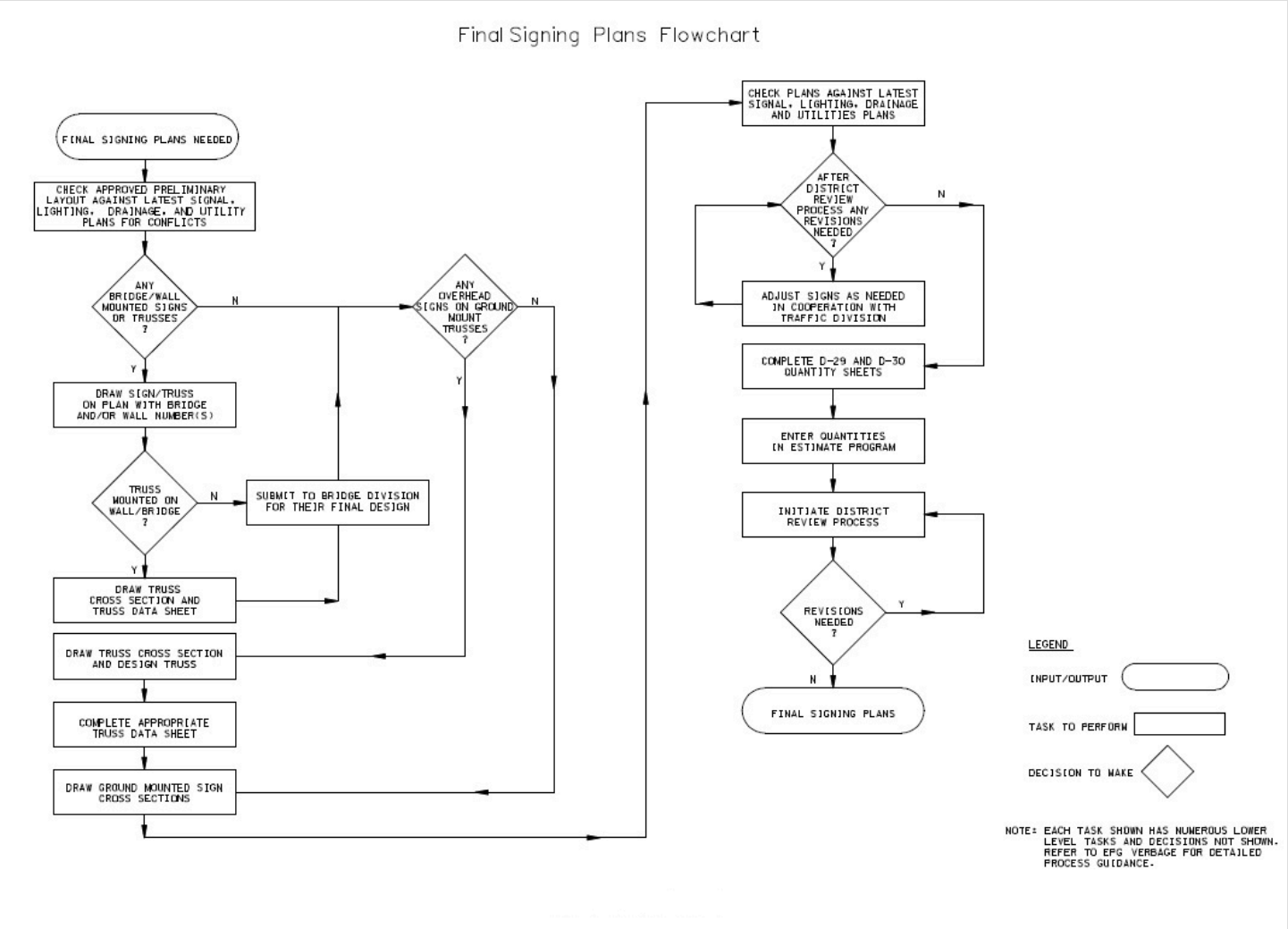


Figure 903.16.2.2 Final Signing Plans Flowchart

Location plans show the proposed pavement geometrics, the sign location, sign number, station, width and height, sign code (if applicable) and special or standard legend. Sign sizes are shown as width x height, in feet and/or inches for sheet signs, and in feet only for structural signs. Tabulated removals and general information are shown for existing signs. The standard sign code (e.g. R5-1a, W10-1, etc.) is shown for signs found in the SMS Sign Catalog.

Signs are numbered in a logical order. Existing signs that are removed or remain in place are not numbered. Multiple signs on a single mount are further indicated with lower-case letters (e.g. 45(a), 45(b), 45(c)). If signs are added or deleted at a later date, renumbering all signs is not required. If signs are added, signs may be numbered 43, 43A, 43B, etc., or the next highest sign number may be used. If signs are deleted, a general note listing voided signs is provided.

Existing signs are shown with dashed lines and are listed as a removal item where appropriate. Existing signs to be relocated to new posts and new signs on existing posts are numbered and noted as such. Existing signs in poor condition should be replaced.

When replacing signs for many miles of roadway to be let in sections, it is desirable to generate an overall sign location plan to coordinate guide sign placement through numerous projects. For this situation it is not necessary to show signs other than guide signs. It is recommended to show the limits of each project on this location plan. Signs are identified as truss, bridge- or post-mounted or as strapped to a signal post or column. If applicable,

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truss type (cantilever, span and butterfly) and location are shown. Whether the truss is box or tubular does not need to be noted on preliminary location plan, but is shown on the final plan. A standard legend identifying symbols is used to alleviate crowding on plans. Typical location plans at interchanges are shown in EPG 903.15.

When staged projects are scheduled in unison or closely together, complete signs are provided with the inappropriate legend covered until needed. Legends to be covered are noted on the plans, and the engineer is to approve the covering method. No direct pay is made for covering legends. When structural signs should be erected with only part of the legend in place at the initial time of construction, the sign and legend are shown on the plans with solid lines, and the legend to be placed at a later date is shown with dashed lines. A note is included indicating the dashed legend will be provided by future construction. The omitted legend is included in the roadway contract, which completes the sign.

When the legend of an existing sign built to current standards is modified, the existing sign and legend are shown with dashed lines and the legend to be added is shown with solid lines. Sufficient information is provided to show series, type, size and spacing of new legend on the sign detail sheet.

The district prepares tabulation sheets on Forms D-29 (https://www.modot.org/media/16702) (Sign Posts, Footings, Delineators and Mileposts), D-30 (https://www.modot.org/media/16703) (Signs) and Data Sheets D-32 (https://www.modot.org/media/16705), D-33 (https://www.modot.org/media/16706) and D-34 (https://www.modot.org/media/16707). These forms are available as MicroStation seed files.

On Form D-29 (https://www.modot.org/media/16702), all signs are listed in order according to sign number. This form includes truss footing and pedestal concrete quantities.

On Form D-30 (https://www.modot.org/media/16703), all standard signs are totaled on the left-hand side of the sheet. The right-hand side is used to list special signs and provides an overall summary of all sign types.

Truss data sheet forms are completed for all trusses. Form D-32 (https://www.modot.org/media/16705) is used for cantilever and butterfly box trusses. Form D-33 (https://www.modot.org/media/16706) is used for span and span-cantilever box trusses. Form D-34 (https://www.modot.org/media/16707) is the truss data sheet used for all tubular sign supports.

Design variances require district justification at the preliminary sign location stage. Signing variances are also noted in the plans. Some deviations from design standards require approval.

Overhead sign support structure foundations are not placed in gore areas or other areas with high exposure to traffic. See EPG 903.17 for additional overhead sign support structure information.

903.16.3 Types of Fabricated Signs

Support. There are two types of sign material available, structural (ST) and sheet (SH).

Sheet signs are sheet aluminum, usually one-piece units, and have several available thicknesses as indicated in the standard plans.

Structural signs are usually made of multiple extruded panels. These signs are used primarily for guide signs on expressways and freeways, but may be found on other routes on a limited basis, and are used on all overhead-mounted signs, including “LOW CLEARANCE” and exit number panels, signs greater than 6 ft. wide, and signs greater than 30 sq. ft. in area.

Extruded panels are composed of a 1 ft. tall "E" shaped aluminum substrate, assembled to a desired height and cut to a uniform width for each sign. These panels are bolted together to form the larger “blank” substrate needed for structural signs.

There are two types of reflective sheeting available to MoDOT:

1. MoDOT Type III High Intensity Prismatic (R2)
2. MoDOT Type VII Prismatic (R4).

Guidance. Generally, R2 sheeting should be used on all sign backgrounds. R3 sheeting should be used on all legend and symbols on guide signs.

903.16.4 Ground Mounted Sign Supports

903.16.4.1 Ground Mounted Sign Installation

Guidance. Signs should be ground-mounted whenever possible unless mounting overhead is justified or required.

Standard. If signs are placed on existing supports, they shall meet other placement criteria contained in this article.

Utility and light poles shall not be used to mount signs as they are either not the property and maintenance responsibility of MoDOT or are not designed to carry the additional wind loading a sign adds to the structure.

Option. In areas with space restrictions, available sign truss columns, signal poles, bridge columns, or other significant MoDOT structures, excluding roadway lighting structures, may be used to mount flat sheet aluminum signs.

903.16.4.2 Lateral Offset

Guidance. The provisions below should be applied unless specifically stated otherwise in the EPG for a particular sign or object marker. See Figures 903.1.13.1 and 903.1.13.2 which illustrate typical examples of the lateral offset requirements contained in this portion of the article.

Maximum offset will depend on roadway geometrics, profiles, and cross-sections, which all affect the visibility of the sign. Signs are generally to be placed no more than 15 ft. from the edge of shoulder.

Ground-mounted signs placed in a gore only requires a minimum of 2 ft. lateral offset from edges of shoulder, face of barrier walls or guard rail.

For divisional and channelizing islands, a 2 ft. lateral offset should be maintained between the edge of sign and the front face of curb. For islands with restricted width the sign should not extend beyond the curb face.

Option. Deviation from the standard lateral offset may be used if a signs effectiveness and visibility are maintained to account for variations in roadside features. For example, to avoid placing signposts in the flow line of a ditch, avoiding drainage structures, pull boxes or sidewalks.

Option. Lesser lateral offsets may be used in business, commercial or residential areas where limited space is available to place signs due to limited right of way, sidewalks or other restrictions which keep the sign from being installed at the correct offset. In these cases, the edge of the sign may be placed up to, but not beyond the face of the curb making every effort to maximize the offset with the space available.

Support. See EPG 903.1.16 for additional information on Lateral Offset.

903.16.4.3 Mounting Height

Support. See EPG 903.1.15 for additional information on Mounting Height.

903.16.4.3.1 Mounting Height – U-Channel, Wood, Perforated Square Steel Tube (PSST), Pipe Posts and 4 in. Square Steel Posts

Support. There are typically two mounting heights for signs on u-channel, wood, PSST, pipe posts and 4 in. square steel posts, 5 feet and 7 feet. Traditionally, the 5-foot mounting height has been applied to "rural" areas and the 7-foot mounting high applied to "urban" areas or within incorporated city limits. However, the term "urban" has more to do with the conditions the signs are being installed within and less about being located within an incorporated city limit. The purpose of the 7-foot mounting height is to provide clearance for passing bicycle and pedestrian traffic, making the sign more visible over parked vehicles along the roadway and permits improved sight distance to drivers permitting them to see below the sign.

Standard. Standard Plans 903 (https://www.modot.org/standard-plans-section-900) shall be referenced for specific installation and mounting height details. The details in Standard Plans 903 (https://www.modot.org/standard-plans-section-900) and EPG 903.16.4 shall apply to all signs unless specifically stated otherwise for a specific sign or object marker elsewhere in the EPG.

The minimum mounting height of a sign shall be measured vertically from the bottom of the sign to the elevation of the near edge of the pavement. Minimum sign mounting heights shall be as follows:

- Sign located in rural areas – 5 feet,
- Sign located in urban areas – 7 feet,
- Signs located on freeways and expressways – 7 feet.

The length of post measured from the bottom of the sign to the ground shall also be a minimum of 5 feet. If the length of any post within a sign assembly measures less than 5 feet from the bottom of the sign to the ground, the minimum sign mounting height shall be increased to achieve the minimum 5-foot post length.

Option. Signs may be installed at 5 feet within the boundaries of incorporated city limits if the all following conditions apply:

- The sign is located outside of business, commercial or residential areas where there are no high densities of entrances and cross street intersections
- There is no on street parking
- There are no sidewalks with bicycle or pedestrian traffic

If a secondary sign is mounted below the primary sign on the same signpost(s), the mounting height for the assembly, measured from the near edge of the pavement to the bottom of the secondary sign, may be 1 foot lower than the minimums listed above.

Guidance. Signs located outside of incorporated city limits that are located in areas having characteristics of an urban area, such as around businesses, heavy residential areas, areas with on street parking and areas with sidewalks which support bicycle and pedestrian traffic, should be installed at 7 feet.

Support. Figure 903.1.13.1 illustrates typical examples of the mounting height requirements contained for signs installed on U-Channel, Wood, PSST and Pipe Posts.

903.16.4.3.2 Mounting Height – Wide Flange (I-Beam) Posts

Support. Installing signs at the proper mounting height is critical not only for the sign to be seen and function, but also to the functionality of the breakaway design. Proper mounting height is more critical for breakaway function on Wide Flange posts compared to all other posts due to the hinge component of this post design. As with the other post types, mounting heights for Wide Flange posts are listed as "nominal" as excessive mounting

heights have the same negative effects for these installations as exists with the other post types. Wide Flange post mounting heights are greater than other posts, so in areas with back slopes it is recommended to seek out a flatter location in advance or downstream of the original installation to keep the sign as low as possible.

Minimum mounting heights for Wide Flange post installations are not related to rural or urban classifications, but are directly related to how the breakaway system functions. Standard Plans 903 (https://www.modot.org/standard-plans-section-900) provides details on the nominal mounting heights on wide flange posts. Key details to focus on are:

- No wide flange post can be shorter than 7' 9" measured from the hinge to the top of the stub.
- The hinge point is always below the lowest sign which is attached to the wide flange post.
- Nominal mounting heights vary depending if there is one sign mounted on the posts or two.
- For signs located in areas of back slopes, the minimum mounting height may have to be increased, or the sign installed in a different location, in order to achieve the minimum post length of 7ft. 9 in

Support. See EPG 903.1.15 for additional information on Mounting Height.

903.16.4.4 Ground-Mounted Sign Support Selection

Support. The majority of MoDOT signs are installed and supported on one of 5 types of ground-mounted sign supports or signposts. The selection of signpost is based on many factors, but primarily on the size of sign being installed and the type of roadway the sign is being installed along. There is some overlap in signpost applications; more than one signpost may be applicable to a given installation. The final selection of the post type is based on the attributes needed for a support as discussed in each classification of signpost below.

The number of posts needed to support a sign is primarily based on the width of a sign. Typically, signs 48 inches wide and wider are installed on two or more posts. This requirement is based on two factors, the capacity of the post and the long-term stability of the assembly. A wide sign installed on one post will place a torsional force onto a post and in windy conditions can result in an assembly not staying plumb and, in some cases, an actual failure of the post itself.

Standard. The selection of the proper size of signpost shall be based on the Signpost Selection Guide listed above. These tools will specify if a post type has the capability to support the sign in question and then specify what size post is required based on the requirements of the installation. Before the correct size of PSST or Wide Flange post can be selected, the length of the longest post must first be determined. To determine this, the offset and mounting height must first be determined.

903.16.4.4.1 U-Channel Posts

Support. MoDOT utilizes two primary sizes of U-Channel Posts, a 3 lb/ft high carbon, rerolled rail steel post for sign installations and a low carbon steel 1 lb/ft post for road side delineation.

U-channel posts can be used to support MoDOT's small signs, such as no parking signs, object markers and chevrons on two lane roadways. U-channel posts are typically not suited to support larger permanent signs as they have limited torsional rigidity and have less ability to hold a larger sign steady in windy conditions. These are typically the most economical posts to use to support smaller signs and given these types of signs tend to be installed closer to the roadway their ability to yield more easily to impacts means they pose less of a damage risk to vehicles. U-channel posts are typically installed by driving the post into the ground without a stub or anchor, however, there is a stub / post installation option available which is detailed in the standard plans.

U-Channel posts are considered breakaway with no additional breakaway devices needing to be added. While there are breakaway devices available for U-channel posts, MoDOT's use of this type of post for smaller signs typically doesn't justify their use. A U-channel post's breakaway is typically a yielding function, meaning as a

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vehicle impacts the assembly, the post yields and lies down in front of the vehicle so it can pass over the assembly.

Standard. U-channel posts shall be installed in accordance with the details found in Standard Plans 903 (https://www.modot.org/standard-plans-section-900). Signpost selection tools shall be used to determine sign sizes U-channel posts can support and the number of posts needed.

903.16.4.4.2 Wood Posts

Support. MoDOT's specs permit three sizes of wood posts to be used: 4 in. x 4 in., 4 in. x 6 in., or 6 in. x 6 in. MoDOT's wood posts are pressure treated to promote longer life and resist rot and insect damage. Wood posts were once MoDOT's primary post to support signs on two lane roadways; however, due to issues with material stability PSST posts have become MoDOT's standard post.

When used, wood posts are capable of supporting most sign assemblies on two lane roadways, from route marker assemblies, speed limit signs, warning signs and distance and destination signs. The use of a high quality wood post and proper installation is the key to a successful installation.

Guidance. The continued use should take into consideration the special characteristics listed in EPG 903.16.4.

Proper installation is also critical for the stability of the sign assembly. The wood post should be placed a minimum of 36 inches into the ground, deeper for larger signs or in areas where the soil is weak or sandy, to keep the signpost plumb. When backfilling the hole, material should be added in lifts, or levels, in order to properly compact the backfill. Loose or fine materials, such as sand, sandy soil or dry concrete mix typically will not provide a long term solid backfill and can result in the post falling out of plumb over time.

MoDOT's specifications should be followed when purchasing wood signposts. These specifications address a posts load capacity, breakaway attributes and the compatibility between the pressure treatment chemicals and our aluminum signs and sign hardware.

Option. While the soil originally removed from the hole can be used to back fill around the post other alternatives may be used, such as smaller quarry rock with the crushing fines mixed in, concreted mix or expanding polyurethane foam.

Support. Wood posts are considered breakaway without an add-on breakaway device; however, some sizes of post do need special preparation. 4 in. x 4 in. wood post are considered breakaway without any special modifications; however, 4 in. x 6 in. and 6 in. x 6 in. posts must be cross drilled at the base to weaken them so they will break away. The size of the holes and where they are drilled is critical to these posts meeting breakaway requirements. The details for these holes are found in the Standard Plans 903 (https://www.modot.org/standard-plans-section-900), it is important to note these breakaway holes are drilled in the sides of the post, not in the front of the post where the sign is mounted.

Standard. If wood posts are used, the proper size and number of posts shall be determined by using the post selection tools.

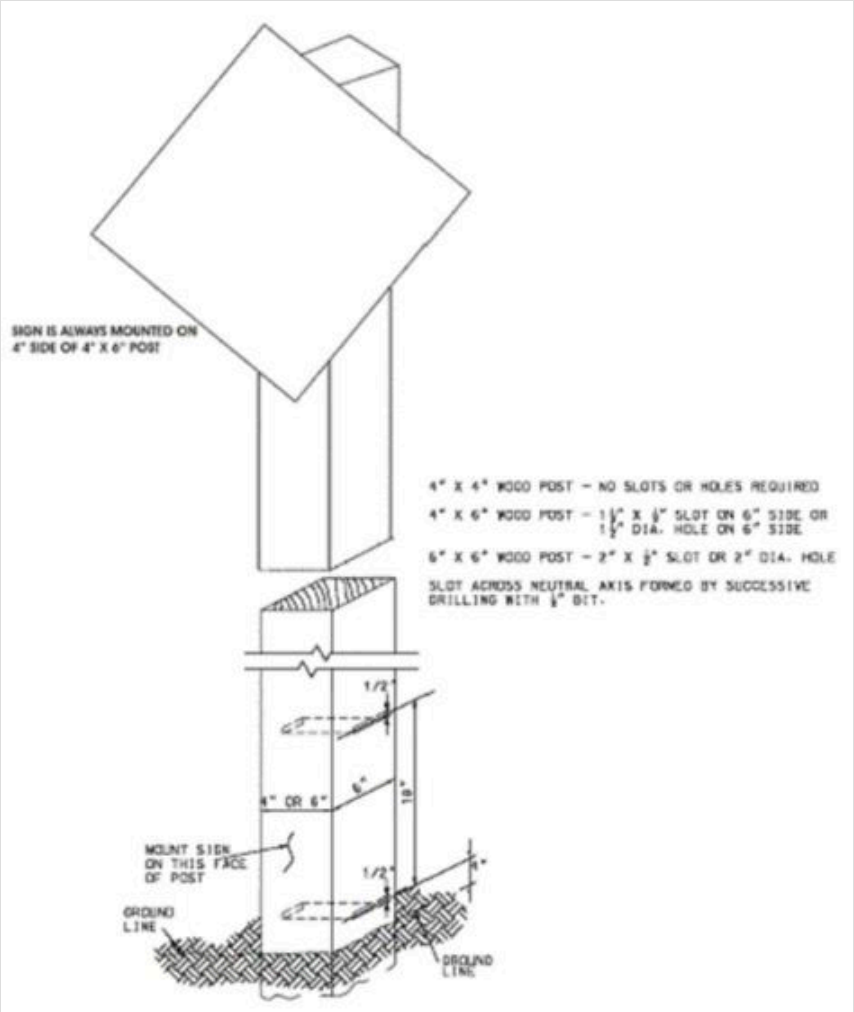


Figure 903.16.4.4.2 Details for Wood Posts Requiring Breakaway Design

History. One of the earliest issues experienced with wood posts is their tendency to warp and twist, both before and after installation. Keeping a sign plumb and appropriately oriented to the roadway is critical to maintain the sign's legibility and night time retroreflectivity performance. This aspect of wood posts resulted in significant waste of inventory when the posts warped and twisted before being used and increased work load on signing crews who had to correct warped and twisted posts after installations. Another concern with the use of wood posts was the installation required a hole to be dug, the posts set and property back filled so the sign would remain upright. If soil conditions prohibited a hole being dug deep enough or the back fill not capable for being compacted sufficiently the assembly would fall out of plumb. Along with these installation aspects, a wood post sign assembly can be very heavy, especially when the pressure treated wood is still wet with the pressure treating fluids and this can result in the need for additional people to set the post and/or increased risk of injury setting the post by hand.

Towards the end of MoDOT's reliance on wood posts a new issue was identified relating to the more environmentally friendly treatment process called ACQ (Ammoniacal Copper Quaternary). ACQ replaced CCA (Chromated Copper Arsenate) for residential applications as CCA had chemical component which were not recommended for routine contact with skin. However, unlike CCA, ACQ (especially early versions) turned out to be very corrosive to metals, especially to aluminum. This corrosive nature requires special fasteners to resist this corrosive effect. Early applications of ACQ in other states realized serious sign corrosion to the point the sign would fall off the post in a matter of a few years. While it appears this has improved, special fasteners with special protective coatings are still recommended for use with ACQ posts. As a result, ACQ posts do not meet MoDOT's

specifications and should not be used to support signs. CCA treated posts are still MoDOT's standard for wood posts, however, it is not commonly available at local home improvement centers and at many lumber yards. Due to MoDOT's limited use of this product contract purchasing typically is not economical or possible.

903.16.4.4.3 Perforated Square Steel Tube Posts (PSST)

Support. MoDOT utilizes two sizes of PSST posts, 2 in. and 2.5 in., both being made from 12-gauge steel. PSST became MoDOT's standard post for most sign installation applications on two lane roadways in the early 2000's, replacing wood posts. PSST usage has since expanded to some applications on freeways and expressways.

Unlike U-channel or Wood posts, PSST utilizes a ground anchor, or footing, within which the post is then placed. MoDOT has several options in its specifications with respect to ground anchor/foundation systems, the use of each option is heavily based on the soil condition.

The anchor/footing types for PSST are:

- 12-Gauge PSST Anchor – this is the basic direct-driven anchor for 2 in. PSST posts. A 12-gauge anchor does not exist for 2.5 in. PSST posts.
- 7-Gauge Anchor – this is a heavy wall box tube anchor which is the basic direct-driven anchor for 2.5 in. PSST posts. It is also an optional heavy anchor for 2 in. PSST posts in rocky ground where a 12-gauge anchor may deform when driven. The 7-gauge anchor is also the anchor that must be used when installing a concrete or polyurethane footing.
- Omnidirectional, or stabilization, Anchor – this is the appropriate 12-gauge or 7-gauge direct-driven anchor with 4 soil stabilization plates added to the anchor to increase soil surface area to help keep signs plumb in weaker soils and/or in windy areas. A JSP will be needed to specify this anchor type on a project.
- Concrete Footings – In some applications it may be desired to install a concrete footing for PSST, similar to the footings for Pipe Post or Wide Flange Post. Concrete footings provide a stronger foundation compared to the directly-driven anchors listed above. A concrete footing may also be required in cases where the ground is too hard or rocky to direct drive the anchor and a hole may need to be dug in order to install the anchor. All concrete footing installations use a 7-gauge anchor (that only has holes at the top of the tube) because concrete would flow through the holes of a normal 12-gauge PSST anchor.
- Polyurethane Foam Footings – This is an alternate to a concrete footing for PSST post installations. This permits the footing and the sign to be installed in one trip compared to concrete, which requires a second trip to allow the concrete to cure. The installation requirements for an expanding foam footing are the same as a concrete footing except for the diameter of the footing, which is smaller. It is important to make sure the expanding foam used meets MoDOT specifications as not all foam products are acceptable to support a breakaway sign.

The connection between the PSST posts and anchors varies based on the anchor gauge:

- 12-gauge anchor – The connection between a 12-gauge anchor and the PSST post is accomplished using a corner bolt. The corner bolt pulls the post into a corner of the anchor and eliminates any slack or play between the post and the anchor.
- 7-gauge anchor – The fit between a 7-gauge anchor and the PSST post is much looser and the radii of each do not match so a corner bolt will not eliminate the slack or play between these two devices. Shoulder bolts installed at 90-degree angles corrects this issue; the shoulder of the bolt will pass through the holes in the 7-gauge anchor, but not through the holes in the post. As a result, the two bolts push and lock the post in two directions making a solid connection.
- Add-on breakaway devices – when required/used, the manufacture's recommendations and hardware (if supplied) need to be used to connect the anchor, breakaway and post together.

Breakaway aspects of PSST are a little more complicated compared to other MoDOT posts, the requirement for an add-on breakaway device heavily depends on the size and number of posts needed to support the sign. It is important to follow the guidance found in the signpost selection tools and MoDOT's standard plans to determine when an add-on breakaway device is required and when it is not. In applications where add-on breakaway devices are not required/used, PSST breaks away like a U-channel post in a yielding fashion, typically staying attached to

the ground and lying down in front of the vehicle so the vehicle can pass over the assembly. However, when an add-on breakaway device is used the breakaway function changes and the assembly is designed to break away from the ground and permit the vehicle to pass under the airborne assembly.

POST AND ANCHOR DATA TABLE

POST		ANCHOR		BREAKAWAY REQUIRED NUMBER OF POSTS		
GAUGE	SIZE	GAUGE	DIMENSIONS	1	2	3
12	2" x 2"	12	2.25" x 2.25" x 36"	NO	NO	YES
		7*	2.5" x 2.5" x 36"	NO	NO	YES
12	2.5" x 2.5"	7	3 x 3 x 36"	NO	YES	YES
12	(2.5"x2.5")+(2.25"x2.25")	7	3 x 3 x 36"	YES	YES	YES

* TO BE USED WITH CONCRETE FOOTINGS OR IS AN OPTION IN ROCKY SOIL CONDITIONS

Standard. If PSST posts are used, they shall be either 2 in. or 2.5 in. 12-gauge posts. The size and number of posts, as well as the requirement for add-on breakaway devices, shall be determined using the post selection tools. PSST posts shall be installed in accordance with Standard Plans 903 (https://www.modot.org/standard-plans-section-900). **PSST posts installed on freeways, expressways, and ramps shall be installed using concrete footings.**

Guidance. District operations should be consulted to determine the most appropriate footing for PSST posts alongside other roadways as footing requirements vary based on soil conditions.

903.16.4.4.4 Pipe Posts

History. In 2022, a pipe post capacity evaluation was conducted that resulted in a change to the pipe post load capacity and pipe post inventory. Historically it was believed that pipe posts could support a sign size of up to 30 sq. ft. but the evaluation determined pipe posts could support a sign of up to 58.5 sq. ft. The evaluation also determined that the 3 sizes of pipe post being utilized were redundant. MoDOT historically used 2 ½ in., 3 in., and 4 in. pipe posts, however, the evaluation determined that the sign capacity of a post is determined by the breakaway assembly. The 2 ½ in. and 3 in. pipe posts used the same breakaway design and therefore the 3 in. pipe posts did not have any additional capacity over the 2 ½ in. post. As a result, the 3 in. post is redundant and was discontinued. This decision allows for a simplified inventory and eliminates confusion on pipe size. Maintenance can continue to utilize 3 in. pipe posts until the inventory is depleted but shall not order new 3 in. pipe posts. All existing 3 in. pipe posts shall be treated as 2 ½ in. posts for purposes of choosing posts using the post selection tables. 2 ½ in. pipe posts can be installed on existing 3 in. stubs.

Support. MoDOT utilizes two sizes of pipe post, 2 ½ in. and 4 in. An important fact to understand is pipe post sizes are based on the inside diameter (I.D.) of the pipe post and not the outside diameter, this is the industry standard for pipe measurement. This is critical in selecting the correct pipe from inventory as well as charging out the correct post to keep your inventory levels correct.

Pipe posts have a similar sign capacity as PSST, even though they would appear to be able to carry a larger sign load due to size and thickness of the steel pipe. While the post themselves are far stronger than PSST, it is the breakaway of the pipe post which controls the sign load capacity of the post. The heavy-duty construction of a pipe post is not specifically related to sign load capacity but is more directly related to the durability of the post. Unlike PSST, which must be replaced after each vehicular impact, pipe posts are constructed with much thicker steel so the signpost can be impacted by a vehicle without being damaged and reinstalled for continued use. There are many pipe posts on our right of way that have been there for two or three generations of signs and are still functional so while they are heavier and more expensive, they are a long term investment and are far more durable.

Pipe posts are used for single and double signpost assemblies to support signs up to 58.5 sq.ft. These posts are typically used on freeways and expressways where signs are larger, wind speeds can be higher due to more open right of way and the sign may see larger snow load impact from plows pushing more snow from across multiple lanes to the right side of the roadway.

Pipe posts are also the preferred post to support large route assemblies, especially on freeways and expressways. In the past, Wide Flange posts were once used to support these assemblies (and many remain in place) as the design of the post was well suited to attaching a series of backing bars needed to support the assemblies. However, the multi-direction breakaway and high resistance to torsional or twisting forces makes pipe posts the preferred post over the Wide Flange design.

Pipe posts are designed and fabricated with the breakaway device as part of the post / stub combination; as long as the post and stub breakaway is assembled correctly the post is capable of being impacted from any direction. Details for the assembly of this post system are found in Standard Plans 903 (https://www.modot.org/standard-plans-section-900), special attention must be paid to the placement of three breakaway bolts, the required and proper placement of all washers within the breakaway and most critically to the proper tightening and torque of the breakaway bolts.

Standard. If Pipe posts are used, they shall be either 2 ½ in. or 4 in. in size. The size and number of posts shall be determined using the post selection tools. Pipe posts shall be installed in accordance with Standard Plans 903 (https://www.modot.org/standard-plans-section-900).

903.16.4.4.5 Wide Flange (I-Beam) Posts

Support. MoDOT uses 6 sizes of Wide Flange posts, commonly referred to as Design #1, #2, #3, #4, #5 and #6, increasing in size and capacity respectively. Wide Flange posts are typically used to support signs 30 ft2 and larger and are MoDOT's highest capacity ground-mount sign support. As with Pipe Posts, Wide Flange post are designed to be a more durable post intended to last multiple generations of signs and designed to be able to be impacted by vehicle and then reassembled and reused.

Wide Flange post are designed and used to support large structural signs, signs made using extruded aluminum panels instead of flat sheet aluminum. The cross section of a wide flange post being that of an I-beam permits structure signs to be easily attached to the post using post clips or "dog clamps" instead of using traditional sign bolts. These posts are traditionally used on freeways and expressways only; however, there may be special applications where they may be used on two lane roadways if the size of the sign is too large for other post options.

Wide Flange posts were once the standard to support large route assemblies on freeways and expressways, however, over time two weaknesses were identified that changed this direction, making Pipe posts the better option. The two weaknesses of Wide Flange posts used to support route assemblies are:

- Safety - Route assemblies many times are installed in and around intersections and in these locations it is theoretically possible some assemblies could be impacted from any direction of travel. Single Wide Flange posts are only breakaway in two directions and are not designed to be breakaway if impacted on either side, just the front and back of the sign. Pipe posts are designed as a multi-breakaway post and can be impacted from any direction making them the better option for these installations.
- Torsional / Twisting Force Resistance – Although Wide Flange posts are very strong, they do have a limited resistance to twisting moments when installed as a single post installation. In wind prone locations, sign assemblies on a single Wide Flange post can begin to twist in the wind, and if this continues long enough, it can cause the post to fatigue and break off at the base. Pipe posts have an extreme resistance to twisting and can resist much larger torsional forces compared to wide flange posts.

As with Pipe Posts, Wide Flange posts are fabricated with the breakaway system as part of the post / stub assembly. While Wide Flange posts have a breakaway assembly at ground level like Pipe posts, they also require a hinge system located directly below the sign. The hinge system permits the wide flange post (the portion from the ground to the bottom of the sign) to swing up out of the way of a vehicle when impacted without the upper portion of the post and the sign needing to move. This reduces the mass that a vehicle must move when it impacts the post and in return reduces the impact energy to the car.

Unlike all other MoDOT posts, there are minimum post spacing which must be taken into consideration when selecting the correct number and size of post. Wide Flange Posts are much heavier than any other MoDOT post and hitting two of these posts at the same time in most cases would impart too much energy to the vehicle and would not meet minimum breakaway standards. These special considerations are included in Standard Plans 903 (https://www.modot.org/standard-plans-section-900) which contains all of the fabrication and installation details for Wide Flange Posts, however, due to their critical nature they are also listed here:

- Wide Flange Post Designs #1 and #2 have no minimum post spacing requirements.
- Wide Flange Post Designs #1 or #2 shall not be installed in three post configurations supporting signs less than 11 feet width.
- Wide Flange Post Designs #3, #4, #5 and #6 shall be spaced at least 7 ft. apart.

The post selection tool is designed to utilize two post installations over three post installations to help address minimum post spacing; it also reduces the number of footings which need to be constructed. However, there are some general rules based on sign size used to judge the number post for different size ranges of signs:

- Signs between 6 ft. and 17 ft. wide will typically be supported on two posts
- Signs wider than 17 ft. will typically be supported by three posts
- Signs of any size are not recommended to be installed on one Wide Flange post

Standard. If Wide Flange posts are used, they shall be either a structural #1, #2, #3, #4, #5 or #6 in design. The size and number of posts shall be determined using the post selection tools. Wide Flange posts shall be installed in accordance with Standard Plans 903 (https://www.modot.org/standard-plans-section-900).

903.16.4.5 Secondary Sign Supports – Post Extensions

Support. These supports are 3 in. aluminum I-Beam used to attach exit number panels to the top of, or to hang a secondary sign below, structural signs on new installations. Details of these posts are shown in the Standard Plans 903 (https://www.modot.org/standard-plans-section-900).

Option. There are occasions where modifications and/or additions must be made to existing sign installations where the existing posts are not long enough to support the new sign assembly. In these cases, it is permissible to utilize secondary sign supports to effectively extend the primary signposts to support signs a maximum of 3 feet taller than the existing primary signposts.

Secondary sign supports may only be used to allow taller signs to be installed on existing signposts if the signposts have the capacity to carry the larger sign based on signpost selection tools.

If a new sign assembly is more than 3 ft taller than the existing primary signposts, new signposts shall be installed.

903.16.4.6 Backing Bars

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Support. Backing bars are typically used to support and stiffen wide flat sheet signs mounted on single signpost or to help support the individual signs which make up sign assemblies to form one unified sign assembly. Details for backing bars can be found in Standard Plans 903 (https://www.modot.org/standard-plans-section-900).

903.16.4.7 Breakaway Assemblies

Standard. All signposts installed on right of way shall meet federal breakaway standards and MoDOT standards. Signposts not meeting current standards, but met the standards at the time of their installation, may remain in place until the end of their service life.

Sign trusses and other large sign support structures that are not breakaway shall be protected by acceptable shielding, such as guard rail or barrier wall.

Support. 4 in. x 4 in. wood posts do not need any modification to be breakaway, however 4 in. x 6 in. and 6 in. x 6 in. wood posts will need to be cross drilled to meet breakaway standards. U-Channel posts do not require breakaway modifications if they are direct driven into the ground, however, if the ground stub and slice installation method is used the installation will need to be installed according to the Standard Plans 903 (https://www.modot.org/standard-plans-section-900) to meet breakaway requirements. PSST will require breakaway devices added in certain applications based on sign and number of posts used for an installation. The signpost selection tools will indicate when a breakaway is required for PSST posts. Pipe and Wide Flange posts have the breakaway devices integrated into the post design.

903.16.4.8 Sign Orientation

Support. The orientation of the face of a sign in relation to the driver and roadway is critical to visibility and legibility, especially at night. The effectiveness of the retroreflective sheeting on a sign can be negatively impacted if the orientation of the sign face is not correct, due to incorrect installation and/or a signpost being damaged and knocked out of alignment.

The orientation of a sign can also help reduce unwanted reflection or glare off of the sign face. The skew angle, shown in Standard Plans 903 (https://www.modot.org/standard-plans-section-900), is designed to help address this glare issue for tangent sections.

Option. While the standard skew angle is 93 degrees, the skew angle may be adjusted to maintain brightness and avoid glare for signs on curved sections of road.

Support. See EPG 903.1.17 for additional information on Sign Orientation.

903.16.4.9 Sign Mountings

Support. Attaching a sign properly to a sign support is critical in order to properly orient the sign in relation to the driver as well as provide a durable, long life installation.

Standard. Plastic/nylon washers shall be used between the heads of all twist fasteners (such as screws, bolts or nuts) and the sign face to protect the sheeting from the twisting action of the fasteners.

Signs shall be attached to each type of sign support in accordance with Standard Plans 903 (https://www.modot.org/standard-plans-section-900).

Support. See EPG 903.1.18 for additional information on Sign Mountings.

903.16.5 Signing Plans

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Standard. When signing is a separate project, the plans are assembled in the following order:

1. title sheet
2. quantity sheets for roadway items
3. sign location plan sheets
4. special sheets
5. traffic control plans
6. erosion control plan
7. tabulation sheet (D-29 (https://www.modot.org/media/16702))
8. tabulation sheet (D-30 (https://www.modot.org/media/16703))
9. special sign detail sheets (D-31 (https://www.modot.org/media/16704))
10. design data sheets for cantilever and butterfly box trusses (D-32 (https://www.modot.org/media/16705))
11. design data sheets for overhead span box trusses (D-33 (https://www.modot.org/media/16706))
12. design data sheet for tubular trusses (D-34 (https://www.modot.org/media/16707))
13. truss cross-section sheets
14. cross-sections for post-mounted signs
15. special sheets for bridge-mounted signing

Typically, signing is included with the roadway plans. When this is the case, the plans are assembled together, including the quantity sheets. Separate quantity sheets shall not be generated for signing quantities. The signing plans shall be arranged in the following order:

1. sign location plan sheet
2. tabulation sheet (D-29 (https://www.modot.org/media/16702))
3. tabulation sheet (D-30 (https://www.modot.org/media/16703))
4. special sign detail sheets (D-31 (https://www.modot.org/media/16704))
5. design data sheets for cantilever and butterfly box trusses (D-32 (https://www.modot.org/media/16705))
6. design data sheets for overhead span box trusses (D-33 (https://www.modot.org/media/16706))
7. design data sheet for tubular trusses (D-34 (https://www.modot.org/media/16707))
8. truss cross-section sheets
9. cross-sections for post-mounted signs
10. special sheets for bridge-mounted signs
11. any miscellaneous special signing detail sheets.

903.16.6 Quantity Computations

Standard. Signs and posts will each be paid for individually. This includes emergency reference markers and object markers. Combined unit prices for sign and support combinations have been discontinued. All signs including stop signs, object markers, emergency reference markers and signal signs shall be totaled on Form D-30 (https://www.modot.org/media/16703) in four categories: Flat Sheet (FS), Flat Sheet Fluorescent (FSF), Structural (ST) and Structural Fluorescent. Structural signs' width and height are designed to the nearest foot. Each standard, non-standard or special sign shall be calculated to the nearest 0.1 sq. ft., subtotaled to the nearest 0.1 sq. ft., and final pay total should be to the nearest 1.0 sq. ft.

All post quantities shall be calculated and totaled on Form D-29 (https://www.modot.org/media/16702). All post lengths shall be calculated in increments of 0.25 ft. including the length that extends into the concrete footing or ground as shown on the standard plans. All U-channel post lengths shall include the full length of both pieces when overlaps are required. The post length for wide flange and pipe posts shall be multiplied by the pounds per foot (lb/ft) factor, as shown in the standard plans; each sign's posts are subtotaled to the nearest pound; all sign posts are subtotaled; and the final pay totals are shown to the nearest 10 pounds. All U-channel, wood and perforated square steel tube post length quantities shall be totaled and rounded to the nearest foot. For perforated square steel tube posts, an additional pay item shall be included for the anchor sleeve which is paid for by the

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linear foot for each post used (and may also include a soil plate). See the Post and Anchor Data Table in Standard Plan 903.03 (https://www.modot.org/media/16921) to select the necessary anchor size. Omni-Directional anchors may be used for installation in weak or loose soil conditions.

Concrete for sign support structures shall be totaled on Form D-29 (https://www.modot.org/media/16702). Concrete for overhead structure foundations shall be bolted down. Concrete for all post-mounted sign foundations shall be embedded. Bolted down and embedded quantities shall be calculated for each sign to the nearest 0.01 cubic yard, subtotaled to the nearest 0.01 cubic yard and a final pay total is shown to the nearest 0.1 cubic yard.

Cantilever and butterfly tubular support trusses shall have standard pay items. Span tubular trusses shall require special pay items. Information in the description shall include span length, truss number and span design type. Structure pay items shall include costs for all labor and materials associated with the structure, from the bottom of the base plate up, on up, as a lump sum item. Each span structure shall have a separate pay item. Structure data shall be provided on Form D-34 (https://www.modot.org/media/16707).

All box trusses shall require a special pay item for each truss. All pay item descriptions shall include span length and truss number. Truss pay items shall include costs for all labor and materials associated with the truss, from the bottom of the base plate up, as a lump sum item. Each box truss, regardless of type, shall have a separate pay item.

See Standard Plan 903.00 (https://www.modot.org/media/51221) for payment of delineators. Delineators shall be paid for per each on Form D-29 (https://www.modot.org/media/16702), and include installation, bolts, post and sign.

Perforated Square Steel Tube Post Breakaway assemblies shall be totaled on Form D-29 (https://www.modot.org/media/16702). Breakaway assemblies are incidental for pipe and structural steel posts.

Backing bar lengths and weights shall be shown on Form D-29 (https://www.modot.org/media/16702), and are totaled with the pay item for structural steel posts. No weight deductions shall be made for punched or drilled holes. If no structural steel posts are used on a project, backing bar weights shall be added to pipe post weights.

Signal Sign Mounting Hardware shall be paid for per each on Form D-37A separate from signal signs, which will be paid for by square feet. Signal Sign Hardware will include all mounting hardware necessary to install one sign on the mast arm.

Special pay items shall not be included for items considered to be small amounts of work such as: strapping signs to lighting or signal posts or truss columns; covering inappropriate legends; "EXIT ONLY" panels on new signs; any symbol, arrow, shield or legend on new guide signs; hinge plates; aluminum wide flange posts for connecting service signs and exit number panels to structural guide signs; etc. No additional payment shall be made for hardware. Other than the above, it shall be left to the designer to decide which items require direct pay.

Option. Special pay items for signing may be required. Some examples of special work include: modifying legends, relocating existing signs to new posts, temporary ground mounting guide signs, bridge mounted support brackets, truss painting, pedestal repair, etc. It is left to the designer to decide which items require special pay items.

Support. Most jobs include the removal of existing signs and/or trusses. All removals are listed with other roadway Removal of Improvements. It is preferred to list the type of truss to be removed, number of pedestals, posts, footings and a rough estimate of sign area. Consult the District Traffic Engineer or District Constructions and Materials Engineer about which removals to salvage and where the contractor should deliver the salvaged materials. Items to be salvaged and delivery of these items are mentioned in the job special provisions and this work is paid for under Removal of Improvements.

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903.17 Overhead Sign Mounting

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903.17.1 Overhead Sign Installations (MUTCD (https://mutcd.fhwa.dot.gov/) Section 2A.17)

Support. EPG 903.1.14 includes provisions from the MUTCD related to Overhead Sign Installation.

Option. Aesthetic messages displaying a city name or street name may be installed on bridge structures in specifically designated areas on the structure. (See EPG 241.4).

Additional Information
General Procedure for Overhead Span Box Truss Design

Standard. Trusses in paved medians with concrete traffic barrier shall be located to allow for barrier transitions and field adjustments of the underground storm culvert, if necessary.

Bridge Division (https://modotgov.sharepoint.com/sites/br) shall design all bridge and wall mounted truss pedestals.

Guidance. Supplemental guide signs for traffic generators should not to be mounted overhead for any highway system and should not be considered when determining whether to mount all guide signs overhead.

If a mix of situations exists on a route, where some locations require overheads and others do not, then all guide signs on the project should be mounted overhead. Mixing ground mounted guide signs with overhead guide signs is discouraged.

To minimize glare and sign obstructions, trusses should be located so that signs do not face roadway lighting units and traffic signals. When limited geometrics require numerous traffic control devices within a given area, a 300 ft. minimum should be maintained between the sign face and the stop bar location. This includes trusses located before or after the stop bar. For lighting units, the minimum distance between the front of a sign and the luminaire should be 75 feet. Signals, lighting, and sign trusses should be coordinated to achieve the best layout and remain within the standards indicated in EPG 902.

Roadway geometrics may cause sign glare at night from vehicle headlights on parallel outer roads, service roads, or the mainline. Headlights from a mainline vertical crest curve located before overhead signs may create sign glare and, if possible, trusses should be located to reduce or eliminate this glare.

Roadway curvature should be considered when placing overhead guide signs with down arrows (Type C). Down arrows on the outside of a curve may give the illusion of pointing to a lane other than intended. Down arrows on the inside of a curve may appear to point down at the shoulder or side slope. Consideration should be given to move overhead guide signs out of curves or provide additional advance overhead signs on tangent sections of roadway.

The pedestal location should be outside the clear zone. Normally, this may only be accomplished with span trusses. When this clearance is not economically feasible, the minimum horizontal clearance to the nearest part of the overhead sign support pedestal should be designed with an appropriate barrier according to the standard plans and the *AASHTO Roadside Design Guide*. Cantilever trusses with appropriate guardrail design should be used to mount single guide signs at the exit gore location.

Type A guardrail designed according to the standard plans and the *AASHTO Roadside Design Guide* should be used to shield traffic from truss pedestals. Type E guardrail should be used only when necessary for areas with limited horizontal clearance, and installed within the guidelines as shown in the standard plans. Trusses should be designed to eliminate the need for Type E guardrail.

Aluminum and steel span, combination span-cantilever, butterfly and cantilever box trusses should be used when the required span exceeds the 90 ft. maximum span of standard tubular supports, or when sign height, sign design area, or sign spread exceeds the limits of tubular support designs.

Column height "H" for box trusses should be shown to the nearest inch on the truss cross-section sheet. Pedestal heights should be designed as shown in the standard plans. Use an assumed elevation of 100 ft. at the highest point of the roadway to create the truss cross-section and a scale of 1 in. = 5 ft. (1:60). An assumed elevation will allow the movement of a truss over an area with the same template without adjusting all the elevations. Elevations to be shown (referenced to the assumed elevation) on the cross-section are to include: top of pedestal, top of footing, bottom of base plate, and the centerline elevations of truss, signs, and bottom chord. A 0.2 ft. elevation difference should be assumed between the bottom of base plate and top of pedestal for placement of expansive grout. The truss cross-section is to contain, at a minimum, the following information: truss number, station, roadway, column types, sign design area, overall truss length, pedestal and footing information, sign locations, guardrail, and any signs to be strapped to the truss column. Columns should be numbered from left to right. Different column types are allowed for each column. Truss sections should be drawn as the driver views the main sign(s). If applicable, signs should be indicated as near and far side, the far side sign being shown with dashed lines. Lighting is not to be provided for any overhead sign. Provision should be made for hand holes and pedestal conduit, as shown in the standard plans.

Required information for cross-sections is similar to box truss cross-sections. For two-arm spans between 40 and 75 ft., post lengths should be in 3 in. increments. Post lengths for other designs should be in 1 ft. increments. The footing height above the ultimate ground line should be designed as shown in the standard plans. The footing height plus the post length provides the minimum vertical clearance of 17 ft. 6 in. and is to meet the minimum post length requirements.

Bridges should be utilized wherever possible to mount guide signs. This concept removes a potential roadside obstacle and any need for guardrail or concrete traffic barrier, and is generally more economical. The district should request Bridge Division to prepare details for bridge-mounted sign support brackets after preliminary sign location approval. Bridge Division prepares plans that are included in the appropriate bridge details. Bridge Division is responsible for pay items and design of bridge- and wall-mounted sign support brackets on new bridges. When retrofitting an existing bridge with a new bracket, Bridge Division designs the bracket and submits the plan to the district for inclusion into the roadway plans.

The sign and sign brackets are designed to provide a clear distance of 2 ft. from the outside edge of the bridge to the edge of the sign. The sign is to have a maximum skew angle of 5 degrees to the roadway for which it is provided. The sign bracket is designed so that the sign is visible to traffic at least 1,000 ft. ahead of the installation.

For wall- and bridge-mounts, the district prepares and submits a truss cross-section to Bridge Division for their concurrence of location, column type and height. The sign dimensions and location over the roadway should be included with the request. The district coordinates design details with Bridge Division so that footing and pedestal details are included in the bridge or wall plans. Bridge Division is responsible for pay items and design of pedestals for bridge- and wall-mounted trusses. The district is responsible for the truss and column design and pay items.

When retrofitting an existing structure with a new truss, the preferred truss location and existing bridge- or wall-number should be submitted to Bridge Division along with the same data as required for a new bridge mounted truss. The incorporation of pay items is similar to new bridge-mounted trusses.

Option. Box span trusses may also support a cantilever support beyond one or both columns. This may help eliminate the need for a truss for the opposing traffic direction. Guide signs may be placed over the left hand lanes to utilize a span-cantilever design.

Signs may be raised above the standard vertical clearance to improve visibility and avoid other obstructions such as signal equipment.

Consideration may be given to placing guardrail at the edge of the clear zone to protect traffic from pedestals placed outside the clear zone.

Column height "H" for box trusses may be adjusted up 6 in. or down 3 in. during construction to meet field conditions. This will avoid any change in design height "H" of the prefabricated steel columns.

Columns for overhead sign trusses shorter than 10 ft. or taller than 30 ft. are nonstandard and require a special design. Column type may not be extrapolated from Figure 903.17.1.4 or 903.17.1.5. Nonstandard columns shall be identified on the plans and details of special design shall be shown. (Do not identify a nonstandard column with a column type number from standard plans. Use a different number or call-out to identify column in order to avoid confusion.)

During construction the footing height may be adjusted up 6 in. or down 3 in. to match actual field conditions. This will avoid changes in the prefabricated post lengths and accommodate actual field conditions.

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Support. Aluminum and steel span, combination span-cantilever, butterfly and cantilever box trusses are shown on the standard plans. Details necessary to complete truss data sheets for overhead trusses are obtained from Figure 903.17.1.3 and 903.17.1.5. Design data for both aluminum and steel span box trusses are shown on Forms D-32 (https://www.modot.org/media/16705) and D-33 (https://www.modot.org/media/16706). The contractor has the option to use steel or aluminum for span designs. Steel box trusses are used without option for all types of bridge-mounted trusses and for all butterfly and cantilever trusses.

Truss designs for spans exceeding 160 ft., bridge-, wall-, and any special mounting conditions are requested from Bridge Division. See other areas in this article for truss design procedures involving Bridge Division.

See Figure 903.17.1.1 and General Procedure for Overhead Span Box Truss Design for examples of span, cantilever, and butterfly box truss cross-sections.

Combination span-cantilever truss cross-sections require similar information. Tubular span, cantilever, and butterfly sign supports are shown on the standard plans. Details necessary to complete Form D-34 (https://www.modot.org/media/16707) are shown on various drawings on the standard plans. These structures have limiting design factors including sign height, total sign area, and sign spread, as noted on each drawing. When any one of these limits is exceeded, box type trusses are used.

Quantities for concrete footings and various bolt-down heights and types of pedestals are shown in Figure 903.17.1.4 and in the standard plans.

See Figure 903.17.1.2 for an example of a one-arm span tubular truss cross-section. Other types of tubular designs require similar information as shown on this figure.

Special design details are required on spans greater than 160 feet. A truss cross-section is submitted to Bridge Division as required for any new truss. The district receives recommendations from the Bridge Division for special footing, pedestal, truss and column information. Unless otherwise noted, the district is responsible for including the information in the final plans.

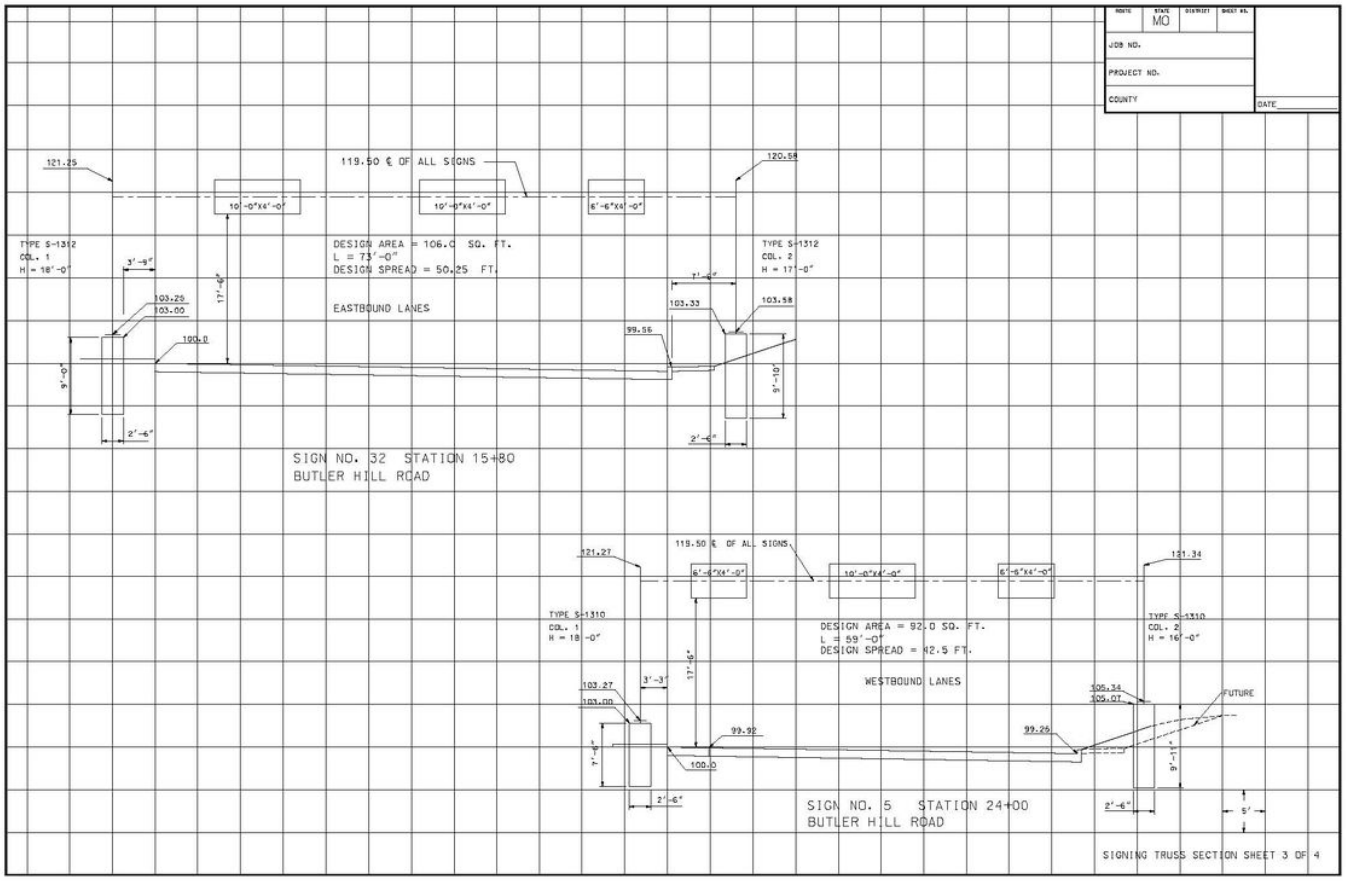
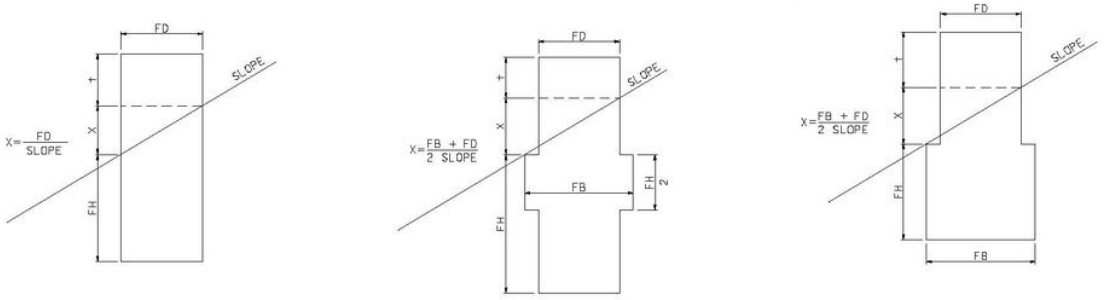


Fig. 903.17.1.1, Examples of span, cantilever and butterfly box truss cross-sections

		DIMENSIONS			DIMENSION "+" & CUBIC YARDS FOR LEVEL GROUND										ADDITIONAL FOR SLOPES							
		FB	FD	FH	2'-3"	2'-4"	2'-5"	2'-6"	2'-7"	2'-8"	2'-9"	2'-10"	2'-11"	3'-0"	6:1		4:1		3:1		2:1	
DWG	TYPE				C.Y.	C.Y.	C.Y.	C.Y.	C.Y.	C.Y.	C.Y.	C.Y.	C.Y.	C.Y.	X	C.Y.	X	C.Y.	X	C.Y.	X	C.Y.
903.05	S-1310		2'-6"	5'-0"	1.32	1.33	1.35	1.36	1.38	1.39	1.41	1.42	1.44	1.45	5"	0.08	7½"	0.11	10"	0.15	1'-3"	0.23
	S-1312		2'-6"	5'-6"	1.59	1.61	1.62	1.64	1.65	1.67	1.68	1.70	1.71	1.73	5"	0.08	7½"	0.11	10"	0.15	1'-3"	0.23
903.06	S-2315		2'-6"	8'-0"	1.86	1.88	1.89	1.91	1.92	1.94	1.95	1.97	1.98	2.00	5"	0.08	7½"	0.11	10"	0.15	1'-3"	0.23
	S-2316.5		2'-6"	9'-0"	2.05	2.06	2.08	2.09	2.11	2.12	2.14	2.15	2.17	2.18	5"	0.08	7½"	0.11	10"	0.15	1'-3"	0.23
	S-2318		3'-0"	10'-0"	3.21	3.23	3.25	3.27	3.29	3.32	3.34	3.36	3.38	3.40	6"	0.13	9"	0.20	1'-0"	0.26	1'-6"	0.39
	S-27716		3'-0"	10'-0"	3.21	3.23	3.25	3.27	3.29	3.32	3.34	3.36	3.38	3.40	6"	0.13	9"	0.20	1'-0"	0.26	1'-6"	0.39
	S-2018		3'-6"	11'-0"	4.72	4.75	4.78	4.81	4.84	4.87	4.90	4.93	4.96	4.99	7"	0.21	10½"	0.31	1'-2"	0.42	1'-9"	0.62
	S-27718		3'-6"	11'-0"	4.72	4.75	4.78	4.81	4.84	4.87	4.90	4.93	4.96	4.99	7"	0.21	10½"	0.31	1'-2"	0.42	1'-9"	0.62
	S-23316.5		3'-6"	12'-0"	5.08	5.11	5.14	5.17	5.20	5.23	5.26	5.29	5.31	5.34	7"	0.21	10½"	0.31	1'-2"	0.42	1'-9"	0.62
	S-23317		3'-6"	12'-0"	5.08	5.11	5.14	5.17	5.20	5.23	5.26	5.29	5.31	5.34	7"	0.21	10½"	0.31	1'-2"	0.42	1'-9"	0.62
	S-20018		4'-0"	12'-0"	6.63	6.67	6.71	6.75	6.79	6.83	6.68	6.90	6.94	6.98	8"	0.31	1'-0"	0.47	1'-4"	0.62	2'-0"	0.93
903.07	C-1710	4'-0"	2'-0"	4'-0"	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	6"	0.06	9"	0.09	1'-0"	0.12	1'-6"	0.17
	C-1310	4'-0"	2'-0"	5'-0"	1.21	1.22	1.23	1.24	1.25	1.26	1.27	1.28	1.29	1.30	6"	0.06	9"	0.09	1'-0"	0.12	1'-6"	0.17
	C-2315	4'-0"	3'-0"	7'-0"	2.81	2.83	2.85	2.88	2.90	2.92	2.94	2.96	2.98	3.01	7"	0.15	10½"	0.23	1'-2"	0.31	1'-9"	0.46
	C-2318	5'-0"	3'-6"	7'-6"	4.20	4.23	4.26	4.29	4.32	4.35	4.38	4.41	4.44	4.47	8½"	0.25	1'-¾"	0.38	1'-5"	0.50	2'-1½"	0.76
	C-2018	5'-0"	3'-6"	8'-0"	4.43	4.46	4.49	4.52	4.55	4.58	4.61	4.64	4.67	4.70	8½"	0.25	1'-¾"	0.38	1'-5"	0.50	2'-1½"	0.76
903.08	B-2018	6'-0"	3'-6"	7'-6"	4.69	4.72	4.75	4.78	4.81	4.84	4.87	4.90	4.93	4.96	9"	0.27	1'-2¼"	0.42	1'-7"	0.56	2'-4½"	0.85
	B-23318	7'-0"	3'-6"	8'-0"	5.47	5.50	5.53	5.56	5.59	5.62	5.64	5.67	5.70	5.73	10½"	0.32	1'-3¾"	0.47	1'-9"	0.62	2'-7½"	0.94
	B-20018	7'-0"	3'-6"	9'-6"	6.34	6.37	6.40	6.43	6.46	6.49	6.52	6.55	6.58	6.61	10½"	0.32	1'-3¾"	0.47	1'-9"	0.62	2'-7½"	0.94

FOOTING IN ROCK

903.05	SEE NOTE																					
903.06	SEE NOTE																					
903.07	C-1710	3'-0"	2'-0"	2'-6"	0.74	0.75	0.76	0.77	0.78	0.79	0.80	0.81	0.82	0.83	5"	0.05	7½"	0.07	10"	0.10	1'-3"	0.15
	C-1310	3'-0"	2'-0"	2'-6"	0.74	0.75	0.76	0.77	0.78	0.79	0.80	0.81	0.82	0.83	5"	0.05	7½"	0.07	10"	0.10	1'-3"	0.15
	C-2315	3'-6"	3'-0"	3'-6"	1.70	1.72	1.75	1.77	1.79	1.81	1.83	1.85	1.88	1.90	6½"	0.14	9¾"	0.21	1'-1"	0.28	1'-7½"	0.43
	C-2318	3'-6"	3'-6"	3'-9"	2.14	2.17	2.20	2.23	2.26	2.29	2.32	2.35	2.38	2.41	7"	0.21	10½"	0.31	1'-2"	0.42	1'-9"	0.62
	C-2018	3'-6"	3'-6"	4'-0"	2.23	2.26	2.29	2.32	2.35	2.38	2.41	2.44	2.47	2.50	7"	0.21	10½"	0.31	1'-2"	0.42	1'-9"	0.62
903.08	B-2018	3'-6"	3'-6"	3'-9"	2.14	2.17	2.20	2.23	2.26	2.29	2.32	2.35	2.38	2.41	7"	0.21	10½"	0.31	1'-2"	0.42	1'-9"	0.62
	B-23318	4'-6"	3'-6"	4'-0"	2.75	2.78	2.81	2.83	2.86	2.89	2.92	2.95	2.98	3.01	8"	0.24	1'-0"	0.36	1'-4"	0.48	2'-0"	0.71
	B-20018	4'-6"	3'-6"	5'-0"	3.23	3.26	3.29	3.32	3.35	3.38	3.41	3.44	3.47	3.50	8"	0.24	1'-0"	0.36	1'-4"	0.48	2'-0"	0.71



Concrete for Tubular Steel Support Footings

Fig. 903.17.1.2

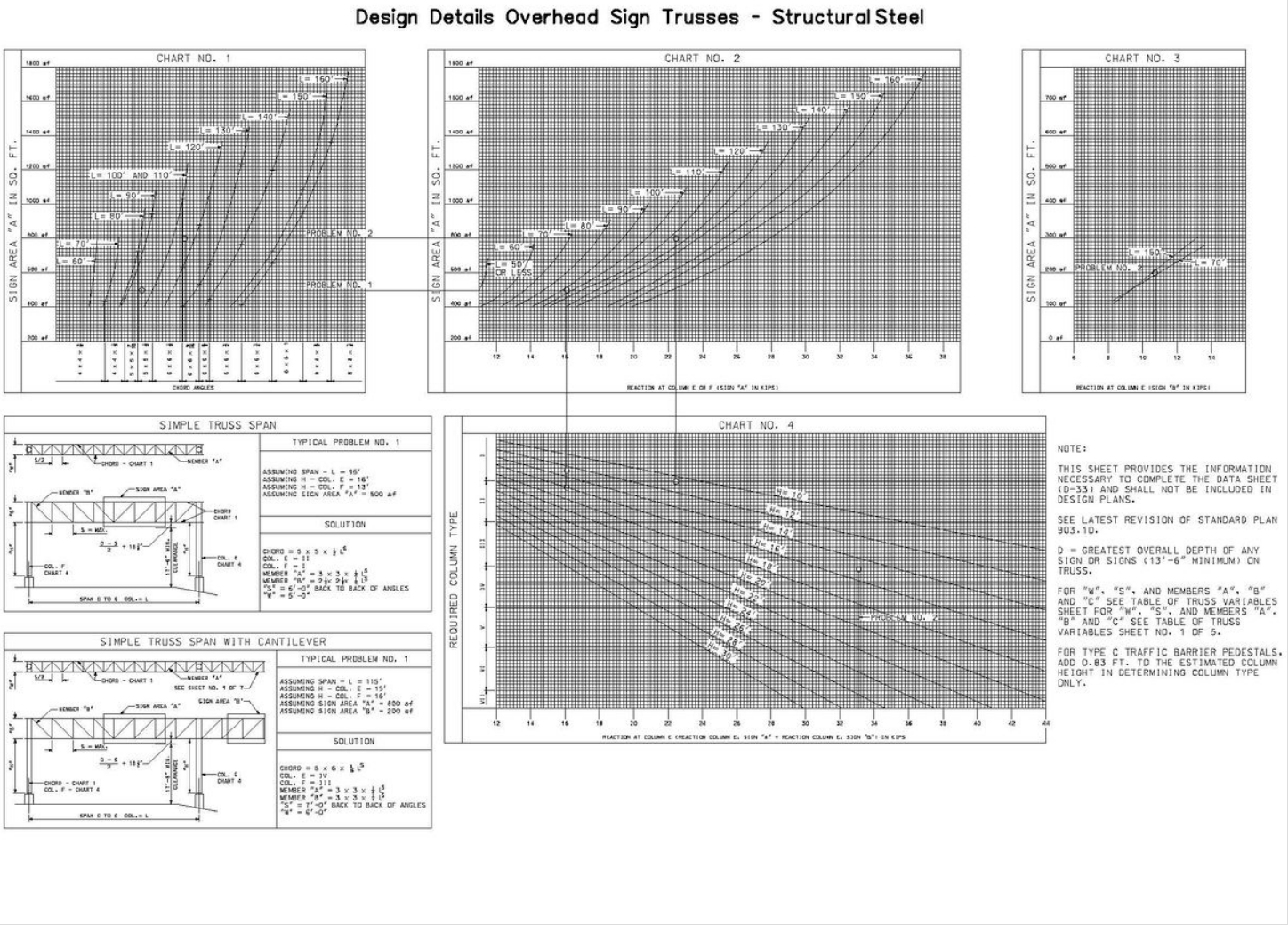

Design Details Overhead Sign Trusses - Structural Steel
CHART NO. 1
CHART NO. 2
CHART NO. 3
CHART NO. 4
SIGN AREA "A" IN SQ. FT.
REACTION AT COLUMN E OR F (SIGN "A" IN KIPS)
REACTION AT COLUMN E (SIGN "B" IN KIPS)
PROBLEM NO. 1
PROBLEM NO. 2
PROBLEM NO. 3
CHORD ANGLES
REQUIRED COLUMN TYPE
REACTION AT COLUMN E (REACTION COLUMN E, SIGN "A" + REACTION COLUMN E, SIGN "B") IN KIPS
SIMPLE TRUSS SPAN
TYPICAL PROBLEM NO. 1
ASSUMING SPAN = L = 95'
ASSUMING H = COL. E = 16'
ASSUMING H = COL. F = 13'
ASSUMING SIGN AREA "A" = 500 sf
SOLUTION
SIMPLE TRUSS SPAN WITH CANTILEVER
TYPICAL PROBLEM NO. 1
ASSUMING SPAN = L = 115'
ASSUMING H = COL. E = 15'
ASSUMING H = COL. F = 16'
ASSUMING SIGN AREA "A" = 400 sf
ASSUMING SIGN AREA "B" = 200 sf
SOLUTION
NOTE:
THIS SHEET PROVIDES THE INFORMATION NECESSARY TO COMPLETE THE DATA SHEET (D-33) AND SHALL NOT BE INCLUDED IN DESIGN PLANS.
SEE LATEST REVISION OF STANDARD PLAN 903.10.
D = GREATEST OVERALL DEPTH OF ANY SIGN OR SIGNS (13'-6" MINIMUM) ON TRUSS.
FOR "W", "S", AND MEMBERS "A", "B" AND "C" SEE TABLE OF TRUSS VARIABLES SHEET FOR "W", "S", AND MEMBERS "A", "B" AND "C" SEE TABLE OF TRUSS VARIABLES SHEET NO. 1 OF 5.
FOR TYPE C TRAFFIC BARRIER PEDESTALS, ADD 0.83 FT. TO THE ESTIMATED COLUMN HEIGHT IN DETERMINING COLUMN TYPE ONLY.

Fig. 903.17.1.3

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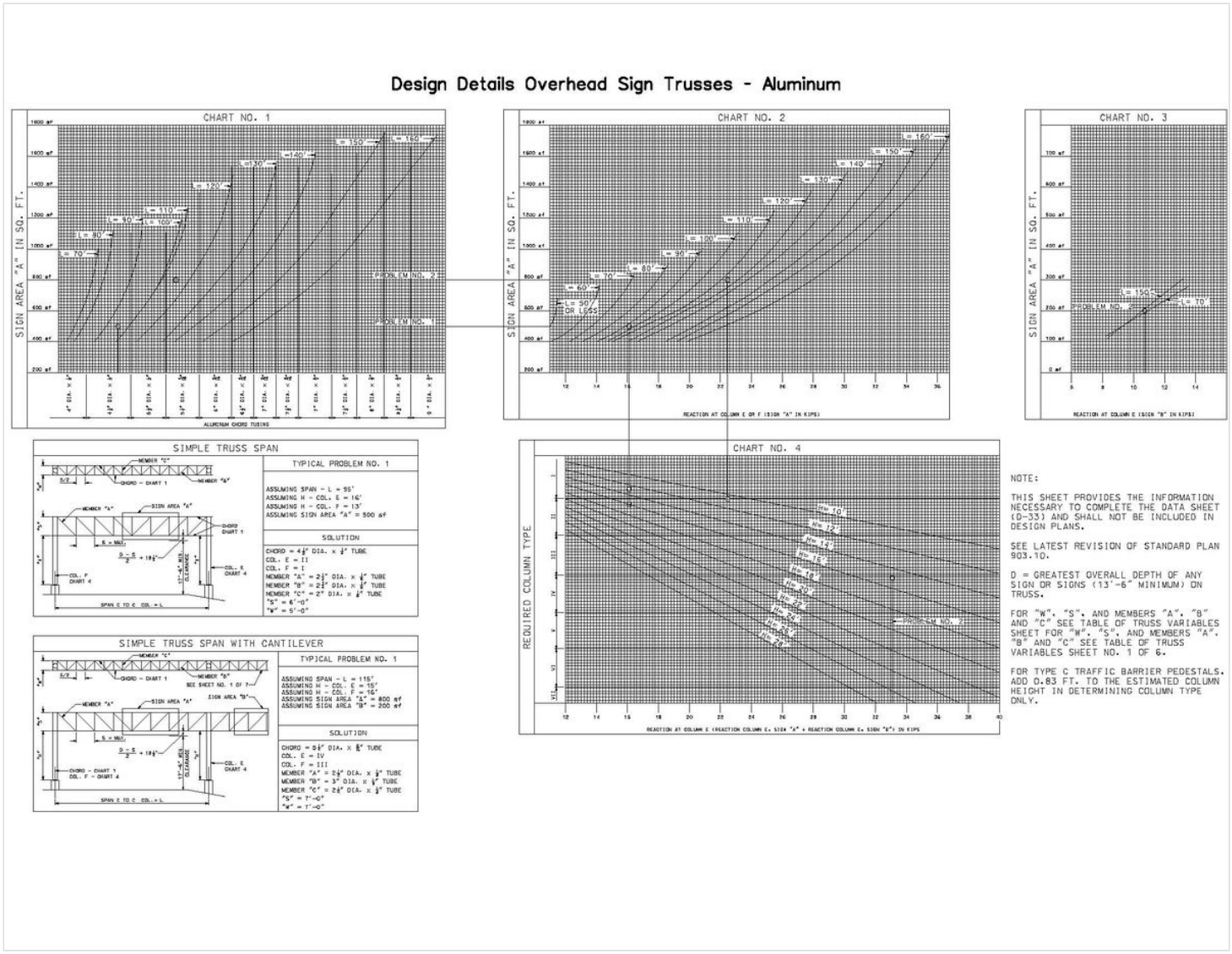


Fig. 903.17.1.4

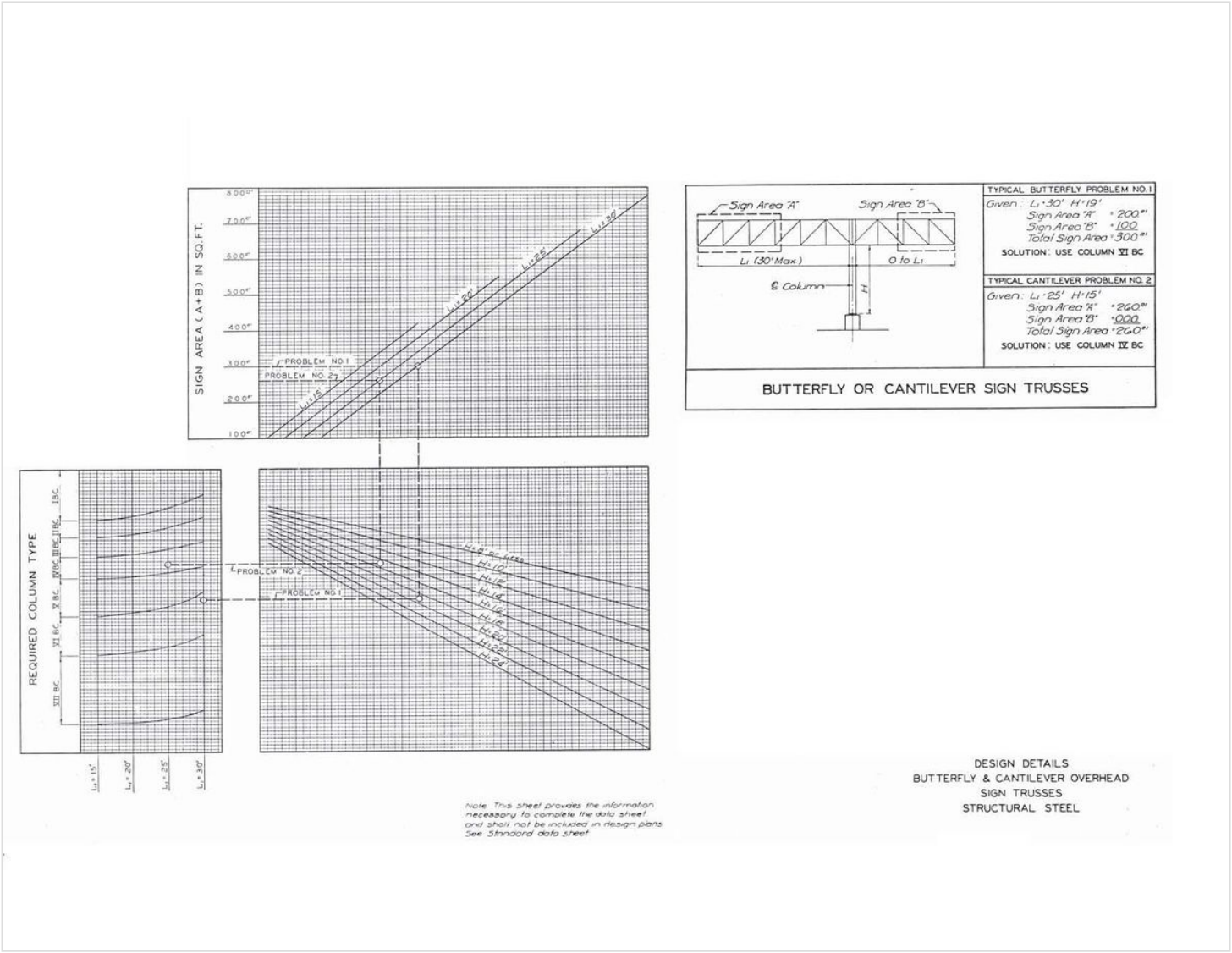


Fig. 903.17.1.5

903.17.2 Locating Support Structures

Guidance. Truss foundations of any type should not to be placed in pavement gores or other exposed locations. Every attempt should be made to avoid special truss foundations and column designs. Whenever possible, trusses should not to be mounted on bridges or walls and should be placed in areas that may already require guardrail or traffic barrier due to other obstacles. Truss locations should be checked against existing and proposed underground drainage and utilities for potential conflicts.

Option. Box span trusses (refer to Standard Plans 903.10 (https://www.modot.org/media/16927) or 903.60 (https://www.modot.org/media/16929)) may also support a cantilever support beyond one or both columns. This may help eliminate the need for a structure for the opposing traffic direction. Guide signs may be placed over the left-hand lanes to utilize a span-cantilever design.

903.17.3 Lateral Offset

Support. EPG 903.1.16 includes provisions from the MUTCD related to Lateral Offset.

Support. The preferred location of the exposed foundation is outside the clear zone. Normally, this may only be accomplished with span structures. When this clearance is not economically feasible, the minimum lateral offset to the nearest part of the exposed foundation is designed with an appropriate barrier according to the standard

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plans (https://www.modot.org/currently-effective-standard-plans) and the *AASHTO Roadside Design Guide*. Cantilever structures with appropriate guardrail design are used to mount single guide signs at the exit gore location.

903.17.4 Vertical Clearances (MUTCD (https://mutcd.fhwa.dot.gov/) Section 2A.18)

Support. EPG 903.1.15 includes provisions from the MUTCD related to sign Mounting Height.

Support. Bridge-mounted signs are no lower than the bridge, or 17 ft. 6 in., whichever clearance is lower.

903.17.5 Guardrail

Support. Type A guardrail designed according to the standard plans and the AASHTO Roadside Design Guide is used to shield traffic from structure foundations. Type E guardrail is used only when necessary for areas with limited horizontal clearance, and installed within the guidelines as shown in the standard plans (https://www.modot.org/standard-plans-section-900). Structures are designed to eliminate the need for Type E guardrail.

Consideration may be given to placing guardrail at the edge of the clear zone to protect traffic from pedestals placed outside the clear zone.

