Traffic Engineering for Better Signs and Markings

SDDCTEA Pamphlet 55-14

Military Surface Deployment and Distribution Command
Transportation Engineering Agency

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The pamphlet content is brief and covers multiple excerpts from reference sources. Therefore, engineers and designers should supplement this pamphlet with reference sources as necessary.

Military Surface Deployment and Distribution Command
Transportation Engineering Agency

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Chapter 1 General

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1.1 Forward

The *Traffic Engineering for Better Signs and Markings* pamphlet is designed for persons with responsibilities relating to the installation and maintenance of traffic signs and markings on military installations. The purpose of the pamphlet is to clarify existing standards and to help military installations conform to national standards.

Each year thousands of crashes occur on military installations that result in millions of dollars in losses. One of the best ways to reduce crashes is to ensure that traffic-control devices provide the proper regulation, warning and guidance in a familiar, easy-to-understand format.

This pamphlet should be used in conjunction with the *Manual on Uniform Traffic Control Devices* (*MUTCD*), as approved by the U.S. Secretary of Transportation. In addition to the *MUTCD* and this pamphlet, the following military pamphlets also provide valuable insights:

- ✓ *Traffic Engineering for Better Roads* (Pamphlet 55-10)
- ✓ *Traffic and Safety Engineering for Better Entry Control Facilities* (Pamphlet 55-15)
- ✓ *Better Military Traffic Engineering* (Pamphlet 55-17)

1.1.1 Who is SDDCTEA?

SDDCTEA can provide on-site studies of high-crash locations at no cost to the military installations.

The Military Surface Deployment and Distribution Command Transportation Engineering Agency, or SDDCTEA, executes the Department of Defense's (DoD) overall transportation engineering program on behalf of the military services.

SDDCTEA's mission is to improve highway safety and reduce traffic congestion on DoD roads and on routes providing access to installations. Objectives include saving lives, decreasing injuries, minimizing lost time, and maintaining readiness.

To achieve the mission and objectives, SDDCTEA focuses their efforts in two key areas:

1. **Training and Education** – Includes the development of training and educational materials for distribution throughout the military. Materials include traffic engineering and highway safety bulletins, pamphlets, and interactive training materials. As presented in Exhibit 1.1, SDDCTEA offers several forms of training and education.
2. **Engineering Services** – As noted in Section 4-1d of the *Motor Vehicle Traffic Supervision Regulation* [AR 190-5/OPNAV 11200.5D/ AFI 31-218(I)/MCO 5110.1D/DLAR 5720.1], SDDCTEA will help installation commanders solve complex problems. Examples include roadway planning, geometric design, road safety audits, traffic operations analysis, engineering guidance, and contract assistance. Therefore, if your installation requires a study, SDDCTEA can help you by one of the most frequently used methods shown in Exhibit 1.2. SDDCTEA's focus is to deliver a quality product to the installation in a timely manner.

A July 2009 bulletin entitled "*Who Is SDDCTEA?*" also addresses additional SDDCTEA roles. See this and other traffic engineering bulletins at www.tea.army.mil/pubs/dod.asp.

Traffic Engineering and Highway Safety Bulletin

Who Is SDDCTEA?

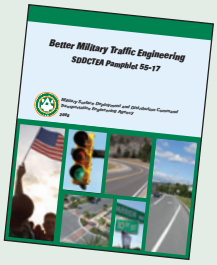
July 2009

Did You Know?

In This Issue...

Military Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA)

Exhibit 1.1: SDDCTEA Training and Education

Training and Education Program	Subject Matter Covered
Traffic Engineering and Highway Safety Bulletins Bulletins are published three to four times yearly and address a broad range of transportation and safety topics. When possible, timely issues such as Entry Control Facilities (ECFs), meeting minimum sign retroreflectivity requirements, etc., are covered. Bulletins are available online at http://www.tea.army.mil/pubs/dod.asp. Sign up to receive bulletins at http://sddcteacontacts.gfnet.com/contactentry.aspx.	Recent bulletins include: ✓ ECF Automation ✓ Intersection Control ✓ Markings ✓ Traffic Signals ✓ Traffic Signs ✓ Speed Limits ✓ You Should Consider a Roundabout! ✓ Sign Retroreflectivity ✓ How to Meet Minimum Sign Retroreflectivity Requirements ✓ Who is SDDCTEA?
Pamphlets  SDDCTEA has produced a variety of pamphlets and manuals on transportation issues. These materials provide specific, detailed engineering guidance on key issues. Pamphlets and manuals are available online at http://www.tea.army.mil/pubs/dod.asp.	✓ Pamphlet 55-8, Traffic Engineering Study Reference ✓ Pamphlet 55-10, Traffic Engineering for Better Roads ✓ Pamphlet 55-14, Better Traffic Engineering for Signs and Markings ✓ Pamphlet 55-15, Traffic and Safety Engineering for Better Entry Control Facilities ✓ Pamphlet 55-17, Better Military Traffic Engineering
Traffic Engineering Training and Reference CD-ROM Originally released in June 2002 and updated in May 2005, SDDCTEA developed the interactive multimedia CD-ROM, Better Military Traffic Engineering (BMTE) 2005, to provide the military engineering community with state-of-the-art information regarding the proper use of traffic control and safety devices on military installations. The BMTE CD is an instructional tool to train installation personnel, but can also be used as a reference tool. Animation and original illustrations are only part of the features available. Links are available to reference materials, Web sites, and for e-mail assistance. Order copies of the BMTE CD at http://www.tea.army.mil/cdrom/.	The CD is divided into sections, each containing a different topic: ✓ Signs ✓ Signals ✓ ECFs ✓ Parking ✓ Roadside Safety ✓ Intersections The BMTE CD also includes several traffic calculators for reference when planning a variety of traffic engineering projects.

SDDCTEA's personalized services include the following:

Safety

- ✓ Crash Location Enhancement Studies (CrashLES)
- ✓ Fatal crash analysis
- ✓ Safety audits
- ✓ Pedestrian studies
- ✓ Speed studies
- ✓ Traffic calming evaluations
- ✓ Sign retroreflectivity assessments

Transportation Engineering

- ✓ Traffic impact studies
- ✓ Signal warrant and operations evaluations
- ✓ Corridor evaluations
- ✓ Comprehensive transportation studies
- ✓ Roadway and intersection design/reviews

Force Protection and Installation Access

- ✓ ECF/ACP studies and assessments
- ✓ ECF/ACP design
- ✓ Force protection assessments
- ✓ Access roads studies
- ✓ Active vehicle barrier location assessment and safety schemes design/reviews

Exhibit 1.2: SDDCTEA Traffic Engineering Services

Study Type	Cost	Duration
Funded Crash Location Enhancement Studies (CrashLES) These studies generally involve one or more high crash locations and a safety audit. A high crash location is any location with five or more property-damage-only, three or more injury, or one or more fatal crashes in a 12-month period.	✓ FHWA funded with no cost to the installation.	✓ The studies are typically performed in one week. ✓ A draft report with recommendations is provided at the end of the week along with an outbrief to installation personnel.
In and Out These studies are limited to the installation's most pressing problem locations. The study team can typically analyze three locations. SDDCTEA provides recommendations to correct deficiencies, and generally includes low-cost improvements that are within installation funding capabilities.	✓ The installation may be required to assist with funding.	✓ The studies are typically performed in one week. ✓ A draft report with recommendations is provided at the end of the week along with an outbrief to installation personnel.
Comprehensive Typically studies may address 10 to 50 intersections, as well as ECFs, access roadways, master planning issues, speed limits, pedestrian safety, and access management.	✓ The installation pays for the study, but SDDCTEA usually can cost-share. ✓ SDDCTEA manages the study for the installation; to include scope of work preparation, scheduling, and technical reviews.	✓ SDDCTEA's engineer produces the pre-final and final studies over a period of several months.

1.2 Traffic Control Devices

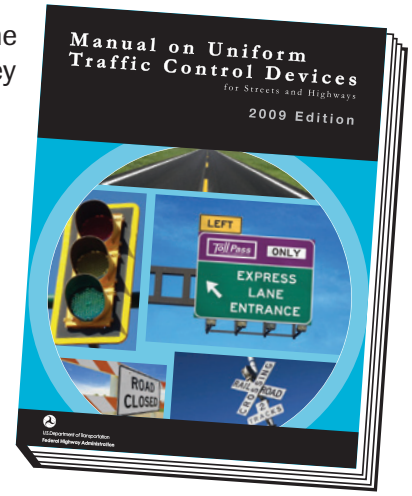
Traffic control devices include signs, signals, markings, and a few other devices such as channelizing devices and islands which are used to regulate, warn or guide traffic. However, this pamphlet will basically address only the two most common categories; i.e., traffic signs and markings.

1.2.1 Purpose of Traffic Control Devices

Motorists should be able to expect that a traffic control device will always have the same meaning and require the same action any time or any place that they see it.

The purpose of traffic control devices on streets and highways is to promote highway safety and efficiency by providing for the orderly movement of all road users. Traffic control devices notify users of regulations, and provide warning and guidance needed for the reasonably safe and efficient operation of all elements of the traffic stream.

Standardization is an important factor in driver compliance. Motorists should be able to expect that a traffic control device will always have the same meaning and will require the same action wherever they see it. Therefore, to maximize safety and efficiency, and to minimize driver frustration, both the design and the application of traffic control devices must be uniform.



1.2.2 Federal Mandates

The MUTCD *is recognized as the national standard for all traffic control devices installed on any street, highway, or bicycle trail open to public travel. The* MUTCD *is available at www.mutcd.fhwa.dot.gov.*

The *Manual on Uniform Traffic Control Devices* (*MUTCD*) is the national standard for all traffic control traffic devices installed on any street or highway in the United States. The National Committee on Uniform Traffic Control Devices (NCUTCD) and the Federal Highway Administration (FHWA) jointly develop the *MUTCD*, and the U.S. Secretary of Transportation ultimately approves it.

By military regulations, Commanders are required to conform to the *MUTCD*, in accordance with Joint Regulation of the DoD Transportation Engineering Program (AR 55-80, OPNAVINST 11210.2, AFMAN 32-1017, MCO 11210.2D and DLAR 4500.19). The 2009 *MUTCD* is available at: www.mutcd.fhwa.dot.gov.

The primary purpose of the *MUTCD* is to improve safety and reduce driver frustration by promoting uniformity in the design and application of traffic control devices. In addition to sponsoring research to improve safety, FHWA also works internationally to share and borrow ideas so that uniformity is much broader than just in the United States.

Throughout the *MUTCD*, the words standard, guidance, option, and support are used to provide the information required to make appropriate decisions regarding the use of traffic control devices on streets and highways.

Section 1A.13 in the *MUTCD* defines these terms as follows:

- ✓ **Standard** – a statement of required, mandatory, or specifically prohibitive practice regarding a traffic control device. 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 Options. Standard statements shall not be modified or compromised based on engineering judgment or engineering study.
- ✓ **Guidance** – a statement of recommended, but not mandatory, practice in typical situations, with deviations allowed if engineering judgment or engineering study indicates the deviation to be appropriate. All Guidance statements are labeled, and the text appears in unbold type. The verb "should" is typically used. The verbs "shall" and "may" are not used in Guidance statements. Guidance statements are sometimes modified by Options.
- ✓ **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.
- ✓ **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.

The *MUTCD* and this pamphlet both reference many other publications. Section 1.4 identifies some of the most relevant publications.

This pamphlet supplements the *MUTCD* for the military installations, and is intended for use by military employees and contractors that may be working for the military and who are responsible to place and maintain signs and markings on military installations.

The first *MUTCD* was developed in 1935, and a sampling of some of the signs in the original document are illustrated in Exhibit 1.3. Since 1935 there were nine new editions, and several intermediate updates. Exhibit 1.4 identifies some of the changes in each edition of the *MUTCD*, and Exhibit 1.5 highlights some of the significant changes in the current edition.

Exhibit 1.3: Sample Signs in the 1935 *MUTCD*

Exhibit 1.4: Changes in the *MUTCD*

***MUTCD* Edition**	**Some of the Changes Through the Years**
1935	✓ Regulatory and guide signs were both white rectangular shapes; and warning signs were yellow diamonds, squares, circles, or octagons (the STOP sign was a yellow octagon) ✓ Markings were only used at "hazardous" locations, and were white, yellow or black
1948	✓ Required retroreflectivity or illumination of regulatory and warning signs ✓ Required pavement markings to be white except yellow could be used for no-passing zones ✓ Discouraged the use of edge line pavement markings
1954	✓ Changed the colors of the STOP sign from black-on-yellow to white-on-red ✓ Introduced the "yield" sign – it was black-on-yellow with the words YIELD RIGHT OF WAY
1961	✓ Shortened the legend on the "yield" sign to YIELD, but kept it as a black-on-yellow sign ✓ Allowed guide signs on Interstate highways to use lowercase letters and be white on green ✓ Recommended white center line markings on paved highways, and required a solid yellow line to indicate a no-passing zone, which was on the right side of the white center line marking
1971	✓ Added many new symbol signs to provide better international uniformity ✓ Added the pennant-shaped no-passing zone sign and the pentagon-shaped school signs ✓ Changed the YIELD signs to the current red and white colors ✓ Required all center line markings to be yellow
1978	✓ Added the Stop Ahead and Narrow Bridge symbol signs (Narrow Bridge sign was eliminated in 2003) ✓ Required guide signs to be white-on-green
1988	✓ Added logo signs (e.g., gas, restaurant, motel, and camping trademark symbols) ✓ Added signs for recreational and cultural interests
2000	✓ This was the first on-line edition ✓ Added Metric units of measurements ✓ Changed the "yield line" from a solid white line to a series of isosceles triangles
2003	✓ Added In-Street Pedestrian Crossing signs ✓ Replaced the advance regulatory speed reduction sign with a warning sign ✓ Allow retroreflective strips on sign posts of regulatory and warning signs to increase visibility ✓ Eliminated the symbol-type Narrow Bridge sign because of confusion
2009	✓ Greatly increased the amount of text and the number of figures and tables ✓ Added paragraph numbering throughout for easier cross-referencing, and eliminated all metric dimensions ✓ Require mixed-case legends for the names of places, streets, and highways on guide signs ✓ Require fluorescent yellow-green color for all school signs

Exhibit 1.5: Significant Changes in the 2009 MUTCD

1. Larger 36"x36" STOP signs are now required on multi-lane approaches to a STOP sign, and on single-lane approaches to multi-lane roadways with a speed limit of 45 mph or higher.
2. Provisions for area-wide speed limits such as citywide and neighborhood speed limits were added. This provision has application on military installations, and if used it would normally reduce the total number of signs.
3. A new symbol Turning Vehicles Must Yield to Pedestrians (R10-15) sign was added to help improve pedestrian safety.
4. Barricades and gates were moved to Chapter 2B with regulatory signs (Sections 2B.67 and 2B.68, respectively).The stripes on gates must now be vertical instead of diagonal. Obviously, this has ramifications at all military installations.
5. The minimum size of most warning signs on multi-lane roads was increased to 36"x36".
6. All school-series signs are now required to use the fluorescent yellow-green color. This color is still optional for pedestrian and bicycle type signs.
7. A requirement to use the combination of lowercase letters with an initial capital letter for the names of all places, streets and roads when used on guide signs. For destination signs, it is now recommended that horizontal lines be used between places with different directions (see the illustration).