903.17.6 Span, Cantilever and Butterfly Box Trusses

Support. Aluminum and steel span, combination span-cantilever, butterfly and cantilever box trusses are shown on Standard Plans 903.10 (https://www.modot.org/media/16927), 903.12 (https://www.modot.org/media/16928) and 903.60 (https://www.modot.org/media/16929). These types are used when the required span exceeds the 90 ft. maximum span of standard tubular supports, or when sign height, sign design area, or sign spread exceeds the limits of tubular support designs. Necessary information to complete truss data sheets for overhead trusses include:

- Design details for structural steel overhead sign trusses
- Design details for aluminum overhead sign trusses
- Column design table for butterfly sign trusses, and
- Column design table for cantilever sign trusses.

Design data for both aluminum and steel span box trusses are shown on Forms D-32 and D-33 (https://www.modot.org/d-sheets). The contractor has the option to use steel or aluminum for span designs. Steel box trusses are used without option for all types of bridge-mounted trusses and for all butterfly and cantilever trusses.

The standard footing for steel and aluminum box truss structures is a spread footing. If a drilled shaft footing is determined to be necessary, the design of a drilled shaft footing by other than MoDOT will require submitted signed and sealed plans. The standard footing for box truss cantilever and butterfly structures is a drilled shaft footing or an optional spread footing. Savings may be realized by basing the foundation design on actual sign area rather than maximum and by using site specific geotechnical information. Upon request, Bridge Division will determine the most cost-effective design. Note that ample time must be allowed for this determination. See Guidelines for the Design of Miscellaneous Foundations (https://epg.modot.org/index.php?title=Category:747_Bridge_Reports_and_Layouts#747.2.5_Other_Miscellaneous_Structures) in Bridge Reports and Layouts for the proper procedure.

Truss designs for spans exceeding 160 ft., bridge, wall, and any special mounting conditions are requested from Bridge Division. See other areas in this section for truss design procedures involving the Bridge Division.



Footing

Column height, "H", for box trusses is shown to the nearest inch on the truss cross-section sheet. Exposed foundation heights are designed as shown in the standard plans. This height may be adjusted up 6 in. or down 3 in. during construction to meet field conditions. This will avoid any change in design height "H" of the prefabricated steel columns. An assumed elevation of 100 ft. at the highest point of the roadway is used to create the truss cross-section and the scale is 1 in. = 5 ft. (1:60). An assumed elevation will allow the movement of a truss over an area with the same template without adjusting all the elevations. Elevations to be shown (referenced to the assumed elevation) on the cross-section include: top of foundation, top of footing (as applicable), bottom of base plate, the centerline elevations of truss and signs, the top of the top chord, and the bottom of the bottom chord. The elevation difference between the bottom of base plate and top of pedestal for placement of expansive grout is approximately equal to the anchor bolt diameter + 1/2 inch. Refer to the standard plans for anchor bolt diameters. The truss cross-section contains, at a minimum, the following information: truss number, station, roadway, column types, sign design area, overall truss length, foundation information, sign locations, guardrail, and any signs to be strapped to the truss column. Columns are numbered from left to right. Different column types are allowed for each column. Truss sections are drawn as the driver views the main sign(s). If applicable, signs are indicated as near and far side, the far side sign being shown with dashed lines. Lighting is not provided for any overhead sign. Provisions are made for hand holes and foundation conduit, as shown in the standard plans, in case lighting is needed in the future.

Examples of cross-sections for cantilever, butterfly, and span box trusses are available. Combination span-cantilever truss cross-sections require similar information.

903.17.7 Tubular Steel Sign Supports

Support. Tubular steel span, cantilever and butterfly sign supports are shown on Standard Plans 903.05, 903.06, 903.07 and 903.08 (https://www.modot.org/standard-plans-section-900). Details necessary to complete Form D-34 (https://www.modot.org/media/16707) are shown on the standard plans. These structures have limiting design factors including sign height, total sign area, and sign spread, as noted on each drawing. When any one of these limits is exceeded, box type trusses are used.

Required information on cross-sections is similar to box truss cross-sections. For two arm spans between 40 and 75 ft., post lengths are in 3 in. increments. Post lengths for other designs are in 1 ft. increments. The foundation height above the ultimate ground line is designed as shown in the standard plans. During construction the foundation height may be adjusted up 6 in. or down 3 in. to match actual field conditions. This will avoid changes in the prefabricated post lengths and accommodate actual field conditions. The quantities of concrete for tubular steel support footings have been tabulated and are also shown in the standard plans (see Figure 903.17.1.2).

Figure 903.17.1.1 shows an example of a one-arm span tubular structure cross-section. Other types of tubular steel structure designs require similar information as shown on this figure.

903.17.8 Bridge-Mounted Signs

Support. Bridges are utilized wherever possible to mount overhead signs. This concept removes a potential roadside obstacle and any need for guardrail or concrete traffic barrier and is generally more economical.

Standard. Bridge Division (http://sp/sites/br/Pages/default.aspx) shall prepare details for bridge-mounted sign support brackets that will be attached to new bridges and existing bridges that require other bridge work. Consultants shall prepare details for bridge-mounted sign support brackets that will be attached to existing

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bridges that do not require other bridge work.

New Bridges: The district requests Bridge Division to prepare details for bridge-mounted sign support brackets after preliminary sign location approval. Bridge Division prepares plans that are included in the appropriate bridge details. Bridge Division is responsible for bid items (http://www.modot.mo.gov/business/contractor_resources/biditemslisting.htm) and design of bridge-mounted sign support brackets. The district shall provide the following information to the Bridge Division where applicable:

- Project No., Bridge No. and letting date
- Dimensions of sign(s)
- For traffic under the bridge
    - o number of lanes
    - o width of lanes
    - o shoulder dimensions
    - o direction of traffic and dimension from centerline of roadway to the lanes under the bridge
    - o identify the lanes receiving an overhead sign.

Existing Bridge (with other bridge work): When retrofitting an existing bridge with a new bracket, Bridge Division designs the bracket and incorporates the sign attachment sheets into the bridge plans. The district shall provide the same information to the Bridge Division as required for new bridges. Design Division is responsible for job special provisions related to removal and storage of existing signs.

Existing Bridge (no other bridge work): When retrofitting an existing bridge with a new bracket, the consultant designs the bracket and submits the plan to the district for inclusion into the roadway plans. For tracking purposes, the Bridge Survey Processor is contacted so a bridge rehab number can be assigned. A copy of the final sign attachment sheets is sent to the Bridge Survey Processor for incorporation with the existing bridge plans.

The sign and sign brackets are designed to provide a clear distance of 2 ft. from the outside edge of the bridge to the edge of the sign. The sign has a maximum skew angle of 5 degrees to the roadway for which it is provided. The sign bracket is designed so the sign is visible to traffic at least 600 ft. ahead of the installation.

903.17.9 Bridge-Mounted Structure Designs

Support. Bridges are utilized wherever possible to mount sign support structures. This concept removes a potential roadside obstacle and any need for guardrail or concrete traffic barrier and is generally more economical.

Standard. Bridge Division (http://sp/sites/br/Pages/default.aspx) shall prepare details for bridge-mounted sign support structures that will be attached to new bridges and existing bridges that require other bridge work. Consultants shall prepare details for bridge-mounted sign support structures that will be attached to existing bridges that do not require other bridge work.

New Bridges: For bridge-mounts, the district prepares and submits a sign support structure cross-section to Bridge Division for their concurrence of location, column type, and height. The sign dimensions and location over the roadway are included with the request. The district coordinates design details with Bridge Division so pedestal details are included in the bridge plans. Bridge Division is responsible for design of pedestals for bridge-mounted structures and related pay items. The district is responsible for the design of the structure above the pedestal and related bid items.

Existing Bridge (with other bridge work): When retrofitting an existing bridge with a new sign support structure, the preferred location and existing bridge number is submitted to Bridge Division, along with the same data as required for a new bridge-mounted sign support structure. The incorporation of bid items is similar to new bridge-mounted sign support structures.

Existing Bridge (no other bridge work): When retrofitting an existing bridge with a new sign support structure, the preferred location and existing bridge number is submitted to the consultant, along with the

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same data as required for a new bridge-mounted sign support structure. The consultant is responsible for design of pedestals and structure above the pedestal for bridge-mounted structures and all related bid items.

903.17.10 Non-Standard Sign Support Structures

Support. Special design details are required on spans greater than 160 ft. and other situations not covered by the Standard Plans. A truss cross-section is submitted to Bridge Division as required for any new truss. The district receives recommendations from Bridge for special foundation, truss, and column information. Design of non-standard structures should be in accordance with the latest version and latest interims of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*. Unless otherwise noted, the district is responsible for including the information in the final plans.

903.17.11 Sign Supports on Fill

Support. The pole's design height for overhead sign supports placed on elevated roadway fill is to include the height of the fill. Consult Bridge Division if the pole's design height exceeds the values shown in the standard plans.

903.17.12 Overhead Sign and Truss Inspection/Inventory

Option. Sign truss inspection may be made by consultant as determined by Bridge Division (http://sp/sites/br/pages/default.aspx).

Standard. Bridge Division shall determine the frequency of inspection for all sign trusses and shall maintain the sign truss inventory.

903.17.13 Structure Loading

Support. There is a maximum signage area allowed for each structure. For changes in signing call Central Office Highway Safety and Traffic for assistance and review.

Retrieved from "https://epgtest.modot.org/index.php?title=903.17_Overhead_Sign_Mounting&oldid=59964"

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903.18 Memorial Signs

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- 903.18.2.2 Application Process

903.18.3 Heroes Way Designation Program

903.18.4 Drunk Driving Victim Program

903.18.1 Memorial Designation Programs

Support. The Missouri General Assembly statutorily established the Memorial Designation Programs to memorialize certain individuals, events, places or organizations on Missouri's state roadway system.

The Missouri Highways and Transportation Commission establish fees for these memorial designation signs. The fee is for participating in the Memorial Designation Programs, which covers the cost of constructing signs or constructing, installing and maintaining markers. These memorial signs and markers are the property of MoDOT.

MoDOT's involvement in memorial designations is limited to the administration of the designation programs and to the installation and maintenance of signs or markers.

Standard. MoDOT has no authority to designate or install memorial signs or markers on non-state (e.g., city or county) routes.

MoDOT will require written consent from the honoree's family authorizing the designation, if designating after an individual. To be mindful and respectful of the family, their consent is required. Not all families have interest in seeing a loved one's memorial sign or marker and want to be reminded of their loss.

MoDOT shall provide notice of any proposed designation on the state's roadway system by posting the proposal on MoDOT's Memorial Designation Programs website (https://www.modot.org/memorial-designation-programs) in addition to making available to any representative of the news media or public upon request.

Organization of memorial dedication ceremonies shall be the responsibility of the family and/or their designee. MoDOT does not participate in organizational planning or provide signs for ceremonies. To ensure the safety of attendees and traveling public, ceremonies shall not take place on state right-of-

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way. MoDOT does not coordinate the sign installation with dedication ceremonies.

Following the approval of a memorial designation, MoDOT will notify the family or its designee of the approval. MoDOT will send either an approval or payment request letter to the family or its designee, or to the legislator who sponsored the memorial if the family or its designee is unknown. The official letter will provide specific and necessary information regarding the subsequent steps in MoDOT's memorial designation process.

MoDOT will order signs after the memorial receives approval or becomes law and once the fees, if required are received in full. Signs for memorial designations established through the Legislative Process will not be ordered or installed until after August 28th, date the bill becomes law. Signs for memorial designations established through MoDOT's Application Process will be ordered and scheduled for installation after the designation is approved by the Joint Committee on Transportation Oversight. Sign delivery can take five to seven weeks. Memorial signs or markers are installed within 120 days from the date the signs are received from the manufacturer, weather permitting.

MoDOT shall determine the sign location to ensure safe operation of the state roadway system.

MoDOT will not publicly announce the installation date for memorial signs or markers to ensure safety is not compromised for all individuals involved, including our personnel, and the traveling public.

Option. The family or its designee may request a PDF file of the memorial sign at no cost, provided their written acceptance of MoDOT's PDF terms and condition declaration. The PDF allows the family or its designee to utilize local sign/banner companies to fabricate commemorative or replica signs for their own personal use.

Support. MoDOT will provide the PDF file of the memorial sign electronically to the family or its designee at the email address provided.

Following installation, MoDOT will send digital images of the completed memorial signs or markers and the official installation date to the email address provided by the family or its designee. Memorial sign or marker installations shall not preempt critical highway work or any department directives pertaining to prioritization of sign maintenance.

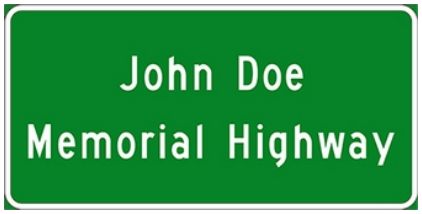
Option. The family or its designee may submit a biography for an individual honored with a memorial designation on the state roadway system. A photo of the honoree may be added to the biography, if electronically provided.

Support. MoDOT will publicize the honoree's biography and post a website link on the MoDOT Memorial Map.

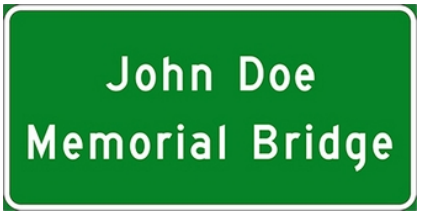
Standard. All biographies will have the same format, as designed by MoDOT. MoDOT shall reserve the right to review and edit the biography,

903.18.2 Memorial Highway and Bridge Program (M18-1, M18-2, M18-5, M18-6, M18-7, M18-8) (MUTCD Section

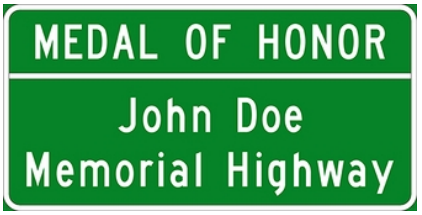
2M.10)



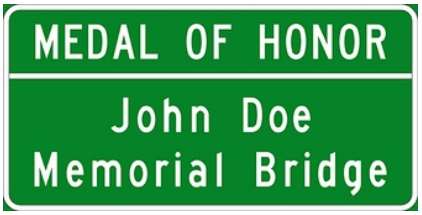
M18-1



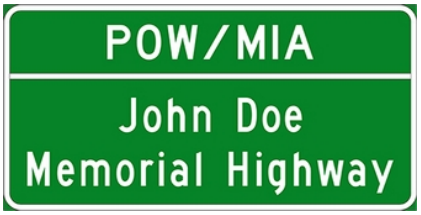
M18-2



M18-5



M18-6



M18-7



M18-8

Support. The Missouri Legislature routinely establishes memorial designations on Missouri's State highways and bridges each year.

A highway designated as a memorial is not considered to be a named highway for the purposes of highway signing or road user navigation and orientation.

EPG 903.1.20 contains information regarding excessive use of signs. Because memorial names are not official highway names, memorial signing is not essential to providing navigational guidance.

Under certain conditions, and within specific guidelines, Missouri highways and bridges may be designated after an individual (deceased 2 years), an event, place, or organization. The 2-year waiting period after a death is required by state statute to allow for grieving before memorialization decisions are made.

MoDOT will require the family or its designee to provide verification of the honoree's death. A copy of the death certificate or obituary is an acceptable form of documentation.

Before contacting a member of the General Assembly or completing a MoDOT Application, contact the MoDOT Highway Safety and Traffic Division at (573) 751-7643 or via email at Memorial.Designations@modot.mo.gov to verify availability of the desired section of highway (two-mile-or-less) or bridge location.

MoDOT can help identify an available roadway. The family or its designee will need to provide a general location (e.g., county, route, crossroad) to assist in their research.

Standard. Where such memorial signs are installed on the highway mainline, (1) memorial names shall not appear on directional guide signs, (2) memorial signs shall not interfere with the placement of any other traffic control devices, and (3) memorial signs shall not compromise the safety or efficiency of traffic flow. MoDOT shall determine the exact sign location to ensure safe operation of the state roadway system.

Memorial signs shall not imply that a highway has been officially renamed, Memorial Designation names shall not replace or alter the official names of state routes with numerals, letters, or city streets. Memorial Designation names are honorary designations only and are not official highway names.

Memorial names shall not appear on supplemental signs or on any other information sign on or along the highway or its intersecting routes.

MoDOT shall erect and maintain signs provided under this policy.

The location of these signs shall be determined by MoDOT.

No bridge or section of a highway on the state roadway system shall be designated more than once. Each event, place, organization or person shall only be eligible for one bridge or highway designation. These are the provisions of Missouri Revisor of Statutes - Revised Statutes of Missouri, RSMo Section 227.299.8.

In the event a bridge or highway has a designated name, another bridge or highway shall be selected.

A total of two signs shall be erected for each highway or bridge designation on the state's roadway system, as specified by the Manual on Uniform Traffic Control Devices (MUTCD).

Signing shall consist of one shoulder post-mounted sign at each end of the bridge or section of highway. Memorial bridge signs will be installed on the roadway carried by the bridge, not on the roadway traveling under the bridge. Memorial signs shall not appear on or be placed on any bridge structure or bridge span over a divided or undivided highway.

The memorial signs shall be rectangular in shape and shall be 6 ft. by 3 ft. The signs shall have a white legend on a green background. The signs shall use MoDOT standard retroreflective sheeting. Legend on the signs shall use 6 in. tall letters with a maximum of 3 lines of text. The legend displayed on memorial signs shall be limited to the name of the individual, event, place, or organization being designated and the required simple message preceding or following the name, such as "MEMORIAL HIGHWAY" or "MEMORIAL BRIDGE". Additional legends, such as biographical information, nicknames, or any appearance of advertising, shall not be displayed on memorial signs. Decorative or graphical elements, pictographs, logos, or symbols shall not be displayed on or attached to memorial signs or posts.

MoDOT shall have the right to modify the proposed legend based on design limitations.

The lettering on memorial signs shall be composed of lower-case letters with initial upper-case letters.

Guidance. When used, memorial or dedication signs should be located in accordance with the provisions for excessive use of signs (see EPG 903.1.20).

903.18.2.1 Legislative Process

Support. Legislative bodies will occasionally adopt an act or resolution memorializing or designating a highway or bridge on Missouri's state roadway system.

MoDOT can help identify an available roadway. The family or its designee will need to provide a general location (e.g., county, route, or crossroad) to assist in their research.

MoDOT can work with members of the General Assembly or House and Senate Research to draft the appropriate bill language.

Standard. A directive for naming shall come through the action of the General Assembly. In the event a bridge or highway has a designated name, another bridge or highway shall be selected.

Only one memorial name shall be used to identify any highway or bridge designation under the provisions of Missouri Revisor of Statutes - Revised Statutes of Missouri, RSMo Section 227.299 (https://revisor.mo.gov/main/OneSection.aspx?section=227.299&bid=57602&hl=).

Only the following residents of Missouri shall be eligible for memorial signing through the legislative process:

1. Members of the U.S. Armed Forces killed in the line of duty
2. Members of the U.S. Armed Forces who are missing in action
3. Missouri Medal of Honor Recipients
4. Emergency personnel killed while performing duties relating to their employment
5. State employees killed while serving the state

Standard. For designations honoring Missouri Armed Forces killed in the line of duty or missing in action, Missouri Medal of Honor recipients, Missouri emergency personnel or state employees killed while performing duties relating to their employment, no fees shall be assessed and all costs associated with such designations shall be funded by MoDOT.

MoDOT will waive the participation fee if verification is provided to certify the honoree meets the circumstances outlined in Missouri Revisor of Statutes - Revised Statutes of Missouri, RSMo Section 227.296 (https://revisor.mo.gov/main/OneSection.aspx?section=227.296&bid=54091&hl=). A copy of the U.S. Armed Forces Casualty Report, a website link to a fallen military webpage or news article, statement from the Missouri Veterans Commission or the U.S. Department of Veterans Affair, or any military office or state document certifying such facts are acceptable forms of documentation.

MoDOT will design memorial signs for any highway or bridge designation as specified in legislation. MoDOT has no authority to deviate from law. If any part of the memorial designation is incorrect, legislation must be modified during a subsequent legislative session. MoDOT can only change the memorial designation or signs after the correction has been signed into law.

903.18.2.2 Application Process

Standard. A MoDOT application shall be submitted to MoDOT.

A list of one hundred (100) wet-signed signatures of individuals who support the naming of the highway or bridge designation shall be submitted to MoDOT. A 100-signature petition is required by state statute to show community support from the specific area the family, or its designee wishes to designate. The list must be of Missouri residents who are 18 years or older and live in the county or counties surrounding the memorial's location.

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MoDOT will require the family or its designee to have a legislative sponsor supporting the application. All memorial designation programs in the state of Missouri are based on state law. The law requires every memorial application to have a member of the Missouri General Assembly who will sponsor the designation. The sponsor should serve the local community for where the memorial is designated.

A total of two signs shall be erected for each highway or bridge designation on the state's roadway system, as specified by the Manual on Uniform Traffic Control Devices (MUTCD).

The participating fee shall be paid by the applicant, private donations, or organizations. MoDOT shall maintain the signs for 20 years, after which a renewal application and renewal fee shall be submitted, or the signs are removed.

In the event a bridge or highway has a designated name, another bridge or highway shall be selected.

Only one memorial name shall be used to identify any highway or bridge designation under the provisions of Missouri Revisor of Statutes - Revised Statutes of Missouri, RSMo Section 227.299 (https://revisor.mo.gov/main/OneSection.aspx?section=227.299&bid=57602&hl=).

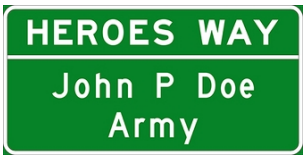
Support. The Joint Committee on Transportation Oversight reviews and approves proposed designations. The Committee normally meets three times a year: in late January or early February, in late April or mid-May (before end of session), and in mid-September (during veto session). MoDOT has no influence over when the Joint Committee on Transportation Oversight meets. If the Committee is unable to gather a quorum to vote on the application, the application will be held, reviewed, and voted on at the next meeting.

Before completing an application, contact the MoDOT Highway Safety and Traffic Division at (573) 751-7643 or via email at Memorial.Designations@modot.mo.gov (mailto:Memorial.Designations@modot.mo.gov) to verify roadway availability of the desired section of highway (two-mile-or-less) or bridge designation.

MoDOT can help identify an available route. The family or its designee will need to provide a general location (e.g., county, route, or crossroad) to assist in their research.

Additional program information and application can be found at Memorial Highway and Bridge Program (https://www.modot.org/memorial-highway-and-bridge-program).

903.18.3 Heroes Way Designation Program



Heroes Way

Support. This program allows for state-maintained highway interchanges, bridges, or segments of highway (two-miles-or-less) to be designated for Missouri residents, who were in the U.S. Armed Forces and were killed in action while performing active military duty.

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Additional program information and application can be found at Heroes Way Designation Program (https://www.modot.org/heroes-way-designation-program).

Option. Any individual who is related by marriage, adoption, or consanguinity within the second degree to the member of the United States Armed Forces who was killed in action may apply for a Heroes Way designation.

Support. To protect the family's interest, MoDOT corresponds only with the family member who submitted and signed the application.

Standard. MoDOT is the assigned program administrator under the provisions of Missouri Revisor of Statutes - Revised Statutes of Missouri, RSMo Section 227.297 (https://revisor.mo.gov/main/OneSection.aspx?section=227.297).

An application shall be submitted to MoDOT.

Verification the honoree was in the U.S. Armed Forces and was killed while performing military duty is required by state statue and shall be submitted to MoDOT. Acceptable forms of verification include a copy of the U.S. Armed Forces Casualty Report, website link to a fallen military webpage, a statement from the Missouri Veterans Commission or the U.S. Department of Veterans Affair, or any official military document certifying such facts.

Interstate or state-numbered highway interchanges, bridges or segments of highway shall only be designated in memory of one fallen solider. All interchanges, bridges, and sections of highway shall be identified and tied to the primary route. (e.g., an interchange at Interstate 70 and U.S. Highway 63 shall be considered an Interstate interchange and not a U.S. interchange).

A total of two signs shall be erected for each interchange, bridge, or section of highway designation on the state's roadway system, as specified by the Manual on Uniform Traffic Control Devices (MUTCD).

Signing shall consist of one shoulder post-mounted sign at each end of the interchange, bridge, or section of highway. Heroes Way bridge signs will be installed on the roadway carried by the bridge, not on the roadway traveling under the bridge. Heroes Way interchange signs will be installed within the triangle area between the mainline and the ramp of the designated interchange. Heroes Way signs shall not appear on or be placed on any bridge structure or bridge span over a divided or undivided highway.

The signs shall be rectangular in shape and shall be 6 ft. by 3 ft. The signs shall have a white legend on a green background. The signs shall use MoDOT standard retroreflective sheeting. The legend displayed on the signs shall be limited to the simple message of "HEROES WAY", the name of the individual being designated and the branch of U.S. Armed Forces the individual serviced. Additional legends, such as biographical information, nicknames, or any appearance of advertising, shall not be displayed on the signs. Decorative or graphical elements, pictographs, logos, or symbols shall not be displayed or attached to the signs or posts.

MoDOT shall have the right to modify the proposed legend based on design limitations of the sign.

MoDOT shall determine the sign location to ensure safe operation of the state roadway system.

MoDOT shall maintain the signs for 20 years, after which a renewal application shall be submitted to MoDOT or the signs are removed.

Support. The Joint Committee on Transportation Oversight reviews and approves the proposed designations. The Committee normally meets three times a year: in late January or early February, in late April or mid-May (before end of session), and in mid-September (during veto session). MoDOT has no influence over when the Joint Committee on Transportation Oversight meets. If the Committee is unable to gather a quorum to vote on the application, the application will be held, reviewed, and voted on at the next meeting.

MoDOT will order the signs and schedule for installation after the memorial receives approval. Sign delivery can take five to seven weeks. Memorial signs are installed within 120 days from the date the signs are received from the manufacturer, weather permitting. Before completing an application, contact the MoDOT Highway Safety and Traffic Division at (573) 751-7643 or via email at Memorial.Designations@modot.mo.gov (mailto:Memorial.Designations@modot.mo.gov) to verify roadway availability of the desired interchange, bridge, or section of highway (two-miles-or-less).

MoDOT can help identify an available roadway. The family will need to provide a general location (e.g., county, route, or crossroad) to assist in their research.

Standard. No interchange, bridge or section of a highway on the state roadway system shall be designated after more than one member of the U.S. Armed Forces killed in action. Such person shall only be eligible for one interchange, bridge or highway designation under the provision of Missouri Revisor of Statutes - Revised Statutes of Missouri, RSMo Section 227.297.8 (https://revisor.mo.gov/main/OneSection.aspx?section=227.297#:~:text=No%20interchange%2C%20bridge%2C%20or%20highway%20may%20be%20named%20or%20designated%20after%20more%20than%20one%20member%20of%20the%20United%20States%20Armed%20Forces%20killed%20in%20action.%C2%A0%C2%A0Such%20person%20shall%20only%20be%20eligible%20for%20one%20interchange%2C%20bridge%2C%20or%20highway%20designation%20under%20the%20provisions%20of%20this%20section.).

Heroes Way designations shall not replace existing memorial designations for any bridge or section of highway designated on the roadway system. In the event a bridge or highway has a designated name, another bridge or section of highway shall be selected.

903.18.4 Drunk Driving Victim Program



Fig. 903.18.4,
David's Law

Support. This program allows memorial markers to be placed along state-maintained roadways for any victim killed on a state highway as result of a vehicular accident caused by an impaired driver.

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Additional program information and application can be found at Drunk Driving Victim (David's Law) (https://www.modot.org/drunk-driving-victim-davids-law).

Standard. MoDOT is the program administrator. Applicants must submit an application to MoDOT, along with a copy of a Missouri Law Enforcement report or other legal documentation. This documentation must indicate one of the vehicle operators involved in the crash was impaired.

One marker shall be allowed for one individual who died in Missouri. In cases involving multiple victims, one marker per victim may be installed at the discretion of MoDOT; this is subject to additional costs. A marker shall not be installed in memory of an individual who themselves were impaired and in violation of the provisions in section 577.010 (https://revisor.mo.gov/main/OneSection.aspx?section=577.010&bid=34718&hl=) or 577.012 (https://revisor.mo.gov/main/OneSection.aspx?section=577.012&bid=33823&hl=).

One marker shall be erected as close as possible to the location where the crash occurred. MoDOT determines the marker location to ensure safe operation of the highway system.

The marker shall consist of one shoulder post-mounted sign on the right-hand side of the roadway, placed parallel to the roadway at approximately the mowing limit and facing the median. The marker shall not be placed perpendicular to the roadway. The marker shall not interfere with the placement of other signs, traffic control devices, other safety devices, or impede the safety of the traveling public.

The marker shall be rectangular in shape and shall be 30 inches by 18 inches. The marker shall have white legend on a blue background. The marker shall use MoDOT standard retroreflective sheeting. The legend displayed on the marker is mandated by state statue and shall be limited to the simple message of “Drunk Driving Victim”, the initials (e.g., first, middle, and last name) of the individual being designated, the month and year (e.g., two-digits) of the accident and the simple message of “Think About It”. Additional legends, such as ranks, or titles, shall not be displayed on the marker. Decorative or graphical elements, pictographs, logos, or symbols shall not be displayed on or attached to the marker or post.

The participating fee shall be paid by the applicant, private donations, or organizations.

MoDOT will order the marker and schedule for installation after the memorial receives approval. Sign delivery can take five to seven weeks. Memorial markers are installed within 120 days from the date the signs are received from the manufacturer, weather permitting.

MoDOT shall determine the marker location to ensure safe operation of the state roadway system.

MoDOT will not publicly announce the installation date for memorial markers to ensure safety is not compromised for all individuals involved, including our personnel, and the traveling public.

MoDOT shall maintain the markers for 10 years, after which a renewal application and renewal fee shall be submitted, or the markers are removed.

Option. Immediate family members of the deceased victim may request a memorial marker. An individual with written consent from an immediate family member may also apply on the family member’s behalf.

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Support. The MoDOT Highway Safety and Traffic Division reviews and approves these proposed designations.

Before completing an application, contact the MoDOT Highway Safety and Traffic Division at (573) 751-7643 or via email at Memorial.Designations@modot.mo.gov (mailto:Memorial.Designations@modot.mo.gov) to verify roadway availability of the desired highway designation.

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903.23 Signing Maintence Guidelines

903.23.1 Sign ID Labels

History. The display of the MoDOT ID label on the front of the sign was standard practice on all signs produced by the MoDOT Sign Production Center (SPC) up to its closing mid-2012 when MoDOT first began outsourcing the production of signs for maintenance operations. MoDOT's sign fabrication vendors were also required to apply the traditional MoDOT ID on the front of the sign identifying it as Commission Property and listing the penalty for tampering and/or theft. The requirement to add the MoDOT ID label to signs fabricated and installed for construction projects was added to the standard plans in July of 2018.

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- 903.23.2.4 Post Inventory
  - 903.23.2.4.1 Wood, U-Channel and PSST Posts
  - 903.23.2.4.2 Pipe and Wide Flange (I-Beam) Posts
  - 903.23.2.4.3 Post Storage and Handling

903.23.3 Sign and Post Ordering

- 903.23.3.1 Sign Ordering
- 903.23.3.2 Post Ordering

903.23.4 Sign and Post Disposal

- 903.23.4.1 Sign Disposal
- 903.23.4.2 Post Disposal

903.23.5 Sign Inspection

903.23.6 Emergency Response

903.23.7 Guidelines for the use of the Sign Management System (SMS)

Beginning mid-2012 with the first sign outsourcing contract, MoDOT's sign fabrication vendors were also required to add a manufacture ID label on the back of every sign to indicate who fabricated the sign and the date the sign was produced for warranty issues. The warranty of a sign begins the day it was fabricated, not the day it is installed as sign sheeting has a limited life span (10-15 years) so this date is critical to address warranty issues. The manufacturing date can also be used by the department to help manage inventory and assure the oldest sign on the shelf are used first. July 2018 the requirement to add the manufacture ID was added to the standard plans so all signs manufactured and installed on construction projects would include this ID label as well.

Digital printing has been an option with our sign outsourcing contract since 2012. Digital printing is not currently part of our standard plans for contract/warranty issues, it was added to the sign outsourcing contract as a controlled way for the department to gain experience with the technology before adopting it as fabrication technology in our standards. With the renewal of the outsourcing contract in 2018, an additional ID label was added as a requirement for our vendor to make the identification of digitally printed signs easier. A black diamond is required to be applied to the back side of any sign the vendor chooses to fabricate using digital

printing technology. While there are ways to identify digitally printed signs, the clues are very subtle, and you must be up close to the sign face to see them. The black diamond on the back side of the sign allows the department to quickly identify these signs from a distance.

The design and location of the vendor ID/fabrication date label and the MoDOT ID label can be found in Standard Plans 903 (https://www.modot.org/standard-plans-section-900) and the detail for the digital print ID label are found in the sign outsourcing contract.

Standard. Every MoDOT sign, regardless of the type or style, shall have two Identification Labels on the sign. This applies to signs manufactured for maintenance operations as well as those manufactured for construction installations. The first label is the MoDOT ID label placed on the front of the sign which identifies the sign as belonging to MoDOT and defining the penalty for tampering with the sign. The second label is the Vendor ID label placed on the back of the sign and identifies who fabricated the sign, their contact information and the date the sign was manufactured.

Support. The MoDOT ID label on the front of the sign is used to identify the sign as belonging to MoDOT. MoDOT does not sell or give away its signs, only disposing old signs as scrap (see EPG 903.23.4.1). If a person is found in possession of a sign(s) with the MoDOT ID label the sign is considered stolen and the label is utilized by law enforcement to take the necessary actions.

The Vendor ID label placed on the back of the sign is used to identify who manufactured the sign and when it was fabricated. This information is used if there is a warranty issue identified with the sign. The warranty for sign sheeting is based on the fabrication date. The fabrication date also permits MoDOT warehouse managers to identify and utilize the oldest stock signs first to assure stock is rotated.

Identification Label design and placement details are shown in Standard Plan 903.02 (https://www.modot.org/sites/default/files/documents/90302_5.pdf), see Figure 903.23.1 for ID label general appearance.

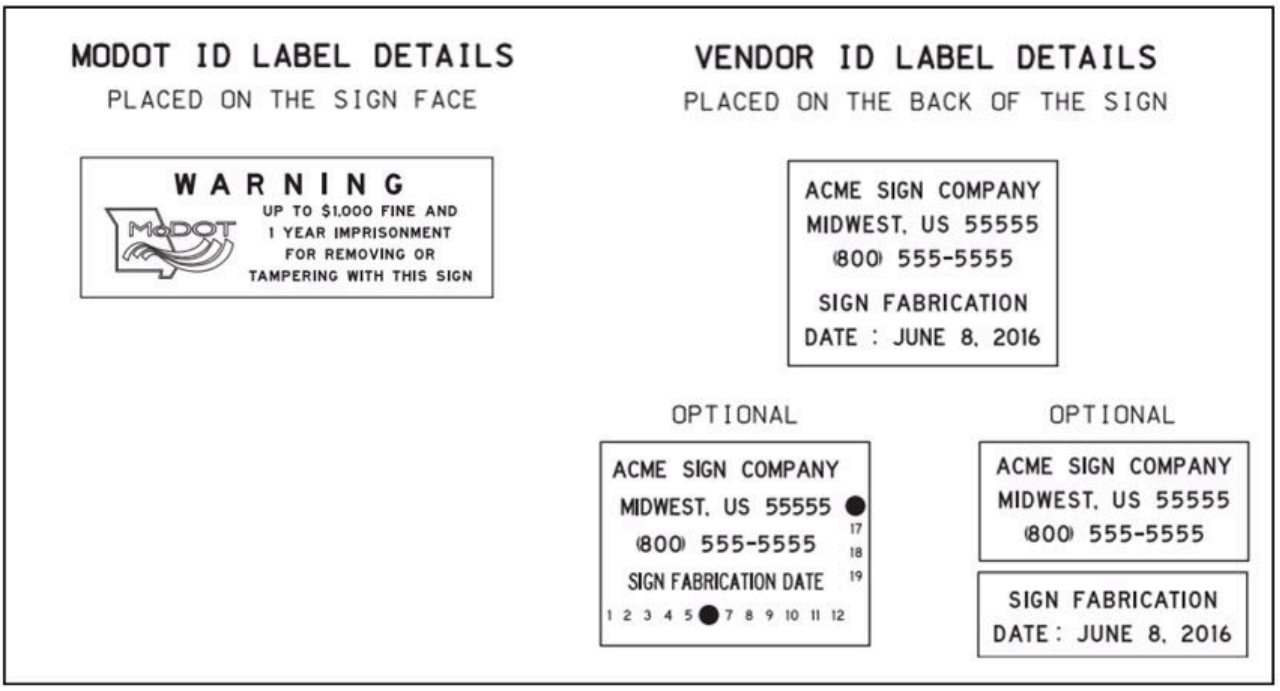


Figure 903.23.1, MoDOT ID and Vendor ID Labels for Signs

903.23.2 Sign and Post Inventory and Storage

Support. MoDOT allocates millions of dollars each year to maintain almost 700,000 signs installed along its highways. To maintain these signs in an efficient and timely manner, appropriate sign and post inventories need to be maintained. Sign inventories need to include Priority 1 and Priority 2 signs and may include other high use signs to make ordering and request fulfilment more efficient.

To maintain the appropriate inventory level of priority and high usage signs, the inventory levels need to be based on the historical usage of each sign by the district, a level which will allow timely repairs to signs in the field, yet not represent a waste of resources with an overabundance of inventory or signs that exceed their shelf-life.

Maintaining appropriate inventory levels for each sign post is also critical for timely sign maintenance. Each post type has different lead times which must be accounted for when determining appropriate inventory levels. Pipe and Wide Flange posts are MoDOT specific designs and must be fabricated when ordered which results in very long lead times for delivery. Other post types tend to be more readily available and in stock with our vendors resulting in a shorter delivery time, such as PSST and U-channel posts.

Guidance. Given the importance of maintaining an inventory of signs and posts and the value of this resource, districts should consider assigning the duties of warehouse management to an individual, or individuals. Typical duties of an individual(s) who manages these inventories can include ordering signs and posts, receiving and inspecting signs from vendors, maintaining the district warehouse inventory of signs and posts and processing sign and post needs from field crews. This may also include delivering these materials to some or all remote locations within a district. Without proper management, inventories can easily grow out of control or be insufficient to meet the needs of the field crews.

Standard. Districts shall determine their maximum inventory levels by using the sign and post usage reports, running each report at the beginning of each fiscal year. The reports will identify the maximum and minimum recommended levels for each sign and post commodity. These reports will calculate the values based on the average usage over the previous 36 months from the date the reports are run. The average of the past 36 months will flatten spikes in any given year which will result in maximum levels being too high or low.

903.23.2.1 Supply Items (Non-Inventory Items)

Support. There are many components used to install and maintain signs, these can be broken down into two categories; inventory items and supplies, see Table 903.23.2.1. Supplies are those items that are not individually inventoried and are generally smaller items purchased in larger quantities. These items will not have commodity codes associated with them as Inventory Items typically do. Guidance for inventory items can be found in subsequent sections of this article.

Table 903.23.2.1

Inventory Items	Supply Items
Wide Flange Post / Stub	Base Bolts / Washers / Nuts / Concrete Anchors
Pipe Post / Stub	Bolt Retainer Plates
PSST Post / Anchor (7 gauge & 12 gauge)	Brass Shims
Channel Post / Stub	Dent Breakaway Bolts
Wood Post	Wide Flange Breakaway Bolts / Washers / Nuts
PSST 2.25" Insert (72" X 2.25")	PSST Post Splice (12" X 1.75" and 2.25" PSST)
PSST Surface Mount Bases (for 2" and 2.5")	Aluminum Backer Bar
PSST Redi-Torque Assembly (for 2.5")	Slip Base Parts (top only, wedge, replacement bolt)
PSST Kleen Break Assemblies (for 2")	Wood Post Clamps
PSST Snap n Safe Couplers (for 2" and 2.5")	Pipe Post Clamps
	Pipe Post Caps
	PSST Bolts / Washers / Nuts
	Nylon Sign Washers
	Ready-Mix Concrete
	Bags of Concrete
	Pole Setting Foam

Guidance. While supplies are not tracked and counted as inventory, these items should still be managed in an efficient manner. Like inventoried items, the quantity of any given supply should be based on the district's average 36-month usage. The maximum inventory level for each supply item should not exceed the average 3-month usage rate and the minimum inventory level should be based on the time it takes to order and receive the supply item.

903.23.2.2 Sign Inventory

Support. Signs have a shelf-life and a warranty; the warranty begins the day the sign is fabricated. All signs have a manufacturer's ID decal on the back of the sign which includes the date of manufacturing that can be used to determine the age of signs in inventory.

The need for inventory of signs is based on the priorities assigned to sign replacement and maintenance and is focused on Priority 1 and Priority 2 signs. These are signs which are critical to the safety of the roadway and need to be readily available to repair or replace damaged or missing signs in a short period of time, see EPG 903.23.6 Emergency Response for lists of priority signs and the required repair time. Priority 1 and Priority 2 sign repairs cannot wait for a sign to be ordered, manufactured and shipped resulting in the need to keep a reasonable number of each type of sign on hand to fulfill these work orders.

Standard. Priority 1 and Priority 2 signs shall be maintained in inventory to facilitate timely repairs. For Priority 2 signs with usage less than 1 per year, a single sign shall be inventoried, or a 7-day accelerated order shall be used to acquire the sign when needed.

Inventory levels for signs shall be based on the district's average 36-month usage report for all sign commodities. The maximum inventory level for each sign commodity shall not exceed the average 3-month usage rate. The minimum inventory should be no less than your average usage in one month.

The maximum inventory levels for signs are maintained at the district warehouse. Local maintenance buildings shall keep small inventories of Priority 1 signs and may keep a small inventory of select Priority 2 signs (see Figures 903.23.2.2.1 through 903.23.2.2.5).

As signs are pulled from MoDOT inventories, the oldest signs shall be used first to ensure the department gets the maximum life from any given sign and to ensure inventory doesn't exceed its shelf-life. The age of the sign is determined by the manufacturing date found on the manufacture's ID on the back of the sign.

Option. Maximum inventory levels of signs may exceed the 3-month usage when signs are ordered to fulfill the needs of specific work orders generated by annual sign log inspections. To avoid an overabundance of signs at a building and to avoid overloading our vendors, orders need to be submitted at a rate that closely matches the crew's ability to install the signs once they are delivered. These temporary inventory levels must be installed for the locations they were ordered for in less than a year.

Guidance. Minimum inventory levels for each sign should be equal to the average 1-month usage rate. This would be the quantity of signs expected to be used during the time it takes the vendor to resupply the inventory with a new order.

Table 903.23.2.2, Sign Priority Levels

Sign Priority	Inventory Levels*		Kept in Stock
	Max	Min	
Priority 1	3 months	1 month	Required
Priority 2	3 months	1 month	Required
Priority 3 high usage	3 months	1 month	Optional
Priority 3 low usage	0	0	Not Recommended
* Inventory levels of each sign number are based on the 36-month average usage for the district			



Figure 903.23.2.2.1

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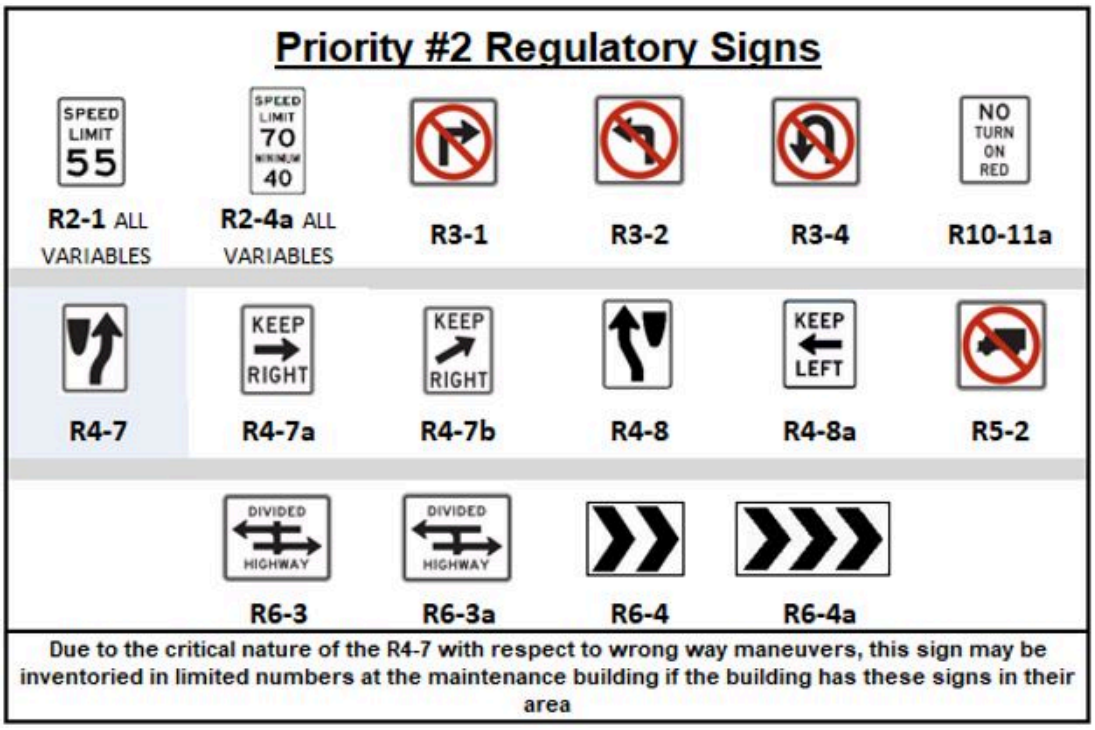


Figure 903.23.2.2.2

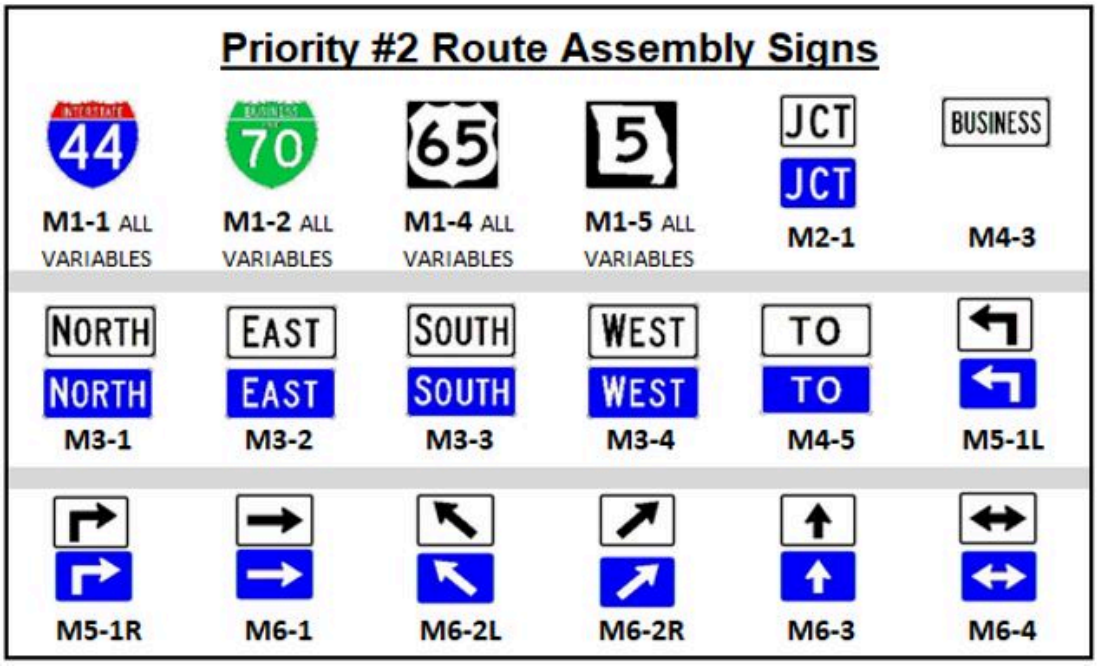


Figure 903.23.2.2.3

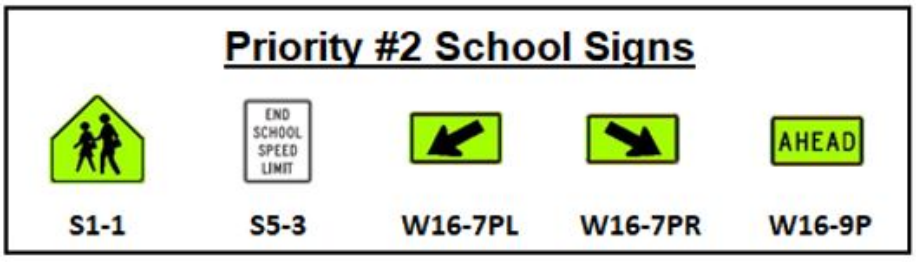


Figure 903.23.2.2.4

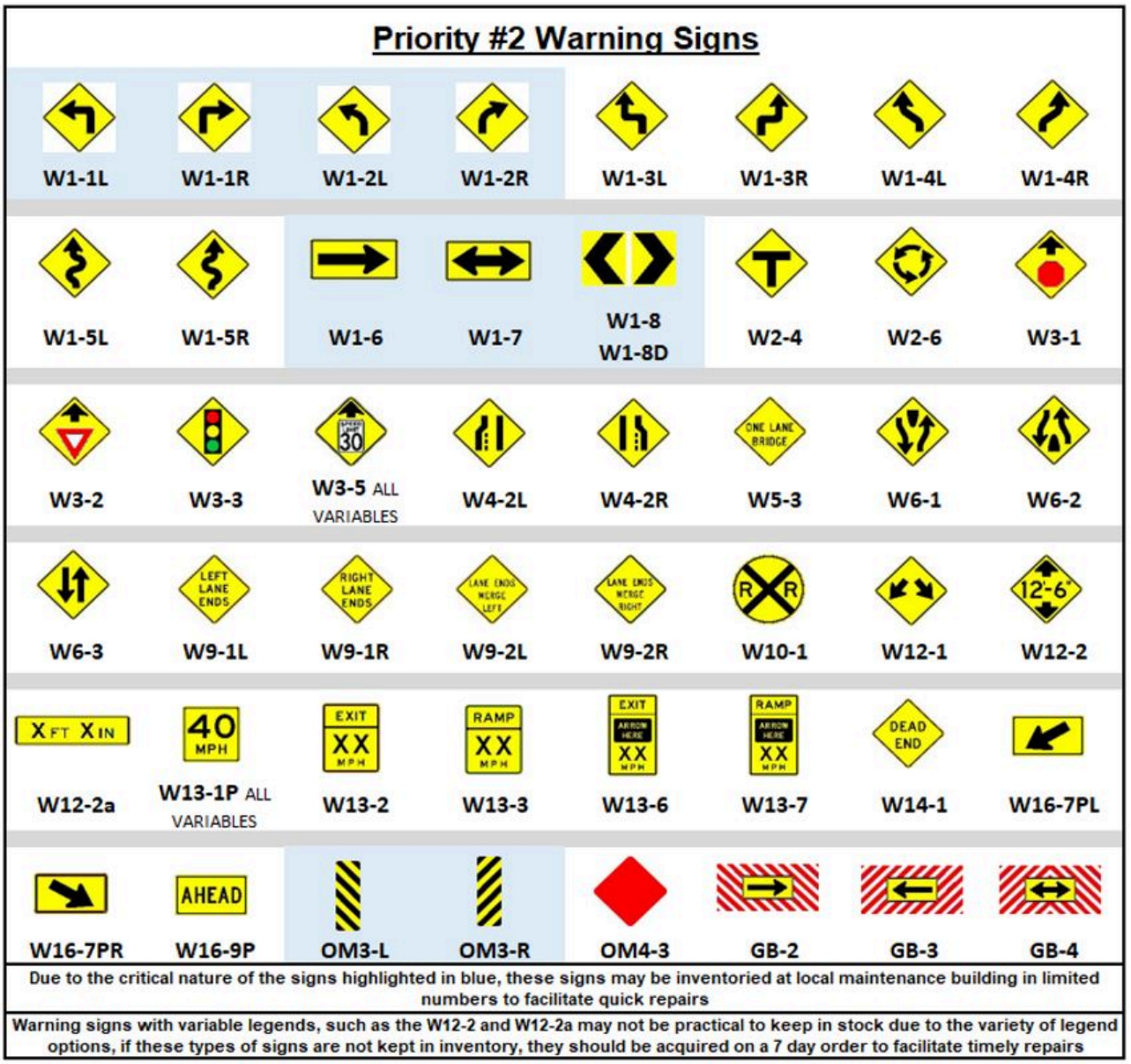


Figure 903.23.2.2.5

903.23.2.3 Sign Storage and Handling

Support. Proper storage and handling of highway signs before and during installation is critical to achieve the maximum sign life and effectiveness. Sign sheeting is easily damaged by impacts, abrasions, weight, heat and moisture before installation. Sign sheeting has a minimum of a 10-year warranty from the date of fabrication, however, this warranty is void if the sheeting is damaged due to improper storage or handling.

Standard. Flat sheet signs shall be stored indoors in a cool and dry environment with the signs being placed in the racks on their edge. If for some reason signs are wet in storage or shipping, they shall be removed from any packaging immediately, separated and placed on their vertical edge so they can air dry.

Support. Extruded panel signs should be stored indoors in a cool and dry location, however, given the size of these signs this is not always possible. If extruded panel must be stored outdoors, they need to be kept dry. Ideally, signs would be removed from their packaging, assembled (in whole or in pieces) and temporarily mounted to posts or an A-frame trailer so water can shed off of the sign face and air dry as if they were installed permanently.

During transport, flat sheet signs should be carried on their vertical edge and both flat sheet and extruded signs (and pieces of signs) should be secured so the sign sheeting side of the signs do not rub on one another or against the vehicles causing damage.

903.23.2.4 Post Inventory

Support. Unlike signs, sign posts do not have a shelf-life. While they can be stored indefinitely without loss of integrity, it is still critical to properly manage inventory levels to ensure the best use of MoDOT resources.

Table 903.23.2.4, Post Inventory Levels

Post Type	Post Size	Inventory Levels		Kept in Stock
		Max	Min*	
Wood	4x4	3 months	0	Optional
	4x6	3 months	0	Optional
U-Channel	3 lb/ft	3 months	2 months	Required
PSST	2x2	3 months	1.5 months	Required
	2.5x2.5	3 months	1.5 months	Required
Pipe***	2.5" ID	6 months	3 months or 2 posts	Recommended**
	3" ID	6 months	3 months or 2 posts	Recommended**
	4" ID	6 months	3 months or 2 posts	Recommended**
Wide Flange***	#1	6 months	3 months or 3 posts	Recommended**
	#2	6 months	3 months or 3 posts	Recommended**
	#3	6 months	3 months or 3 posts	Recommended**
	#4	6 months	3 months or 3 posts	Recommended**
	#5	6 months	3 months or 3 posts	Recommended**
	#6	6 months	3 months or 3 posts	Recommended**
* Minimum inventory levels based on contract delivery period of each post type				
** Given the long lead times for acquiring these types of posts, it is recommended districts keep the minimum levels indicated unless a size is extremely rarely used in a district. If one set of posts are retained as a minimum, the longest length that may be needed should be what is retained.				
*** If a district has inventory greater than the maximum listed, the posts shall be retained, and their availability made known to the rest of the state. They shall not be scrapped unless they no longer meet MoDOT specifications.				

903.23.2.4.1 Wood, U-Channel and PSST Posts

Standard. Inventory levels for these posts shall be based on the district's average 36-month usage report for all post commodities. The maximum inventory level for each U-Channel and PSST post commodity shall not exceed the average 3-month usage rate. Minimum inventory levels for these posts should typically equal the average number of posts used during the length of time it takes to order and receive new posts.

Wood posts shall be purchased on an as needed basis from local sources not only to minimize inventory levels, but to minimize the chances of waste due to the tendency of a wood post to warp and twist over time.

Option. Maximum inventory levels of sign posts may exceed 3-month usage when posts are ordered to fulfill the needs of specific work orders generated by annual sign log inspections. To avoid an overabundance of sign posts at a building and to avoid overloading our vendors, orders need to be submitted at a rate that closely

matches the crew's ability to install signs and posts once they are delivered. These temporary inventory levels must be installed for the locations they were ordered for in less than a year.

903.23.2.4.2 Pipe and Wide Flange (I-Beam) Posts

Support. Pipe and Wide Flange posts are unique in that they are far more expensive to purchase compared to other MoDOT standard posts. These designs are specific to MoDOT so a vendor must fabricate these post types as the orders are received resulting in long lead times for delivery. The usage rates for these posts, especially for certain sizes of posts, are not as regular as other types of posts. As a result, an inventory based on the 36-month average usage may not result in the proper number of posts in inventory.

Each post type comes in a variety of different lengths and each length is individually inventoried. This variety of inventoried lengths was established to provide posts in inventory that would be as close to the length needed to reduce the amount of waste as posts were trimmed to the proper length. This method was established when post usage on all posts was much higher and inventory level management was not as critical.

Standard. Inventory levels for these posts shall be based on the district's average 36-month usage report for all post commodities. The maximum inventory level for each Pipe and Wide Flange post commodity shall not exceed the average 6-month usage rate.

Guidance. Minimum inventory levels for these posts should typically equal the average number of posts used during the length of time it takes to order and receive new posts. However, due to the long delivery lead times for Pipe and Wide Flange posts, the minimum quantity for these posts typically should not be zero unless a size of post is very rarely used in the district. In these cases, a minimum quantity of 2-3 should be kept on hand to repair or install one sign for emergency situations.

For low usage post types, such as structural #6 Wide Flange posts, it is important to have posts on hand for unexpected needs; however, maintaining a minimum inventory of all available sizes is not recommended. For these low usage posts, the longest post length that may be needed in the district is what should be inventoried, and any actual length needed can be cut from this length. While this will likely generate greater waste as more posts may be cut off to size the post for the need, this waste is preferred over excessive numbers of posts of various lengths on inventory.

903.23.2.4.3 Post Storage and Handling

Support. Unlike signs, posts do not have a shelf life and can be stored indefinitely without loss of integrity if stored properly.

Standard. Sign posts shall be stored up off the ground to avoid corrosion that would result from ground contact.

Guidance. If the galvanized coating of the posts is damaged, it should be patched using a zinc-based product to prevent corrosion.

903.23.3 Sign and Post Ordering

Support. Ordering practices have a direct impact on pricing and vendor participation in our contracts. The primary factor is the quantity of materials ordered at one time and more specifically placing small orders for items which are expensive to ship like sign posts and signs. Shipping costs per item for large items tends to

decrease as quantities increase. As an example, the shipping costs for 20 posts on a flatbed truck is the same as it is for a shipment of 200 posts, but if posts are ordered in quantities of 20, the cost of each post is higher as the shipping costs are associated to a smaller number of posts.

903.23.3.1 Sign Ordering

Support. MoDOT began outsourcing the fabrication of signs for maintenance operations and closed its Sign Production Center in 2012. This change also incorporated many modifications to the way MoDOT did business. MoDOT eliminated many department specific sign designs and adopted federal sign standards. The funding for the acquisition of signs was transferred from central office to the districts and the sign ordering practices were structured to better accommodate acquiring signs through a 3rd party vendor.

MoDOT's sign outsourcing contract is set up on a weekly cycle format. Orders are submitted to the vendor on Wednesday of each week with normal delivery time being 21 calendar days starting on the next day (Thursday). There are accelerated delivery timelines for special needs, 7-day and 14-day deliveries, that can be submitted any day of the week. There is also a 36-hour rush order; however, this is only utilized for critical needs and its use must be approved by Highway Safety and Traffic. Pricing for signs in this contract is by square foot and the contract is separated into three categories of flat sheet signs, extruded panel signs and a unique category that contains items such as stop/slow paddles and delineators. The way sign orders are assembled has a dramatic impact on the amount of time it takes to process them once submitted. The following guidance was developed to help stream-line the process and control the overall cost of the signs MoDOT purchases.

Guidance. A district sign warehouse inventory should fill a large portion of sign requests for Priority 1 and Priority 2 signs as well as high usage signs. Requests for signs not kept in inventory should be consolidated and added to a weekly sign order. Replenishment of inventory should also be added to the weekly sign order. Weekly orders should be submitted as a normal 21-day order with 7-day and 14-day accelerated orders being reserved for special cases where a sign (or small number of signs) must be received more quickly. These accelerated orders need to be used sparingly as it places an extra burden on our vendor that can affect their ability to fulfill orders for the rest of the state if overused.

Sign orders are established to match the contract format so like sign types are contained on a given order resulting in one order per week for:

- Flat sheet signs
  - o Adopt-a-Highway (as its own flat sheet order)
- Structural signs
- Unique signs.

If the number of sign requests per sign order exceeds the maximum limit of 99 lines, more than one weekly sign order shall be submitted for that sign type.

Individual sign requests for like sign numbers and sizes should be pulled from stock, and a consolidated sign request should be submitted to replenish stock. This minimizes the time it takes for Highway Safety and Traffic Division to review and process sign orders, but more importantly, makes it more efficient for our vendor to determine what signs need to be fabricated for the state each week.

The weekly sign ordering process takes place as follows:

- Thursday through Tuesday – District warehouses receive and process sign requests from the field, filling requests from stock when possible and adding others to the list of signs to add to the weekly vendor order in the Sign Management System (SMS).

- Tuesday – All vendor orders for the week need to be submitted Tuesday afternoon and no later than 5:00 pm so they will interface with SAM II for the creation of purchase orders that night. The vendor orders may be submitted earlier if employees are out of the office on Tuesday, but this will count toward the districts one purchase order per sign type for the week.
- Wednesday – All purchase orders should be submitted to Central Office Highway Safety and Traffic Division by 10 am.
- Expedited purchase orders – 36-hour rush, 7 day, and 14-day orders may be sent to Central Office Highway Safety and Traffic Division any weekday. A district should give additional notice by phone or email of these orders, preferably in advance when the sign is first requested.
- Receiving Signs – The district has five (5) business days after receipt of order (ARO) to notify the contractor of any visible damage or specification compliance issues. After the five (5) working days the contractor will still be responsible for correcting any issues relating to specifications, quantity and quality, but liquidated damages will no longer be applicable. The contractor will not be responsible to correct any damages not identified within the first five (5) business after receipt of the signs. The contractor shall replace any sign(s) that fails inspection within the original delivery timeframe. The contractor shall understand and agree any replacement sign(s) that is shipped beyond the original delivery timeframe shall be subject to liquidated damages.
- Liquidated Damages – While it is not MoDOT's intent to negatively impact our vendors by imposing liquidated damages, this contractual condition does ensure MoDOT's orders receive priority.
- Shipping Locations – To keep sign costs as low as possible, the MoDOT shipping locations have been limited to the sign warehouses in NW, NE, KC, CD and SL only. Due to the geographical size of SW and SE districts, each has a secondary delivery location at their regional offices in Joplin and Willow Springs. While it would be more efficient for MoDOT to have signs shipped directly to each maintenance building, the shipping costs would be so extreme it would drive the cost of signs beyond acceptable limits.

903.23.3.2 Post Ordering

Guidance. Post orders should incorporate quantities to replenish inventories at the district warehouse location as well as any additional needs at the various maintenance buildings to make these orders as cost effective as possible.

Standard. Due to the higher cost, long lead times for acquisition and sometimes erratic usage of Pipe and Wide Flange posts, districts shall first determine if the posts they need are available in any other district before ordering. At the time this guidance was drafted, there was excess inventory in the state for Pipe and Wide Flange posts which needed to be utilized.

Option. Once the state-wide inventory levels of Pipe and Wide Flange posts are normalized and the excess inventory is used, the practice of looking at state-wide inventories of Pipe and Wide Flange posts may be used to fulfill the need for these posts if the posts are needed more quickly than the vendor can supply them.

903.23.4 Sign and Post Disposal

Support. Signs and Posts are state property and as such when no longer needed due to being obsolete, damaged or reaching the end of their service life need to be disposed of through the competitive bid process like any other MoDOT property.

903.23.4.1 Sign Disposal

History. During the operations of MoDOT's Sign Production Center (SPC), old signs were shipped to the Moberly Correctional Center where they were sorted and stored until the SPC submitted a request. Once the request was received, the prison would clean and straighten the appropriate sign blanks from the reclaimed inventory and ship to the SPC for production. At the peak, 75% of the sign the SPC produced were on these

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reclaimed sign blanks. When sign production was first outsourced, the use of reclaimed sign blanks was investigated; however, the shipping cost to the prison and then to the vendor was cost prohibitive, making the use of reclaimed sign blanks more expensive than the use of new aluminum. As a result, old signs are now sold for scrap at the end of their service life.

Support. All signs, including those that have reached the end of their service life or signs in warehouses which have become obsolete, are state property and must be disposed of as scrap. MoDOT's policy does not permit the transfer ownership of its signs, other than selling signs as scrap, to other entities. This makes prosecution for sign theft easy as anyone who is in the possession of one of these signs could not have legally acquired it.

Standard. When signs are removed from the field or warehouse inventory, they shall be collected and sold as scrap following General Services policies for the disposal of state materials. The disposal of signs that are traffic control devices, whose use is regulated by state and federal law, includes an additional step. Any traffic control devices which are taken out of service and scrapped (signs, signal heads, changeable message signs, etc.) must be sold using the GS-23 Bill of Sale of Traffic Control Devices. The GS-23 contains a legal statement the purchaser of these materials is prohibited from reselling them in the form of traffic control devices, and reads:

> *(3) TRAFFIC CONTROL DEVICES TO BE USED AS SCRAP ONLY: The Buyer shall use traffic control devices purchased under this Bill of Sale for purposes other than traffic control unless the buyer is a political subdivision of the State of Missouri or authorized contractor. These materials shall not be sold or distributed in their current forms as traffic control devices. In the event the Buyer chooses to sell said traffic control devices, the Buyer shall, prior to any sale, permanently deface or otherwise disable the traffic control devices to impede their use in current form as traffic control devices. Buyer also acknowledges that the Manual on Uniform Traffic Control Devices, 23 CFR 655, 23 USC 109(d) and 23 USC 402(a) apply to the use of traffic control devices and do not allow the presentation of advertising messages or other messages unrelated to traffic control on a traffic control device. Buyer also acknowledges that Buyer has read and understands Missouri Statute 304.321, attached.*

When sign inventory levels are managed correctly, there is typically no need to dispose of new/unused signs unless they are damaged. However, if guidance from Highway Safety and Traffic Division is given to purge certain signs from inventory before use, these signs shall be disposed of in the same manner as used signs.

903.23.4.2 Post Disposal

Support. Unlike signs, posts do not have a shelf-life so they can be stored indefinitely until needed.

Standard. The only time unused sign posts, stubs, hardware, etc. shall be sold as scrap is if those materials have been identified as no longer meeting state specifications. These materials shall remain in inventory until the district, or another district, is able to utilize them. Used and damaged sign posts, stubs and hardware shall be disposed of as scrap following standard GS procedures.

903.23.5 Sign Inspection

Support. Sign inspection is critical to the maintenance of MoDOT's highway signs. The process assures we identify deficient signs, establishes the sign maintenance program for the year and is the department's means to complying with federal sign maintenance standards.

Night time visual sign inspections are used to evaluate MoDOT's signs as sign visibility is the most critical and difficult to achieve during dark conditions. Signs become more critical at night as other visual cues a driver needs are going to fade away in the dark (trees, ditches, etc.). Night time crashes are also typically higher compared to daytime crashes making highly visible signs a key tool to help reduce crashes.

Inspectors need to view the signs during the inspection from the perspective of the motorist, from the driver seat, traveling in the lane and looking at the signs from the distances a driver needs to see the sign from to make appropriate decisions. In addition to the guidance which follows, the Sign Log Inspection Guidance Training PowerPoint walks an inspector through the process and provides photographic examples of what to look for during an inspection.

Training Document
Sign Log Inspection Guidance (http://sp/sites/ts/signing/RefTool/_layouts/15/WopiFrame.aspx?sourcedoc={B0E5C787-0CE8-467D-8B2C-990298C50B2C}&file=Sign%20Log%20Inspection%20Guidance.pptx&action=default)

Standard. All MoDOT signs shall be inspected every other year based on the county they are located in. Figure 903.23.5.1, and Table 903.23.5 for the county inspection schedule, indicates which counties shall be inspected in the even and odd year cycles.

Options. There are sign deficiencies which can be easily identified during normal day time operations outside the annual night time inspection period. Typical deficiencies that are easy to identify during the day can include:

- Vegetation growing in front of signs
- Signs which are leaning and out of plumb or twisted away from traffic
- Signs mounted on the incorrect post or have the incorrect number of posts
- Missing breakaway devices or the breakaway device is incorrectly assembled
  - o These are deficiencies which cannot be identified at night but can represent serious safety issues for the public.
- Sign faces which have faded colors, pealing sign legend or sign sheeting
- Signs which have been physically damaged by impacts, gun shots, etc.

Correcting deficiencies such as these outside the annual night time inspection will result in fewer deficiencies identified during the inspection and will result in the inspection taking less time to complete.

Table 903.23.5, Sign Inspection Schedule by District

Annual Night Sign Inspection Schedule

	Inspection ending March 31 of Even Years	Inspection ending March 31 of Odd Years
NW	Andrew	Caldwell
	Atchison	Carroll
	Buchanan	Chariton
	Clinton	Daviess
	Dekalb	Grundy
	Gentry	Harrison
	Holt	Linn
	Nodaway	Livingson
	Worth	Mercer
		Putnam
		Sullivan

	Inspection ending March 31 of Even Years	Inspection ending March 31 of Odd Years
CD	Boone	Camden
	Callaway	Crawford
	Cole	Dent
	Cooper	Laclede
	Gasconade	Maries
	Howard	Miller
	Moniteau	Phelps
	Morgan	Pulaski
	Osage	Washington

	Inspection ending March 31 of Even Years	Inspection ending March 31 of Odd Years
NE	Adair	Audrain
	Clark	Macon
	Knox	Marion
	Lewis	Monroe
	Lincoln	Pike
	Montgomery	Ralls
	Scotland	Randolph
	Schuyler	Shelby
	Warren	

	Inspection ending March 31 of Even Years	Inspection ending March 31 of Odd Years
SW	Barton	Barry
	Bates	Benton
	Cedar	Christian
	Dade	Dallas
	Henry	Greene
	Jasper	Hickory
	Lawrence	Polk
	Mcdonald	Stone
	Newton	Taney
	St. Clair	Webster
	Vernon	

	Inspection ending March 31 of Even Years	Inspection ending March 31 of Odd Years
KC	Clay	Jackson
	Cass	Lafayette
	Johnson	Ray
	Pettis	Saline
	Platte	

	Inspection ending March 31 of Even Years	Inspection ending March 31 of Odd Years
SL	Franklin	Jefferson
	St. Louis	St. Charles
	St. Louis City	

	Inspection ending March 31 of Even Years	Inspection ending March 31 of Odd Years
SE	Bollinger	Butler
	Cape Girardeau	Carter
	Howell	Douglas
	Iron	Dunklin
	Oregon	Madison
	Ozark	Mississippi
	Pemiscot	New Madrid
	Reynolds	Perry
	Scott	Ripley
	Shannon	St. Francois
	Stoddard	Ste. Genevieve
	Wayne	Texas
		Wright

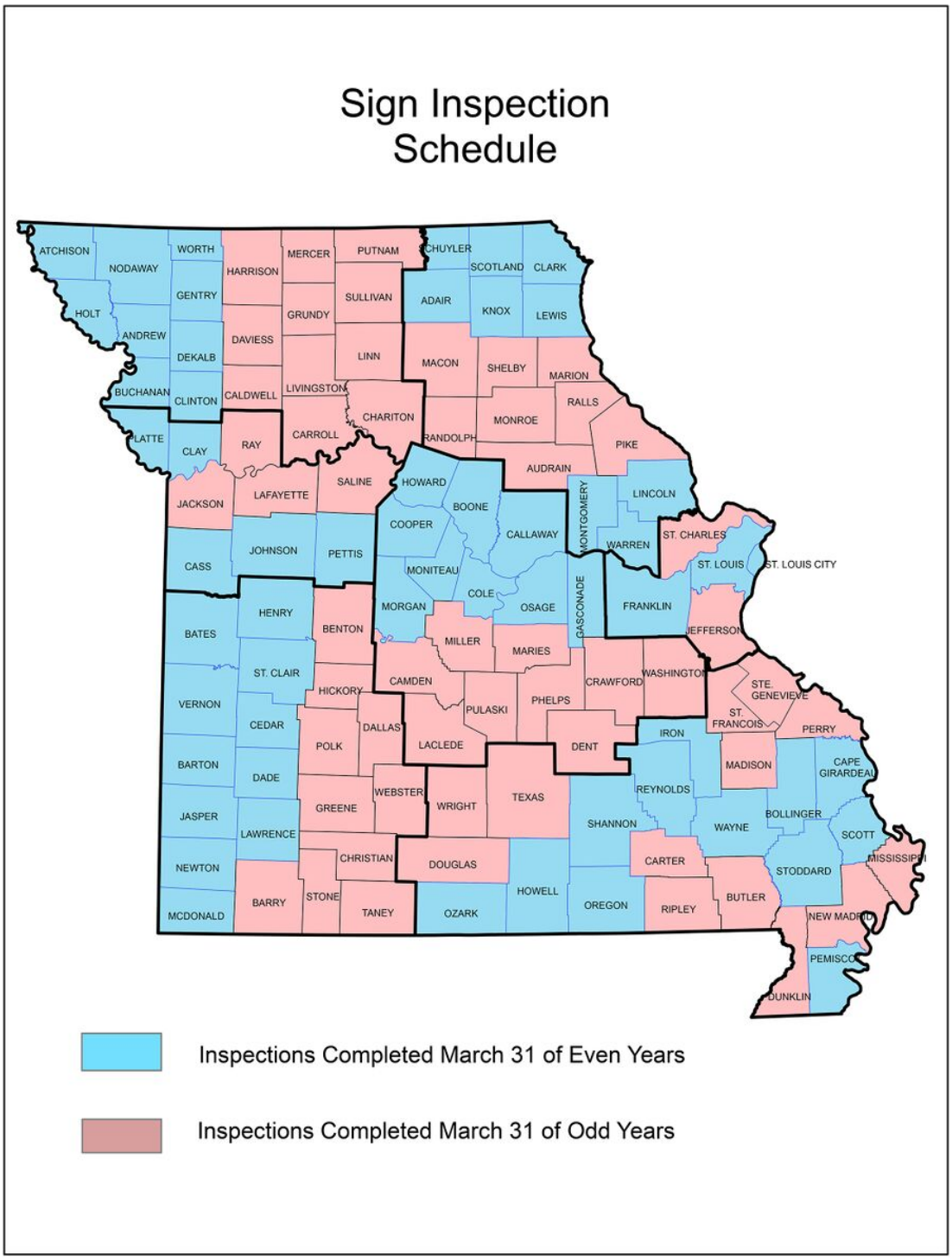


Figure 903.23.5.1, Sign Inspection Schedule Map

Standard. Annual night sign log inspections shall follow these basic criteria:

- Signs shall be inspected 1 hour after sunset and at least 1 hour prior to sunrise to ensure complete darkness
- Signs shall be inspected with low beam headlights
- Keep interior lights off so eyes are acclimated to darkness (dim lights are OK to illuminate computer keyboard)
- Once frost and/or dew begin to settle on the signs (thus affecting retroreflectivity), discontinue inspections
- Signs on side streets shall be inspected by driving the side street approaching the sign

- The sign legend and background colors should be recognizable both day and night (for example, a guide sign's white legend should be clearly visible and the background should be recognizable as green). If not, replace the sign.
- If inspection takes place after leaves have dropped and tree limbs fall within the view of the sign, but do not obscure sign: trim limbs to account for the time when leaves will regrow
- Inspection vehicles should be typical cars, SUVs or pickups, 2002 or newer
- Two-person inspection crews for safety
- Inspection conducted from travel lane (not shoulder) and conducted at normal travel speed
- Headlights should be cleaned before inspection begins. Clouded or hazed lenses should be polished
- Headlights should be checked to ensure they are properly aimed.

Signs shall be visible from the following distances:

- Flat Sheet Signs must be visible from approximately 300 ft to provide drivers enough time to see and react to the sign. Any deficiencies which prohibit a sign from being seen at this minimum distance shall be identified in the inspection and corrected.

- Structural Signs (Extruded Panel Substrate) must be visible and legible from a minimum of approximately 300 ft. on two-lane roadways and 600 ft. on multilane highways (based on 30 ft. visibility for every 1 in. of legend height, per EPG 903.1.8).

Issues that can affect sign visibility and shall be corrected are, but are not limited to:

- Sign sheeting which has fallen below acceptable performance levels
- Vegetation or other obstructions blocking the view of the sign
- Sign installation location, requiring sign to be moved to a better more visible location
- Damage to the sign face, such as gun shots, paint ball or other vandalism activities

Sign posts shall be within acceptable tolerances of being vertically plumb (see Figure 903.23.5.2, below) and must hold the sign perpendicular to the travel way unless the sign type and installation intentionally requires the sign to be parallel to the roadway. Sign posts out of plumb and not supporting the sign in the proper orientation to the roadway shall be repaired or replaced as necessary.

Signs shall be inspected to assure they are at the proper mounting height above the roadway and above the ground. Any deficiencies shall be corrected as mounting heights affect not only visibility of the sign, but also the breakaway characteristics / safety of the sign (see EPG 903.1.13 for details):

- Non-Wide Flange sign installations shall have a mounting height of 5 ft. above the roadway on two-lane roadways and 7 ft. above the roadway inside city limits or on freeways or expressways (does not include object markers, chevrons, supplemental plaques or any other special sign mounting criteria).
  - o The length of any post of a non-Wide Flange sign installation shall be a minimum of 5 ft measured from the ground to the bottom of the sign

- Wide Flange sign installations shall have a mounting height of 7 ft 6 in above the roadway.
  - o The length of the shortest post of an Wide Flange sign installation shall be a minimum of 7 ft 9 in measured from the breakaway to the hinge point for breakaway performance.
  - o Post spacing for #3 through #6 Wide Flange posts shall be spaced a minimum of 7 ft apart from one another in order to meet federal breakaway standards.

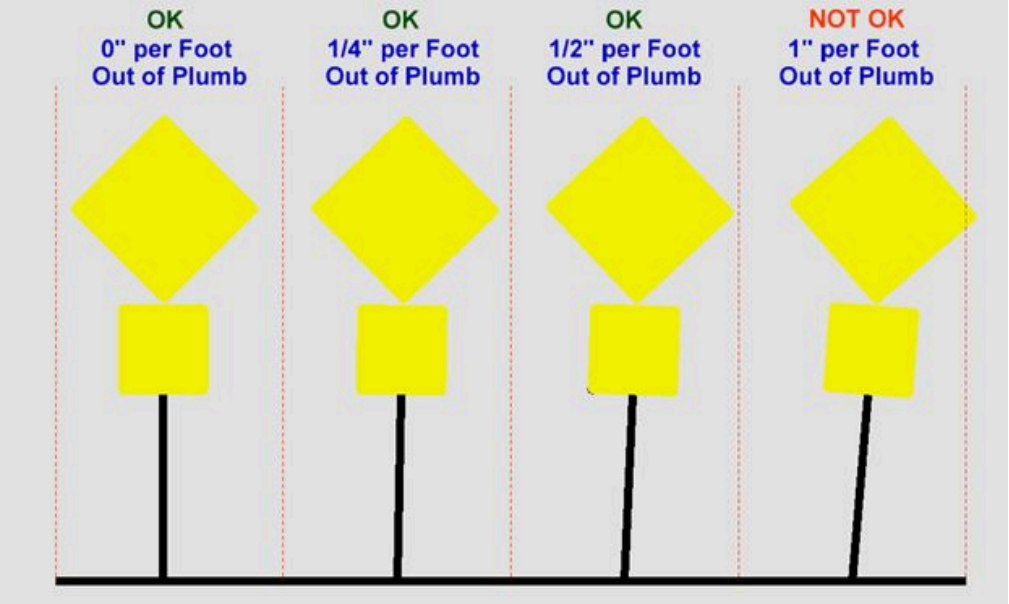


Figure 903.23.5.2, Sign Post Plumb Tolerances

Deficiencies in the number or spacing of posts shall also be identified and corrected. The number and spacing of posts are based on the guidance found in the post selection tools in EPG 903.16.4. Having the proper number, size and spacing of posts not only assures a long-lasting sign assembly, but incorrect installations can dramatically affect the breakaway characteristics of the sign assembly.

903.23.6 Emergency Response

Support. Risk Management has established guidelines concerning the response to replacing signs that have been knocked down or otherwise lost, see Table 903.23.6 for the response plan as it pertains to highway signing.

Guidance. MoDOT's Incident Response Plan should be consulted for further details.

Support. Priority ranking are defined as follows:

Priority 1 – Urgent, respond as soon as possible (day or night, weekends or holidays) suspending other lower priority work if necessary. May represent immediate hazard to the public.
Priority 2 – Repair should be accomplished as soon as practical during normal working hours, but only after Priority 1 repairs are completed.
Priority 3 – Repair should be accomplished with higher urgency than routine maintenance.
Routine – Not urgent, normally considered routine maintenance.

Table 903.23.6, Incident Response Signing Plan

Signs	Priority			
	1	2	3	Routine
Barricades (permanent)	-	X	-	-
Delineators	-	-	-	X
Guide[1]	-	-	X	-
Information[1]	-	-	X	-
Route Assemblies	-	See Figure 903.23.2.2.3	-	-
Regulatory[1]	Stop, Yield, Do Not Enter, Wrong Way, One Way	See Figure 903.23.2.2.1 & Figure 903.23.2.2.2	Signs not on the priority 1 or 2 list	-
Warning[1]	-	See Figure 903.23.2.2.5	Signs not on the priority 1 or 2 list	-
School[1]	-	See Figure 903.23.2.2.4	Signs not on the priority 1 or 2 list	-
Visibility (weeds, trees, etc.)	For Priority 1 Signs	For Priority 2 signs	-	For Priority 3 signs
Sign Truss Structure Damage	Creating a Traffic Hazard	-	Not A Traffic Hazard	-
Lane Closure Notification/ Approval Required[2]	No	No	Yes	Yes
[1] Damage that makes the sign ineffective.				
[2] NHS routes and all other routes with AADT of 1,700 or greater.				

903.23.7 Guidelines for the use of the Sign Management System (SMS)

History. MoDOT has a long history of maintaining an inventory of signs located along its roadways and inspecting signs utilizing this database. MoDOT's original database was housed on a mainframe computer and sign logs were done on paper. The first computer-based system was implemented in the early 2000s and was utilized until 2012 when it was replaced with Sign Management System (SMS), our current system. SMS was developed as a cradle-to-grave sign management system to manage field inventories, but also to manage sign ordering, work orders and warehouse management. MoDOT Management System (MMS) is expected, at later phases of development, to incorporate and possibly replace portions of SMS.

Support. SMS has six major components. Details on each component and their specific use can be found in a wiki link and user manuals located on the SMS home page. While the sign catalog is accessible by any MoDOT employee, all other components require a STARTS request to gain access. The STARTS request is granted based on the level of access needed for the user's role in signing and is approved by Highway Safety and Traffic. The following are the six major components of SMS:

- Sign catalog
- Sign ordering
- Field inventory
- Sign inspection

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- Work orders
- Warehouse management

Sign Catalog is the heart of the SMS. It contains the signs and sizes of signs from the MUTCD, and any MoDOT-specific signs used on MoDOT roadways. The information in the catalog is used to populate the sign field inventory for each sign assembly record. The data in the catalog is also used by the sign ordering system to populate the critical fields needed to generate a purchase order.

Sign Ordering must be used to acquire signs for maintenance operations. This system is made up of a requisition component where sign requests are generated by field crews. These requisitions are sent to the district's parent sign warehouse where it is either filled from the warehouse inventory, or the request is added to a vendor order. The vendor order component compiles sign requests and then interfaces with the state Financial Management System (FMS) to generate a purchase order. This component is required to be used in order to acquire signs from MoDOT's sign manufacturer.

Field Inventory is the component of SMS which contains records for locations of all signs located on MoDOT right of way, including signs MoDOT does not maintain. This component of SMS must be used to inventory all signs on MoDOT right of way. These records are in terms of "sign assemblies" or a record of a sign support and all of the signs that are mounted on that support. Sign supports can be one of MoDOT's typical ground-mounted sign posts or the variety of overhead sign mounting structures. Details for each sign assembly can be recorded in this system, including, but not limited to the number of posts, type of post, type of overhead sign structure, sign location (left, overhead, right) and mounting height. The history of each assembly and each sign on each assembly can also be recorded in this system, including but not limited to sign installation date, repair date and inspection date. The only piece of data which is automatically recorded for an assembly record is the inspection history from the inspection component of the system. As with any database, the quality and accuracy of the data available is directly related to the accuracy and management of the data entered into the system. There are many fields for data available for each assembly record, some fields are required and others are optional.

At a minimum an assembly record must include:

- District
- County
- Travelway ID
- Maintained by and Org Code
- GPS sign location (recorded from the travel lane)
- Sign number/code
- Support type (post or structure)
- Post / Structure Type
- Orientation of sign to the roadway.

Optional fields, but recommended as bests practices include:

- Sign legend, for variable message signs
- Number of posts
- Post type and size
- Post offset from the roadway
- Footing type
- Breakaway.

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Sign Inspection must be conducted utilizing the sign inspection tool of SMS. This component is referenced as the "client tool" as it is one of the few components of SMS that is not web-based. The inspection tool is a software component of SMS loaded on individual laptops allowing field inventory data and TMS data to be loaded on the machine. Once on the laptop, the system can be operated independent of a network connection to inspect and update field inventories. Once an inspection is completed and/or inventory is updated, the data must be uploaded back to the web-based system to update the primary database. Work Orders are used in SMS to process the work generated by sign inspections. Work orders are auto-generated when a deficiency is identified during an inspection. Once generated, a work order must be approved and assigned to the appropriate crew. Once the work is completed, the work order must be closed. The identification of the deficiencies and the completion of the work order create the history of the correction in each record. The work order system can be used for any sign work conducted outside of inspections, but it is not a required use for this application.

Warehouse Management is a component of SMS whose use is optional. This system was created as a user interface for FMS to offer more options in viewing and managing sign inventories. The system was designed to permit warehouse managers to establish minimum inventory levels / order points as well as maximum inventory levels. To help promote the use of excess inventory statewide, the system was designed to show the inventory for any sign with an inventory greater than the maximum set by the manager as "excess" so other districts could see availability. The tool is also designed to give managers the ability to reserve part of their inventory for special projects so these would not appear as excess.

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Category:908 Traffic Controls for School Areas (MUTCD Part 7)

Support. Category 908 of the EPG contains information related to traffic controls for school areas and is similar to Part 7 of the MUTCD.

See EPG 900.1 for a description of how MUTCD content is incorporated into the EPG.



Articles in "908 Traffic Controls for School Areas (MUTCD Part 7)"

The following 4 pages are in this category, out of 4 total.

9

- 908.1 General (MUTCD Chapter 7A)
- 908.2 Signs (MUTCD Chapter 7B)
- 908.3 Markings (MUTCD Chapter 7C)
- 908.4 Crossing Supervision (MUTCD Chapter 7D)

Media in category "908 Traffic Controls for School Areas (MUTCD Part 7)"

This category contains only the following file.



908 School Areas.jpg
250 × 375; 19 KB

Retrieved from "https://epgtest.modot.org/index.php?title=Category:908_Traffic_Controls_for_School_Areas_(MUTCD_Part_7)&oldid=61132"

This page was last edited on 29 November 2025, at 07:05.

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908.1 General (MUTCD Chapter 7A)

908.1.1 Introduction (MUTCD Section 7A.01)

Support. EPG 908 sets forth basic principles and prescribes standards for the design, application, installation, and maintenance of all traffic control devices (including signs, signals, and markings) and other controls (including adult crossing guards) for the special pedestrian conditions in school areas.

908.1.2 School Route Plans and School Crossings (MUTCD Section 7A.02)

Guidance. A school route plan for each school serving elementary to high school students should be prepared in order to develop uniformity in the use of school area traffic controls and to serve as the basis for a school traffic control plan for each school.

The school route plan, developed in a systematic manner by the school, law enforcement, and traffic officials responsible for school pedestrian safety, should consist of a map (see Figure 908.1.2) showing streets, the school, existing traffic controls, established school walk routes, and established school crossings.

MoDOT is not responsible for preparing school route plans. MoDOT district staff should be consulted when developing school route plans that include installation of traffic control devices on state-maintained roadways.

Bicycle use as a mode of transportation, as applicable, should also be considered if students biking to and from school are not allowed to use the sidewalks along the pedestrian route.

The type(s) of school area traffic control devices used, either warning or regulatory, should be related to the volume and speed of vehicular traffic, street width, and the number and age of the students using the crossing.

School area traffic control devices should be included in a school traffic control plan.

Standard. No school area traffic control devices shall be installed on state-maintained roadways without the necessary agreements and approvals from MoDOT district staff.

Support. To establish a safer route to and from school for schoolchildren, the application of planning criterion for school walk routes might make it necessary for children to walk an indirect route to an established school crossing located where there is existing traffic control and to avoid the use of a direct crossing where there is no existing traffic control.

The frequency of gaps in the traffic stream that are sufficient for student crossing is different at each crossing location. When the delay between the occurrences of adequate gaps becomes excessive, students might become impatient and endanger themselves by attempting to cross the street during an inadequate gap. In these instances, the creation of sufficient gaps needs to be considered to accommodate the crossing demand.

Guidance. School walk routes should be planned to take advantage of existing traffic controls.

The following factors should be considered when determining the feasibility of requiring children to walk a longer distance to a crossing with existing traffic control:

A. The availability of adequate sidewalks or other pedestrian walkways to and from the location with existing control,

B. The number of students using the crossing,

C. The age levels of the students using the crossing, and

D. The total extra walking distance.

Support. A School Crossing signal warrant is provided in EPG 902.3.6.



Figure 908.1.2 Example of a School Route Plan Map

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908.2 Signs (MUTCD Chapter 7B)

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908.2.1 Design of School Signs (MUTCD Section 7B.01)

Standard. Except as provided in EPG 903.1.7, the sizes of signs and plaques to be used in school areas shall be as shown in Table 908.2.1.

Signs and plaques larger than those shown in Table 908.2.1 shall only be used if approved by the MoDOT Highway Safety and Traffic Division (see EPG 903.1.7).

School warning signs, including the "SCHOOL" portion of the School Speed Limit (S5-1) sign and including any supplemental plaques used in association with these warning signs, shall have a fluorescent yellow-green background with a black legend and border unless otherwise provided in the EPG for a specific sign.

The signs used for school area traffic control shall be retroreflective.

Support. EPG 903.1.13 and EPG 903.1.14 contain provisions regarding the installation, placement, and location of signs.

EPG 903.1.15 contains provisions regarding the mounting heights of signs.

EPG 903.1.16 contains provisions regarding the lateral offsets of signs.

The FHWA "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)) contains information regarding sign lettering.

Option. In-roadway signs for school traffic control areas may be used consistent with the requirements of EPG 903.2.19 and EPG 908.2.3.

Table 908.2.1, School Area Sign and Plaque Sizes

Sign or Plaque	Sign Designation	EPG Article	Conventional Road		
			Standard	Oversized	Special
School	S1-1	908.2.2	36 x 36	-	-
School Bus Stop Ahead	S3-1	908.2.4	36 x 36	-	-
School	S4-3P	908.2.2	36 x 12	-	-
School Speed Limit XX When Flashing	S5-1	908.2.5	36 x 72	-	-
End School Zone	S5-2	908.2.2	24 x 30	-	-
End School Speed Limit	S5-3	908.2.5	24 x 30	-	-
Yield Here for School Crossing	R1-5a	908.2.3	36 x 36	-	-
In-Street School Crossing	R1-6b	908.2.3	12 x 36	-	-
Directional Arrow	W16-5P	908.2.2, 908.2.3	21 x 15	-	-
Advance Turn Arrow	W16-6P	908.2.2, 908.2.3	21 x 15	-	-
Downward Diagonal Arrow	W16-7P	908.2.2, 908.2.3	21 x 15	-	-
Ahead	W16-9P	908.2.2, 908.2.3	24 x 12	-	-

Note:

1. Dimensions are shown in inches and are shown as width x height

908.2.2 School Area Signs and Plaques (MUTCD Section 7B.02)



S1-1



S4-3P



W16-5P



W16-6P



W16-7P



W16-9P



S5-2

Support. Many state and local jurisdictions find it beneficial to advise road users that they are approaching a school that is adjacent to a highway, where additional care is needed, even though no school crossing is involved and the speed limit remains unchanged. Additionally, some jurisdictions designate school zones that have a unique legal standing in that fines for speeding or other traffic violations within designated school zones are increased or special enforcement techniques such as photo radar systems are used (see EPG 950). It is important and sometimes legally necessary to mark the beginning and end points of these designated school zones so that the road user is given proper notice.

The School (S1-1) sign has the following four applications:

A. School Area – the S1-1 sign can be used to warn road users that they are approaching school buildings or grounds immediately adjacent to the highway.

B. School Zone – the S1-1 sign can be used to identify the location of the beginning of a designated school zone.

C. School Advance Crossing – if combined with an AHEAD (W16-9P) plaque to comprise the School Advance Crossing assembly, the S1-1 sign can be used to warn road users that they are approaching a crossing where schoolchildren cross the roadway (see EPG 908.2.3). MoDOT does not use the XX FEET plaque for School Advance Crossing assemblies.

D. School Crossing – if combined with a diagonal downward-pointing arrow (W16-7P) plaque to comprise the School Crossing assembly, the S1-1 sign can be used to warn approaching road users of the location of a crossing where schoolchildren cross the roadway (see EPG 908.2.3).

Option. If a school area or school zone is located on a cross street in close proximity to the intersection, a School (S1-1) sign with a supplemental arrow (W16-5P or W16-6P) plaque may be installed on each approach of the street or highway to warn road users making a turn onto the cross street that they will encounter a school area soon after making the turn.

Standard. If a school zone has been designated under State or local statute, a School (S1-1) sign shall be installed to identify the beginning point(s) of the designated school zone (see Figure 908.2.2).

Option. If a school zone is not established by a State or local statute, school zone signing may be installed adjacent to the school's property lines or as determined by engineering judgement.

A School Zone (S1-1) sign may be supplemented with a SCHOOL (S4-3P) plaque.

Standard. The downstream end of a designated school zone shall be identified with an END SCHOOL ZONE (S5-2) sign (see Figure 908.2.2).

Option. A Warning Beacon (see EPG 902.18.3) may be installed above a School (S1-1) sign for supplemental emphasis at a school zone.

Standard. Prior to the installation of a Warning Beacon, a TR08 Roadside Flashers for School Operations contract shall be executed.

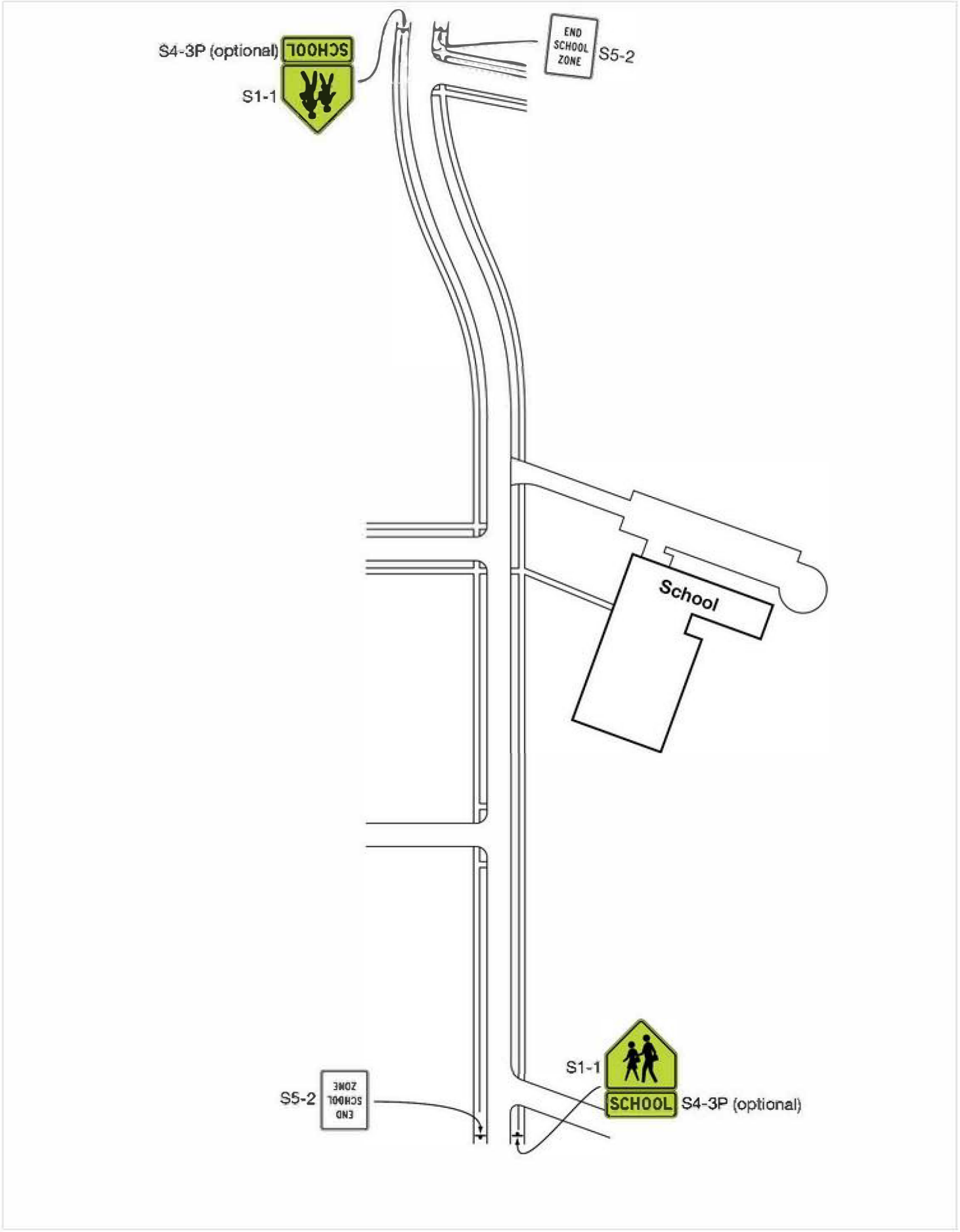
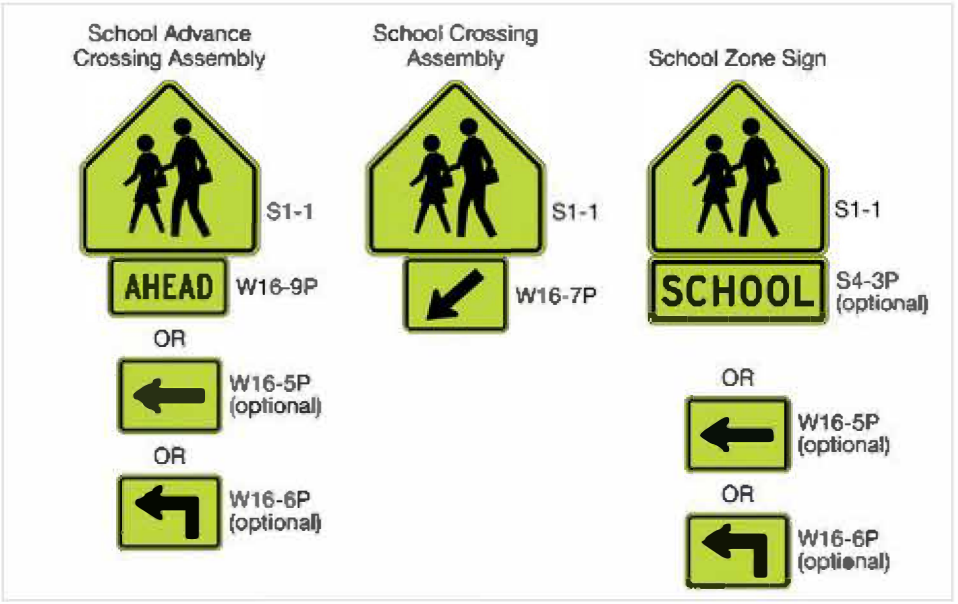


Figure 908.2.2 Example of Signing for a School Zone

908.2.3 School Crossing Signs (MUTCD Section 7B.03)



School area signs



R1-5a



R1-6b

Standard. The School Advance Crossing assembly shall consist of a School (S1-1) sign supplemented with an AHEAD (W16-9P) plaque.

Except as provided in the first Option paragraph below, a School Advance Crossing assembly shall be used in advance (see Table 903.3.4 for advance placement guidelines) of the first School Crossing assembly that is encountered in each direction as traffic approaches a school crosswalk).

Prior to the installation of an Advanced School Crossing sign(s), a TR10 or TR11 School Crossing contract shall be executed.

Option. The School Advance Crossing assembly may be omitted (see Figure 908.2.5.1) where a School Zone (S1-1) sign (see EPG 908.2.2) is installed to identify the beginning of a school zone in advance of the School Crossing assembly if determined to be unnecessary by engineering judgement.

If a school crosswalk is located on a cross street in close proximity to an intersection, a School Advance Crossing assembly with a supplemental arrow (W16-5P or W16-6P) plaque may be installed on each approach of the street or highway to warn road users making a turn onto the cross street that they will encounter a school crosswalk soon after making the turn (see Figure 908.2.5.1).

If used, the School Crossing assembly shall be installed at the school crossing (see Figure 908.2.5.1), or as close to it as possible, and shall consist of a School (S1-1) sign supplemented with a diagonal downward-pointing arrow (W16-7P) plaque (see EPG 903.3.62) to show the location of the crossing.

The School Crossing assembly shall not be used at crossings other than those adjacent to schools.

The School Crossing assembly shall not be installed on an approach controlled by a STOP or a YIELD sign except as provided in the first two Option paragraphs below.

Prior to the installation of a School Crossing sign(s), a TR10 or TR11 School Crossing contract shall be executed. All requests for School Crossing sign(s) shall be reviewed in the district.

Option. The School Crossing assembly may be installed on an approach to a circular intersection controlled by a YIELD sign where the crosswalk is at least 20 feet in advance of the yield point at the entrance to a circulatory roadway.

At a signalized or stop-controlled intersection the School Crossing assembly may be installed on an approach to a channelized right turn lane controlled by a YIELD sign where the crosswalk is at least 20 feet in advance of the yield point.

A Yield Here To School Crossing (R1-5a) sign may be used, in accordance with the provisions of EPG 903.2.18, in advance of a marked crosswalk that crosses an uncontrolled multi-lane approach within school zones.

The In-Street School Crossing (R1-6b) sign may only be used at midblock school crossings on approaches that are not controlled by a traffic control signal, a pedestrian hybrid beacon, or emergency-vehicle hybrid beacon.

Standard. When used at an uncontrolled crossing, the In-Street School Crossing sign shall be used only as a supplement to a School Crossing assembly with a diagonal downward-pointing arrow (W16-7P) plaque at the crosswalk location.

An In-Street School Crossing sign shall not be placed in advance of the crosswalk to educate road users about the State law prior to reaching the crosswalk, nor shall it be installed as an educational display that is not near any crosswalk.

Option. In-Street School Crossing signs may be mounted back-to-back on the center line of an undivided roadway.

Standard. In-Street School Crossing signs shall only be installed:

A. Permanently on a raised island, or
B. Temporarily on a portable base.

If an In-Street School Crossing sign is installed permanently in the roadway, the sign support shall comply with the mounting height and special mounting support requirements for an In-Street Pedestrian Crossing (R1-6) sign (see EPG 903.2.19).

If an In-Street School Crossing sign is temporarily placed in the roadway, the sign shall be retroreflective and shall be deployed on a portable temporary sign support. The sign support shall be a crashworthy portable base meeting a minimum of NCHRP 350 standards. The top of an In-Street School Crossing sign shall be a maximum of 4 feet above the pavement surface.

Temporary In-Street School Crossing signs shall be removed from the roadway when the school crossing guard is not present.

Support. MoDOT does not provide or install temporary In-Street School Crossing signs. If used, temporary portable In-Street School Crossing signs are supplied and installed by school districts.

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Standard. The In-Street School Crossing sign shall not be used on approaches that are controlled by a traffic control signal, pedestrian hybrid beacon, or an emergency-vehicle hybrid beacon.

908.2.4 School Bus Stop Signs (MUTCD Section 7B.04)



S3-1

Support. Section 304.050, RSMo (https://revisor.mo.gov/main/OneSection.aspx?section=304.050), paragraph 5, defines, by state statute the locations where school buses can stop to load and unload passengers based on the number of lanes on the roadway, presence of shoulders, visibility, and speed limits.

It is not intended that School Bus Stop Ahead (S3-1) signs be used everywhere a school bus stops to load or unload passengers, but for use where terrain and roadway features limit the approach sight distance and where there is no opportunity to relocate the school bus stop to another location with adequate sight distance. For this article, a school bus stop is defined as the location where schoolchildren wait to be picked up by a school bus and/or where schoolchildren are discharged from a school bus.

Standard. Requests for School Bus Stop Ahead signs shall be submitted to MoDOT district staff by the school district. When a request for a S3-1 sign is received, sight distance shall be evaluated at the school bus stop location. Sight distance shall be measured using a 3.5-foot driver's eye height and an 8-foot object height. Each approach for the school bus stop shall be measured independently for each direction of travel along the roadway.

If the minimum sight distance in Table 908.2.4 is not met, a school bus stop shall not be allowed by state statute. If the maximum sight distance in Table 908.2.4 is not met, the school district shall attempt to relocate the school bus stop to a location that does meet or exceed the maximum sight distance.

Table 908.2.4, Sight Distance Requirements for use of the S3-1 Sign

Posted Speed (mph)	Minimum Sight Distance (ft.)	Maximum Sight Distance (ft.)
30	300	500
35	300	500
40	300	500
45	300	500
50	300	510
55	300	560
60	300	625
65	500	700
70	500	740

Option. If the school district has reviewed a school bus stop location and there are no viable alternative locations to relocate the school bus stop, the school district may submit a letter to MoDOT district staff verifying that there are no alternate locations.

The School Bus Stop Ahead sign may be installed on an approach to a school bus stop based on engineering judgement if all the following conditions are met:

A. Sight distance exceeds the minimum value in Table 908.2.4 when measured as described in the first Standard paragraph above,
B. Sight distance is less than the maximum value in Table 908.2.4 when measured as described in the first Standard paragraph above, and
C. A letter has been provided to MoDOT as described in the previous paragraph.

Guidance. Each approach to a school bus stop should be evaluated independently as it may not be necessary to install S3-1 signs for both approaches to a school bus stop.

If a School Bus Stop Ahead sign is installed, it should be located for a stop condition per Table 903.3.4.

Standard. To ensure proper placement of signs and encourage driver compliance, all requests for School Bus Stop Ahead signs shall be submitted by school district staff, and the school district must verify the status of all school bus stops with signing as active or inactive on a yearly basis.

Guidance. MoDOT district staff should send a standard letter requesting verification of school bus stop status prior to the fall session.

Option. If the school district fails to verify the status of school bus stops, the MoDOT district may remove the School Bus Stop Ahead signs at those stops.

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Guidance. If the signs are removed due to lack of compliance with these requirements, the signs should not be reinstalled for one year. Whenever the school district moves a school bus stop location with S3-1 sign(s), they should advise the district office as soon as possible rather than waiting for the annual review.

908.2.5 School Speed Limit Signs (MUTCD Section 7B.05)



School Speed Limit When Flashing Sign — S5-1

Note:
The sign with WHEN FLASHING legend shall be accompanied by a flashing yellow Speed Limit Sign Beacon (see EPG 902.18.4)



S5-3

Standard. A School Speed Limit When Flashing (S5-1) sign shall be used to indicate the speed limit where a reduced school speed limit zone has been established based upon an engineering study or where a reduced school speed limit is specified for such areas by statute. The School Speed Limit When Flashing sign shall be placed at or as near as practicable to the point where the reduced school speed limit zone begins (see Figures 908.2.5.1 and 908.2.5.2).

If a reduced school speed limit zone has been established, a School (S1-1) sign shall be installed in advance (see Table 903.3.4 for advance placement guidelines) of the first School Speed Limit When Flashing (S5-1) sign that is encountered in each direction as traffic approaches the reduced school speed limit zone (see Figures 908.2.5.1 and 908.2.5.2).

The downstream end of an authorized and posted reduced school speed limit zone shall be identified with an END SCHOOL SPEED LIMIT (S5-3) sign (see Figures 908.2.5.1 and 908.2.5.2).

Option. A standard Speed Limit sign showing the speed limit for the section of highway that is downstream from the authorized and posted reduced school speed limit zone may be mounted on the same post above the END SCHOOL SPEED LIMIT (S5-3) sign or the END SCHOOL ZONE (S5-2) sign.

Guidance. The beginning point of a reduced school speed limit zone should be at least 200 feet in advance of the school grounds or a school crossing; however, this 200-foot distance should be increased if the reduced school speed limit is 30 mph or higher. The maximum beginning point of a reduced school speed limit zone should not be greater than 500 feet in advance of the school grounds or a school crossing.

Standard. When a School Speed Limit When Flashing (S5-1) sign is used, a Speed Limit Sign Beacon (see EPG 902.18.4) shall be used to identify the periods that the school speed limit is in effect.

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Prior to the installation of a School Speed Limit When Flashing sign with a Speed Limit Sign Beacon, a TR08 Roadside Flashers for School Operations contract shall be executed.

Guidance. If a Speed Limit Sign Beacon is installed, no other Warning Beacons should be permitted on school zone signs inside the same school zone.

Standard. Upon receipt of a school speed limit request, the district shall perform a site investigation. A speed study and a crash study may be performed based on engineering judgement. The school speed limit shall be 10 mph below the posted speed limit. In no case shall a school speed limit of less than 25 mph be allowed.

If in the course of the speed study it is determined that the posted speed for the corridor is not proper, the posted speed shall be reevaluated and changed as necessary following EPG 905.2.14.

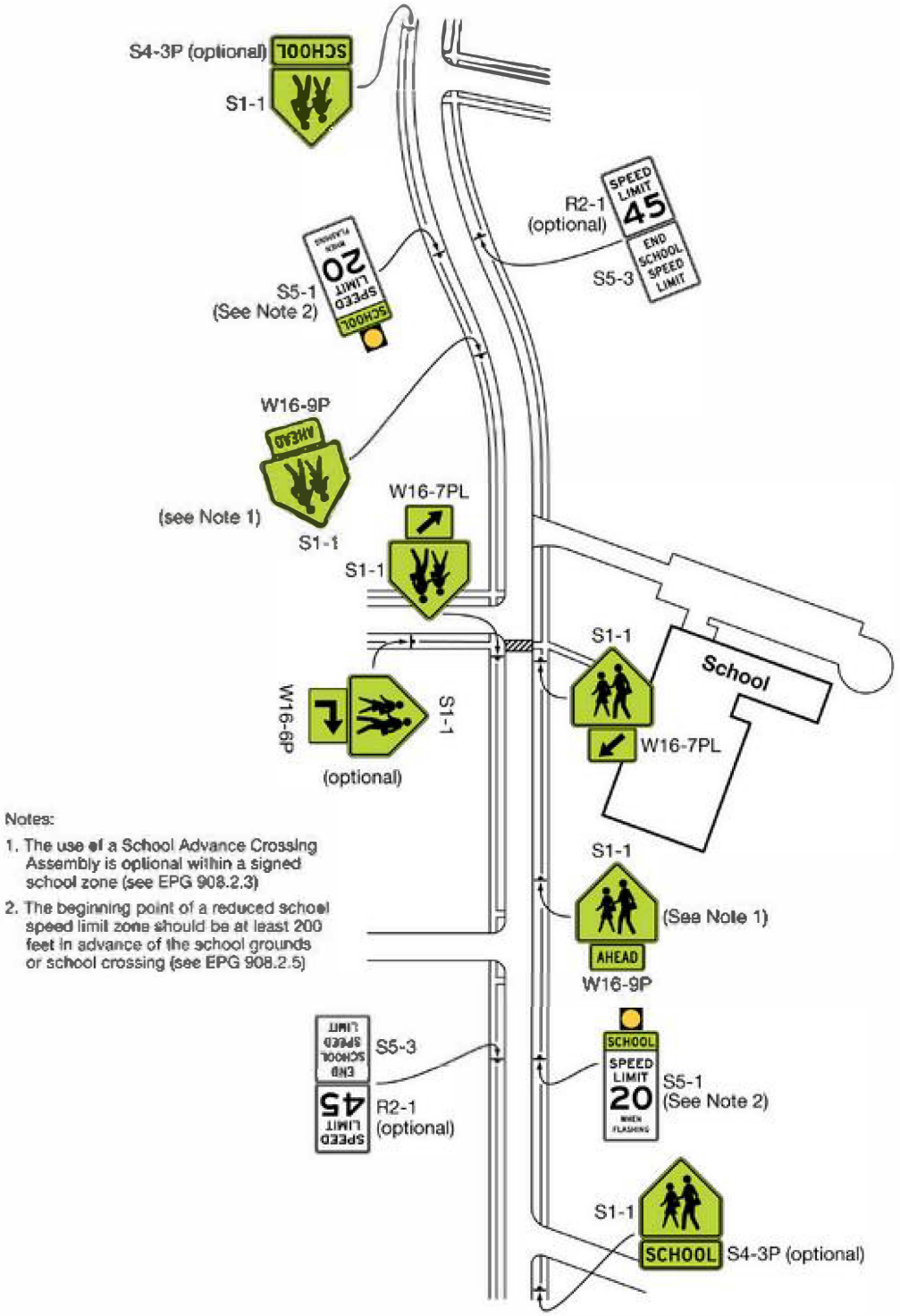


Figure 908.2.5.1 Example of Signing for a School Zone with a School Speed Limit and School Crossing

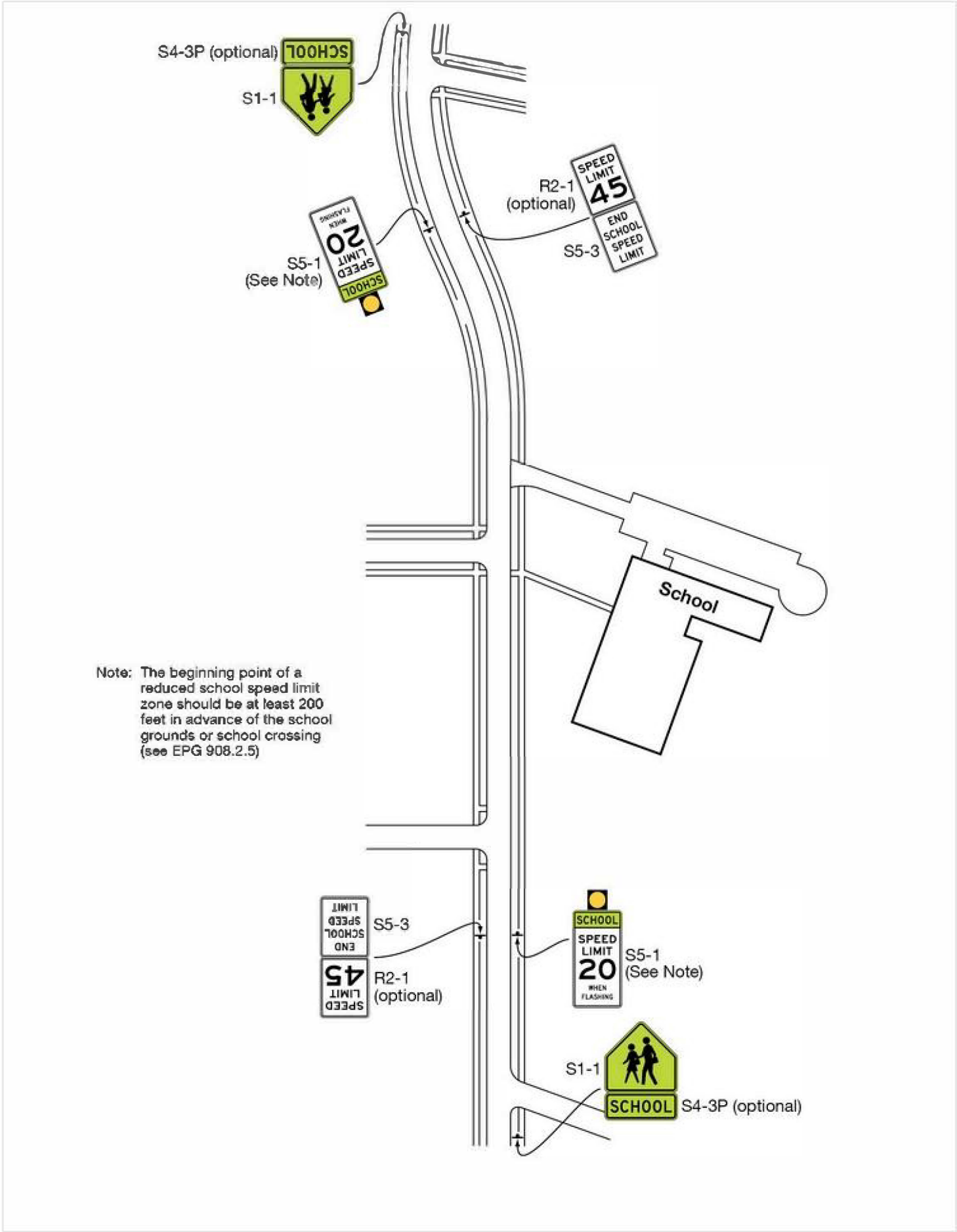


Figure 908.2.5.2 Example of Signing for a School Speed Limit

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908.2.6 Higher Fines Zone Signs and Plaques in School Areas (MUTCD Section 7B.06)

Support. Higher Fines Zone Signs and Plaques are not used by MoDOT. There is no authority under state law to charge higher fines for moving or speeding violations in school zones.

908.2.7 Parking and Stopping (R7 and R8 Series) Signs (MUTCD Section 7B.07)

Option. Parking and stopping regulatory signs may be used to prevent parked or waiting vehicles from blocking pedestrians' views, and drivers' views of pedestrians, and to control vehicles as a part of the school traffic plan.

Support. Parking signs and other signs governing the stopping and standing of vehicles in school areas cover a wide variety of regulations.

EPG 903.2.43 through 903.2.45 contain information regarding the signing of parking regulations in school zone areas.

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908.3 Markings (MUTCD Chapter 7C)

908.3.1 Crosswalk Markings (MUTCD Section 7C.01)

Guidance. Crosswalks should be marked at all intersections on established routes to a school where there is substantial conflict between motorists, bicyclists, and student movements; where students are encouraged to cross between intersections; where students would not otherwise recognize the proper place to cross; or where motorists or bicyclists might not expect students to cross (see Figure 908.1.2).

An engineering study considering the factors described in EPG 620.3.2 should be performed before a marked crosswalk is installed at a location away from a traffic control signal or an approach controlled by a STOP or YIELD sign.

Standard. Because non-intersection school crossings are generally unexpected by the road user, warning signs (see EPG 908.2.3) shall be installed for all marked school crosswalks at non-intersection locations. Adequate visibility of students by approaching motorists and of approaching motorists by students should be provided by parking prohibitions or other appropriate measures.

Support. EPG 620.3.3 contains provisions regarding the placement and design of crosswalks, and EPG 620.2.18 contains provisions regarding the placement and design of the stop lines and yield lines that are associated with them. Provisions regarding the curb markings that can be used to establish parking regulations on the approaches to crosswalks are contained in EPG 620.2.17.

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908.4 Crossing Supervision (MUTCD Chapter 7D)

908.4.1 Adult Crossing Guards (MUTCD Section 7D.01)

Standard. Adult crossing guards acting for the school district shall be used to provide gaps in traffic at school crossings on the state highway system during times when school children are present before and after school is in session. A school-crossing contract providing for an adult crossing guard shall be required before a marked and signed school crossing is established.

Support. The school crossing contracts can be found in EPG 153.21 Traffic Agreements and Contracts. The District Engineer is authorized to sign all school crossing contracts.

Adult crossing guards add conspicuity at the crossing where children, who are typically smaller in stature, might not be as visible.

High standards for selection of adult crossing guards are essential because they are responsible for the safety of and the efficient crossing of the street by schoolchildren within and in the immediate vicinity of school crosswalks.

Guidance. School districts should have policies and procedures for the qualifications, selection, and training of adult crossing guards.

908.4.1 Operating Procedures for Adult Crossing Guards (MUTCD Section 7D.02)

Standard. Law enforcement officers performing school crossing supervision and adult crossing guards shall wear high-visibility retroreflective safety apparel labeled as ANSI 107-2020 standard performance for Class 2, Type R, as described in EPG 616.3.5.

Adult crossing guards shall not direct traffic in the usual law enforcement regulatory sense. In the control of traffic, they shall pick opportune times to create a sufficient gap in the traffic flow. At these times, they shall stand in the roadway to indicate that pedestrians are about to use or are using the crosswalk, and that all vehicular traffic must stop.

Adult crossing guards shall use a STOP paddle. The STOP paddle shall be the primary hand-signaling device.

The STOP paddle shall comply with the provisions for a STOP/SLOW paddle (see EPG 616.4.2) except both sides shall be a STOP face.

The paddle shall be retroreflective or illuminated when used during hours of darkness.

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910.3 Dynamic Message Signs (DMS)

Related Information
Portable Changeable Message Signs (CMS)

Support. Dynamic Message Signs (DMSs) are stationary traffic control devices capable of displaying one or more alternative messages that provide travelers with real-time, traffic-related variable messages. DMSs are used to warn, regulate, route and manage traffic.

MoDOT operates DMSs through its transportation management centers (TMCs) in Kansas City (KC Scout (http://www.kcscout.net/)), St. Louis (Gateway Guide (https://www.modot.org/gatewayguide/)) and Springfield (Ozarks Traffic (https://www.ozarkstraffic.com/)). Each of these TMCs operates DMSs within its metropolitan coverage area. The KC Scout and Gateway Guide TMCs also operate DMSs on the statewide rural I-29, I-35, I-44, I-55, I-57, I-70 and US 60.



Dynamic Message Sign

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910.3.1 DMS Policy

Policies, standards, and guidelines for DMS signs are included in EPG 910.3 and in EPG 903.12 for Changeable Message Signs. Content in EPG 903.12 includes applicable language from the Manual on Uniform Traffic Control Devices.

910.3.2 MoDOT DMS Policy

910.3.2.1 Basic Requirements

Guidance. DMSs should not promote commercial events or entities and should not repeat guide sign, regulatory sign or warning sign messages.

Messages displayed shall convey pertinent information to assist motorists in their driving decisions. Messages shall be conveyed in a standard, non-confusing manner that allows drivers to both perceive and react to the information in a timely fashion. DMSs will be effective if five basic requirements are met.

1) Fulfill a need: Messages must only be posted to signs when there is a real need, and when the purpose is clear to the driver. If messages on DMSs are perceived to be unnecessary, drivers will begin to disregard all DMS messages.

2) Command attention: The mere size of the signs themselves help to command driver attention, but the wording of messages can also contribute. Colors and graphics may also be used in a manner consistent with MoDOT policy.

3) Convey a clear, simple meaning: At typical speeds, drivers have only a few seconds to notice, read and interpret posted messages. Proper composition and formatting is critical to conveying the most vital information in a manner that the driver will be able to assimilate. Consistency is an important aspect of this type of communication. Consistently composed and formatted messages become familiar to drivers and easier for them to comprehend quickly. Statewide messaging standards will improve the effectiveness of all DMS usage. Graphics can also reduce the time necessary for drivers to interpret messages.

4) Command respect from travelers: Fulfilling a need and conveying a clear, simple meaning are important components of commanding respect. They must also display information that is accurate and timely. Drivers will ignore all DMSs if they find information to be unreliable, either because it is frequently in error or often out-of-date.

5) Give adequate time for proper response: This requirement may be most pertinent to the placement of portable signs, but also speaks to the composition of messages. The desired response, in many cases, is simply for the driver to comprehend the information and become aware of possible congestion ahead. Messages that are poorly composed or contain too much information may be difficult for drivers to read in the few seconds they have while traveling at highway speed.

Support. EPG 903.12.2 includes information from the MUTCD regarding Applications of DMS signs.

910.3.2.2 Responsibility for Operation of DMS

The district engineer shall authorize the use of all DMSs, both state and contractor-furnished, and may designate a person or persons to be responsible for the authorization of use, messages to be displayed, and the care, maintenance, and security of the DMSs. Access to the DMS shall only be given to responsible individuals. The district engineer shall ensure that efforts are coordinated so that motorists are informed of the most critical information based on priority of messages listed below. In the Kansas City, St. Louis and Springfield metropolitan areas, Scout, Gateway Guide and Ozarks Traffic TMC operations staffs have been delegated the responsibility to operate the DMSs under their control.

The DMSs located on I-29, I-35 and I-70 are operated by the KC Scout TMC on a 24/7 basis with the exception of DMSs on I-70 in the St. Louis District. The Northwest, Northeast and Central Districts have the capability to operate the DMSs within their boundaries, but coordination with the KC Scout TMC is required.

The DMSs located on I-44, I-55, I-57 and US 60 are operated by the Gateway Guide TMC on a 24/7 basis. The Ozarks Traffic TMC in Springfield will have the capability to operate the I-44 DMSs located in the Southwest District. The Central, Southwest and Southeast Districts will have the capability to operate the DMSs within their boundaries; coordination of operations with the Gateway Guide TMC is required.

Districts without a TMC may also serve in a back-up role for their respective corridor in the event that the KC Scout, Gateway Guide or Ozarks Traffic TMCs have other activities in their local metropolitan areas that prevent them from managing operations on the I-29, I-35, I-44, I-55, I-57, I-70 and US 60 corridors.

910.3.2.3 Message Priorities

The following message hierarchy determines what type of message has priority should more than one request be made to post a message to the same sign. The DMS messages shall be prioritized in the following order unless overridden by a supervisor:

1) Emergencies, such as evacuations or closures, required by MoDOT, the State Emergency Management Agency (SEMA), local law enforcement or the military.

2) Hazardous and/or uncommon road conditions that require motorists to alter their driving, such as severe weather conditions, accidents, work zone activities or other incidents. Traffic operators should contact their floor supervisor when multiple incidents are taking place along the same route.



Severe Weather

3) Traveler information and suggested alternative routes for delays and/or congestion caused by planned or unplanned events. Alternative routes are suggested with caution; sufficient trailblazing must be provided.

4) AMBER or Blue Alerts originating in the local area

5) Travel times

6) AMBER or Blue Alerts originating outside the local area

7) Ozone alerts

8) Advance date or time notice for scheduled incidents such as lane closures, road closures, moving operations or special events.

9) Approved standard public service messages associated with special campaigns (i.e. work zone awareness week, share the ride) or other public information that improves highway safety and reduces congestion.

10) When circumstances exist so that no message regarding safety or traveler information as defined by the previous listed priorities is warranted, Messages and Special Messages as outlined in EPG 910.3.2.16 Driver Safety Campaigns shall be displayed on all DMSs in Missouri. Messages shall be rotated regularly so that a variety of information is displayed to the traveling public. No message shall be excluded from the rotation unless otherwise approved by Traffic (http://sp/sites/ts/Pages/default.aspx) and Community Relations (http://wwwi/intranet/cr/) staffs.

Sometimes operators are faced with competing message needs when two or more incidents are simultaneously occurring on the freeway system downstream of a DMS. In such situations, operators must decide which of the incidents should be signed for, because it is not normally advisable to sign for both, unless a two-phase message is used. Procedures for posting two-phase messaging and situations that justify it are provided in EPG 910.3.2.14 Use of One-Phase and Two-Phase Messages. The following priority principles should be used in determining which competing incident should be signed for when a single phase is used:

- Messages about the closer of two or more downstream incidents on the primary freeway should receive priority over the incidents that are further downstream, except as modified by Table 910.3.2.3 Suggested Message Priority for Downstream Major Accidents, below.
- Messages about a downstream incident on the primary freeway should receive priority over incidents on downstream intersecting freeways or highways.

Suggested message priorities when a major accident occurs downstream of the closest incident on the primary highway are as shown in Table 910.3.2.3 below. District staff should be consulted prior to determining message priorities for incidents occurring on the I-29, I-35, I-44, I-55, I-57, I-70 and US 60 corridors.

Table 910.3.2.3 Suggested Message Priority for Downstream Major Accidents

Major Accident Occurs Downstream of:	Give Message Priority to:
Major accident	Upstream major accident
Minor accident	Upstream minor accident
Roadwork with lane closure	Downstream major accident
Roadwork with freeway closure	Upstream roadwork
Incident (stalled vehicle, load spill, debris in roadway) requiring lane closure	Downstream major accident
Incident requiring total freeway closure	Upstream incident

910.3.2.4 Incident Verification

It is very important that operators verify an incident before posting an incident message on a DMS. The best source of verification is by viewing it with a CCTV camera, but if a CCTV camera view is not available, it must be verified by a reliable source. Examples of reliable sources are Emergency Response Patrols, law enforcement agencies (i.e., MSHP, local sheriff and police departments) and MoDOT district staff or Construction/ Maintenance field staff. Media sources or the general public are not considered to be reliable sources for incident verification purposes. However, this unreliable information should be useful to operators in identifying information that needs to be explored further. Lines of communication need to be established between the above noted reliable sources and the TMCs.

It is also important that operators continue to monitor and modify, as necessary, the incident message as the incident progresses. Where CCTV camera views are not available, operators need to maintain communication with the reliable sources at the incident scene to ensure that the current message is

accurate and timely. Generally when CCTV cameras are not available, operators should attempt to get updated incident information from reliable sources every 15 minutes for incidents within the metropolitan areas controlled by the KC Scout and Gateway Guide TMCs and every 30 minutes for incidents along the I-29, I-35, I-44, I-55, I-57, I-70 and US 60 corridors.

MoDOT DMS Contact List for Issue Reporting

DMSHelpDesk	(573) 751-5000
Northwest District	(816) 262-0367
Northeast District	(573) 248-5961
Kansas City District	(816) 607-2000
Central District	(800) 892-7332
St. Louis District	(314) 275-1500
Southwest District	(417) 864-1160
Southeast District	(573) 380-9631



Testing a new DMS

910.3.2.5 Legibility and Visibility of DMS

Support. EPG 903.12.3 contains information from the MUTCD regarding Legibility and Visibility.

910.3.2.6 Permanently-Located Changeable Message Signs (DMS) (MUTCD Section 2L.08)

Support. Dynamic message signs (DMS) are permanently-located changeable message signs. EPG 903.12 contains provisions from the MUTCD regarding all changeable message signs. The provisions of EPG 910.3.2.6 apply to DMS and other permanently-located CMS.

Careful consideration of CMS or DMS installation location is important to having a safe and effective message, taking into account several factors. CMS or DMS message length and complexity will vary and often include two-phase displays, all of which might require longer glance times by motorists than would be required for conventional sign messages.

Permanently-located CMS or DMS are generally used on higher-speed, multi-lane facilities with high traffic volumes where more time might be required to properly respond to a message, such as by changing lanes or reducing speed. It also is common for other signs to be in the same vicinity of the desired location for a permanently-located CMS raising the concern of overloading road users with information.

Guidance. A CMS or DMS that is used in place of a conventional sign (such as a blank-out or variable legend regulatory sign) should be located in accordance with the provisions of EPG 903.1 and the provisions for the conventional sign it replaces.

Permanently-located CMS or DMS should:

A. Be located sufficiently upstream of known bottlenecks and high crash locations to enable road users to select an alternate route or take other appropriate action in response to a recurring condition.

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B. Be located sufficiently upstream of major diversion decision points, such as interchanges, to provide adequate distance over which road users can change lanes to reach one destination or the other.
C. Not be located within an interchange.
D. Not be positioned at locations where the information load on drivers is already high because of guide signs and other types of information.
E. Not be located in areas where drivers frequently perform lane-changing maneuvers in response to guide sign information, or because of merging or weaving conditions.

Support. Many of the factors in locating permanently-located CMS or DMS apply to PCMS. Information regarding the design and application of PCMS in temporary traffic control zones is contained in EPG 616.12.5.

910.3.2.7 Message Creation and Termination

Although it is desirable to post an incident message based on complete and perfect information, situations often occur when the operator has received only limited information on the incident from reliable sources, particularly in the early stages of the incident. In these situations, operators should determine if there is at least general information about the incident location and type. If so, the operator should post a message with the information available and be prepared to modify the message as soon as more detailed information is received.

Incident messages should be terminated when all lanes are open and all emergency responders have left the scene. In addition, incident clearance messages should be posted for a short time after the incident clears if congestion remains at the scene. Procedures for posting incident clearance messages are provided in EPG 910.3.2.11 Incident Clearance Messages.

Congestion often exists at the incident scene after the incident has cleared and the incident clearance message is terminated. In those cases, it is necessary to post congestion messages that include either travel time or congestion location information. Procedures for posting congestion messages are available.

910.3.2.8 DMS Capabilities and Message Formats

910.3.2.8.1 Design Characteristics of Messages

Standard. Dynamic Message Signs shall be capable of displaying several messages in a sequence. Such messages shall be changed manually, by remote control or by automatic controls. DMSs shall display pertinent traffic operational and guidance information only. DMSs shall not include advertising, animation, rapid flashing, dissolving, exploding, scrolling or other dynamic elements.

Guidance. DMSs should be used as a supplement to and not as a substitute for conventional signs and markings.

Support. EPG 903.12.4 includes information from the MUTCD regarding Design Characteristics of Messages.

For DMS signs, the first letter of every word in the message should be upper case.

When displaying color messages using full background color should be avoided in nighttime conditions. Full background color at night can cause a washout effect of the text or other image being displayed.



910.3.2.8.2 Message Format

910.3.2.8.2.1 Message Length and Units of Information

Support. EPG 903.12.5 contains information from the MUTCD regarding Message Length and Units of Information.

Guidance. Some DMS on the MoDOT system are capable of displaying multiple colors and graphics. There are limitations on what is acceptable to be displayed and limits on the size of the image (in terms of bytes).

The limit on the byte size the graphic cannot exceed is set by the National Transportation Communications of Intelligent Transportation System Protocol (NTCIP). The limit set by NTCIP is 64449 bytes for a single graphic.

To conform to these regulations and to remain consistent throughout the state there is a library of available graphics contained in the Advanced Transportation Management System (ATMS) software which may be used for certain messages. These graphics have been decided on by the Central Office Message Group and the TMCs. Any special requests may be directed to the State Highway Safety and Traffic Engineer.

When using graphics or color for a message, there are best practices that should be followed:

- Do no use graphics that have lettering smaller than 18”. Any lettering smaller than that cannot be read at free flow speeds and will then be clutter on the sign.
- Avoid graphics that cover the entire sign. These large images take longer to push to a DMS and as previously mentioned there is a size limitation on the number of bytes allowed to be displayed according to NTCIP.
- Avoid using full background color in the nighttime conditions. Full background color at night can cause a washout effect of the text or other image being displayed. In addition, the sign will be appear too bright to the driver in dark conditions.
- Avoid text as part of the graphic. This allows a graphic to be more easily reused and the changes can be made in the text field.
- The use of color should be limited. Although the addition of color to a message can be very beneficial, if there is too much color used it can become distracting and unhelpful.

910.3.2.8.2.2 General Principles

Guidance. DMS messages should present necessary information in the expected sequence that allows motorists to easily read, comprehend and rationally respond. Consistent formatting of the information enhances motorists' expectations and reduces the time required to read and comprehend messages.



The Tour of MO was a planned event

The basic message format to answer the questions from Table 903.12.5 can be reduced to the following elements:

- Incident Descriptor informs the motorist of the problem (e.g., ACCIDENT, ROADWORK).
- Closure Descriptor is used in place of the Incident Descriptor when all lanes of the facility or exit ramp are closed (e.g., I-70 CLOSED, EXIT 225 CLOSED).
- Lanes Closed gives specific information about which lanes are closed (e.g., LEFT LANE CLOSED, 2 RIGHT LANES CLOSED).
- Target Audience is used when the Action Message applies to a specific group of motorists rather than all motorists passing the sign (e.g., TRUCKS, STADIUM TRAFFIC).
- Incident Location informs the motorist about the location of the problem (e.g., AT MAIN, PAST EXIT 15).
- Closure Location specifically states the location of the freeway closure and is used in place of the Incident Location (e.g., AT MAIN, AT EXIT 15).
- Effect on Travel informs the motorist of the severity of the problem in terms of delay or travel time and assists the motorist in making a decision whether to divert from the freeway or not (e.g., EXPECT DELAY, 30 MIN DELAY).
- Action message informs the motorist what to do (e.g., USE OTHER ROUTES, FOLLOW DETOUR).

Although all of these elements provide critical information for the motorist, it is usually not possible to provide them all on the same sign due to limited space. Therefore, consider tradeoffs to determine which elements are to be included and omitted for different situations.

The general DMS message format to be used statewide is as follows:

Line 1	Incident Descriptor, Closure Descriptor, Lanes Closed or Target Audience
Line 2	Incident Location, Closure Location
Line 3	Lanes Closed (if not used in Line 1), Effect on Travel, Action

Line 1 provides the information, intended to capture motorists' attention, that they will soon be encountering a problem. Normally that information will be an Incident Descriptor or a Closure Descriptor and occasionally a Lanes Closed or Target Audience.

The Closure Descriptor should always be used on Line 1, in lieu of an Incident Descriptor, for road and exit closure incidents.

The Target Audience element should be on the first line if the message applies to a specific group of motorists passing the sign.

The Incident Descriptor should be omitted and replaced with the Lane Closed information on Line 1 if the Incident Descriptor cannot be identified (such as in the initial stages of the incident), if there are more important elements that need to be posted on the sign, or if messages need to be shortened to accommodate two-phase messages.

Line 2 provides location information for the incident or road closure. This location is provided in terms of the route and direction of the highway that the incident is on (if different than the road that the motorist is currently traveling on), the cross-street or highway closest to the incident (street/ highway name or exit number) and a preposition to describe the relative location of the incident to the cross-street/highway (BEFORE, AT or PAST). On the interstate corridors, mile markers are normally used for location descriptions rather than cross-streets or highways.

In determining whether to use street/highway names or exit numbers to describe incident or closure locations, street /highway names are normally more useful for motorists familiar with the area, and exit numbers are normally more useful for motorists, such as tourists, who are unfamiliar with the area. When signing for unfamiliar motorists in the Kansas City, St. Louis and Springfield metropolitan areas, the exit number of the closest cross-street/highway should be used to define the location rather than the mile marker of the incident.

When referring to interstates in the incident and closure locations, the prefix "I-" (e.g., I-70) should be used only if there is available space on the sign. Otherwise it should be omitted.

Line 3 provides specific information to the motorist about which lanes are closed (Lanes Closed) when this information has not already been placed on the first line, the severity of the incident in terms of delay or travel time (Effect on Travel), or what action the motorist is expected to take (Action Message).

The ONE LANE CLOSED message should only be used on DMSs where the lane closure is more than a mile downstream of the DMS. Using this general message rather than a specific lane closure message prevents motorists from making unnecessary early lane changes.

910.3.2.9 Acceptable Message Words and Terms

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In determining the appropriate messages to post on DMSs, operators often have to choose words and terms for certain situations. To eliminate any confusion in the appropriate words and terms for these situations, the following list provides the acceptable words or terms to be used on DMSs on MoDOT-managed freeways and highways:

ACCIDENT vs. CRASH

The term CRASH is currently the preferred term used by representatives of the safety community, although it is not a common term used by the general public. No human factors studies have been conducted that have determined motorists' understanding and response times to messages containing the term CRASH in comparison to messages containing the term ACCIDENT. Accordingly, it has been concluded that ACCIDENT is the term more generally recognized by motorists and should be used.

PAST vs. AFTER

Both terms are easily recognizable by motorists. The term PAST should be used because it is shorter and therefore takes less space.

EXIT vs. RAMP

The term EXIT should be used because it is generally better understood by motorists. RAMP is generally understood by motorists, but tends to have different shades of meaning for some motorists.

CLOSED vs. BLOCKED

BLOCKED indicates that an incident is affecting a lane or lanes and response personnel have not yet arrived while CLOSED indicates that response personnel have arrived and are directing traffic out of the affected lane or lanes. MoDOT primarily uses CLOSED, and it is considered to be the acceptable term.

Days of Week vs. Calendar Dates

When notifying motorists of future roadwork or events, Days of the Week (e.g., MONDAY, THURSDAY) should be used while Calendar Dates should never be used. Accordingly, notifications of such events should only be placed for up to a week in advance of the event.

910.3.2.10 Acceptable Abbreviations

Because DMSs have limited available space, it is often necessary for operators to abbreviate words to place the appropriate message. KC Scout and Gateway Guide staff should develop standard abbreviations for street and highway names used in the areas controlled by these TMCs. In the development of these abbreviations, expected recognition by travelers in the area should be the primary consideration.

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Acceptable abbreviations for common words used on DMSs are summarized in EPG 911 (MUTCD Section 1D.08).

910.3.2.11 Incident Clearance Messages

An incident clearance message is posted on the DMS when the incident has been cleared, all lanes have been opened to traffic and some residual congestion remains upstream of the incident scene. The message is only posted for about five minutes, after which the message is terminated or a congestion message is placed. The purpose of the incident clearance message is to inform approaching motorists that all lanes are open at the incident scene, but some congestion upstream of the incident scene may still exist. The incident clearance message is not necessary if there is no residual upstream congestion when the incident clears.

910.3.2.12 Congestion Messages

Congestion is categorized as either recurring or non-recurring. Recurring congestion occurs at the same time and same location on a regular basis, usually because the traffic demand exceeds the roadway capacity at that location. Non-recurring congestion is congestion resulting from incidents, including special events, short-term roadwork or severe weather.

A congestion message is used to inform motorists that residual congestion still exists upstream of an incident after the incident clearance message has been terminated. Congestion messages can also be placed for recurring congestion when the congestion is more severe than normal, extends beyond the normal boundaries, or persists past the typical end of the peak period. Congestion messages should describe the limits of the congestion (e.g., METCALF to HOLMES) if the DMS is upstream of the congestion or the end of the congestion when the DMS is within the limits of congestion.

When congestion messages are posted on the rural corridor DMSs, it is critical that MoDOT field personnel provide KC Scout/ Gateway Guide operators timely updates on the congestion extent and limits. Updates should be provided at five- to ten-minute intervals.

When travel times are used and incorporated into the TMC software, as in the KC Scout and Gateway Guide TMCs, these travel time messages should be used in lieu of the congestion messages described above. These travel time messages provide valuable congestion information during incidents requiring two-phase messages and during other congested periods in both peak and non-peak periods. They also provide assurances to motorists when there is no congestion and the normal traffic conditions exist.

Support. EPG 903.12.6 contains information from the MUTCD related to Travel Time Messages.

910.3.2.13 Weather Messages on Dynamic Message Signs

In addition to winter weather, travel conditions may also be impacted by other weather events such as thunderstorms, significant periods of rain, fog, or excessive wind. Severe weather is not usually considered to be an incident, but weather-related messages should be displayed for the conditions below. Other weather messages may be posted with the approval of the TMC supervisor.

- Roads are impassable due to flooding, snow, etc.
- Ice or black ice on a specific roadway segment
- Tornado sighted in area near roadway
- Low visibility due to fog in localized area
- Snow squall warnings from the National Weather Service
- High wind warnings from the National Weather Service

910.3.2.14 Use of One-Phase and Two-Phase Messages

Although operators should attempt to limit messages to a single phase, it is often necessary to use two phases to convey important information to motorists. When a two- phase message is warranted, it is critical to minimize the information on each phase to ensure that motorists will be able to read, comprehend and respond to both messages while driving at freeway speeds. The following situations will normally warrant the use of two-phase messages:

- Travel time messages are placed as the second phase to an incident message.
- Two downstream incidents are of equal priority as described in EPG 910.3.2.3 Message Priorities.

If two-phases are used, the following principles should be followed:

- Under no circumstances should more than two phases be used.
- Each phase should be understood by itself.
- Compatible units of information should be displayed on the same phase.
- Whenever possible, each phase should be limited to two lines. One way to reduce an incident message to two lines is to omit the Incident Descriptor on Line 1 and replace it with the Lanes Closed information.
- Each phase should be displayed for a minimum of three, and preferably four, seconds.
- Words or messages should never be flashed.

910.3.2.15 Child Abduction, Blue Alert and Ozone Alert Messages

If a child abduction occurs and it meets the local AMBER Plan Program's criteria for triggering an alert, a child abduction alert (AMBER Alert) message should be displayed on all stationary DMS in the area of the abduction, but should not create adverse traffic impacts such as queues, unexpected slowing of traffic, etc. If a higher priority message is needed on a DMS, then a child abduction alert messages should be alternated with that message until the child abduction alert is cancelled.

The TMCs will be responsible for coordinating with local and state police, as well as media to determine the need for the AMBER Alert message.

1) The AMBER Alert Message is to remain on the DMS until:
   a) The AMBER Alert has been cancelled by the local agency or state police
   b) The TMC receives consensus from the local agency or state police to remove the message
   c) The child is recovered.

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2) TMCs will evaluate the need for the message on the DMS every 6 hours based on information received from law enforcement and/or media.

Both KC Scout and Gateway Guide have agreements with local law enforcement officials to post child abduction alerts for abductions that meet minimum criteria. The model used by both TMCs is the national AMBER (America's Missing Broadcast Emergency Response) Program. The AMBER Program in the St. Louis metropolitan area is referred to as the SARAA (St. Louis Area Regional Abduction Alerts) Program.

Based on their agreements with the local law enforcement agencies, KC Scout and Gateway Guide TMCs use different messages for their child abduction alerts. KC Scout posts specific information on the abduction on its DMSs, while Gateway Guide posts only general information and provides information on where to go to get specific information.

Child abduction alerts are posted on the rural corridor DMSs when the information from the KC Scout or Gateway Guide TMCs indicates that the abductor may be using one of the corridors or if local enforcement agencies on the corridors issue alerts for their local areas. If local alerts are issued, the messages to be posted should be coordinated with the local enforcement agency.

If a sworn law enforcement officer in the state of Missouri has been assaulted and suffered serious or fatal injuries and the Missouri State Highway Patrol's (MSHP) criteria for a Blue Alert is met, MSHP may request a Blue Alert be displayed on DMS in the area of the incident. The TMCs will be responsible for coordinating with state police to determine the need for the Blue Alert message.

1) The Blue Alert Message is to remain on the DMS until:
    a) The Blue Alert has been cancelled by the state police
    b) The TMC receives consensus from the state police to remove the message
2) TMCs will evaluate the need for the message on the DMS every 6 hours based on information received from law enforcement.

Both metropolitan areas also have agreements with local agencies to place ozone alert messages when thresholds for the pollutant are exceeded. KC Scout has an agreement with the Mid-America Regional Council (MARC) and Gateway Guide has a similar agreement with Missouri Chapter of the American Lung Association.

In order to maintain the existing local agreements, these messages should continue to be used in the respective Kansas City and St. Louis metropolitan areas, and standard messages for these Alerts will not be developed.

910.3.2.16 Driver Safety Campaigns

MoDOT has developed an Electronic Message Boards Communications Plan to provide safety and public service information on all MoDOT DMSs. Details of the plan are provided to the TMCs on a monthly basis.

Communications Goal

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Develop informative messages that can be used on a regular basis to provide pertinent information and reminders to travelers.

Message Guidelines

The safety messages will provide variety and guard against message boredom. Higher priority messages, as provided in EPG 910.3.2.3 Message Priorities, will always override the general messages. Special messages will be placed on the DMSs as needed. Traffic (http://sharepoint/systemdelivery/tr/Pages/default.aspx) staff will regularly monitor the DMS usage.

910.3.2.17 On-Site Control of Portable Changeable Message Signs

Portable Changeable Message Signs (CMSs) are normally used by MoDOT personnel or contractors to post information regarding construction or maintenance projects. To the maximum extent practicable, CMS messages should follow the provisions of EPG 616.12.5.

Particularly in the Kansas City and St. Louis metropolitan areas, CMSs can be used to supplement the messages posted on the KC Scout and Gateway Guide DMSs. If these CMSs are to be useful in supplementing messages on DMSs, close coordination is needed between the TMC operators and those responsible for operating the CMSs to ensure that the DMSs and CMSs are not located too closely together and that that the messages don't conflict.

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Category:911 General (MUTCD Part 1)

Support. The information in EPG 911 is directly from the National MUTCD with minimal modifications. See EPG 900.1 for a description of how MUTCD content is incorporated into the EPG.

Contact the Highway Safety and Traffic Division for all official interpretations, experiments, changes to the National MUTCD, or interim approvals.

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Purpose of the MUTCD (MUTCD Section 1A.01)

Support. The purpose of the MUTCD is to establish uniform national criteria for the use of traffic control devices that meet the needs and expectancy of road users on all streets, highways, pedestrian and bicycle facilities, and site roadways open to public travel.

This purpose is achieved through the following objectives:

A. Promote safety, inclusion, and mobility for all users of the road network;

B. Promote efficiency through creating national uniformity in the meaning and appearance of traffic control devices;

C. Promote national consistency in the use, installation, and operation of traffic control devices; and

D. Provide basic principles for traffic engineers to use in making decisions regarding the use, installation, operation, maintenance, and removal of traffic control devices.

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Uniformity of the meaning of traffic control devices is vital to their effectiveness. Uniformity means treating similar situations in a similar way. Uniformity of devices simplifies the task of the road user because it aids in recognition and understanding, thereby reducing perception/reaction time. Uniformity assists road users, law enforcement officers, and traffic courts by giving everyone the same interpretation. Uniformity assists public highway officials through efficiency in manufacture, installation, maintenance, and administration.

The use of uniform traffic control devices also requires uniform and appropriate application.

The applicability of the MUTCD to facilities open to public travel is independent of the type of ownership or jurisdiction (public or private) and the source of funding (Federal, State, local, or private).

This Manual presumes the user of the MUTCD has sufficient working knowledge, professional training and experience, and education in the principles of traffic engineering. Other resources can be consulted to understand the basis for decisions that are made in which engineering study or judgment will be applied.

Traffic Control Devices – General Description (MUTCD Section 1A.02)

Support. As defined in Section 1C.02 of this Manual, traffic control devices include all signs, signals, markings, channelizing devices, or other devices that use colors, shapes, symbols, words, sounds, and/or tactile information for the primary purpose of communicating a regulatory, warning, or guidance message to road users on a street, highway, pedestrian facility, bikeway, pathway, or site roadway open to public travel.

Infrastructure elements that restrict the road user's travel paths or vehicle speeds, such as islands, curbs, speed humps, and other raised roadway surfaces, are not traffic control devices. Transverse or longitudinal rumble strips are also not traffic control devices. Operational devices associated with the application of traffic control strategies such as fencing, roadway lighting, barriers, and attenuators are shown in this Manual for context, but their design, application, and usage are not specified since they are not traffic control devices.

Certain types of signs and other devices that do not have any traffic control purpose are sometimes placed within the highway right-of-way by or with the permission of the public agency or the official having jurisdiction over the street or highway. These signs and other devices are not considered to be traffic control devices and provisions regarding their design and use are not included in this Manual. Among these signs and other devices are the following:

A. Devices whose purpose is to assist highway maintenance personnel, such as markers to guide snowplow operators, devices that identify culvert and drop inlet locations, and devices that precisely identify highway locations for maintenance or mowing purposes;

B. Devices whose purpose is to assist fire or law enforcement personnel, such as markers that identify fire hydrant locations, signs that identify fire or water district boundaries, speed measurement pavement markings, small indicator lights to assist in enforcement of red light violations, and photo enforcement systems;

C. Devices whose purpose is to assist utility company personnel and highway contractors, such as markers that identify underground utility locations;

D. Signs posting local non-traffic ordinances; and

E. Signs giving civic organization meeting information.

Target Road Users (MUTCD Section 1A.03)

Support. Traffic control devices can be targeted at operators of motor vehicles, including driving automation systems, and at vulnerable road users.

Targeted operators of motor vehicles include motorists, public transportation operators, truck drivers, and motorcyclists. Targeted users also include vulnerable road users, who have little to no protection from crash forces. These users are defined in Title 23, U.S.C. 148(a). They include bicyclists and pedestrians, including persons with disabilities. Pedestrians with disabilities might be blind or vision-impaired, have mobility limitations, or other impairments. Protection of vulnerable users is a priority in this Manual as directed in Section 11135 of the Infrastructure Investment and Jobs Act.

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Operators of motor vehicles and vulnerable road users are both likely to be present on roadways where adjacent land use suggests that trips could be served by varied modes. Application of traffic control devices on these roadways requires careful consideration of measures to set and design for appropriate speeds; separation of various users in time and space; improvement of connectivity and access for pedestrians, bicyclists, and transit riders, including for people with disabilities; and implementation of safety countermeasures.

Use of the MUTCD (MUTCD Section 1A.04)

Support. Traffic control device principles in the MUTCD are developed for and used by individuals who are duly authorized and qualified to conduct traffic control device activities.

Standard. Where the content of this Manual requires a decision for implementation, such decisions shall be made by an engineer, or an individual under the supervision of an engineer, who has the appropriate levels of experience and expertise to make the traffic control device decision. Those decisions shall be made using engineering judgment or engineering study, as required by the MUTCD provision.

Support. Section 1C.02 contains definitions of "engineering study" and "engineering judgment."

Guidance. In making traffic control device decisions, individuals should consider the impacts of the decision on the following: safety and operational efficiency (mobility) of all road users at that location, the effective use of agency resources, cost-effectiveness, and enforcement and education aspects of traffic control devices.

Support. Throughout this Manual the headings Standard, Guidance, Option, and Support, the meanings of which are defined in Section 1C.01, are used to classify the nature of the text that follows. Figures and tables, including the notes contained therein, supplement the text and might constitute a Standard, Guidance, Option, or Support. The user needs to refer to the appropriate text to classify the nature of the figure, table, or note contained therein.

Guidance. Except when a specific numeral is required or recommended by the text of a Section of this Manual, numerals displayed on the images of devices in the figures that specify quantities such as times, distances, speed limits, and weights should be regarded as examples only. When installing any of these devices, the numerals should be appropriately altered to fit the specific situation.

Similarly, destination names, route numbers, and State route shields that are displayed on the images of devices in the figures should be regarded as examples only. When installing any of these devices, the destination names, route numbers, and State route shields should be appropriately altered to fit the specific situation.

Support. The information contained in the following paragraphs will be useful when reference is being made to a specific portion of text in this Manual.

There are nine Parts in this Manual and each Part includes one or more Chapters. Each Chapter includes one or more Sections. Parts are identified by a single-digit numerical identification, such as "Part 2 – Signs." Chapters are identified by the Part number and a letter, such as "Chapter 2B – Regulatory Signs." Sections are identified by the Chapter number and letter followed by a decimal point and a 2-digit number, such as "Section 2B.03 – Size of Regulatory Signs." In some Chapters, the Sections are grouped together by subject into unnumbered sub-chapters with a heading, such as "Signing for Right-of-Way at Intersections" (for Sections 2B.06 through 2B.20).

Each Section includes one or more paragraphs. The paragraphs are indented and are identified by a number. Paragraphs are counted from the beginning of each Section without regard to the intervening text headings (Standard, Guidance, Option, or Support) or any intervening text in embedded Figures or Tables. Some paragraphs have lettered or numbered items. As an example of how to cite this Manual, the phrase "[n]ot less than 40 feet beyond the stop line" that appears in Section 4D.08 of this Manual would be referenced in writing as "Section 4D.08, Par.1, A.1," and would be verbally referenced as "Item A.1 of Paragraph 1 of Section 4D.08."

Relation to Other Publications (MUTCD Section 1A.05)

Standard. To the extent that they are incorporated by specific reference, the latest editions of the following publications shall be a part of this Manual: "Standard Highway Signs" publication (FHWA), and "Color Specifications for Retroreflective Sign and Pavement Marking Materials" (appendix to Subpart F of Part 655 of Title 23 of the Code of Federal Regulations).

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Support. The "Standard Highway Signs" publication includes standard alphabets and symbols and arrows for signs and pavement markings.

The MUTCD is not a roadway design manual, and engineers seeking guidance on design should refer to appropriate roadway design guides recognized by the Federal Highway Administration as needed for the design application.

Other publications are referenced in this Manual as useful resources, but they are not regulatory in nature and are not independently legally enforceable.

Uniform Vehicle Code – Rules of the Road (MUTCD Section 1A.06)

Support. The "Uniform Vehicle Code" (UVC) is one of the publications referenced in the MUTCD. The UVC contains a model set of motor vehicle codes and traffic laws for use throughout the United States, the intent of which is to promote national uniformity in these laws. The Rules of the Road contained in the UVC are intended to be recommendations for States to adopt in their State statutes and are not independently legally enforceable.

Guidance. The actions required of road users to obey regulatory devices should be specified by State statute, or in cases not covered by State statute, in local ordinances or resolutions. Such statutes, ordinances, and resolutions should be consistent with the "Uniform Vehicle Code."

National Standard (MUTCD Section 1B.01)

Standard. The Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) is incorporated by reference in 23 Code of Federal Regulations (CFR), Part 655, Subpart F and shall be recognized as the national standard for all traffic control devices installed on any street, highway, bikeway, or site roadway open to public travel (see definition in Section 1C.02) in accordance with 23 U.S.C. 109(d) and 402(a).

In accordance with 23 CFR 655.603(a), the MUTCD shall apply to all of the following types of facilities:

A. Any street, roadway, or bikeway open to public travel, either publicly or privately-owned.
B. Streets and roadways on sites that are off the public right-of-way that are open to public travel without full-time access restrictions. Examples include roadways within shopping centers, office parks, airports, sports arenas, other similar business and/or recreation facilities, governmental office complexes, schools, universities, recreational parks, and other similar publicly-owned complexes and/or recreation facilities. The above-described examples of streets and roadways are referred to in this Manual as site roadways open to public travel;
C. Publicly-owned toll roads, including those under the jurisdiction of a public agency, public authority, or public-private partnership;
D. Privately-owned toll roads where the public is allowed to travel without access restriction. This includes gated toll roads or roadways where the general public is able to pay to access the facility; and
E. Grade crossings of publicly-owned roadways with railroads or light rail transit.

The MUTCD shall not apply to the following types of facilities:

A. Roadways within private gated properties where access to the general public is restricted at all times;
B. Grade crossings of privately-owned roadways with railroads; and
C. Parking areas, including the driving aisles within those parking areas, that are either publicly or privately-owned.

Support. The policies and procedures of the Federal Highway Administration (FHWA) to obtain basic uniformity of traffic control devices are as described in 23 CFR 655, Subpart F.

Section 15-116 of the UVC (see Section 1A.06) states, "No person shall install or maintain in any area of private property used by the public any sign, signal, marking, or other device intended to regulate, warn, or guide traffic unless it conforms with the State manual and specifications adopted under Section 15-104." Adoption by agencies of such a provision through statute or ordinance can help maintain the integrity of official traffic control devices and provide continuity of uniformity at locations that are not subject to the provisions of this Manual.

State Adoption and Conformance (MUTCD Section 1B.02)

Support. All States have officially adopted the National MUTCD either in its entirety, with supplemental provisions, or as a separate published document. The National MUTCD has also been adopted by the National Park Service, the U.S. Forest Service, the U.S. Military Command, the Bureau of Indian Affairs, the Bureau of Land Management, and the U.S. Fish and

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Wildlife Service.

Standard. States or other Federal agencies that have their own MUTCDs or Supplements shall revise these MUTCDs or Supplements to be in substantial conformance with changes to the National MUTCD within 2 years of the effective date of the Final Rule for the changes [23 CFR 655.603(b)(3)]. Substantial conformance of such State or other Federal agency MUTCDs or Supplements shall be as defined in 23 CFR 655.603(b)(1).

For the purposes of the above paragraph, policies, directives, specifications, standard drawings, or similar documents that are issued by an agency and that change or modify Standard, Guidance, or Option provisions in this Manual shall be considered as supplements to the MUTCD and shall also be revised to be in substantial conformance with the National MUTCD.

Compliance of Devices (MUTCD Section 1B.03)

Standard. The U.S. Secretary of Transportation, under authority granted by the Highway Safety Act of 1966, decreed that traffic control devices on all streets and highways open to public travel in accordance with 23 U.S.C. 109(d) and 402(a) in each State shall be in substantial conformance with the Standards issued or endorsed by the FHWA.

Support. 23 CFR 655.603 also requires traffic control devices on all streets, highways, bikeways, and site roadways open to public travel in each State be in substantial conformance with standards issued or endorsed by the Federal Highway Administrator.

Standard. After the effective date of a new edition of the MUTCD or a revision thereto, or after the adoption thereof by the State, whichever occurs later, new or reconstructed devices installed shall comply with the new edition or revision, as required by 23 CFR 655.603.

In cases involving Federal-aid projects for new construction, reconstruction, resurfacing, restoration, or rehabilitation of a facility to which this Manual applies, the traffic control devices installed (temporary or permanent) shall comply with the most recent edition of the National MUTCD before that highway is opened or re-opened to the public for unrestricted travel [23 CFR 655.603(d)(2) and (d)(3)].

Unless a particular device is no longer serviceable (see definition in Section 1C.02), non-compliant devices on existing highways and bikeways shall be brought into compliance with the current edition of the National MUTCD as part of the systematic upgrading of substandard traffic control devices (and installation of new required traffic control devices) required pursuant to the Highway Safety Program, 23 U.S.C. §402(a).

Support. The FHWA has the authority to establish other target compliance dates for implementation of particular changes to the MUTCD [23 CFR 655.603(d)(1)].

Standard. The target compliance dates established by the FHWA shall be as shown in Table 1B-1.

Design, application, and placement of traffic control devices other than those adopted in this Manual shall be prohibited unless the provisions of Section 1B.04 through Section 1B.08 are followed regarding official interpretations, experiments, changes to the MUTCD, and interim approvals granted by the FHWA.

Support. Many of the provisions in this Manual that are explicitly prohibitive have been included to address practices that have been shown to be ineffective, unsafe, or inconsistent with uniformity. A provision of mandatory or recommended practice represents the accepted and established practice that promotes uniformity and consistency. The absence of a provision in this Manual that explicitly prohibits a particular practice, use, design, application, operation, or other aspect of a traffic control device does not, in itself, constitute acceptability or permission to use the device in a manner not provided for in this Manual.