8. Community Wayfinding signs were added as Section 2D.50, and this could have application on military installations (see the illustration).
9. Toll Road signs were added as Chapter 2F, including signs with new purple backgrounds that have possible application for entry control facilities (ECFs) with electronic card readers.
10. Over 20 new figures for roundabouts were added, including a new Chapter 3C that addresses pavement markings at roundabouts.
11. U-turn arrow signal indications were added. In addition, red arrow signal indication (including the red U-Turn arrow) may be put on flashing to allow that specific turn after first stopping.
12. To enhance the visibility of traffic signals, 12-inch signal indications are now required for new signals on roads with a speed limit greater than 30 mph, and backplates are recommended on roads with a speed of 45 mph or greater. Yellow retroreflective strips may be used to outline the backplates.

1.2.3 Principles of Traffic Control Devices

As noted in Section 1A.02 of the *MUTCD*, a traffic control device should meet five basic requirements:

- ✓ Fulfill a need;
- ✓ Command attention;
- ✓ Convey a clear, simple meaning;
- ✓ Command respect from road users; and
- ✓ Give adequate time for proper response.

Therefore, it is important to consider the design, placement, operation, maintenance, and uniformity of all traffic control devices in order to maximize their ability to meet these five requirements. Also, carefully consider vehicle speed as an element that governs the design, operation, placement, and location of virtually all traffic control devices.

The proper use of traffic control devices should provide the reasonable and prudent road user with the information necessary to use the streets, highways, pedestrian facilities, and bikeways, both safely and lawfully. Uniformity of the meaning and application of traffic control devices is vital to their effectiveness.

1.2.4 Removing Unauthorized Signs and Markings

It is illegal for anyone to place, maintain, or display upon or in view of any highway any unauthorized sign or marking, which purports to be, is an imitation of, or resembles an official traffic-control device. If you are aware of an illegal or non-conforming "traffic-control device," have it removed as soon as possible because an illegal device:

- ✓ Creates disrespect for the official traffic-control devices.
- ✓ Encourages others to install similar illegal devices.
- ✓ May create a safety problem.

There is no need to provide any advance notice prior to removing an illegal device.

Instead of standard STOP (R1-1) sign with additional lettering, use a DO NOT ENTER (R5-1) sign with a SEVERE TIRE DAMAGE (R5-29P-TEA) plaque

1.2.5 Engineering Study and Engineering Judgment

Always base the decision to use a particular device at a specific location on either an engineering study or the application of engineering judgment. Thus, while the *MUTCD* and this pamphlet provide standards, guidance, and options for the design and application of traffic control devices, these documents should not be considered a substitute for engineering judgment.

Exercise engineering judgment in the selection and application of traffic control devices, as well as in the location and design of the roads and streets that the devices complement. A qualified traffic engineer should make the final decision concerning the addition or removal of any traffic restriction.

1.2.6 Requests to Experiment with Unique Traffic Control Devices

If a military installation wishes to experiment with a traffic control device that is not included in either the *MUTCD* or this pamphlet, or if they wish to request an official change to or an interpretation of the requirements of the *MUTCD*, an official should submit a request in writing to the traffic engineer at the SDDCTEA. Requests should:

- ✓ Include information in accordance with Section 1A.10 of the *MUTCD* (relating to interpretations, experimentations, changes, and interim approvals);
- ✓ Identify the information that the military installation proposes to compile during any experiment identified in the request, since the collection of any data and the development of any follow-up report generally will be a conditional part of the request.

SDDCTEA may forward an official request to FHWA for their review and approval.

Contact Us

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1.2.7 Abbreviations for Signs and Markings

Section 1A.15 in the *MUTCD* identifies acceptable abbreviations for use on traffic signs and pavement markings. In some cases a prompt word is required either immediately before or after the abbreviation. Periods should not be used with abbreviations.

In addition to the abbreviations in the *MUTCD*, Exhibit 1.6 identifies some additional abbreviations that SDDCTEA approves for use on military installations. If additional abbreviations are desired, the recommended procedure is to forward your suggestions to SDDCTEA for them to determine if they are acceptable to use. This will also help SDDCTEA expand the list in Exhibit 1.6.

In the past, FHWA determined that there were a lot of abbreviations that were misinterpreted or were so difficult that they unnecessarily detracted drivers' attention. Table 1A-3 in the *MUTCD* identifies some of the problem words which should not be used.

Exhibit 1.6: Acceptable Abbreviations for Traffic Control

Word Message	Abbreviation*
Air Force Base	AFB
Building	BLDG, Bldg
Department	DEPT, Dept
Division	DIV, Div
Fort	FT, Ft
Headquarters	HQ, Hq
Naval Air Station	NAS
Point	PT, Pt
United States Air Force	USAF
United States Army	US ARMY, US Army
United States Coast Guard	USCG
United States Marine Corps	USMC, US Marine Corps
United States Navy	USN, US Navy
Veterans Affairs	VA

**Upper/lowercase abbreviations are for use only on guide signs.*

1.3 Traffic Law Enforcement

In accordance with Motor Vehicle Traffic Supervision Regulations [AR 190-5/OPNAV 11200.5D/AFI 31-218(I)/MCO 5110.1D/DLAR 5720.1], traffic violations can be enforced either under:

1. Laws of the state or U.S. territory in which the installation is located, by using a DoD Form 1805 (United States District Court Violation Notice).
2. DoD regulations or administrative procedures established by installation commanders, by using a DD Form 1408 (Armed Forces Traffic Ticket).

In most cases, traffic violators on military installations probably have the greatest fear facing their installation commander as opposed to paying a fine to a local magistrate and possibly receiving points from the state driver licensing bureau. Therefore, Option 2 may be a more effective deterrent to drivers committing a follow-up violation.

Option 2 also provides some opportunities to enforce regulations not addressed in the applicable state motor vehicle code or to reduce the need to install as many traffic control devices. For example:

- ✓ Military regulations may prohibit drivers from using cell phones, or may require all people on motorcycles and mopeds to wear protective helmets, eye protection, hard-soled shoes, long trousers, and brightly colored or reflective outer upper garments; but this may or may not be required at other locations within the state or host nation.
- ✓ Military installations can establish a base wide speed limit without the need to post the signs at maximum intervals that may otherwise be required by laws of the state or host nation.

Although Option 2 may allow some flexibility, this should not be construed to mean that traffic control devices should not conform to the standards and principles established in the *MUTCD*.

1.4 Other Publications and References

The following publications are excellent reference documents that support and supplement this pamphlet:

1. "*The Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)*," July 23, 2004 Edition (The U.S. Access Board) – available online at http://www.access-board.gov/ada-aba/final.pdf.
2. *Better Military Traffic Engineering (Pamphlet 55-17)* – available online at http://www.tea.army.mil/pubs/nr/dod/pmd/PAM_55-17.htm.
3. "*Clearview Typeface Supplement*," dated September 2, 2004, FHWA – available online at http://MUTCD.fhwa.dot.gov/HTM/clearfont/.
4. *Manual of Transportation Engineering Studies*, 1994 Edition (ITE).
5. *Manual on Uniform Traffic Control Devices* (*MUTCD*), *U.S. Department of Transportation, Federal Highway Administration*, 2009 – available online at http://MUTCD.fhwa.dot.gov/.
6. *A Policy on Geometric Design of Highways and Streets*, 2004 Edition (AASHTO). Also known as the "Greenbook."
7. Recommended Practice for Roadway Sign Lighting, RP-19-01, Sign Lighting Committee of the IESNA Roadway Lighting Committee, Illuminating Engineering Society (IES).
8. "*Retroreflective Sheeting Identification Guide,*" September 2005 (FHWA), and as Exhibit 2.11 in this pamphlet – available online at http://safety.fhwa.dot.gov/roadway_dept/night_visib/sign_visib/sheetguide_sept05/.
9. *Roadside Design Guide*, 2006 Edition (AASHTO).
10. *Roundabouts: An Informational Guide*, Pub. No. FHWA-RD-00-067, June 2000 (FHWA) – available online at http://www.tfhrc.gov/safety/00-0671.pdf.
11. *Standard Highway Signs and Markings (SHSM) Book*, 2004 Edition (FHWA) – available online at http://MUTCD.fhwa.dot.gov/ser-pubs.htm.
12. *Traffic and Safety Engineering for Better Entry Control Facilities (Pamphlet 55-15)* – available online at http://www.tea.army.mil/pubs/nr/dod/pmd/PAM_55-15(GateManual).pdf.
13. *Traffic Control Devices Handbook*, 2001 Edition (ITE).
14. *Traffic Engineering for Better Roads (Pamphlet 55-10)* – available online at http://www.tea.army.mil/pubs/nr/dod/pmd/PAM_55-10.htm.
15. *Traffic Engineering Handbook*, 2009 Edition (ITE).
16. *Traffic Engineering Study Reference (Pamphlet 55-8)* – available online at http://www.tea.army.mil/pubs/nr/dod/pmd/PAM_55-8.pdf.
17. "*Travel Better, Travel Longer: A Pocket Guide to Improve Traffic Control and Mobility for Our Older Population*," FHWA-OP-03-098, 2003 (FHWA) – available online at http://MUTCD.fhwa.dot.gov/pdfs/PocketGuide0404.pdf.
18. *Uniform Vehicle Code (UVC) and Model Traffic Ordinance*, 2000 Edition (National Committee on Uniform Traffic Laws and Ordinances).
19. *Updates to Research on Recommended Minimum Levels for Pavement Marking Retroreflectivity to Meet Driver Night Visibility Needs, U.S. Department of Transportation, Federal Highway Administration, FHWA, Report No. FHWA-HRT-07-059*, October 2007 – available online at http://www.tfhrc.gov/safety/pubs/07059/02.htm#tbl5.

1.5 Definitions

The following words and phrases when used in this pamphlet shall have the following meanings:

Advisory speed – A recommended safe speed at a given location such as a curve, where the recommended speed is shown on a warning sign. (See Section 2.3.2 to determine the advisory speed.)

Arterial highway – 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.

Average workday traffic (AWDT) – The number of vehicles in a 24-hour period during a typical Monday to Friday workday.

Collector – 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.

Conventional road – Any street or highway other than a "low-volume road" (as defined below), expressway, or freeway.

Crosswalk –

1. 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; and
2. 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.

Designated disabled parking space – A space marked and reserved for vehicles carrying a government-issued registration plate or parking placard. The space shall be designated by a conspicuously posted sign bearing the international disabled symbol of a wheelchair, and, if paved, by a clearly visible depiction of this symbol applied to the pavement.

85th-percentile speed – The speed at or below which 85 percent of free-flowing vehicles are traveling. This speed should be determined by conducting a spot speed study during ideal conditions; i.e., daylight, dry road, tangent section, etc.

Expressway – A divided highway with partial control of access.

Freeway – A divided high-speed highway with full control of access; i.e., all access is by an interchange.

Highway or Street – A public way generally open to the use of the public as a matter of right for the purpose of vehicular travel, including the entire area within the right-of-way.

Intersection –

1. 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.
2. The junction of an alley or driveway with a roadway or highway shall not constitute an intersection, unless the roadway or highway at said junction is controlled by a traffic control device.
3. If a highway includes two roadways that are 30 feet or more apart (see definition of Median), then every crossing of each roadway of such divided highway by an intersecting highway shall be a separate intersection.
4. If both intersecting highways include two roadways that are 30 feet or more apart, then every crossing of any two roadways of such highways shall be a separate intersection.
5. At a location controlled by a traffic control signal, regardless of the distance between the separate intersections as defined in paragraphs 3 and 4 above:
   a. 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;
   b. 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
   c. 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.

Low-volume road – A road other than a freeway, expressway, interchange ramp, freeway service road or a state highway, and which is outside of built-up areas of cities, towns and communities, with a traffic volume less than 400 AWDT and typically serves recreational areas and resource development activities.

Multi-lane – Having 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 intersection approach has two or more lanes moving toward the intersection, including turning lanes.

Roadway – That portion of a street or highway improved, designed, or ordinarily used for vehicular travel or parking, but exclusive of the sidewalk, berm, or shoulder. In the event a highway includes two or more separate roadways, the term “roadway” refers to any such roadway separately, but not to all such roadways collectively.

Rural highway – A type of roadway normally characterized by lower volumes, higher speeds, fewer turning conflicts, and less conflict with pedestrians.

Sign legend – All word messages, distances, symbols, logos, shields, and arrows as applied to a sign face. The border, if any, is not considered to be part of the sign legend.

Speed limit – The maximum speed applicable to a section of roadway as established by law or regulation. If shown on signs, the signs would always be black and white regulatory signs.

Spot speed study – A structured process using an engineering and traffic study to determine the proper speed limit.

Traffic – Pedestrians, bicyclists, ridden or herded animals, vehicles, streetcars, and other conveyances either singularly or together while using any highway for purposes of travel.