Table 1B-1. Target Compliance Dates Established by the FHWA

MUTCD Section(s)	Subject Area	Specific Provision	Compliance Date
2B.64	Weight Limit Signs	Paragraph 14 - requirement for additional Weight Limit sign with the advisory distance or directional legend in advance of applicable section of highway or structure	5 years from the effective date of this edition of the MUTCD
2C.25	Low Clearance Signs (W12-2)	Paragraph 1 - Required posting of the Low Clearance Advance (W12-2) sign in advance of the structure	5 years from the effective date of this edition of the MUTCD
2C.25	Low Clearance Signs (W12-2a, W12-2b)	Paragraph 8 - Recommended posting of Low Clearance Overhead (W12-2a or 12-2b) signs on an arch or other structure under which the clearance varies greatly	5 years from the effective date of this edition of the MUTCD
3A.05	Maintaining Minimum Retroreflectivity	Implementation and continued use of a method that is designed to maintain retroreflectivity of longitudinal pavement markings (see Paragraph 1 of Section 3A.05)	September 6, 2026
8B.16	High-Profile Grade Crossings	Paragraphs 3 and 7 - Recommended installation of Low Ground Clearance and/or Vehicle Exclusion signs and detour signs for vehicles with low ground clearances that might hang up on high-profile grade crossings at locations with a known history	5 years from the effective date of this edition of the MUTCD
8D.09 through 8D.12	Highway Traffic Signals at or Near Grade Crossings	Assessment and determination of appropriate treatment to achieve compliance (preemption, movement prohibition, pre-signals, queue cutter signals)	10 years from the effective date of this edition of the MUTCD

Guidance. Agencies should contact the FHWA when considering employing a practice or application that is not explicitly addressed in this Manual to ensure continued compliance with the provisions in this Manual.

Support. The FHWA reviews and interprets the provisions in this Manual for agencies on an as-needed basis, which can lead to the issuance of official interpretations (see Section 1B.04), or interim approvals (see Section 1B.07).

Standard. A non-compliant traffic control device that is being replaced or refurbished because it is damaged, missing, or no longer serviceable (see definition in Section 1C.02) for any reason shall be replaced with a compliant device, except as provided for in the paragraph below.

Option. A non-compliant traffic control device may be replaced in kind when engineering judgment indicates it is more appropriate because:

A. One compliant device in the midst of a series of adjacent non-compliant devices would be confusing to road users, and/or

B. The schedule for replacement of the whole series of non-compliant devices will result in achieving timely compliance with the MUTCD.

Interpretations (MUTCD Section 1B.04)

Support. The FHWA issues authoritative interpretations of this Manual when necessary to provide clarity in response to unique situations for device application or general requests for clarification of a provision.

An interpretation includes a consideration of the application and operation of standard traffic control devices, the official meanings of standard traffic control devices, or the variations from standard device designs and design requirements.

Guidance. Requests for an interpretation of this Manual should contain the following information:

A. A concise statement of the interpretation being sought;

B. A description of the condition that provoked the need for an interpretation;

C. Any illustration that would be helpful to understand the request; and

D. Any supporting research data that is pertinent to the item to be interpreted.

Support. Section 1B.08 contains information on submitting a request for interpretation.

Experimentation (MUTCD Section 1B.05)

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Support. Requests for experimentation (see Section 1B.08) include consideration of field deployment for the purpose of testing or evaluating a new traffic control device, its application or manner of use, or a provision not specifically described in this Manual.

Standard. A traffic control device or application that does not comply with the provisions of this Manual shall not be used on any street, highway, bikeway, or site roadway open to public travel (see definition in Section 1C.02) without first receiving official approval to experiment from the FHWA's Office of Transportation Operations.

Support. A request for permission to experiment (see Section 1B.08) will be considered only when submitted by the public agency or toll facility authority responsible for the operation of the road or street on which the experiment is to take place. For a site roadway open to public travel, the request will be considered only if it is submitted by the private owner or official having jurisdiction.

A request for experimentation with a novel device or application across multiple jurisdictions as a single experiment with a common hypothesis, evaluation plan, and evaluation team will be considered when submitted jointly by all the authorities responsible for operation of the roads or streets on which the experiment is to take place. Similarly, a request to add experimental sites to an experimentation approved for another jurisdiction will be considered when submitted jointly by the all the authorities for operation of the roads or streets on which the experiment is then to take place.

Manufacturers or inventors of novel devices are encouraged to engage the services of a qualified traffic engineer or other professional who is versed in traffic control devices. Early engagement during the concept and development processes will help ensure the efficacy of the device with regard to human factors, operational, safety, and other considerations prior to an agency requesting experimentation.

In some cases, an off-roadway closed-course or laboratory study might be required before a request for experimentation can be considered. The purpose of such a study is to determine whether testing the experimental device or application in an open-road setting could result in an undue safety risk.

Guidance. Before requesting permission to experiment with a new device or application, an owner of a site roadway open to public travel should first check for any laws, regulations, and/or directives covering the application of the MUTCD that might apply.

Option. An agency may request a preliminary assessment of the viability of a potential request for experimentation by submitting an abstract that briefly describes the experimental concept.

Support. A diagram indicating the process for requesting and conducting experimentations with traffic control devices is shown in Figure 1B-1.

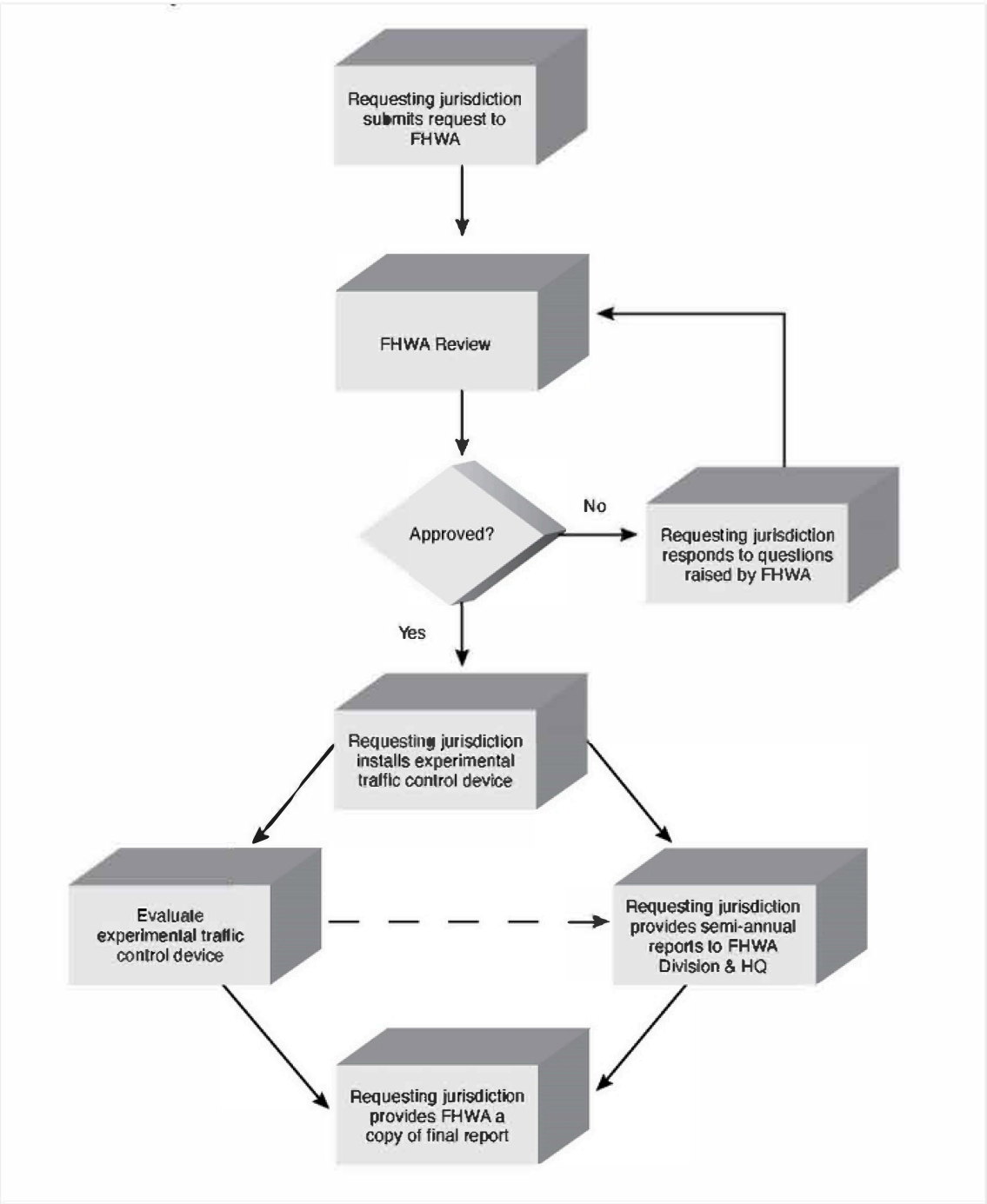


Figure 1B-1. Process for Requesting and Conducting Experimentations for New Traffic Control Devices

Standard. The request for permission to experiment shall contain the following:

A. A statement indicating the nature of the problem and a hypothesis establishing the premise of the experiment.

B. A description of the proposed change to the traffic control device or application of the traffic control device, including the manner in which it deviates from the provisions of this Manual, and how it is expected to be an improvement over existing provisions.

C. Illustrations that would help to explain the traffic control device or use of the traffic control device.

D. Any supporting data explaining how the traffic control device was developed, including if it has been tested, in what ways it was found to be adequate or inadequate, and how this choice of device or application was derived.

E. Comparison of the proposed device to other compliant devices or treatments, either individually or in combination, that address the same condition, if applicable.

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F. A legally-binding statement that the experimental device or application is in the public domain, in accordance with the following paragraphs of this Section.

G. The time period and location(s) of the experiment.

H. Control sites for comparison purposes or justification for not using control sites.

I. A detailed research and evaluation plan that provides for close monitoring of the experimentation, throughout all stages of its field implementation. The evaluation plan shall include an appropriate evaluation methodology, such as before and after analysis, or other appropriate methodology as well as quantitative data describing the performance of the experimental device.

J. An agreement to provide semi-annual progress reports for the duration of the experimentation, in accordance with the schedule provided in Paragraph 12 of this Section, and an agreement to provide a report of the final results of the experimentation to the FHWA's Office of Transportation Operations within 3 months following completion of the experimentation (see following paragraphs). The FHWA's Office of Transportation Operations shall have the right to terminate approval of an agency's experiment if reports are not received in accordance with this schedule.

K. An agreement to restore the site of the experiment to a condition that complies with the provisions of this Manual within 3 months following the end of the time period of the experiment. This agreement shall also provide that the agency sponsoring the experimentation will terminate the experimentation at any time that it determines that safety concerns are directly or indirectly attributable to the experimentation and the agency shall provide timely notification to the FHWA's Office of Transportation Operations. The FHWA's Office of Transportation Operations shall have the right to terminate approval of the experimentation at any time if there is an indication of safety or operational concerns, or if the terms of the approval are not being adhered to. If, as a result of the experimentation, a request is made that this Manual be changed to include the device or application being experimented with, the FHWA's Office of Transportation Operations will determine whether the device or application can be permitted to remain in place until an official rulemaking action has occurred.

Where an item in the above paragraph is determined to not be applicable to the type of experiment, device, or application, the request shall provide sufficient explanation.

The required semi-annual progress reports shall be submitted throughout the course of an approved experiment in accordance with the following schedule:

A. No later than August 1st for the preceding period of January through June; and

B. No later than February 1st for the preceding period of July through December.

The experimenting agency shall submit a semi-annual progress report for any approved experiment even if no work was performed during the previous reporting period. Failure to submit two consecutive progress reports shall result in termination of the experiment and shall constitute rescission of the FHWA's approval to the experimenting agency, requiring restoration of the site(s) to a condition that complies with the provisions of this Manual within 3 months.

The experimenting agency shall submit a final report within 3 months of the conclusion of an approved experiment. If a final report is not received by the FHWA's Office of Transportation Operations, and the experimenting agency fails to notify the FHWA of any mitigating circumstances within 6 months of the end of the approved experimentation period, then the experiment shall be considered terminated and shall constitute rescission of the FHWA's approval to the experimenting agency, requiring restoration of the site(s) to a condition that complies with the provisions of this Manual within 3 months.

Support. Under certain circumstances the FHWA Office of Transportation Operations might allow an experimental device or device application that has been shown to be effective and without safety concerns to remain in use after the experiment has ended. This typically would occur if the device or application is actively being considered for interim approval under the provisions of Section 1B.07.

Standard. A request for experimentation that involves a new traffic control device or a new application of an existing traffic control device shall include from the agency conducting the experiment, the manufacturer and/or developer of the device, and the supplier of the device, a legally-binding statement certifying that the traffic control device is not protected by a patent, trademark, or copyright in accordance with Section 1D.06, and that the traffic control device is in the public domain and can be used freely in traffic control device design and application without infringement or claim of trade secret misappropriation. The legally-binding statement shall also state that the agency conducting the experiment, the manufacturer and/or developer of the device, and the supplier of the device are aware that if patent, trademark, or copyright protection is established in the future for the device or application, such action will result in its removal from the MUTCD, cancellation of its interim approval, or cancellation of the authorization for experimentation.

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Support. For the purpose of the Standard paragraph above, traffic control device refers to those aspects of a sign, signal, marking or other device which regulates, warns, or guides traffic. The limitation on patent, trademark, or copyright protection does not include the legal protection of individual elements of such devices. For example, manufacturing methods, assembly methods, or individual components of such devices can be protected, whereas the traffic control device cannot be subject to protection so long as it remains in this Manual. As a further example, an internal circuit board for an electronic traffic control device can be legally protected, but the electronic traffic control device itself or its operational function cannot be legally protected by any of the above forms of intellectual property rights.

Changes to the MUTCD (MUTCD Section 1B.06)

Support. Continuing advances in technology and approaches to traffic safety will produce changes in the highway, vehicle, and road-user proficiency; therefore, portions of the system of traffic control devices in this Manual will require updating. It is important to have a procedure for recognizing these developments and for introducing new ideas and modifications into the system.

A change includes consideration of a new device to replace a present standard device, an additional device to be added to the list of standard devices, or a revision to a traffic control device application or placement criteria.

Guidance. Requests for a change to this Manual (see Section 1B.08) should contain the following information:

A. A statement indicating what change is proposed;

B. Any illustration that would be helpful to understand the request; and

C. Any supporting research data that is pertinent to the item to be reviewed.

Support. Requests for a change to this Manual will be evaluated to consider the potential safety and operational benefits of the requested change and be considered for inclusion in the future rulemaking to issue a new edition or revision of the Manual. A diagram indicating the process for incorporating new traffic control devices into this Manual is shown in [[#fig1b2|Figure 1B-2].

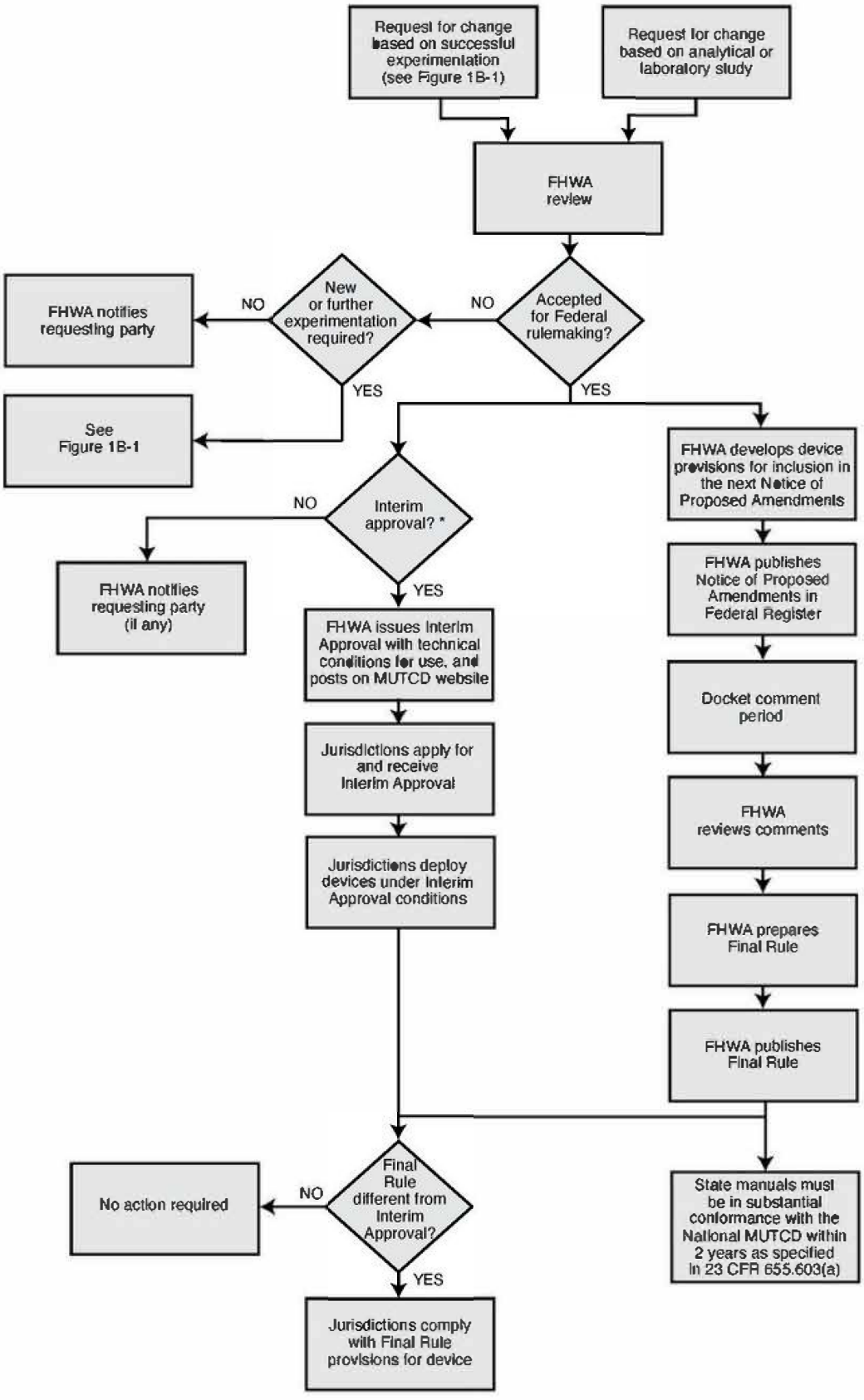


Figure 1B-2. Process for Incorporating New Traffic Control Devices into the MUTCD

Interim Approvals (MUTCD Section 1B.07)

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Support. Interim approval allows for provisional use, pending official rulemaking, of a new traffic control device, a revision to the application or manner of use of an existing traffic control device, or a provision not specifically described in this Manual.

The FHWA issues an interim approval by official memorandum signed by the Associate Administrator for Operations and posts this memorandum on the MUTCD Web site.

Interim approval allows for the optional use of a traffic control device or application and does not create a new mandate or recommendation for its use. Interim approval includes conditions that jurisdictions, toll facility operators, or owners of site roadways open to public travel agree to comply with in order to use the traffic control device or application until an official rulemaking action has occurred.

The issuance by FHWA of an interim approval might result in the traffic control device or application being proposed for adoption in the next scheduled rulemaking process to issue a new edition or revision of this Manual. If the device or application under interim approval is not proposed in the next rulemaking for a new edition or revision, then a statement of the status of the interim approval, whether it is to be rescinded or remain in effect, will be included in the Federal Register notice for the rulemaking.

Interim approval is considered based on the results of experimentation, and/or results of analytical or laboratory studies with a traffic control device or application that analytically demonstrates a device effectively communicates its intended meaning. Interim approval considerations include an assessment of relative risks, benefits, costs, impacts, and other factors.

Section 1B.08 contains information on submitting a request for interim approval.

Interim approval is ordinarily considered only after published authoritative research and experimentation sufficiently demonstrate that the device or application provides a significant safety or operational improvement. Individual experiments by various jurisdictions, without a research report on the overall findings of the experimental device or application, will not ordinarily qualify for issuance of an interim approval.

Interim approval ordinarily is not considered based solely on non-U.S. experience with a new traffic control device or application. Differences in regulations, enforcement and penalties, and driver licensing requirements, among other factors, can result in dissimilar road-user behavior. Additionally, due to variations in conventions for traffic control device design, a non-U.S. traffic control device concept might need to be adapted to U.S. criteria to ensure consistency with the provisions and principles of this Manual. However, documented non-U.S. experience can be considered in the development of requests for experimentation (see Section 1B.05) and within the evaluation plan for traffic control device research.

Standard. A jurisdiction, toll facility operator, or owner of a site roadway open to public travel that desires to use a traffic control device or application for which FHWA has issued an interim approval shall request and receive permission from FHWA in writing prior to applying the device or application.

The request to place a traffic control device or application under an existing interim approval shall be made by Highway Safety and Traffic Division and shall contain the following:

A. A description of where the device or application will be used, such as a list of specific locations or highway segments or types of situations, or a statement of the intent to use the device or application jurisdiction-wide;

B. An agreement to abide by the specific conditions for use of the device or application as contained in the FHWA's interim approval memorandum;

C. An agreement to maintain and continually update a list of locations where the device or application has been installed; and

D. An agreement to:

1. Restore the site(s) of the interim approval to a condition that complies with the provisions in this Manual within 3 months following the issuance of a Final Rule on this traffic control device or application; and
2. Terminate use of the device or application installed under the interim approval at any time that it determines that safety concerns are directly or indirectly attributable to the device or application. The FHWA's Office of Transportation Operations shall have the right to terminate the interim approval at any time if there is an indication of safety, operational, or other concerns.

Option. A State may submit a request for permission to use a device or application under an existing interim approval for all jurisdictions in that State, as long as the request contains the information required in the above paragraph.

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Standard. A jurisdiction, toll facility operator, or owner of a site roadway open to public travel that elects to use a device or application under a statewide interim approval shall inform the State of its use of the device or application.

Under a statewide interim approval, the respective jurisdictions, toll facility operators, and owners of site roadways open to public travel shall maintain and continually update a record of all locations on their roads where the device or application is implemented (see Item C of the paragraph above) and shall furnish this information to the State.

Requesting Official Interpretations, Experiments, Changes to the MUTCD, or Interim Approvals (MUTCD Section 1B.08)

Guidance. A local jurisdiction, toll facility operator, or owner of a site roadway open to public travel that is requesting permission to experiment or permission to use a device or application under an existing interim approval should first check for any State laws, regulations, and/or directives covering the application of the MUTCD provisions that might apply.

Standard. Except as provided in the Option paragraph below, requests for an interpretation, permission to experiment, a change to the MUTCD, granting of an interim approval, or permission to use an existing interim approval shall be submitted electronically to the Federal Highway Administration (FHWA), Office of Transportation Operations, MUTCD team, at the following e-mail address: MUTCDofficialrequest@dot.gov.

All requests shall be submitted to FHWA by the Highway Safety and Traffic Division.

Option. If electronic submittal is not possible, requests for an interpretation, permission to experiment, a change to the MUTCD, granting of an interim approval, or permission to use an existing interim approval may instead be mailed to the Office of Transportation Operations, HOTO-1, Federal Highway Administration, 1200 New Jersey Avenue, SE, Washington, DC 20590.

Support. Communications regarding other MUTCD matters that are not related to official requests will receive quicker attention if they are submitted electronically to the MUTCD Team Leader or to the appropriate individual MUTCD technical lead team member. Their e-mail addresses are available through the links contained on the "MUTCD Team" page on the MUTCD Web site at http://mutcd.fhwa.dot.gov/team.htm.

For additional information concerning interpretations, experimentation, changes, or interim approvals, visit the MUTCD Web site at http://mutcd.fhwa.dot.gov.

Definitions of Headings Used in this Manual (MUTCD Section 1C.01)

Standard. When used in this Manual, the text headings of Standard, Guidance, Option, and Support shall be defined as follows:

A. Standard—a statement of required, mandatory, or specifically prohibitive practice regarding a traffic control device. In limited, location-specific cases, the results of a documented engineering study (see Section 1D.03) might indicate a deviation from one or more requirements of a Standard provision to be appropriate. All Standard statements are labeled, and the text appears in bold type. The verb "shall" is typically used. The verbs "should" and "may" are not used in Standard statements. Standard statements are sometimes modified by Option statements.
B. Guidance—a statement of recommended practice in typical situations, with deviations allowed if engineering judgment or engineering study (see Section 1D.03) indicates the deviation to be appropriate. All Guidance statements are labeled, and the text appears in unbold italic type. The verb "should" is typically used. The verbs "shall" and "may" are not used in Guidance statements. Guidance statements are sometimes modified by Option statements.
C. Option—a statement of practice that is a permissive condition and carries no requirement or recommendation. Option statements sometimes contain allowable modifications to a Standard or Guidance statement. All Option statements are labeled, and the text appears in unbold type. The verb "may" is typically used. The verbs "shall" and "should" are not used in Option statements.
D. Support—an informational statement that does not convey any degree of mandate, recommendation, authorization, prohibition, or enforceable condition. Support statements are labeled, and the text appears in unbold type. The verbs "shall," "should," and "may" are not used in Support statements.

Definitions of Words and Phrases Used in this Manual (MUTCD Section 1C.02)

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Standard. Unless otherwise defined in this Section, or in other Parts of this Manual, words or phrases shall have the meaning(s) as defined in the "Uniform Vehicle Code," "AASHTO Transportation Glossary (Highway Definitions)," or other appropriate publications. Where a term that is defined in this Section or elsewhere in this Manual has a different definition in another resource or in common use, the definition herein shall govern for purposes of the applicability of the provisions of this Manual. The following words and phrases, when used in this Manual, shall have the following meanings:

1. Accessible Pedestrian Signal—a device that communicates information about pedestrian signal timing in a non-visual format such as audible tones and/or speech messages and vibrating surfaces.
2. Accessible Pedestrian Signal Detector—a device designated to assist the pedestrian who has vision or physical disabilities in activating the pedestrian phase.
3. Active Grade Crossing—a grade crossing equipped with automatic traffic control devices, such as flashing-light signals, gates, and/or traffic control signals, that are activated upon the detection of approaching rail traffic.
4. Actuated—a type of traffic control signal operation in which some or all signal phases are operated on the basis of actuation.
5. Actuation—initiation of, a change in, or an extension of a traffic signal phase or a sign legend through the operation of any type of detector.
6. Advance Preemption—the notification of approaching rail traffic that is forwarded to the highway traffic signal controller unit or assembly by the railroad or light rail transit equipment in advance of the activation of the railroad or light rail transit warning devices.
7. Advance Preemption Time—the period of time that is the difference between the required maximum highway traffic signal preemption time and the activation of the railroad or light rail transit warning devices.
8. Advisory Speed—a recommended speed for all vehicles operating on a section of highway and based on the highway design, operating characteristics, and conditions.
9. Agency—an organization with the responsibility for providing, maintaining, and/or operating a public or private road system.
10. Alley—a street or highway intended to provide access to the rear or side of lots or buildings in urban areas and not intended for the purpose of through vehicular traffic.
11. Annual Average Daily Traffic (AADT)—the total volume of traffic passing a point or segment of a highway facility in both directions for one year divided by the number of days in the year. Normally, periodic daily traffic volumes are adjusted for hours of the day counted, days of the week, and seasons of the year to arrive at annual average daily traffic.
12. Application—in regard to a traffic control device, the act of deciding to use a device, generally or at a particular location for a particular condition.
13. Approach—all lanes of traffic moving toward an intersection or a midblock location from one direction, including any adjacent parking lane(s).
14. Arterial Highway (Street)—a general term denoting a highway primarily used by through traffic, usually on a continuous route or a highway designated as part of an arterial system.
15. Automated Vehicle—see Driving Automation System.
16. Automatic Lane—see Exact Change Lane within the definition of Toll Collection.
17. Average Daily Traffic (ADT)—the average 24 hour volume, being the total volume during a stated period divided by the number of days in that period. Normally, this would be periodic daily traffic volumes over several days, not adjusted for days of the week or seasons of the year.
18. Average Day—a day representing traffic volumes normally and repeatedly found at a location, typically a weekday when volumes are influenced by employment or a weekend day when volumes are influenced by entertainment or recreation.
19. Backplate—see Signal Backplate.
20. Barrier-Separated Lane—a preferential lane or other special purpose lane that is separated from the adjacent general-purpose lane(s) by a physical barrier.
21. Beacon—a highway traffic signal with one or more signal indications that operates in a flashing mode. Types of beacons include:
    a. Emergency-Vehicle Hybrid Beacon—a special type of beacon (see Hybrid Beacon).
    b. Intersection Control Beacon—a beacon used only at an intersection to control two or more directions of travel.
    c. Pedestrian Hybrid Beacon—a special type of beacon (see Hybrid Beacon).
    d. Rectangular Rapid-Flashing Beacon (RRFB)—a pedestrian-activated and/or bicycle-activated device comprising two horizontally arranged, rapidly flashed, rectangular-shaped yellow indications that is used to provide supplemental emphasis for a pedestrian, school, or trail crossing warning sign at a marked crosswalk across an uncontrolled approach.
    e. Speed Limit Sign Beacon—a beacon used only to supplement a SPEED LIMIT sign.
    f. Stop Beacon—a beacon used only to supplement a STOP sign, a DO NOT ENTER sign, or a WRONG WAY sign.
    g. Warning Beacon—a beacon used only to supplement an appropriate warning or regulatory sign or marker.
22. Bicycle—a pedal-powered vehicle upon which the human operator sits.

23. Bicycle Box—a designated area on the approach to a signalized intersection, between an advance motorist stop line and the crosswalk or intersection, intended to provide bicyclists a visible place to wait in front of stopped motorists during the red signal phase.
24. Bicycle Facilities—a general term denoting improvements and provisions that accommodate or encourage bicycling, including parking and storage facilities, and shared roadways not specifically defined for bicycle use.
25. Bicycle Lane—a portion of a roadway that has been designated for preferential or exclusive use by bicyclists. A typical bicycle lane is delineated from the adjacent general-purpose lane(s) by longitudinal pavement markings and bicycle lane symbol or word markings and, if used, signs. Other types of bicycle lanes include:
    a. Buffer-Separated Bicycle Lane—a bicycle lane that is separated from the adjacent general-purpose lane(s) by a pattern of standard longitudinal pavement markings that is wider than a normal or wide lane line marking.
    b. Counter-Flow Bicycle Lane—a one-directional bicycle lane that provides a lawful path of travel for bicycles in the opposite direction from general traffic on a roadway that allows general traffic to travel in only one direction. Counter-flow bicycle lanes are designated by the traffic control devices used for other bicycle lanes.
    c. Separated Bicycle Lane—an exclusive facility for bicyclists that is located within or directly adjacent to the roadway and that is physically separated from motor vehicle traffic with a vertical element. Separated bicycle lanes are differentiated from other bicycle lanes by a vertical element.
26. Bicycle Signal Face—a signal face that displays only bicycle symbol signal indications, that exclusively controls a bicycle movement from a designated bicycle lane or from a separate facility such as a shared-use path, and that displays signal indications that are applicable only to the bicycle movement.
27. Bicycle Symbol Signal Indication—a red, yellow, or green signal indication that displays a bicycle symbol rather than a circular or arrow indication.
28. Bikeway—a generic term for any road, street, path, or way that in some manner is specifically designated for bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or are to be shared with other transportation modes.
29. Blank-Out Sign—a sign that displays a single predetermined message only when activated. When not activated, the sign legend is not visible.
30. Buffer-Separated Lane—a preferential lane or other special purpose lane that is separated from the adjacent general-purpose lane(s) by a pattern of standard longitudinal pavement markings that is wider than a normal or wide lane line marking. The buffer area might include rumble strips, textured pavement, or channelizing devices such as tubular markers or traversable curbs, but does not include a physical barrier.
31. Business Identification Sign Panel—a panel containing a word legend or logo used to identify a business on a Specific Service sign.
32. Busway—a traveled way that is used exclusively by buses.
33. Cantilevered Signal Structure—a structure, also referred to as a mast arm, that is rigidly attached to a vertical pole and is used to provide overhead support of highway traffic signal faces or grade crossing signal units.
34. Center Line Markings—the yellow pavement marking line(s) that delineates the separation of traffic lanes that have opposite directions of travel on a roadway. These markings need not be at the geometrical center of the pavement.
35. Changeable Message Sign—a sign that is capable of displaying more than one message (one of which might be a “blank” display), changeable manually, by remote control, or by automatic control. Electronic-display changeable message signs are referred to as Dynamic Message Signs in the National Intelligent Transportation Systems (ITS) Architecture and are referred to as Variable Message Signs in the National Electrical Manufacturers Association (NEMA) standards publication.
36. Channelizing Line—a solid wide or double white line marking used to form islands where traffic in the same direction of travel is permitted on both sides of the island.
37. Circular Intersection—an intersection that has an island, generally circular in design, located in the center of the intersection where traffic passes to the right of the island. Circular intersections include roundabouts, rotaries, and traffic circles.
38. Circulatory Roadway—the roadway within a circular intersection on which traffic travels in a counterclockwise direction around an island in the center of the circular intersection.
39. Clear Storage Distance—when used in EPG 913, the distance available for vehicle storage measured between 6 feet from the rail nearest the intersection to the intersection stop line or the normal stopping point on the highway. At skewed grade crossings and intersections, the 6-foot distance shall be measured perpendicular to the nearest rail either along the center line or edge line of the highway, as appropriate, to obtain the shorter distance. Where exit gates are used, the distance available for vehicle storage is measured from the point where the rear of the vehicle would be clear of the exit gate arm. In cases where the exit gate arm is parallel to the track(s) and is not perpendicular to the highway, the distance is measured either along the center line or edge line of the highway, as appropriate, to obtain the shorter distance.
40. Clear Zone—the total roadside border area, starting at the edge of the traveled way, that is available for an errant driver to stop or regain control of a vehicle. This area might consist of a shoulder, a recoverable slope, and/or a non-recoverable, traversable slope with a clear run-out area at its toe.
41. Collector Highway—a term denoting a highway that in rural areas connects small towns and local highways to arterial highways, and in urban areas provides land access and traffic circulation within residential, commercial, and business areas and connects local highways to the arterial highways.

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42. Conflict Monitor—a device used to detect and respond to improper or conflicting signal indications and improper operating voltages in a traffic controller assembly.
43. Constant Warning Time Detection—a means of detecting rail traffic that provides relatively uniform warning time for the approach of through rail traffic that is not accelerating or decelerating after being detected.
44. Contiguous Lane—a lane, preferential or otherwise, that is separated from the adjacent lane(s) only by a normal or wide lane line marking.
45. Controller Assembly—a complete electrical device mounted in a cabinet for controlling the operation of a highway traffic signal.
46. Controller Unit—that part of a controller assembly that is devoted to the selection and timing of the display of signal indications.
47. Conventional Road—a street or highway other than an expressway or freeway.
48. Counter-Flow Lane—a lane operating in a direction opposite to the normal flow of traffic designated for peak direction of travel during at least a portion of the day. Counter-flow lanes are usually separated from the off-peak direction lanes by tubular markers or other flexible channelizing devices, temporary lane separators, or movable or permanent barrier.
49. Crashworthy—the ability of a roadside safety hardware device or appurtenance to minimize risks to vehicle occupants by allowing a vehicle impacting the appurtenance to be slowed before stopping, redirected, or to continue without significant resistance. Section 1D.11 contains additional information about crashworthiness.
50. Crosswalk—(a) that part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or in the absence of curbs, from the edges of the traversable roadway, and in the absence of a sidewalk on one side of the roadway, the part of a roadway included within the extension of the lateral lines of the sidewalk at right angles to the center line; (b) any portion of a roadway at an intersection or elsewhere distinctly indicated as a pedestrian crossing by pavement marking lines on the surface, which might be supplemented by contrasting pavement texture, style, or color.
51. Crosswalk Lines—white pavement marking lines that identify a crosswalk.
52. Cycle Length—the time required for one complete sequence of signal indications.
53. Dark Mode—the lack of all signal indications at a signalized location. The dark mode is most commonly associated with power failures, ramp meters, hybrid beacons, beacons, and some movable bridge signals.
54. Dedicated Lane—a lane on a freeway or expressway that provides access to: (a) either an exit lane or the mainline, but not both, at a freeway or expressway exit, or (b) only one roadway at a freeway or expressway split.
55. Delineator—a retroreflective device mounted at the side of the roadway in a series to indicate the alignment of the roadway, especially at night or in adverse weather.
56. Design Vehicle—the longest vehicle permitted by statute of the road authority (State or other) on that roadway.
57. Designated Bicycle Route—a system of bikeways designated by the jurisdiction having authority with appropriate directional and informational route signs, with or without specific bicycle route numbers.
58. Detectable—a continuous edge within 6 inches of the surface so that pedestrians with vision disabilities can sense its presence and receive usable guidance information.
59. Detector—a device used for determining the presence or passage of motor vehicles, bicycles, or pedestrians.
60. Detection Plate—a smooth continuous plate used on pedestrian channelizing devices to facilitate the use of low-vision canes for pedestrians with vision disabilities. The bottom edge of the detection plate shall be no more than 2 inches above the walkway and the top edge of the detection plate shall be at least 8 inches above the walkway. The detection plate shall share the same vertical plane as the hand trailing edge of the pedestrian channelizing device.
61. Diagnostic Team—a group of knowledgeable representatives of the parties of interest in a grade crossing or group of grade crossings (see 23 CFR Part 646.204).
62. Downstream—a term that refers to a location that is encountered by traffic subsequent to an upstream location as it flows in an “upstream to downstream” direction. For example, “the downstream end of a lane line separating the turn lane from a through lane on the approach to an intersection” is the end of the lane line that is closest to the intersection.
63. Driveway—an access from a roadway to a building, site, or abutting property.
64. Driving Aisle—circulation area for motor vehicles within a parking area, typically between rows of parking spaces. Driving aisles provide one-way or two-way travel. Driving aisles are exempted from compliance with MUTCD provisions.
65. Driving Automation System—technology that automates some or all aspects of the driving task to assist or replace the human vehicle operator. Section 5A.03 contains descriptions of the automation levels.
66. Dropped Lane—see Lane Drop.
67. Dual-Arrow Signal Section—a type of signal section designed to include both a yellow arrow and a green arrow.
68. Dynamic Envelope—the clearance required for light rail transit traffic, or a train and its cargo overhang due to any combination of loading, lateral motion, or suspension failure.
69. Dynamic Exit Gate Operating Mode—a mode of operation where the exit gate operation is based on the presence of vehicles within the minimum track clearance distance.
70. Dynamic Message Sign—see Changeable Message Sign.
71. Edge Line Markings—white or yellow pavement marking lines that delineate the right or left edge(s) of a traveled way.

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72. Electronic Toll Collection (ETC) Account Only Lane—a non-attended toll lane that is restricted to use only by vehicles with a registered toll payment account.
73. Emergency-Vehicle Hybrid Beacon—see Hybrid Beacon.
74. Emergency-Vehicle Traffic Control Signal—see Highway Traffic Signal.
75. Engineer—see Professional Engineer.
76. Engineering Judgment—the evaluation of available pertinent information including, but not limited to, the safety and operational efficiency of all road users, and the application of appropriate principles, provisions, and practices as contained in this Manual and other sources, for the purpose of deciding upon the design (see Section 1D.03), use, installation, or operation of a traffic control device. Engineering judgment shall be exercised by a professional engineer (see definition in this Section) with appropriate traffic engineering expertise, or by an individual working under the supervision of such an engineer, through the application of procedures and criteria established by the engineer. Documentation of engineering judgment is not required.
77. Engineering Study—the analysis and evaluation of available pertinent information including, but not limited to, the safety and operational efficiency of all road users, and the application of appropriate principles, provisions, and practices as contained in this Manual and other sources, for the purpose of deciding upon the design (see Section 1D.03), use, installation, or operation of a traffic control device. An engineering study shall be performed by a professional engineer (see definition in this Section) with appropriate traffic engineering expertise, or by an individual working under the supervision of such an engineer, through the application of procedures and criteria established by the engineer. An engineering study shall be documented in writing.
78. Entrance Gate—an automatic gate that can be lowered across the lanes approaching a grade crossing to block road users from entering the grade crossing.
79. Exclusive Alignment—a light rail transit track(s) or a bus rapid transit busway that is grade-separated or protected by a fence or traffic barrier. No grade crossings exist along the track(s) or busway. Motor vehicles, bicycles, and pedestrians are prohibited within the right-of-way. Subways and elevated structures are included within this definition.
80. Exit Gate—an automatic gate that can be lowered across the lanes departing a grade crossing to block road users from entering the grade crossing by driving in the opposing traffic lanes.
81. Exit Gate Clearance Time—for Four-Quadrant Gate systems at grade crossings, the amount of time provided to delay the descent of the exit gate arm(s) after entrance gate arm(s) begin to descend.
82. Exit Gate Operating Mode—for Four-Quadrant Gate systems at grade crossings, the mode of control used to govern the operation of the exit gate arms.
83. Expressway—a divided highway with partial control of access.
84. Fail-Safe—when used in EPG 913, a railroad signal design philosophy applied to a system or device such that the result of a hardware failure or the effect of a software error shall either prohibit the system or device from assuming or maintaining an unsafe state or shall cause the system or device to assume a state that is known to be safe.
85. Flagger—a person who actively controls the flow of vehicular traffic into and/or through a temporary traffic control zone using hand-signaling devices or an Automated Flagger Assistance Device (AFAD).
86. Flasher—a device used to turn highway traffic signal indications on and off at a repetitive rate of approximately once per second.
87. Flashing—an operation in which a light source, such as a traffic signal indication or LEDs in a sign, is turned on and off repetitively.
88. Flashing-Light Signals—a warning device consisting of two red signal indications arranged horizontally that are activated to flash alternately when rail traffic is approaching or present at a grade crossing.
89. Flashing Mode—a mode of operation in which at least one traffic signal indication in each vehicular signal face of a highway traffic signal is turned on and off repetitively.
90. Four-Quadrant Gate System—an exit gate system that includes entrance and exit gates that control and block road users on all lanes entering and exiting the grade crossing.
91. Freeway—a divided highway with full control of access.
92. Full-Actuated—a type of traffic control signal operation in which all signal phases function on the basis of actuation.
93. Gate—an automatically-operated or manually-operated traffic control device that is used to physically obstruct road users such that they are discouraged from proceeding past a particular point on a roadway or pathway, or such that they are discouraged from entering a particular grade crossing, ramp, lane, roadway, or facility.
94. General-Purpose Lane—a highway lane or set of lanes, other than a Managed Lane (see definition in this Section) or a Preferential Lane (see definition in this Section), that all or most of the traffic that is allowed on that highway is also allowed to use. Certain classes of vehicles, such as commercial vehicles or vehicles exceeding a certain weight or size, might be prohibited from using one or more of the general-purpose lanes. A general-purpose lane might also be restricted to certain uses, such as passing or turning or as an auxiliary lane.
95. Gore Area—see Physical Gore and Theoretical Gore.
96. Grade Crossing—the general area where a highway and a railroad and/or light rail transit route cross at the same level, within which are included the tracks, highway, and traffic control devices for traffic traversing that area.
97. Grade Crossing Warning System—the flashing-light signals, with or without automatic gates, together with the necessary control equipment used to inform road users of the approach or presence of rail traffic at a grade crossing.

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98. Guide Sign—a sign that shows route designations, highway names, destinations, directions, distances, services, points of interest, or other geographical, recreational, or cultural information.
99. High-Occupancy Vehicle (HOV)—a motor vehicle carrying at least two (or more than two if the signs for a specific roadway indicate a higher minimum occupancy requirement) persons, including carpools, vanpools, and buses.
100. Highway—a general term for denoting a public way for purposes of travel by vehicles and vulnerable road users, including the entire area within the right-of-way.
101. Highway-Light Rail Transit Grade Crossing—the general area where a highway and a light rail transit route cross at the same level, within which are included the light rail transit tracks, highway, and traffic control devices for traffic traversing that area.
102. Highway-Rail Grade Crossing—the general area where a highway and a railroad cross at the same level, within which are included the railroad tracks, highway, and traffic control devices for highway traffic traversing that area.
103. Highway Traffic Signal—a power-operated traffic control device by which traffic is warned or directed to take some specific action. These devices do not include power-operated signs (except as provided in EPG 902.18 and 902.19, steadily-illuminated raised pavement markers, gates, flashing-light signals (see EPG 913.4.2), warning lights (see EPG 616.12.7), or steady-burning electric lamps. Highway traffic signals include:

    a. Flashing Beacon—see Beacon.
    b. In-Roadway Warning Lights—a special type of highway traffic signal installed in the roadway surface to warn road users that they are approaching a condition on or adjacent to the roadway that might not be readily apparent and might require the road users to reduce speed and/or come to a stop.
    c. Lane-Use Control Signal—a signal face or comparable display on a full-matrix Changeable Message Sign (see EPG 903.12 and EPG 902.19) displaying indications to permit or prohibit the use of specific lanes of a roadway or a shoulder where driving is sometimes permitted, or to indicate the impending prohibition of such use.
    d. Traffic Control Signal (Traffic Signal)—a highway traffic signal placed at intersections, movable bridges, fire stations, midblock crosswalks, alternating one-way sections of a single lane road, private driveways, or other locations that require conflicting traffic to be directed to stop and permitted to proceed in an orderly manner. These devices do not include pedestrian hybrid beacons (see EPG 902.10) or emergency-vehicle hybrid beacons (see EPG 902.14). Traffic control signals include vehicular signal indications, pedestrian signal indications, and bicycle symbol signal indications. Special traffic control signals include:

        1. Emergency-Vehicle Traffic Control Signal—a traffic control signal that directs all conflicting traffic to stop in order to permit the driver of an authorized emergency vehicle to proceed into the roadway or intersection.
        2. Movable Bridge Traffic Control Signal—a traffic control signal installed at a movable bridge to notify traffic to stop during periods when the roadway is closed to allow the bridge to open.
        3. Portable Traffic Control Signal—a temporary component of a traffic control signal on a mobile support with one or more signal faces that is designed so that it can be easily transported, deployed, or relocated as part of a temporary traffic control signal, or during construction and maintenance as a temporary part of a permanent traffic control signal installation.
        4. Pre-Signal—traffic control signal faces that are located upstream from a signalized intersection and are operated in conjunction with the traffic control signal faces at the downstream signalized intersection in a manner that is designed to keep the area between the stop line for the upstream traffic control signal faces and the stop line for the downstream signalized intersection clear of queued vehicles. When used in conjunction with a grade crossing, the pre-signal is operated for the purpose of preventing vehicles from queuing within the minimum track clearance distance. Supplemental near-side traffic control signal faces for the downstream signalized intersection are not considered to be pre-signals.
        5. Queue Cutter Signal—an independently-controlled traffic control signal (not operated in conjunction with the traffic control signal faces at a downstream signalized intersection) located at a grade crossing that controls traffic in one direction only on the roadway for the purpose of keeping the minimum track clearance distance clear of vehicles. The display of red signal indications is activated from a downstream queue detection system, by time of day, by approaching rail traffic, by an approaching bus on a busway, or by a combination of any of these methods.
        6. Ramp Control Signal—a traffic control signal installed to control the merging flow of traffic onto a freeway at an entrance ramp or at a freeway-to-freeway ramp connection.
        7. Temporary Traffic Control Signal—a traffic control signal that is installed for a limited time period using fixed or portable traffic control signal units.

104. HOV Lane—any preferential lane designated for exclusive use by high-occupancy vehicles for all or part of a day—including a designated lane on a freeway, other highway, street, or independent roadway on a separate right-of-way.
105. Hybrid Beacon—a special type of beacon that is intentionally placed in a dark mode (no indications displayed) between periods of operation and, when operated, displays both steady and flashing traffic control signal indications. Hybrid beacons include:

    a. Emergency-Vehicle Hybrid Beacon—used to warn and control traffic at an unsignalized location to assist authorized emergency vehicles in entering or crossing a street or highway.
    b. Pedestrian Hybrid Beacon—used to warn and control traffic at an unsignalized location to assist pedestrians in crossing a street or highway at a marked crosswalk.

106. Identification Marker—a shape, color, and/or pictograph that is used as a visual identifier for a destination guide signing system of a community wayfinding system or a shared-use path system for an area.
107. Inherently Low Emission Vehicle (ILEV)—any kind of vehicle that, because of inherent properties of the fuel system design, will not have significant evaporative emissions, even if its evaporative emission control system has failed.
108. In-Roadway Warning Lights—see Highway Traffic Signal.
109. Interchange—a system of interconnecting roadways providing for traffic movement between two or more highways that do not intersect at grade.
110. Interchange Lane Drop—see Lane Drop.
111. Preemption Interconnection—the electrical connection between the railroad or light rail transit active warning system and the highway traffic signal controller assembly for the purpose of preemption.
112. Intermediate Interchange—an interchange with an urban or rural route that is not a major or minor interchange as defined in this Section.
113. Intersection—intersection is defined as follows:

    a. The area embraced within the prolongation or connection of the lateral curb lines, or if none, the lateral boundary lines of the roadways of two highways that join one another at, or approximately at, right angles, or the area within which vehicles traveling on different highways that join at any other angle might come into conflict.
    b. The junction of an alley, driveway, or site roadway with a public roadway or highway shall not constitute an intersection, unless the public roadway or highway at said junction is controlled by a traffic control device.
    c. If a highway includes two roadways separated by a median, then every crossing of each roadway of such divided highway by an intersecting highway shall be a separate intersection if the opposing left-turn paths cross and there is sufficient interior storage for the design vehicle (see Figure 903.1.23).
    d. At a location controlled by a traffic control signal, regardless of the distance between the separate intersections as defined in (c) above:

        1. If a stop line, yield line, or crosswalk has not been designated on the roadway (within the median) between the separate intersections, the two intersections and the roadway (median) between them shall be considered as one intersection;
        2. Where a stop line, yield line, or crosswalk is designated on the roadway on the intersection approach, the area within the crosswalk and/or beyond the designated stop line or yield line shall be part of the intersection; and
        3. Where a crosswalk is designated on a roadway on the departure from the intersection, the intersection shall include the area extending to the far side of such crosswalk.

114. Intersection Control Beacon—see Beacon.
115. Interval—the part of a signal cycle during which signal indications do not change.
116. Island—a defined area between traffic lanes for control of vehicular movements, for toll collection, or for pedestrian or bicyclist refuge. It includes all end protection and approach treatments. Within an intersection area, a median or an outer separation is considered to be an island.
117. Jughandle Turn—a left-turn or U-turn that, in conjunction with special geometry, is made by initially making a right-turn or diverging to the right. With other special geometry, a right-turn or U-turn makes a jughandle turn by initially making a left-turn or diverging to the left.
118. Lane Drop—a through lane that becomes a mandatory turn lane on a conventional roadway, or a through lane that becomes a mandatory exit lane on a freeway or expressway. The end of an acceleration lane and reductions in the number of through lanes that do not involve a mandatory turn or exit are not considered lane drops.
119. Lane Line Markings—white pavement marking lines that delineate the separation of traffic lanes that have the same direction of travel on a roadway.
120. Lane Reduction—a gradual narrowing of the travel pavement (taper) through physical construction or pavement markings at which traffic in the lane being eliminated must merge into the adjacent through lane and continue in the same direction of travel. A lane reduction can occur outside the influence of an intersection or interchange, or within an interchange a short distance downstream of the gore of an exit ramp. Through lanes that become a mandatory turn or exit are considered lane drops rather than lane reductions.
121. Lane-Use Control Signal—see Highway Traffic Signal.
122. Legend—see Sign Legend.
123. Lens—see Signal Lens.
124. Light Rail Transit Traffic (Light Rail Transit Equipment)—every device in, upon, or by which any person or property can be transported on light rail transit tracks, including single-unit light rail transit cars (such as streetcars and trolleys) and assemblies of multiple light rail transit cars coupled together.
125. Loading Zone—a specially marked, signed or designated area for the loading or unloading of vehicles (passenger or freight).
126. Locomotive Horn—an air horn, steam whistle, or similar audible warning device (see 49 CFR Part 229.129) mounted on a locomotive or control cab car. The terms “locomotive horn,” “train whistle,” “locomotive whistle,” and “train horn” are used interchangeably in the railroad industry.

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127. Logo—a distinctive emblem or trademark that identifies a commercial or non-commercial business, program, or organization.
128. Longitudinal Markings—pavement markings that are generally placed parallel and adjacent to the flow of traffic such as lane lines, center lines, edge lines, channelizing lines, and others.
129. Louver—see Signal Louver.
130. Low-Volume Rural Road—a category of paved or unpaved conventional or special-purpose roadways having an AADT of less than 400 vehicles and lying outside of built-up or urbanized areas of cities, towns, and communities.
131. Major Interchange—an interchange with another freeway or expressway, or an interchange with a high-volume multi-lane highway, principal urban arterial, or major rural route where the interchanging traffic is heavy or includes many road users unfamiliar with the area.
132. Major Street—the street normally carrying the higher volume of vehicular traffic.
133. Malfunction Management Unit—see Conflict Monitor.
134. Managed Lane—a highway lane or set of lanes, or a highway facility, for which variable operational strategies such as direction of travel, tolling, pricing, and/or vehicle type or occupancy requirements are implemented and managed in real-time in response to changing conditions. Managed lanes are typically buffer-separated or barrier-separated lanes parallel to the general-purpose lanes of a highway in which access is restricted to designated locations. There are also some highways on which all lanes are managed.
135. Manual Lane—see Attended Lane within the definition of Toll Collection.
136. Maximum Highway Traffic Signal Preemption Time—the maximum amount of time needed following initiation of the preemption sequence for the highway traffic signals to complete the timing of the right-of-way transfer time, queue clearance time, and separation time.
137. Median—the portion of a highway separating opposing directions of the traveled way or the area between two roadways of a divided highway measured from edge of traveled way to edge of traveled way. The median excludes turn lanes. The median width might be different between intersections, interchanges, and at opposite approaches of the same intersection.
138. Minimum Track Clearance Distance—the length along a highway over the track(s) where a vehicle could be struck by rail traffic. The minimum track clearance distance is measured from a point upstream from the track(s) on the approach to the grade crossing to a point downstream from the track(s) on the departure from the grade crossing. The length along the highway between the two points is the minimum track clearance distance.
139. Minor Interchange—an interchange where traffic is local and very light, such as interchanges with land service access roads. Where the sum of the exit volumes is estimated to be lower than 100 vehicles per day in the design year, the interchange is classified as local.
140. Minor Street—the street normally carrying the lower volume of vehicular traffic.
141. Mixed-Use Alignment—a light rail transit track(s), a busway, or a bus only lane(s) where the light rail transit (LRT) or bus rapid transit (BRT) vehicles operate in mixed traffic with all types of road users. This includes streets, transit malls, and pedestrian malls where the right-of-way is shared. In a mixed-use alignment, the light rail transit or the bus rapid transit traffic does not have the right-of-way over other road users at grade crossings and intersections. If the LRT traffic or buses are controlled by traffic control signals or LRT signal faces at an intersection with a roadway, the alignment is considered to be mixed-use even if some of the approaches to the intersection are used exclusively by LRT traffic or buses.
142. Movable Bridge Resistance Gate—a type of traffic gate, which is located downstream of the movable bridge warning gate, that provides a physical deterrent to vehicle and/or pedestrian traffic when placed in the appropriate position.
143. Movable Bridge Signal—see Highway Traffic Signal.
144. Movable Bridge Warning Gate—a type of traffic gate designed to warn, but not primarily to block, vehicle and/or pedestrian traffic when placed in the appropriate position.
145. Multi-Lane—more than one lane moving in the same direction. A multi-lane street, highway, or roadway has a basic cross-section comprised of two or more through lanes in one or both directions. A multi-lane approach has two or more lanes moving toward the intersection, including turning lanes.
146. Neutral Area—the paved area between the channelizing lines separating an entrance or exit ramp or a channelized turn lane or channelized entering lane from the adjacent through lane(s).
147. Object Marker—a device used to mark obstructions within or adjacent to the roadway.
148. Occupancy Requirement—any restriction that regulates the use of a facility or one or more lanes of a facility for any period of the day based on a specified minimum number of persons in a vehicle.
149. Occupant—a person driving or riding in a car, truck, bus, or other vehicle.
150. On-Street Parking—parking within or along, and accessed directly from, a public roadway or a site roadway open to public travel.
151. Open-Road ETC Lane—a non-attended lane that is designed to allow toll payments to be electronically collected from vehicles traveling at normal highway speeds. Open-Road ETC lanes are typically physically separated from the toll plaza, often following the alignment of the mainline lanes, with toll plaza lanes for cash toll payments being on a different alignment after diverging from the mainline lanes or a subset thereof.
152. Open-Road Tolling Point—the location along an Open-Road ETC lane at which roadside or overhead detection and receiving equipment are placed and vehicles are electronically assessed a toll.

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153. Opposing Traffic—vehicles that are traveling in the opposite direction. At an intersection, vehicles entering from an approach that is approximately straight ahead would be considered to be opposing traffic, but vehicles entering from approaches on the left or right would be considered to be conflicting traffic rather than opposing traffic.
154. Option Lane— a lane on a freeway, expressway, or conventional road multi-lane exit or multi-lane split that widens on the approach to allow access, without changing lanes, to:
    a. Both an exit lane and the mainline at a freeway or expressway exit; or
    b. Both diverging roadways at a freeway, expressway, or conventional road split.
155. Overhead Sign—a sign that is placed such that a portion or the entirety of the sign or its support is directly above the roadway or shoulder such that vehicles travel below it. Typical installations include signs placed on cantilever arms that extend over the roadway or shoulder, signs placed on sign support structures that span the entire width of the pavement, signs placed on mast arms or span wires either independently or that also support traffic control signals, and signs placed on highway bridges that cross over the roadway.
156. Parking Area—a parking lot or parking garage that is separated from a roadway. Parallel, perpendicular, or angle parking spaces along a roadway are not considered a parking area.
157. Parking Space—an area marked or designated for storage of a vehicle while the driver is not present.
158. Preemption Clearance Interval—the part of a traffic signal sequence displayed as a result of a preemption request when vehicles are provided the opportunity to clear the railroad or light rail transit tracks, or a movable bridge, prior to the arrival of the train or boat for which the traffic signal is being preempted.
159. Preemption Time Variability—the result that occurs when the traffic signal controller enters the Preemption Clearance Interval with less than the maximum design Right-of-Way Transfer Time or the speed of a train approaching the grade crossing varies.
160. Passive Grade Crossing—a grade crossing where none of the automatic traffic control devices associated with an Active Grade Crossing Warning System are present and at which the traffic control devices consist entirely of signs and/or markings.
161. Pathway—a general term denoting a public way for purposes of travel by authorized users outside the traveled way and physically separated from the roadway by an open space or barrier and either within the highway right-of-way or within an independent alignment. Pathways include shared-use paths, but do not include sidewalks.
162. Pathway Grade Crossing—the general area where a pathway and railroad and/or light rail transit tracks cross at the same level, within which are included the tracks, pathway, and traffic control devices for pathway traffic traversing that area.
163. Paved—having a roadway surface that has both a structural (weight bearing) and a sealing purpose for the roadway, such as a bituminous surface treatment, mixed bituminous concrete, or Portland cement concrete.
164. Pedestrian—a person on foot, in a wheelchair, on other devices determined by local law to be equivalent, which might include skates or a skateboard.
165. Pedestrian Change Interval—an interval during which the flashing UPRAISED HAND (symbolizing DONT WALK) signal indication is displayed.
166. Pedestrian Clearance Time—the time provided for a pedestrian crossing in a crosswalk, after leaving the curb or edge of pavement, to travel to the far side of the traveled way or to a median.
167. Pedestrian Facility—a general term denoting a location where improvements and provisions have been made to accommodate or encourage pedestrian activity.
168. Pedestrian Hybrid Beacon—see Hybrid Beacon.
169. Pedestrian Signal Head—a signal head, which contains the symbols WALKING PERSON (symbolizing WALK) and UPRAISED HAND (symbolizing DONT WALK), that is installed to direct pedestrians at a traffic control signal.
170. Permissive Mode—a mode of traffic control signal operation in which left or right turns are permitted to be made after yielding to pedestrians, if any, and/or opposing traffic, if any. When a CIRCULAR GREEN signal indication is displayed, both left and right turns are permitted unless otherwise prohibited by another traffic control device. When a flashing YELLOW ARROW or flashing RED ARROW signal indication is displayed, the turn indicated by the arrow is permitted.
171. Physical Gore—a longitudinal point where a physical barrier or the lack of a paved surface inhibits road users from crossing from a ramp or channelized turn lane or channelized entering lane to the adjacent through lane(s) or vice versa.
172. Pictograph—a pictorial representation used to identify a governmental jurisdiction, an area of jurisdiction, a governmental or other public transportation agency or provider, a military base or branch of service, a governmental-approved university or college, a governmental-approved institution, or a toll payment system.
173. Plaque—a traffic control device intended to communicate specific information to road users through a word, symbol, or arrow legend that is placed immediately adjacent to a sign to supplement the message on the sign. The difference between a plaque and a sign is that a plaque cannot be used alone. The designation for a plaque includes a “P” suffix.
174. Platoon—a group of vehicles or pedestrians traveling together as a group, either voluntarily or involuntarily, because of traffic signal controls, geometrics, or other factors.
175. Portable Traffic Control Signal—see Highway Traffic Signal.
176. Post-Exit Ramp Lane Reduction—see Lane Reduction.
177. Post-Mounted Sign—a sign that is placed to the side of the roadway such that no portion of the sign or its support is directly above the roadway or shoulder.

178. Posted Speed Limit—a speed limit determined by law or regulation and displayed on Speed Limit signs.
179. Preemption—the transfer of normal operation of a traffic control signal or a hybrid beacon to a special control mode of operation.
180. Preferential Lane—a highway lane or set of lanes, or a highway facility, reserved for the exclusive use of one or more specific types of vehicles or of vehicles with a specific minimum number of occupants.
181. Pre-Signal—see Highway Traffic Signal.
182. Pretimed Operation—a type of traffic control signal operation in which none of the signal phases function on the basis of actuation.
183. Primary Signal Face—one of the required or recommended minimum number of signal faces for a given approach or separate turning movement, but not including near-side signal faces required as a result of the far-side signal faces exceeding the maximum distance from the stop line.
184. Principal Legend—place names, street names, and route numbers displayed on guide signs.
185. Priority Control—a means by which the assignment of right-of-way is obtained or modified.
186. Private Road—see Site Roadways Open to Public Travel.
187. Professional Engineer (P.E.)—an individual who has fulfilled education and experience requirements and passed examinations that, under State licensure laws, permit the individual to offer engineering services within areas of expertise directly to the public.
188. Protected Mode—a mode of traffic control signal operation in which left or right turns are permitted to be made only when a left or right GREEN ARROW signal indication is displayed.
189. Public Road—any road, street, or similar facility under the jurisdiction of and maintained by a public agency and open to public travel.
190. Push Button—a button to activate a device or signal timing for pedestrians, bicyclists, or other road users.
191. Push Button Information Message—a recorded message that can be actuated by pressing a push button when the walk interval is not timing and that provides the name of the street that the crosswalk associated with that particular push button crosses and can also provide other information about the intersection signalization or geometry.
192. Push Button Locator Tone—a repeating sound that informs approaching pedestrians that a push button exists to actuate pedestrian timing or receive additional information and that enables pedestrians with vision disabilities to locate the push button.
193. Queue Clearance Time—when used in EPG 913, the time required for the design vehicle of maximum length stopped just inside the minimum track clearance distance to start up and move through and clear the entire minimum track clearance distance.
194. Queue Cutter Signal—see Highway Traffic Signal.
195. Quiet Zone—a segment of a rail line, within which is situated one or a number of consecutive public highway-rail grade crossings at which locomotive horns are not routinely sounded per 49 CFR Part 222.
196. Rail Traffic—every device in, upon, or by which any person or property can be transported on rails or tracks and to which all other traffic must yield the right-of-way by law at grade crossings, including trains, one or more locomotives coupled (with or without cars), other railroad equipment, and light rail transit operating in exclusive or semi-exclusive alignments. Light rail transit operating in a mixed-use alignment, to which other traffic is not required to yield the right-of-way by law, is a vehicle and is not considered to be rail traffic.
197. Raised Pavement Marker—a device mounted on or in a road surface that has a height generally not exceeding approximately 1 inch above the road surface for a permanent marker, or not exceeding approximately 2 inches above the road surface for a temporary flexible marker, and that is intended to be used as a positioning guide and/or to supplement or substitute for pavement markings. Raised pavement markers might also be recessed into or flush with the pavement surface.
198. Ramp Control Signal—see Highway Traffic Signal.
199. Red Clearance Interval—an interval that follows a yellow change interval and precedes the next conflicting green interval.
200. Regulatory Sign—a sign that gives notice to road users of traffic laws or regulations.
201. Retroreflectivity—a property of a surface that allows a large portion of the light coming from a point source to be returned directly back to a point near its origin.
202. Road—see Roadway.
203. Road User—a vehicle operator, bicyclist, or pedestrian, including persons with disabilities, within the highway or on a site roadway open to public travel.
204. Roadway—that portion of a highway improved, designed, or ordinarily used for vehicular travel and parking lanes, but exclusive of the sidewalk, berm, or shoulder even though such sidewalk, berm, or shoulder is used by persons riding bicycles or other human-powered vehicles. In the event a highway includes two or more separate roadways, the term roadway as used in this Manual shall refer to any such roadway separately, but not to all such roadways collectively.
205. Roadway Network—a geographical arrangement of intersecting roadways.
206. Roundabout—a circular intersection with yield control at entry, which permits a vehicle on the circulatory roadway to proceed, and with deflection of the approaching vehicle counter-clockwise around a central island.

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207. Rumble Strip—a series of intermittent, narrow, transverse areas of rough-textured, slightly raised, or depressed road surface that extend across the travel lane to alert vehicle operators to unusual traffic conditions or are located along the shoulder, along the roadway center line, or within islands formed by pavement markings to alert road users that they are leaving the travel lanes.
208. Rural Highway—a type of roadway normally characterized by lower volumes, higher speeds, fewer turning conflicts, and less conflict with pedestrians.
209. Scanning Graphic—a graphic designed for scanning by machine, and includes bar codes, quick-response (QR) codes or other matrix bar code formats, or similar graphics.
210. School—a public or private educational institution recognized by the State education authority for one or more grades K through 12 or as otherwise defined by the State.
211. School Zone—a designated roadway segment approaching, adjacent to, and beyond school buildings or grounds, or along which school related activities occur.
212. Semi-Actuated—a type of traffic control signal operation in which at least one, but not all, signal phases function on the basis of actuation.
213. Semi-Exclusive Alignment—a light rail transit track(s) or a bus rapid transit busway that is in a separate right-of-way or that is along a street or railroad right-of-way where motor vehicles, bicycles, and pedestrians have limited access and cross only at designated locations, such as at grade crossings where road users must yield the right-of-way to the light rail transit or the bus rapid transit traffic.
214. Separate Turn Signal Face—a signal face that exclusively controls a turn movement and that displays signal indications that are applicable only to the turn movement.
215. Separation Time—the component of maximum highway traffic signal preemption time during which the minimum track clearance distance is clear of vehicular traffic prior to the arrival of rail traffic.
216. Serviceable—a condition in which a traffic control device appears (day and night) and operates as intended, beyond which it requires replacement due to damage or wear. Whether a device is serviceable will depend on the type of device under consideration. In general, if the device is capable of being serviced with minimal effort or replacement parts so that it continues to appear and operate as intended, and the device is otherwise substantially intact, then it can be considered to be in serviceable condition. If the device is damaged or not operational beyond reasonable repair, then it is likely no longer serviceable.
217. Shared Roadway—a roadway that is officially designated and marked as a bicycle route, but which is open to motor vehicle travel and upon which no bicycle lane is designated.
218. Shared Turn Signal Face—a signal face, for controlling both a turn movement and the adjacent through movement, that always displays the same color of circular signal indication that the adjacent through signal face or faces display.
219. Shared-Use Path—a bikeway outside the traveled way and physically separated from motorized vehicular traffic by an open space or barrier and either within the highway right-of-way or within an independent alignment. Shared-use paths are also used by pedestrians (including skaters, users of manual and motorized wheelchairs, and joggers) and other authorized motorized and non-motorized users.
220. Shoulder—a longitudinal area contiguous with the traveled way that is used for accommodation of stopped vehicles for emergency use and for lateral support of base and surface courses, and that is graded for emergency stopping. A shoulder might be paved or unpaved. A paved shoulder might be opened to part-time travel by some or all vehicles and might also be available for use by pedestrians and/or bicycles in the absence of other pedestrian or bicycle facilities.
221. Sidewalk—that portion of a street between the curb line, or the lateral line of a roadway, and the adjacent property line or on easements of private property that is paved or improved and intended for use by pedestrians.
222. Sidewalk Extension—a pedestrian facility at an intersection or midblock crosswalk which extends the sidewalk by physically and visually narrowing the roadway.
223. Sidewalk Grade Crossing—the portion of a highway-rail grade crossing or of a highway-light rail transit grade crossing where a sidewalk and railroad tracks or a sidewalk and light rail transit tracks cross at the same level, within which are included the tracks, sidewalk, and traffic control devices for sidewalk users traversing that area.
224. Sign—with regard to controlling traffic, any traffic control device that is intended to communicate specific information to road users through a word, symbol, and/or arrow legend. Signs do not include highway traffic signals, pavement markings, delineators, or channelization devices. Signs whose purpose is unrelated to traffic control are addressed in Section 1A.02.
225. Sign Assembly—a group of signs, located on the same support(s), that supplement one another in conveying information to road users.
226. Sign Illumination—either internal or external lighting that shows similar color by day or night. Street or highway lighting shall not be considered as meeting this definition.
227. Sign Legend—all word messages, logos, pictographs, and symbol and arrow designs that are intended to convey specific meanings. The border, if any, on a sign is not considered to be a part of the legend.
228. Sign Panel—a separate panel or piece of material containing a word, logo, pictograph, symbol, and/or arrow legend that is affixed to the face of a sign.
229. Signal—see Highway Traffic Signal.
230. Signal Backplate—a thin strip of material that extends outward from and parallel to a signal face on all sides of a signal housing to provide a background for improved visibility of the signal indications.

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231. Signal Coordination—the establishment of timed relationships between adjacent traffic control signals.
232. Signal Dimming—a reduction of the light output from a signal indication, hybrid beacon, or rectangular rapid-flashing beacon indication, typically for nighttime conditions, to a value that is below the minimum specified intensity for daytime conditions. If a variety of intensity levels are used during daytime conditions and all of the various levels (including the lowest of the intensities) are above the minimum specified intensity for daytime conditions, this would not be considered to be signal dimming.
233. Signal Face—an assembly of one or more signal sections that is provided for controlling one or more traffic movements on a single approach.
234. Signal Head—an assembly of one or more signal faces that is provided for controlling traffic movements on one or more approaches.
235. Signal Housing—that part of a signal section that protects the light source and other required components.
236. Signal Indication—the illumination of a signal lens or equivalent device.
237. Signal Lens—that part of the signal section that redirects the light coming directly from the light source and its reflector, if any.
238. Signal Louver—a device that can be mounted inside a signal visor to restrict visibility of a signal indication from the side or to limit the visibility of the signal indication to a certain lane or lanes, or to a certain distance from the stop line.
239. Signal Phase—the right-of-way, yellow change, and red clearance intervals in a cycle that are assigned to an independent traffic movement or combination of movements.
240. Signal Section—the assembly of a signal housing, signal lens, if any, and light source with necessary components to be used for displaying one signal indication.
241. Signal Sequence (Sequence of Indications)—the order of appearance of signal indications during successive intervals of a signal cycle.
242. Signal System—two or more traffic control signals operating in signal coordination.
243. Signal Timing—the amount of time allocated for the display of a signal indication.
244. Signal Visor—that part of a signal section that directs the signal indication specifically to approaching traffic and reduces the effect of direct external light entering the signal lens.
245. Signing—individual signs or a group of signs, not necessarily on the same support(s), that supplement one another in conveying information to road users.
246. Simultaneous Preemption—notification of approaching rail traffic is forwarded to the highway traffic signal controller unit or assembly and railroad or light rail transit active warning devices at the same time.
247. Site Roadways Open to Public Travel—roadways and bikeways on sites of shopping centers, office parks, airports, schools, universities, sports arenas, recreational parks, and other similar business, governmental, and/or recreation facilities that are publicly or privately-owned but where the public is allowed to travel without full-time access restrictions. Two types of roadways are not included in this definition: (1) roadways where access is restricted at all times by gates and/or guards to residents, employees, or other specifically-authorized persons; and (2) private highway-rail grade crossings. Site roadways open to public travel do not include parking areas (see definition in this Section), including the driving aisles (see definition in this Section) within those parking areas.
248. Special-Purpose Road—a low-volume, low-speed road that serves recreational areas or resource development activities.
249. Speed—speed is defined based on the following classifications:
    a. Average Speed—the summation of the instantaneous or spot-measured speeds at a specific location of vehicles divided by the number of vehicles observed.
    b. Design Speed—a selected speed used to determine the various geometric design features of a roadway.
    c. 85th-Percentile Speed—the speed at or below which 85 percent of the motor vehicles travel.
    d. Operating Speed—a speed at which a typical vehicle or the overall traffic operates. Operating speed might be defined with speed values such as the average, pace, or 85th-percentile speeds.
    e. Pace—the 10 mph speed range representing the speeds of the largest percentage of vehicles in the traffic stream.
250. Speed Limit—the maximum (or minimum) speed applicable to a section of highway as established by law or regulation.
251. Speed Zone—a section of highway with a speed limit that is established by law or regulation, but which might be different from a legislatively-specified statutory speed limit.
252. Splitter Island—a median island used to separate opposing directions of traffic entering and exiting a roundabout.
253. Station Crossing—a pathway grade crossing that is associated with a station platform.
254. Statutory Speed Limit—a speed limit established by legislative action (such as Federal or State law) that typically is applicable for a particular class of highways with specified design, functional, jurisdictional, and/or location characteristics and that is not necessarily displayed on Speed Limit signs.
255. Steady (Steady Mode)—the continuous display of a signal indication for the duration of an interval, signal phase, or consecutive signal phases.
256. Stop Line—a solid white pavement marking line extending across approach lanes to indicate the point at which a stop is intended or required to be made.
257. Street—see Highway.

258. Supplemental Signal Face—a signal face that is not a primary signal face but which is provided for a given approach or separate turning movement to enhance visibility or conspicuity.
259. Swing Gate—a self-closing fence-type gate designated to swing open away from the track area and return to the closed position upon release.
260. Symbol—the approved design of a pictorial or graphical representation of a specific traffic control message for signs, pavement markings, traffic control signals, or other traffic control devices, as shown in the MUTCD.
261. Temporary Traffic Control Signal—see Highway Traffic Signal.
262. Temporary Traffic Control Zone—an area of a highway, pedestrian or bicycle facility where road user conditions are changed because of a work zone or incident by the use of temporary traffic control devices, flaggers, uniformed law enforcement officers, or other authorized personnel.
263. Theoretical Gore—a longitudinal point at the upstream end of a neutral area at an exit ramp or channelized turn lane where the channelizing lines that separate the ramp or channelized turn lane from the adjacent through lane(s) begin to diverge, or a longitudinal point at the downstream end of a neutral area at an entrance ramp or channelized entering lane where the channelizing lines that separate the ramp or channelized entering lane from the adjacent through lane(s) intersect each other.
264. Through Train—a train movement that continues without stopping or reversing direction throughout the entire length of the rail traffic detection circuit length approaching a highway-rail grade crossing.
265. Timed Exit Gate Operating Mode—a mode of operation where the exit gate descent at a grade crossing is based on a predetermined time interval.
266. Toll Booth—a shelter where a toll attendant is stationed to collect tolls or issue toll tickets. A toll booth is located adjacent to a toll lane and is typically set on a toll island.
267. Toll Collection—manual or electronic methods and elements used to collect a fee for use of a toll facility. Toll collection methods include:

    a. Electronic Toll Collection (ETC)—a cashless system for automated collection of tolls from moving or stopped vehicles through wireless technologies such as radio-frequency communication or optical scanning. ETC systems are classified as one of the following:

        1. systems that require users to have registered toll accounts, with the use of equipment inside or on the exterior of vehicles, such as a transponder or barcode decal, that communicates with or is detected by roadside or overhead receiving equipment, or with the use of license plate optical scanning, to automatically deduct the toll from the registered user account,
        2. systems that do not require users to have registered toll accounts because vehicle license plates are optically scanned and invoices for the toll amount are typically sent through postal mail to the address of the vehicle owner, or systems that allow electronic toll collection for both registered and non-registered toll accounts.

    b. Open-Road Tolling (ORT)—a system designed to allow electronic toll collection (ETC) from vehicles traveling at posted speeds. Open-road tolling might be used on toll roads or toll facilities in conjunction with toll plazas. Open-road tolling is also typically used on managed lanes and on toll facilities that only accept payment by ETC.
    c. Manual Toll Collection—a system of toll collection from stopped vehicles through acceptance of cash, toll tickets, tokens, or credit cards, and may involve issuance of receipts. Toll collection may be by a machine or toll booth attendant.

        1. Ticket from a machine or toll booth attendant upon entering the toll facility. The ticket denotes the user's point of entry and, upon exiting the toll system, the user surrenders the ticket and is charged a toll based on the distance traveled between the points of entry and exit.
        2. Attended Lane (Manual Lane)—a toll lane adjacent to a toll booth occupied by a human toll collector who makes change, issues receipts, and performs other toll-related functions. Attended lanes at toll plazas typically require vehicles to stop to pay the toll.
        3. Exact Change Lane (Automatic Lane)—a non-attended toll lane that has a receptacle into which road users deposit coins totaling the exact amount of the toll. Exact Change lanes at toll plazas typically require vehicles to stop to pay the toll.

268. Toll Island—a raised island on which a toll booth or other toll collection and related equipment are located.
269. Toll Lane—an individual lane located within a toll plaza in which a toll payment is collected or, for toll-ticket systems, a toll ticket is issued.
270. Toll Plaza—the location at which tolls are collected consisting of a grouping of toll booths, toll islands, toll lanes, and, typically, a canopy. Toll plazas might be located on highway mainlines or on interchange ramps. A mainline toll plaza is sometimes referred to as a barrier toll plaza because it interrupts the traffic flow.
271. Toll Road (Facility)—a road or facility that is open to traffic only by payment of a user toll or fee.
272. Traffic—pedestrians, bicyclists, ridden or herded animals, vehicles, streetcars, and other conveyances either singularly or together while using for purposes of travel any highway or site roadway open to public travel.
273. Traffic Control Device—all signs, signals, markings, channelization devices, or other devices that use colors, shapes, symbols, words, sounds, and/or tactile information for the primary purpose of communicating a regulatory, warning, or

guidance message to road users on a street, highway, pedestrian facility, bikeway, pathway, or site roadway open to public travel. Section 1A.02 contains information regarding items that are not traffic control devices.

274. Traffic Control Signal (Traffic Signal)—see Highway Traffic Signal.
275. Train—one or more locomotives coupled, with or without cars, that operates on rails or tracks and to which all other traffic must yield the right-of-way by law at highway-rail grade crossings.
276. Transverse Markings—pavement markings that are generally placed perpendicular and across the flow of traffic such as shoulder markings; word, symbol, and arrow markings; stop lines; crosswalk lines; parking space markings; and others.
277. Traveled Way—the portion of the roadway for the movement of vehicles, exclusive of the shoulders, berms, sidewalks, and parking lanes.
278. Turn Bay—a lane for the exclusive use of turning vehicles that is formed on the approach to the location where the turn is to be made. In most cases where turn bays are provided, drivers who desire to turn must move out of a through lane into the newly-formed turn bay in order to turn. A through lane that becomes a turn lane is considered to be a lane drop rather than a turn bay.
279. Two-Stage Bicycle Turn Box—a designated area at an intersection intended to provide bicyclists a place to wait for traffic to clear before proceeding in a different direction of travel.
280. Uncontrolled Approach—an approach on which vehicles are not controlled by a traffic control signal, hybrid beacon, STOP sign, or YIELD sign.
281. Upstream—a term that refers to a location that is encountered by traffic prior to a downstream location as it flows in an "upstream to downstream" direction. For example, "the upstream end of a lane line separating the turn lane from a through lane on the approach to an intersection" is the end of the line that is furthest from the intersection.
282. Urban Street—a type of street normally characterized by relatively low speeds, wide ranges of traffic volumes, narrower lanes, frequent intersections and driveways, significant pedestrian traffic, and more businesses and houses.
283. Variable Message Sign—see Changeable Message Sign.
284. Vehicle—every device in, upon, or by which any person or property can be transported or drawn upon a highway, except trains and light rail transit operating in exclusive or semi-exclusive alignments. Light rail transit equipment operating in a mixed-use alignment, to which other traffic is not required to yield the right-of-way by law, is a vehicle.
285. Vibrotactile Pedestrian Device—an accessible pedestrian signal feature that communicates, by touch, information about pedestrian timing using a vibrating surface.
286. Visibility-Limited Signal Face or Visibility-Limited Signal Section—a type of signal face or signal section designed (or shielded, hooded, or louvered) to restrict the visibility of a signal indication from the side, to a certain lane or lanes, or to a certain distance from the stop line.
287. Walk Interval—an interval during which the WALKING PERSON (symbolizing WALK) signal indication is displayed.
288. Warning Light—a portable, powered, yellow, lens-directed, enclosed light that is used in a temporary traffic control zone in either a steady burn or a flashing mode.
289. Warning Sign—a sign that gives notice to road users of a situation that might not be readily apparent.
290. Warrant—a warrant describes a threshold condition based upon average or normal conditions that, if found to be satisfied as part of an engineering study, shall result in analysis of other traffic conditions or factors to determine whether a traffic control device or other improvement is justified. Warrants are not a substitute for engineering judgment. The fact that a warrant for a particular traffic control device is met is not conclusive justification for the installation of the device.
291. Wayside Horn System—a stationary horn (or a series of horns) located at a grade crossing that is used in conjunction with train-activated or light rail transit-activated warning systems to provide audible warning of approaching rail traffic to road users on the highway or pathway approaches to a grade crossing, either as a supplement or alternative to the sounding of a locomotive horn.
292. Worker—a person on foot whose duties place him or her within the right-of-way of a street, highway, or pathway, such as: construction and maintenance forces; survey crews; utility crews; responders to incidents within the right-of-way; and law enforcement personnel when directing traffic, investigating crashes, and handling lane closures, obstructed roadways, and disasters within the right-of-way.
293. Wrong-Way Arrow—a slender, elongated, white pavement marking arrow placed upstream from the ramp terminus to indicate the correct direction of traffic flow. Wrong-way arrows are intended primarily to warn wrong-way road users that they are going in the wrong direction.
294. Yellow Change Interval—the first interval following the green or flashing arrow interval during which the steady yellow signal indication is displayed.
295. Yield Line—a row of solid white isosceles triangles pointing toward approaching vehicles extending across approach lanes to indicate the point at which the yield is intended or required to be made.

Meanings of Acronyms and Abbreviations Used in this Manual (MUTCD Section 1C.03)

Standard. The following acronyms and abbreviations, when used in this Manual, shall have the following meanings:

1. AADT—annual average daily traffic

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2. AASHTO—American Association of State Highway and Transportation Officials
3. AC—alternating current
4. ADA—Americans with Disabilities Act
5. ADAS—Advanced Driver Assistance Systems
6. ADS—Automated Driving System
7. ADT—average daily traffic
8. AFAD—Automated Flagger Assistance Device
9. ANSI—American National Standards Institute
10. AREMA—American Railway Engineering and Maintenance-of-Way Association
11. AV—automated vehicle
12. cd/lx/m2---candelas per lux per square meter
13. CFR—Code of Federal Regulations
14. CMS—changeable message sign
15. dBA—A-weighted decibels
16. DC—direct current
17. DDT—Dynamic Driving Task
18. EPA—Environmental Protection Agency
19. ETC—electronic toll collection
20. EV—electric vehicle
21. FHWA—Federal Highway Administration
22. FRA—Federal Railroad Administration
23. ft—foot or feet
24. FTA—Federal Transit Administration
25. HOV—high-occupancy vehicle
26. IEEE—Institute of Electrical and Electronics Engineers
27. IES—Illuminating Engineering Society
28. ILEV—inherently low-emission vehicle
29. in—inch(es)
30. ISEA—International Safety Equipment Association
31. ITE—Institute of Transportation Engineers
32. ITS—intelligent transportation systems
33. L—taper length
34. LED—light-emitting diode
35. LP—liquified petroleum
36. LRT—light rail transit
37. mi—mile(s)
38. MPH or mph—miles per hour
39. MUTCD—Manual on Uniform Traffic Control Devices for Streets and Highways
40. N—length of one line segment plus one gap of a broken line
41. NCEES—National Council of Examiners for Engineering and Surveying
42. NCHRP—National Cooperative Highway Research Program
43. ODD—Operational Design Domain
44. OPM—U.S. Office of Personnel Management
45. ORT—open-road tolling
46. PCMS—portable changeable message sign
47. PRT—perception-response time
48. RRFB—rectangular rapid-flashing beacon
49. RV—recreational vehicle
50. SAE—Society of Automotive Engineers
51. SHV—Specialized Hauling Vehicle
52. SPF—safety performance function
53. TA—Typical Application
54. TDD—telecommunication device for the deaf
55. TRB—Transportation Research Board
56. TTC—temporary traffic control

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57. U.S.—United States
58. U.S.C.—United States Code
59. USDOT—United States Department of Transportation
60. UVC—Uniform Vehicle Code
61. VPH or vph—vehicles per hour
62. V2I—vehicle to infrastructure

Purpose and Principles of Traffic Control Devices (MUTCD Section 1D.01)

Support. The purpose of traffic control devices, as well as the principles for their use, is to promote highway safety, inclusion and mobility of all road users, and efficiency by providing for the orderly movement of road users on streets, highways, bikeways, and site roadways open to public travel throughout the Nation. Section 1A.03 contains additional information on target road users.

This Manual contains the basic principles that govern the design and use of traffic control devices for all streets, highways, bikeways, and site roadways open to public travel (see definition in Section 1C.02) regardless of type or class or the public agency, official, or owner having jurisdiction. The text of this Manual specifies the restriction on the use of a device if it is intended for limited application or for a specific system. It is important that these principles be given primary consideration in the selection and application of each device.

Guidance. To be effective, a traffic control device should:

A. Fulfill a need;
B. Command attention;
C. Convey a clear, simple meaning;
D. Command respect from road users; and
E. Give adequate time for proper response.

Design, placement, operation, maintenance, and uniformity are aspects that should be carefully considered in order to maximize the ability of a traffic control device to be consistent with the five principles listed in the above paragraph. Vehicle speed and road-user types should be carefully considered as an element that governs the design, operation, placement, and location of various traffic control devices.

The proper use of traffic control devices should provide the road user with the information necessary to safely, efficiently, and lawfully use the streets, highways, pedestrian facilities, and bikeways.

Standard. Traffic control devices used on site roadways open to public travel shall have the same shape, color, and meaning as those required by the MUTCD for use on public highways, except as provided otherwise elsewhere in this Manual. Sign size exceptions are noted in each Part as applicable.

Responsibility and Authority for Traffic Control Devices (MUTCD Section 1D.02)

Standard. The responsibility for the design, placement, operation, maintenance, and uniformity of traffic control devices in compliance with the provisions of this Manual shall rest with the public agency or the official having jurisdiction, or, in the case of site roadways open to public travel, with the private owner or private official having jurisdiction.

All regulatory traffic control devices shall be supported by laws, ordinances, or regulations.

Traffic control devices, public announcements or notices, and other signs or messages within the highway right-of-way shall be placed only as authorized by a public authority or the official having jurisdiction, or, in the case of site roadways or private toll roads open to public travel, by the private owner or private official having jurisdiction, for the purpose of regulating, warning, or guiding traffic.

When the public agency or the official having jurisdiction over a street or highway or, in the case of site roadways open to public travel, the private owner or private official having jurisdiction, has granted proper authority, others such as contractors and public utility companies shall be allowed to install temporary traffic control devices in temporary traffic control zones. Such traffic control devices shall comply with the provisions of this Manual.

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Signs and other devices that do not have any traffic control purpose that are placed within the highway right-of-way shall not be located where they will interfere with, or detract from, traffic control devices.

Support. States are encouraged to adopt, through policy or legislation, the provisions of 23 CFR 750.108 that restrict outdoor advertising from resembling traffic control devices. See EPG 236.16.

Engineering Study and Engineering Judgment (MUTCD Section 1D.03)

Support. Definitions of professional engineer, engineering study, and engineering judgment are provided in Section 1C.02.

The application of engineering study and engineering judgment is a fundamental principle of the use of traffic control devices. It is for this reason that, in most cases, the selection of a particular device is not required by a Standard provision, but is determined by engineering study or engineering judgment. Many Standard provisions in this Manual specifically require, by explicit language in the individual provisions or by implication, the application of engineering study or engineering judgment in applying those Standards. Site-specific conditions might result in the determination that it is impossible or impracticable to comply with a Standard at that location. In such a case, a deviation from the requirement of a particular Standard at that location might be the only possibility. In such limited, specific cases, the deviation is allowed, provided that the agency or official having jurisdiction fully documents, through an engineering study, the engineering basis for the deviation.

Standard. This Manual describes the application of traffic control devices, but shall not be a legal requirement for their installation.

Support. The MUTCD does not mandate, and is not intending to imply, that an engineer must make the final decision whether to implement or execute the determination or advice of an engineer by installing or constructing the traffic control device to the engineer's specification in the field. Rather, the engineer, individual under supervision of an engineer, or other individual as duly authorized by State law to engage in the practice of engineering, develops an engineering-based solution that includes the specifications for selection and placement of traffic control devices, but the responsibility for a final decision to implement that solution rests with the agency having jurisdiction over the roadway, after consultation with and based on advice from the engineer.

Guidance. The decision to use a particular device at a particular location should be made on the basis of either an engineering study or the application of engineering judgment by an engineer, someone under the direct supervision of an engineer, or other individual as duly authorized by State law to engage in the practice of engineering. Thus, while this Manual provides Standards, Guidance, and Options for design and application of traffic control devices, this Manual should not be considered a substitute for engineering judgment. Engineering judgment should be exercised in the selection and application of traffic control devices, as well as in the location and design of roads and streets that the devices complement.

Early in the processes of location and design of roads and streets, engineers should coordinate such location and design with the design and placement of the traffic control devices to be used with such roads and streets.

Jurisdictions, or owners of site roadways or private toll roads open to public travel, with responsibility for traffic control that do not have an engineer on their staff who is trained and/or experienced in traffic control devices should seek engineering assistance from others, such as the State transportation agency, their county, a nearby large city, or a traffic engineering consultant.

Support. The provisions of this Manual are intended to be interpreted and applied by engineers or those under the supervision of an engineer. The construction of the provisions of this Manual, therefore, are informed by bases referenced in Paragraphs 9 and 10 of this Section.

The National Council of Examiners for Engineering and Surveying (NCEES) has defined the practice of engineering as "any service or creative work requiring engineering education, training, and experience in the application of engineering principles and the interpretation of engineering data to engineering activities that potentially impact the health, safety, and welfare of the public." The practice of engineering is, therefore, subject to regulation in the public interest and is regulated by the State licensing boards in order to safeguard the health, safety, and welfare of the public. The NCEES has defined an engineer as "an individual who is qualified to practice engineering by reason of engineering education, training, and experience in the application of engineering principles and the interpretation of engineering data."

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The U.S. Office of Personnel Management (OPM) has defined the professional knowledge of engineering as “the comprehensive, in-depth knowledge of mathematical, physical, and engineering sciences applicable to a specialty field of engineering that characterizes a full 4-year engineering program leading to a bachelor's degree, or the equivalent.” The OPM has defined professional ability to apply engineering knowledge as “the ability to (a) apply fundamental and diversified professional engineering concepts, theories, and practices to achieve engineering objectives with versatility, judgment, and perception; (b) adapt and apply methods and techniques of related scientific disciplines; and (c) organize, analyze, interpret, and evaluate scientific data in the solution of engineering problems.”

Requisite technical training in the application of the principles of the MUTCD might be available from the State’s Local Technical Assistance Program (LTAP) for needed engineering guidance and assistance.

Design of Traffic Control Devices (MUTCD Section 1D.04)

Guidance. Devices should be designed so that features such as size, shape, color, composition, lighting or retroreflection, and contrast are combined to draw attention to the devices; so that size, shape, color, and simplicity of message combine to produce a clear meaning; so that legibility and size combine with placement to provide adequate time for response; and so that uniformity, size, legibility, and reasonableness of the message combine to command respect.

Option. Except for symbols and colors, minor modifications in the specific design elements of a device may be made based on an engineering study or engineering judgment, in accordance with the paragraph below, provided the essential appearance characteristics are preserved.

Guidance. Aspects of the standard design of a traffic control device should not be modified unless there is a demonstrated need in unusual circumstances, based on an engineering study or engineering judgment.

Support. An example of acceptably modifying the design of a device would be to modify the Combination Horizontal Alignment/Intersection (W1-10) sign to show intersecting side roads on both sides rather than on just one side of the major road within the curve.

Color Code (MUTCD Section 1D.05)

Support. The following color code establishes general meanings for 11 colors of a total of 13 colors that have been identified as being appropriate for use in conveying traffic control information.

Standard. The general meaning of the 13 colors shall be as follows:

A. Black—regulation
B. Blue—road-user services guidance, tourist information, and evacuation route
C. Brown—recreational and cultural interest area guidance
D. Coral—reserved for future designation (see Paragraph 4 of this Section)
E. Fluorescent Pink—incident management
F. Fluorescent Yellow-Green—school bus warning and school warning
G. Green—indicated movements or actions permitted and direction guidance
H. Light Blue—reserved for future designation (see Paragraph 4 of this Section)
I. Orange—temporary traffic control
J. Purple—restricted to use only by vehicles with registered electronic toll collection (ETC) accounts
K. Red—stop or prohibition
L. White—regulation
M. Yellow—warning

These colors shall be used only as prescribed for the specific devices or applications throughout this Manual.

Support. The two colors for which general meanings have not yet been assigned are being reserved for future applications that will be determined only by the FHWA after consultation with the States, the engineering community, and the general public. The meanings described in this Section are of a general nature. More specific assignments of colors are given in the individual Parts of this Manual relating to each class of devices.

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Tolerance limits for each color are contained in 23 CFR Part 655, Appendix to Subpart F and are available at the Federal Highway Administration's MUTCD Web site at http://mutcd.fhwa.dot.gov.

Public Domain, Copyrights, and Patents (MUTCD Section 1D.06)

Standard. Traffic control device design or application provisions contained in this Manual shall be in the public domain. Traffic control devices contained in this Manual shall not be protected by a patent, trademark, or copyright, except for the Interstate Shield, 511 Travel Information pictograph, National Scenic Byway graphic, and any items under the stewardship of or owned by FHWA.

A traffic control device design or application shall not be eligible for official experimentation (see Section 1B.05) or interim approval (see Section 1B.07) unless it is in the public domain. Express abandonment of any and all forms of proprietary protection, such as patents, trademarks, or copyrights, related to the design and application of the traffic control device shall satisfy the requirement for the traffic control device to be in the public domain.

The requirement for the traffic control device to be in the public domain shall not apply to individual components used in the assembly or manufacture of the traffic control device.

Support. The limitation on patented, trademarked, or copyrighted traffic control devices applies to the message that the device conveys to the road user. If a patent or other protection covers the device's communication to the road user by virtue of its appearance, audible message, or other aspects of the message conveyed (such as the order in which traffic control signal indications change from green to yellow and red), then the device is considered to be protected and not in the public domain. Such a device is precluded from inclusion in this Manual. The purpose of this limitation is to ensure uniformity of the messaging of individually approved traffic control devices. This limitation does not apply to other aspects of a device (such as internal controls, circuitry, electronics, mechanics, or housing) so long as the appearance, audible message, or other aspects of the message conveyed, including the manner of conveyance, remain freely reproducible by all without infringing on any proprietary rights or interests. This Manual does not prohibit such other aspects of a traffic control device that meet the legal requirements from being protected through patent, trademark, or copyright; and does not restrict components, parts, manufacturing processes, or similar aspects of traffic control devices from being patented or otherwise protected. Examples of acceptable protected traffic control device components or parts might include: sign sheeting or retroreflectivity technology, internal electronic components of traffic signal controllers, and breakaway sign support mechanisms.

Pictographs, as defined in Section 1C.02, are embedded in traffic control devices, but the pictographs themselves are not considered traffic control devices for the purposes of the above paragraph.

Business identification logos, as defined in Section 1C.02, are embedded in traffic control devices, but the logos themselves are not considered traffic control devices for the purposes of the above Support paragraph.

Advertising (MUTCD Section 1D.07)

Standard. Traffic control devices or their supports shall not bear any advertising message or any other message that is not related to traffic control.

Support. Acknowledgment signs (see EPG 903.8.12), Specific Service signs (see EPG 903.10), and Tourist-Oriented Directional signs (see EPG 903.11) are not considered advertising.

Abbreviations Used on Traffic Control Devices (MUTCD Section 1D.08)

Standard. When the word messages shown in Table 1D-1 need to be abbreviated in connection with traffic control devices, the abbreviations shown in Table 1D-1 shall be used.

When the word messages shown in Table 1D-2 need to be abbreviated on a portable changeable message sign, the abbreviations shown in Table 1D-2 shall be used. Unless indicated by an asterisk, these abbreviations shall only be used on portable changeable message signs.

Guidance. The abbreviations for the words listed in Table 1D-2 that also show a prompt word should not be used on a portable changeable message sign (or on a static sign if indicated in Table 1D-2 by an asterisk) unless the prompt word shown in Table 1D-2 either precedes or follows the abbreviation, as applicable.

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Standard. The abbreviations shown in Table 1D-3 shall not be used in connection with traffic control devices because of their potential to be misinterpreted by road users.

Guidance. If Table 1D-1 or Table 1D-2 indicates that more than one abbreviation is allowed for a given word or phrase, the same abbreviation should be used throughout a single jurisdiction.

Except as otherwise provided in Table 1D-1 or Table 1D-2 or unless necessary to avoid confusion, periods, commas, apostrophes, question marks, ampersands, and other punctuation marks or characters that are not letters or numerals should not be used in any abbreviation.

Table 1D-1. General Abbreviations

Word Message	Standard Abbreviation
Afternoon	PM
Alternate	ALT
AM Radio	AM
Avenue	Ave, Av*
Bicycle(s)	BIKE, BIKES
Boulevard	Blvd*
Bridge	(See Table 1D-2)
CB Radio	CB
Center	Ctr**
Circle	Cir*
Civil Defense	CD
Compressed Natural Gas	CNG
Court	Ct*
Crossing (other than highway-rail)	X-ING
Drive	Dr*
East	E
Electric Vehicle	EV
Expressway	Expwy*
Feet	FT
FM Radio	FM
Freeway	Fwy*
Hazardous Material(s)	HAZMAT, HAZMATS
High Occupancy Vehicle(s)	HOV
Highway	Hwy*
Hospital	HOSP
Hour(s)	HR, HRS
Information	INFO
Inherently Low Emission Vehicle	ILEV
International	Intl
Interstate	(See Table 1D-2)
Junction / Intersection	JCT
Lane	(See Table 1D-2)
Liquified Petroleum Gas	LP-GAS
Maximum	MAX
Mile(s)	MI
Miles per Hour	MPH
Minimum	MIN
Minute(s)	MIN, MINS
Morning / Late Night	AM
Mount	Mt**
Mountain	Mtn**
National	Natl**
North	N

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Northeast	NE
Northwest	NW
Parkway	Pkwy*
Pedestrian(s)	PED, PEDS
Place	Pl*
Pounds	LBS
Road	Rd*
Saint	St**
South	S
Southeast	SE
Southwest	SW
State, county, or other non-US or non-Interstate numbered route	(See Table 1D-2)
Street	St*
Telephone	PHONE
Temporary	TEMP
Terrace	Ter*
Thruway	Thwy*
Ton(s)	T
Trail	Tr*
Turnpike	Tpk*
Two-Way Intersection, Two-Way Traffic	2-WAY
US Numbered Route	(See Table 1D-2)
West	W
Days of the Week	
Day	**Standard Abbreviation**
Sunday	SUN
Monday	MON
Tuesday	TUES***
Wednesday	WED
Thursday	THURS***
Friday	FRI
Saturday	SAT

Legend:
* Abbreviation shall not be used for any application other than the name of a roadway. See Table 2D-3 for complete list of street name descriptors. Examples include: Bayshore Fwy, Cross County Hwy, Mid-County Pkwy
** Abbreviation shall not be used for any application other than as a descriptor or title within a proper name. Examples include: Vestal Ctr, Mt Hope, Pocono Mtn, Eldorado Natl Forest, St Louis
*** Tuesday and Thursday may be abbreviated on a Changeable Message Sign (CMS) to TUE and THU, respectively, when the number of Characters in a message to be displayed cannot be practically reduced through rewording to fit thenumber of characters supported by the CMS, such as might occur at times on a portable CMS.
Note: Abbreviations shown in upper- and lower-case lettering may be in all upper-case lettering when displayed on a changeable message sign with lower resolution that will not accommodate lower-case letter forms. See Chapter 2L of this Manual.

Table 1D-2. Abbreviations that Shall be Used Only for Temporary Messages on Portable Changeable Message Signs

Word Message	Standard Abbreviation	Prompt Word Preceding the Abbreviation	Prompt Word Following the Abbreviation	Example
Access	ACCS	—	Road	ACCS ROAD
Ahead	AHD	Fog	—	FOG AHD
Blocked	BLKD	Lane	—	2 LANES BLKD
Bridge	BR*	[Name]	—	BAY BR
Cannot	CANT	—	—	—
Center	CNTR	—	Lane	CNTR LANE, CNTR LN
Chemical	CHEM	—	Spill	CHEM SPILL
Condition	COND	Traffic	—	TRAFFIC COND
Congested	CONG	Traffic	—	TRAFFIC CONG AHD
Construction	CONST	—	Ahead	CONST AHEAD
Crossing	XING	—	—	PED XING
Do Not	DONT	—	—	—
Downtown	DWNTN	—	Traffic	DWNTN TRAFFIC
Eastbound	EAST	Route Number, Road Name	—	I-4 EAST
	E-BND	—	Lane, Traffic	E-BND LANE
Emergency	EMER	—	—	EMER VEHICLES
Entrance, Enter	ENT	—	—	ENT TO I-90
Exit	EX	Next	—	NEXT EX
Express	EXP	—	Lane	EXP LANE OPEN
Frontage	FRNTG	—	Road	FRNTG RD
Hazardous	HAZ	—	Driving	HAZ DRIVING
Highway-Rail Grade Crossing	RR XING	—	—	RR XING
Interstate	I-*	—	[Number]	I-80
It Is	ITS	—	—	—
Lane(s) (travel lanes of a highway)	LN, LNS	Right, Left, Center	—	LEFT LN ONLY 2 RIGHT LNS
Left	LFT	Keep, Next	—	NEXT LFT
	LFT	—	Lane	LFT LANE
Local	LOC	—	Traffic	LOC TRAFFIC ONLY
Lower	LWR	—	Level	LWR LEVEL
Maintenance	MAINT	—	—	ROAD MAINT
Major	MAJ	—	Crash	MAJ CRASH
Minor	MNR	—	Crash	MNR CRASH
Normal	NORM	—	—	—
Northbound	NORTH	Route Number, Road Name	—	US 1 NORTH
	N-BND	—	Lane, Traffic	N-BND TRAFFIC
Oversized	OVRSZ	—	Load	OVRSZ LOAD
Parking	PKING	—	—	—
Pavement	PVMT	Icy	—	ICY PVMT
Prepare	PREP	—	To Stop	PREP TO STOP
Quality	QLTY	Air	—	AIR QLTY

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Right	RT Keep, Next	—	KEEP RT	
	RT	—	Lane	RT LANE
Road Work	RD WK	—	Ahead, [Distance]	RD WK 1 MILE
Route	RTE	Best	—	BEST RTE
Service	SERV	—	—	SERV AREA OPEN
Shoulder	SHLDR	—	—	SHLDR CLOSED
Slippery	SLIP	—	—	—
Southbound	SOUTH	Route Number, Road Name	—	CA 1 SOUTH
	S-BND	—	Lane, Traffic	S-BND TRAFFIC
Speed	SPD	—	—	SPD LIMIT
State, County, or other non-U.S. or non-Interstate numbered route	[Route Abbreviation determined by highway agency]*	—	[Number]**	NY 7, CR 43
Tires With Lugs	LUGS	—	—	—
Traffic	TRAF	—	—	—
Travelers	TRVLRS	—	—	—
Two-Wheeled Vehicles	CYCLES	—	—	—
Upper	UPR	—	Level	UPR LEVEL
U.S. Numbered Route	US*	—	[Number]**	US 202
Vehicle(s)	VEH, VEHS	—	—	—
Warning	WARN	—	—	—
Westbound	WEST	Route Number, Road Name	—	IL 53 WEST
	W-BND	—	Lane, Traffic	W-BND LANES
Will Not	WONT	—	—	—

Legend:
* Abbreviation, when accompanied by the prompt word, may be used on traffic control devices other than portable message signs. See Table 1D-1 for uses and format.
** A space and no hyphen shall be placed between the abbreviation and the number of the route.
Note: See Chapter 2L of this Manual for additional information on changeable message signs.

Table 1D-3. Unacceptable Abbreviations

Abbreviation	Intended Word	Common Misinterpretation
ACC	Accident	Access (Road)
CLRS	Clears	Colors
DLY	Delay	Daily
FDR	Feeder	Federal
L	Left	Lane (Merge)
LT	Light (Traffic)	Left
PARK	Parking	Park
POLL	Pollution (Index)	Poll
RED	Reduce	Red
STAD	Stadium	Standard
WRNG	Warning	Wrong

Placement and Operation of Traffic Control Devices (MUTCD Section 1D.09)

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Standard. Before any highway, site roadway open to public travel (see definition in Section 1C.02), detour, or temporary route is opened to public travel, all traffic control devices necessary for safe operation shall be in place.

Option. Temporary traffic control devices, as provided for in Part 6 of this Manual, may be used in place of permanent devices that have yet to be installed for safe operation.

Guidance. Placement of a traffic control device should be within the road user's view so that adequate visibility is provided. To aid in conveying the proper meaning, the traffic control device should be appropriately positioned with respect to the location, object, or situation to which it applies. The location and legibility of the traffic control device should be such that a road user has adequate time to make the proper response in both day and night conditions.

Traffic control devices should be placed and operated in a uniform and consistent manner as part of maintaining uniformity in traffic control.

Support. Inconsistent placement or use of a device can result in disrespect for the device at locations where the device is needed and appropriate.

Guidance. Unnecessary traffic control devices should be removed. The fact that a device is in good physical condition should not be a basis for deferring needed removal or change.

Support. EPG 903.1.2 contains information on excessive use of signs and other considerations that can reduce their effectiveness and the effectiveness of other traffic control devices.

Maintenance of Traffic Control Devices (MUTCD Section 1D.10)

Guidance. Functional maintenance of traffic control devices should be used to determine if certain devices need to be changed to meet current traffic conditions.

Physical maintenance of traffic control devices should be performed to retain the legibility and visibility of the device, and to retain the proper functioning of the device.

Support. Clean, legible, properly-mounted devices in good working condition command the respect of road users.

Crashworthiness of Traffic Control Devices and Other Roadside Appurtenances (MUTCD Section 1D.11)

Standard. In accordance with various Sections of this Manual, certain traffic control devices and their supports, and/or related appurtenances shall be crashworthy (see definition in Section 1C.02). Crashworthiness provisions in this Manual shall apply to all streets, highways, and site roadways open to public travel.

Support. Roadside appurtenances include permanent and portable sign supports, other permanent or temporary traffic control devices, and other roadside fixtures that are not traffic control devices, such as longitudinal barriers, bridge railings, and crash cushions, within the clear zone. Crashworthiness of a device or appurtenance is determined by nationally established standards such as the "Manual for Assessing Safety Hardware" (MASH), 2016, AASHTO. Information on the FHWA's policy on crashworthiness of devices on the National Highway System and other roadways is available at the FHWA Office of Safety Web site at https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/policy_memo_guidance.cfm.

Media in category "911 General (MUTCD Part 1)"

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1,649 × 2,010; 195 KB

Figure 1B-2. Proce…
2,230 × 2,791; 562 KB

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Category:912 Traffic Control Device Considerations for Automated Vehicles (MUTCD Part 5)

Contents

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Traffic Control for Highway-Rail and Highway-Light Rail Transit Grade Crossings (MUTCD Section 5B.05)

Traffic Control for Bicycle Facilities (MUTCD Section 5B.06)

MoDOT Automated Vehicle Activities
MoDOT has several programs and policies to support Automated Vehicle (AV) readiness. These activities include the 2025 MoDOT Connected and Automated Vehicle Action Plan (https://www.modot.org/sites/default/files/documents/FR1_MoDOT_CAVPlan_Apr25_ACCESSIBLE.pdf), developed as part of MoDOT's Transportation Systems Management and Operations (TSMO) program (see EPG 909 for more information). MoDOT is also a national leader in the deployment of Autonomous Truck-Mounted Attenuators (TMAs). More information on MoDOT's Autonomous TMA project is available here (https://www.modot.org/improve-work-zone-and-system-wide-safety-autonomous-truck-mounted-attenuators). Refer to EPG 612 for more information on TMAs in general.

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Support. MoDOT adopts Part 5 of the MUTCD as Category 912 of the EPG with minimal modifications. See EPG 900.1 for a description of how MUTCD content is incorporated into the EPG.

The information in EPG 912 includes general considerations related to automated vehicles (AVs). This information does not fully describe MoDOT policies and directions. Refer to other categories of the EPG for specific information regarding traffic control devices.

Scope and Purpose (MUTCD Section 5A.01)

Support. The scope of the provisions in this Part are intended for consideration of traffic control devices that are specifically being designed to accommodate automated vehicles capable of performing partial or full real-time operational functions in general traffic on a sustained basis. This Part does not require agencies to use these provisions in their accommodation of automated vehicles on their roadways. Rather, the purpose of these provisions is to provide agencies with general considerations and guidance for traffic control devices that can be more helpful in the accommodation of such vehicles, while at the same time being more beneficial to road users.

It is important for early implementers of automated vehicles to understand the ramifications of traffic control devices in a mixed fleet environment and to consider the needs of both human and machine-led road users. Partial automation technologies are already commercially available in the vehicle fleet and are operating under current infrastructure conditions. The overall effectiveness of the automation is impacted by the uniformity and consistent application of the highway infrastructure, including traffic control devices.

This Chapter provides an overview of foundational driving automation system (see definition in Section 5A.03) technology terminology, key principles, considerations for traffic control device selection, and topics for agencies to consider. The MUTCD does not address standardization of digital infrastructure, geometric road design, traffic control device maintenance levels, minimum pavement conditions, or other items that might be important for safe and effective operation of driving automation system technologies.

Overview of Automated Vehicles and Connected Vehicles (MUTCD Section 5A.02)

Support. Driving automation system technology automates some or all aspects of the driving tasks to assist or replace the human driver and can include driver assistance technology generally known as advanced driver assistance systems (ADAS). Automated vehicles (AVs) are vehicles in which at least one element of vehicle control (such as steering, speed control, or braking) occurs without direct human driver input. AVs function by gathering information from a suite of sensors that can include, but are not limited to:

A. Cameras,
B. Radar,
C. Light detection and ranging (LiDAR),
D. Ultrasonic, and
E. Infrared.

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AVs can combine sensor data with other inputs including detailed map data and information from other connected vehicles or infrastructure. AVs might be able to detect and classify objects in their surroundings and might predict how they are likely to behave.

Connected vehicle technology enables cars, buses, trucks, trains, roads, and roadside infrastructure, as well as other devices such as cellular telephones, to communicate with one another. Connected vehicle technology enabling vehicles to communicate with each other is known as vehicle-to-vehicle (V2V). Connected vehicle technology enabling vehicles to communicate with infrastructure is known as vehicle-to-infrastructure (V2I). Connected vehicle technology enables equipped vehicles on the road to be aware of the location and status of other nearby equipped vehicles or devices. Road users could receive notifications and alerts of dangerous situations, such as a vehicle that is about to run a red traffic signal as it nears an intersection, or an oncoming car, that is out of sight beyond a curve swerving into the opposing lane to avoid an object on the road.

Definitions and Terms (MUTCD Section 5A.03)

Support. The definitions and terms shown in Items A through G below, which are found in the Society of Automotive Engineers standard SAE J3016 and other sources, are used extensively in automated vehicle technology. Their definitions, which are summarized below for reference and for use with the provisions of this Manual, are as follows:

A. Advanced Driver Assistance Systems (ADAS) – Electronic systems that aid a vehicle driver with one or more driving tasks while driving. They are intended to increase the safe operation of a vehicle and include applications such as automatic braking, lane keeping assistance, adaptive cruise control, and others.
B. Automated Driving System (ADS) – The hardware and software that are collectively capable of performing the entire Dynamic Driving Task (DDT) on a sustained basis, regardless of whether it is limited to a specific Operational Design Domain (ODD); this term is used specifically to describe a Level 3, 4, or 5 driving automation system.
C. Automation Levels – The levels of automation that are described in Table 5A-1.
D. Cooperative Automation – Technology that enables communication with other vehicles and the infrastructure to coordinate automated vehicle operation.
E. Driving Automation System – The hardware and software that are collectively capable of performing part or all of the DDT on a sustained basis; this term is used generically to describe any system capable of Levels 1 through 5 driving automation.
F. Dynamic Driving Task (DDT) – All of the real-time operational and tactical functions required to operate a vehicle in on-road traffic, excluding the strategic functions such as trip scheduling and selection of destinations and waypoints.
G. Operational Design Domain (ODD) – Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics.

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Table 5A-1. Automation Levels

Automation Level	Description	Automation Category	Automation Type
Level 0	The full-time performance by the human driver of all aspects of the Dynamic Driving Task, even when enhanced by warning or momentary intervention systems.	None*	None
Level 1	The driving mode specific execution by a sustained driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver performs all remaining aspects of the Dynamic Driving Task.	Advanced Driver Assistance Systems (ADAS)	Driving Automation System
Level 2	The driving mode specific execution by one or more sustained driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver performs all remaining aspects of the Dynamic Driving Task.		
Level 3	The driving mode specific sustained performance by an ADS of all aspects of the Dynamic Driving Task within a given ODD with the expectation that the human driver will respond appropriately to a request to intervene.	Automated Driving Systems (ADS)	
Level 4	The driving mode specific sustained performance by an ADS of all aspects of the Dynamic Driving Task, even if a human driver does not respond appropriately to a request to intervene.		
Level 5	The full-time sustained performance by an ADS of all aspects of the Dynamic Driving Task under all roadway and environmental conditions that can be managed by a human driver.		
*NOTE: Level 0 might include some ADAS features, but they are considered to be warning or momentary intervention systems at this level.			

Traffic Control Device Design and Use Considerations (MUTCD Section 5A.04)

Support. The interaction of traffic control devices with driving automation systems can create many challenges for agencies in determining traffic control device selection and application. The lack of tolerance of driving automation systems for non-uniformity in traffic control device design and application is a limiting factor of current driving automation system sophistication. This is because driving automation systems have a limited ability to interpolate across gaps in traffic control device cues to the vehicle in the following types of situations:

A. The driving automation system technology's ability to adapt to existing traffic control device design and typical quality, such as the refresh rates of electronic changeable message sign displays or the overall quality of a device that has been in service on the roadway for many years;
B. The color perception of signs;
C. The electronically perceptible conspicuity and contrast of markings in different environments and lighting conditions;
D. The driving automation system camera technology and device photometric characteristics in interpreting various types of traffic signals;
E. The ability to discern and comprehend temporary traffic control devices and their varying applications, such as active electronic display devices or flaggers; and
F. The ability to decipher traffic control at highway-rail or highway-LRT grade crossings, especially at passive grade crossings.

These and other challenges might limit the functionality of driving automation systems, thus making them less effective or functional, with potential implications for safety and traffic operations. The uniform design and consistent application of standardized traffic control devices supports the functionality of driving automation system technology in many situations. Similarly, good traffic control device maintenance practices and programs will help improve the potential for driving automation systems to operate properly in many roadway environments.

Guidance. Agencies should adopt traffic control device maintenance policies and or practices with consideration to both the human driver and driving automation system technology needs (see EPG 911 (MUTCD Section 1D.10), EPG 903.1.19, EPG 620.1.5 and EPG 902.1.10). Engineering judgment (see EPG 911 (MUTCD Section 1D.03) used to determine traffic control device selection and placement should consider uniformity in application and location needed to support both the human driver and driving automation system technology.

Support. A systematic approach to traffic control device selection, application, and maintenance taking into consideration certain fundamental principles, will help agencies considering the inclusion of AVs on their roadways. Generally, improvements to traffic control device uniformity and improved maintenance policies and practices that keep traffic control devices in good working order with high levels of conspicuity that are beneficial to the human driver will be beneficial to AVs as well.

Guidance. Agencies should apply the following fundamental principles and considerations as they evaluate traffic control devices and other maintenance practices to support driving automation system technologies during maintenance and infrastructure improvements:

A. Applying uniform and consistent traffic control devices on each type of roadway, and applying a similar approach to traffic control at similar locations in similar situations.
B. Establishing maintenance policies that incorporate effective practices to identify and then fix or replace in a timely manner any traffic control device that is reaching the end of its useful life, or that is damaged or otherwise no longer serviceable.
C. Making sure that temporary or emergency traffic control, to the extent practicable, is planned in advance using devices that comply with the provisions of this Manual and that follow policies designed to provide uniformity throughout the site and across jurisdictions.
D. Removing extraneous devices that are no longer necessary or that provide limited benefit to vehicle operation or navigation.

Signs (MUTCD Section 5B.01)

Support. This section of the MUTCD is included in the EPG for reference only. MoDOT has developed specific policies for signing to enhance safety and uniformity of traffic control devices that will be beneficial to AVs. Refer to EPG 903 Highway Signing for information related to signs.

Driving automation systems use sensors, algorithms, and processing to locate, read, and comprehend traffic signs and assist the human driver or AV in appropriately making vehicle operational decisions. Location, condition, uniformity, design characteristics, and consistent application all affect the ability of driving automation systems to perform these functions.

Standard. When scanning graphics (see EPG 903.1.4) of any type are used on a sign for support of driving automation systems, the scanning graphics shall not be visible to the human eye and the sign shall have no apparent loss of resolution or recognition for the road user.

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Guidance. Agencies seeking to better accommodate driving automation systems to support AVs, while also potentially benefitting human drivers, should consider:

A. Clearly associating the sign location and application with the displayed message to the specific lane or road to which it applies, such as in the case of parallel roads or lanes with different speed limits or restrictions.
B. The practice of sign and information spreading (see EPG 903.1.20) to limit the amount of information displayed in one location or on one sign to minimize sign clutter.
C. Signs with designs that are otherwise not provided for in this Manual or the MUTCD "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)) are designed based on the standardized sign design practices and features as provided for in this Manual for the type of sign, the location, and the characteristics of the roadway on which it is used.
D. The refresh rate of LEDs in the illuminated portion of electronic-display signs to provide for greater consistency in driving automation system detection.

Markings (MUTCD Section 5B.02)

Support. This section of the MUTCD is included in the EPG for reference only. MoDOT has developed policies for markings to enhance safety and uniformity of traffic control devices that will be beneficial to AVs. Refer to EPG 620 Pavement Marking for specific information related to markings.

Driving automation systems use sensors, algorithms, and processing to locate, read, and comprehend pavement markings. Location, condition, uniformity, design characteristics, and consistent application all have some effect on the ability of driving automation systems to perform this function. Certain pavement marking applications and practices have been shown through research to better support driving automation system technology, while also benefitting, or at least not detracting from, the performance of the human operator.

Guidance. Agencies seeking to better accommodate driving automation system to support AVs, while also potentially benefitting human drivers, should consider:

A. Normal width longitudinal lines of at least 6 inches in width (see EPG 620.1.4).
B. Edge lines of at least 6 inches in width (see EPG 620.1.4 and 620.2.10).
C. Dotted edge line extensions along all entrance and exit ramps, all auxiliary lanes, and all tapers where a deceleration or auxiliary lane is added (see EPG 620.2.13).
D. Chevron markings in the neutral areas of exit gores to distinguish them from travel lanes (see EPG 620.2.24).
E. Inlaid pavement markers only as a supplement to, rather than as a substitute for, pavement markings (see EPG 620.2.16).
F. Uniform contrast markings on light-colored pavements to create greater contrast.
G. Broken lines with uniform marking and gap length (see EPG 620.1.4).

Highway Traffic Signals (MUTCD Section 5B.03)

Support. This section of the MUTCD is included in the EPG for reference only. MoDOT has developed policies for traffic signals to enhance safety and uniformity of traffic control devices that will be beneficial to AVs. Refer to EPG 902 for specific information related to traffic signals.

Guidance. Agencies seeking to better accommodate driving automation systems to support AVs, while also potentially benefitting human drivers, should consider:

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A. Consistent signal face placement along corridors with respect to overhead mounting versus post mounting on the side of the roadway.
B. Consistent number of signal faces for approach lanes and the selection of signal indications and signal clusters along a corridor to promote uniform displays for identical or similar situations.
C. The refresh rate of LED traffic signals to provide for greater consistency in driving automation system detection.
D. Providing signal faces with backplates (see EPG 902.4.6) having retroreflective borders to enhance signal face conspicuity and detection by driving automation system sensors.
E. Using FLASHING YELLOW ARROW signal indications for permissive turns.

Support. Signal faces that display a CIRCULAR GREEN indication and that are located over or directly in line with a mandatory turn lane can be less effective for driving automation systems to recognize as a traffic signal face controlling permissive turning movements.

Achieving uniformity along a corridor is desirable for driving automation systems, but can be challenging. Multiple options are available for traffic signal displays to allow design variations based on specific intersection variables such as available overhead clearance, utility conflicts, signal support design constraints, and other factors. V2I capabilities can complement driving automation system recognition of traffic signals to provide redundancy, and to improve reliability and accuracy.

Temporary Traffic Control (MUTCD Section 5B.04)

Support. This section of the MUTCD is included in the EPG for reference only. MoDOT has developed policies for temporary traffic control to enhance safety and uniformity of traffic control devices that will be beneficial to AVs. Refer to EPG 616 for specific information related to temporary traffic control.

Guidance. Agencies seeking to better accommodate driving automation systems to support AVs, while also potentially benefitting human drivers, in and through temporary traffic control (TTC) zones should consider:

A. Consistent type, spacing, and mounting height of signs (see EPG 616.2.4 and EPG 616.6.2).
B. Use of the END ROAD WORK (G20-2) sign to establish the end of the TTC zone (see EPG 616.8.34).
C. Wider retroreflective material on, or reduced spacing of, channelizing devices to better accommodate driving automation system sensors in nighttime and adverse weather conditions (see EPG 616.11).
D. Continuous markings at the beginning of TTC zones and in lane transitions.
E. Temporary raised pavement markers only as a supplement to, rather than as a substitute for, pavement markings.
F. Removal or obliteration of pavement markings that are no longer applicable as soon as practicable, for long-term stationary operations in the temporary traveled way (see EPG 616.10.1).

Support. Pavement markings that are not fully removed and pavement scarring are of particular concern as there can be misinterpretation by driving automation systems that can result in erroneous vehicle positioning in TTC zones.

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V2I communications can complement driving automation systems recognition in TTC zones by communicating the presence of a TTC zone to vehicles.

EPG 616.10.1 describes the use of pavement markings in TTC zones and the removal or obliteration of existing pavement markings.

EPG 616.10.2 describes the use of temporary pavement markings in TTC zones.

Traffic Control for Highway-Rail and Highway-Light Rail Transit Grade Crossings (MUTCD Section 5B.05)

Support. This section of the MUTCD is included in the EPG for reference only. MoDOT has developed policies for highway-rail grade crossings to enhance safety and uniformity of traffic control devices that will be beneficial to AVs. Refer to EPG 913 for specific information related to highway-rail grade crossings.

Guidance. Agencies seeking to better accommodate driving automation systems to support AVs, while also potentially benefitting human drivers, at grade crossings should consider:

A. Consistent placement of signs and markings for passive and active grade crossings along a corridor to promote uniformity and to improve the ability of driving automation system technology to recognize grade crossings.
B. Removal of signs and pavement markings associated with grade crossings that are out of service (see EPG 913.1.9).

Support. V2I communications can complement driving automation system recognition of grade crossings to improve reliability and accuracy, and to relay information on the arrival or presence of a train or LRT vehicle at a grade crossing.

Traffic Control for Bicycle Facilities (MUTCD Section 5B.06)

Support. This section of the MUTCD is included in the EPG for reference only. MoDOT has developed policies for bicycle facilities to enhance safety and uniformity of traffic control devices that will be beneficial to AVs. Refer to EPG 914 for specific information related to bicycle facilities.

Guidance. Agencies seeking to better accommodate driving automation systems to support AVs, while also potentially benefitting human road users, should consider:

A. Use of an END (R3-9dP) plaque with a BIKE LANE (R3-17) sign to indicate the end of a bicycle lane that is merging with other traffic (see EPG 914.2.3).
B. Use of Bicycle Lane Ends (W9-5) and Bicycle Merging (W9-5a) warning signs in advance of the end of a bicycle lane and where a merging maneuver might occur (see EPG 914.3.2).

Support. Bicycle facilities that are physically separated from motor vehicle traffic using vertical objects or vertical separation can facilitate detection from driving automation system sensors (see EPG 914.5.7).

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Category:913 Traffic Control for Railroad and Light Rail Transit Grade Crossings (MUTCD Part 8)

Support. Category 913 of the EPG contains information related to traffic control for railroad and light rail transit grade crossings and is similar to Part 8 of the MUTCD. See EPG 900.1 for a description of how MUTCD content is incorporated into the EPG.



Articles in "913 Traffic Control for Railroad and Light Rail Transit Grade Crossings (MUTCD Part 8)"

The following 5 pages are in this category, out of 5 total.

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- 913.1 General (MUTCD Chapter 8A)
- 913.2 Signs (MUTCD Chapter 8B)
- 913.3 Markings (MUTCD Chapter 8C)
- 913.4 Flashing-Light Signals, Automatic Gates, and Traffic Control Signals (MUTCD Chapter 8D)
- 913.5 Pathway and Sidewalk Grade Crossings (MUTCD Chapter 8E)

Media in category "913 Traffic Control for Railroad and Light Rail Transit Grade Crossings (MUTCD Part 8)"

This category contains only the following file.



913 Railroad.jpg
800 × 563; 59 KB

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913.1 General (MUTCD Chapter 8A)

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913.1.1 Introduction (MUTCD Section 8A.01)

Support. Where the acronym “LRT” is used in EPG 913, it refers to “light rail transit.”

To promote an understanding of common terminology between highway and railroad and LRT signaling issues, definitions and acronyms pertaining to EPG 913 are provided in EPG 911 (MUTCD Section 1C.02).

EPG 913.1, EPG 913.2, EPG 913.3, and EPG 913.4 describe the traffic control devices that are used at highway-rail and highway-LRT grade crossings. Unless otherwise provided in the text or on a figure or table, the provisions of EPG 913 are applicable to both highway-rail and highway-LRT grade crossings. Where the phrase “grade crossing” is used by itself without the prefix “highway-rail” or “highway-LRT,” it refers to both highway-rail and highway-LRT grade crossings.

EPG 913.5 describes the traffic control devices that are used at pathway and sidewalk grade crossings.

Traffic control for grade crossings includes all signs, signals, markings, other warning devices, and their supports along highways approaching and at grade crossings. The function of this traffic control is to promote safety and provide effective operation of rail and/or LRT and highway traffic at grade crossings.

For purposes of design, installation, operation, and maintenance of traffic control devices at grade crossings, it is recognized that the crossing of the highway and rail tracks is situated on a right-of-way available for the joint use of both highway traffic and railroad or LRT traffic.

Grade crossings and the traffic control devices that are associated with them are unique in that in many cases, the highway agency or authority with jurisdiction (e.g., MoDOT, City, County, or Special Road District), the MoDOT Multimodal Division (Rail Section), the railroad company, and/or transit agency are jointly involved in the development of engineering judgment or the performance of an engineering study. This joint process is accomplished through the efforts of a Diagnostic Team made up of the highway agency with jurisdiction, the MoDOT Multimodal Division (Rail Section), and the railroad company and/or transit agency (if applicable).

In EPG 913, the combination of traffic control devices selected or installed at a specific grade crossing is referred to as a "traffic control system."

The combination of railroad or LRT active traffic control devices used to inform road users at a grade crossing of the approach or presence of rail traffic and the necessary control equipment for the devices are referred to as a "grade crossing warning system." The "2023 AREMA Communications and Signals Manual" published by the American Railway Engineering and Maintenance-of-Way Association (AREMA) contains further information about grade crossing warning systems.

Standard. The traffic control devices, systems, and practices described in The EPG shall be used at all grade crossings on the state highway system, consistent with Federal, State, and local laws and regulations.

Support. 23 CFR 655.603 contains information on the applicability of the EPG at private grade crossings.

913.1.2 Highway-LRT Grade Crossings (MUTCD Section 8A.02)

Support. EPG 913 also describes the traffic control devices that are used in locations where light rail transit (LRT) vehicles are operating along streets and highways in mixed traffic with road users.

LRT is a mode of public transportation that employs LRT vehicles (commonly known as light rail vehicles, streetcars, or trolleys) that operate on rails in streets in mixed traffic, and LRT traffic that operates in semi-exclusive rights-of-way, or in exclusive rights-of-way. Where the phrase "LRT" is used in EPG 913, it refers to light rail vehicles, streetcars, and trolleys. Grade crossings with LRT can occur at intersections or at midblock locations, including public and private driveways.

An initial educational campaign along with an ongoing program to continue to educate new drivers is beneficial when introducing LRT operations to an area and, hence, new traffic control devices.

LRT alignments can be grouped into one of the following three types (see definitions in EPG 911 (MUTCD Section 1C.02)):

> A. Exclusive: An LRT right-of-way that is grade-separated or protected by a fence or traffic barrier. Motor vehicles, pedestrians, and bicycles are prohibited within the right-of-way.

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This type of alignment does not have grade crossings and is not further addressed in EPG 913.
B. Semi-exclusive: An LRT alignment that is in a separate right-of-way or along a street or railroad right-of-way where motor vehicles, pedestrians, and bicyclists have limited access and cross at designated locations only, such as at grade crossings where road users must yield the right-of-way to the light rail transit traffic.
C. Mixed-use: An alignment where LRT operates in mixed traffic with all types of road users. In a mixed-use alignment, the light rail transit traffic does not have the right-of-way over other road users at grade crossings and intersections. If the LRT traffic is controlled by traffic control signals or LRT signal faces at an intersection with a roadway, the alignment is considered to be mixed-use even if some of the approaches to the intersection are used exclusively by LRT traffic.

Guidance. If a highway-LRT grade crossing is equipped with flashing-light signals and is located 200 feet or less from an intersection or midblock location controlled by a traffic control signal, a pedestrian hybrid beacon, or an emergency-vehicle hybrid beacon, the intersection should be provided with rail preemption in accordance with EPG 902.6.19 and EPG 913.4.9 unless otherwise determined by the Diagnostic Team.

Option. Where LRT vehicles are operating in a mixed-use alignment, traffic signal priority or preemption may be used as determined by a Diagnostic Team.

Standard. Where LRT and railroads use the same tracks or adjacent tracks, the traffic control devices, systems, and practices for highway-rail grade crossings shall be used.

913.1.3 Traffic Control Systems and Practices at Grade Crossings (MUTCD Section 8A.03)

Support. Because of the large number of significant variables to be considered, no single standard system of traffic control devices is universally applicable for all grade crossings.

Standard. Before any new grade crossing traffic control system is installed or before modifications are made to an existing system, approval shall be obtained from the highway agency with jurisdiction, the MoDOT Multimodal Division (Rail Section) and the railroad company and/or transit agency.

The Diagnostic Team members shall make a recommendation, documented in an engineering study (see EPG 913.1.5), on new grade crossing traffic control systems and on proposed changes to an existing grade crossing traffic control system. The Diagnostic Team recommendation shall be made based on the Diagnostic Team's site visits, meetings, conference calls, or a combination of some or all of these methods.

Except as provided in the second Option paragraph below, operational changes made to a grade crossing traffic control system shall be evaluated by a Diagnostic Team.

Among the types of changes at a grade crossing for which a Diagnostic Team shall conduct an engineering study are: additions, removals, or modifications of the lanes approaching or traversing the grade crossing; addition or removal of tracks; significant changes in the number or speed of trains; significant changes in the number or speed of vehicles; addition of vehicle access near the grade crossing; additions or modifications to sidewalks; additions or modifications to bicycle lanes,

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especially if a counter-flow bicycle lane is added on a one-way street; changes to roadway use, including conversion to or from one-way operation or reversible lanes; and the installation of or significant operational changes to traffic control signals that might affect the grade crossing.

Option. A Diagnostic Team may conduct an engineering study and make recommendations as part of the Quiet Zone establishment process (see EPG 913.1.11).

Where determined by the responsible public agency, the railroad company, and/or the transit agency, general maintenance activities or minor operational changes to the grade crossing traffic control system that do not have a negative impact on the overall operation of the traffic control system may be made without a review and determination by a Diagnostic Team.

Support. Many other details of grade crossing traffic control systems that are not set forth in EPG 913 are contained in publications such as the "2023 AREMA Communications and Signals Manual" published by the American Railway Engineering and Maintenance-of-Way Association (AREMA), the Third Edition of "Highway-Rail Crossing Handbook" published by the FHWA and the FRA, and the 2nd Edition of "Preemption of Traffic Signals Near Railroad Crossings" published by the Institute of Transportation Engineers (ITE).

913.1.4 Traffic Control Systems at Highway-LRT Grade Crossings (MUTCD Section 8A.04)

Support. The combination of devices selected or installed at a specific highway-LRT grade crossing is referred to as a "Light Rail Transit Traffic Control System."

The normal rules of the road and traffic control priority identified in the "Uniform Vehicle Code" (see EPG 911 (MUTCD Section 1A.06)) govern the order assigned to the movement of vehicles at an intersection unless the local agency determines that it is appropriate to assign a higher priority to LRT vehicles. Examples of different types of LRT priority control include separate traffic control signal phases for LRT movements, restriction of movement of roadway vehicles in favor of LRT operations, and preemption of highway traffic signal control to accommodate LRT movements.

Standard. Highway-LRT grade crossings in semi-exclusive alignments outside of a roadway shall be equipped with flashing-light signals, with or without automatic gates, unless a Diagnostic Team determines that the use of Crossbuck Assemblies, STOP signs, or YIELD signs alone would be adequate.

913.1.5 Engineering Studies at Grade Crossings (MUTCD Section 8A.05)

Standard. The appropriate traffic control system to be used at a grade crossing shall be determined based on an engineering study conducted by a Diagnostic Team involving the highway agency with jurisdiction, the MoDOT Multimodal Division (Rail Section), and the railroad company and/or transit agency (as applicable).

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Option. The MoDOT Multimodal Division (Rail Section) may approve the grade crossing traffic control system.

Guidance. Among the factors that should be considered in the determination by a Diagnostic Team of which traffic control devices would be appropriate to install at a grade crossing are road geometrics, stopping sight distance, clearing sight distance, the proximity of nearby roadway intersections (including the traffic control devices at the intersections), adjacent driveways, traffic volume across the grade crossing, extent of queuing upstream or downstream from the grade crossing, train volume, pedestrian and bicycle volumes, operation of passenger trains, presence of nearby passenger station stops, maximum allowable train speeds, variable train speeds, accelerating and decelerating trains, multiple tracks, high-speed train operation, number of school buses or hazardous material haul vehicles, and the crash history at or near the location.

Option. The engineering study may include the Highway-Rail Intersection (HRI) components of the National Intelligent Transportation Systems (ITS) architecture, which is a USDOT accepted method for linking the highway, vehicles, and traffic management systems with rail operations and wayside equipment.

Support. More detail on Highway-Rail Intersection components is available from the USDOT's Federal Railroad Administration, 1200 New Jersey Avenue, SE, Washington, DC 20590, or https://www.fra.dot.gov.

913.1.6 Uniform Provisions (MUTCD Section 8A.06)

Standard. All signs used in grade crossing traffic control systems shall be retroreflective or illuminated as described in EPG 903.1.21 to show the same shape and similar color to an approaching road user during both day and night.

No sign or signal shall be located in the center of an undivided highway, unless it is crashworthy (breakaway, yielding, or shielded with a longitudinal barrier or crash cushion) or unless it is placed on a raised island.

Guidance. Any signs or signals placed on a raised island in the center of an undivided highway should be installed with a clearance of at least 2 feet from the outer edge of the raised island to the nearest edge of the sign or signal, except as permitted in EPG 903.1.16.

Where a raised median island is installed supplemental to an automatic gate to discourage road users from driving around a lowered gate, the Diagnostic Team should consider the length of the vehicle queues that typically form on the approach to the grade crossing when determining how far in advance of the grade crossing to extend the island.

If the roadway at a grade crossing includes a two-way left-turn lane (see EPG 620.2.6), the two-way left-turn lane should be discontinued in the immediate vicinity of the grade crossing by installing median islands, by designating the lane for left turns in one direction only, or by installing yellow diagonal markings in the lane (see Figure 620.2.3.3). If yellow diagonal markings are used, the use of channelizing devices (see EPG 620.8.1), such as supplemental tubular markers, should also be considered.

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Option. If yellow diagonal markings are used, extending the automatic gate across the lane may be considered.

913.1.7 Minimum Track Clearance Distance and Clear Storage Distance (MUTCD Section 8A.07)

Support. The upstream point of the minimum track clearance distance is determined in the following manner:

A. If an automatic gate is present on the approach, the upstream point is the portion of the automatic gate arm that is farthest from the nearest rail.
B. If an automatic gate is not present on the approach, the upstream point is the portion of the stop line that is farthest from the nearest rail.
C. If the roadway is not paved, the upstream point is the point that is farthest from the nearest rail that is 10 feet measured perpendicular from the nearest rail.

The downstream point of the minimum track clearance distance is 6 feet beyond the track(s) or the edge of the downstream highway-highway intersection, whichever is closer, and is measured perpendicular to the farthest rail, along the center line or edge line of the highway, as appropriate, to obtain the longer distance. Where an Exit Gate system (see EPG 913.4.5) is present, the downstream point is the point where the rear of the vehicle would be clear of the exit gate arm. In cases where the exit gate arm is not perpendicular to the highway, the distance is measured either along the center line or edge line of the highway, as appropriate, to obtain the longer distance.

Where two adjacent grade crossings (see EPG 913.1.8) are located within 200 feet of each other as measured along the highway, the minimum track clearance distance is measured from a point that is upstream of the first grade crossing to a point that is downstream from the second grade crossing.

Where a highway-highway intersection is located beyond a grade crossing, the clear storage distance defines on a lane-by-lane basis the area of the roadway between the downstream point of the minimum track clearance distance and the intersection stop line, yield line, or normal stopping point on the highway.

The Highway-Rail Crossing Handbook contains an illustration of the minimum track clearance distance and the clear storage distance.

The minimum track clearance distance and the clear storage distance are used by the Diagnostic Team to determine the appropriate traffic control devices and/or roadway treatments to be used at the grade crossing, and to determine the queue start-up and queue clearance time necessary where a traffic signal or hybrid beacon is interconnected with a grade crossing active warning system.

913.1.8 Adjacent Grade Crossings (MUTCD Section 8A.08)

Support. Adjacent grade crossings sometimes exist within 200 feet of each other as measured along the highway between the inside rails. These closely-spaced grade crossings sometimes result from separate railroads or from a railroad and an LRT alignment operating in parallel corridors.

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Guidance. Where adjacent grade crossings are located within 200 feet of each other along the highway as measured along the highway between the inside rails, the Diagnostic Team should consider the possibility that rail traffic might arrive at a grade crossing when rail traffic is already occupying the adjacent grade crossing.

Where the shortest distance between the tracks at adjacent grade crossings, measured along the highway between the inside rails, is 100 feet or less, the grade crossings should be treated as one individual grade crossing.

Where the shortest distance between the tracks at adjacent grade crossings, measured along the highway between the inside rails, is more than 100 feet and less than 200 feet, additional signs or other appropriate traffic control devices should be used to inform approaching road users of the long distance to cross the tracks.

Where active traffic control devices are installed between adjacent grade crossings that are more than 100 feet apart and less than 200 feet apart as measured along the highway between the inside rails, the operation of the devices should provide additional time for vehicles to clear the extended minimum track clearance distance (see EPG 913.1.7) that results from the closely-spaced grade crossings.

Where the shortest distance between the tracks at adjacent grade crossings, measured along the highway between the inside rails, is more than 200 feet, the grade crossings should be treated as individual grade crossings and traffic control devices should be installed between the grade crossings.

Support. The "2023 AREMA Communications and Signals Manual" published by the American Railway Engineering and Maintenance-of-Way Association (AREMA) contains further information and recommendations about the location and operation of active traffic control devices at adjacent grade crossings that are located within 200 feet of each other.

913.1.9 Grade Crossing Elimination (MUTCD Section 8A.09)

Option. If a particular grade crossing appears to be redundant or unnecessary for motor vehicle, pedestrian, and bicycle traffic, an engineering study may be conducted to determine the costs and benefits of eliminating the crossing.

Guidance. If an engineering study is conducted, any necessary improvements to adjacent grade crossings and the surrounding roadway network to accommodate diverted traffic should also be included in the analysis.

If the conclusion of the engineering study is that the grade crossing should be eliminated, a Diagnostic Team should use the engineering study to determine the appropriate steps that need to be taken to accomplish the grade crossing elimination.

Standard. Where a grade crossing is eliminated, the traffic control devices for the crossing shall be removed, and shall be covered or turned from view in the interim period prior to removal.

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Guidance. If the existing traffic control devices at a multiple-track grade crossing become improperly placed or are no longer applicable because of the removal of some of the tracks, the existing devices should be relocated and/or modified.

Where a roadway is removed from a grade crossing, the roadway approaches in the railroad or LRT right-of-way should also be removed and appropriate signs and object markers should be placed at the roadway end in accordance with EPG 903.3.73.

Where a railroad or LRT is eliminated at a grade crossing, the tracks should be removed or paved over.

913.1.10 Illumination at Grade Crossings (MUTCD Section 8A.10)

Support. Illumination is sometimes installed at or adjacent to a grade crossing in order to provide better nighttime visibility of trains or LRT equipment and the grade crossing (for example, where a substantial amount of railroad or LRT operations are conducted at night, where grade crossings are blocked for extended periods of time, or where crash history indicates that road users experience difficulty in seeing trains or LRT equipment or traffic control devices during hours of darkness).

Recommended types and locations of luminaires for illuminating grade crossings are contained in the American National Standards Institute's "ANSI/IES RP-8-22, Recommended Practice: Lighting Roadway and Parking Facilities," which is available from the Illuminating Engineering Society.

913.1.11 Quiet Zone Treatments at Highway-Rail Grade Crossings (MUTCD Section 8A.11)

Support. 49 CFR Part 222 (Use of Locomotive Horns at Highway-Rail Grade Crossings; Final Rule) prescribes Quiet Zone requirements and treatments.

Standard. Any traffic control device and its application, where used as part of a Quiet Zone, shall comply with all applicable provisions of the MUTCD.

913.1.12 Grade Crossings Within or In Close Proximity to Circular Intersections (MUTCD Section 8A.12)

Support. At circular intersections, such as roundabouts and traffic circles, that include or are within close proximity to a grade crossing, a queue of vehicular traffic could cause motor vehicles to stop on the grade crossing.

Standard. Where circular intersections include or are within 200 feet of a grade crossing, an engineering study shall be made to determine if queuing could impact the grade crossing.

Guidance. The Diagnostic Team should review the findings of the engineering study and determine the appropriate measures to clear highway traffic from the grade crossing prior to the arrival of rail traffic.

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Support. Among the actions that can be taken to keep the grade crossing clear of traffic or to clear traffic from the grade crossing prior to the arrival of rail traffic are the following:

A. Grade crossing regulatory and warning devices;
B. Highway traffic signals;
C. Traffic metering devices;
D. Activated signs;
E. Geometric design revisions, including reconstruction or elimination of the circular intersection; or
F. A combination of these or other actions.

913.1.13 Temporary Traffic Control Zones (MUTCD Section 8A.13)

Support. Temporary traffic control planning provides for continuity of operations (such as movement of motor vehicle traffic, pedestrians, and bicyclists, transit operations, and access to property/utilities) when the normal function of a roadway at a grade crossing is suspended because of temporary traffic control operations. Temporary traffic control planning is also needed when traffic is detoured over an existing grade crossing.

Standard. Traffic controls for temporary traffic control zones that include grade crossings shall be as provided in EPG 616.

Guidance. Where a temporary traffic control zone extends over an active grade crossing (see EPG 616.14.17), and where the direction of traffic in any lane is reversed over the grade crossing, the railroad company or transit agency should be part of the temporary traffic control planning process. Where a grade crossing warning system is not modified to support the temporary traffic control operation, at least one uniformed law enforcement officer should be in place at all times that rail traffic might approach or occupy the grade crossing.

Where traffic is detoured over an existing passive grade crossing, a temporary traffic control plan (see EPG 616.2.1) should be prepared.

Public and private agencies, emergency services, businesses, and railroad companies or transit agencies should meet to plan appropriate traffic detours and the necessary signing, marking, signalization, and flagging requirements for operations during temporary traffic control zone activities or during the period when traffic is being detoured over an existing passive grade crossing. Consideration should be given to the length of time that the grade crossing is to be closed, the length of time that a detour is to be in place, the type of rail or LRT and highway traffic affected, the time of day, and the materials and techniques of repair.

The agencies responsible for the operation of the LRT and highway should be contacted when the initial planning begins for any temporary traffic control zone that might directly or indirectly influence the flow of traffic on facilities where LRT vehicles operate on a mixed-use alignment.

Temporary traffic control operations should minimize the inconvenience, delay, and crash potential to affected traffic. Prior notice should be given to affected public or private agencies, emergency services, businesses, railroad companies or transit agencies, and road users before the free movement of road

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users or rail traffic is infringed upon or blocked.

Support. EPG 616.14.17 contains additional information regarding temporary traffic control zones in the vicinity of grade crossings, and TA-46 shows an example of a typical situation that might be encountered.

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913.2 Signs (MUTCD Chapter 8B)

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913.2.1 Purpose and Application (MUTCD Section 8B.01)

Support. Passive traffic control systems, consisting of signs and pavement markings only, identify and direct attention to the location of a grade crossing and advise road users to reduce their speed or stop at the grade crossing as necessary in order to yield to any rail traffic occupying, or approaching and in proximity to, the grade crossing.

Signs and markings regulate, warn, and guide the road users so that they, as well as LRT vehicle operators on mixed-use alignments, can take appropriate action when approaching a grade crossing.

Unless otherwise provided in this article, the provisions of EPG 903 are applicable to the design and location of signs at grade crossings.

913.2.2 Sizes of Grade Crossing Signs (MUTCD Section 8B.02)

Standard. The sizes of grade crossing signs shall be as shown in Table 913.2.2.

Table 913.2.2, Railroad and Light Rail Transit Grade Crossings Sign and Plaque Sizes

Sign or Plaque	Sign Designation	EPG Article	Conventional Road (in. x in.)			Freeway/Expressway (in. x in.)
			Standard	Oversized	Special	Mainline and Ramps
STOP	R1-1	-	36 x 36	48 x 48	-	48 x 48
YIELD	R1-2	-	48 x 48	60 x 60	-	60 x 60
No Right Turn - Train (symbol)	R3-1a	913.4.10	24 x 30	30 x 36	-	-
No Left Turn - Train (symbol)	R3-2a	913.4.10	24 x 30	30 x 36	-	-
DO NOT STOP ON TRACKS	R8-8	913.2.7	24 x 30	24 x 30	-	36 x 48
STOP HERE ON RED	R10-6	913.2.8	24 x 36	24 x 36	-	-
LEFT (RIGHT) LANE SIGNAL	R10-10b	913.4.11, 913.4.12	24 x 30	30 x 36	-	30 x 36
LEFT (RIGHT) TURN LANE SIGNAL	R10-10C	913.4.11, 913.4.12	24 x 30	30 x 36	-	30 x 36
Grade Crossing (Crossbuck) [Railroad Responsibility]	R15-1	913.2.3	48 x 9	-	-	48 x 9
Number of Tracks (plaque) [Railroad Responsibility]	R15-2P	913.2.3	27 x 18	-	-	27 x 18
EXEMPT	R15-3P	913.2.9	24 x 12	-	-	-
Railroad Crossing	W10-1	913.2.6	42 dia.	-	-	48 dia.
EXEMPT	W10-1aP	913.2.6	24 x 12	-	-	-
Crossroad Railroad Crossing	W10-2	913.2.6	36 x 36	48 x 48	-	48 x 48
Side Road Railroad Crossing	W10-3	913.2.6	36 x 36	48 x 48	-	48 x 48
T-Intersection Railroad Crossing	W10-4	913.2.6	36 x 36	48 x 48	-	48 x 48
Low Ground Clearance (symbol)	W10-5	913.2.14	36 x 36	48 x 48	-	48 x 48
Low Ground Clearance (plaque)	W10-5P	913.2.14	30 x 24	-	-	30 x 24
No Train Horn (plaque)	W10-9P	913.2.15	30 x 24	-	-	30 x 24
Emergency Notification [Railroad Responsibility]	I13-1	913.2.16	12 x 9	-	-	12 x 9

Notes:

1. Dimensions in inches are shown as width x height
2. Table 914.1.2 shows the minimum sizes that may be used for grade crossing signs and plaques that face shared-use paths and pedestrian facilities

913.2.3 Grade Crossing (Crossbuck) Sign (R15-1) and Number of Tracks Plaque (R15-2P) at Active and Passive Grade Crossings

(MUTCD Section 8B.03)



R15-1



R15-2P

Standard. The Grade Crossing (R15-1) sign, commonly identified as the Crossbuck sign, shall be retroreflective white with the words RAILROAD CROSSING in black lettering, mounted as shown in Figure 913.2.3.

Support. The Grade Crossing (R15-1) sign and Number of Tracks (R15-2P) plaque are provided by the appropriate railroad company. Railroad companies and/or transit agencies are responsible for the installation and maintenance of these signs.

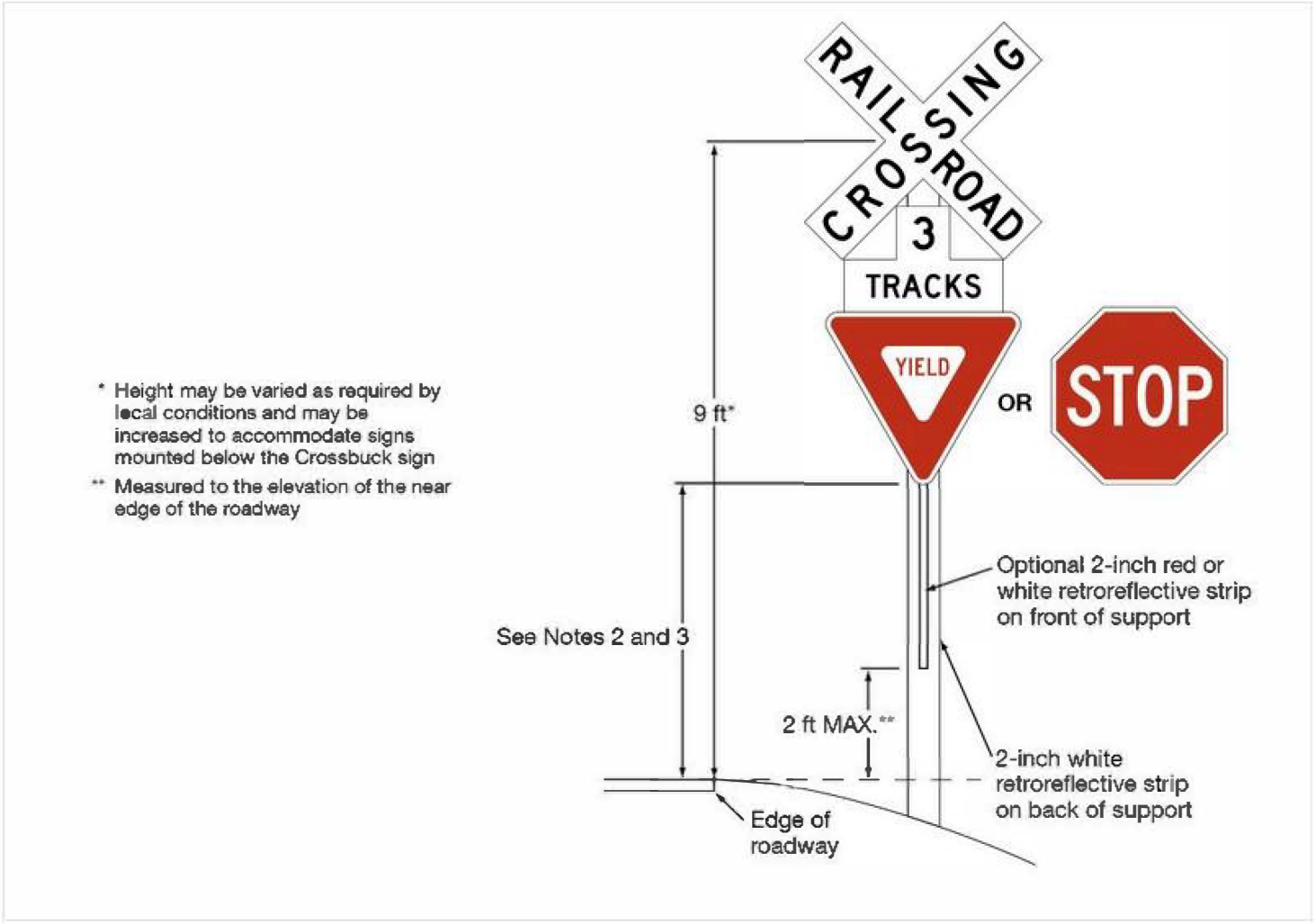


Figure 913.2.3 Crossbuck Assembly with a YIELD or STOP Sign on the Crossbuck Sign Support

Notes:

1. YIELD or STOP signs are used only at passive crossings. A STOP sign is used only if an engineering study determines that it is appropriate for that particular approach.
2. Mounting height shall be at least 4 feet for installations of YIELD or STOP signs on existing Crossbuck sign supports.
3. Mounting height shall be at least 5 feet for new installations in rural areas and at least 7 feet for new installations in areas where parking or pedestrian movements are likely to occur.

Standard. As a minimum, one Crossbuck sign shall be used on each highway approach to every highway-rail grade crossing, alone or in combination with other traffic control devices.

As a minimum, one Crossbuck sign shall be used on each highway approach to every highway-LRT grade crossing where flashing-light signals or automatic gates are used, alone or in combination with other traffic control devices.

Option. A Crossbuck sign may be used on a highway approach to a highway-LRT grade crossing where flashing-light signals or automatic gates are not used, alone or in combination with other traffic control devices.

Standard. If there are two or more tracks at a grade crossing, the number of tracks shall be indicated on a supplemental Number of Tracks (R15-2P) plaque of inverted T shape mounted below the Crossbuck sign in the manner shown in Figure 913.2.3.

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On each approach to a highway-rail grade crossing and, if used, on each approach to a highway-LRT grade crossing, the Crossbuck sign shall be installed on the right-hand side of the highway on each approach to the grade crossing. Where restricted sight distance or unfavorable highway geometry exists on an approach to a grade crossing, or where there is a one-way multi-lane approach, an additional Crossbuck sign shall be installed on the left-hand side of the highway, possibly placed back-to-back with the Crossbuck sign for the opposite approach or otherwise located so that two Crossbuck signs are displayed for that approach.

A strip of retroreflective white material not less than 2 inches in width shall be used on the back of each blade of each Crossbuck sign for the length of each blade at all passive grade crossings, except those where Crossbuck signs have been installed back-to-back or where double-faced Crossbuck signs have been installed.

Option. A strip of retroreflective white material not less than 2 inches in width may be used on the back of each blade of each Crossbuck sign for the length of each blade at active grade crossings.

Guidance. Minimum clearance dimensions for crossbuck signs relative to the proximity to the nearest rail should conform to the requirements of the railroad company and/or transit agency, and MoDOT Multimodal Division (Rail Section).

Except as provided in the Option paragraph below, the mounting height of Crossbuck signs, measured vertically from the center of the sign to the elevation of the near edge of the pavement, should be approximately 9 feet (see Figure 913.2.3).

Option. The 9-foot mounting height for the Crossbuck sign may be varied as required by local conditions and may be increased to accommodate signs mounted below the Crossbuck sign.

913.2.4 Crossbuck Assemblies with YIELD or STOP Signs at Passive Grade Crossings (MUTCD Section 8B.04)

Support. The MoDOT Multimodal Division developed a Stop Sign Fact Sheet Sheet to help determine if a Stop sign should be displayed below the Crossbuck sign instead of a Yield sign at passive railroad crossings.

Standard. A Crossbuck Assembly shall consist of a Crossbuck (R15-1) sign, and a Number of Tracks (R15-2P) plaque if two or more tracks are present, that complies with the provisions of EPG 913.2.3, and either a YIELD (R1-2) or STOP (R1-1) sign installed on the same support, except as provided in the Option paragraph below. YIELD or STOP signs used at passive grade crossings shall be installed in compliance with the provisions of EPG 903.2.17, and Figures 913.2.3, 913.2.4.1, and 913.2.4.2.

At all public highway-rail grade crossings that are not equipped with the active traffic control systems that are described in EPG 913.4, except crossings where road users are directed by an authorized person on the ground to not enter the crossing at all times that an approaching train is about to occupy the crossing, a Crossbuck Assembly shall be installed on the right-hand side of the highway on each approach to the highway-rail grade crossing.

If a Crossbuck sign is used on a highway approach to a public highway-LRT grade crossing that is not equipped with the active traffic control systems that are described in EPG 913.4, a Crossbuck Assembly shall be installed on the right-hand side of the highway on each approach to the highway-LRT grade crossing.

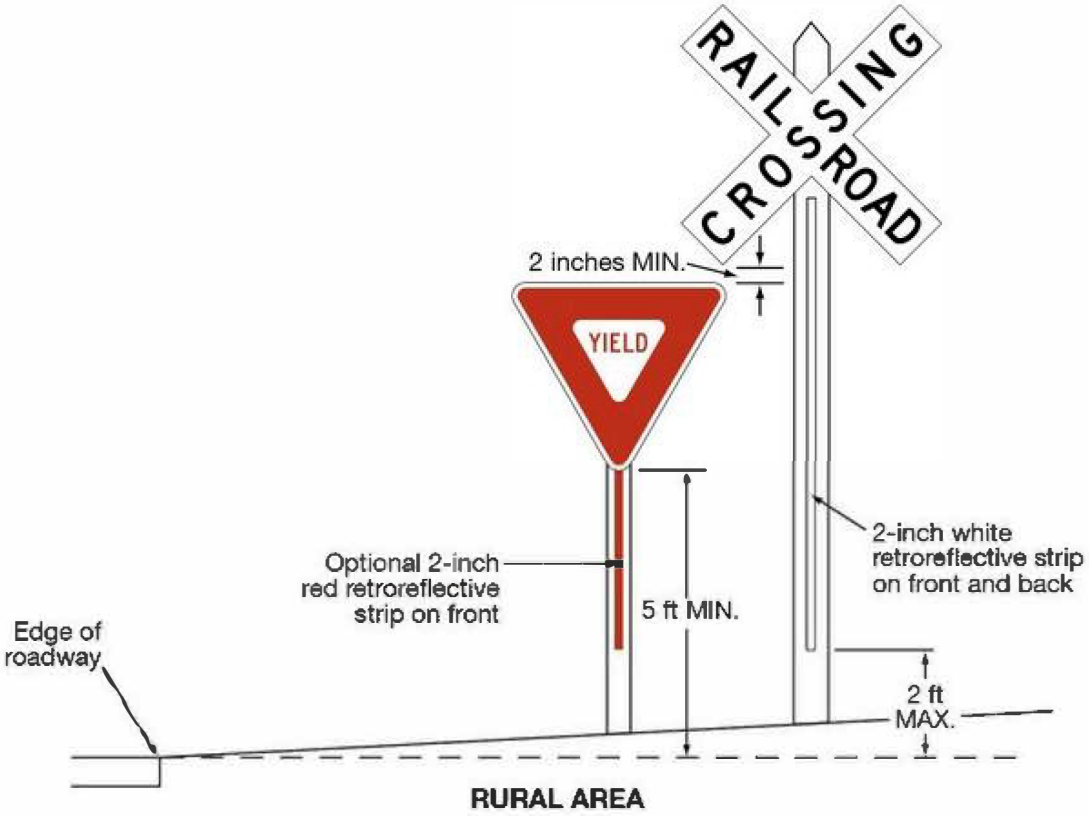
Where restricted sight distance or unfavorable highway geometry exists on an approach to a grade crossing that has a Crossbuck Assembly, or where there is a one-way multi-lane approach, an additional Crossbuck Assembly shall be installed on the left-hand side of the highway.

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A YIELD sign shall be the default traffic control device for Crossbuck Assemblies on all highway approaches to passive grade crossings unless an engineering study performed by the MoDOT Multimodal Division (Rail Section) or highway authority having jurisdiction over the roadway approach determines that a STOP sign is appropriate.

Guidance. The use of STOP signs at passive grade crossings should be limited to unusual conditions where requiring all motor vehicles to make a full stop is determined to be necessary by a Diagnostic Team. Among the factors that should be considered by the Diagnostic Team are the line of sight to approaching rail traffic (giving due consideration to seasonal crops or vegetation beyond both the highway and railroad or LRT rights-of-ways), the number of tracks, the speeds of trains or LRT equipment and motor vehicles, and the crash history at the grade crossing.

Where a passive grade crossing is located on a stop-controlled approach and the clear storage distance is less than the length of the design vehicle, and where adequate sight distance to oncoming traffic on the parallel roadway is available to road users stopped on the approach to the grade crossing, consideration should be given to installing a STOP sign at the Crossbuck Assembly instead of at the highway-highway intersection. If the STOP sign is installed at the Crossbuck Assembly instead of at the highway-highway intersection, the Diagnostic Team should consider installing some other intersection traffic control device at the highway-highway intersection.