Traffic control device – A sign, signal, marking, or other device used to regulate, warn, or guide traffic, placed on, over, or adjacent to a street, highway, pedestrian facility, or shared-use path.

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.

1.6 Common Acronyms

This pamphlet uses many different acronyms throughout the document. For ease of reference, Exhibit 1.5 summarizes commonly used acronyms.

Exhibit 1.5: Acronyms Used in This Pamphlet

AASHTO	American Association of State Highway and Transportation Officials
ACP	access control point (variation of ECF)
ADA	Americans with Disabilities Act
AVB	active vehicle barrier
AWDT	average workday traffic; i.e., the number of vehicles in a 24-hour period during a typical workday
BMTE	Better Military Traffic Engineering
DoD	Department of Defense
DoT	Department of Transportation
ECF	entry control facility
FHWA	Federal Highway Administration
ITE	Institute of Transportation Engineers
LED	light emitting diode
LOS	level of service
MUTCD	*Manual on Uniform Traffic Control Devices*
NCHRP	National Cooperative Highway Research Program
PRT	perception-response time (this is identical to the older "PIEV" term; i.e., perception, identification, emotion, and volition)
RRPM	retroreflective raised pavement marker
SDDCTEA	Surface Deployment and Distribution Command Transportation Engineering Agency
SHSM	*Standard Highway Signs and Markings* Book

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Signs

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2.1 General

Traffic signs are the most common and recognizable type of traffic control device. In fact, more than half of the *MUTCD* is devoted to the discussion and application of signs.

However, despite the explicit guidance in the *MUTCD*, a continuing problem is the use of unofficial, homemade-type signs, which are sometimes made with the wrong colors and shapes. This problem persists not only on public highways, but also on military installations.

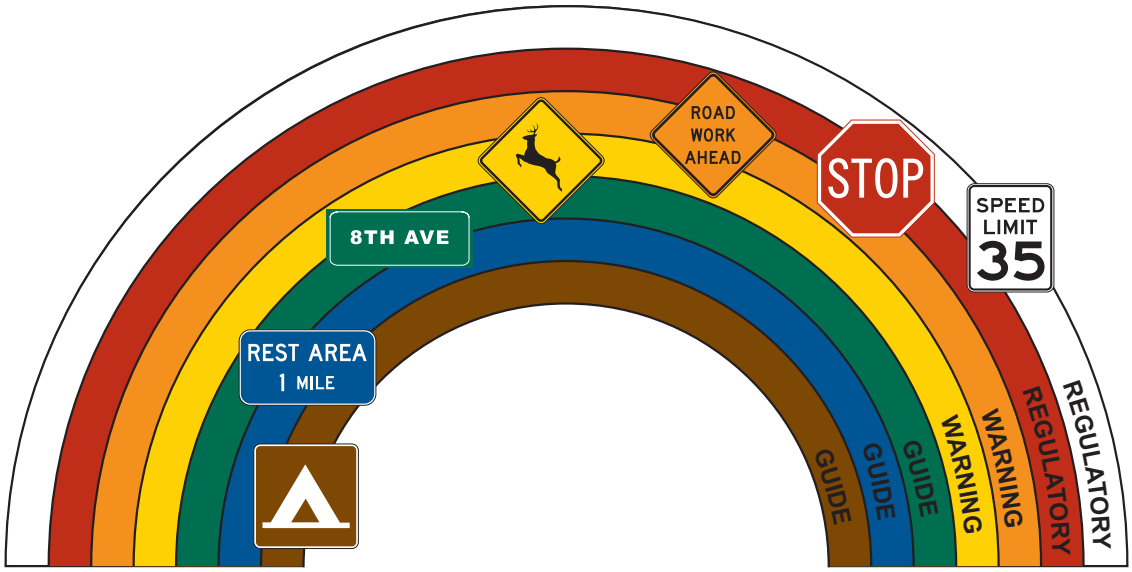
2.1.1 Function and Purpose of Signs

There are only three classifications of signs as illustrated in Exhibit 2.1:

- ✓ Regulatory – give notice of traffic laws or restrictions.
- ✓ Warning – give notice of a situation that might not be readily apparent.
- ✓ Guide – show route designations, destinations, directions, distances, street names, services, points of interest and other geographical, recreational, or cultural information.

Exhibit 2.1: Sign Type Basics

Sign Category	General Shape	Basic Color	Common Exceptions
Regulatory	Rectangular	Black legend and border on a white background	✓ STOP (R1-1), YIELD (R1-2), and Railroad Crossbuck (R15-1) signs have a unique shape. ✓ STOP (R1-1), YIELD (R1-2), DO NOT ENTER (R5-1), and WRONG WAY (R5-1a) signs are red-and-white in color. ✓ A red circle and slash indicate prohibitions.
Warning	Diamond	Black symbols, legend, and border on a yellow background	✓ School (S1-1) and Advance Railroad Crossing (W10-1) signs, and the NO PASSING ZONE (W14-3) pennant, have a unique shape. ✓ All plaques and some warning signs have a rectangular shape. ✓ School signs use a fluorescent yellow-green background, and it is also optional for pedestrian and bicycle signs. ✓ Warning signs in construction areas have an orange background.
Guide	Rectangular	White legend and border on a green background	✓ Route (M-series) markers generally have a unique color and shape. ✓ Motorist service signs (e.g., gas, food, lodging, attractions, etc.) have a blue background. ✓ Recreational signs may have a brown background.



Sign color examples

In addition to the colors depicted above, the *MUTCD* also includes the following colors:

- ✓ Purple may be used for electronic toll collection (ETC) pictographs. Since the application of the ECFpass pictograph is very similar to the ETC pictograph, purple is used on the ECFpass Advance Lane Assignment (M4-29-TEA) and ECFpass Overhead Lane Assignment (M4-30-TEA) signs in this pamphlet.
- ✓ Fluorescent yellow-green is now required for school signs, and may be used for pedestrian and bicycle signs instead of the normal yellow color.

Although there are only three basic classifications of signs, the *MUTCD* groups signs into a few additional categories as indicated in Exhibit 2.2. Some of the signs in Exhibit 2.2 are not addressed in this pamphlet because they generally do not apply to military installations; but on the other hand, there are other types of signs such as on-premise signs and building name signs that are discussed in this pamphlet but not in the *MUTCD*.

Exhibit 2.2: Categories of Signs in the 2009 *MUTCD*

Type of Sign	Chapter in the MUTCD
Regulatory Signs	2B
Warning Signs	2C
Guide Signs – Conventional Roads	2D
Guide Signs – Freeways and Expressways	2E
Toll Road Signs	2F
Preferential and Managed Lane Signs	2G
General Information Signs	2H
General Service Signs	2I
Specific Service Signs	2J
Tourist-Oriented Directional Signs	2K
Changeable Message Signs	2L
Recreational and Cultural Interest Area Signs	2M
Emergency Management Signs	2N
Temporary Traffic Control Signs	6F
School Signs	7B
Railroad and Light Rail Transit Grade Crossing Signs	8B
Bicycle Signs	9B

2.1.2 Excessive Use of Signs

There is a common misconception that extra signs "can't do any harm." However, in reality, extra signs create unnecessary clutter and detract from important and necessary traffic signs.

Signs should only be used when warranted by facts and field studies since unnecessary signs create a safety problem by adding extra fixed objects to hit and extra visual clutter to distract drivers. Therefore, avoid excessive use of signs.

For example, signs are generally not necessary to confirm rules of the road or general provisions regarding the operation of vehicles (e.g., slower traffic keep right, pass only on the left, etc.). However, signs are essential where unusual regulations apply at specific places or specific times, or where hazardous conditions are not self-evident. When signs are required, take a conservative approach since too many regulatory and warning signs will, in general, cause signs to lose their usefulness.

Guide signs provide information as to highway routes, street names, destinations, distances, available services, and points of interest. Military installations are encouraged to use a frequent display of street name signs and destination signs to keep unfamiliar road users informed of their route and location.

The placement of a sign where it is not appropriate or justified is as objectionable as a substandard or obsolete sign. As soon as possible, remove or cover all signs that were required by uncommon circumstances or temporary restrictions when those conditions cease to exist. Do not allow anyone to use highway signs for advertising or for any purpose other than related to traffic control.

Sometimes it is not that the signs are unnecessary, but the problem is that too many signs are at one location and no one can read them.

Too many signs!

Sign Clutter

Common sign clutter problems on military installations include:

- ✓ Too many signs at a single location; e.g., at an ECF.
- ✓ Allowing railroad warning and cross buck signs to remain in place even though the railroad tracks were removed or paved over.
- ✓ Leaving pedestrian crossing signs when the pedestrian walkways were removed.
- ✓ Using DO NOT ENTER signs at the only entrance to parking lots in an apparent attempt to "reserve" the parking spaces.

The application of signs should comply with this pamphlet and the *MUTCD*. Engineering judgment and studies are critical to the accurate use of traffic control devices; e.g., a traffic engineering study may indicate that signs are unwarranted at certain locations.

But the tracks were removed years ago!

2.1.3 Standard Signs

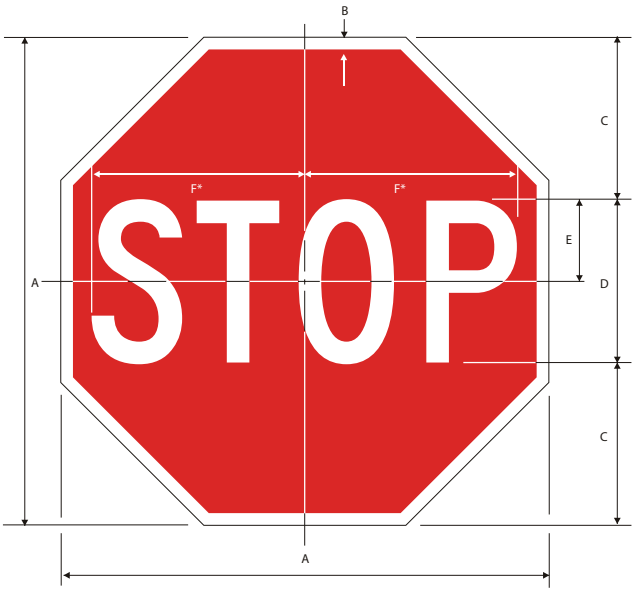
Uniformity in the design of sign faces improves sign recognition and legibility; thereby reducing driver frustration and promoting safety.

Uniform sign designs help everyone, because as drivers we can see and understand the sign messages in less time. To this end, the *MUTCD* establishes the basic framework for the design and application of signs, and the *Standard Highway Signs and Markings (SHSM) Book* provides detailed drawings of the standard signs and alphabets. Exhibit 2.3 shows a typical page from the *SHSM Book*, but with a few extra notes.

Some standard signs can be recognized at great distances because of their bold symbols (e.g., Curve, Cross Road) or their unique shape (e.g., STOP, YIELD, Railroad, School, etc.). On the other hand, research indicates that word messages are normally legible from a distance equal to 30 feet for every inch of height for drivers with 20/40 corrected vision (as allowed in most states). For example, 6-inch legend should be legible from a distance of about 180 feet.

In addition, some signs may not be completely legible or have a unique shape, but they are readily recognized at greater distances because of their unique mixture of legend sizes (e.g., Speed Limit Sign) or even the mix of word lengths (e.g., DO NOT PASS Sign).

Exhibit 2.3: STOP Sign Details from the *SHSM Book*



1 R1-1
STOP

4 *Reduce spacing 40%

2

A	B	C	D	E	F
18	.375	6	6 C	3	7.75
24	.625	8	8 C	5	10
30	.75	10	10 C	5	12.5
36	.875	12	12 C	6	15
48	1.25	16	16 C	8	20

3 C

5

6

COLORS: LEGEND – WHITE (RETROREFLECTIVE)
BACKGROUND – RED (RETROREFLECTIVE)

1-1

NOTES:

1. R1-1 is the "sign code" for the STOP sign.
2. The dimensions are for the A, B, C's in the sign layout. The dimensions are in English units; i.e., in inches.
3. The "C" denotes that this is the standard sign size for use on conventional highways. The smaller sizes are for low-volume roads and bicycle facilities.
4. This note applies to dimension F on the STOP sign face, and it means that the spacing between the letters is reduced by this percentage. (See the asterisk beside the dimension "F" on the sign face.)
5. 10-inch Highway Gothic legend, Series C.
6. Both the white and the red colors must be retroreflective.

Funny-Looking Sign Names

At first glance, sign names in this pamphlet may look awkward because some are in all capital letters while others are in mixed-case lettering. This mix of styles is also used in the *MUTCD* and most other national sign manuals, and is based on the following:

- ✓ All capitals are used for sign names when the sign name and the sign legend message is the same (e.g., STOP, YIELD, and DO NOT PASS signs).
- ✓ Mixed-case lettering is used for all symbol signs, and for signs with legend messages when the sign name and the sign message are not the same (e.g., Speed Limit signs, Weight Limit signs, etc.)

Sign Codes

The *MUTCD* and the *SHSM Book* use a unique sign code for each standard traffic sign. The first letter in the sign code should conform to the following *MUTCD* practice:

- ✓ Regulatory signs – R
- ✓ Warning signs – W, except school signs start with the letter S
- ✓ Guide signs – a variety of letters, but most commonly D, G, I, or M

Other Standard Signs

It is important to use standard sign designs to avoid the "homemade look." In most cases, this means using the sign face designs included in the *SHSM Book*; however, like other highway agencies, military installations also need some unique signs in order to satisfy specific needs. Since these unique signs are not in the *SHSM Book*, some of the most common special signs are included in Appendix A of this pamphlet.

Sign codes assigned by SDDCTEA are similar to those assigned by FHWA except "TEA" is added to the end of the code to distinguish these official signs from those in the *MUTCD* and *SHSM Book*. Therefore, if a sign code such as "R1-7a-TEA" is used, you should look in Appendix A of this pamphlet for design details. Just like the drawings in the *SHSM Book*, drawings for SDDCTEA-approved signs include the following information:

- ✓ sign code
- ✓ sign size, color, and shape
- ✓ size and series of legend
- ✓ sign face layouts details

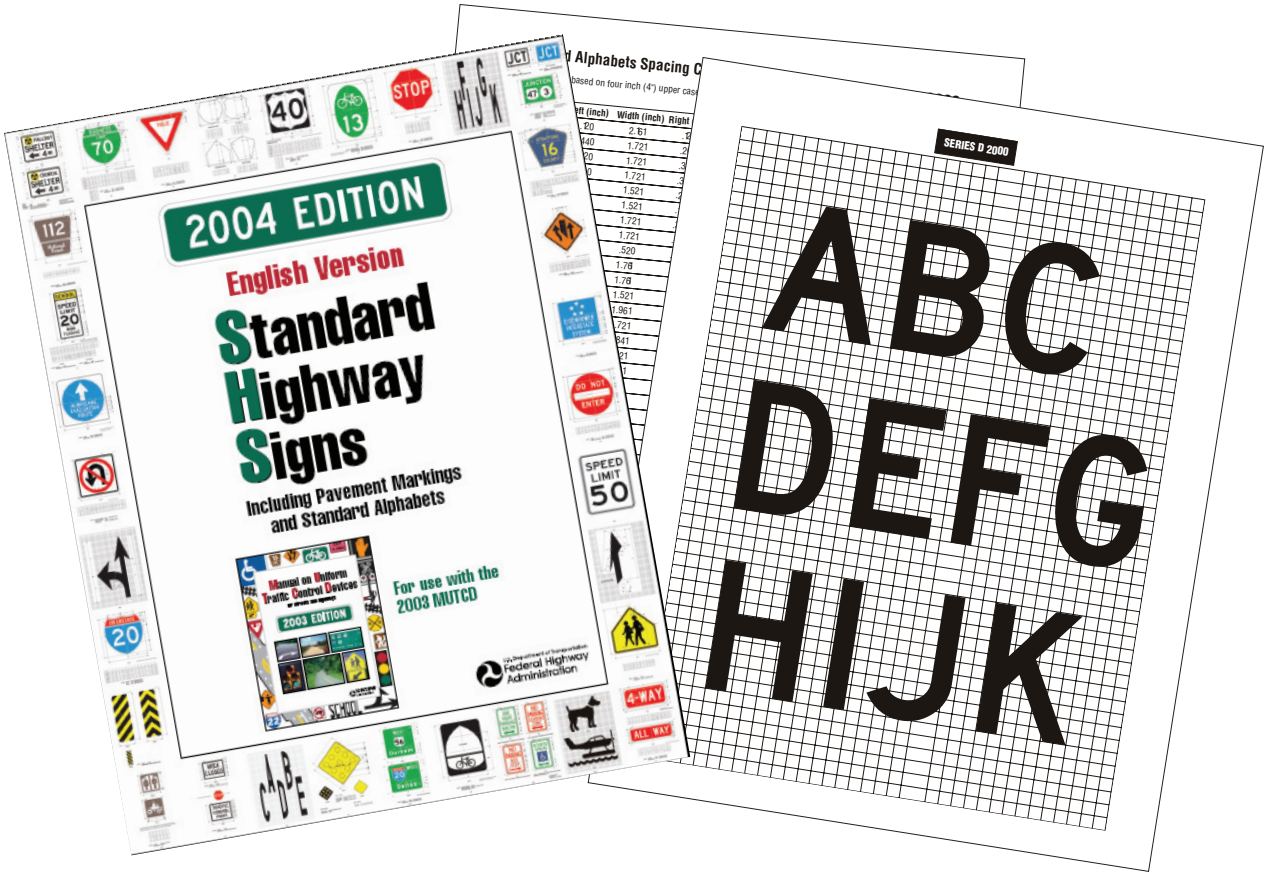
Drawings for the standard signs in Appendix A also include a brief description of where the sign could be used.

2.1.4 Alphabets

Most letters made with the Series F font are over twice as wide as the same letter made with a Series B font.

The *SHSM Book* includes graphics and spacing requirements for the standard alphabets as used on traffic signs; i.e., Highway Gothic. Altogether there are six different font series in order of increasing boldness; i.e., Series B, C, D, E, E-Modified (EM), and F.

Series D is the most common legend for guide signs on conventional roads, and for regulatory and warning signs. Sometimes a lower series (i.e., Series B or C) is used due to limited lateral space on the sign, perhaps most noticeable for No Parking signs. On the other hand, guide signs on expressways and freeways usually use Series E-Modified (EM) legends.



The current *SHSM Book* has spacing charts for each series of Highway Gothic; i.e., Series B, C, D, E, EM, and F. And for each of these six series, the charts include the width of 80 characters and the width of the spacing before and after each of the 80 characters. The characters include the 26 uppercase letters, 26 lowercase letters, 10 digits, and 18 characters that are common to most computer keyboards.

It is important to note that these dimensions are always for 4-inch high characters, which means that users need to multiply these values by a fraction if other legend sizes are used. For example, if using 6-inch legend, it is necessary to multiply the values for the 4-inch legend by the fraction 6/4.

The spacing methodology is illustrated in Exhibit 2.4.

Exhibit 2.4: Alphabet Spacing Charts

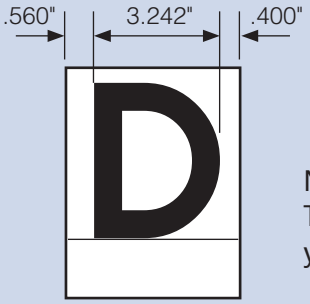
Standard Alphabets Spacing Chart

Series E Modified 2000

Measurements based on four inch (4") upper case letter height

Character	Left (inch)	Width (inch)	Right (inch)
A	.160	4.043	.160
B	.560	3.242	.320
C	.400	3.242	.320
D	.560	3.242	.400
E	.560	2.962	.280
F	.560	[illegible]	.280

Character	Left (inch)	Width (inch)	Right (inch)
o	.440	2.722	.440
p	.800	2.642	.440
q	.440	2.642	.800
r	.800	2.000	.160
s	.360	2.642	.440
t	[illegible]	2.081	.480



Note:
The dimensions came from the yellow highlighted values.

Although not currently in the *MUTCD* or the *SHSM Book*, FHWA allows the use of a new Clearview font for names using white legend on guide signs. (The Clearview font is discussed in Section 2.4.2.)

Computer software is available to calculate the length of legends and to design the layout of new signs. Manual spacing charts for all approved fonts are included in Appendix B.

2.1.5 Design Guidelines for Additional Sign Faces

In addition to the standard signs included in the *SHSM Book* or the TEA signs in Appendix A, military installations will frequently need to use some additional signs. Therefore, additional guidance has been developed.

Regulatory and Warning Signs

Sometimes, you may need to design a unique regulatory or warning sign that is not in either the *SHSM Book* or in Appendix A, and then obtain SDDCTEA's approval prior to having the sign fabricated. In these situations, adhere to the guidelines listed below.

Guidelines for Designing Regulatory and Warning Signs

1. Follow the basic principles established in the *MUTCD* relating to sign size, shape, color, and legend size and series.
2. Ensure that word messages are clear so that everyone has the same understanding of the sign message. If abbreviations are necessary, only use abbreviations in accordance with Section 1.2.7. Do not use abbreviations listed in Table 1A-3 of the *MUTCD*.
3. Use the appropriate letter width and spacing between individual letters as specified in the Standard Alphabets Spacing Charts (See Part 9 in the *SHSM Book*).
4. Ideally, use spacing between successive lines of legend that is about 75 percent of the average height of the uppercase legend (i.e., capitals) in the adjacent lines of legend.
5. When possible, use a clear spacing between the legend and inside of the borders that is at least 50 percent of the legend height. (It should be noted, that much smaller clear spaces exist on many standard signs, some with clear spaces less than 10 percent of the legend height.)
6. Diamond-shaped warning signs are more difficult to lay out due to their diagonal edges. In the absence of computer software, designers can use scaled strings of cutout legend and either electronically or manually position the legend within the sign border to obtain the best optically-balanced design.
7. Submit the proposed sign design to SDDCTEA for approval. If approved, have the sign fabricated.

By submitting these unique sign designs to SDDCTEA, military installations help ensure that the sign message and layout are easy to understand. This practice also enables SDDCTEA to request FHWA concurrence on any new symbols (as required in the *MUTCD*), and it allows SDDCTEA to expand their library of official signs for use on other military installations.

Exhibit 2.5: Words and Terms Not Recommended on Signs

Do Not Use	Because
"HAZARDOUS" or "DANGEROUS"	Installations should be eliminating these problem locations and there is no need to identify the site for potential lawsuits.
"WARNING"	The shape and color of the sign should provide a warning.
"SLOW"	This relative term means different speeds to different people; i.e., what speed is slow? On the other hand, an Advisory Speed (W13-1P) plaque ("25 MPH") is an acceptable legend.
"NOTICE" or "CAUTION"	These are unnecessary words – a warning sign should provide this information with its shape and color.
"TRAFFIC LAWS STRICTLY ENFORCED"	It is assumed that the traffic laws will be enforced so the legend is unnecessary.
Unfamiliar terms or destinations	These are unnecessary and may create confusion for road users. For example, avoid terms like "TRAFFIC QUEUE," etc.
Cute or trite symbols, phrases, or words	These may reduce road user's respect for signs. For example, do not use, "EVEN IF YOU ARE LATE, DON'T TAILGATE," "ANGER IS ONE LETTER AWAY FROM DANGER," "SPEED LIMIT 44," etc.

Guide Signs

By their very nature and application, destination and distance signs, and some other guide signs, are unique, one-of-a-kind signs. Therefore, these signs need some final design details to determine the sign layout and dimensions. Specific approval of SDDCTEA is not required, but SDDCTEA is available for consultation.

Legend

All letters on signs are required to be in uppercase letters (i.e., capital letters), except the names of places, streets, highways, etc., when used on guide signs are required to be in "mixed-case;" i.e., a combination of lowercase letters with initial uppercase letters as discussed in Section 2A.13 of the *MUTCD*. On military installations, names that should be in mixed-case on guide signs include:

- ✓ cities
- ✓ military installations
- ✓ geographic areas within installations
- ✓ gates
- ✓ roads and streets
- ✓ buildings

What are "*Mixed-Case" Legends*?

This is the common practice for capitalization of titles and headings where a capital letter is used for the first letter of every major word and lowercase letters are used for all other letters. Sometimes this lettering is referred to as "upper-and-lowercase legend," or as "title-case legend."

Some small words (e.g., a, an, and, but, for, nor, of, or, so, the, and to) generally are not capitalized unless they are the first word in the name. However, acronyms such as AFB would always be in all capitals.

Using mixed-case legends for these names accomplishes three things:

1. It improves the legibility of the names. The improvement in legibility distance is because some lowercase letters have extenders (b, d, f, h, i, j, k, l and t) and others have descenders (g, j, p, q and y), which creates unique, recognizable word footprints so that drivers frequently do not need to read the names letter-by-letter. Studies show that this increase in legibility distance is about 15 to 20 percent.
2. Mixed-case legends are usually shorter than words with all capitals, thus allowing smaller signs.
3. It helps to set the names apart from other legends.

The *MUTCD* specifies that signs should use the alphabets in the *SHSM Book*, which are generally called "Highway Gothic" fonts. However, the FHWA has granted interim approval to use the Clearview font for white legends on guide signs because this font is more legible than the standard Highway Gothic legend. Spacing charts for the Highway Gothic fonts and the Clearview fonts are in Appendix B.

Highway Gothic and Clearview fonts are both illustrated at http://www.triskele.com/roadgeek-fonts/font-license as "Series B-F" and "Series 1W-6W," respectively.

There are several computer software programs available to help design sign faces. Two popular programs are SignCAD and GuidSIGN, both of which also interface with sign manufacturing software.

2.1.6 Bilingual Messages

To assist drivers with limited knowledge of the English language, always use symbol-type signs whenever an approved design is available.

One of the benefits of using international style signs is the benefit of universally recognized sign shapes, colors, and symbols. Some areas surrounding military installations have extensive populations that are not fluent in English; however, these drivers can still understand most signs. For example, a STOP sign's shape and color is universal; therefore, there is no need to use bilingual STOP signs with messages such as "STOP / ALTO."

To assist drivers with limited knowledge of the English language, always use symbol-type signs when an approved design is available. If you believe that limited understanding of some signs is a significant problem, contact SDDCTEA and discuss the possibility of using a limited number of bilingual signs.

If you are considering bilingual applications, what would you consider to be the most important? It should not be a STOP, YIELD, Speed Limit or guide signs. Instead, consider ROAD CLOSED; DO NOT STOP ON TRACKS; special parking restrictions; THRU TRAFFIC KEEP RIGHT; and mandatory stops for customs, inspections, etc.

2.1.7 Retroreflectivity and Illumination

At night, drivers need visible traffic signs and markings to enhance safety and reduce driver stress.

Nighttime driving is inherently more dangerous than travel during the daytime, making it extremely important that signs are visible. Therefore, the *MUTCD* requires traffic signs to be either retroreflective or illuminated to show the same shape and color both day and night. It is more cost effective to make signs retroreflective than it is to illuminate them, and it is also possible that the bulbs will burn out. Therefore, all signs should be made with retroreflective sheeting even if the sign is illuminated.

Nighttime Crash Rate

National studies show that the average fatality rate per mile of travel is about three times higher during the night than during the day. Factors that contribute to a higher nighttime crash rate include:

1. Older drivers have difficulty seeing at night. It has been said, that after age 20, drivers typically need twice as much light every 13 years in order to read. For example, compared to a 20-year old driver, a 33-year old driver needs twice as much light, a 46-year old driver needs four times as much light, a 59-year old driver needs eight times as much light, and a 72-year old driver needs 16 times as much light.
2. There are fewer visual clues to delineate the roadway alignment at night.
3. Dew and frost reduce the retroreflection.
4. Glare from approaching traffic may temporarily blind drivers.
5. There are more intoxicated and sleepy drivers.