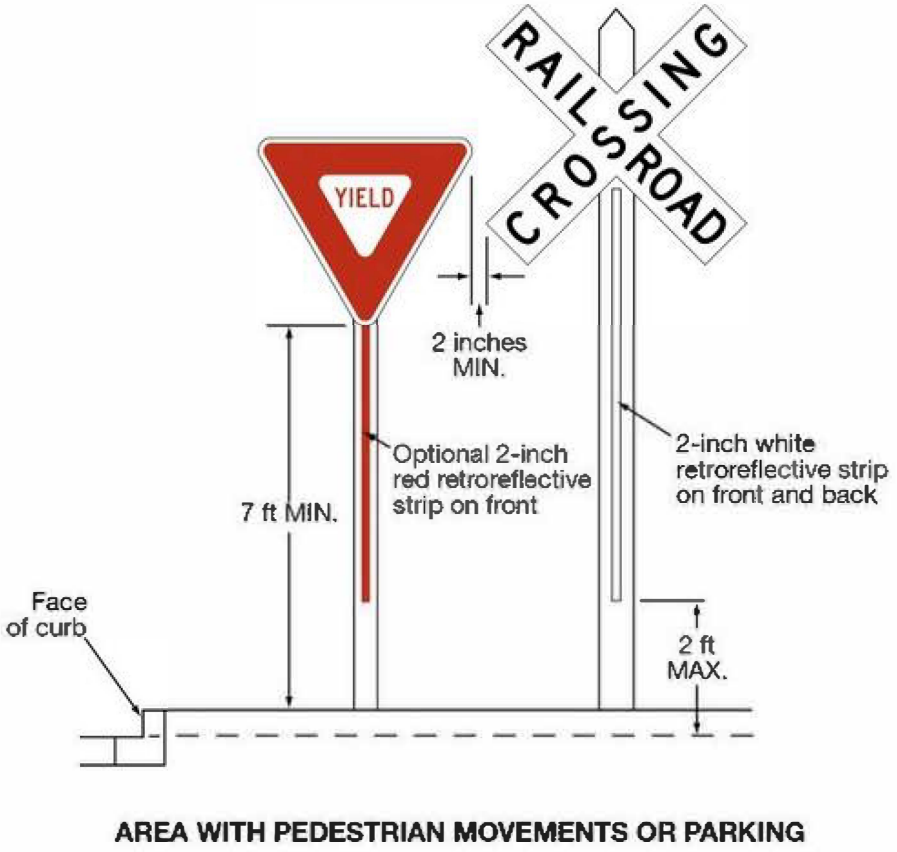


Figure 913.2.4.1. Crossbuck Assembly with a YIELD or STOP Sign on a Separate Sign Support *(Sheet 1 of 2)*

Notes:

1. YIELD signs are used only at passive crossings.

2. Place the face of the signs in the same plane and place the YIELD sign closer to the traveled way. Provide a 2-inch minimum separation between the edge of the Crossbuck sign and the edge of the YIELD sign.

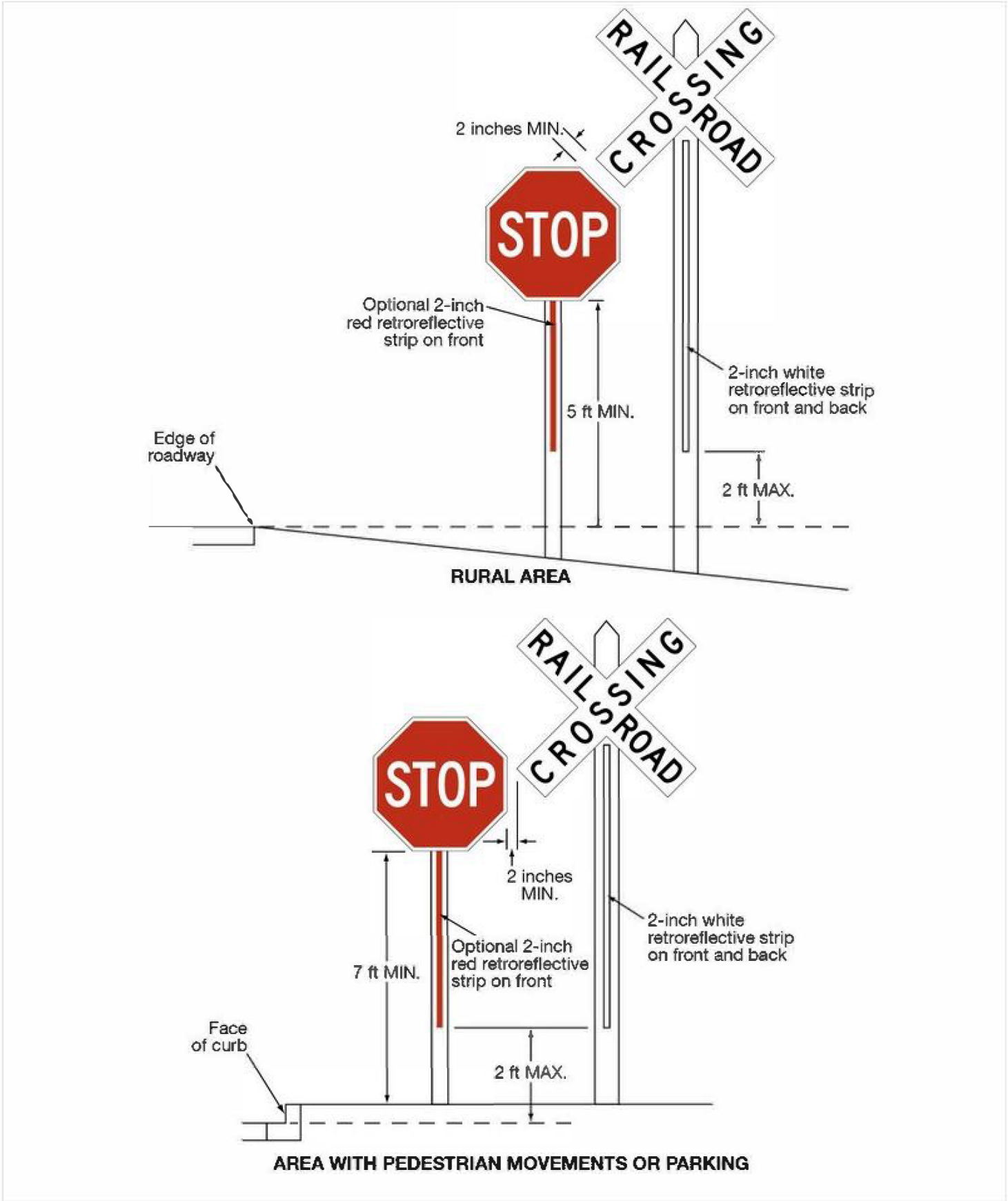


Figure 913.2.4.2 Crossbuck Assembly with a YIELD or STOP Sign on a Separate Sign Support *(Sheet 2 of 2)*

Notes:

1. STOP signs are used only at passive crossings and only if an engineering study determines that it is appropriate for that particular approach.

2. Place the face of the signs in the same plane and place the STOP sign closer to the traveled way. Provide a 2-inch minimum separation between the edge of the Crossbuck sign and the edge of the STOP sign.

Standard. If a Crossbuck Assembly is installed on the approach to a passive grade crossing located at a highway-highway intersection controlled by a traffic control signal that is not interconnected with the grade crossing and not preempted by the approach of rail traffic, a Diagnostic Team shall be convened to determine the appropriate traffic control devices. A STOP sign shall not be installed on a Crossbuck Assembly in this situation.

Support. EPG 913.1.1 through EPG 913.1.5 contain information regarding the responsibilities of the Diagnostic Team, highway agency, MoDOT Multimodal Division (Rail Section), and the railroad company or transit agency regarding the selection, design, and operation of traffic control devices placed at grade crossings.

Option. If a YIELD or STOP sign is installed for a Crossbuck Assembly at a grade crossing, it may be installed on the same support as the Crossbuck sign or it may be installed on a separate support at a point where the motor vehicle is to stop, or as near to that point as practicable, but in either case, the YIELD or STOP sign is considered to be a part of the Crossbuck Assembly.

Standard. If a YIELD or STOP sign is installed on an existing Crossbuck sign support, the mounting height, measured vertically from the bottom of the YIELD or STOP sign to the top of the curb, or in the absence of curb, measured vertically from the bottom of the YIELD or STOP sign to the elevation of the near edge of the traveled way, shall be at least 4 feet Figure 913.2.3).

If a Crossbuck Assembly is installed on a new sign support (see Figure 913.2.3) or if the YIELD or STOP sign is installed on a separate support (see Figures 913.2.4.1 and 913.2.4.2), the mounting height, measured vertically from the bottom of the YIELD or STOP sign to the top of the curb, or in the absence of curb, measured vertically from the bottom of the YIELD or STOP sign to the elevation of the near edge of the traveled way, shall be at least 5 feet in rural areas and shall be at least 7 feet in areas where parking or pedestrian movements are likely to occur.

Guidance. If a YIELD or STOP sign is installed for a Crossbuck Assembly at a grade crossing on a separate support than the Crossbuck sign (see Figures 913.2.4.1 and 913.2.4.2), the YIELD or STOP sign should be placed in the same plane as the Crossbuck sign and closer to the traveled way than the Crossbuck sign. The minimum separation between the nearest point of the YIELD or STOP sign and the nearest point of the Crossbuck sign should be 2 inches as shown in Figures 913.2.4.1 and 913.2.4.2.

Support. The meaning of a Crossbuck Assembly that includes a YIELD sign is that a road user approaching the grade crossing needs to be prepared to decelerate, and when necessary, yield the right-of-way to any rail traffic that might be occupying the crossing or might be approaching and in such close proximity to the crossing that it would be unsafe for the road user to cross.

Certain commercial motor vehicles and school buses are required to stop at all grade crossings in accordance with 49 CFR 392.10 even if a YIELD sign (or just a Crossbuck sign) is posted.

The meaning of a Crossbuck Assembly that includes a STOP sign is that a road user approaching the grade crossing must come to a full stop not less than 15 feet short of the nearest rail, and remain stopped while the road user determines if there is rail traffic either occupying the crossing or approaching and in such close proximity to the crossing that the road user must yield the right-of-way to rail traffic. The road user is permitted to proceed when it is safe to cross.

Standard. A vertical strip of retroreflective white material, not less than 2 inches in width, shall be used on each Crossbuck support at passive grade crossings for the full length of the back of the support from the Crossbuck sign or Number of Tracks plaque to within 2 feet above the near edge of the roadway, except as provided in the

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first Option paragraph below. A white retroreflective strip wrapped around a round support for the full length of the support from the Crossbuck Sign or Number of Tracks plaque to within 2 feet above the near edge of the roadway shall satisfy this requirement as long as the round support has an outside diameter of at least 2 inches.

Option. The vertical strip of retroreflective material may be omitted from the back sides of Crossbuck sign supports installed on one-way streets and at pathway or sidewalk grade crossings (see EPG 913.5.5).

If a YIELD or STOP sign is installed on the same support as the Crossbuck sign, a vertical strip of red (see EPG 903.1.11) or white retroreflective material that is at least 2 inches wide may be used on the front of the support from the YIELD or STOP sign to within 2 feet above the near edge of the roadway.

Standard. If a Crossbuck sign support at a passive grade crossing does not include a YIELD or STOP sign (either because the YIELD or STOP sign is placed on a separate support or because a YIELD or STOP sign is not present on the approach), a vertical strip of retroreflective white material, not less than 2 inches in width, shall be used for the full length of the front of the support from the Crossbuck sign or Number of Tracks plaque to within 2 feet above the near edge of the roadway. A white retroreflective strip wrapped around a round support for the full length of the support from the Crossbuck Sign or Number of Tracks plaque to within 2 feet above the near edge of the roadway shall satisfy this requirement as long as the round support has an outside diameter of at least 2 inches.

At all grade crossings where YIELD or STOP signs are installed, Yield Ahead (W3-2) or Stop Ahead (W3-1) signs shall also be installed if the criteria for their installation in EPG 903.3.29 is met.

Support. EPG 913.3.3 contains provisions regarding the use of stop lines or yield lines at grade crossings.

913.2.5 Use of STOP (R1-1) or YIELD (R1-2) Signs without Crossbuck Signs at Highway-LRT Grade Crossings (MUTCD Section 8B.05)

Guidance. The use of only STOP or YIELD signs for road users at highway-LRT grade crossings should be limited to those crossings where the need and feasibility is determined by the Diagnostic Team. Such crossings should have all of the following characteristics:

A. The crossing roadways are secondary in character (such as a minor street with one lane in each direction, an alley, or a driveway) with low traffic volumes and low speed limits. The specific thresholds of traffic volumes and speed limits should be determined by the local agencies.
B. The line of sight for an approaching LRT operator is adequate from a sufficient distance such that the operator can sound an audible signal and bring the LRT equipment to a stop before arriving at the crossing.
C. The road user has sufficient sight distance at the stop line to permit the vehicle to cross the tracks before the arrival of the LRT equipment.
D. If at an intersection of two roadways, the intersection does not meet the warrants for a traffic control signal as provided in EPG 902.3.
E. The LRT tracks are located such that motor vehicles are not likely to stop on the tracks while waiting to enter a crossroad or highway.

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Standard. For all highway-LRT grade crossings where only STOP (R1-1) or YIELD (R1-2) signs are installed, the placement shall comply with the requirements of EPG 903.2.17. Stop Ahead (W3-1) or Yield Ahead (W3-2) Advance Warning signs shall also be installed if the criteria for their installation given in EPG 903.3.29 is met.

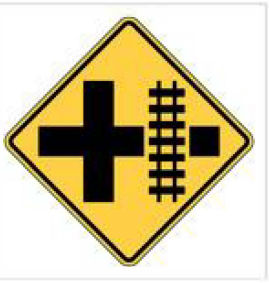
913.2.6 Grade Crossing Advance Warning Signs (W10-1 through W10-4) (MUTCD Section 8B.06)



W10-1



W10-1aP


W10-2


W10-4

Standard. A Grade Crossing Advance Warning (W10-1) sign shall be used on each highway in advance of every grade crossing, except in the following circumstances:

A. On an approach to a grade crossing from an intersection with a parallel highway if the distance from the nearest rail of the tracks to the edge of the parallel roadway is less than 100 feet and W10-2, W10-3, or W10-4 signs are used on the approaches of the parallel highway (see the third Standard paragraph below);
B. In business or commercial areas where active grade crossing traffic control systems are in use;
C. Where physical conditions do not permit even a partially effective display of the sign; or
D. At highway-LRT grade crossings where Crossbuck signs are not used (see EPG 913.2.3).

The placement of the Grade Crossing Advance Warning sign shall be in accordance with EPG 903.3.4 and Table 903.3.3.

If a YIELD or STOP sign is present at a passive grade crossing, a Yield Ahead (W3-2) or Stop Ahead (W3-1) Advance Warning sign shall also be installed if the criteria for their installation given in EPG 903.3.29 is met. If a Yield Ahead or Stop Ahead sign is installed on the approach to the crossing, the W10-1 sign shall be installed upstream from the Yield Ahead or Stop Ahead sign. The Yield Ahead or Stop Ahead sign shall be located in accordance with Table 903.3.3. The minimum distance between the signs shall be in accordance with EPG 903.3.4 and Table 903.3.3.

Option. On divided highways and one-way streets, an additional W10-1 sign may be installed on the left-hand side of the roadway.

Standard. If the distance between the tracks and a parallel highway, from the nearest rail of the tracks to the edge of the parallel roadway, is less than 100 feet, a W10-2, W10-3, or W10-4 sign shall be installed on each approach of the parallel highway to warn road users making a turn that they will encounter a grade crossing soon after making a turn, and a W10-1 sign for the approach to the tracks shall not be required to be between the tracks and the parallel highway.

If the W10-2, W10-3, or W10-4 sign is used, sign placement in accordance with the guidelines for Intersection Warning signs in Table 903.3.3 using the speed of through traffic shall be measured from the highway intersection.

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Guidance. If the distance between the tracks and the parallel highway, from the nearest rail of the tracks to the edge of the parallel roadway, is 100 feet or more, a W10-1 sign should be installed in advance of the grade crossing, and the W10-2, W10-3, or W10-4 sign should not be used on the parallel highway.

913.2.7 DO NOT STOP ON TRACKS Sign (R8-8) (MUTCD Section 8B.07)



R8-8

Guidance. If motor vehicle queues are likely to extend onto the tracks, a DO NOT STOP ON TRACKS (R8-8) sign should be used.

Support. Locations where motor vehicles could queue onto the grade crossing include intersections where a STOP or YIELD sign is installed downstream of the grade crossing, where there is a downstream circular intersection, or where there is a pre-signal installed at the grade crossing.

Guidance. The R8-8 sign, if used, should be located on the right-hand side of the highway on either the near or far side of the grade crossing, depending upon which position provides better visibility to approaching drivers.

Option. DO NOT STOP ON TRACKS signs may be placed on both sides of the track.

On divided highways and one-way streets, a second DO NOT STOP ON TRACKS sign may be placed on the near or far left-hand side of the highway at the grade crossing to further improve the visibility of the sign.

913.2.8 STOP HERE ON RED Signs (R10-6) (MUTCD Section 8B.10)



R10-6

Support. The STOP HERE ON RED (R10-6) sign defines and facilitates observance of stop lines at traffic control signals.

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Option. STOP HERE ON RED signs may be used at locations where motor vehicles frequently violate the stop line or where it is not obvious to road users where to stop.

Guidance. If possible, stop lines should be placed at a point where the motor vehicle driver has adequate sight distance along the track.

913.2.9 EXEMPT Grade Crossing Plaques (R15-3P and W10-1aP) (MUTCD Section 8B.11)



R15-3P

Option. Where authorized by MoDOT Multimodal Division (Rail Section), an EXEMPT (R15-3P) plaque with a white background may be used below the Crossbuck sign or Number of Tracks plaque, if present, at the grade crossing, and an EXEMPT (W10-1aP) plaque with a fluorescent yellow background may be used below the Grade Crossing Advance Warning (W10-1 through W10-4) sign.

Where neither the Crossbuck sign nor the advance warning signs exist for a particular highway-LRT grade crossing, an EXEMPT (R15-3P) plaque with a white background may be placed on its own post on the near right-hand side of the approach to the crossing.

Support. These plaques inform drivers of motor vehicles carrying passengers for hire, school buses carrying students, or motor vehicles carrying hazardous materials that a stop is not required at certain designated grade crossings, except when rail traffic is approaching or occupying the grade crossing, or the driver's view is blocked.

913.2.10 Light Rail Transit Only Lane Signs (R15-4 Series) (MUTCD Section 8B.12)

Support. Reserved for future use. R15-4 Series signs are not currently used on MoDOT facilities.

913.2.11 Do Not Pass Light Rail Transit Signs (R15-5 and R15-5a) (MUTCD Section 8B.13)

Support. Reserved for future use. R15-5 and R15-5a signs are not currently used on MoDOT facilities.

913.2.12 No Motor Vehicles On Tracks Signs (R15-6 and R15-6a) (MUTCD Section 8B.14)

Support. Reserved for future use. R15-6 and R15-6a signs are not currently used on MoDOT facilities.

913.2.13 Divided Highway with Light Rail Transit Crossing Signs (R15-7 Series) (MUTCD Section 8B.15)

Support. Reserved for future use. R15-7 Series signs are not currently used on MoDOT facilities.

913.2.14 Low Ground Clearance Grade Crossing Sign (W10-5) (MUTCD Section 8B.16)



W10-5 W10-5P

Guidance. If the highway profile conditions are sufficiently abrupt to create a hang-up situation for long wheelbase vehicles or for trailers with low ground clearance, the Low Ground Clearance Grade Crossing (W10-5) sign should be installed in advance of the grade crossing.

Standard. Because this symbol might not be readily recognizable by the public, the Low Ground Clearance Grade Crossing (W10-5) warning sign shall be accompanied by a LOW GROUND CLEARANCE (W10-5P) educational plaque. The LOW GROUND CLEARANCE educational plaque shall remain in place for at least 3 years after the initial installation of the W10-5 sign (see EPG 903.1.9).

Guidance. Because other vehicle types and combinations also face the potential risk of hanging up at a grade crossing, word message warning signs and selective exclusion regulatory signs (see EPG 903.2.36) for specific vehicle types and combinations should be used in addition to, or in place of, the Low Ground Clearance Grade Crossing (W10-5) sign.

Support. While not all inclusive, some potential low ground clearance vehicles and combinations include single-unit trucks, buses, motor coaches, low-boy trailers, car carriers, and recreational vehicles.

Guidance. Auxiliary plaques such as AHEAD, NEXT CROSSING, or USE NEXT CROSSING (with appropriate arrows), or a supplemental distance plaque should be placed below the W10-5 sign at the nearest intersecting highway where a vehicle can detour or at a point on the highway wide enough to permit a U-turn.

If engineering judgment of roadway geometric and operating conditions confirms that motor vehicle speeds across the tracks should be below the posted speed limit, a W13-1P advisory speed plaque should be posted.

A signed detour should be installed to guide potential hang-up vehicles to alternate nearby crossings to avoid the potential hang-up condition.

Support. Information on ground clearance requirements at grade crossings is available in the 2019 edition of the "American Railway Engineering and Maintenance-of-Way Association's Engineering Manual," or in "A Policy on Geometric Design of Highways and Streets," 2018 Edition, AASHTO.

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An inventory of crossings with low ground clearance concerns, including a list of potential vehicle types that could hang up on the crossing, can be useful in tracking locations of low ground clearance crossings. Specific geometric conditions, known incidents, or anecdotal evidence of vehicle hang-ups can also be used to identify crossings with low ground clearance concerns.

913.2.15 NO TRAIN HORN Sign or Plaque (W10-9P) (MUTCD Section 8B.20)



W10-9P

Standard. A NO TRAIN HORN (W10-9P) plaque shall be installed in each direction at each highway-rail grade crossing where a Quiet Zone has been established in compliance with 49 CFR Part 222. Where it is used, a W10-9P plaque shall supplement and be mounted directly below the Grade Crossing Advance Warning (W10-1 through W10-4) sign.

913.2.16 Emergency Notification System Sign (I13-1) (MUTCD Section 8B.27)



I13-1

Support. Emergency Notification Signs (I-13) are installed by the Railroad that operates through the crossing.

Standard. The Emergency Notification System (I13-1) sign shall be installed on each approach at all highway-rail grade crossings, and at all highway-LRT grade crossings with automatic gates or flashing light-signals, to provide information to road users so that they can notify the railroad company or transit agency about emergencies or malfunctioning traffic control devices.

At a highway-rail grade crossing, the Emergency Notification System sign shall, at a minimum, include the USDOT grade crossing inventory number and the emergency contact telephone number.

Where Emergency Notification System signs are used at a highway-LRT grade crossing, they shall, at a minimum, include a unique crossing identifier and the emergency contact telephone number.

The minimum width of the Emergency Notification System sign shall be 12 inches and the minimum height shall be 9 inches. The lettering on Emergency Notification System signs for the telephone number, the grade crossing inventory number, and the explanation of the purpose of the sign shall be composed of numerals and upper-case letters that are at least 1 inch in height.

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Emergency Notification System signs shall be retroreflective.

Except as provided in the Option paragraph below, Emergency Notification System signs shall have a white legend and border on a blue background.

Option. The seven-character grade crossing inventory number may be shown on the sign as a black legend on a white rectangular background.

Guidance. Except as provided in the first Option paragraph below, Emergency Notification System signs should be attached to the Crossbuck Assemblies or grade crossing signal masts on the right-hand side of each roadway approach to the grade crossing rather than on the railroad or LRT signal control equipment housings. Emergency Notification System signs should be oriented so the face of the sign is approximately parallel or approximately perpendicular to the edge of the roadway or pathway and is visible to road users or pathway users. The visibility of the Emergency Notification System sign should not be obstructed by automatic gates in either the vertical or horizontal position.

The Emergency Notification System signs should be positioned so as to not obstruct any traffic control devices or limit the view of rail traffic approaching the grade crossing.

Emergency Notification System signs mounted on Crossbuck Assemblies or signal masts should only be large enough to provide the necessary contact information. Use of larger signs on Crossbuck Assemblies or signal masts that might obstruct the view of rail traffic or other motor vehicles should be avoided.

At station crossings, Emergency Notification System signs or information should be posted in a conspicuous location.

Option. Emergency Notification System signs may be located on a separate post. Where located on a separate post, the size of the Emergency Notification System sign may be increased for improved visibility.

Where the improvement of the conspicuity of an Emergency Notification System sign is desired, a solid yellow rectangular header panel with a legend of “NOTICE” in black letters may be used (see EPG 903.1.11).

Additional Emergency Notification System signs may be installed at a grade crossing.

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913.3 Markings (MUTCD Chapter 8C)

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913.3.1 Purpose and Application (MUTCD Section 8C.01)
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913.3.4 Lane-Use Arrow Markings (MUTCD Section 8C.04)
913.3.5 Edge Lines, Lane Lines, Center Lines, Raised Pavement Markers, and Tubular Markers (MUTCD Section 8C.05)

913.3.1 Purpose and Application (MUTCD Section 8C.01)

Support. Passive traffic control systems, consisting of signs and pavement markings only, identify and direct attention to the location of a grade crossing and advise road users to reduce their speed or stop at the grade crossing as necessary in order to yield to any rail traffic occupying, or approaching and in proximity to, the grade crossing.

Signs and pavement markings regulate, warn, and guide the road users so that they, as well as LRT vehicle operators on mixed-use alignments, can take appropriate action when approaching a grade crossing.

Unless otherwise provided in this article, the provisions of EPG 620 are applicable to the design and location of pavement markings at grade crossings.

913.3.2 Grade Crossing Pavement Markings (MUTCD Section 8C.02)

Standard. On paved roadways, grade crossing pavement markings shall consist of an X, the letters RR, a no-passing zone marking (on two-lane, two-way highways with center line markings in compliance with EPG 620.2.1, and certain transverse lines as shown with detailed dimensions in Figures 913.3.2.1 and 913.3.2.2.

Except as provided in the following two paragraphs, grade crossing pavement markings shall be placed in each approach lane on all paved approaches to highway-rail grade crossings where signals or automatic gates are located, and at all other grade crossings where the posted or statutory highway speed is 40 mph or higher.

Grade crossing pavement markings shall not be required at highway-rail grade crossings where the posted or statutory highway speed is less than 40 mph if the Diagnostic Team determines that other installed devices provide suitable warning and control.

Grade crossing pavement markings shall not be required at highway-rail grade crossings in urban areas if the Diagnostic Team determines that other installed devices provide suitable warning and control.

Grade crossing pavement markings shall be placed in each approach lane on all paved approaches to highway-LRT grade crossings where a Crossbuck sign is placed at the grade crossing.

If grade crossing pavement markings are used on a multi-lane approach to a grade crossing, identical markings shall be placed in each approach lane that crosses the tracks.

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All grade crossing pavement markings shall be retroreflective white. All other markings shall be in accordance with EPG 620.

Guidance. Where grade crossing pavement markings are used, a portion of the X symbol should be directly opposite the Grade Crossing Advance Warning sign.

Option. Where determined by the Diagnostic Team, supplemental pavement marking symbol(s) may be placed between the Grade Crossing Advance Warning sign and the grade crossing.

Guidance. If supplemental pavement marking symbol(s) are placed between the Grade Crossing Advance Warning sign and the grade crossing, the downstream transverse line should be at least 50 feet upstream from the stop or yield line at the grade crossing.

913.3.3 Stop and Yield Lines (MUTCD Section 8C.03)

Guidance. On paved roadway approaches to passive grade crossings where a STOP sign is installed in conjunction with the Crossbuck sign, a stop line should be installed to indicate the point behind which motor vehicles are required to stop or as near to that point as practicable.

Option. On paved roadway approaches to passive grade crossings where a YIELD sign is installed in conjunction with the Crossbuck sign, a yield line (see EPG 620.2.18) or a stop line may be installed to indicate the point behind which motor vehicles are required to yield or stop or as near to that point as practicable.

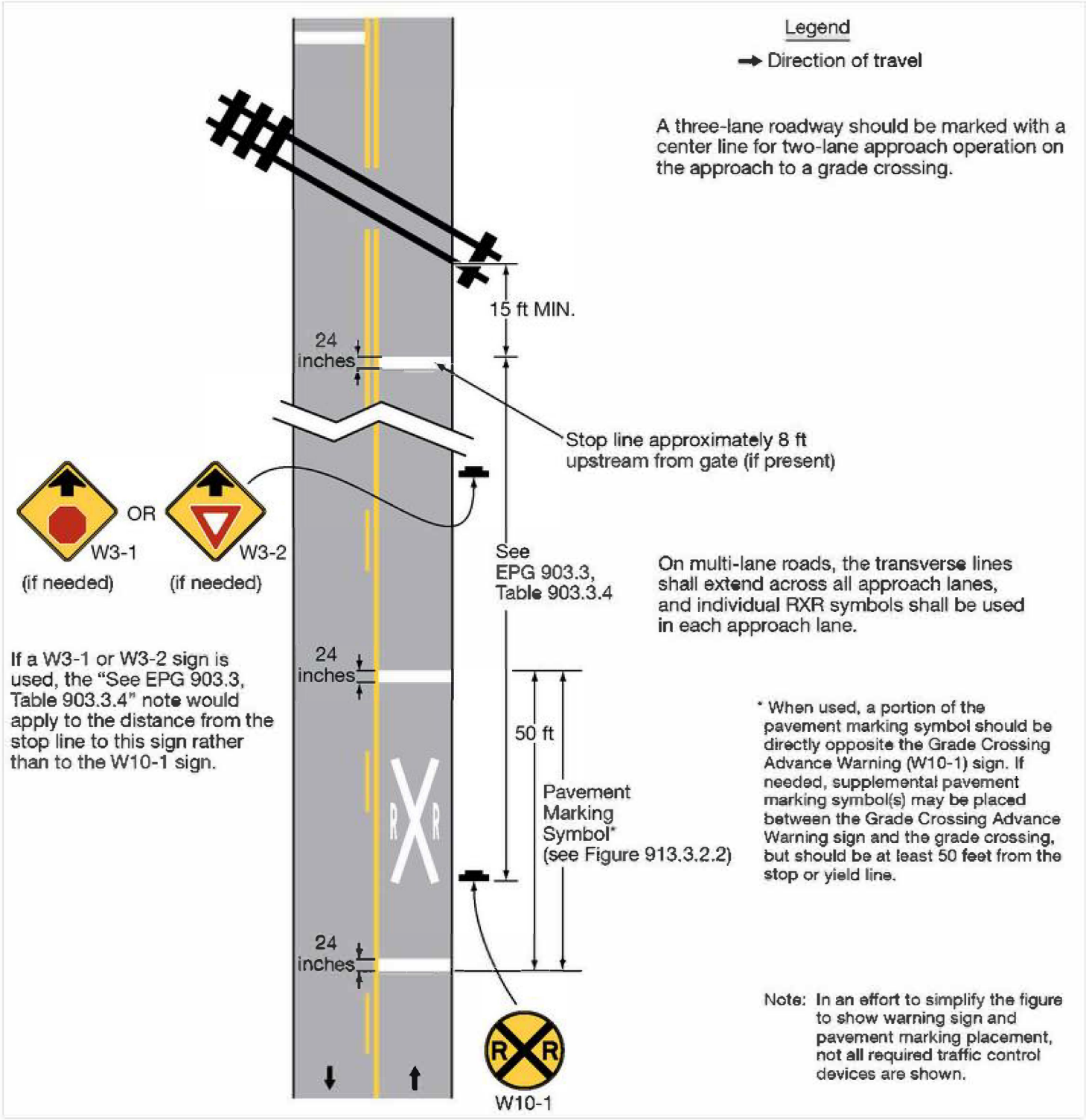


Figure 913.3.2.1 Example of Placement of Warning Signs and Pavement Markings at Grade Crossings

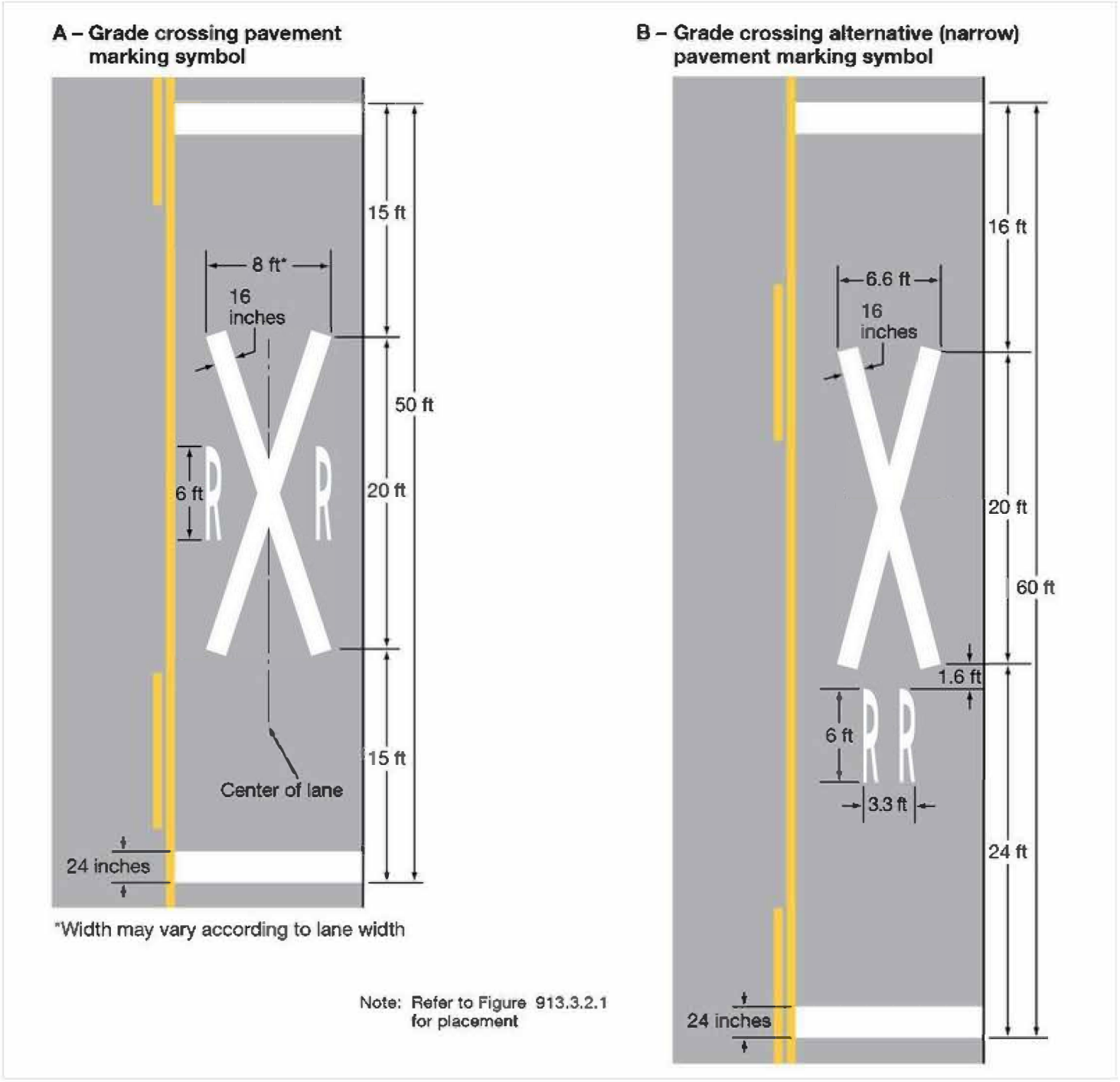


Figure 913.3.2.2. Grade Crossing Pavement Markings

Guidance. If a yield line (see Figure 620.2.18) or stop line is used at a passive grade crossing, it should be a transverse line at a right angle to the traveled way and should be placed no closer than 15 feet in advance of the nearest rail.

Standard. On paved roadways at grade crossings that are equipped with active control devices such as flashing-light signals, automatic gates, or traffic control signals, a stop line (see EPG 620.2.18) shall be installed to indicate the point behind which motor vehicles are or might be required to stop.

Guidance. If a stop line is used at an active grade crossing where road users are controlled by flashing-light signals, it should be a transverse line at a right angle to the traveled way and should be placed approximately 8 feet in advance of the flashing-light signals or automatic gate (if present), whichever is farther from the track(s), but no closer than 15 feet in advance of the nearest rail (see Figure 913.3.2.1).

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If a stop line is used at an active grade crossing where road users are controlled by a traffic control signal, it should be a transverse line at a right angle to the traveled way and should be placed no closer than 15 feet in advance of the nearest rail.

Standard. If a stop line is used at an active grade crossing where road users are controlled by a traffic control signal, it shall be placed such that the lateral and longitudinal positions of the signal faces for the approach comply with the provisions of EPG 902.4.7 and 902.4.8.

913.3.4 Lane-Use Arrow Markings (MUTCD Section 8C.04)

Standard. Lane-use arrow markings (see EPG 620.2.22) that indicate that a turning movement must be made or is permitted to be made from a lane that crosses a grade crossing shall not be placed between the stop line for the grade crossing and the track(s).

Guidance. Lane-use arrow markings that indicate that a turning movement must be made or is permitted to be made from a lane that crosses a grade crossing should not be placed less than 100 feet upstream from the stop line for the grade crossing or less than 20 feet beyond the farthest rail.

913.3.5 Edge Lines, Lane Lines, Center Lines, Raised Pavement Markers, and Tubular Markers (MUTCD Section 8C.05)

Guidance. Except as provided in the first three Option paragraphs below, if edge lines (see EPG 620.2.10), lane lines (see EPG 620.2.7), or center lines (see EPG 620.2.1) are used on an approach to a grade crossing, the edge lines, lane lines, and center lines should extend up to and across the grade crossing to reduce the likelihood that road users might inadvertently turn into the track area.

If crossing surface maintenance or highway approach maintenance is performed that alters the markings, the removal or replacement of the markings, raised pavement markers, and/or tubular markers should be coordinated with the road authority and the railroad company or transit agency.

Option. Edge lines, lane lines, and center lines may be omitted on or between the rails to conform to the requirements of the railroad company and/or transit agency.

Edge lines, lane lines, and center lines may be omitted on or between the rails where the highway profile is sufficiently abrupt to create a hang-up situation for pavement marking equipment with low ground clearance.

The edge lines, lane lines, and center lines may be omitted from the highway surface at a grade crossing if the surface cannot retain the application of the edge line, lane line, or center line marking.

If recommended by a Diagnostic Team, tubular markers (see EPG 620.8.2) may be used to supplement the edge lines that extend up to and across the grade crossing.

Guidance. Tubular markers should be installed in accordance with the clearance requirements of the railroad company and/or transit agency.

Standard. The color under both daytime and nighttime conditions of raised pavement markers or tubular markers that are used at a grade crossing shall be the same color as the edge line, lane line, or center line that they supplement.

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913.4 Flashing-Light Signals, Automatic Gates, and Traffic Control Signals (MUTCD Chapter 8D)

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913.4.15 Use of LRT Signals for Control of LRT Vehicles at Highway-LRT Grade Crossings (MUTCD Section 8D.15)

913.4.1 Introduction (MUTCD Section 8D.01)

Support. Active traffic control systems inform road users of the approach or presence of rail traffic at grade crossings. These systems include Exit Gate systems, automatic gates, flashing-light signals, traffic control signals, actuated blank-out and variable message signs, and other active traffic control devices that are used in conjunction with the signs and pavement markings that are described in EPG 913.2 and EPG 913.3, respectively.

The design, installation and maintenance of these devices are normally the responsibility of the railroad company with the approval of the MoDOT Multimodal Division (Rail Section).

Figure 913.4.1 shows a post-mounted flashing-light signal (two light units mounted in a horizontal line), a flashing-light signal mounted on an overhead structure, and an automatic gate assembly.

Where LRT speed is cited in EPG 913, it refers to the maximum speed at which LRT equipment is permitted to traverse a particular grade crossing.

Option. Post-mounted and overhead flashing-light signals may be used separately or in combination with each other as determined by the Diagnostic Team. Also, flashing-light signals may be used without automatic gate assemblies, as determined by the Diagnostic Team.

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Standard. The meaning of flashing-light signals and automatic gates shall be as stated in Sections 11-701 and 11-703 of the Uniform Vehicle Code (see EPG 911 (MUTCD Section 1A.06)).

Location for flashing-light signals and automatic gates shall be as shown in Figure 913.4.1.

Where there is a curb, a horizontal offset of at least 2 feet shall be provided from the face of the vertical curb to the nearest part of the signal or automatic gate arm in its upright position. Where a cantilevered-arm flashing-light signal is used, the vertical clearance shall be at least 17 feet above the crown of the highway to the lowest point of the signal unit.

Where there is a shoulder, but no curb, a horizontal offset of at least 2 feet from the edge of a paved shoulder shall be provided, with an offset of at least 6 feet from the edge of the traveled way.

Where there is no curb or shoulder, the minimum horizontal offset shall be 6 feet from the edge of the traveled way.

Minimum clearance dimensions for flashing-light signals and automatic gates relative to the closest track shall conform to standards provided by the railroad company and/or transit agency, and the MoDOT Multimodal Division (Rail Section).

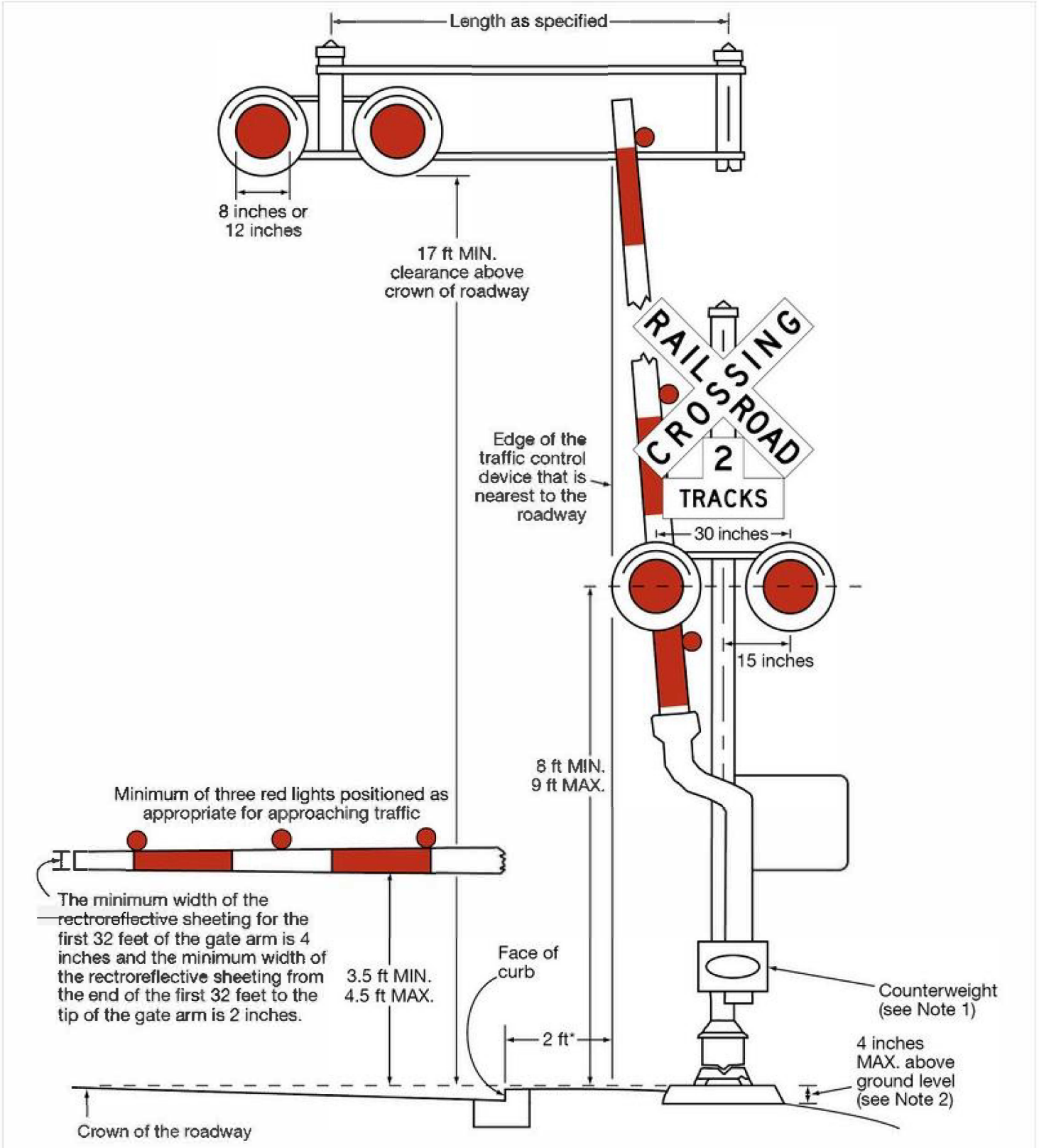
Guidance. Equipment housings (controller cabinets) should have a lateral offset of at least 30 feet from the edge of the highway, and where railroad or LRT property and conditions allow, at least 25 feet from the nearest rail.

If a pedestrian route is provided, sufficient clearance from supports, posts, and automatic gate mechanisms should be maintained for pedestrian travel.

Where determined by the Diagnostic Team, a lateral escape route to the right-hand side of the highway in advance of the grade crossing traffic control devices should be kept free of guardrail or other ground obstructions. Where guardrail is not deemed necessary or appropriate, barriers should not be used for protecting signal supports.

The same lateral offset and roadside safety features should apply to flashing-light signal and automatic gate locations on both the right-hand and left-hand sides of the roadway.

Option. In industrial or other areas involving only low-speed highway traffic or where signals are vulnerable to damage by turning truck traffic, guardrail may be installed to provide protection for the signal assembly.



*For locating this reference line on an approach that does not have a curb, see EPG 913.4.1.

Notes:

1. Where gates are located in the median, additional median width may be required to provide the minimum clearance for the counterweight supports.
2. The top of the signal foundation should be no more than 4 inches above the surface of the ground and should be at the same elevation as the crown of the roadway. Where site conditions would not allow this to be achieved, the shoulder side slope should be re-graded or the height of the signal post should be adjusted to meet the 17-foot vertical clearance requirement.

Figure 913.4.1. Composite Drawing of Active Traffic Control Devices for Grade Crossings Showing Clearances

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Guidance. Where both traffic control signals and flashing-light signals (with or without automatic gates) are in operation at the same highway-LRT grade crossing, the operation of the devices should be coordinated to avoid any display of conflicting signal indications.

Option. If highway traffic signals must be located within close proximity to the flashing-light signals, the highway traffic signals may be mounted on the same overhead structure as the flashing-light signals with the approval of the MoDOT Multimodal Division (Rail Section).

913.4.2 Flashing-Light Signals (MUTCD Section 8D.02)

Support. EPG 913.4.4 contains additional information regarding flashing-light signals at highway-LRT grade crossings in semi-exclusive and mixed-use alignments.

Standard. If used, the flashing-light signal assembly (shown in Figure 913.4.1) on the side of the highway shall include a standard Crossbuck (R15-1) sign, and where there is more than one track, a supplemental Number of Tracks (R15-2P) plaque, all of which indicate to motorists, bicyclists, and pedestrians the location of a grade crossing.

Guidance. The bottom of the Number of Tracks (R15-2P) plaque (when used) should be located as low as practicable above the flashing-light backgrounds. The Crossbuck (R15-1) sign should be located just above the Number of Tracks (R15-2P) plaque or, if no plaque is present, the bottom of the Crossbuck sign should be located as low as practicable above the flashing-light backgrounds.

Support. Additional information regarding sizes and clearances of components used on flashing-light signals can be found in Part 3 of the "2023 AREMA Communications and Signals Manual" published by the American Railway Engineering and Maintenance-of-Way Association (AREMA).

Option. At highway-rail grade crossings, bells or other audible warning devices may be included in the assembly and may be operated in conjunction with the flashing-light signals to provide additional warning for pedestrians, bicyclists, and/or other non-motorized road users.

Standard. When indicating the approach or presence of rail traffic, the flashing-light signal shall display toward approaching highway traffic two red lights mounted in a horizontal line flashing alternately.

If used, flashing-light signals shall be placed to the right-hand side of approaching highway traffic on all highway approaches to a grade crossing. They shall be located laterally with respect to the highway in compliance with Figure 913.4.1 except where such location would adversely affect signal visibility.

If used at a grade crossing with highway traffic in both directions, back-to-back flashing-light signals shall be placed on each side of the tracks. On multi-lane one-way streets and divided highways, flashing-light signals shall be placed on the approach side of the grade crossing on both sides of the roadway or shall be placed above the highway.

Each red signal unit in the flashing-light signal shall flash alternately. The number of flashes per minute for each lamp shall be 35 minimum and 65 maximum. Each lamp shall be illuminated for approximately the same length of time. The total time of illumination of each pair of lamps shall be the entire operating time.

Flashing-light units shall use either 8-inch or 12-inch nominal diameter lenses.

Guidance. In choosing between the 8-inch or 12-inch nominal diameter lenses for use in grade crossing flashing-light signals, consideration should be given to the principles stated in EPG 902.5.2.

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If flashing-light signals are used, at least one pair of flashing lights should be provided for each approach lane of the roadway.

The center-to-center distance between the two red lights in a flashing-light unit should be approximately 30 inches.

The mounting height of the flashing-light units, measured from the center of the flashing-light unit housing to the elevation of the crown of the roadway, should be between 8 feet and 9 feet .

The top of the support pole foundation should be no more than 4 inches above the surface of the ground and should be at the same elevation as the crown of the roadway.

Standard. Grade crossing flashing-light signals shall operate at a low voltage using storage batteries either as a primary or stand-by source of electrical energy. Provision shall be made to provide a source of energy for charging batteries.

Option. Additional flashing-light signals may be mounted on the same supporting post and directed toward vehicular traffic approaching the grade crossing from other than the principal highway route, such as where there are approaching routes on highways closely adjacent to and parallel to the track(s).

Guidance. Where the storage distance for vehicles approaching a grade crossing is less than a design vehicle length, the Diagnostic Team should consider providing additional flashing-light signals aligned toward the movement turning toward the grade crossing.

The Diagnostic Team should consider the use of additional flashing-light signals to provide supplemental warning to pedestrians, especially on one-way streets and divided highways.

Standard. References to lenses in this article shall not be used to limit flashing-light signal optical units to incandescent lamps within optical assemblies that include lenses.

Support. Research has resulted in flashing-light signal optical units that are not lenses, such as, but not limited to, light-emitting diode (LED) flashing-light signal modules.

Option. If a Diagnostic Team determines that it is appropriate, the flashing-light signals may be installed on overhead structures or cantilevered supports as shown in Figure 913.4.1 where needed for additional emphasis, or for better visibility to approaching traffic, particularly on multi-lane approaches or highways with profile restrictions.

If it is determined by a Diagnostic Team that one flashing-light signal on the cantilever arm is not sufficiently visible to road users, one or more additional flashing-light signals may be mounted on the supporting post and/or on the cantilever arm.

Standard. Breakaway or frangible bases shall not be used on the supporting posts for overhead structures or cantilevered arms that support overhead flashing-light signals.

913.4.3 Automatic Gates (MUTCD Section 8D.03)

Support. An automatic gate is a traffic control device used in conjunction with flashing-light signals.

Standard. The automatic gate (see Figure 913.4.1) shall consist of a drive mechanism and a fully retroreflective red-and-white-striped gate arm with lights. When in the down position, the gate arm shall extend across the approaching lanes of highway traffic.

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In the normal sequence of operation, unless constant warning time detection or other advanced system requires otherwise, the flashing-light signals and the lights on the gate arm (in its normal upright position) shall be activated immediately upon detection of approaching rail traffic. The gate arm shall start its downward motion not less than 3 seconds after the flashing-light signals start to operate, shall reach its horizontal position at least 5 seconds before the arrival of the rail traffic, and shall remain in the down position until the rail traffic completely clears the grade crossing.

When the rail traffic clears the grade crossing, and if no other rail traffic is detected, the gate arm shall ascend to its upright position, following which the flashing-light signals and the lights on the gate arm shall cease operation.

Gate arms shall be fully retroreflective on both sides and shall have vertical stripes alternately red and white at 16-inch intervals measured horizontally. The width (which becomes the height of the retroreflective sheeting when the automatic gate is in the down position) of the retroreflective sheeting on the front of the gate arm shall be at least 4 inches for the first 32 feet of gate arm length measured from the center of the gate mast. The front of the gate arm beyond 32 feet to the tip of the gate arm shall have retroreflective sheeting at least 2 inches in width.

Support. It is acceptable to replace a damaged gate arm with a gate arm having vertical stripes even if the other existing gate arms at the same grade crossing have diagonal stripes; however, it is also acceptable to replace a damaged gate arm with a gate arm having diagonal stripes if the other existing gate arms at the same grade crossing have diagonal stripes in order to maintain consistency per the provisions of the last Option paragraph of EPG 911 (MUTCD Section 1B.03).

Standard. Gate arms shall have at least three red lights as shown in Figure 913.4.1.

When activated, the gate arm light nearest the tip shall be illuminated continuously and the other lights shall flash alternately in unison with the flashing-light signals such that the left-most flashing gate arm light(s) flashes simultaneously with the left-hand light of the flashing-light signals and the right-most flashing gate arm light(s) flashes simultaneously with the right-hand light of the flashing-light signals.

Support. Typical gate arm lights are approximately 4 inches in diameter if they are circular. Rectangular gate arm lights with approximately the same illuminated surface area are sometimes used on gate arms instead of circular lights.

Standard. The entrance gate arm mechanism shall be designed to fail safe in the down position.

Guidance. The gate arm should ascend to its upright position in 12 seconds or less.

In its normal upright position, when no rail traffic is approaching or occupying the grade crossing, the gate arm should be approximately vertical (see Figure 913.4.1).

In the design of individual installations, consideration should be given to timing the operation of the gate arm to accommodate large and/or slow-moving motor vehicles.

The gate arms should cover the approaching highway to block all motor vehicles from being driven around the gate arms without crossing the center line.

The height of the gate arm when it is in the down position should be between 3.5 feet and 4.5 feet above the crown of the roadway. When the gate arm is in the down position, no portion of the counterweight should extend into the traveled way, sidewalk, or pathway.

Option. Channelizing devices and/or raised median islands may be used to discourage driving around lowered automatic gates.

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Guidance. Where sufficient space is available, median islands should be at least 60 feet in length.

Option. Where automatic gates are located in the median, additional median width may be required to provide the minimum clearance for the counterweight supports.

Automatic gates may be supplemented by cantilevered flashing-light signals (see Figure 913.4.1) where there is a need for additional emphasis or better visibility.

913.4.4 Use of Active Traffic Control Systems at LRT Grade Crossings (MUTCD Section 8D.04)

Standard. At highway-LRT grade crossings where LRT speeds exceed 25 mph, active traffic control systems (see EPG 913.4.1) shall be used.

At highway-LRT grade crossings where LRT speeds exceed 40 mph, the active traffic control system shall include automatic gates.

Option. The Diagnostic Team may recommend an active traffic control system with automatic gates at highway-LRT grade crossings where LRT speeds do not exceed 40 mph.

Guidance. At highway-LRT grade crossings where LRT speeds are 25 mph or less, active traffic control systems should be used unless the Diagnostic Team determines that the use of Crossbuck Assemblies, STOP signs alone, or YIELD signs alone would be adequate.

Where the highway-LRT grade crossing is at a location other than an intersection and LRT speeds exceed 20 mph, traffic control signals should not be used in lieu of flashing-light signals.

Support. EPG 913.4.2 and 913.4.3 contain additional provisions regarding the design and operation of flashing-light signals and automatic gates, respectively.

Standard. If flashing-light signals are in operation at a highway-LRT crossing that is used by pedestrians, bicyclists, and/or other non-motorized road users, an audible device such as a bell shall also be provided and shall be operated in conjunction with the flashing-light signals.

913.4.5 Exit Gate and Four-Quadrant Gate Systems (MUTCD Section 8D.05)

Option. Exit Gate systems may be installed to improve safety at grade crossings where a Diagnostic Team determines that less restrictive measures, such as automatic gates and median islands, are not effective.

Support. A grade crossing that includes exit gates on some, but not all, of the exiting lanes is an Exit Gate system, but is not considered to be a Four-Quadrant Gate system.

The term Four-Quadrant Gate system is used in a generic sense in that it refers to the fact that all entrances and exits from a grade crossing are controlled by automatic gates in order to provide a full closure to all entering and exiting lanes. The term Four-Quadrant Gate system does not refer to the number of gates installed, but rather the fact that a full closure is provided.

Standard. The Exit Gate system shall use a series of automatic gates with fully retroreflective red-and-white-striped gate arms with lights, and when in the down position the gate arms extend individually across the entrance and exit lanes of the roadway as shown in Figure 913.4.5. The provisions contained in EPG 913.4.2 for flashing-light signals shall be followed for signal specifications, location, and clearance distances.

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Gate arm design, colors, and lighting requirements shall be in accordance with the provisions contained in EPG 913.4.3.

Support. The provisions contained in EPG 913.4.3 for automatic gates are applicable to exit gates.

Standard. In the normal sequence of operation, unless constant warning time detection or other advanced system requires otherwise, the flashing-light signals and the lights on the gate arms (in their normal upright positions) shall be activated immediately upon the detection of approaching rail traffic. The entrance gate arms shall start their downward motion not less than 3 seconds after the flashing-light signals start to operate and shall reach their horizontal position at least 5 seconds before the arrival of the rail traffic. Exit gate arm activation and downward motion shall be based on detection or timing requirements established by a Diagnostic Team. If an Exit Gate system is present, the exit gate clearance time (see AREMA Manual) shall be long enough to permit the exit gate arm to lower after a design vehicle of maximum length is clear of the minimum track clearance distance (see EPG 913.1.7). The gate arms shall remain in the down position as long as the rail traffic occupies the grade crossing.

When the rail traffic clears the grade crossing, and if no other rail traffic is detected, the gate arms shall ascend to their upright positions, following which the flashing-light signals and the lights on the gate arms shall cease operation.

Except as provided in the first Option paragraph below, the exit gate arm mechanism shall be designed to fail-safe in the up position.

At locations where gate arms are offset a sufficient distance for motor vehicles to drive between the entrance and exit gate arms, median islands (see Figure 913.4.5) shall be installed in accordance with the needs determined by the Diagnostic Team.

Guidance. The gate arm should ascend to its upright position in 12 seconds or less.

Constant warning time detection circuits should be used with Exit Gate systems where practical.

The operating mode of the exit gates should be determined by a Diagnostic Team.

If the Timed Exit Gate Operating Mode is used, the Diagnostic Team should also determine the Exit Gate Clearance Time (see definition in EPG 911 (MUTCD Section 1C.02)).

If the Dynamic Exit Gate Operating Mode is used, highway vehicle intrusion detection devices that are part of a system that incorporates processing logic to detect the presence of motor vehicles within the minimum track clearance distance (see EPG 913.1.7) should be installed to control exit gate operation. Exit gates should be independently controlled for each direction of roadway traffic.

Regardless of which exit gate operating mode is used, the Exit Gate Clearance Time should be considered when determining additional time requirements for the Minimum Warning Time.

Support. The minimum warning time is the least amount of time that active warning devices operate prior to the arrival of rail traffic at a grade crossing.

Guidance. If an Exit Gate system is used at a location that is adjacent to an intersection that could cause motor vehicles to queue within the minimum track clearance distance (see EPG 913.1.7), the Dynamic Exit Gate Operating Mode should be used unless the Diagnostic Team determines otherwise.

If an Exit Gate system is interconnected with a highway traffic signal (see EPG 913.1.9), back-up or standby power should be considered for the highway traffic signal. Also, circuitry should be installed to prevent the highway traffic signal from leaving the track clearance green interval until all of the gates are lowered.

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Exit Gate systems should include remote health (status) monitoring capable of automatically notifying railroad or LRT signal maintenance personnel when anomalies have occurred within the system.

Option. Exit gate arms may fail in the down position if the grade crossing is equipped with remote health (status) monitoring.

Exit Gate system installations may include median islands between opposing lanes on an approach to a grade crossing.

Guidance. Where sufficient space is available, median islands should be at least 60 feet in length.

The locations of the gates and the placement of medians or islands between the gates are to be determined by the Diagnostic Team.

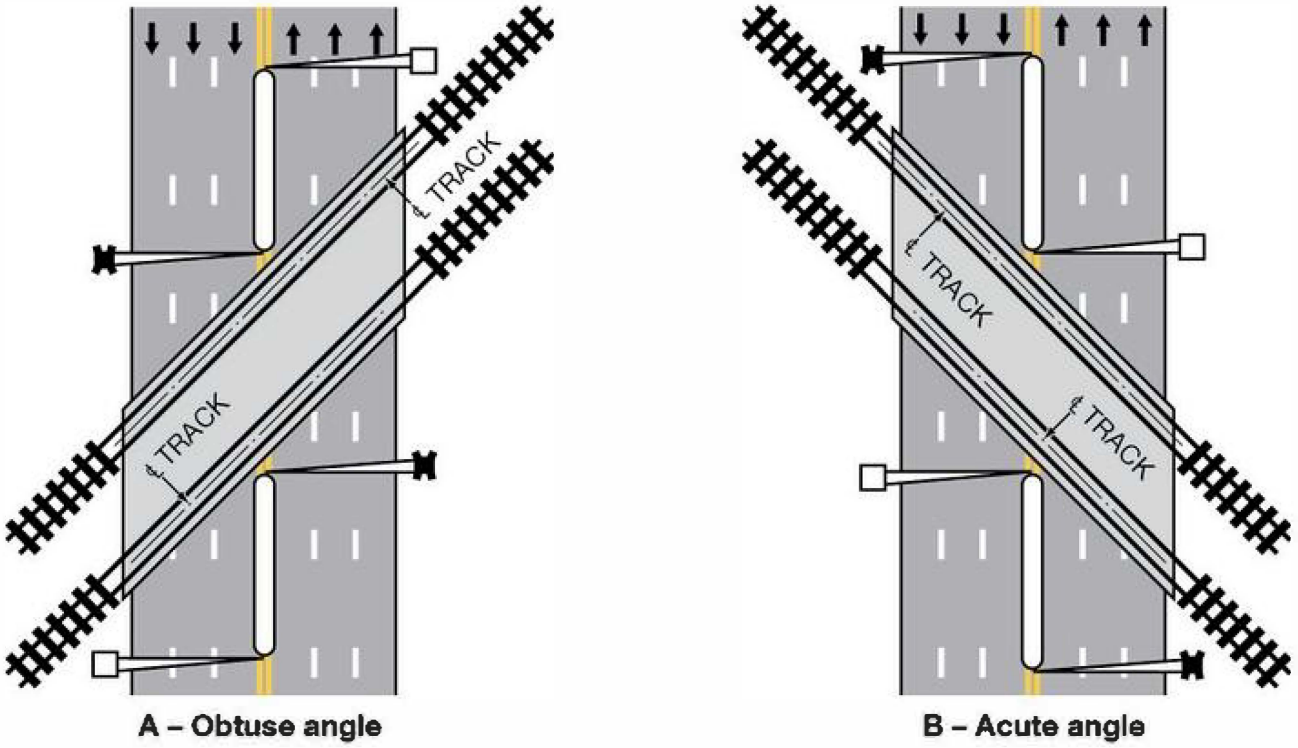


Figure 913.4.5 Examples of Location Plan for Flashing-Light Signals and Four-Quadrant Gates

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913.4.6 Wayside Horn Systems (MUTCD Section 8D.06)

Option. A wayside horn system (see definition in EPG 911 (MUTCD Section 1C.02)) may be installed in compliance with 49 CFR Part 222 to provide audible warning directed toward the road users at a highway-rail grade crossing or at a pathway grade crossing.

Standard. Wayside horn systems used at grade crossings where the locomotive horn is not sounded shall be equipped and shall operate in compliance with the requirements of Appendix E to 49 CFR Part 222.

Guidance. The same lateral clearance and roadside safety features should apply to wayside horn systems as described in the provisions contained in EPG 913.4.1 Wayside horn systems, when mounted on a separate pole assembly, should be installed no closer than 15 feet from the center of the nearest track and should be positioned to not obstruct the motorists' line of sight of the flashing-light signals.

913.4.7 Rail Traffic Detection (MUTCD Section 8D.07)

Standard. The devices employed in active traffic control systems shall be actuated by some form of rail traffic detection.

Rail traffic detection circuits, insofar as practical, shall be designed on the fail-safe principle.

Flashing-light signals shall operate for at least 20 seconds before the arrival of any rail traffic, except as provided in the first Option paragraph below.

Option. On tracks where all rail traffic operates at less than 20 mph and where road users are directed by an authorized person on the ground to not enter the crossing at all times that approaching rail traffic is about to occupy the crossing, a shorter signal operating time for the flashing-light signals may be used.

Additional warning time may be provided when determined by an engineering study.

Guidance. Where the speeds of different rail traffic on a given track vary considerably under normal operation, special devices or circuits should be installed to provide reasonably uniform notice in advance of all rail traffic movements over the grade crossing. Special control features should be used to eliminate the effects of station stops and switching operations within approach control circuits to prevent excessive activation of the traffic control devices while rail traffic is stopped on or switching upon the approach track control circuits.

913.4.8 Use of Traffic Control Signals at Grade Crossings (MUTCD Section 8D.08)

Standard. Except as provided in the Option paragraph below, traffic control signals shall not be used instead of flashing-light signals to control road users at a highway-rail grade crossing.

Option. Traffic control signals may be used instead of flashing-light signals to control road users at industrial highway-rail grade crossings and other places where the maximum speed of trains is 10 mph or less with approval of the MoDOT Multimodal Division (Rail Section).

Support. EPG 913.4.4 and 913.4.14 contain information regarding the use of traffic control signals at highway-LRT grade crossings.

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Standard. The appropriate provisions of EPG 902 relating to traffic control signal design, installation, and operation shall be applicable where traffic control signals are used instead of flashing-light signals to control road users at grade crossings.

913.4.9 Preemption of Highway Traffic Signals at or Near Grade Crossings (MUTCD Section 8D.09)

Support. Traffic signal preemption for grade crossings is a complex topic that requires a specific understanding of grade crossing warning systems and highway traffic signal operations. While most traffic signal operations are governed only by the traffic signal controller unit and the associated traffic signal equipment, preemption for grade crossings is also governed by the grade crossing warning system. Active grade crossing warning systems include flashing-light signals and possibly automatic gates, as well as various types of train detection equipment. Where the traffic signal controller unit is interconnected with the grade crossing warning system for the purpose of preemption, a combined system is created. It is the combined system that requires a thorough understanding of the design and operating parameters in order to provide proper operation of the preemption system.

The Federal Railroad Administration (FRA) has issued two documents that provide additional information relating to preemption of highway traffic signals at or near grade crossings. The first document is "Technical Bulletin S-12-01, Guidance Regarding the Appropriate Process for the Inspection of Highway-Rail Grade Crossing Warning System Pre-emption Interconnections with Highway Traffic Signals" and the second document is "Safety Advisory 2010-02, Signal Recording Devices for Highway-Rail Grade Crossing Active Warning Systems that are Interconnected with Highway Traffic Signal Systems."

Guidance. If a grade crossing is equipped with flashing-light signals and is located 200 feet or less from an intersection or midblock location controlled by a traffic control signal, a pedestrian hybrid beacon, or an emergency-vehicle hybrid beacon, the intersection should be provided with rail preemption in accordance with EPG 902.6.19 unless otherwise determined by the Diagnostic Team.

Coordination with the flashing-light signals, such as using queue detection and queue cutter signals, blank-out signs, or other alternatives, should be considered where a traffic control signal, a pedestrian hybrid beacon, or an emergency-vehicle hybrid beacon is located more than 200 feet from the grade crossing. Factors to be considered should include traffic volumes, highway vehicle mix, highway vehicle and train approach speeds, frequency of trains, presence of midblock driveways or unsignalized intersections, and the potential for vehicular queues resulting from an adjacent downstream grade crossing or highway traffic signal to extend into the minimum track clearance distance (see EPG 913.1.7).

The highway agency or authority with jurisdiction and the MoDOT Multimodal Division (Rail Section), if applicable, should jointly determine the preemption operation and the timing of highway traffic signals interconnected with grade crossings adjacent to signalized locations.

If a highway traffic signal is installed 200 feet or less from a passive grade crossing, unless otherwise determined by the Diagnostic Team, an active grade crossing warning system should be installed at the grade crossing to provide a means to preempt the highway traffic signal in order to clear vehicles from the minimum track clearance distance (see EPG 913.1.7) upon approach of rail traffic.

If a highway traffic signal is interconnected with flashing-light signals, the flashing-light signals should be provided with automatic gates to prevent additional vehicles from being drawn into the minimum track clearance distance (see EPG 913.1.7) during the track clearance interval prior to the arrival of rail traffic unless a Diagnostic Team determines otherwise.

Support. Regular joint inspections by the highway agency or authority with jurisdiction, the MoDOT Multimodal Division (Rail Section), if applicable, and the railroad company or transit agency are a best practice and typically include verification of the preemption operation, the amount of warning time and/or preemption time being provided by the grade crossing warning system, and the timing of highway traffic signals interconnected and/or coordinated with the flashing-light signals.

EPG 902.6.19 includes a recommendation that traffic control signals that are adjacent to highway-rail grade crossings and that are coordinated with the flashing-light signals at the grade crossing or that include railroad preemption features be provided with a back-up power supply.

Standard. Information regarding the type of preemption and any related timing parameters shall be provided to the railroad company or transit agency so that the railroad company or transit agency can design the appropriate train detection circuitry.

If preemption is provided, unless otherwise determined by a Diagnostic Team, the normal sequence of highway traffic signal indications shall be preempted upon the approach of a train to provide a track clearance interval to provide an opportunity for motor vehicles at the grade crossing to clear the minimum track clearance distance (see EPG 913.1.7) prior to the arrival of rail traffic.

Option. Where train switching or train restarts occur close to a grade crossing, the Diagnostic Team may determine that the preemption time can be reduced in accordance with the operating requirements of the railroad company and/or transit agency.

Standard. Where flashing-light signals are in place at a grade crossing, any highway traffic signal faces installed within 50 feet of any rail shall be preempted upon the approach of rail traffic. The Diagnostic Team shall determine the signal indications displayed by the highway traffic signal faces that control movements across the grade crossing in accordance with EPG 902.6.19 in order to avoid the display of signal indications that conflict with the flashing-light signals.

Guidance. Where the flashing-light signals are in place at a grade crossing, the operation of any flashing yellow beacon installed within 50 feet of any rail should be considered by a Diagnostic Team to determine whether the operation of the beacon should be terminated during the approach and passage of rail traffic.

Standard. The preemption special control mode shall be activated by a supervised preemption interconnection using fail-safe design principles between the control circuits of the grade crossing warning system and the traffic signal controller unit. The approach of rail traffic to a grade crossing shall de-energize the interconnection or send a message via a fail-safe data communication protocol (such as the "IEEE Standard for the Interface Between the Rail Subsystem and the Highway Subsystem at a Highway Rail Intersection," 1570-2002 (R2008), Institute of Electrical and Electronics Engineers), which in turn shall activate the traffic signal controller preemption sequence. This shall establish and maintain the preemption condition during the time the grade crossing warning system is activated, except that when automatic gates exist, the preemption condition shall not be terminated until the automatic gates are energized to start their upward movement.

Support. Advance preemption is the notification of approaching rail traffic that is forwarded to the highway traffic signal controller unit or assembly by the railroad or light rail transit equipment in advance of the activation of the grade crossing warning system.

The maximum preemption time is the maximum amount of time needed following initiation of the preemption sequence for the highway traffic signals to complete the timing of the right-of-way transfer time, queue clearance time, and separation time.

The separation time is the component of maximum preemption time during which the minimum track clearance distance is clear of vehicular traffic prior to the arrival of rail traffic.

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Simultaneous preemption is the notification of approaching rail traffic that is forwarded to the highway traffic signal controller unit or assembly and grade crossing warning system at the same time.

The right-of-way transfer time is the amount of time needed prior to display of the track clearance interval. This includes any time needed by the railroad, light rail transit, or highway traffic signal control equipment to react to a preemption call, and any traffic control signal green, pedestrian walk and clearance if used (see EPG 902.6.19), yellow change, and red clearance intervals for conflicting traffic.

A supervised preemption interconnection is one that incorporates both a normally-open and a normally-closed circuit from the grade crossing warning system to verify the proper operation of the interconnection.

Option. Instead of supervision, a double-break preemption interconnection circuit that uses two normally-closed circuits that open both the source and return energy circuits may be used.

A preemption interconnection may incorporate both supervision and double-break circuits.

Guidance. Where train detection circuits are present at a passive grade crossing, the operation of the preemption interconnection should be treated as if active traffic control devices exist at the crossing and the preemption operation should be determined by a Diagnostic Team.

Where left turns are permitted at a downstream highway-highway traffic control signal from the roadway approach that crosses the track and a delayed or impeded left-turn movement could prevent vehicles from clearing the track, a protected left-turn movement should be provided during the track clearance interval if green signal indications are displayed to the approach for track clearance.

The decision to implement simultaneous or advance preemption should include consideration of the right-of-way transfer time, the queue clearance time, and the separation time in order to determine the maximum preemption time. These time periods should be compared to and verified with the operation of the grade crossing traffic control devices in order to evaluate the operation of the highway traffic signal and the preemption operation. These factors should be considered regardless of whether simultaneous or advance preemption operation is implemented as they are based on traffic signal minimum timing, vehicle acceleration characteristics, and physical distances along the roadway.

Support. Preemption time variability occurs when the traffic signal controller enters the preemption clearance interval with less than the maximum design right-of-way transfer time or when the speed of a train approaching the grade crossing varies.

The time interval between the initiation of advance preemption and the operation of the grade crossing warning system for rail traffic will decrease in situations when rail traffic is accelerating or increase in situations when rail traffic is decelerating.

Guidance. Where preemption is used and automatic gates are present, the possibility that an automatic gate might descend upon a vehicle should be analyzed.

If simultaneous preemption is used, an analysis of extended grade crossing warning time requirements should be conducted.

If advance preemption is used, an analysis of preemption operation, traffic signal sequencing, and traffic signal phasing should be conducted to identify preemption time variability. The analysis should include both the condition requiring the longest amount of time to enter the track clearance interval and the condition requiring the shortest amount of time to enter the track clearance interval.

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Standard. Where automatic gates are present and green signal indications are displayed at the downstream traffic control signal during the track clearance interval, the preemption sequence shall be designed such that the green signal indications are not terminated until the automatic gate(s) that controls access over the grade crossing toward the downstream intersection is fully lowered.

Support. The following are two examples of mutually-exclusive methods to resolve preemption time variability:

A. Gate-down circuitry provides a means to hold the traffic signal controller sequence in the track clearance interval until the automatic gate(s) that controls access over the grade crossing toward the downstream intersection is fully lowered.
B. Timing correction resolves preemption time variability by adding the right-of-way transfer time to the track clearance interval in the traffic signal controller unit and setting a fixed maximum period of time between the start of advance preemption and the operation of the flashing-light signals.

The Third Edition of the "Railroad-Highway Grade Crossing Handbook" and the "2023 AREMA Communications and Signals Manual" published by the American Railway Engineering and Maintenance-of-Way Association (AREMA) provide additional information about preemption time variability.

Standard. Where gate-down circuitry is used to resolve preemption time variability and an automatic gate is broken or is not fully lowered, the crossing control circuits shall not terminate the track clearance interval before the rail traffic has entered the grade crossing.

Where timing correction is used to resolve preemption time variability, a timing circuit shall be used to maintain a maximum time interval between the initiation of advance preemption and the operation of the grade crossing warning system when the approaching rail traffic is decelerating.

Guidance. Where a highway-highway intersection controlled by traffic control signals is interconnected with a grade crossing equipped with exit gates, advance preemption should be used because of the additional operating time that is required for the exit gates.

Where rail traffic routinely stops and re-starts within or just outside of the approaches to a grade crossing that is interconnected with highway traffic signals, the effects of rail traffic operations on the preemption operation should be analyzed.

Highway traffic signal control equipment should be capable of providing immediate re-service of successive requests for preemption from the railroad warning devices, even if the initial preemption sequence has not been completed. As appropriate, the highway traffic signal control equipment should be able to promptly return to the start of the track clearance interval at any time that the demand for preemption is cancelled and then reactivated. The highway traffic signal control equipment should have the ability to provide this immediate re-service at any point in the preemption sequence.

Standard. Where traffic control signals are programmed to operate in a flashing mode during the preemption dwell interval (the period following the track clearance interval that lasts for the duration of the preemption interconnection activation), the beginning of the preemption dwell flashing mode shall not occur until the grade crossing equipment indicates that the rail traffic has entered the grade crossing.

At locations where conflicting preemption calls might be received to serve boats and trains, the Diagnostic Team shall determine the relative priority when conflicting preemption calls occur (see EPG 902.6.19). Where the boat and the train do not conflict with each other, the Diagnostic Team shall determine the preemption sequence when both preemption calls are occurring simultaneously. The United States Coast Guard or other appropriate authority that regulates the operation of the waterway shall be invited to participate on the Diagnostic Team and/or to provide input to the Diagnostic Team.

Support. EPG 902.3.10 describes the Intersection Near a Grade Crossing signal warrant that is intended for use at a location where the proximity to the intersection of a grade crossing on an intersection approach controlled by a STOP or YIELD sign is the principal reason to consider installing a traffic control signal.

EPG 902.6.19 describes additional considerations regarding preemption of traffic control signals at or near grade crossings.

913.4.10 Movements Prohibited During Preemption (MUTCD Section 8D.10)

Support. The use of blank-out turn prohibition signs requires the authorization of the Highway Safety and Traffic Division.

Guidance. At a signalized intersection that is located within 100 feet of a grade crossing and the intersection traffic control signals are preempted by the approach of rail traffic, all existing permissive-only turning movements toward the grade crossing should be prohibited, steady red arrow signal indications should be shown to all existing protected/permissive and protected-only turning movements toward the grade crossing, and red signal indications should be shown to the straight-through movement toward the grade crossing during the signal preemption sequences. The prohibition of a permissive-only turning movement toward the grade crossing during preemption should be accomplished through the installation of a blank-out turn prohibition (R3-1a or R3-2a) sign.

Option. All movements toward the track may be prohibited at a signalized intersection that is preempted by the approach of rail traffic, even if the clear storage distance is more than 100 feet.

Support. Including the word "TRAIN" as part of the blank-out turn prohibition sign informs road users that the turn prohibition being displayed by the sign is in effect because rail traffic is approaching or occupying a nearby rail grade crossing, and that the turn prohibition will be terminated after the rail traffic has cleared the grade crossing.



R3-1a (Activated Blank Out) R3-2a (Activated Blank Out)

Rail operations can include the use of activated blank-out turn prohibition (R3-1a or R3-2a) signs at unsignalized highway-highway intersections in the vicinity of grade crossings, such as where a semi-exclusive or mixed-use alignment is within or parallel to the roadway where road users are normally permitted to turn across the tracks.

Guidance. An LRT-activated blank-out turn prohibition (R3-1a or R3-2a) sign should be used during preemption where all three of the following conditions are present:

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A. There is no active warning system for the LRT grade crossing,
B. Vehicles traveling along a parallel roadway would normally be permitted to turn left or right to travel across tracks that are located within 100 feet of the highway-highway intersection or within the median of the intersection, and
C. The drivers turning at the highway-highway intersection are not controlled by a traffic control signal.

Standard. Blank-out turn prohibition signs that are associated with preemption shall display their message only when a preemption signal is being received from the railroad or LRT equipment or while the automatic gate is activated.

Support. The provisions contained in EPG 903.12 for blank-out signs are applicable to R3-1a and R3-2a signs.

913.4.11 Pre-Signals at or Near Grade Crossings (MUTCD Section 8D.11)

Guidance. If a grade crossing is located in close proximity to an intersection controlled by a traffic control signal and the clear storage distance is less than the design vehicle length, the use of pre-signals to control traffic approaching the grade crossing in the direction toward the intersection should be considered.

If a grade crossing equipped with flashing-light signals, but without automatic gates, is located within 200 feet of an intersection controlled by a traffic control signal, a pre-signal should be provided.

Support. A pre-signal is generally used where the grade crossing is located less than 200 feet from a downstream signalized intersection. EPG 913.4.12 contains information for grade crossings located 200 feet or more from a downstream signalized intersection.

Other measures that could be considered instead of or in addition to a pre-signal to minimize the possibility of vehicles queuing across the grade crossing include providing additional lanes, reducing the cycle length, using split phasing, using protected turn phasing, and/or providing an extended green interval for the approach.

Standard. Pre-signal faces shall display a steady red signal indication during the track clearance interval of the signal preemption sequence to prohibit additional motor vehicles from entering the minimum track clearance distance (see EPG 913.1.7).

Pre-signal faces shall not display green signal indications when the grade crossing flashing-light signals are displaying flashing red indications.

Guidance. Consideration should be given to using visibility-limited signal faces (see definition in EPG 911 (MUTCD Section 1C.02)) at the intersection for the downstream signal faces that control the approach that is equipped with pre-signals.

Option. The duration of the extended green interval may be adjusted by vehicle detection located between the pre-signal and the downstream signalized intersection.