What is Retroreflection?

Most objects reflect light. The most common type of reflection is "diffuse reflection" where light scatters after striking rough surfaces such as trees, clothing, and carpet. Only a very small amount of the diffused light reflects back toward the light source.

Another type of reflection is "mirror reflection" that occurs when light strikes smooth or glossy surfaces, and the light reflects off the surface at an equal but opposite angle. Mirror reflection frequently occurs at night on wet roads when the headlights of approaching vehicles create extensive glare. Sign faces also produce some mirror reflection due to their glossy surfaces, and for this reason, it is a good practice to rotate signs away from the driver (see Section 2.1.11).

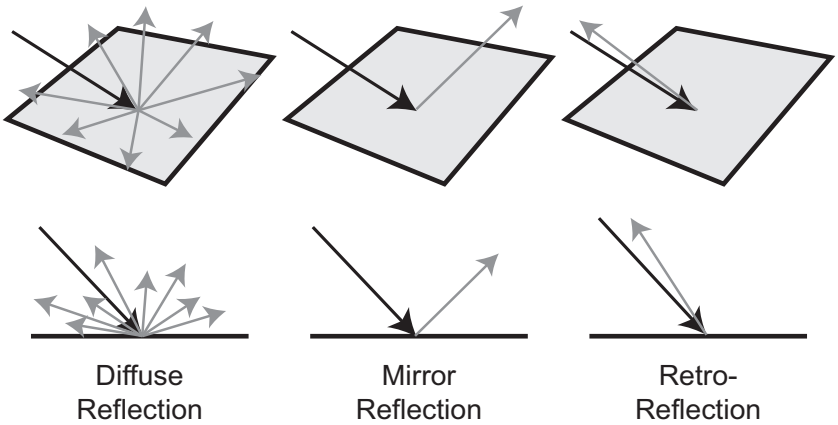
In contrast, "retroreflection" is the unique ability of a surface to reflect light back toward the light source even when the surface is not perpendicular to the light source; and "retroreflectivity" is the measure of this unique property.

The three types of reflection are illustrated in Exhibit 2.6.

Retroreflective Sheeting Materials

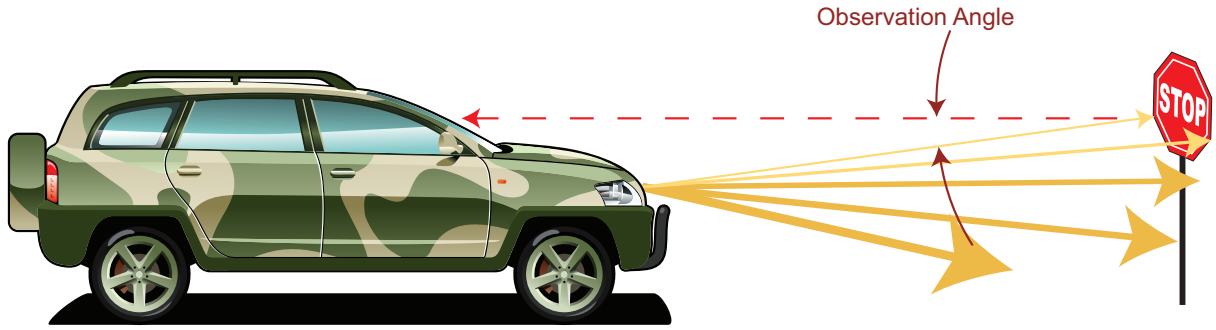
To make signs retroreflective, sign shops apply retroreflective sheeting to the face of each sign, which incorporates either microscopic glass beads or microscopic cube-corner reflectors (frequently called "microprismatic material") behind a smooth translucent pigmented surface layer. If the manufacturers could make perfectly shaped glass beads or cube-corner reflectors, all light from a

Exhibit 2.6: Types of Reflection



vehicle's headlights would return directly back to the headlights. Although we do not have perfectly shaped glass beads or reflectors, drivers do see more reflected light when their eyes are closer to the headlights. As illustrated in Exhibit 2.7, the angle formed between the headlights, the sign, and the driver's eyes is the observation angle, and the smaller the angle the higher the retroreflection.

Exhibit 2.7: Graphic Illustration of the Observation Angle



Retroreflective materials are also more efficient when the light source is approximately perpendicular to the sign face; therefore, it is important to have signs oriented toward approaching traffic.

Some traffic signs may look almost new during the day but are completely ineffective at night. This nighttime visibility problem is usually a function of the type and age of the retroreflective material. For example, the STOP sign in Exhibit 2.8 looks almost new during the day, but it is not retroreflective because the sign shop used a non-retroreflective sheeting material (the sign shop also used a non-standard lettering font). Therefore, these problems illustrate the importance of:

- ✓ obtaining all signs from a reputable sign shop; and
- ✓ performing nighttime inspections of the signs.

Factors that Affect a Driver's Ability to "Read" Signs at Night

Of the following eight items, military installations can only help drivers by modifying Items 5, 6, 7, and 8:

1. The driver's night vision and acuity.
2. Intensity and light distribution of the headlights.
3. Location of driver's eyes with respect to the headlights.
4. Frost, dew, or snow on the sign face; or rain, snow, fog, smoke, etc., between the vehicle and the sign.
5. Obstructions in the line-of-sight between the driver and the sign.
6. Size and readability of the sign.
7. Locations, mounting height, and orientation of the sign in relation to the vehicle's headlights.
8. Type and age of the retroreflective sheeting material.

Exhibit 2.8: An Unacceptable, Non-retroreflective Sign

Making Retroreflective Signs

Signs are made retroreflective by applying white or colored retroreflective sheeting on the sign blank. Sign messages for mass-produced signs are typically silk-screened directly on the sheeting. All non-black inks need to be a transparent type and applied on white sheeting so that the screened color is both retroreflective and the proper color.

One-of-a-kind signs are typically made with cutout, pressure-sensitive legend (i.e., letters, symbols, numbers, and arrows). Non-black cutout legends and borders need to be made from retroreflective sheeting material.

Measuring Retroreflectivity

Retroreflectivity is measured with a retroreflectometer. Hand-held instruments for use in the field cost about $12,000 and measure the retroreflectivity value at preset angles to simulate what drivers see. Many units also capture GPS coordinates which can be downloaded into an inventory or asset management database.

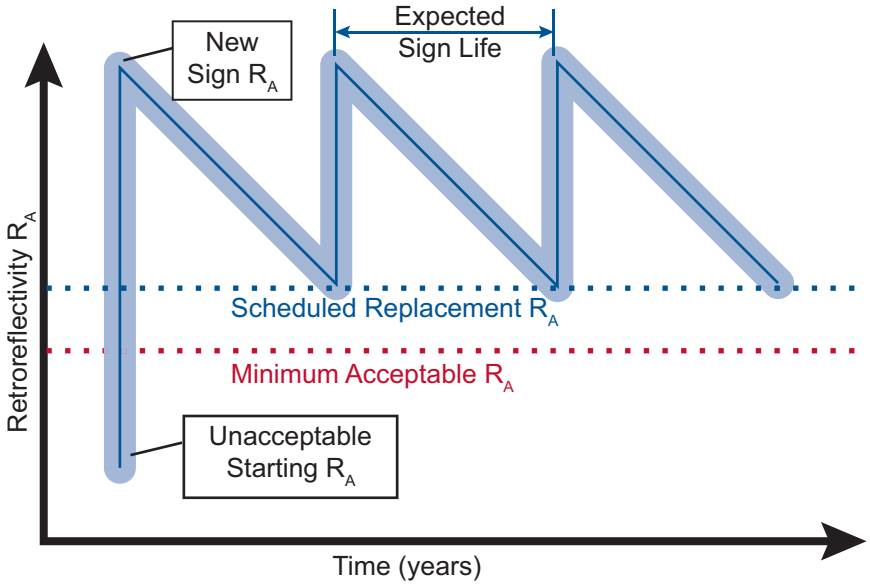
However, using a portable retroreflectometer is not child's play because signs are normally on posts and either the retroreflectometer needs to be supported by an extension pole and accurately held against the sign face, or the user must climb on a ladder.

In addition, researchers typically suggest taking about three readings on signs, at least those signs that are nearing the end of their useful life, since retroreflectivity sometimes varies at different locations on a sign face. And to make matters worse, the unit must also be precisely centered on white legends on signs such as STOP signs and guide signs. Therefore, up to six readings are sometimes recommended, making the process both challenging and time-consuming. Taking retroreflectivity readings on signs installed over the road on mast arms or sign structures is another problem.

Retroreflectivity readings are normally defined as the value R_A measured in candelas per lux per square meter (cd/lx/m2). The R_A value deteriorates over time, but materials of even the same type and color do not always deteriorate uniformly.

Therefore, it is desirable to provide a safety factor when scheduling replacement signs as illustrated in Exhibit 2.9.

Exhibit 2.9: The Decline of Retroreflectivity over Time



When is Sign Lighting Required?

Since only "brighter" types of retroreflective sheeting materials should be used, only use sign lighting if a traffic engineering study documents a need.

2.1.8 Minimum Retroreflectivity Levels

Because of a congressional mandate, minimum retroreflectivity values now exist for most traffic signs.

Because of safety concerns about nighttime driving, in 1993 congress directed the U.S. Secretary of Transportation to include minimum retroreflectivity levels in the *MUTCD* for both signs and markings. After extensive research, FHWA adopted minimum retroreflectivity values for traffic signs in 2007, and these values are now included as Table 2A-3 in the *MUTCD*.

However, the values adopted vary by the type and color of sheeting, and the sign size and type of message. In an effort to avoid using different types of materials on a sign-by-sign basis, some of FHWA's recommendations were rounded upward to the values in Exhibit 2.10. This exhibit also includes some values that are not yet included in the *MUTCD* but which are supported by research.

Exhibit 2.10: Simplified Minimum Maintained Retroreflectivity Levels

Color	Minimum Maintained Retroreflectivity, R_A (cd/lx/m²)
Blue	25*
Brown	20*
Green	25
Orange	75
Red	7**
White	150
	Except, white legends and borders on overhead signs: ✓ 250 on green signs ✓ 250 on blue signs* ✓ 350 on brown signs*
Yellow	75

* Minimum R_A values for blue and brown retroreflective materials are not in the current *MUTCD*, but these are the values suggested by recent research.

** Agencies must also maintain a minimum contrast ratio of 3:1; i.e., the ratio of white retroreflectivity divided by the red retroreflectivity.

Except for white legend and border on overhead signs, Type III or Type IV retroreflective sheeting material should be able to satisfy all of the above minimum retroreflectivity values.

To date, FHWA has not established minimum retroreflectivity values for the following signs:

- ✓ Parking, Standing, and Stopping (R7- and R8-series) signs.
- ✓ Walking/Hitchhiking/Crossing (R9-series, R10-1 through R10-4b) signs.
- ✓ All signs with a blue or a brown background.
- ✓ Bikeway signs that are intended for the exclusive use by bicyclists or pedestrians.

Originally, there was only one type of retroreflective sheeting material, but as technology developed, brighter and more durable materials became available. Moreover, with the mandated minimum retroreflectivity values, Type I and Type II retroreflective sheeting should no longer be used.

FHWA has a Retroreflective Sheeting Identification Guide at http://www.trafficsign.us/reflidguide.pdf. The portion of FHWA's guide that covers rigid signs is included in Exhibit 2.11.

Why Are "Brighter" Signs Necessary Today?

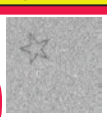
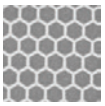
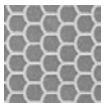
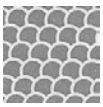
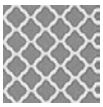
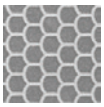
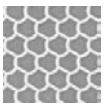
1. Higher travel speeds.
2. Low beam headlights on newer vehicles do not provide as much upward light as older headlights.
3. There are more SUVs and trucks where drivers sit at a greater height above the headlights, and this reduces the amount of retroreflection for the drivers in these vehicles.
4. Signs are set back farther from the roadway to establish a clear zone, but this reduces the amount of illumination and retroreflection.
5. There are more older drivers and they generally have poorer nighttime vision.
6. Better research.

Exhibit 2.11: FHWA's Retroreflective Sheeting Guide*

FHWA Retroreflective Sheeting Identification Guide – September 2005

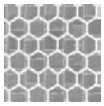
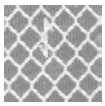
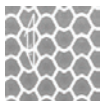
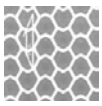
Notes: ASTM Types are shown as stated by the manufacturers using ASTM D4956-04 "type designations. Agencies should verify that the sheeting they use complies with their specifications or ASTM D4956. FHWA does not endorse or approve any material no does it determine type category(s) for materials. This side of the Sheeting ID Guide is for rigid surfaces only. The other side if for flexible surfaces and non-signing applications.

Retroreflective Sheeting Materials for Rigid Sign Surfaces Made with Glass Beads

Example of Sheeting									
ASTM Type	I	II	II	III	III	III	III	III	III
Manuvacurer(s)	note A	Avery Dennison®	Nippon Carbide	3M™	ATSM, Inc.	Avery Dennison®	Kiwalite®	LG Lite	Nippon Carbide
Brand Name	Engineer Grade	Super Engineer Grade	Super Engineer Grade	High Intensity	High Intensity	High Intensity	High Intensity	High Intensity	High Intensity
Series Number	Several	T-2[illegible]	15000 17000 18000	2800 3800	ASTM HI	T-5500	22000	LH8000 LH8100	N500 N800
Notes	A								

DO NOT USE

Retroreflective Sheeting Materials for Rigid Sign Surfaces Made with Prisms

Example of Sheeting									
ASTM Type	III, IV	III, IV, X	VII, VIII, X	VIII	IV, VIII	IX	IX	X	Unassigned
Manufacturer	Avery Dennison®	3M™	3M™	Avery Dennison®	Nippon Carbide	3M™	Avery Dennison®	Nippon Carbide	3M™
Brand Name	High Intensity Prismatic	High Intensity Prismatic	Diamond Grade™ LDP	MVP Prismatic	Crystal Grade	Diamond Grade™ VIP	Omni-View™	Crystal Grade	Diamond Grade™ DG3
Series Number	T-6500	393	3970	T-7500	94000 (IV) 92000 (VIII)	3990	T-9500	93000	4000
Notes	B	B	B, D		B, C			C	

A – All the manufacturers listed on the other side of this guide (except Reflexite) provide Engineer Grade sheeting. Engineer Grade sheeting is uniform without any patterns or identifying marks. Visually, it is indistinguishable from lower quality grades (i.e., utility and commercial grades).