The pre-signal phase sequencing may be timed with an offset from the downstream signalized intersection such that the pre-signal's green signal indication terminates prior to the downstream intersection's green signal indication to minimize the possibility of stopping motor vehicles within the minimum track clearance distance (see EPG 913.1.7) and the clear storage distance.

Guidance. If pre-signals are used, the queue clearance time (see EPG 913.1.9) should be long enough to allow a design vehicle of maximum length stopped just inside the minimum track clearance distance (see EPG 913.1.7) to start up and move through the downstream intersection, or to clear the minimum track clearance distance if there is sufficient clear storage distance.

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R10-10b

Support. The storage area for mandatory left-turn and right-turn lanes at signalized intersections that are downstream from grade crossings sometimes extends from the signalized intersection back to and across the grade crossing. In such cases, drivers that are in the turn lane are required to make a straight-through movement when they cross the track(s) and then are required to make a turning movement when they reach the downstream signalized intersection.

Guidance. A separate pre-signal face for the mandatory left-turn lane and/or right-turn lane should be provided in addition to the pre-signal signal faces provided for the through movement where both of the following conditions are met:

A. The storage area for the turn lane extends from the downstream signalized intersection back to and across the grade crossing, and
B. The green interval for the turning movement at the downstream intersection does not always begin and end simultaneously with the green interval for the adjacent through movement at the downstream intersection.

Standard. Where adjacent lanes at a pre-signal are controlled separately, all of the signal faces shall be capable of displaying the following signal indications: CIRCULAR RED, CIRCULAR YELLOW, and straight-through GREEN ARROW. Left-turn GREEN ARROW and right-turn GREEN ARROW signal indications shall not be used in pre-signal faces. CIRCULAR GREEN signal indications shall not be used in pre-signal faces where adjacent lanes are controlled separately.

Option. Where all adjacent lanes at a pre-signal are controlled together, CIRCULAR GREEN signal indications may be used in pre-signal faces.

Standard. If a separate signal face is provided at a pre-signal for separate control of a mandatory left-turn and/or right-turn lane that extends from the downstream signalized intersection back to and across the grade crossing, the separate signal face shall be devoted exclusively to controlling traffic in the turn lane separately from adjacent lanes, and:

A. Shall be visibility-limited from the adjacent through movement, or
B. A LEFT (RIGHT) LANE SIGNAL (R10-10b) sign shall be mounted adjacent to the separate signal face controlling traffic in a single turn lane or in the turn lane that is farthest from the adjacent through lane(s) if multiple turn lanes are present for a particular turning movement, and a LEFT (RIGHT) TURN LANE SIGNAL (R10-10c) sign shall be mounted adjacent to the separate signal face controlling traffic in the other turn lanes if multiple turn lanes are present for a particular turning movement.

Support. Because the signal faces at a pre-signal do not always display the same signal indications as the downstream signalized intersection, the approach to the pre-signal is considered to be a separate approach from the approach to the downstream signalized intersection. This means that the provisions in EPG 902.4.5 through 902.4.8 regarding the number of signal faces, the visibility and aiming of the signal faces, and the lateral and longitudinal positioning of the signal faces apply separately to the approach to the pre-signal.

The provisions in EPG 902.4.7 regarding the lateral positioning of separate turn signal faces are applicable to the separate signal faces that are provided at pre-signals for a mandatory turn lane that extends from the downstream signalized intersection back to and across the grade crossing.

Guidance. A STOP HERE ON RED (R10-6) sign should be installed at the pre-signal's stop line.

Standard. If a pre-signal is installed upstream from a signalized intersection, a No Turn on Red (R10-11) sign (see EPG 903.2.49) shall be installed at the pre-signal for the approach that crosses the track if turns on red would otherwise be permitted at the downstream intersection.

Option. DO NOT STOP ON TRACKS (R8-8) signs may be installed in conjunction with a pre-signal.

Pre-signal faces may be located either upstream or downstream from the grade crossing in order to provide the most effective display to road users approaching the grade crossing.

If pre-signal faces must be located within close proximity to the flashing-light signals, the pre-signal faces may be mounted on the same overhead structure as the flashing-light signals.

913.4.12 Queue Cutter Signals at or Near Grade Crossings (MUTCD Section 8D.12)



R10-10c

Support. A queue cutter signal is a traffic control signal that controls one direction of traffic at a grade crossing to minimize the possibility of vehicles stopping within the minimum track clearance distance (see EPG 913.1.7). Although a queue cutter signal has a similar purpose as a pre-signal (see EPG 913.4.11), the difference is that a queue cutter signal is independent from the downstream signalized intersection, whereas a pre-signal is part of the downstream signal.

Option. At grade crossing locations where the queue from a bottleneck (usually a signalized intersection) that is downstream from the grade crossing frequently extends back to and across the grade crossing, a queue cutter signal may be installed.

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A queue cutter signal may be operated in one of the following modes:

A. Actuated mode – the queue cutter signal operation is dependent on downstream detection of a growing queue.
B. Non-actuated mode – the queue cutter signal operates on a time-of-day plan based on anticipated downstream queues. This mode could be similar to the functional operation of a pre-signal.
C. Variable mode – the queue cutter signal operation varies between the actuated mode and the non-actuated mode based on the time of day, on queue detection, or both.

Support. A non-actuated queue cutter signal is generally used where the grade crossing is located between 200 feet and 400 feet from a downstream bottleneck. An actuated queue cutter signal is generally used where the grade crossing is located more than 400 feet from a downstream bottleneck. EPG 913.4.11 contains information for grade crossings located less than 200 feet from a downstream signalized intersection.

Standard. Where adjacent lanes at a queue cutter signal are controlled separately, all of the signal faces shall be capable of displaying the following signal indications: CIRCULAR RED, CIRCULAR YELLOW, and straight-through GREEN ARROW. Left-turn GREEN ARROW and right-turn GREEN ARROW signal indications shall not be used in queue cutter signal faces. CIRCULAR GREEN signal indications shall not be used in queue cutter signal faces where adjacent lanes are controlled separately.

Option. Where all adjacent lanes at a queue cutter signal are controlled together, CIRCULAR GREEN signal indications may be used in queue cutter signal faces.

Queue cutter signal faces may be located either upstream or downstream from the grade crossing in order to provide the most effective display to road users approaching the grade crossing.

If queue cutter signal faces must be located within close proximity to the flashing-light signals, the queue cutter signal faces may be mounted on the same overhead structure as the flashing-light signals.

Guidance. A STOP HERE ON RED (R10-6) sign should be installed at the queue cutter signal's stop line.

Option. DO NOT STOP ON TRACKS (R8-8) signs may be installed in conjunction with a queue cutter signal.

Guidance. Where a queue cutter signal operates in an actuated mode based on vehicle presence detection, the queue detector should be located to provide adequate distance to detect a growing queue, permit the queue cutter signal to complete any programmed minimum green or yellow change interval time, and then allow a design vehicle that lawfully crosses the queue cutter signal's stop line during the yellow change interval to clear the minimum track clearance distance (see EPG 913.1.7) before the growing queue extends to the grade crossing.

A queue cutter signal that is operating in an actuated mode and that is displaying CIRCULAR RED signal indications should continue to display CIRCULAR RED signal indications as long as the downstream detection system continues to detect the presence of a vehicular queue at the detection point on the departure side of the grade crossing.

Where a queue cutter signal operates in actuated mode based on vehicle presence detection, consideration should be given to the potential for turning movements between the grade crossing and the downstream bottleneck that could create an intermediate queue of vehicles. Supplemental queue detectors should be considered to detect the formation of these intermediate queues to activate the queue cutter signal.

Where a queue cutter signal is operated in a non-actuated mode, the queue cutter signal should be coordinated with adjacent signals to provide for the progressive movement of traffic.

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Option. Where a queue cutter signal is always operated in a non-actuated mode based on anticipated queues, the queue cutter signal may be operated in a flashing mode at times when the downstream queues are not expected to extend back to and across the grade crossing.

When a variable-mode queue cutter signal is operating in the non-actuated mode, the queue detector may be used to extend the display of the CIRCULAR RED signal indication as long as the downstream detection system continues to detect the presence of a vehicular queue at the detection point on the departure side of the grade crossing.

Standard. A queue cutter signal shall be interconnected with the flashing-light signals at the grade crossing.

Queue cutter signal faces shall not display green signal indications when the grade crossing flashing-light signals are displaying flashing red indications.

When a queue cutter signal that is displaying straight-through GREEN ARROW signal indications (when operating in a steady, stop-and-go mode) or flashing CIRCULAR YELLOW signal indications (when operating in a programmed flashing mode) is preempted by the approach of rail traffic, it shall immediately display steady CIRCULAR YELLOW signal indications during the yellow change interval (see EPG 902.6.17) followed by steady CIRCULAR RED signal indications. The queue cutter signal shall continue to display the steady CIRCULAR RED signal indications until the rail traffic clears the grade crossing and no other rail traffic is detected.

A queue cutter signal operating in an actuated mode shall display straight-through GREEN ARROW signal indications except when it receives an actuation from the downstream vehicle presence detection system or is preempted by the approach of rail traffic. When it receives an actuation from the vehicle presence detection system, the queue cutter signal shall finish timing any active minimum green interval, if used, and then display steady CIRCULAR YELLOW signal indications during the yellow change interval (see EPG 902.6.17) followed by steady CIRCULAR RED signal indications. When no preemption call is present and the queue length is such that no vehicles are detected in the detection zone of the downstream vehicle presence detection system, the queue cutter signal shall finish timing any active minimum red interval, if used, and then return to the display of straight-through GREEN ARROW signal indications.

The failure modes of the queue cutter signal control system and vehicle presence detection circuitry shall be evaluated and accounted for in the design of any such system. Fail-safe design techniques shall be used in the system design. If a queue detector fails, the queue cutter signal shall display flashing CIRCULAR RED signal indications until the normal functioning of the detection system is restored.

Support. The storage area for mandatory left-turn and right-turn lanes at signalized intersections that are downstream from grade crossings sometimes extends from the signalized intersection back to and across the grade crossing. In such cases, drivers that are in the turn lane are required to make a straight-through movement when they cross the track(s) and then are required to make a turning movement when they reach the downstream signalized intersection.

Guidance. A separate queue cutter signal face for the mandatory left-turn lane and/or right-turn lane should be provided in addition to the queue cutter signal faces provided for the through movement where both of the following conditions are met:

A. The storage area for the turn lane extends from the downstream signalized intersection back to and across the grade crossing, and
B. The green interval for the turning movement at the downstream intersection does not always begin and end simultaneously with the green interval for the adjacent through movement at the downstream intersection.

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Standard. If a separate signal face is provided at a queue cutter signal for separate control of a mandatory left-turn and/or right-turn lane that extends from the downstream signalized intersection back to and across the grade crossing, the separate signal face shall be devoted exclusively to controlling traffic in the turn lane separately from adjacent lanes, and:

A. Shall be visibility-limited from the adjacent through movement, or
B. A LEFT (RIGHT) LANE SIGNAL (R10-10b) sign shall be mounted adjacent to the separate signal face controlling traffic in a single turn lane or in the turn lane that is farthest from the adjacent through lane(s) if multiple turn lanes are present for a particular turning movement, and a LEFT (RIGHT) TURN LANE SIGNAL (R10-10c) sign shall be mounted adjacent to the separate signal face controlling traffic in the other turn lanes if multiple turn lanes are present for a particular turning movement.

Support. Because the signal faces at a queue cutter signal do not always display the same signal indications as the downstream signalized intersection, the approach to the queue cutter signal is considered to be a separate approach from the approach to the downstream signalized intersection. This means that the provisions in EPG 902.4.5 through 902.4.8 regarding the number of signal faces, the visibility and aiming of the signal faces, and the lateral and longitudinal positioning of the signal faces apply separately to the approach to the queue cutter signal.

The provisions in EPG 902.4.7 regarding the lateral positioning of separate turn signal faces are applicable to the separate signal faces that are provided at queue cutter signals for a turn lane that extends from the downstream signalized intersection back to and across the grade crossing.

While queue cutter signals and queue jumping signals have similar names, their purpose, design, and operation are quite different. Care must be taken to avoid confusion between queue cutter signals used in conjunction with a grade crossing and queue jumping signals used with transit operations.

913.4.13 Warning Beacons or LED-Enhanced Warning Signs at Grade Crossings (MUTCD Section 8D.13)

Option. Warning Beacons (see EPG 902.18.3) or LEDs within the legend, symbol, or border of the sign (see EPG 903.1.12) may be used to supplement warning signs installed at or on an approach to a grade crossing if additional emphasis is desired for the warning sign. The Warning Beacon or LED-enhanced sign may operate continuously or be activated upon the approach or presence of rail traffic.

Support. Most of the warning signs that are used at or on an approach to a grade crossing warn of physical conditions that exist at the grade crossing regardless of whether rail traffic is approaching or occupying the grade crossing. In these cases, a Warning Beacon or LED-enhanced sign would typically be operated continuously to enhance the conspicuity of the sign.

Standard. If a Warning Beacon or LEDs within the legend, symbol, or border of the sign is activated by the approach or presence of rail traffic, the activation of the Warning Beacon or LEDs shall be accomplished by a supervised preemption interconnection using fail-safe design principles (see EPG 913.4.9) between the control circuits of the grade crossing warning system and the Warning Beacon or LED-enhanced sign.

Support. In the event of a system failure, the normal fault state using a fail-safe interconnection for a Warning Beacon or LED-enhanced sign that is activated by the approach or presence of rail traffic at the grade crossing would be for the Warning Beacon or LEDs to operate when no rail traffic is present.

Option. A Warning Beacon or LED-enhanced sign that is activated by the approach or presence of rail traffic at the grade crossing may continue to operate for a period of time following the passage of the rail traffic to permit the standing queue to dissipate.

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Guidance. If a Warning Beacon or LED-enhanced sign is activated by the approach or presence of rail traffic at the grade crossing, the Warning Beacon or LED-enhanced sign should begin operating prior to the activation of the flashing-light signals at the grade crossing based upon the typical travel time from the location of the Warning Beacon or LED-enhanced sign to the stop line for the grade crossing.

If a Warning Beacon or LED-enhanced sign that is activated by the approach or presence of rail traffic at the grade crossing is operated by commercial AC power, a back-up power system should be provided.

913.4.14 Traffic Control Signals at or Near Highway-LRT Grade Crossings (MUTCD Section 8D.14)

Support. There are two types of traffic control signals for controlling vehicular and LRT movements at interfaces of the two modes. The first is the standard traffic control signal described in EPG 902, which is the focus of this article. The other type of signal is referred to as an LRT signal and is discussed in EPG 913.4.15.

Standard. The provisions of EPG 902 and EPG 913.4.8 through 913.4.12 relating to traffic control signal design, installation, and operation, including interconnection with nearby automatic gates or flashing-light signals, shall be applicable as appropriate where traffic control signals are used at highway-LRT grade crossings.

If traffic control signals are in operation at an LRT grade crossing that is used by pedestrians, bicyclists, and/or other non-motorized road users, an audible device such as a bell shall also be provided and shall be operated in conjunction with the traffic control signals.

Guidance. If the highway traffic signal has emergency-vehicle preemption capability, it should be coordinated with LRT operation.

Where LRT operates in a wide median, motor vehicles crossing the tracks and being controlled by both near and far side traffic signal faces should receive a protected left-turn phase from the far side signal face to clear motor vehicles from the crossing when LRT traffic is approaching the crossing.

Option. Signal indications that permit the movement of motor vehicles, pedestrians, and bicyclists and do not conflict with LRT movements may be provided during LRT phases.

A traffic control signal may be installed in addition to Exit Gate systems and automatic gates at a highway-LRT grade crossing if the crossing occurs within a highway-highway intersection and if the installation of the traffic control signal can be justified based on the warrants described in EPG 902.3.

Where a highway-LRT grade crossing is at a location other than an intersection and LRT operating speeds are less than 25 mph, traffic control signals may be used in lieu of flashing-light signals.

Support. Typical circumstances for using traffic control signals might include:

A. Geometric conditions preclude the installation of highway-LRT grade crossing warning devices,
B. LRT vehicles share the same roadway with road users, or
C. Traffic control signals already exist.

EPG 902.6.18 contains information regarding traffic control signals at or near highway-LRT grade crossings that are not equipped with highway-LRT grade crossing warning devices.

EPG 902.3.10 describes the Intersection Near a Grade Crossing signal warrant that is intended for use at a location where the proximity to the intersection of a grade crossing on an intersection approach controlled by a STOP or YIELD sign is the principal reason to consider installing a traffic control signal.

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Guidance. When a highway-LRT grade crossing exists within a signalized intersection, consideration should be given to providing separate turn signal faces (see definition in EPG 911 (MUTCD Section 1C.02)) for the movements crossing the tracks.

Standard. Separate turn signal faces that are provided for turn movements toward the crossing shall display a steady red indication during the approach and/or passage of LRT traffic.

Support. EPG 913.4.10 contains information regarding the prohibition of turning movements toward the crossing during preemption.

913.4.15 Use of LRT Signals for Control of LRT Vehicles at Highway-LRT Grade Crossings (MUTCD Section 8D.15)

Guidance. LRT signals are not currently used on MoDOT facilities. When considering the use of LRT signals the Highway Safety and Traffic Division should be contacted for guidance.

Option. LRT signal indications may be used at grade crossings and at intersections in mixed-use alignments in conjunction with standard traffic control signals where special LRT signal phases are used to accommodate turning LRT vehicles or where additional LRT clearance time is desirable.

LRT signal indications may be used at intersections where special signal phases are used for bus movements.

Standard. If the LRT crossing control is separate from the intersection control, the two shall be interconnected. The LRT signal phase shall not be terminated until after the LRT vehicle has cleared the crossing or intersection.

If a separate set of standard traffic control signal indications (red, yellow, and green circular and arrow indications) is used to control LRT movements, the indications shall be positioned so they are not visible to motorists, pedestrians, and bicyclists (see EPG 902.4.6).

Guidance. If a signal face used to control LRT movements cannot be positioned where the indications are not visible to road users, the LRT signal indications shown in Figure 913.4.15 should be used.

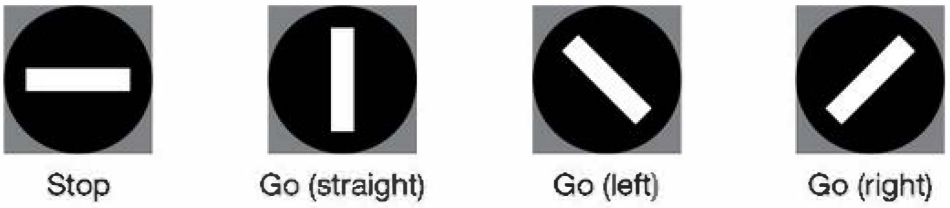
Standard. If special LRT signal indications such as those shown in Figure 913.4.15 are used, the color of the signal indications shall be white.

Option. If used, individual LRT signal sections may be displayed to form clustered signal faces or multiple LRT signal indications may be displayed in an individual housing.

Guidance. LRT signal faces should be located at least 3 feet from the nearest highway traffic signal face for the same approach measured either horizontally perpendicular to the approach between the centers of the signal faces or vertically from the center of the lowest signal indication of the top signal face to the center of the highest signal indication of the bottom signal face.

Support. EPG 902.6.18 contains information about the use of the LRT signal indications shown in Figure 913.4.15 for the control of exclusive bus movements at “queue jumper lanes” and for the control of exclusive bus rapid transit movements on mixed-use alignments.

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Notes:

1. All rectangular bar signal indications shall be white.
2. Go signal indications may be flashed to inform LRT operators to prepare to stop.

Figure 913.4.15. Light Rail Transit Signal Indications

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913.5 Pathway and Sidewalk Grade Crossings (MUTCD Chapter 8E)

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913.5.1 Purpose (MUTCD Section 8E.01)

Support. Traffic control for pathway and sidewalk grade crossings includes all signs, signals, markings, other warning devices, and their supports at pathway and sidewalk grade crossings and along pathway and sidewalk approaches to grade crossings. The function of this traffic control is to promote safety and provide effective operation of both rail and pathway or sidewalk traffic at pathway or sidewalk grade crossings.

Other physical treatments that are described in this article that are also applicable to pathways and sidewalks at grade crossings, such as detectable warnings, swing gates, and fencing, provide increased safety for pathway and sidewalk users.

Crosswalk markings at intersections where pedestrians cross LRT tracks in mixed-use alignments are covered by the provisions of EPG 620.3 rather than by the provisions of this article.

Figure 913.5.2.1 illustrates the difference between a pathway grade crossing and a sidewalk grade crossing. A pathway is frequently placed in its own right-of-way on an alignment that is independent of any roadway. If a pathway is built parallel to a roadway, it is physically separated from the roadway by an open space or barrier such that the traffic control devices for the roadway grade crossing do not exert an influence over or provide adequate warning to pathway users. A sidewalk runs parallel to a roadway within the highway right-of-way and is close enough to the edge of the roadway's traveled way that the traffic control devices for the roadway grade crossing can frequently exert an influence over or provide adequate warning to sidewalk users. Pathways are typically used by both pedestrians and bicyclists, whereas sidewalks are typically used only by pedestrians.

913.5.2 Use of Standard Devices, Systems, and Practices (MUTCD Section 8E.02)

Guidance. The pathway or sidewalk user's ability to detect the presence of approaching rail traffic should be considered in determining the type and placement of traffic control devices at pathway or sidewalk grade crossings.

The traffic control devices, including the appropriate traffic control system to be used, and other physical treatments at a pathway or sidewalk grade crossing should be determined by a Diagnostic Team that includes the agency with jurisdiction over the pathway or sidewalk.

At skewed grade crossings, the adjustment, re-alignment, or relocation of existing sidewalk grade crossings should be considered when determining the placement of traffic control devices for roadway users.

Support. The safety of pathway and sidewalk users is enhanced when pathways and sidewalks are designed such that they do not cross the tracks at a narrow angle. The casters of wheelchairs and the wheels of bicycles could fall into and might be constrained in the flangeway gap at a skewed crossing. The flangeway gap is typically 2.5 inches wide at LRT grade crossings and 3 inches wide at railroad grade crossings.

It is desirable that pathways and sidewalks be designed such that they maintain a relatively consistent horizontal alignment and profile from the nearest rail to the detectable warning (if present) or from the nearest rail to the stop line (if present) on each approach to the crossing. Providing a pedestrian refuge area in advance of the stop line or the detectable warning surface so that pedestrians have a place to wait while rail traffic approaches and occupies the crossing can be beneficial to pedestrian safety.

When designing new sidewalk grade crossings, placing the sidewalk outside of the area occupied by grade crossing traffic control devices for vehicular traffic is desirable (see Figure 913.5.2.2). This includes making sure that the counterweights and support arms for the automatic gates for vehicular traffic do not obstruct the sidewalk when the gate is fully lowered.

Additional information regarding the design of pathways and sidewalks is contained in the U.S. Department of Justice 2010 ADA Standards for Accessible Design, September 15, 2010, 28 CFR 35 and 36, Americans with Disabilities Act of 1990.

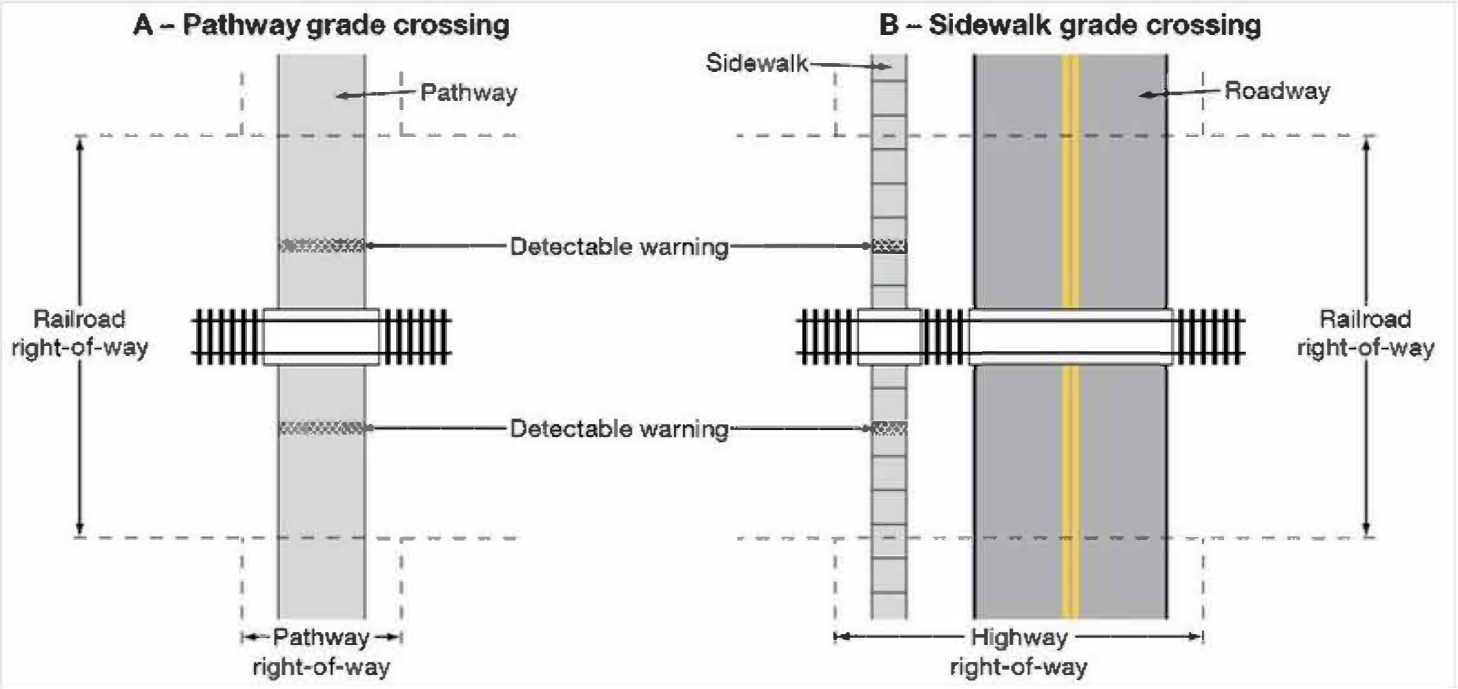
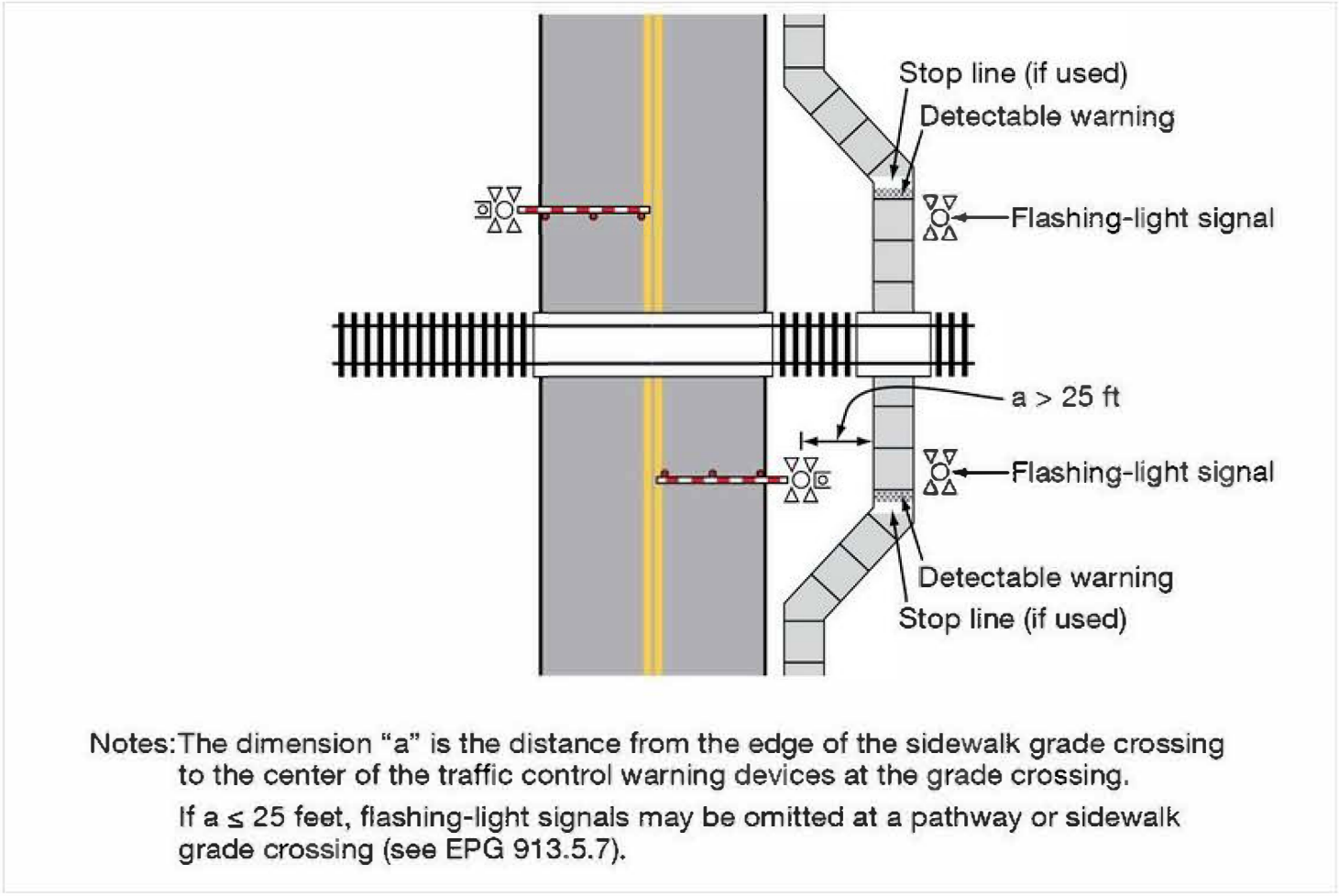


Figure 913.5.2.1 Illustration of the Difference between a Pathway Grade Crossing and a Sidewalk Grade Crossing



Notes: The dimension "a" is the distance from the edge of the sidewalk grade crossing to the center of the traffic control warning devices at the grade crossing.

If a ≤ 25 feet, flashing-light signals may be omitted at a pathway or sidewalk grade crossing (see EPG 913.5.7).

Figure 913.5.2.2 Example of an Active Traffic Control System for a Sidewalk or Pathway Grade Crossing

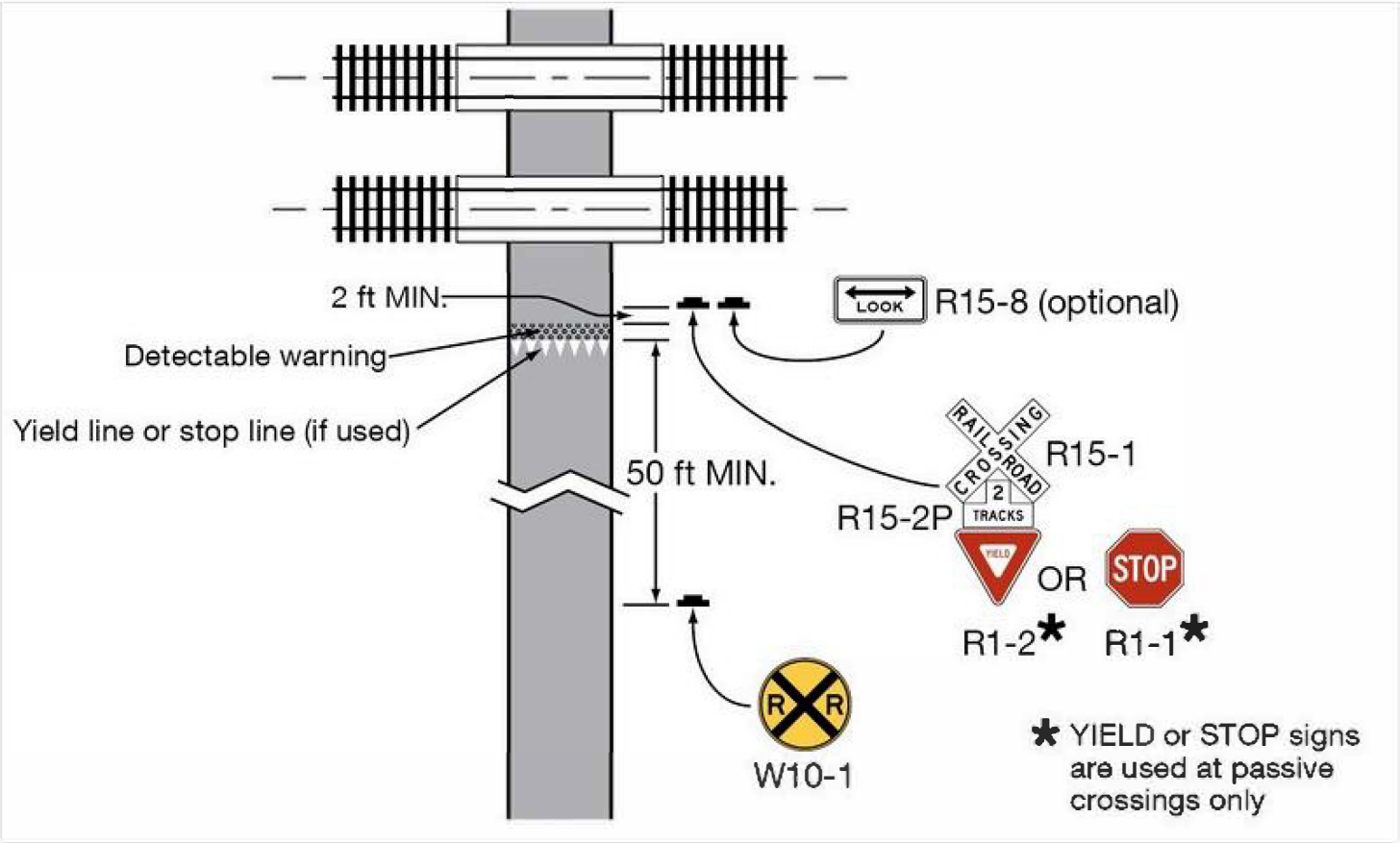


Figure 913.5.2.3 Example of Signing and Markings at a Pathway Grade Crossing

913.5.3 Pathway and Sidewalk Grade Crossing Signs and Markings(MUTCD Section 8E.03)

Standard. Pathway and sidewalk grade crossing signs shall be standard in shape, legend, and color.

The minimum sizes of sidewalk grade crossing signs that are intended to be viewed only by sidewalk users and of pathway grade crossing signs shall be as shown in the shared-use path column in Table 914.1.2.

Guidance. No portion of a traffic control device or its support should protrude into the pathway or sidewalk grade crossing. Sidewalk and pathway grade crossing traffic control devices should be located such that all physical features of the device, including the support hardware, conform to clearance requirements provided by the railroad company and/or transit agency, and the MoDOT Multimodal Division (Rail Section).

The minimum mounting height for post-mounted signs adjacent to pathways and sidewalks should be 4 feet, measured vertically from the bottom of the sign to the elevation of the near edge of the pathway or sidewalk surface.

If overhead traffic control devices are placed above pathways, the clearance from the bottom of the device to the pathway surface directly under the sign or device should be at least 8 feet.

If overhead traffic control devices are placed above pathways that are used by equestrians, the clearance from the bottom of the device to the pathway surface directly under the sign or device should be at least 10 feet.

Standard. If overhead traffic control devices are placed above sidewalks, the clearance from the bottom of the device to the sidewalk surface directly under the sign or device shall be at least 7 feet.

Guidance. Traffic control devices mounted adjacent to pathways at a height of less than 8 feet measured vertically from the bottom of the device to the elevation of the near edge of the pathway surface should have a minimum lateral offset of 2 feet from the near edge of the device to the near edge of the pathway.

If pathway users include those who travel faster than pedestrians, such as bicyclists or skaters, warning signs should be installed in advance of the pathway grade crossing (see Figure 913.5.2.3).

913.5.4 Stop Lines, Edge Lines, and Detectable Warnings (MUTCD Section 8E.04)

Guidance. A stop line should be provided at a pathway grade crossing if the surface where the marking is to be applied is capable of retaining the application of the marking.

Option. A stop line may be provided at a sidewalk grade crossing if the surface where the marking is to be applied is capable of retaining the application of the marking.

Guidance. If used at pathway or sidewalk grade crossings, the stop line should be a transverse line that extends across the full width of the pathway or sidewalk at the point where a pathway or sidewalk user is to stop. If no detectable warning is provided, the stop line should be placed at least 2 feet in advance of the automatic gate, counterweight, flashing-light signals, or Crossbuck Assembly (if any of these are present), and at least 12 feet from the nearest rail.

Option. Edge lines (see EPG 620.2.10) to delineate the designated user route may be used on the approach to and across the tracks at a pathway grade crossing, a sidewalk grade crossing, or a station crossing if the surface where the marking is to be applied is capable of retaining the application of the marking.

Support. Edge line delineation can be beneficial where the distance across the tracks is long, commonly because of a skewed grade crossing or because of multiple tracks, or where the pathway or sidewalk surface is immediately adjacent to a traveled way.

Information regarding the design of detectable warning surfaces is contained in the U.S. Department of Justice 2010 ADA Standards for Accessible Design, September 15, 2010, 28 CFR 35 and 36, Americans with Disabilities Act of 1990.

Standard. Detectable warnings (see EPG 620.3) shall be used at pathway grade crossings where pedestrian travel is permitted and at sidewalk grade crossings and shall extend across the full width of the pathway or sidewalk.

Guidance. The dimension of the detectable warning in the direction of pedestrian travel should be at least 2 feet.

Detectable warnings should be placed immediately beyond the pathway or sidewalk stop line (if a stop line is present) or should be incorporated into and made a part of the stop line. The downstream edge of the detectable warning should be located at least 2 feet upstream from the automatic gate, counterweight, flashing-light signals, or Crossbuck Assembly (if any of these are present) and at least 12 feet from the nearest rail (see Figures 913.5.2.2 and 913.5.2.3).

If the distance between the nearest rail of two adjacent tracks at a sidewalk or pathway grade crossing is 30 feet or more, additional detectable warnings should be used to designate the limits of the pedestrian refuge area (see Figure 913.5.4).

Option. At pathway-LRT and sidewalk-LRT grade crossings, the downstream edge of the detectable warning may be located less than 12 feet from the nearest rail.

Guidance. The downstream edge of the detectable warning at pathway-LRT and sidewalk-LRT grade crossings should be located at least 2 feet upstream from the automatic gate, counterweight, flashing-light signals, or Crossbuck assembly (if any of these are present), at least 6 feet from the nearest rail, and in accordance with the requirements of the railroad company and/or transit agency, and MoDOT Multimodal Division (Rail Section), (if applicable).

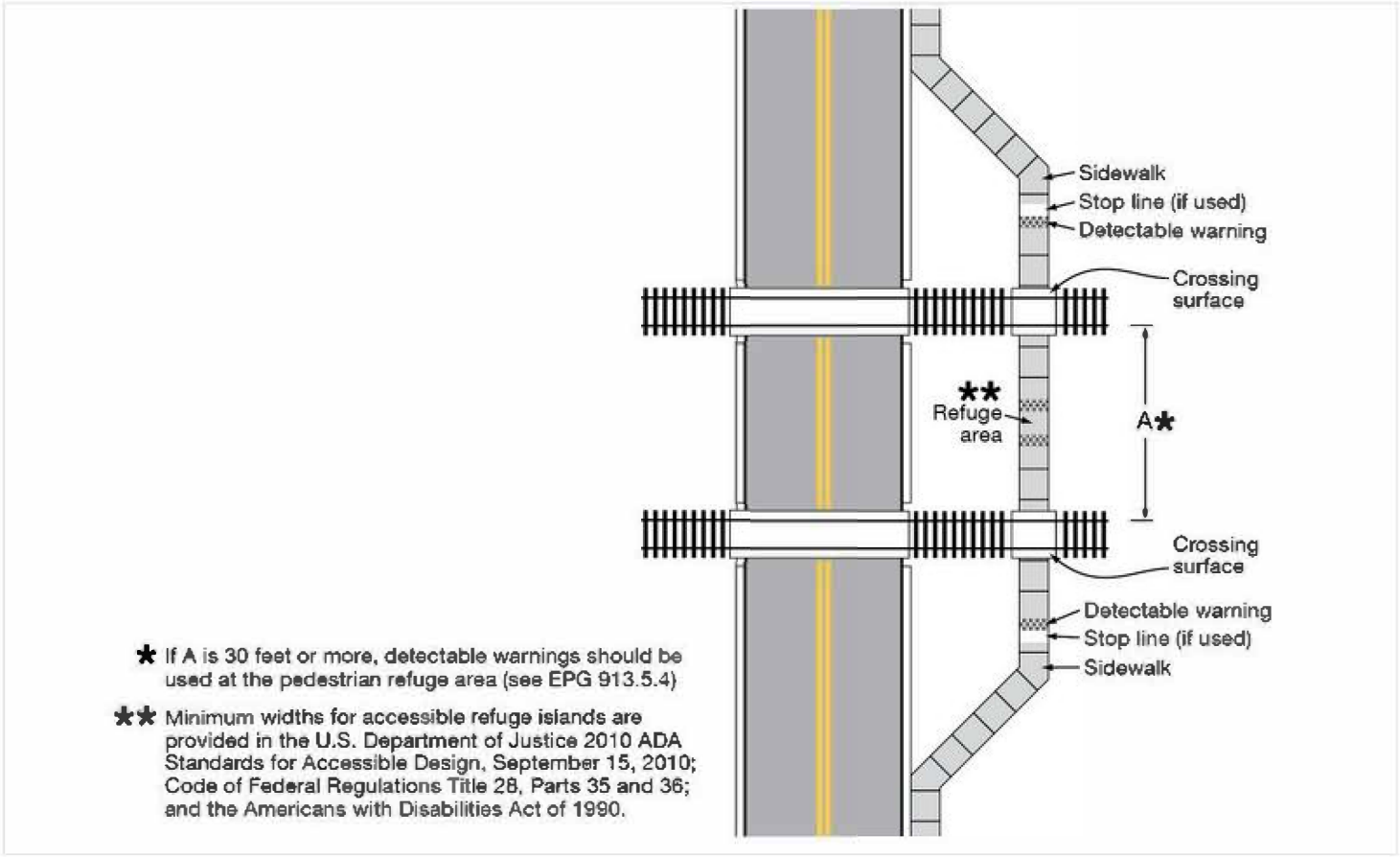


Figure 913.5.4 Example of Detectable Warning and Stop Lines for a Refuge Area at a Sidewalk Grade Crossing

913.5.5 Passive Traffic Control Devices– Crossbuck Assemblies (MUTCD Section 8E.05)

Support. The Crossbuck Assembly is provided by the appropriate railroad company. Railroad companies and/or transit agencies are responsible for the installation and maintenance of these signs.

Standard. Where the nearest edge of a passive pathway or sidewalk grade crossing is located more than 25 feet from the center of the nearest traffic control warning device at the grade crossing, a Crossbuck Assembly (see Figure 913.5.5) shall be installed on each approach to the pathway or sidewalk grade crossing. The distance shall be measured perpendicular to the traveled way from the center of the support post of a Crossbuck Assembly at a passive grade crossing or from the center of the mast of an active traffic control warning device at an active grade crossing to the nearest edge of the pathway or sidewalk surface where it crosses the track(s) (see Figure 913.5.2.2).

Option. A Crossbuck Assembly may be installed on the approaches to a pathway or sidewalk grade crossing where the nearest edge of the pathway or sidewalk is located 25 feet or less from the center of the nearest traffic control warning device at a grade crossing.

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The Crossbuck Assembly may be omitted at station crossings.

The retroreflective strip on the back of the support may be omitted on the Crossbuck support at a pathway or sidewalk grade crossing.

Standard. The minimum height, measured vertically from the bottom of the YIELD or STOP sign to the elevation of the near edge of the pathway or sidewalk, of Crossbuck Assemblies installed on pathways or sidewalks shall be 4 feet where the lateral offset to the nearest edge of the sign is 2 feet or more and shall be 7 feet where the lateral offset to the nearest edge of the sign is less than 2 feet (see Figure 913.5.5).

The minimum lateral offset, measured horizontally from the nearest edge of the pathway or sidewalk to the nearest edge of the Crossbuck Assembly signs, shall be 0 feet for sidewalks and 2 feet for pathways.

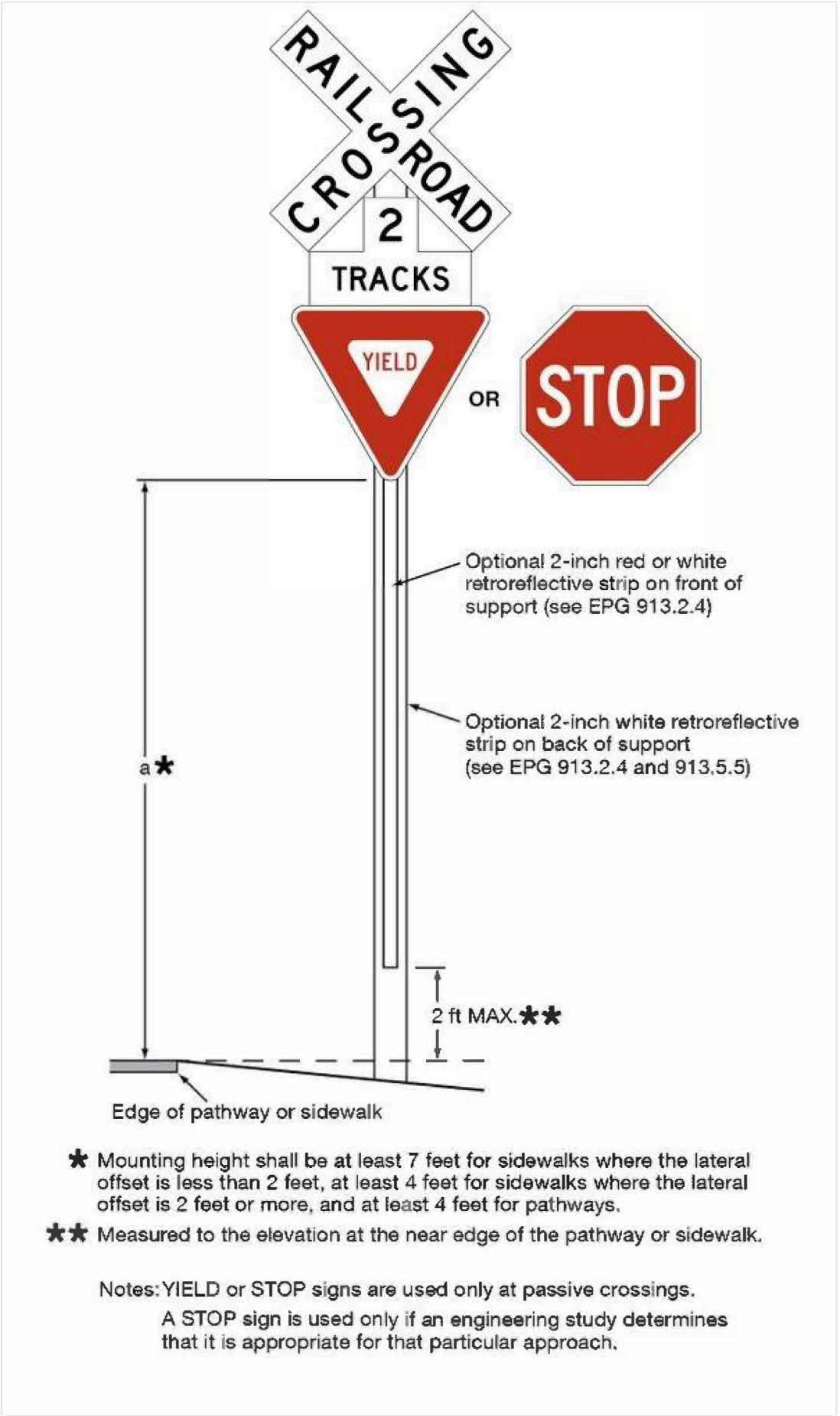


Figure 913.5.5. Example of a Crossbuck Assembly at a Pathway or Sidewalk Grade Crossing

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913.5.6 Channelizing Devices used with Sidewalk and Pathway Traffic Control Devices (MUTCD Section 8E.06)

Support. The design, installation and maintenance of these devices are normally the responsibility of the railroad company with the approval of the MoDOT Multimodal Division (Rail Section).

The pathway or sidewalk user's ability to detect the presence of approaching rail traffic needs to be considered in determining the type and placement of channelizing devices such as swing gates, fencing, and pedestrian barriers.

Where automatic gates and swing gates are used, it is desirable to design the pathway or sidewalk in a manner that channelizes or directs users to the entrance to and exit from the pathway or sidewalk grade crossing.

Swing gates (see Figures 913.5.6, 913.5.9.1, and 913.5.9.2) are designed to open away from the track(s) so that pathway or sidewalk users can quickly push the swing gate open when moving away from the track(s), and to automatically return to the closed position after each use.

It is important to use retroreflective material and/or signs on swing gates, maze fencing, or pedestrian barriers that are placed at pathway or sidewalk grade crossings. Illumination of such areas can also be beneficial.

When used in conjunction with automatic gates at a pathway or sidewalk grade crossing, swing gates are typically equipped with a latching device that permits the swing gate to be opened only from the track side of the swing gate. Push bars, kick plates, or similar devices are also appropriate for use on a swing gate.

Latching devices that are used on swing gates need to be designed in a manner such that they are operable by all users of the pathway or sidewalk.

Guidance. A swing gate should be equipped with a PUSH TO EXIT (I13-2) sign on the track side of the swing gate, and a DO NOT ENTER (R5-1) sign on the side of the swing gate facing away from the tracks (see Figure 913.5.9.2).

Support. The U.S. Department of Justice 2010 ADA Standards for Accessible Design, September 15, 2010, 28 CFR 35 and 36, Americans with Disabilities Act of 1990 contains information regarding the design of swing gates and related hardware.

Where fencing (see Figures 913.5.6 and 913.5.9.1) is installed to direct pathway or sidewalk users to the grade crossing, it is desirable that this fencing be connected to any continuous existing or new fencing or channelization that has been installed parallel to the track(s) to discourage pedestrians from circumventing the grade crossing.

Pedestrian barriers or fencing, sometimes referred to as a "maze fencing," direct pathway or sidewalk users to face approaching rail traffic before entering the trackway.

Where used, maze fencing or pedestrian barriers need to be designed to permit the passage of wheelchairs and power-assisted mobility devices, and if bicycles are permitted, to permit the passage of dismounted bicyclists with tandem bicycles, cargo bicycles, or bicycles with trailers.

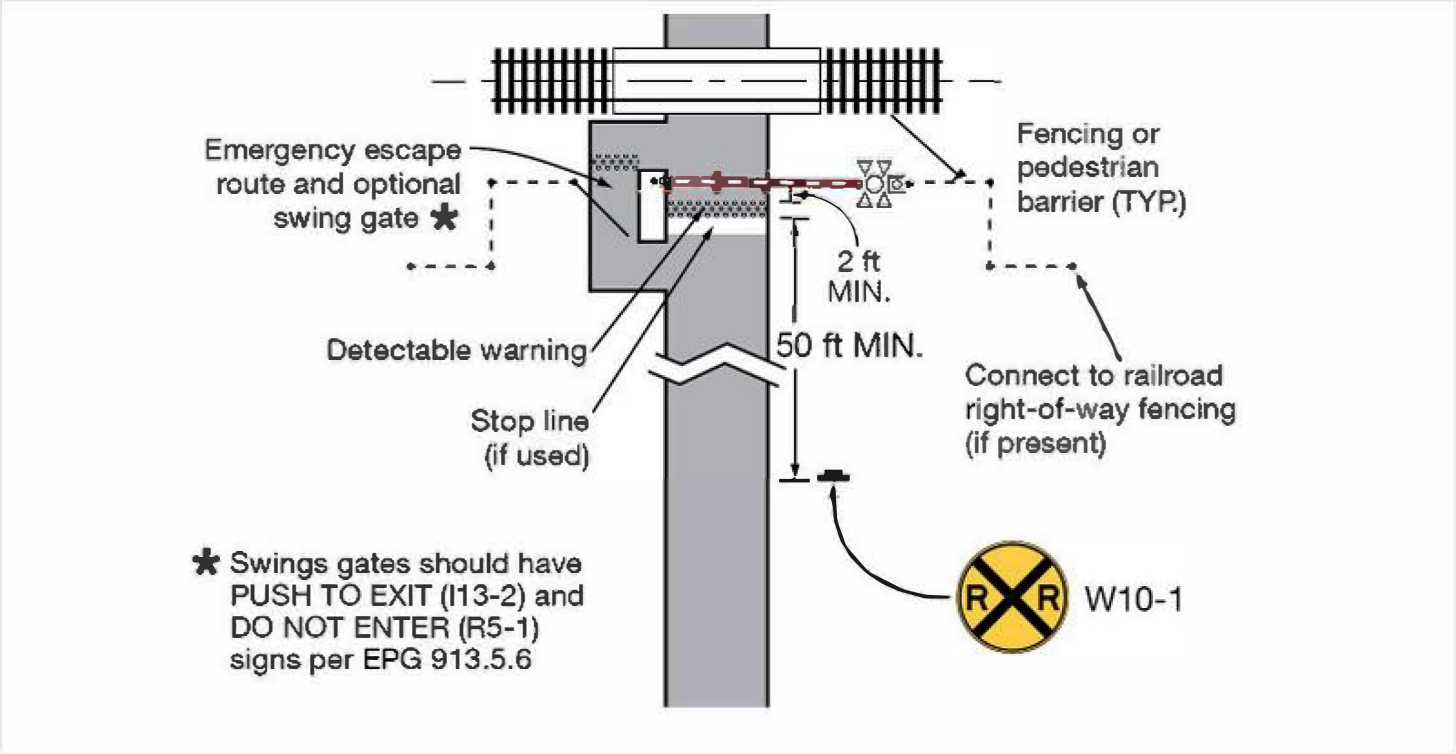


Figure 913.5.6. Example of an Automatic Pedestrian Gate and anEmergency Escape Route at a Pathway Grade Crossing

913.5.7 Active Traffic Control Systems (MUTCD Section 8E.07)

Support. The design, installation and maintenance of these devices are normally the responsibility of the railroad company with the approval of the MoDOT Multimodal Division (Rail Section).

Standard. Except as provided in the first Option paragraph below, at pathway-LRT and sidewalk-LRT grade crossings where LRT operating speeds on a semi-exclusive alignment exceed 25 mph, active traffic control systems shall be used.

Except as provided in the first Option paragraph below, at pathway-LRT and sidewalk-LRT grade crossings where LRT operating speeds on a semi-exclusive alignment exceed 40 mph, active traffic control systems, including automatic gates, shall be used.

If used at a pathway or sidewalk grade crossing, an active traffic control system (see EPG 913.4.1) shall include flashing-light signals (see Figure 913.5.7) on each approach to the crossing.

Guidance. If used at a pathway or sidewalk grade crossing, an active traffic control system (see EPG 913.4.1) should include an audible device such as a bell that is operated in conjunction with the flashing-light signals.

Option. Flashing-light signals, bells, and other audible warning devices may be omitted at pathway or sidewalk grade crossings that are located within 25 feet of an active warning device at a grade crossing that is equipped with those devices.

Additional pairs of flashing-light signals, bells, or other audible warning devices may be installed on the active traffic control devices at a grade crossing for pathway or sidewalk users approaching the grade crossing from the back side of those devices.

Guidance. Where railroad or LRT tracks in a semi-exclusive alignment are parallel and immediately adjacent to a roadway and if adequate space exists, a pedestrian refuge area or island should be provided between the tracks and the roadway to permit pedestrians to stand clear of the tracks while waiting to cross the roadway and to

stand clear of the roadway while waiting to cross the tracks. If a pedestrian refuge area or island is provided at a signalized crossing of the roadway, additional pedestrian features (see EPG 902.9), such as signal heads, signing, and detectors, should be installed in the refuge area or on the island.

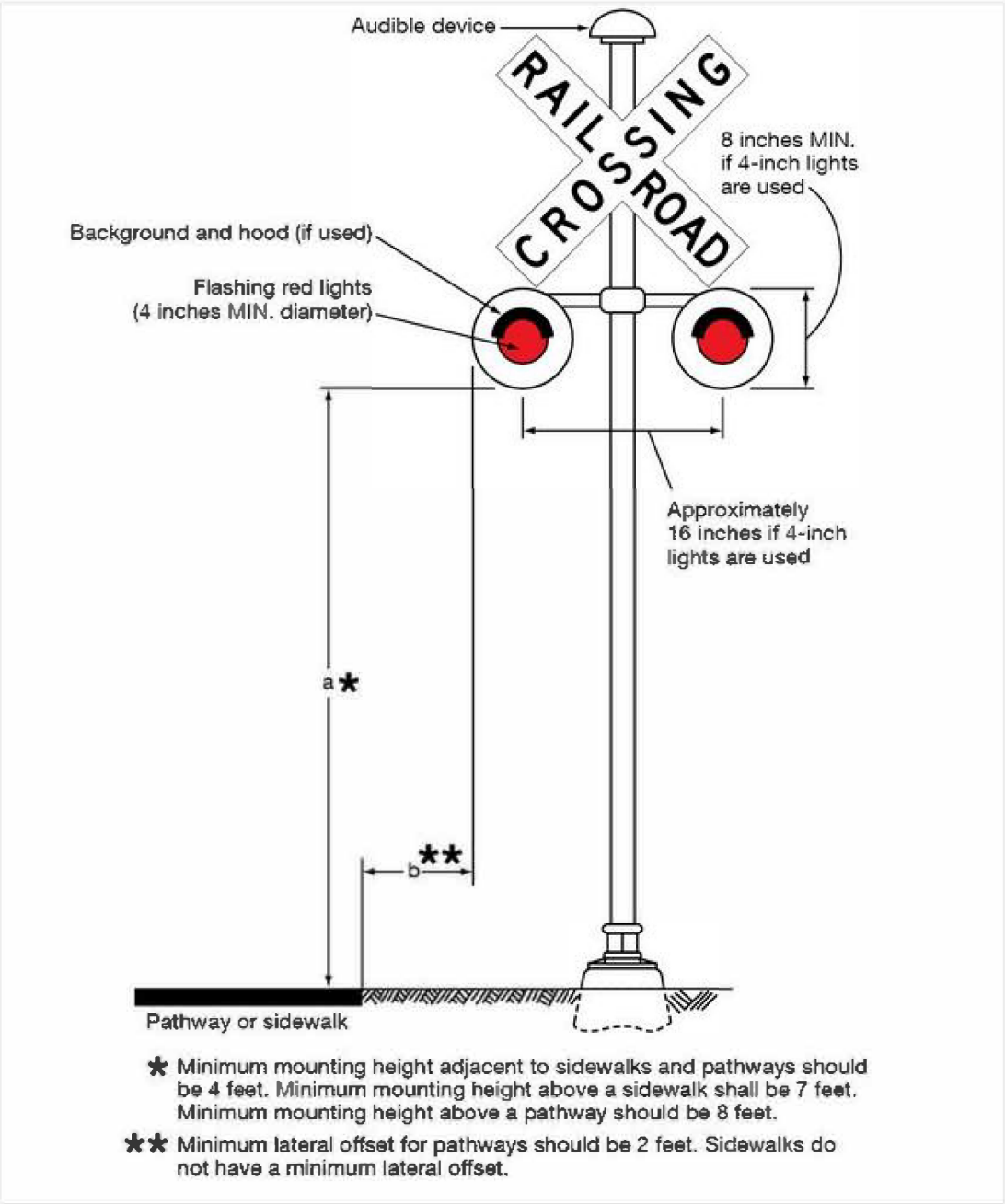


Figure 913.5.7. Example of a Flashing-Light Signal Assembly at a Pathway or Sidewalk Grade Crossing

913.5.8 Active Traffic Control Devices – Signals (MUTCD Section 8E.08)

Support. The design, installation and maintenance of these devices are normally the responsibility of the railroad company with the approval of the MoDOT Multimodal Division (Rail Section).

Pedestrian signal heads are typically used at highway-highway intersections where pedestrians have an expectation that other roadway users will sometimes be legally required to yield the right-of-way to them. At grade crossings where rail traffic does not stop, pedestrians will not have the right-of-way yielded to them.

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Therefore, pedestrian signal heads are not an appropriate traffic control device to use at a pathway or sidewalk grade crossing where rail traffic does not stop. Instead, the universal application of horizontally-aligned, alternately-flashing red lights is the uniform active traffic control device for all grade crossings where rail traffic does not stop including pathway and sidewalk grade crossings.

Standard. Except as provided in the Option paragraph below, pedestrian signal heads as described in Chapter 4I comprised of Upraised Hand and Walking Person symbols shall not be used at a pathway or sidewalk grade crossing.

Option. Pedestrian signal heads may be used at a pathway or sidewalk grade crossing where the movement of LRT vehicles is controlled by a traffic control signal or by special LRT signals (see EPG 913.4.15).

Standard. If used at a pathway or sidewalk grade crossing, flashing-light signals shall be aligned horizontally, and the light units shall have a diameter of at least 4 inches. For 4-inch diameter light units, the light centers shall be spaced approximately 16 inches apart and, if used, the flashing light unit backgrounds shall be at least 8 inches in diameter.

Each red signal unit in the flashing-light signal shall flash alternately. The number of flashes per minute for each lamp shall be 35 minimum and 65 maximum. Each lamp shall be illuminated for approximately the same length of time. The total time of illumination of each pair of lamps shall be the entire operating time.

The minimum mounting height of the flashing-light signals shall be 4 feet, measured vertically from the bottom edge of the lights to the elevation of the near edge of the pathway or sidewalk surface.

Option. At station, pathway, or sidewalk grade crossings with multiple tracks, traffic control devices may be installed between the tracks in compliance with any railroad clearance requirements.

Standard. The mounting height for flashing-light signals that are installed between the tracks at multiple-track crossings shall be a minimum of 1 foot, measured vertically from the bottom edge of the lights to the elevation of the near edge of the pathway surface.

Guidance. If a Diagnostic Team finds that a flashing-light signal with a Crossbuck sign and an audible device is still not resulting in appropriate pedestrian behavior, consideration should be given to also installing an automatic pedestrian gate (see EPG 913.5.9).

Flashing-light signals (see Figure 913.5.7) with a Crossbuck (R15-1) sign and an audible device should be installed along semi-exclusive LRT alignments at station, pathway, or sidewalk grade crossings where the Diagnostic Team has determined that the sight distance is not sufficient for pathway or sidewalk users to complete their crossing prior to the arrival of LRT traffic at the crossing.

If the Diagnostic Team determines that flashing-light signals with a Crossbuck sign and an audible device would not provide sufficient notice of approaching LRT traffic, consideration should be given to also installing an automatic pedestrian gate (see EPG 913.5.9) with appropriate channelization or fencing.

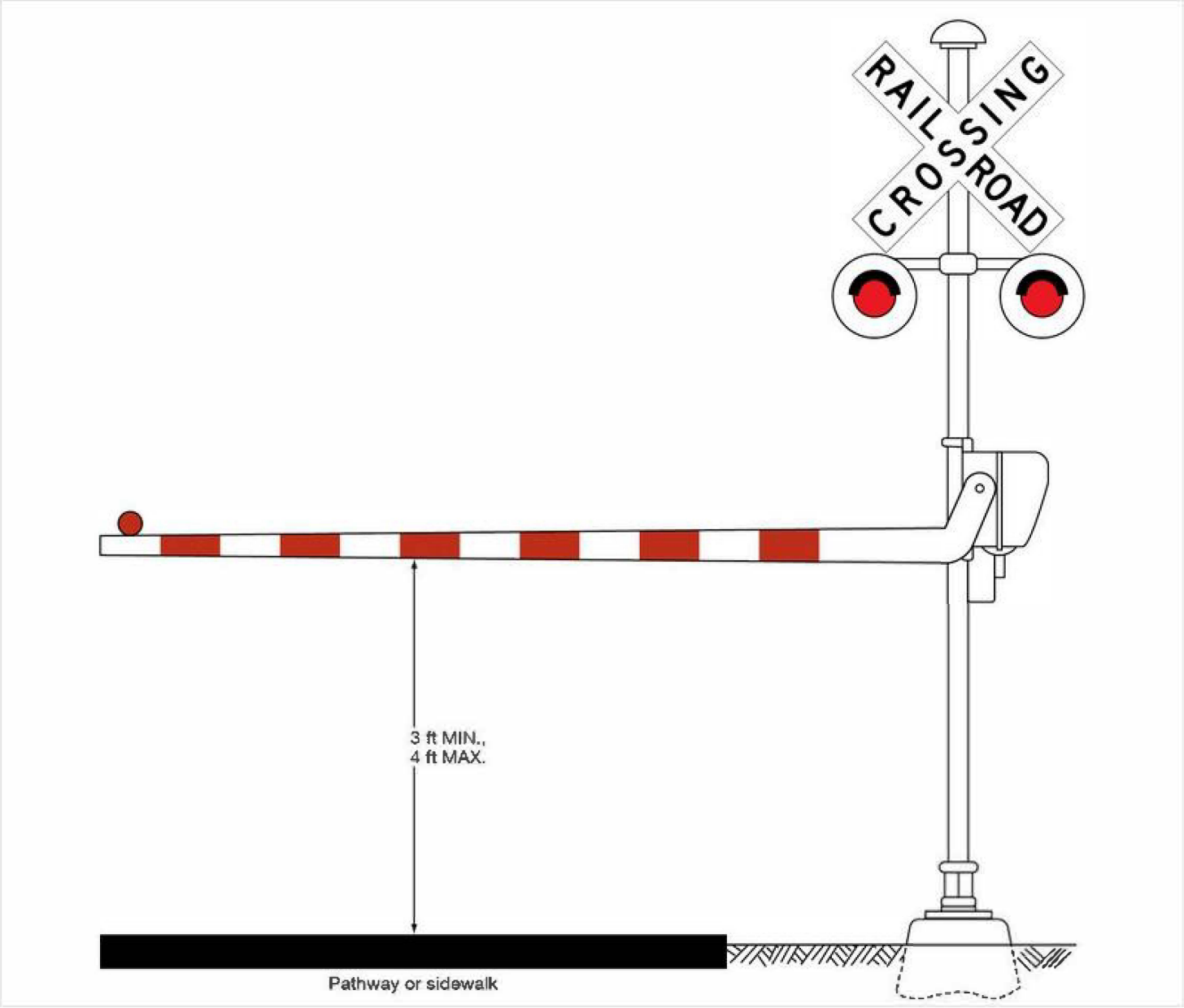


Figure 913.5.8. Example of an Automatic Pedestrian Gate at a Pathway or Sidewalk Grade Crossing

913.5.9 Active Traffic Control Devices – Automatic Pedestrian Gates (MUTCD Section 8E.09)

Support. The design, installation and maintenance of these devices are normally the responsibility of the railroad company with the approval of the MoDOT Multimodal Division (Rail Section).

Option. Automatic pedestrian gates (see Figures 913.5.6, 913.5.8, 913.5.9.1, 913.5.9.3, and 913.5.9.4) may be used at pathway or sidewalk grade crossings.

Standard. A pathway or sidewalk grade crossing across tracks where trains are permitted to travel at speeds of 80 mph or higher shall be equipped with a system of automatic pedestrian gates and an escape area with swing gates and fencing installed in the vicinity of the crossing to direct users to the pathway or sidewalk grade crossing (see Figure 913.5.6) unless the Diagnostic Team determines that other safety treatments for the crossing would be more appropriate.

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Guidance. Where automatic pedestrian gates are installed across a pathway or sidewalk at a grade crossing, or where a sidewalk is located between the edge of a roadway and the support for an automatic gate arm that extends across the sidewalk and into the roadway, an emergency escape route (see Figures 913.5.9.1 and 913.5.9.2) should be provided to allow pedestrians to egress away from the track area when the automatic pedestrian gates are activated.

Standard. Except as provided in the Option paragraph below, automatic pedestrian gate arms shall be provided with at least one red light as shown in Figures 913.5.6, 913.5.8, 913.5.9.1, 913.5.9.3, and 913.5.9.4. This light shall be continuously illuminated whenever the warning system is active.

If any red lights in addition to the continuously-illuminated red light that is required in the preceding paragraph are provided on the automatic pedestrian gate arm, they shall be installed in pairs and shall be flashed alternately in unison with the other flashing-light units at the crossing.

Option. The red light on an automatic pedestrian gate arm may be omitted if the pathway or sidewalk grade crossing is located within 25 feet of the traveled way at a highway-rail or highway-LRT grade crossing that is equipped with active warning devices (see Figure 913.5.9.3).

Guidance. If used at a pathway or sidewalk grade crossing, the height of the automatic pedestrian gate arm when in the down position should be a minimum of 3 feet and a maximum of 4 feet above the pathway or sidewalk.

If used at a pathway or sidewalk grade crossing, the gate configuration, which might include a combination of automatic pedestrian gates and swing gates, should provide for full-width coverage of the pathway or sidewalk on each approach to the crossing.

Standard. Where a sidewalk is located between the edge of a roadway and the support for an automatic gate arm that extends across the sidewalk and into the roadway, the location, placement, and height prescribed for vehicular gates shall be used (see EPG 913.4.3).

Guidance. Except as provided in the first Option paragraph below, if a separate automatic pedestrian gate is used for a sidewalk at a highway-rail or highway-LRT grade crossing, instead of a supplemental or auxiliary gate arm installed as a part of the same mechanism as the vehicular gate, a separate mechanism (see Figure 913.5.9.3) should be provided for the separate automatic pedestrian gate so that if a pedestrian manually raises the pedestrian gate arm, it will have no effect on the vehicular gate.

Option. A supplemental or auxiliary pedestrian gate arm installed as a part of the same mechanism as the vehicular gate may be used if the operating mechanism is designed to prevent the vehicular gate from being raised as a result of a pedestrian manually raising the pedestrian gate arm.

A horizontal hanging bar (see Figure 913.5.9.4) may be attached to an automatic pedestrian gate at a pathway or sidewalk grade crossing to inform pedestrians with vision disabilities that the automatic pedestrian gate is in the down position and to reduce the likelihood that pedestrians will violate a lowered crossing gate.

Guidance. If a horizontal hanging bar is attached to an automatic pedestrian gate, the height of the horizontal hanging bar when in the down position should be a maximum of 26 inches above the pathway or sidewalk.

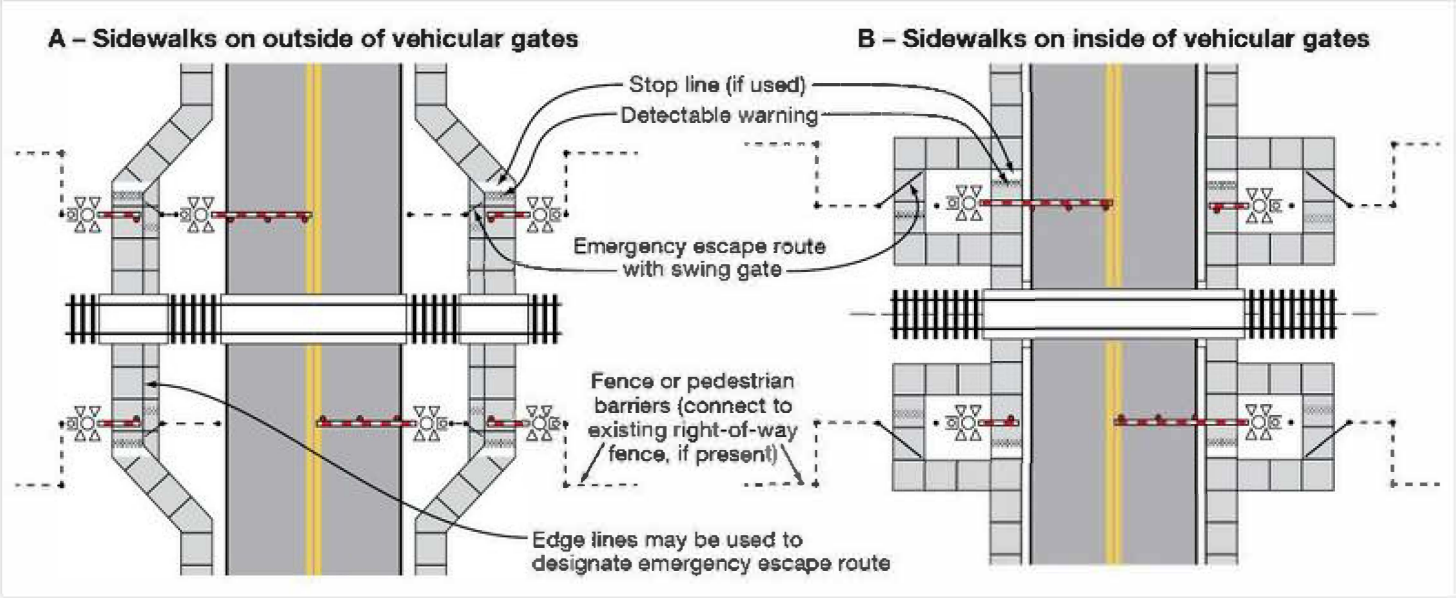


Figure 913.5.9.1. Example of Active Traffic Control Systems with Automatic Pedestrian Gates and Swing Gates at a Sidewalk Grade Crossing

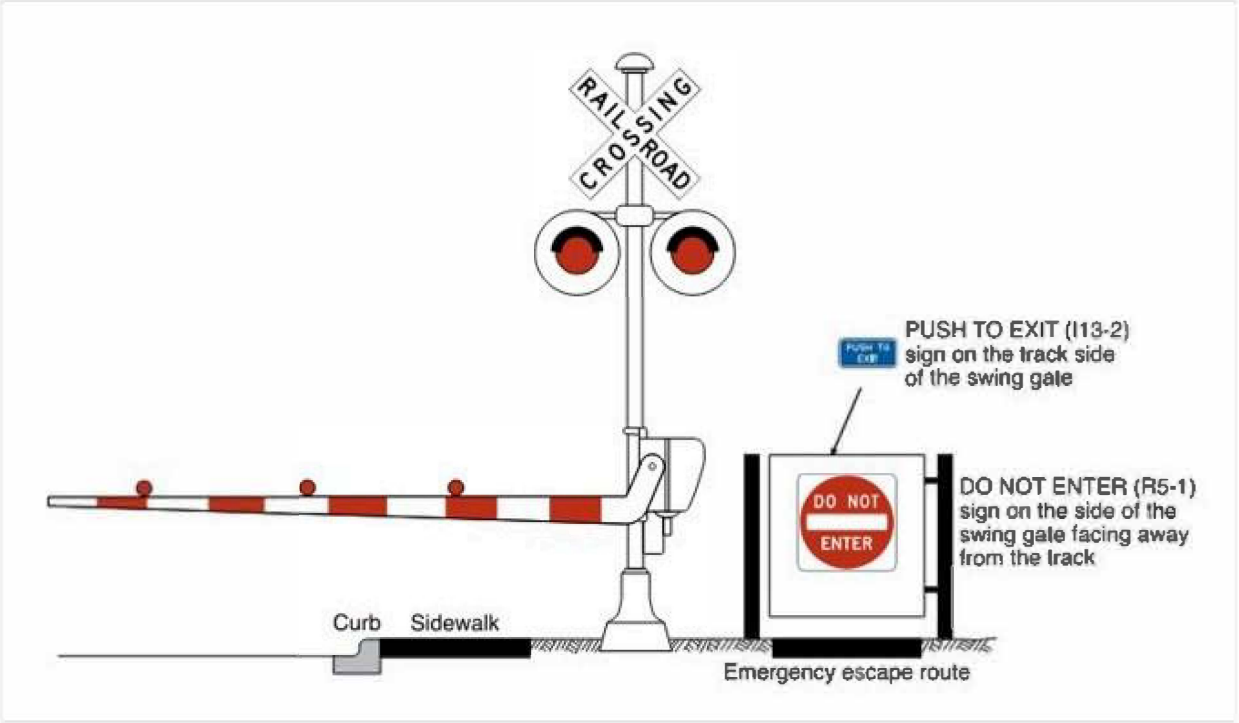


Figure 913.5.9.2. Example of Traffic Control Devices for an Optional Swing Gate

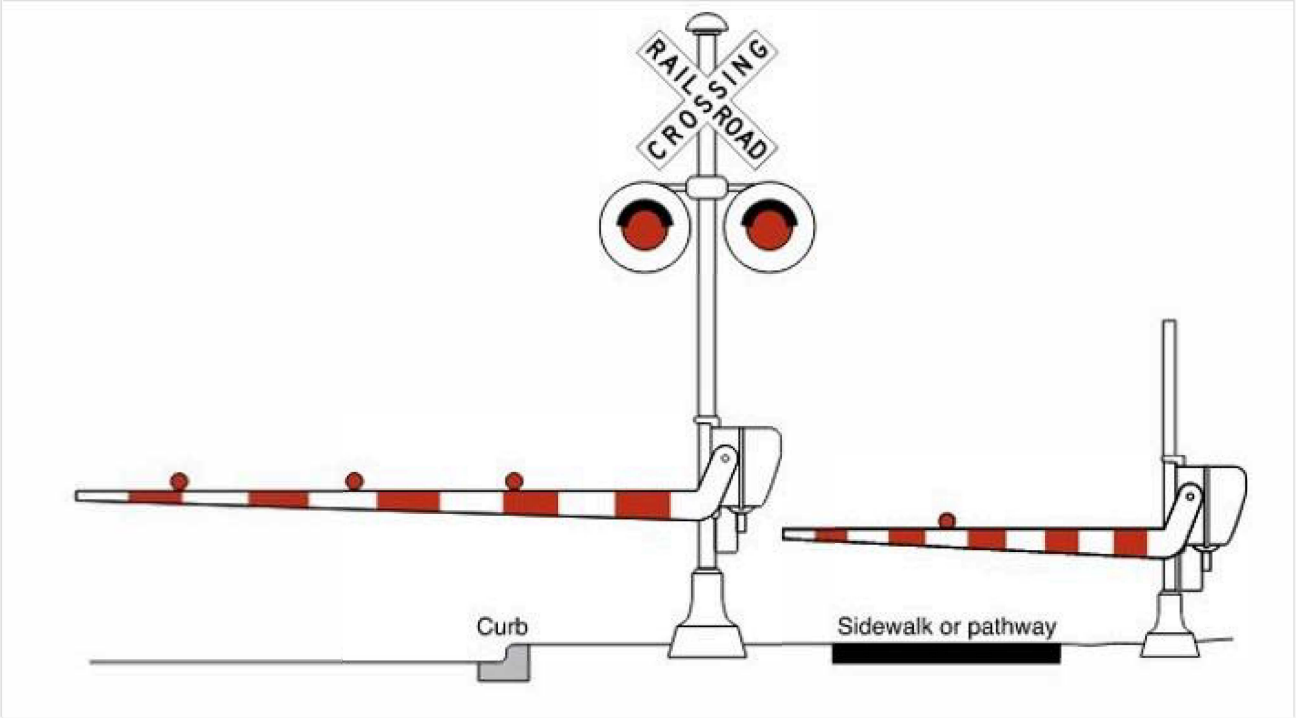


Figure 913.5.9.3. Example of a Separate Automatic Pedestrian Gate

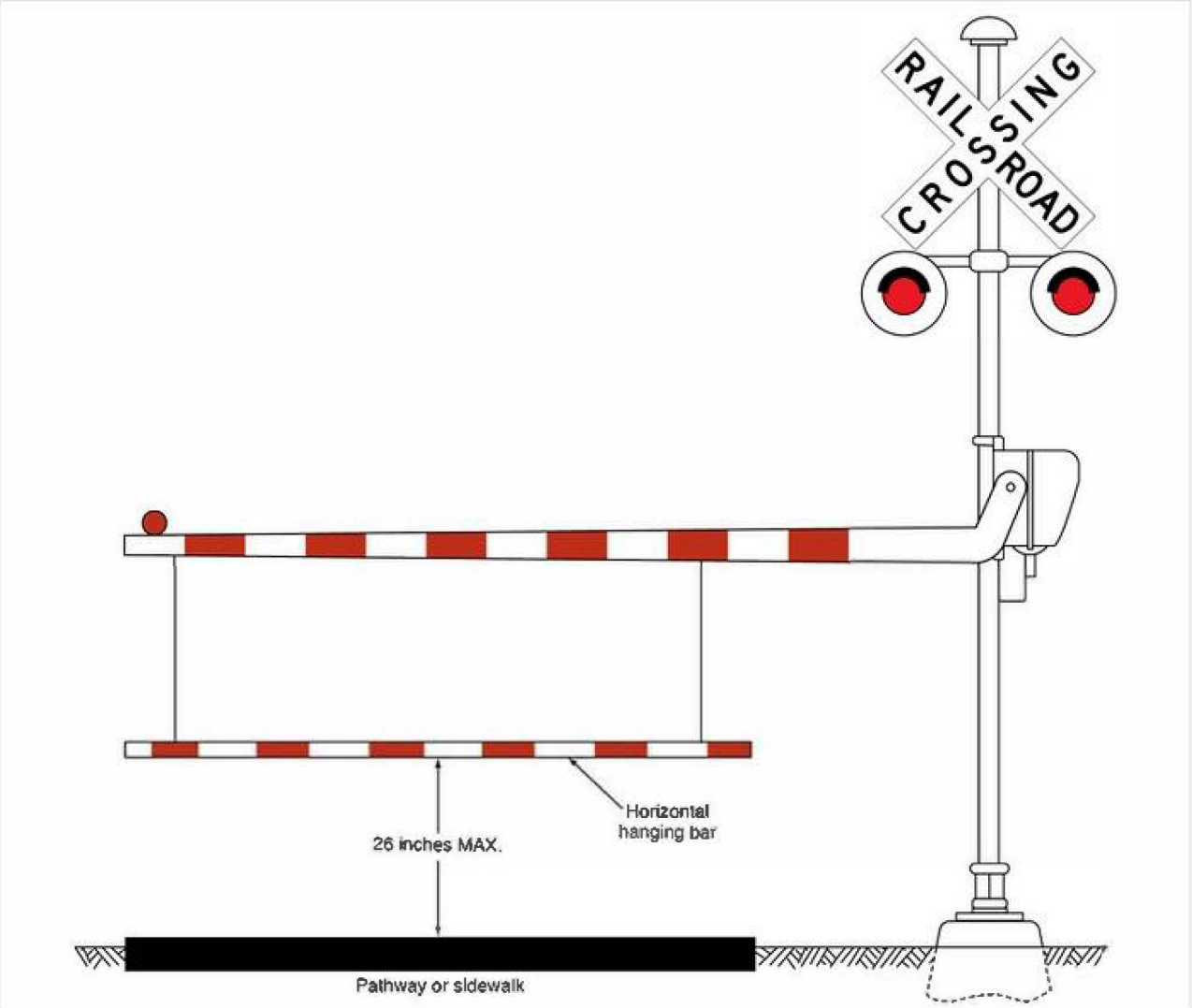


Figure 913.5.9.4. Example of an Automatic Pedestrian Gate with a Horizontal Hanging Bar at a Pathway or Sidewalk Grade Crossing

913.5.10 Active Traffic Control Devices – Multiple-Track Pathway or Sidewalk Grade Crossings (MUTCD Section 8E.10)

Guidance. Where railroad or LRT tracks are immediately adjacent to other tracks, the traffic control devices that control pedestrian movements should be designed to avoid having pedestrians wait between sets of tracks.