B – These materials can be classified as different ASTM Types.

C – These materials are visually indistinguishable from one another.

D – The arrow or "water mark" on this product is no longer included with new productions.

* This exhibit is reduced about 35 percent; therefore, the sheeting examples are shown at a smaller scale.

** As illustrated above, Type I and II materials both have a grainy appearance similar to metallic paint, whereas all other materials have a pattern of hexagons, diamonds, or circular shapes measuring about one-eighth inch across.

Even when brand new, Type I (Engineering Grade) and Type II (Super Engineering Grade) materials frequently cannot meet some of the minimum retroreflectivity values in Exhibit 2.10. Moreover, the higher type materials are more cost effective on an annual cost basis because they last longer. Therefore, Type I and Type II materials are no longer acceptable materials.

Inferior Type I and Type II Materials

Type I and Type II retroreflective materials should not be used. With reference to Exhibit 2.11, these inferior materials are easy to recognize because they have a uniform appearance similar to metallic automotive paints, whereas the better materials all have a pattern of hexagons, diamonds, or other similar shapes that are about one-eighth inch wide.

Some prismatic materials, such as Types VII, VIII, IX, and X material have small arrows or "water marks" to indicate what orientation of the material should be at the top of the sign. It is important for sign shops to comply with this recommendation since failure to comply causes some panels to be less retroreflective than other panels.

This is also a problem with legends when in an effort to reduce material usage, a sign shop rotates material in a die-cutting machine or uses nesting software on a computerized sign maker. However, new omni-directional sheeting eliminates the orientation issue. Moreover, additional innovations are on the horizon; e.g., new full cube prismatic sheeting can be engineered to direct a greater amount of light back to the driver and to meet specific retroreflectivity objectives.

Section 2.1.17 addresses five methods to manage sign programs to maintain acceptable sign retroreflectivity.

Acceptable Retroreflective Sheeting Materials for New Signs

- ✓ Type III or Type IV, or better, for the background material on all signs, and for white legend and border on post-mounted signs.
- ✓ Type VII, VIII, IX, or X material for white legend and border on all overhead signs.

2.1.9 Sign Shapes, Colors, and General Design

Sign shapes and colors should always conform to those in the *MUTCD* and the *SHSM Book*.

The dimensions for signs given in the *MUTCD* are the standard sizes. When listing dimensions for rectangular signs, the width is the first dimension and the height is the second dimension, except dimensions of diamond-shaped and triangular-shaped signs are along each edge. Sign dimensions for width and height should generally be to the nearest 6-inch increment.

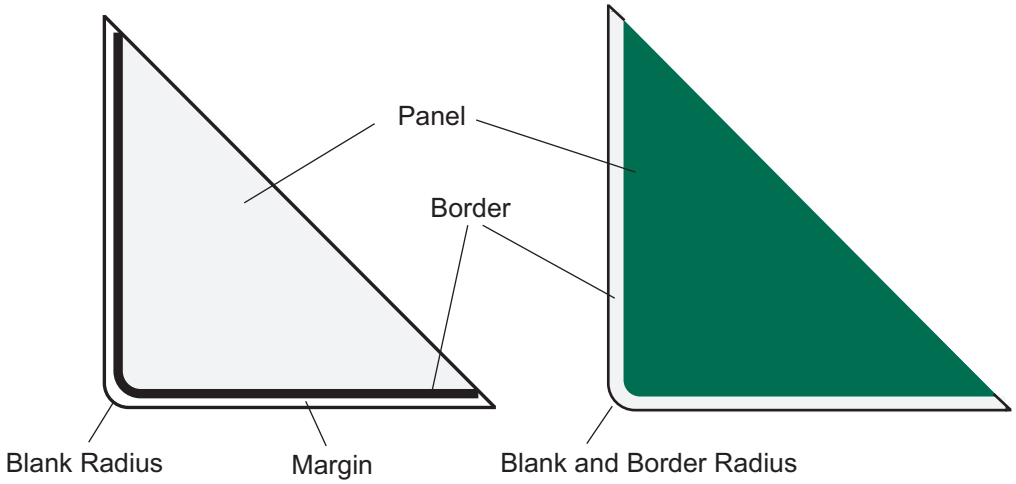
Speed greatly affects the legibility and comprehension of sign legends. Therefore, larger sign sizes are advantageous where increased legibility or emphasis is desirable.

For special circumstances such as limited highway right-of-way, or conditions such as parking facilities, parks, etc., the use of smaller than standard size signs may be justified. When sign sizes are changed, retain the standard shapes, colors, and proportions insofar as practicable.

Unless indicated otherwise, each sign shall have a border of the same color as the legend, at or just inside the panel edge. Except for STOP signs, borders on all signs should have round corners. And with a few exceptions, all sign blanks are required to have rounded corners in order to reduce potential injuries if someone hits the corner of the sign. (Exceptions include the STOP sign, Railroad Crossbuck sign and plaques, temporary signs on plywood blanks, and large signs fabricated from extruded aluminum panels.)

As illustrated in Exhibit 2.12, a dark border on a light background has a "margin" or setback distance from the edge. This setback serves two purposes: (1) it improves aesthetics; and (2) it reduces the possibility that the ink will run over the edge of the blank if manufactured by a silk-screening process. The outside corner radius of a dark-colored border is equal to the radius used on the sign blank, less the width of the margin.

Exhibit 2.12: Location of Borders and Margins



The Appendix in Part 7 of the *SHSM Book* identifies the standard sign blanks. Typical dimensions for margins, borders, and radii are indicated in Exhibit 2.13.

Exhibit 2.13: Typical Dimensions for Margins, Borders, and Blank Radii*

Sign Size* (inch)	Width of White Borders (inch)**	Widths for Signs with a Black Border (inch)		Blank Radius (inch)***
		Margin	Border	
18	0.5	0.375	0.625	1.5
24	0.5	0.375	0.625	1.5
30	0.75	0.5	0.75	1.875
36	0.75	0.625	0.875	2.25
48	1	0.75	1.25	3
60	1	0.75	1.25	3

* Generally the sign width or a side dimension for diamond-shaped signs (use a lower value for signs that have large widths and small heights)

** For example, STOP, YIELD, DO NOT ENTER, and guide signs

*** When applicable

Sometimes it is necessary to use substandard size signs due to limited highway right-of-way, to limit the sign width of overhead signs due to the lane width, or to limit the height of a sign due to vertical clearances. In these situations, there is a natural tendency to crowd letters together; however, legibility may be better with smaller letters and normal spacing between letters than with larger letters and cramped spacing. Spacing between letters should never be reduced more than 50 percent.

2.1.10 Standard Size Sign

Most roads within military installations are conventional highways. Therefore, if more than one size sign is included in the *SHSM Book*, the standard size would be the size indicated by a black box with a white "C" in it, which represents the standard size for conventional roadways (see Exhibit 2.3).

The typical size of some of the most common signs are also shown in Exhibit 2.14. Minimum sign size may be decreased by 6 inches in alleys that have restrictive physical conditions.

Exhibit 2.14: Sizes of Common Signs

Sign Name and Nomenclature	Size, Width x Height (inches)
STOP (R1-1)	30x30*
YIELD (R1-2)	36x36x36*
Speed Limit (R2-1)	24x30*
Turn Prohibition (R3-series)	24x24*
DO NOT PASS (R4-1)	24x30
DO NOT ENTER (R5-1)	30x30*
WRONG WAY (R5-1a)	36x24*
GOVERNMENT VEHICLES ONLY (R5-11g-TEA)	30x24
ONE WAY (R6-1)	36x12*
No Parking (R7-series)	12x12
NO TURN ON RED (R10-11, R10-11a)	24x30*
ROAD CLOSED (R11-2)	48x30
GATE CLOSED (R11-2g-TEA)	48x30
ROAD CLOSED FOR PT (___) (R11-4b-TEA)	36x48
Hazardous Material Prohibition (R14-3)	24x24
USE PARKING LIGHTS AT GATE (R16-5a-TEA)	24x30
RADIO TRANSMISSIONS PERMITTED (R22-4-TEA)	36x24
Turn (W1-1) & Curve (W1-2)	30x30*

Sign Name and Nomenclature	Size, Width x Height (inches)
Chevron (W1-8)	18x24
Intersection (W2-series)	30x30
STOP/YIELD/Signal Ahead (W3-series)	30x30
ACTIVE BARRIER (W3-3a-TEA)	36x36
BARRIER ACTIVATED WHEN FLASHING (W3-3b-TEA)	36x36
Speed Reduction (W3-5)	36x36
CHECK POINT (W3-10-TEA)	36x36
Railroad Advance Warning (W10-1)	36
Pedestrian (W11-2)	30x30*
LOW AIRCRAFT (W11-26-TEA)	30x30*
HAZARDOUS CARGO CROSSING (W11-29-TEA)	36x36
Advisory Speed (W13-1P)	18x18
NO PASSING ZONE (W14-3 pennant)	48x48x36
Advance Street Name (W16-8P-series)	6-inch legend
GATE CLOSED AHEAD (W20-3g-TEA)	36x36
Destination (D1-, D2-series)	6-inch legend
Street Name (D3-1-TEA)	6-inch legend*

**A larger size will normally be required for multi-lane roadways.*

2.1.11 Sign Location and Orientation

Longitudinal Placement

If several signs are competing for a driver's attention at the same time, the driver may become confused or make unsafe maneuvers. Therefore, it is important not to overload drivers with unnecessary signs or signs that are too close together.

The longitudinal spacing between signs in a series may vary, but as a general rule the minimum spacing on conventional roadways should be approximately 200 feet. Installations are encouraged, however, to use greater distances on high-speed conventional roads, but it may be necessary to use reduced spacing in some areas if there are a lot of signs.

The actual placement of a sign depends on the type of sign, the nature of the message, and the desired motorist response:

- ✓ Warning signs generally belong in advance of the condition to which they call attention, whereas regulatory signs belong at the location where a traffic law or regulation applies or at intervals throughout a section of roadway where a restriction applies.
- ✓ Regulatory signs can apply at a specific spot location (e.g., a requirement to stop, or a turn prohibition) or along an entire road or portion of road (e.g., a speed limit or weight limit). The first sign should be installed as close as possible to the location where the restriction applies or begins.
- ✓ The minimum advance distance for some warning signs is defined in Section 2.3.1, but using a greater distance is better than installing signs too close to the hazard that is being warned about.
- ✓ On the other hand, place guide signs at varying locations to inform drivers as to their route of travel, destinations, and points of interest. Exhibit 2.15 defines the priority order when too many signs are competing for the same location.

You can generally shift most signs longitudinally without compromising their intended purpose. Signs may also be shifted longitudinally to improve their visibility, to avoid blocking other signs, to improve safety (by placing sign supports behind an existing barrier), or to improve operations (by providing more distance between signs in a series).

Exhibit 2.15: Sign Location Priority

1. Regulatory Signs – Stop, Yield, Turn Prohibitions, Lane Restrictions, Weight Limit, and Speed Limit, followed by Parking Restrictions and various other regulatory signs.
2. Warning Signs – Turn, Curve, Cross Road, Stop Ahead, Yield Ahead, Signal Ahead, Merging Traffic, Road Narrows, Narrow Bridge, Ramp Narrows, Divided Highway, and various other warning signs.
3. Guide Signs – Route Markers, Trailblazers, Destination, Advance Guide, and Exit Directional.
4. Emergency Service Signs – Hospital, Police, and Telephone.
5. Public Transportation Signs – Park and Ride, Bus Stop, and Light Rail.

While it is preferable to erect signs individually except where one sign supplements another, it is sometimes advantageous to group signs together to eliminate extra posts. This is particularly true in urban areas where the number of signs is greater than the space available. Urban areas, in particular, may require a case-by-case review.

Make signing location decisions on a case-by-case basis considering the signing needs for the entire route. If more than one sign normally belongs at the same location, relocate or eliminate the lower-priority sign. For example:

- ✓ If a curve warning sign and a distance sign would normally belong at the same location, the curve sign should have priority because of the need to place it in advance of the curve. On the other hand, you may be able to move a distance sign further ahead of or beyond the curve sign, or even eliminate it if other similar signs are along the roadway.
- ✓ If two restrictions such as a speed limit and a weight limit both begin at the beginning of a side road, the first Weight Limit (R12-1) sign takes precedence to avoid entrapment of over-weight vehicles. In this situation, the R12-1 sign can be installed within about 25 to 50 feet of the beginning of the road to avoid entrapment, and the first Speed Limit (R2-1) sign should be installed 200 feet or more beyond the R12-1 sign.

Also, avoid placing signs at inappropriate locations. For example, do not place Speed Limit (R2-1) signs just before an intersection, or on or immediately in advance of a curve with a lower advisory speed.

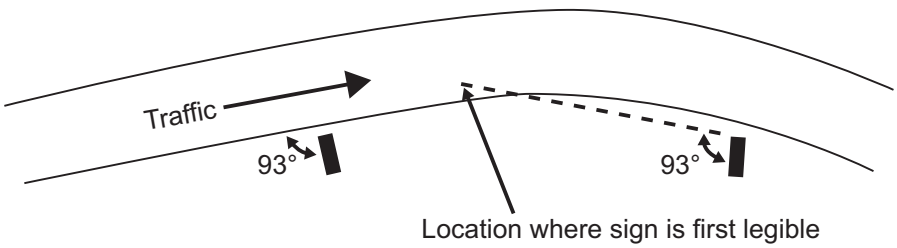
Sign Orientation

Historically, signs have been oriented to be perpendicular to the driver's line of sight, but because of mirror reflection with today's "brighter" materials, it is normally best to angle the sign slightly away from the driver.

To reduce mirror reflection from the glossy face of traffic signs, the recommended orientation for post-mounted signs is as follows, and as illustrated in Exhibit 2.16:

- ✓ On tangent sections, install sign posts plumb, but position the posts so that the face of the sign is angled 93 degrees away from the edge of roadway. (NOTE: This orientation would be approximately a 1:20 angle from being perpendicular.)
- ✓ On horizontal curves, install sign posts plumb, but position the posts so that the face of the sign is angled 93 degrees away from an imaginary straight line between the edge of road at the sign and the edge of the road at a distance where the sign is first legible (based on 30 feet per 1 inch of letter height).

Exhibit 2.16: Recommended Sign Orientation



An exception to this general rule is noted in Section 2.2.11 for parking signs, because parking signs should be installed at a 45-degree angle to the edge of the roadway (i.e., the signs would face drivers if drivers are looking ahead but at a 45-degree angle toward the parking side of the roadway).

If signs are installed over the roadway, position the overhead signs perpendicular to approaching traffic at the location where the sign is first legible (based on 30 feet per 1 inch of letter height). On level roadways and those with an upgrade, angle the sign downward about 3 degrees more than the grade of the roadway. On downgrades, mount the sign vertical.

2.1.12 Sign Blanks

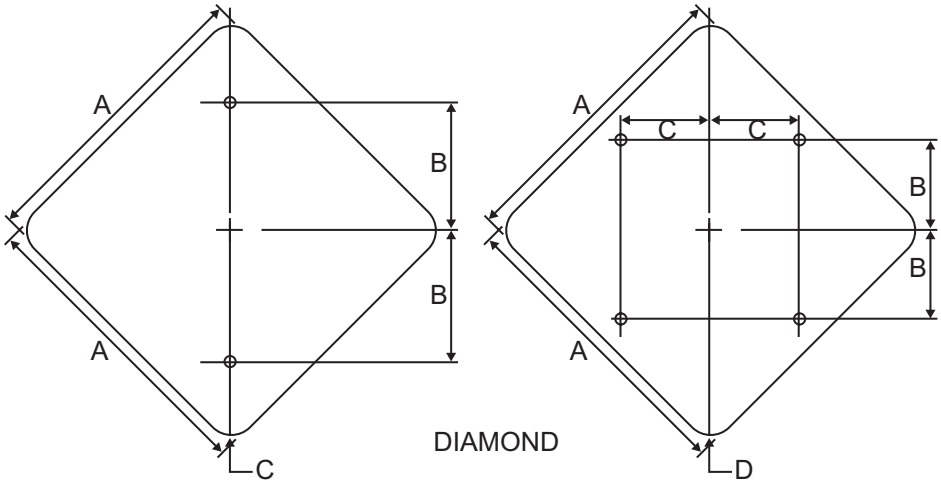
Aluminum is the most cost-effective material for sign blanks, and when the sign needs replaced, the salvage value sometimes is almost 50 percent of the cost of a new sign blank.

Aluminum is the most common material used for sign blanks. Although plywood and steel have been used by some agencies, steel is about three times heavier than aluminum, and neither last as long as aluminum (plywood delaminates and steel rusts). Therefore, all installations are encouraged to specify aluminum for sign blanks, except plywood may be used for temporary signs.

Part 7 of the *SHSM Book* includes blank standards for over 50 combinations of size, shape, and rotation of the sign blanks. The standards, as illustrated in Exhibit 2.17, include dimensions for corner radii and the locations of the mounting holes. It should be noted that the spatial arrangement of the holes generally defines the number of sign posts and their spacing.

Although not included in the *SHSM Book*, most transportation agencies use 3/8th-inch diameter holes and 5/16th-inch diameter aluminum bolts. In addition, military installations are also encouraged to request that sign blanks conform to ASTM B 209; Alloy 5052-H36, 5052-H38, 5154-H38, 6061-T6, 3004-H38, or recycled 3004-H38. Sign blanks should have a chemical conversion coating conforming to MIL-C-5541, or revisions thereto.

Exhibit 2.17: Example of a Sign Blank Standard



A	B	C
24	12	15
30	15	1.875
36	18	2.25

A	B	C	D
48	15	15	3
60	18	18	3.75

Suggested minimum sign blank thickness is identified below.

Suggested Minimum Thickness of Aluminum Sign Blanks*

- ✓ 0.080” if stiffeners are used to strengthen the sign, or if both the sign width and the sign height is not greater than 30 inches.
- ✓ 0.100” if the largest dimension (width or height) of a sign without stiffeners is greater than 30 inches, but not greater than 48 inches.
- ✓ 0.125” if the height or width of a sign without stiffeners is greater than 48 inches.

* NOTE: The width and height of a diagonal-shaped sign is the measurements along the edges, typically the value labeled as Dimension “A”

2.1.13 Sign Supports

Installations are strongly encouraged to specify steel square sign posts because of the inherent advantages and availabilities.

Signs with Areas Less Than 35 Square Feet

Most traffic signs can be manufactured from flat sheet aluminum substrate and mounted on one or two posts depending on the sign area.

To reduce potential injuries and vehicle damage, all sign posts must be a breakaway or yielding design as approved by FHWA. Breakaway post systems generally rely on a two-piece post, with a weakened connection. In addition to reducing damage to an errant vehicle and its occupants, a two-piece post system also allows the anchor post to be installed from the ground level as opposed to an elevated platform or ladder, thereby reducing the likelihood of someone getting hurt.

Common breakaway posts are discussed and illustrated in Exhibits 2.18 and 2.19, respectively.

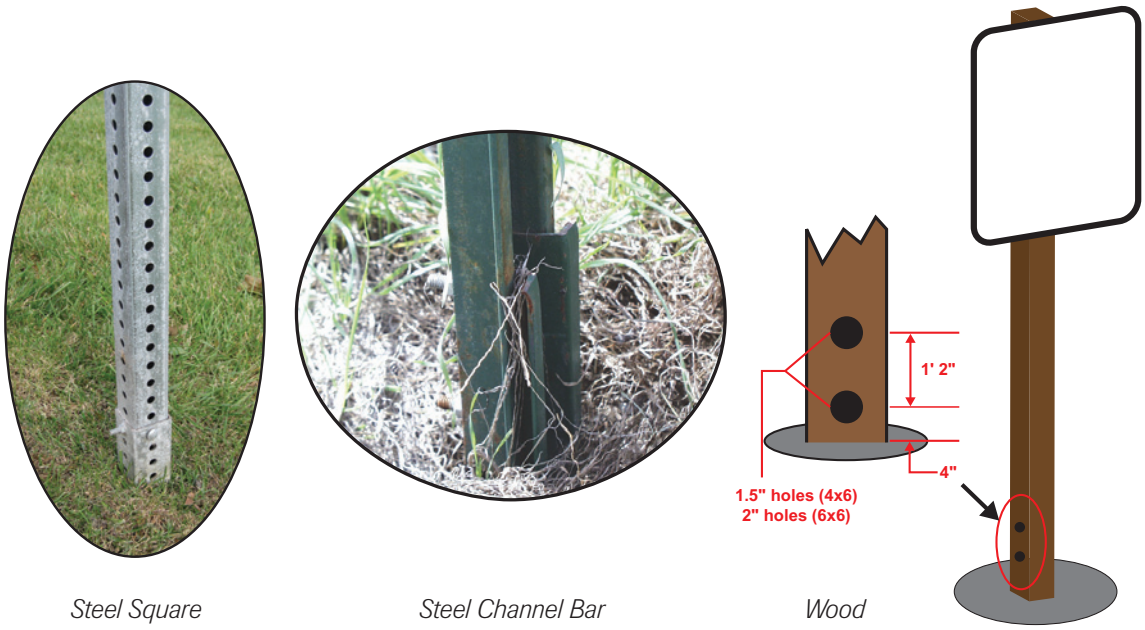
Exhibit 2.18: Common Breakaway Sign Posts

Type	Comments*	Manufacturers**
Steel square (common sizes include 1.75”x1.75”, 2”x2”, 2.25”x2.25” & 2.5”x2.5”)	✓ Due to their closed cross section, these posts have great torsional resistance and this eliminates most sign flutter ✓ A sign post is inserted into a 1/4-inch larger size anchor post and is attached with one bolt ✓ Signs can be mounted on all four sides of the post	✓ Allied Tube/Unistrut: http://www.alliedtube.com/html/signsupport.html ✓ Western Highway Products: http://www.westernhighway.com ✓ Nucor Steel Marion: http://www.nucorhighway.com
Steel channel bar (common sizes: 2.5 lb./foot, & 4 lb./foot)	✓ May be less expensive than steel square posts ✓ Unlike square posts, these posts have an open cross section that lacks torsional resistance, which allows signs to flutter in the wind ✓ Because sign posts twist back and forth both above and below the ground, over time the posts work loose in the soil and start to lean, creating an ongoing maintenance problem	✓ Nucor Steel Marion: http://www.nucorhighway.com
Wood posts (common sizes: 4”x4”, 4”x6” & 6”x6”)	✓ Should specify Yellow Pine or Douglas Fir pressure-treated lumber ✓ Generally require a concrete foundation to satisfy national breakaway criteria, thus making replacement problematic ✓ Except for the 4”x4” posts, installers must drill two transverse holes near the base of each post (See Exhibit 2.19) ✓ Posts sometimes warp or curl as they weather	✓ Available at larger lumber yards

* Anchor posts should never extend more than 4 inches above the ground to minimize the chance of the anchor post snagging the undercarriage of an impacting vehicle. In fact, the 4-inch maximum height is technically above any 60-inch long chord between the ground surface on the left side of the post and the ground surface on the right side to replicate an impacting vehicle running over the anchor post. Therefore, if the ground is humped upward in the vicinity of the post, the maximum allowable height of an anchor post will be less than 4 inches.

** For steel square posts and steel channel bar posts, the post supplier should provide: (1) certification concerning FHWA’s approval, including the maximum number of sign posts that are allowed within a 7-foot path; (2) documentation showing the maximum sign area that the posts will support at various sign heights, based on the locale’s design wind and soil conditions; and (3) proper installation instructions.

Exhibit 2.19: Small Breakaway Sign Posts



Steel Square *Steel Channel Bar* *Wood*

Signs with Areas Greater Than 36 Square Feet

Occasionally, military installations find it necessary to install large signs. When this happens, installations are encouraged to have the signs fabricated from extruded aluminum channels. These signs are available from some of the larger sign manufacturers, and they are constructed from extruded aluminum channels that typically are 12 inches high. Making a sign from these modular components is reminiscent of building with an erector set in that each piece is bolted together, one on top of the other to form the complete sign.

Large signs also create a need for special posts that require heavy duty breakaway connectors. If the need arises, installations may consult with SDDCTEA on the design of the sign and the sign supports.

Overhead Sign Installations

Overhead signs are generally used only with overhead traffic signals and at the following locations:

- ✓ Three or more lanes in one direction
- ✓ Areas with restricted sight distance
- ✓ Left-hand or multi-lane exits
- ✓ Insufficient space for ground-mounted signs

If your installation believes that overhead signs are warranted, the installation is encouraged to contact SDDCTEA for assistance. In most cases, a mast arm can be installed to support the typical signing needs, but overhead sign structures may also require shielding in the form of guardrail, barriers, attenuators, or a combination of properly placed devices.

2.1.14 Enhanced Conspicuity of Standard Signs

When engineering judgment indicates that there is a need to draw additional attention to a sign, there are several acceptable methods to accomplish this, including:

1. Use a larger sign or an additional sign on the opposite side of the roadway.
2. Attach one or two red flags above a standard regulatory or warning sign, oriented at a 45-degree angle, especially for temporary conditions. (NOTE: Within a short period of time, the flags will lose their color and they will need replaced.)
3. Attach a single flashing yellow light to the top of the sign, except use a red light if attaching to a STOP sign. Installations should be aware, however, that the cost of running commercial power to a sign or replacing batteries can be significant.
4. Provide small light emitting diodes (LEDs) along the sign border or to supplement a symbol or word message. To date, the effectiveness of these lights has not been studied and the relatively high cost per installation indicates that it may be beneficial to consider other measures.
5. For regulatory and warning signs, attach a minimum 2-inch wide strip of retroreflective sheeting material on the front side of the sign posts from the bottom of the sign to a location not greater than 2 feet above the elevation of the roadway. The color must match the background color of the sign.

Image provided courtesy of Traffic and Parking Control Co., Inc. TAPCO (www.tapconet.com)

Of the five options, Options 1 and 5 are the preferred options.

For Option 5, plastic retroreflective sleeves are commercially available from several sources, and sign crews can generally attach them to the posts with self-tapping screws. Depending on the type of sign post, a similar effect can be obtained by applying retroreflective sheeting directly to the front of the sign post.

These retroreflective strips are very effective at night, perhaps because they show the physical location of the sign instead of allowing the retroreflective sign to appear to be floating in the air. During daylight hours, the colored strips are also somewhat effective as an attention-getting device. Since these strips are relatively inexpensive, require no batteries or electricity, and should last as long as the sign, they currently are a recommended attention-getting device.

2.1.15 Sign Maintenance

Poorly maintained signs lose the respect of the motorist, and consequently they lose their effectiveness as traffic control devices. Under most circumstances, it is cheaper to replace damaged or unreadable signs than to attempt to repair them.

It is always a good idea to encourage military personnel to report any missing, damaged or ineffective signs. Ineffective signs include those blocked by vegetation and by other signs. Take pride in your facilities!