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Category:914 Traffic Control for Bicycle Facilities (MUTCD Part 9)

Support. Category 914 of the EPG contains information related to traffic control for bicycle facilities and is similar to Part 9 of the MUTCD.

See EPG 900.1 for a description of how MUTCD content is incorporated into the EPG.

Articles in "914 Traffic Control for Bicycle Facilities (MUTCD Part 9)"

The following 6 pages are in this category, out of 6 total.

9

- 914.1 General (MUTCD Chapter 9A)
- 914.2 Regulatory Signs (MUTCD Chapter 9B)
- 914.3 Warning Signs (MUTCD Chapter 9C)
- 914.4 Guide Signs (MUTCD Chapter 9D)
- 914.5 Markings (MUTCD Chapter 9E)
- 914.6 Signals (MUTCD Chapter 9F)

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914.1 General (MUTCD Chapter 9A)

914.1.1 General (MUTCD Section 9A.01)

Support. MoDOT only adopts those portions of the National MUTCD that are relevant to state-maintained highways. MoDOT does not typically install or maintain traffic control devices for shared-use paths or green pavement markings for bicycle facilities. For these reasons, MUTCD content related to these items is not included in the EPG. These devices may be installed and maintained by other agencies with district approval. Practitioners should reference the National MUTCD for provisions related to traffic control devices that are not included in the EPG.

EPG 914 covers signs and pavement markings specifically related to bicycle operation on roadways, separated bikeways, and shared-use paths. In jurisdictions where small, low-speed, human or electric-powered transportation devices (often referred to as a micromobility device) are allowed to use bicycle facilities, they can be regulated by signs, pavement markings, and other traffic control devices related to bicycle operations. EPG 902 contains information on highway traffic signals and bicycle signal faces. EPG 616 contains information on work zones for bicycle facilities and the mitigation of impacts to bicycle travel through work zones.

Definitions and acronyms pertaining to EPG 914 are provided in EPG 911.

When operating on a roadway, bicycles are typically defined as vehicles and the operator of a bicycle is given the same rights and duties as an operator of a motor vehicle. Bicyclists are also vulnerable road users who have little to no protection from crash forces.

Designing bicycle facilities and the traffic control devices on those facilities in a manner that encourages predictable behavior and compliance with traffic laws from all roadway users can improve safety and increase public acceptance of bicyclists from other road users. The misuse of traffic control devices for improperly designed bicycle facilities or non-uniform applications can produce ineffective or counterproductive results. EPG 911 provides more information on the importance of uniformity of traffic control devices.

The “Bikeway Selection Guide” (FHWA-SA-18-077), FHWA, provides information on the designs and configuration of bicycle facilities.

The operation of bicycles is generally allowed on rights-of-way open to motor vehicles, even if the bicycle-specific traffic control devices outlined in EPG 914 are not present.

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Guidance. All signs, signals, and markings, including those on bicycle facilities, should be properly maintained to command respect from all road users. When installing signs and markings on bicycle facilities, an agency should be designated to maintain these devices.

914.1.2 Standardization of Application for Signing (MUTCD Section 9A.02)

Support. The installation of nonstandard signing on bikeways or modifying standard signing in a manner inconsistent with EPG 903.1 to draw special attention, educate users or the community, or brand a bicycle facility can contribute to problems with public acceptance and enforcement.

Standard. Bicycle signs shall comply with the provisions of the EPG for standard shape, legend, and color.

All signs installed on bikeways shall be retroreflective, including those on shared-use paths and bicycle lane facilities.

Where signs serve both bicyclists and other road users, vertical mounting height and lateral placement shall be as provided in EPG 903.1.15 and 903.1.16.

Guidance. Where used on a shared-use path, no portion of a sign or its support should be placed less than 2 feet laterally from the near edge of the path.

Mounting height for post-mounted signs on shared-use paths should be a minimum of 4 feet, measured vertically from the bottom of the sign to the elevation of the near edge of the path surface.

Signs for the exclusive use of bicyclists should be located so that other road users are not confused by them.

Standard. If the sign or plaque applies to motorists and bicyclists, then the size shall be as shown for conventional roads in Tables 903.2.3, 903.3.3, 903.4.3, and 913.2.2, as applicable.

The minimum sign and plaque sizes for signs specific to bicycle-only facilities and shared-use paths shall be those shown in Table 914.1.2. These sizes shall be used only for signs and plaques installed specifically for bicyclist applications.

Option. Larger sizes of signs and plaques may be used on bicycle facilities when appropriate (see EPG 903.1.7).

Any diamond-shaped warning sign that is placed such that it is applicable only to bicyclists or pedestrians on shared-use paths or separated bicycle lanes may be 18” x 18”.

Guidance. Except for size, the design of signs and plaques for bicycle facilities should be identical to that provided in the EPG for signs and plaques for streets and highways.

Support. Uniformity in design of bicycle signs and plaques includes shape, color, symbols, arrows, wording, lettering, and illumination or retroreflectivity.

Table 914.1.2, Bicycle Facility Sign and Plaque Minimum Sizes

Sign or Plaque	Sign Designation	EPG Article	Off Roadway (in. x in.)	Roadway (in. x in.)
Stop	R1-1	914.2.1	18 x 18	-
Bike Lane	R3-17	914.2.3	-	30 x 24
Bike Lane Ahead (plaque)	R3-17aP	914.2.3	-	30 x 12
Bike Lane Ends (plaque)	R3-17bP	914.2.3	-	30 x 12
Begin Right Turn Lane Yield to Bikes	R4-4	914.2.4	-	36 x 30
No Motor Vehicles	R5-3	914.2.5	-	24 x 24
Bicycles Allowed Use of Full Lane	R9-20	914.2.6	-	30 x 30
Bicycles Use Shoulder Only	R9-21	914.2.7	-	24 x 30
Push Button for Green	R10-4	914.2.8	9 x 12	9 x 12
Push Button for Warning Lights - Wait for Gap	R10-25	914.2.8	9 x 12	9 x 12
Bicycle Lane Ends	W9-5	914.3.2	-	30 x 30
Bicycle Warning	W11-1	914.3.1	-	36 x 36
Trail Crossing	W11-15	914.3.1	-	36 x 36
In Road (plaque)	W16-1P	914.3.3	-	24 x 18
XX Feet (plaque)	W16-2P	914.3.3	-	18 x 12
Downward Diagonal Arrow (plaque)	W16-7P	914.3.3	-	30 x 21
Ahead (plaque)	W16-9P	914.3.3	-	30 x 18
Bike Route	D11-1	914.4.1	-	24 x 18
US Bicycle Route	M1-9	914.4.2	-	18 x 24
Bicycle Route Arrow (Left/Right)	M7-1	914.4.4	-	12 x 9
Bicycle Route Arrow (Straight)	M7-2	914.4.4	-	12 x 9
Bicycle Route Arrow Signs (45° Left)	M7-4L	914.4.4	-	12 x 9
Bicycle Route Arrow Signs (45° Right)	M7-4R	914.4.4	-	12 x 9

Notes:

1. Larger signs may be used when appropriate
2. Dimensions are shown as width x height

914.1.3 Standardization of Application for Markings (MUTCD Section 9A.03)

Support. Markings indicate the separation of the lanes for road users, assist the bicyclist by indicating assigned travel paths, indicate correct position for traffic control signal actuation, and provide advance information for turning and crossing maneuvers.

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Guidance. Pavement marking word messages, symbols, and/or arrows should be used in bikeways where appropriate.

Consideration should be given to selecting pavement marking materials that will minimize loss of traction for bicycles under wet conditions.

Standard. Pavement markings on bicycle facilities that must be visible at night or in low-light conditions shall be retroreflective unless the markings are adequately visible under provided lighting.

The colors, width of lines, patterns of lines, symbols, and arrows used for marking bicycle facilities shall be as defined in EPG 620.

Support. EPG 620.7.6 contains information on green-colored pavement for use with certain traffic control devices for bicycles and bicycle facilities.

MoDOT does not typically install or maintain green colored pavement for bicycle lanes.

Guidance. If green colored pavement is installed on a MoDOT route, an agreement should be in place with the local agency that will maintain the green-colored pavement.

Support. EPG 914.5.10 contains information on the use of channelizing devices to emphasize the pavement markings for bicycle facilities.

Guidance. Raised pavement markers should not be used on bicycle lanes or shared-use paths.

If used around bicycle facilities, raised pavement markers should not be placed immediately adjacent to the travel path of bicyclists in a bicycle lane or on a shared-use path.

Support. Using raised pavement markers creates a collision potential for bicyclists by placing fixed objects immediately adjacent to the travel path of the bicyclist. Raised pavement markers can cause a bicyclist to lose balance and fall, and might not be visible to a bicyclist who is following another bicyclist.

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914.2 Regulatory Signs (MUTCD Chapter 9B)

Contents

914.2.1 STOP Sign (R1-1) (MUTCD Section 9B.01)

914.2.2 Advance Intersection Lane Control Signs (R3-8 Series) for Bicycle Lanes (MUTCD Section 9B.03)

914.2.3 Bicycle Lane Signs and Plaques (R3-17, R3-17aP, and R3-17bP) (MUTCD Section 9B.04)

914.2.4 BEGIN RIGHT TURN LANE YIELD TO BIKES Sign (R4-4) (MUTCD Section 9B.05)

914.2.5 NO MOTOR VEHICLES Sign (R5-3) (MUTCD Section 9B.07)

914.2.6 Bicycles Allowed Use of Full Lane Sign (R9-20) (MUTCD Section 9B.14)

914.2.7 Bicycles Use Shoulder Only Sign (R9-21) (MUTCD Section 9B.16)

914.2.8 Bicycle Actuation Signs (R10-4 and R10-25) (MUTCD Section 9B.20)

914.2.9 Left Turn Yield to Bicycles Sign (R10-12b) (MUTCD Section 9B.21)

914.2.10 Bicycle Signal Signs (R10-40, R10-40a, R10-41, R10-41a, R10-41b, and R10-41c) (MUTCD Section 9B.22)

914.2.11 Other Regulatory Signs (MUTCD Section 9B.24)

914.2.1 STOP Sign (R1-1) (MUTCD Section 9B.01)

Standard. STOP (R1-1) signs shall be installed on bicycle facilities at points where bicyclists are required to stop, such as where a shared use path crosses a state-maintained roadway.

A STOP sign shall not be installed in conjunction with a bicycle signal face (see EPG 902.8).

Option. Larger signs may be used on shared-use paths and separated bikeways for added emphasis.

Guidance. Where conditions require shared-use path users or bicyclists on separated bikeways, but not roadway users, to stop or yield, the STOP sign should be placed or shielded so that it is not readily visible to roadway users.

914.2.2 Advance Intersection Lane Control Signs (R3-8 Series) for Bicycle Lanes (MUTCD Section 9B.03)

Option. Advance Intersection Lane Control (R3-8 series) signs (see EPG 903.2.28) may display the arrangement of a conventional or buffer-separated bicycle lane in relation to other lanes in the same direction that are present on a roadway approach to an intersection.

Support. The number and combination of permissible movements by both the motor vehicle and the bicycle on the same approach to an intersection might be practically limited by the amount of information that can be legibly displayed on signs or in signing sequences and still be readily comprehended by road users. The excessive display of all movements by more than one mode can result in unwieldy signs that are difficult to locate and install.

Guidance. On an approach to an intersection with complex geometry that can include multiple through lanes and multiple turn lanes and also includes a bicycle lane, consideration should be given to displaying all allowable movements on separate signs, such as using Mandatory Movement Lane Control (R3-5) signs (see EPG 903.2.26) for the through lanes and Mandatory Movement Lane Control (R3-7) signs (see EPG 903.2.26) for the turn lanes, and guide signs for bicycle routes (see EPG 914.4.1 through EPG 914.4.3) and Bicycle Route Sign auxiliary plaques (see EPG 914.4.4) for the bicycle movement.

Standard. The portion of the sign face for the bicycle lane shall be limited to the relationship of the bicycle lane to the other lanes on the roadway approach to the intersection. The portion of the sign face for the bicycle lane shall not be modified to display specific, supplementary information about the bicycle lane such as bicycle lane extensions, contiguous buffer spaces, or other ancillary bicycle operations such as two-stage turn boxes or bicycle boxes.

Counter-flow bicycle lanes shall not be displayed on Advance Intersection Lane Control signs.

The shared-lane marking symbol shall not be displayed on Advance Intersection Lane Control signs.

Shared-use paths shall not be displayed on Advance Intersection Lane Control signs.

Advance Intersection Lane Control signs that display the bicycle lane shall use a contrasting white legend on a black background for the bicycle lane (see EPG 903.2.28). The portion of the display for the bicycle lane shall not use the color green on the sign face in an attempt to be consistent with the green-colored pavement that might be present on the intersection approach.

914.2.3 Bicycle Lane Signs and Plaques (R3-17, R3-17aP, and R3-17bP) (MUTCD Section 9B.04)



Standard. The Bike Lane (R3-17) sign and the AHEAD (R3-17aP), and ENDS (R3-17bP) plaques shall be used only in conjunction with marked bicycle lanes as described in EPG 914.5.1, 914.5.6, and 914.5.7.

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Guidance. If used, Bicycle Lane signs and plaques should be located at the beginning of the bicycle lane and in advance of the downstream end of the bicycle lane.

Option. Additional Bicycle Lane signs and plaques may be used at periodic intervals along the bicycle lane as determined by engineering judgment based on the operating speed of bicycle and other traffic, block length, distances from adjacent intersections, and other considerations.

The AHEAD (R3-17aP) or ENDS (R3-17bP) plaque, mounted directly below a regulatory sign, may be used to inform road users of the location where a regulatory condition begins or ends.

Support. EPG 914.2.1 contains information on displaying the bicycle lane on Advance Intersection Lane Control signs.

914.2.4 BEGIN RIGHT TURN LANE YIELD TO BIKES Sign (R4-4) (MUTCD Section 9B.05)



R4-4

Option. Where motor vehicles entering a mandatory right-turn lane must weave across bicyclists in bicycle lanes, the BEGIN RIGHT TURN LANE YIELD TO BIKES (R4-4) sign may be used to inform both the motorist and the bicyclist of this weaving maneuver (see Figures 914.5.2.1 through 914.5.2.4).

Guidance. The R4-4 sign should not be used when bicyclists need to move left because of a right-turn lane drop situation.

914.2.5 NO MOTOR VEHICLES Sign (R5-3) (MUTCD Section 9B.07)



R5-3

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Option. The NO MOTOR VEHICLES (R5-3) sign may be installed at the entrance to a shared-use path.

914.2.6 Bicycles Allowed Use of Full Lane Sign (R9-20) (MUTCD Section 9B.14)



R9-20

Support. The Uniform Vehicle Code (UVC) defines a "substandard width lane" as a "lane that is too narrow for a bicycle and a vehicle to travel safely side by side within the same lane."

Option. The Bicycles Allowed Use of Full Lane (R9-20) sign may be used on roadways where no bicycle lanes or adjacent shoulders usable by bicycles are present and where travel lanes are too narrow for bicycles and motor vehicles to operate side-by-side.

The Bicycles Allowed Use of Full Lane sign may be used in locations where it is important to inform road users that bicyclists might occupy the travel lane.

EPG 914.5.8 describes a shared-lane marking that may be used in addition to or instead of the Bicycles Allowed Use of Full Lane sign to inform road users that bicyclists might occupy the travel lane.

914.2.7 Bicycles Use Shoulder Only Sign (R9-21) (MUTCD Section 9B.16)



R9-21

Option. The Bicycles Use Shoulder Only (R9-21) sign may be used to designate locations on a freeway or expressway where bicycles are allowed, but must remain on an available and usable shoulder.

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Guidance. The Bicycles Use Shoulder Only sign should be limited to use on freeways and expressways.

The Bicycles Use Shoulder Only sign should be placed adjacent to the entrance ramp or entrance to the freeway at or near the location where the full-width shoulder resumes beyond the entrance ramp taper.

914.2.8 Bicycle Actuation Signs (R10-4 and R10-25) (MUTCD Section 9B.20)



R10-4



R10-25

Option. Where bicycles are not controlled by pedestrian signal indications, the R10-4, R10-24, or R10-26 sign (see EPG 903.2.47) may be used.

Guidance. If used, the R10-4 sign should be installed in the vicinity of where bicycles will be crossing the street.

Option. If bicycles are crossing a roadway where In-Roadway Warning Lights (see EPG 902.20.2) or other warning lights or beacons have been provided, the R10-25 sign may be used.

914.2.9 Left Turn Yield to Bicycles Sign (R10-12b) (MUTCD Section 9B.21)

Support. EPG 903.2.48 contains provisions on the placement and use of regulatory Traffic Signal signs.

914.2.10 Bicycle Signal Signs (R10-40, R10-40a, R10-41, R10-41a, R10-41b, and R10-41c) (MUTCD Section 9B.22)



R10-40



R10-40a



R10-41



R10-41a



R10-41b



R10-41c

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Support. The purposes of the Bicycle Signal signs are to inform road users that the signal indications in the bicycle signal face are intended only for bicyclists, and to inform bicyclists which specific bicycle movements are controlled by the bicycle signal face.

EPG 902.8.3 contains information on signs that are used in conjunction with bicycle signal faces.

Standard. The Bicycle Signal – Mandatory Movement (R10-40 or R10-40a) sign or the Bicycle Signal – Optional Movement (R10-41, R10-41a, R10-41b, or R10-41c) sign shall require bicycles to turn, shall permit turns where such turns would otherwise not be allowed, shall require a bicycle to stay in the same lane and proceed straight through an intersection, or shall indicate allowed movements when a GREEN BICYCLE signal indication is displayed on a bicycle signal face.

914.2.11 Other Regulatory Signs (MUTCD Section 9B.24)

Option. Other regulatory signs described in EPG 902.2 and EPG 913.2 may be installed on bicycle facilities as appropriate.

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914.3 Warning Signs (MUTCD Chapter 9C)

914.3.1 Bicycle Warning and Trail Crossing Signs (W11-1 and W11-15) (MUTCD Section 9C.04)



W11-1



W11-15

Support. See EPG 903.3.44 for information regarding W11-1 and W11-15 signs.

914.3.2 Bicycle Lane Ends Warning Sign (W9-5) (MUTCD Section 9C.07)



W9-5

Support. Where a warning sign is appropriate, the Bicycle Lane Ends (W9-5) warning sign is intended to alert road users that a bicycle lane is ending and that bicycles will share or occupy the travel lane after merging.

Option. The Bicycle Lane Ends warning sign may be used in advance of the end of a bicycle lane to warn that a bicycle lane will be ending.

Guidance. To avoid excessive use of signs, the Bicycle Lane Ends warning sign should not be used where a bicycle lane is dropped on the approach to an intersection and resumes immediately after the intersection.

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Option. A Bicycles Allowed Use of Full Lane (R9-20) sign (see EPG 914.2.6) and/or shared-lane markings (see EPG 914.5.8) may be installed downstream of the merge area.

914.3.3 Other Bicycle Warning Signs (MUTCD Section 9C.08)



W16-1P W16-2P W16-7P W16-9P

Option. In situations where there is a need to warn road users to watch for bicycles traveling along the highway, the Bicycle Warning (W11-1) sign may be used with the IN ROAD (W16-1P) plaque.

Guidance. If used, other advance bicycle warning signs should be installed at least 50 feet in advance of the beginning of the condition.

Where temporary traffic control zones are present on bikeways, appropriate signs from EPG 616 should be used.

Option. Other warning signs described in EPG 903.3 and EPG 913.3 may be installed on bicycle facilities as appropriate.

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914.4 Guide Signs (MUTCD Chapter 9D)

Contents

914.4.1 Bike Route Guide Sign (D11-1) (MUTCD Section 9D.02)
914.4.2 Numbered Bikeway Systems (MUTCD Section 9D.04)
914.4.3 U.S. Bicycle Route Sign (M1-9) (MUTCD Section 9D.07)
914.4.4 Bicycle Route Sign and Auxiliary Plaques (MUTCD Section 9D.08)

914.4.1 Bike Route Guide Sign (D11-1) (MUTCD Section 9D.02)



D11-1

Support. The Bike Route Guide (D11-1) sign is used where no unique designation of routes is desired. EPG 914.4.1 through EPG 914.4.3 contain information for Bicycle Route signs where the bicycle route is designated by number, name, or both.

Option. Bike Route Guide signs may be provided along designated unnumbered, unnamed bicycle routes to inform bicyclists of bicycle route direction changes and to confirm route direction and destination.

If used, Bike Route Guide signs may be repeated at regular intervals so that bicycles entering from side streets will have an opportunity to know that they are on a bicycle route. Similar guide signing may be used for shared roadways with intermediate signs placed for bicycle guidance.

Guidance. Travel times should not be used on Bike Route Guide signs.

Support. Travel times can vary greatly for bicyclists based on a variety of factors including individual speed, bicycle type, and type of facility.

914.4.2 Numbered Bikeway Systems (MUTCD Section 9D.04)

Support. MoDOT will only install signage for designated United States Bicycle Routes.

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The United States Bicycle Routes are numbered by the American Association of State Highway and Transportation Officials (AASHTO) upon recommendations of State highway organizations.

Bicycle route sign systems can be used to distinguish junctions, turns, the beginning of routes, and route termination points. Extensive use of reassurance markers is typically not needed.

Guidance. Establishing bicycle route systems described in the second paragraph of this article and any other bicycle route system should be followed with effective communication between affected jurisdictions. County and local jurisdictions that are establishing numbered routes should coordinate with MoDOT. Care should be taken to avoid the use of numbers or other designations that have been assigned to U.S. Bicycle Routes or other routes in the same geographical region or State. Overlapping numbered routes should be kept to a minimum.

Numbered bicycle routes should be identified by route signs (see EPG 914.4.3) and auxiliary plaques (see EPG 914.4.4).

If used, Bicycle Route signs should be placed at locations to keep bicyclists informed of changes in route direction.

914.4.3 U.S. Bicycle Route Sign (M1-9) (MUTCD Section 9D.07)



M1-9

Guidance. Where a designated bicycle route extends through two or more States, a coordinated submittal by the affected States for an assignment of a U.S. Bicycle Route number designation should be sent to the American Association of State Highway and Transportation Officials.

Standard. The U.S. Bicycle Route (M1-9) sign shall have a green legend and border with a white background and shall display the route designation as assigned by AASHTO.

914.4.4 Bicycle Route Sign and Auxiliary Plaques (MUTCD Section 9D.08)


M7-1 M7-2 M7-4R M7-4L

Support. EPG 903.4.12 contains additional provisions for the design of route sign auxiliary plaques. EPG 903.4.25 through EPG 903.4.30 contain additional provisions for the general application of route signs.

Guidance. If a designated or numbered bicycle route is concurrent with a numbered highway, the route sign and auxiliary plaques for the bikeway should be installed as independent assemblies and should not be installed with other Route signs or confirmation assemblies for the numbered or named highway on the same assembly.

Standard. Route signs for bikeways shall not be installed on guide signs or overhead.

Option. Route assemblies for a designated or numbered bicycle route may be installed at locations or distances other than those prescribed in EPG 903.4.25 through EPG 903.4.30 if engineering judgment indicates that the operation or speed of the bicycle justifies alternate locations or distances.

Auxiliary plaques may be used in conjunction with Bicycle Route signs as needed.

Guidance. Directional Arrow (M7 series) auxiliary plaques should be mounted below the appropriate Bicycle Route signs.

All route sign auxiliary plaques should match the color combination of the route sign that they supplement.

Route sign auxiliary plaques carrying arrow symbols that are used on bicycle routes should have a minimum size of 12 x 9 inches.

Standard. If the Directional Arrow (M7 series) auxiliary plaques are used on the same sign assembly as a Bicycle Route sign, the Directional Arrow auxiliary plaque shall be installed below the Bicycle Route sign.

Option. With route signs of larger sizes, auxiliary plaques may be suitably enlarged, but not such that they exceed the width of the route sign.

A route sign and any auxiliary plaques used with it may be combined on a single sign as a guide sign.

Standard. If used, a Bicycle Route sign assembly shall consist of a route sign and auxiliary plaques that identify the route and indicate the direction.

Guidance. If the bicycle route is signed, Bicycle Route sign assemblies should be installed on all approaches where that route intersects with other numbered bicycle routes.

Standard. Within groups of assemblies, information for bicycle routes intersecting from the left shall be mounted at the left in horizontal arrangements and at the top or center of vertical arrangements. Similarly, information for bicycle routes intersecting from the right shall be at the right or bottom, and for straight-through bicycle routes at the center in horizontal arrangements or top in vertical arrangements.

A Directional assembly shall consist of a route sign, and a Directional Arrow auxiliary plaque.

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Guidance. The various uses of Directional assemblies should be as follows:

A. Turning movements should be marked by a Directional assembly with a route sign displaying the number of the turning route and a single-headed arrow pointing in the direction of the turn.
B. The beginning of a route should be marked by a Directional assembly with a route sign displaying the number of that route and a single-headed arrow pointing in the direction of the route.
C. An intersected route on a crossroad where the route is designated on both legs should be designated by:

1. Two Directional assemblies, each with a route sign displaying the number of the intersected route and a single-headed arrow pointing in the direction of movement on that route; or
2. A Directional assembly with a route sign displaying the number of the intersected route and a double-headed arrow, pointing at appropriate angles to the left, right, or ahead.

D. An intersected route on a side road or on a crossroad where the route is designated only on one of the legs should be designated by a Directional assembly with a route sign displaying the number of the intersected route and a single-headed arrow pointing in the direction of movement on that route.

Option. Straight-through movements may be indicated by a Directional assembly with a route sign displaying the number of the continuing route and a M7-2 Directional Arrow – Through auxiliary plaque.

Directional assemblies should be located on the near-right corner of the intersection. Where unusual conditions exist, the location of a Directional assembly should be determined by engineering judgment.

Support. It is more important that guide signs be readable, and that the information and direction displayed thereon be readily understood, at the appropriate time and place than to be located with absolute uniformity.

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914.5 Markings (MUTCD Chapter 9E)

Contents

914.5.1 Bicycle Lanes (MUTCD Section 9E.01)
914.5.2 Bicycle Lanes at Intersection Approaches (MUTCD Section 9E.02)
914.5.3 Extensions of Bicycle Lanes through Intersections (MUTCD Section 9E.03)
914.5.4 Bicycle Lanes at Driveways (MUTCD Section 9E.04)
914.5.5 Bicycle Lanes at Circular Intersections (MUTCD Section 9E.05)
914.5.6 Buffer-Separated Bicycle Lanes (MUTCD Section 9E.06)
914.5.7 Separated Bicycle Lanes (MUTCD Section 9E.07)
914.5.8 Shared-Lane Marking (MUTCD Section 9E.09)
914.5.9 Shared-Lane Markings for Circular Intersections (MUTCD Section 9E.10)
914.5.10 Raised Devices (MUTCD Section 9E.17)

914.5.1 Bicycle Lanes (MUTCD Section 9E.01)

Support. Pavement markings designate that portion of the roadway for preferential use by bicyclists. Markings inform all road users of the restricted nature of the bicycle lane.

Standard. Longitudinal pavement markings and bicycle lane symbol or word markings (see Figure 914.5.1.1) shall be used to define bicycle lanes.

Guidance. The first symbol or word marking in a bicycle lane should be placed at the beginning of the bicycle lane and downstream symbol or word markings should be placed after major intersections. Additional symbol or word markings should be placed at periodic intervals along the bicycle lane based on engineering judgment.

Option. An arrow marking may be used in conjunction with the bicycle lane symbol or word marking, placed downstream from the symbol or word marking.

Where the bicycle lane symbols or word markings are used, Bicycle Lane signs (see EPG 914.2.3) may also be used, but not necessarily adjacent to every set of pavement markings in order to avoid overuse of the signs.

Support. MoDOT does not typically install or maintain green-colored pavement for bicycle lanes.

Guidance. If green-colored pavement is installed on a MoDOT route, an agreement should be in place with the local agency that will maintain the green-colored pavement.

Standard. The bicycle symbol or BIKE LANE pavement word marking and the pavement marking arrow shall not be used in a shoulder.

A portion of the roadway shall not be established as both a shoulder and a bicycle lane.

Support. Where a shoulder is provided or is of sufficient width to meet the expectation of a highway user in that it can function as a space for emergency, enforcement, or maintenance activities, or avoidance or recovery maneuvers, EPG 914.2.7 contains information regarding the Bicycles Use Shoulder Only sign that can be used to denote locations on a freeway or expressway where bicycles are permitted on an available and usable shoulder.

Examples of pavement markings for bicycle lanes on a two-way street are shown in Figure 914.5.1.2.

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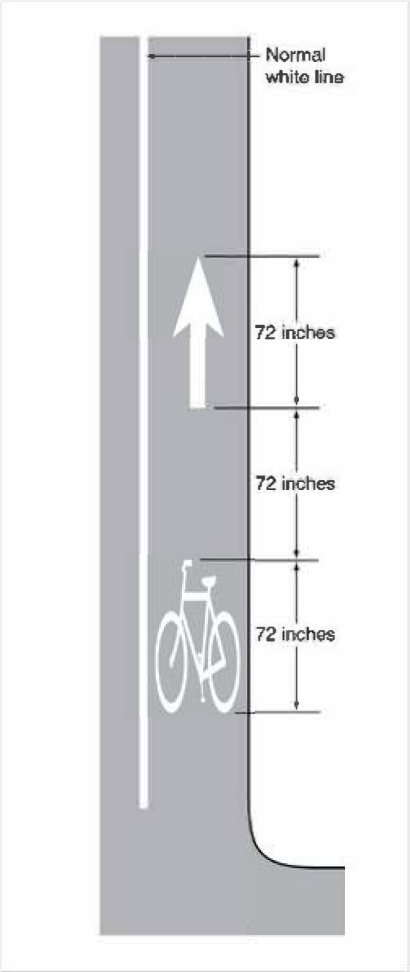


Figure 914.5.1.1 Symbol and Arrow Pavement Markings for Bicycle Lanes

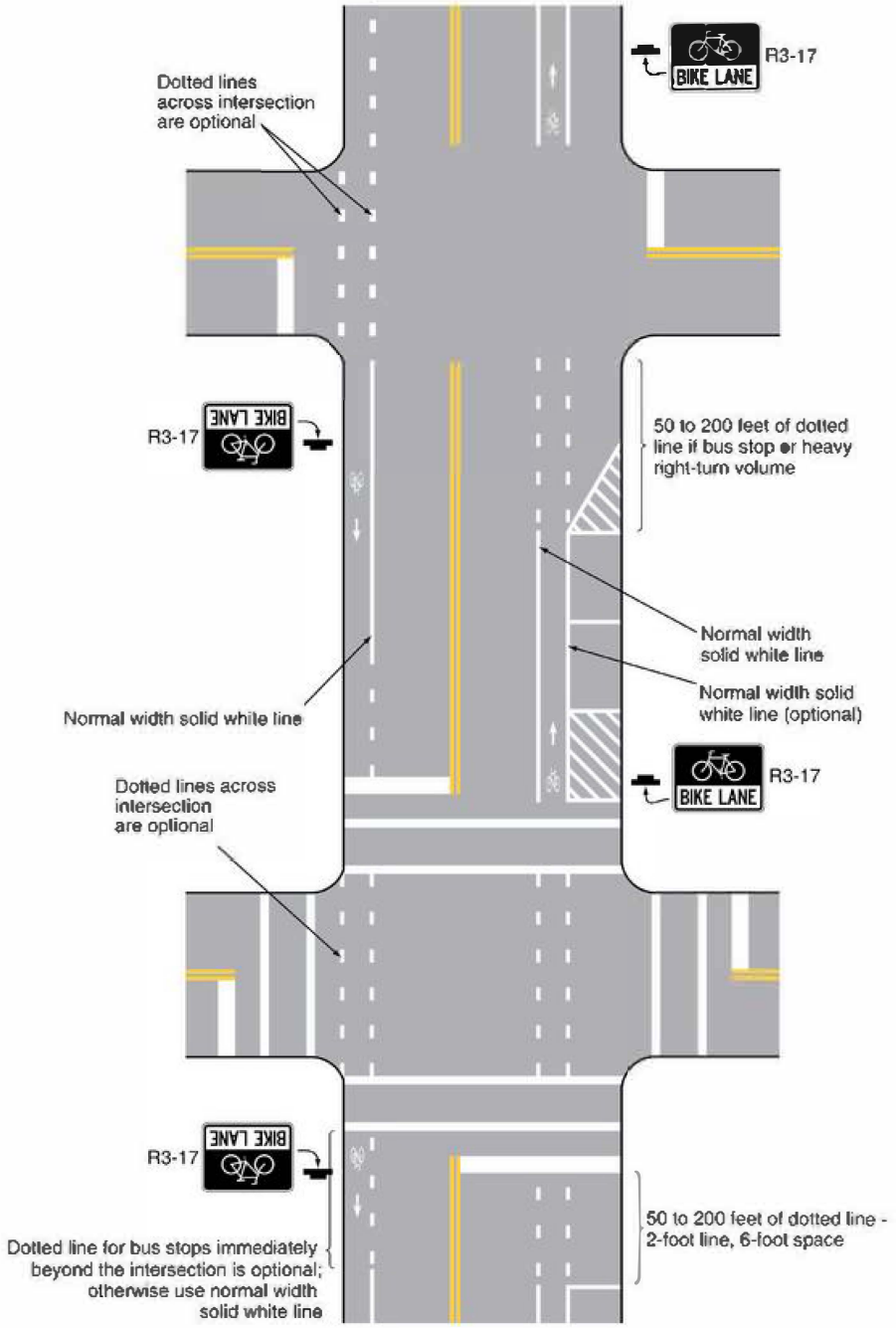


Figure 914.5.1.2 Example of Pavement Markings for Bicycle Lanes on a Two-Way Street

914.5.2 Bicycle Lanes at Intersection Approaches (MUTCD Section 9E.02)

Standard. Except as provided in the following paragraph, a through bicycle lane shall not be positioned to the right of a right turn only lane or to the left of a left turn only lane.

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Option. A through bicycle lane may be positioned to the right of a right turn only lane or to the left of a left turn only lane provided that the bicycle lane is controlled by a traffic signal that displays bicycle signal indications (see EPG 902.8).

Support. Unless controlled by a bicycle signal indication, a bicyclist continuing straight through an intersection from the right of a right turn only lane or from the left of a left turn only lane would be inconsistent with normal traffic behavior and would violate the expectations of right-turning or left-turning motorists.

Guidance. When the right (left) through lane is dropped to become a mandatory right-turn (left-turn) lane, the bicycle lane markings should stop at least 100 feet before the beginning of the right-turn (left-turn) lane. Through bicycle lane markings should resume to the left (right) of the mandatory right-turn (left-turn) lane.

Except as provided in the first Option paragraph of this article, an optional through-right (through-left) turn lane next to a mandatory right-turn (left-turn) lane should not be used where there is a through bicycle lane.

Standard. A bicycle lane located on an intersection approach between general-purpose lanes for motor vehicle movements shall be marked with at least one bicycle symbol and at least one arrow pavement marking as provided in the first Option paragraph of EPG 914.5.1.

A bicycle lane shall not be marked within a general-purpose lane, either with dotted or any other line markings.

Option. Where there is insufficient width in the roadway to include both a bicycle lane and a general-purpose turn lane, bicycle travel may be accommodated within the turn lane or general-purpose lane using shared-lane markings.

Standard. Where a general-purpose turn lane is controlled by a traffic control signal, through bicycle movements shall not be accommodated in the turn lane unless the turning movement is always permitted to proceed simultaneously with the adjacent through movement.

Support. Examples of bicycle lane markings on approaches to intersections are shown in Figures 914.5.2.1 through 914.5.2.4 and 914.5.8.

Guidance. The longitudinal line defining a bicycle lane should be dotted on approaches to intersections where turning vehicles are permitted to cross the path of through-moving bicycles.

Support. Buffer-separated and separated bicycle lanes require additional considerations at intersections, including sight distances for bicycles and other road users, user expectations, and intersection geometry.

Option. A buffer-separated or separated bicycle lane may be shifted closer to, or farther away from the adjacent general-purpose lane depending upon site-specific conditions (see Drawing C in Figure 914.5.7).

Support. A buffer-separated or separated bicycle lane shifted away from the adjacent general-purpose lane at an intersection can create space for a motor vehicle to queue between the general-purpose lane and the extension of the bicycle lane. This design can also improve the safety and comfort of bicyclists by reducing the speed of turning motor vehicles, improving sightlines, and creating additional buffer space prior to the conflict point with turning motor vehicles.

The purpose of shifting a buffer-separated or separated bicycle lane away from the adjacent general-purpose lane is to allow the driver of a turning vehicle to undertake the tasks of turning and scanning for bicycle cross traffic in isolation versus simultaneously. Sufficient sight distance for both drivers and bicyclists is important in this design (see Drawing C in Figure 914.5.7).

The purpose of shifting a buffer-separated or separated bicycle lane toward the adjacent general-purpose lane is to improve the visibility of bicyclists to the adjacent traffic and avoid conflicts between turning motor vehicles and bicyclists.

Option. Where a general-purpose mandatory turn lane is provided at an intersection and the approach also includes a separated or buffer-separated bicycle lane, a mixing zone may be established to allow general-purpose turning traffic to share the roadway space with bicyclists (see Figure 914.5.2.5).

Standard. Mixing zones shall be used only where the bicycle lane is one-way in the same direction of travel as the adjacent general-purpose lane.

Where a mixing zone continues to the intersection itself sharing space between bicyclists and general-purpose turning traffic, shared-lane markings and turn arrows shall be provided in the lane.

Support. Mixing zones require bicycles and general traffic to share space, interrupting a buffer-separated or separated bicycle lane where bicycle traffic is otherwise separated from general traffic. The preference is to provide a dedicated bicycle facility for the intersection approach. If that is not possible, the mixing zone needs to indicate that bicyclists and motorists are entering a shared condition.

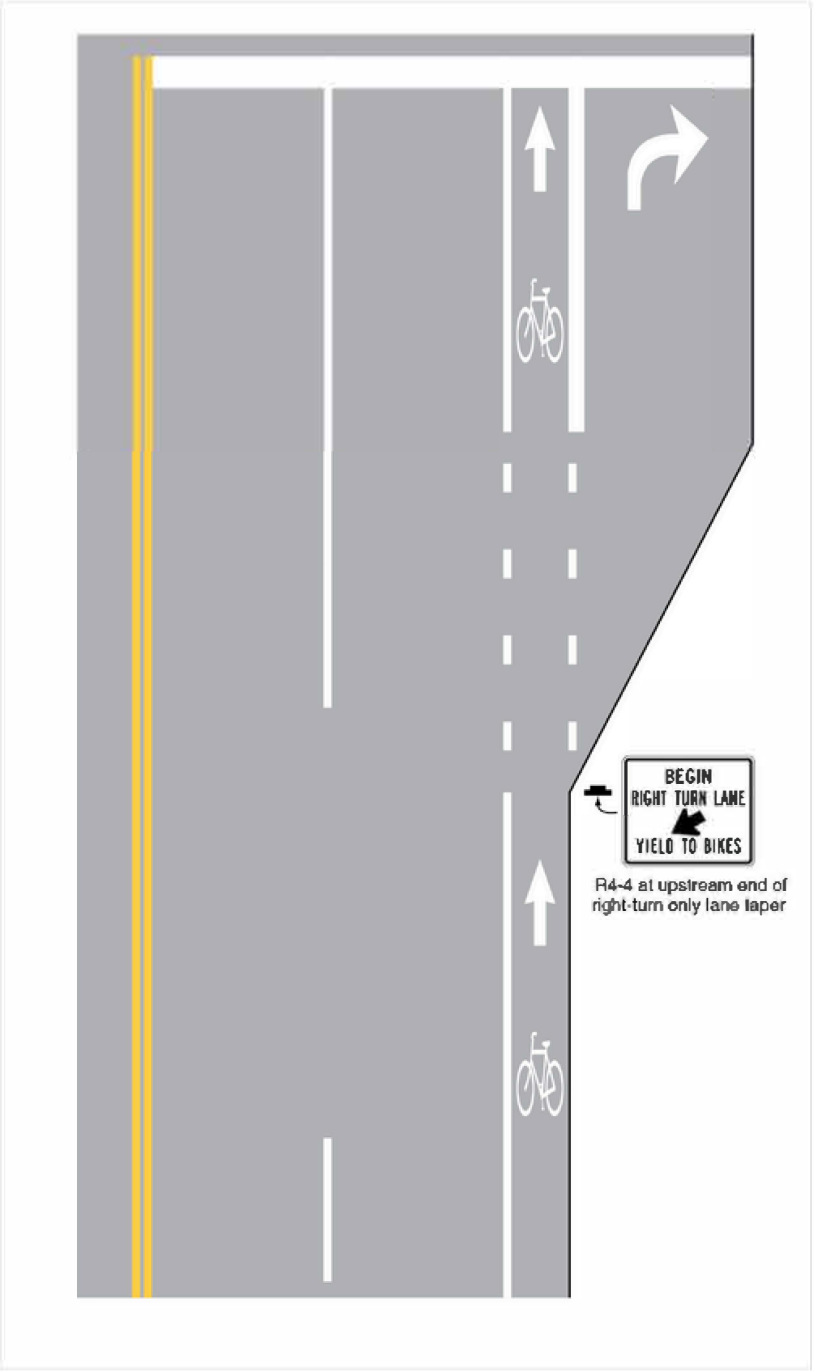


Figure 914.5.2.1 Example of Bicycle Lane Markings on an Approach to an Intersection *(Sheet 1 of 3)*

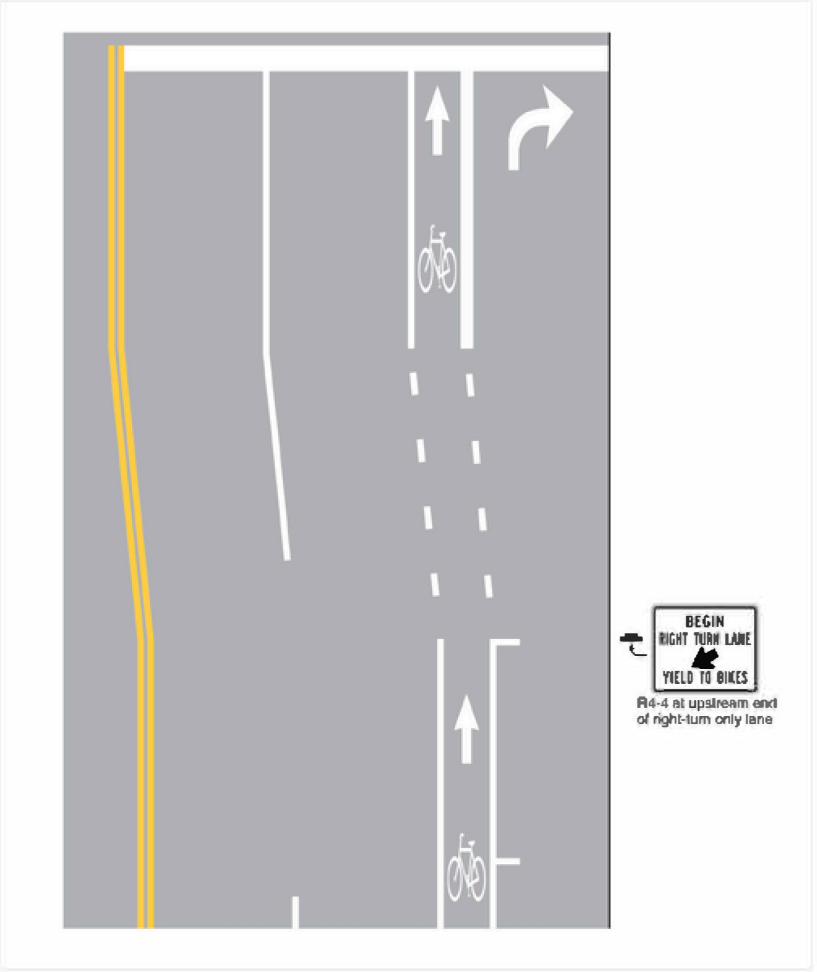


Figure 914.5.2.2 Example of Bicycle Lane Markings on an Approach to an Intersection *(Sheet 2 of 3)*

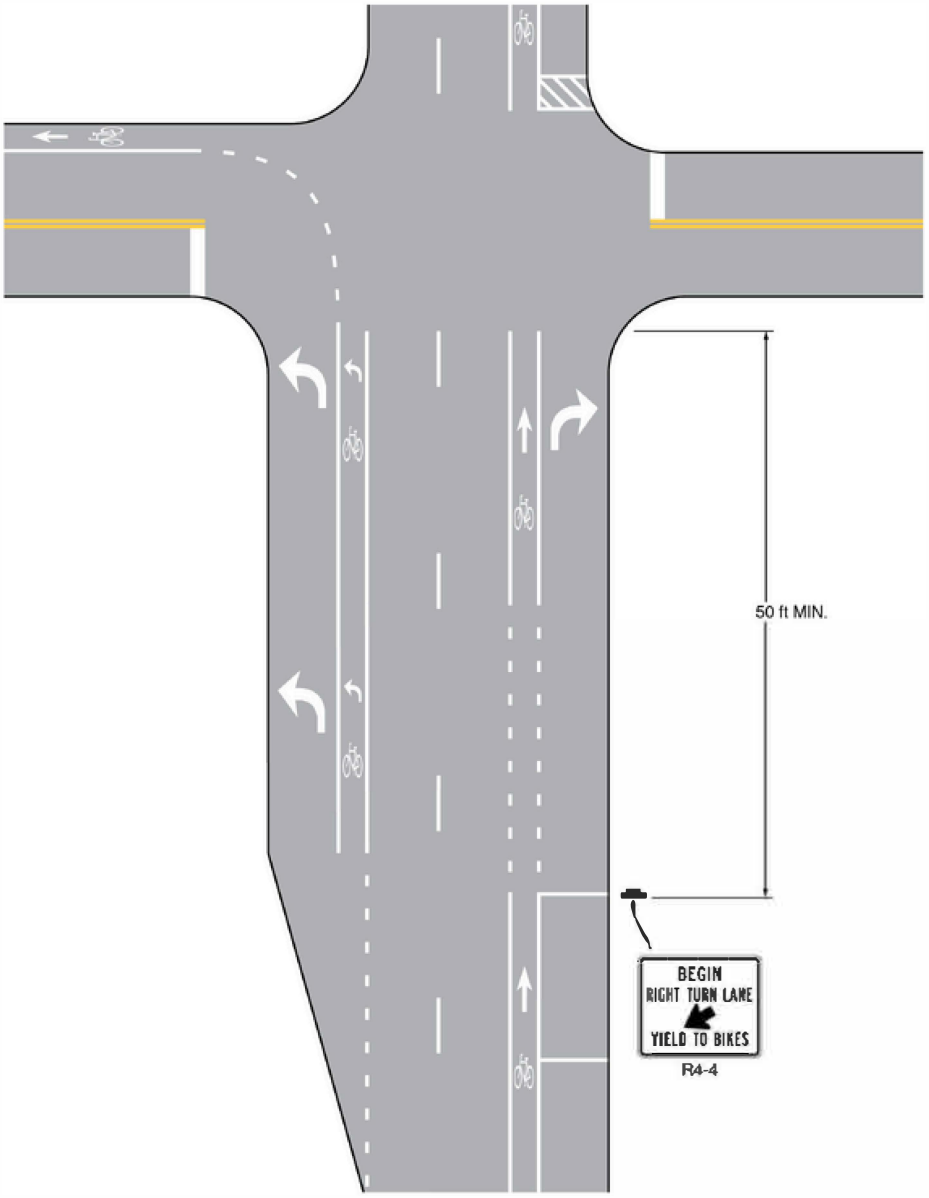


Figure 914.5.2.3 Example of Bicycle Lane Markings on an Approach to an Intersection *(Sheet 3 of 3)*

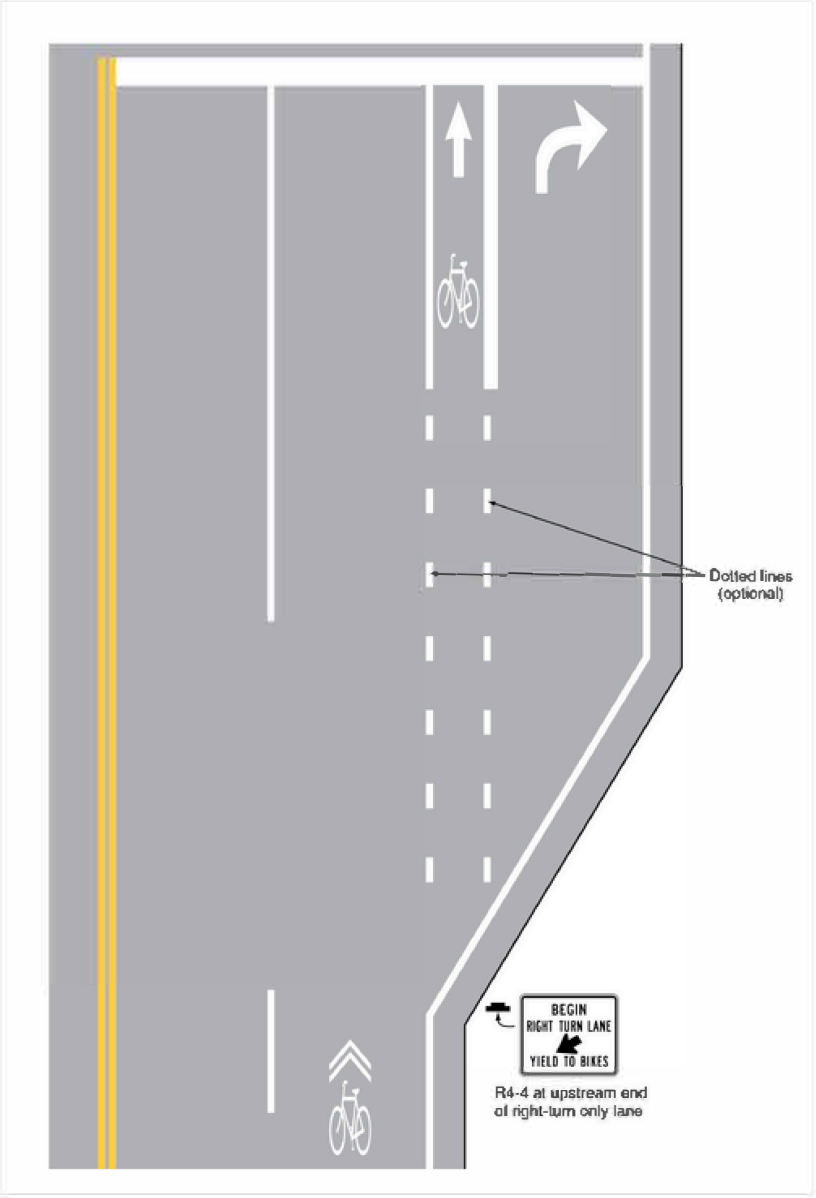


Figure 914.5.2.4 Example of Bicycle Lane Markings on an Approach to an Intersection that Transitions from a Shared Lane

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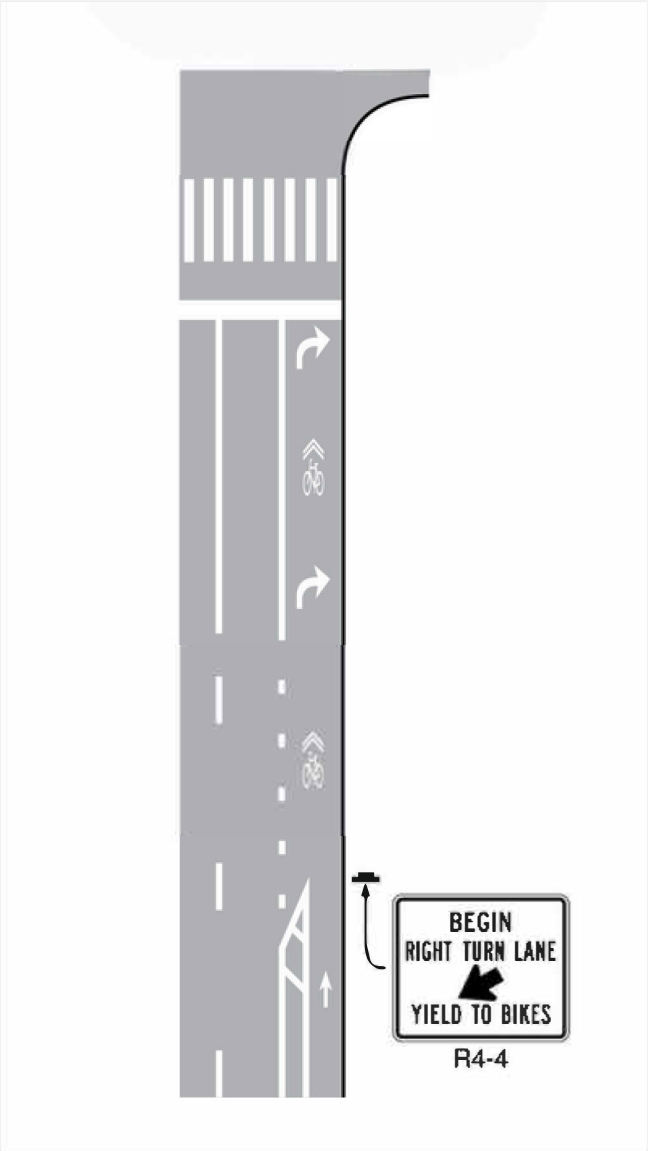


Figure 914.5.2.5 Example of Pavement Markings for Mixing Zones

914.5.3 Extensions of Bicycle Lanes through Intersections (MUTCD Section 9E.03)

Support. Extensions of bicycle lanes through intersections can help identify the paths of bicyclists and guide them on movements that could be difficult to discern. Extensions of bicycle lanes through intersections also assist other road users of the intersection to identify where bicyclists are expected to operate and to recognize potentially unexpected conflict points.

The design, placement, and maintenance of bicycle lane extensions through intersections are important considerations, especially when contiguous to a crosswalk, to avoid potential confusion to pedestrians with vision disabilities.

The width and color of lane extension markings are discussed in EPG 620.2.13.

MoDOT does not typically install or maintain green colored pavement for bicycle lanes. If installed on a MoDOT route, an agreement must be in place with the local agency that will maintain green colored pavement.

Standard. Shared-lane markings or chevron markings shall not be used in bicycle lanes or bicycle lane extensions (see EPG 914.5.8).

Extensions of bicycle lanes through intersections shall use dotted line patterns.

Support. Separated and buffer-separated bicycle lanes may have alignments that are not as obvious within an intersection as a standard bicycle lane, therefore additional conspicuity is important where these types of bicycle lanes cross intersections.

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Guidance. Lane extension markings should be used to extend a buffer-separated or separated bicycle lane through intersections.

The extension of a bicycle lane through an intersection should use two lines defining both lateral limits of the bicycle lane.

Standard. Where the path of the bicycle lane through the intersection is contiguous to a crosswalk, two longitudinal dotted lines shall be provided to establish the lateral limits of the bicycle lane extension. The transverse line establishing one side of the crosswalk, or the limit of a high-visibility crosswalk pattern (see EPG 620.3.5) that does not employ a transverse line, shall not be used to demarcate one side of the bicycle lane extension.

914.5.4 Bicycle Lanes at Driveways (MUTCD Section 9E.04)

Support. The definition of an "Intersection" in EPG 911 (MUTCD Section 1C.02) contains information to determine if a driveway can be considered an intersection.

Option. Bicycle lanes may be continued through a driveway using solid longitudinal lines.

914.5.5 Bicycle Lanes at Circular Intersections (MUTCD Section 9E.05)

Standard. Bicycle lanes shall not be provided in the circulatory roadway of an unsignalized circular intersection that includes conflicts at entry or exit points (see EPG 620.4) except as provided in the first Option paragraph of this article.

Guidance. Bicycle lane markings should stop at least 100 feet before the crosswalk, or if no crosswalk is provided, at least 100 feet before the yield line, or if no yield line is provided, then at least 100 feet before the edge of the circulatory roadway.

If used, bicycle crossings should be a minimum of 20 feet from the edge of the circulatory roadway.

Option. Separated bicycle lanes may be used in circular intersections.

Support. Separated bicycle lanes allow bicycles to navigate a circular intersection and its crossing points without merging into traffic and without dismounting and using a crosswalk at the intersection crossing point. This is beneficial at multi-lane and higher-speed circular intersections.

EPG 914.5.9 contains information on using shared-lane markings to facilitate the bicycle movement through a circular intersection.

The "Guide for the Development of Bicycle Facilities," 2012 Fourth Edition, American Association of State Highway and Transportation Officials, contains information on designing for bicycles on the sidewalk in lieu of, or in addition to, using shared-lane markings in the circulatory roadway of the intersection.

The "Improving Intersections for Pedestrians and Bicyclists Informational Guide" (FHWA-SA-22-017), FHWA contains information on incorporating separated bicycle lanes and other bicycle facilities into circular intersections.

914.5.6 Buffer-Separated Bicycle Lanes (MUTCD Section 9E.06)

Support. Buffer-separated bicycle lanes provide additional lateral separation between a bicycle lane and a general-purpose lane by a pattern of pavement markings without the presence of vertical elements. Providing a buffer space between a bicycle lane and a general-purpose lane creates more separation between motor vehicles and bicycles, can reduce vehicle encroachment into the bicycle lane, and can increase the comfort of bicyclists.

Providing a buffer space between a bicycle lane and a parking lane can reduce crashes involving bicycles and the opening of vehicle doors from the parking lane.

Standard. If used, and except as provided in the first Option paragraph of this article, a buffer space shall be marked with a solid white line along both edges of the buffer space where crossing is discouraged.

Guidance. Engineering judgment should be used to establish intermittent breaks or interruptions in the buffer space, such as for driveways, transit stops, or on-street parallel parking lanes, in order to convey access points or an otherwise general legal movement to cross the buffer space (see Figure 914.5.6).

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Option. Buffer spaces may be established without specific longitudinal lines if contiguous facilities have longitudinal lines or other pavement markings themselves that, when installed, automatically demarcate the buffer space (see Drawing D in Figure 914.5.6).

Standard. Except as provided in the subsequent paragraph, a through buffer-separated bicycle lane shall not be positioned to the right of a mandatory right-turn lane or to the left of a mandatory left-turn lane.

Option. A buffer-separated bicycle lane may be placed to the right of a mandatory right-turn lane (or to the left of a mandatory left-turn lane) only if a bicycle signal face (see EPG 902.8.1) is used and the signal phasing and signing eliminates any potential conflicts between the bicycle movement and the turning movement.

Guidance. The width of the buffer space should be at least 3 times the width of the normal or wide longitudinal line used to mark the buffer space.

Where a buffer space is 2 to 3 feet wide, chevron or diagonal markings (see EPG 620.2.24) should be applied within the buffer space.

Option. Where a buffer space is less than 2 feet wide, diagonal markings or no markings at all in the buffer space may be applied within the buffer space.

Standard. If used, diagonal markings shall slant away from traffic in the adjacent travel lane for motor-vehicle traffic.

Guidance. Where used, the spacing of chevrons or diagonal markings should be 10 feet or greater.

Support. Chevron and diagonal markings convey that the buffer space is not an additional bicycle lane or other travel lane open to traffic.

Standard. Where a buffer space is more than 3 feet wide, chevron or diagonal markings shall be applied within the buffer space.

Guidance. Lane extension markings should be used to extend a buffer-separated bicycle lane across intersections.

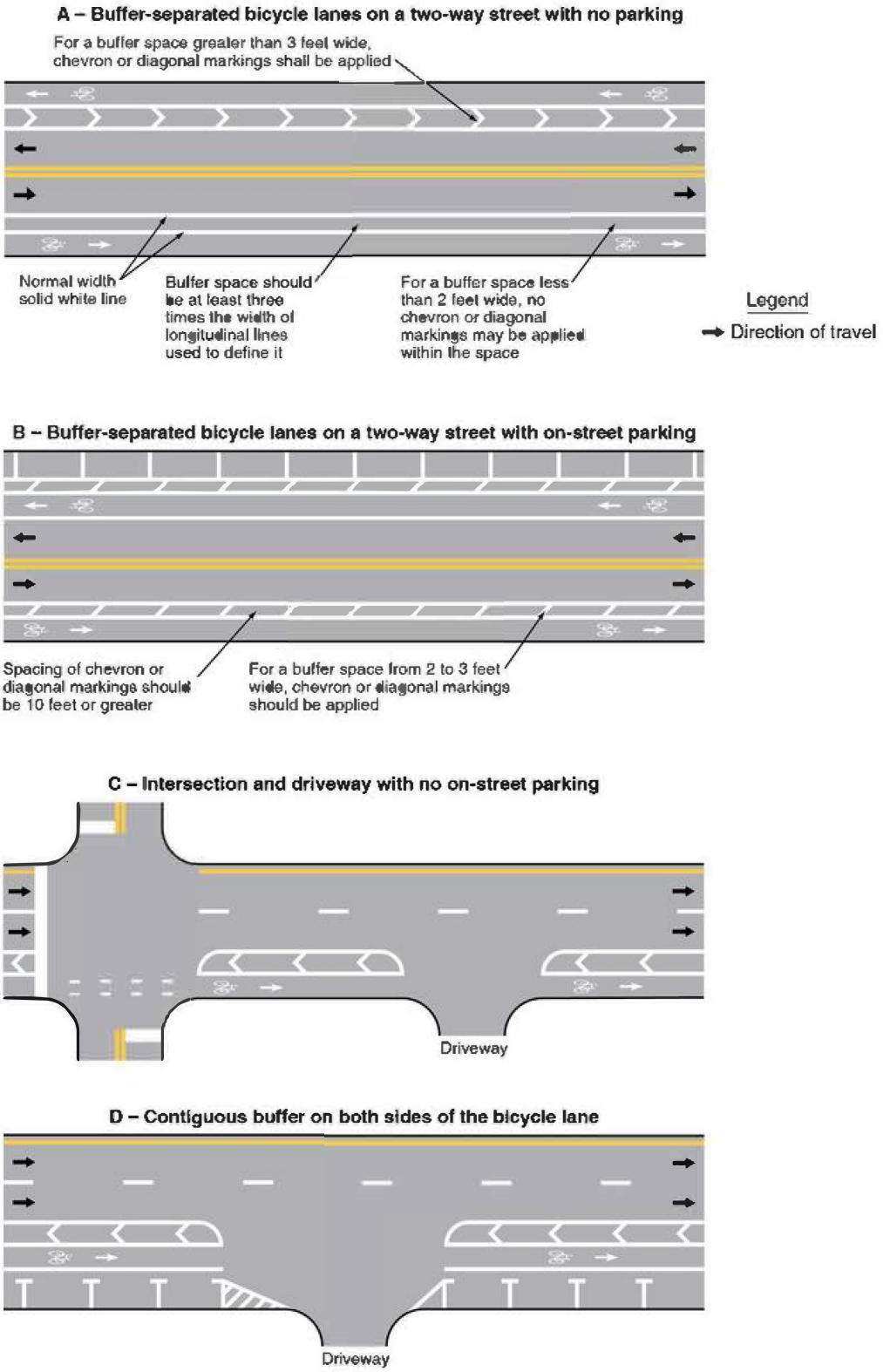


Figure 914.5.6 Examples of Markings for Buffer-Separated Bicycle Lanes

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914.5.7 Separated Bicycle Lanes (MUTCD Section 9E.07)

Support. Separated bicycle lanes provide a physical separation between a general-purpose lane and a bicycle lane through the use of vertical objects or vertical separation between the general-purpose lane and bicycle lane. Providing a physical separation between a bicycle lane and a general-purpose lane can reduce vehicle encroachment into the bicycle lane beyond a marked buffer alone and can in some cases prevent that encroachment altogether.

Physical separation between general-purpose lanes and bicycle lanes introduces additional design considerations over buffer-separated bicycle lanes, including the awareness of a potentially unexpected conflict point for turning motor vehicles and the provision of adequate sight distance for all users at intersections and driveway crossings.

Option. Vertical elements used to provide physical separation between general-purpose lanes and bicycle lanes may include, but are not limited to, tubular markers, raised islands, or parked vehicles.

Support. Where on-street parking is provided adjacent to the buffer area of a separated bicycle lane, pedestrians will need to access those vehicles.

Guidance. BIKE LANE (R3-17) signs (see EPG 914.2.3) should be used to distinguish a separated bicycle lane from a general-purpose lane.

Where an on-street parking lane serves as the separation between a general-purpose lane and a separated bicycle lane, a buffer space should be provided between the parking lane and the bicycle lane to allow for opening doors of parked vehicles.

Support. Separated bicycle lanes may be designed for one-way or two-way bicycle travel. Providing one-way separated bicycle lanes in the same direction as and on the right-hand side of the general-purpose lane, whether on a one-way or two-way roadway, accommodates the expectations of road users and might result in fewer conflict points at intersections or driveway crossings.

Standard. The edge line and lane line colors used for separated bicycle lanes shall conform to the requirements in EPG 620.1 (see Figure 914.5.7).

Directional arrows shall be used in conjunction with the bicycle lane symbol or word marking in separated bicycle lanes, placed downstream from the symbol or word marking.

Turns on red shall be prohibited across separated bicycle lanes while bicyclists are allowed to proceed through the intersection.

Support. Additional information on signals for bicycle facilities is found in EPG 902.8.

Standard. The edges of the buffer space for a separated bicycle lane shall be marked with solid longitudinal lines.

A marked buffer space that is 2 feet or wider for a separated bicycle lane, including those buffer spaces where tubular markers are provided, shall use chevron or diagonal markings within the buffer, unless physical separation is provided that occupies the majority of the buffer space, such as raised islands or other physical dividers, or such as where an on-street parking lane occupies the majority of the buffer space.

Guidance. Where used in the buffer area of a separated bicycle lane, the spacing of chevrons or diagonal markings should be 10 feet or greater.

Crosswalks that cross a separated bicycle lane should be marked consistent with the style of crosswalk marking provided across the adjacent general-purpose lane.

Support. Where on-street parking is provided as the physical separation adjacent to the buffer area of a separated bicycle lane, the chevron or diagonal marking provisions in EPG 914.5.6 apply to the area outside of the marked parking area within the buffer (see Figure 914.5.7).

Intersection treatments for separated bicycle lanes can vary depending on the geometric and operational conditions at the intersection (see EPG 914.5.2).

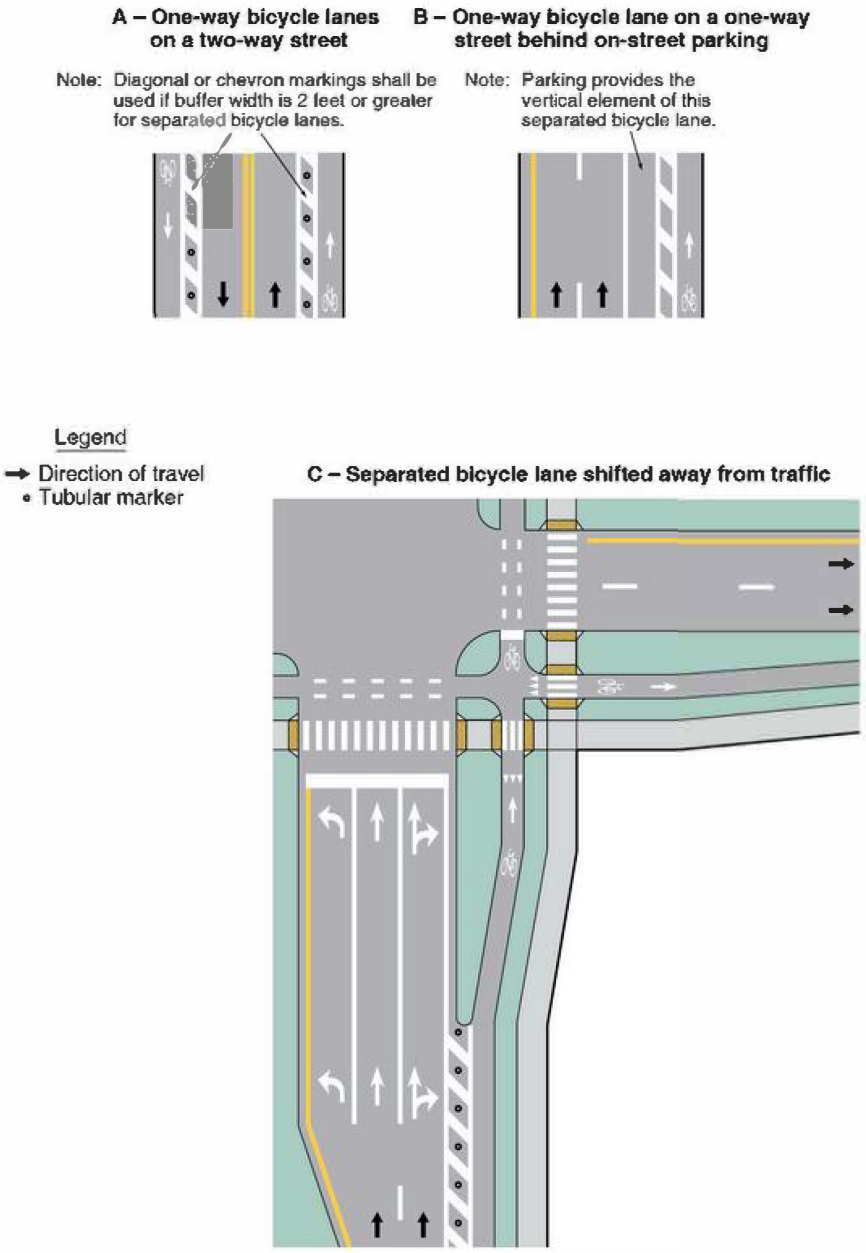


Figure 914.5.7 Examples of Lane Markings for Separated Bicycle Lanes

914.5.8 Shared-Lane Marking (MUTCD Section 9E.09)

Support. The FHWA's "Standard Highway Signs" publication (see EPG 911 (MUTCD Section 1A.05)) contains details on the shared-lane marking symbol.

Option. The shared-lane marking shown in Figure 914.5.8 may be used to:

A. Assist bicyclists with lateral positioning in a shared lane with on-street parallel parking in order to reduce the chance of a bicyclist impacting the open door of a parked vehicle,
B. Assist bicyclists with lateral positioning in lanes that are too narrow for a motor vehicle and a bicycle to travel side-by-side within the same traffic lane,
C. Alert road users of the lateral location bicycles are likely to occupy within the traveled way,
D. Encourage safe passing of bicycles by motor vehicles,
E. Reduce the incidence of wrong-way bicycling in the roadway, and
F. Assist bicyclists with lateral positioning in mixing zones.

Guidance. The shared-lane marking should not be placed on roadways that have a speed limit of 40 mph or greater.

Standard. Shared-lane markings shall not be used in:

A. Shoulders;
B. Bicycle lanes or in designated extensions of bicycle lanes through intersections or driveways,
C. A travel lane in which light-rail transit vehicles also travel;
D. The transition area where a motor vehicle entering a mandatory turn lane must weave across bicyclists in bicycle lanes;
E. Shared-use paths or shared-use path crossings; or
F. Physically-separated bikeways, either in the roadway or on an independent right-of-way.

Green-colored pavement shall not be applied as a background to shared-lane markings (see EPG 620.7.6).

Guidance. If used in a shared lane with on-street parallel parking, shared-lane markings should be placed so that the centers of the markings are a minimum of 12 feet from the face of the curb, or from the edge of the pavement where there is no curb.

If used on a street without on-street parking that has an outside travel lane that is less than 14 feet wide, shared-lane markings should be placed so that the centers of the markings are a minimum of 4 feet from the face of the curb, or from the edge of the pavement where there is no curb.

At non-intersection locations, the shared-lane marking should be spaced at intervals of not less than 50 feet or greater than 250 feet.

The first shared-lane marking downstream from an intersection should be placed no more than 50 feet from the intersection.

Option. EPG 914.2.6 describes a Bicycles Allowed Use of Full Lane sign that may be used in addition to or instead of the shared-lane marking to inform road users that bicyclists might occupy the travel lane.

Guidance. If the Bicycles Allowed Use of Full Lane (R9-20) sign is used as an addition to shared-lane marking, the shared-lane marking should be placed so that the center of the marking is in the approximate center of the travel lane.

Option. The shared-lane marking may be used (see Figure 914.5.8) where the width of the roadway is insufficient to continue a bicycle lane or separated bikeway on the approach to the intersection, or it is advantageous to terminate the bicycle lane or separated bikeway in order to provide for a shared lane.

The shared-lane marking may be used on an approach to an intersection in a mandatory turn lane to indicate a shared space for bicyclists and motorists where there is insufficient width in the roadway for both the bicycle lane and turn lane.

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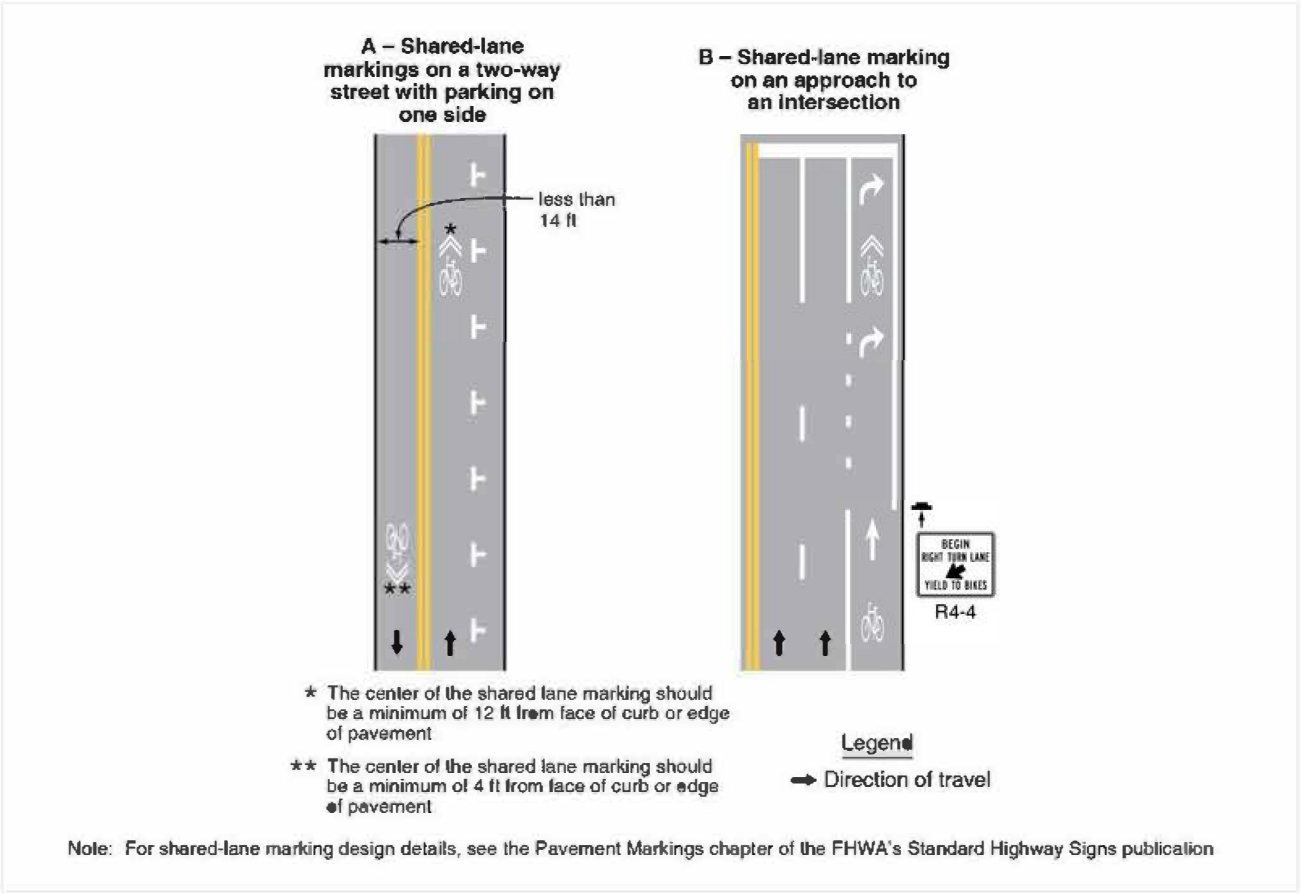


Figure 914.5.8 Examples of Shared-Lane Marking Applications

914.5.9 Shared-Lane Markings for Circular Intersections (MUTCD Section 9E.10)

Option. Shared-lane markings may be used in the circulatory roadway of circular intersections.

Guidance. If used, shared-lane markings should be placed in the center of the lane when used inside of circulatory roadways.

Support. The "Guide for Development of Bicycle Facilities," 2012 Fourth Edition, American Association of State Highway and Transportation Officials, contains information on designing for bicycles on shared-used paths in lieu of, or in addition to, using shared-lane markings in the circulatory roadway of the intersection.

914.5.10 Raised Devices (MUTCD Section 9E.17)

Support. EPG 620.8 contains information on using channelizing devices to emphasize pavement marking patterns associated with certain bicycle facilities. A common application is the use of flexible raised devices to create separated bicycle lanes (see EPG 914.5.7).

Using inflexible raised devices immediately adjacent to the travel path of a bicyclist without a buffer creates a collision potential for bicyclists.

Option. In accordance with EPG 620.8, channelizing devices may be used to emphasize a pavement marking pattern that establishes a bicycle lane or other bicycle facility provided that the installation of channelizing devices does not prevent motor vehicles from turning when the turn requires the motor vehicle to merge with the bicycle lane or facility as required by law or ordinance.

Guidance. If used, channelizing devices for bicycle facilities should be tubular markers (see EPG 620.8.2).

The selection of a raised device for use with bicycle facilities should consider the collision potential of both the post and the base since the base might still be present in the event the post is struck and missing.

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Support. Measures to reduce the likelihood of a road user striking a channelizing device include marking a buffer space, improving lighting, improving retroreflectivity, or the periodic addition of taller vertical elements within runs of shorter elements.

Standard. Channelizing devices that are used to emphasize the pavement marking patterns of bicycle facilities shall not incorporate the color green into either the device or its retroreflective element to supplement the presence of green-colored pavement.

Guidance. If used in separated bicycle lanes, channelizing devices should be placed in the buffer space and at least 1 foot from the longitudinal bicycle lane pavement marking.

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914.6 Signals (MUTCD Chapter 9F)

914.6.1 Application (MUTCD Section 9F.01)

Support. EPG 902 contains information regarding signal warrants and other requirements relating to signal installations.

Option. For purposes of signal warrant evaluation, bicycles may be counted as either vehicles or pedestrians.

914.6.2 Bicycle Signal Faces (MUTCD Section 9F.02)

Support. EPG 902.8 contains information on the design and application of bicycle signal faces. EPG 914.2.10 contains information for the Bicycle Signal sign that is required to be installed with a bicycle signal face.

914.6.3 Signal Operations for Bicycles (MUTCD Section 9F.03)

Standard. At installations where visibility-limited signal faces are used, signal faces shall be adjusted so bicyclists for whom the indications are intended can see the signal indications. If the visibility-limited signal faces cannot be aimed to serve the bicyclist, then separate signal faces shall be provided for the bicyclist. On bikeways, signal timing and actuation shall be reviewed and adjusted to consider the needs of bicyclists.

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