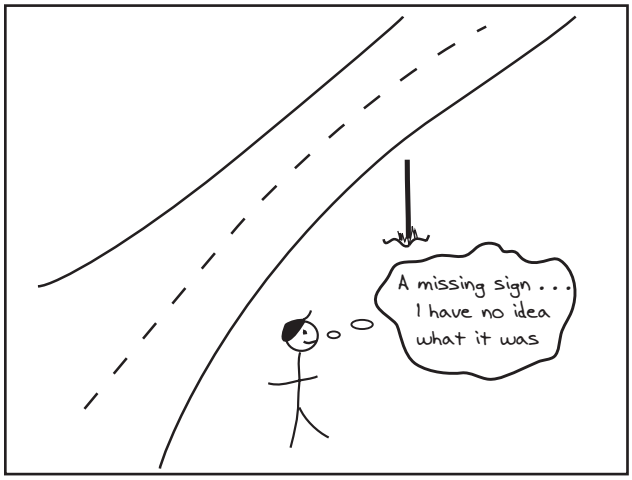
This sign should have been replaced years ago, before the red color disappeared.

2.1.16 Sign Inventory

One cannot overemphasize the importance of having a good sign inventory. For example, without an inventory, missing signs may go unnoticed for years, perhaps until someone complains or a crash problem evolves and someone restudies the location. Computerized listings also facilitate drive-by sign inspections.

A good sign inventory system should improve the quality of a signing program and reduce the number of crashes. A computerized inventory can also assist in determining the anticipated number of any given type of sign that should be replaced next year or during some other time period based on the age of the sign.

The process of capturing, analyzing, and presenting sign inventory information has evolved significantly in the last decade. The reduced cost and increased accuracy of using the Global Positioning System (GPS) has made the process of inventorying assets along highways much easier and more viable. In addition, the sophistication of Geographic Information Systems (GIS) has provided better data models for displaying and integrating asset inventories using Linear Referencing Systems (LRS). Today, it is possible to capture road assets using photography and GPS technologies, integrate the GPS locations using the LRS, and generate milepost/offset values for the sign locations.



Items to Capture in a Sign Inventory

- ✓ Roadway name or designation.
- ✓ Direction of travel.
- ✓ Linear location along the road (or GPS coordinates).
- ✓ Side of road (left, median, overhead, or right side).
- ✓ Sign code and size.
- ✓ Sign message if unique (e.g., destination and distance signs are generally one of a kind signs).
- ✓ Position of the sign on an assembly with other signs.
- ✓ Type and manufacturer of sheeting.
- ✓ Type and number of sign supports.
- ✓ Date installed.
- ✓ Date last inspected.
- ✓ Inspection comments (physical condition, retroreflectivity readings, required maintenance, etc.)
- ✓ Maintenance history (replacement date for sign posts, etc)

Off-the-shelf databases such as SignTRACK™ are available to capture virtually any sign element, plus digital pictures, maintenance history, etc. This system also provides seamless integration with other SignCAD® products.

One of the most popular software packages used for sign inventories is CartêGraph's suite of modules that facilitates asset management not only for signs, but also for water, sewer, storm water, bridge, lights, pavements, etc. For an initial investment of about $10,000 to $15,000, installations can purchase a personal digital assistant (PDA) with GPS and the necessary licenses and training, and then lease the software suite for about $2,500 per year.

Software is also available from GBA Sign Master.

Which is Worse, a Sign with Substandard Retroreflectivity, or a Missing Sign?

If a sign has substandard retroreflectivity, it probably is still effective during the day and perhaps somewhat effective at night. Moreover, there is also an excellent chance that the sign will eventually be replaced.

However, if the sign was knocked down and there is no sign inventory, it is possible that the missing sign may never be replaced. Or even worse, perhaps the missing sign will cause a crash before someone restudies the location and a new sign is installed.

Therefore, the value of a good sign inventory cannot be overemphasized.

The beauty of any electronic sign inventory is that it can help manage a sign maintenance program while keeping costs to a minimum. Military installations can develop their own electronic log of their field reviews using more primitive methods. One method is to manually drive the roads and capture the attributes and location of each sign along the highway. Experienced field and traffic personnel can readily identify the standard signs and select the *MUTCD* sign codes. By keeping electronic copies of the inventory, missing signs and those that need replaced due to their age can be quickly identified.

2.1.17 Sign Management Methods

Historically, the most common method used by highway agencies to evaluate sign retroreflectivity was to have a sign inspector drive the road at night and identify the unacceptable signs and then schedule them for replacement. However, this method is subjective, and now the stakes are higher because minimum retroreflectivity values have been established.

Exhibit 2.20 identifies five methods to maintain adequate sign retroreflectivity, and the advantages and disadvantages of each. The first two methods are assessment methods where signs are evaluated individually, and the last three methods are management methods where signs are evaluated on a macroscopic basis. These methods are not foolproof, but FHWA requires that every agency implement a program to maintain sign retroreflectivity.

Section 2A.08 of the *MUTCD* States:

"Public agencies or officials having jurisdiction shall use an assessment or management method that is designed to maintain sign retroreflectivity at or above the minimum levels in Table 2A-3."

"Compliance with the Standard in Paragraph 2 is achieved by having a method in place and using the method to maintain the minimum levels established in Table 2A-3. Provided that an assessment or management method is being used, an agency or official having jurisdiction would be in compliance with the Standard in Paragraph 2 even if there are some individual signs that do not meet the minimum retroreflectivity levels at a particular point in time."

ASSESSMENT METHODS

Method A: Visual Nighttime Inspection.

As noted before, Method A is the method historically used by most highway agencies, but in order to be acceptable, it must be fine-tuned. Therefore, if Method A is used, inspectors need to be trained, and additional guidelines must be followed.

Although the visual assessment method is subjective, it does help to identify some other issues such as: signs hidden by foliage, signs that are not properly aligned, nighttime visual clutter, blinding floodlights, and other distractions. If used as the sign assessment method, it should generally be repeated annually, or at least every other year.

Method A could be performed several ways, some of which require the use of marginally acceptable signs for "calibrating" the inspector's eyes. However, for small agencies, FHWA suggests using the "Consistent Parameter Procedure" as defined in their *Sign Retroreflectivity Guidebook: How to Meet the New National Standard for Small Agencies, Federal Land Management Agencies, and Tribal Governments*.

If using the consistent parameter procedure, inspections must be conducted at night, and:

- ✓ Inspectors must be 60 years or older;
- ✓ Inspectors must conduct inspections from a sports utility vehicle (SUV) or pickup truck, model year 2000 or later;
- ✓ Inspectors must go through training. Training courses are available at many Local Technical Assistance Program (LTAP) centers, http://www.ltapt2.org.

In addition, if using this method, each military installation should develop additional guidelines for conducting nighttime inspections that, at a minimum, include the following:

1. **Consistency of testing** – Conduct inspections during consistent nighttime conditions. For example, always conduct inspections when there is no rain or fog, and when signs do not have snow or dew on their faces. Keep the interior vehicle lights off, and use a pen light for recording the results of the inspection. Use at least three ratings: good, marginal, and defective. Do not start the inspection until it is completely dark.
2. **Speed of vehicle** – Conduct inspections at normal roadway operating speeds. If you have to slow or stop the vehicle to read the sign, this usually means the sign should be replaced.
3. **Vehicle position** – Signs should be inspected from the travel lane, and at the typical viewing distance, that is, at a distance that provides the driver adequate time for an appropriate response.
4. **Headlights** – Use properly aimed low-beam headlights. Take the vehicle to a local mechanic to verify that the head lamps are properly aimed.
5. **Safety issues** – If possible, designate a driver for the vehicle. This serves the dual purpose of allowing the inspector to focus on the sign evaluation, which promotes consistency and accuracy of results, as well as improving safety for everyone on the roadway. If the inspector has to drive, use a tape recorder to record verbal evaluations.
6. **Recordkeeping** – Use a standardized form for tracking inspection results and maintain results in a file cabinet or a computer database for ease of reference and future use. Have the form partially filled out prior to the nighttime review, including the sign location and type listed in the driving order

so that the inspector can concentrate on the visual evaluation and only needs to enter the score. The form may be a printout from a computerized inventory or a hand-written form similar to the example.

Nighttime Sign Inspection Form

Road: _____ Military Installation: _____

Direction: _____

Route Start Point: _____ Inspector: _____

Route End Point: _____ Date: _____

Trip Odometer	Sign Description	Retroreflectivity			Replacement Date
		Good	Marginal	Defective	
0.1	Speed Limit 35	✔			
0.5	Crossroad			✔	
0.6	STOP		✔		

7. **Replacement** – As soon as possible, replace any sign that is not legible to the inspector at the typical viewing distance and speed. Also, schedule any signs rated as marginal for replacement since it may be at least a year before the signs are reviewed again.
8. **Frequency** – Installations should generally perform inspections on an annual basis, but at least every other year.
9. **Documentation** – Maintain all evaluations for future reference to prove that the inspections were conducted and that defective and marginal signs were replaced.

If using this method, installations are strongly encouraged to retain the list of signs and sign locations in a computerized inventory (e.g., a simple database or spreadsheet) that can be used to generate new inspection forms for the next nighttime inspection. This type of inventory also helps to identify any signs that were lost during the year. However, the ultimate goal should be to eventually transfer the data to a more complex inventory.

Will the "Consistent Parameter Procedure" Work?

Any visual inspection is subjective, but the important thing to remember is that this procedure attempts to duplicate a person with poorer vision in a vehicle that returns less retroreflected light to the driver. The goal is to reduce as many variables as possible, which is essentially the methodology used to develop the minimum retroreflectivity values, except in this case only one trained inspector is being used instead of a series of trained inspectors. Therefore, this procedure should work.

Method B: Measured Sign Retroreflectivity.

Technically, a military installation could take retroreflectivity readings on every sign with a retroreflectometer to determine which signs need replaced. However, as previously mentioned, using a retroreflectometer is definitely not a quick or an easy task. Therefore, taking readings on every sign is not a viable method.

MANAGEMENT METHODS

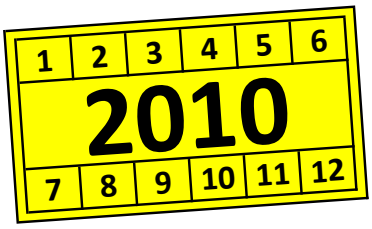
Method C: Expected Sign Life.

Manufacturers of Type III and higher types of sheeting typically provide a minimum 10-year warranty for their materials during which they guarantee a minimum retroreflectivity. Since the guaranteed retroreflectivity values at the end of the warranty period (typically 80 percent of new minimum values) are significantly greater than FHWA's minimum retroreflectivity values, or the values in Exhibit 2.10, these materials should exceed the manufacturer's warranty even if installed under the harshest conditions; i.e., south-facing signs (in the northern hemisphere) installed at locations with high temperatures, high humidity, and high elevation.

Therefore, it should be safe to assume that at a minimum, signs will last at least as long as the warranty. In fact, many highway agencies have determined that signs made from Type III or Type IV material have a life expectancy of 12 to 15 years. However, agencies can occasionally monitor some signs and adopt either a longer or a shorter "expected sign life," as appropriate. In addition, military installations can query their state Department of Transportation (DOT) to learn about their experience, with specific manufacturers, types, and colors of sheeting.

Ideally, military installations should be working from a sign inventory database. However, in the absence of an inventory, the sign installation date can be identified by:

- ✓ Applying a durable preprinted label on the back of the sign that displays the year that the sign was installed. The sticker may also include the months, or the months and the days, where the person installing the sign punches out the appropriate numbers to show the installation date prior to affixing it to the sign. Stickers are typically about 3 to 4 inches wide, and are available from companies like 3M, Custom Products Corporation, and others. If using stickers, military installations are encouraged to use different colors for each year to expedite field reviews.



- ✓ Physically writing the installation date on the back of the sign blanks with a durable paint marker.

> **Expected Sign Life?**
>
> The "*Expected Sign Life*" is your best estimate of the maximum number of years that the retroreflectivity of a specific type and color of retroreflective sheeting on a south-facing sign (in the northern hemisphere) will satisfy the minimum retroreflectivity values. The expected sign life may be based on the manufacturer's warranty or the sign retroreflectivity degradation in the same basic geographic area for each specific manufacturer, type, and color of sheeting.

Military installations must keep in mind, however, that without a sign inventory, the inspector will need to get close enough to each sign to "read" the date on the back of the sign to determine the year that the sign was installed. And, to put things in perspective, if the expected sign life is 12 years, on the average the installation date of 12 signs would need to be reviewed before identifying one sign that needs replaced.

Method D: Blanket Replacement.

The blanket replacement method also uses the expected sign life but with this method all signs in a specified area or all signs of a given type are replaced at the same time. This approach simplifies the date of installation by allowing external records to be kept instead of requiring a sign inventory or adding the date to the back of every sign. For example, if all colors of sheeting provide a minimum 13-year life as determined by sampling or via the local DOT, then if your installation replaces all signs in 2010, the next scheduled replacement program would be in 2023.

By replacing all of the signs at the same time, the need to monitor individual sign replacement dates is eliminated. However, it is always a good idea to inspect signs on a regular basis to ensure that signs are present and properly oriented, and that drivers have a clean line-of-sight to the signs. It is also good to perform some of the reviews at night, because night reviews help identify problems caused by lights and other visual distractions.

To provide a more uniform budgetary impact, it may be desirable to:

1. Divide the military installation into several smaller areas, each having a different replacement cycle, or
2. Spread the type of signs over a series of years; e.g., replace STOP and YIELD signs in one year, speed limit signs a second year, other regulatory signs a third year, etc.

It is important to remember, however, that some signs will be replaced mid-cycle due to crashes, construction, etc., and these signs will eventually need to be replaced prematurely in order to maintain the same cycle. However, the blanket method does have many advantages.

Method E: Control Signs.

This method requires the designation of control signs to represent every manufacturer, type, and color combination from ongoing sign purchases. Because it is labor intensive to take retroreflective readings, this method has broader application for DOTs where these costs can be spread over a larger signing program.

What Method is Best for Your Installation?

In the long-term, it is safe to say that the simplest and most economical way to ensure that signs satisfy the minimum sign retroreflectivity standards is by using one of two management methods, either Method C or D. Moreover, the choice depends on the availability of a sign inventory.

For example, for installations with a sign inventory, Method C (i.e., the “Expected Sign Life” approach) probably is the best choice because new signs can be ordered based on the sign inventory. However, if a sign inventory does not exist, Method D (i.e., the “Blanket Replacement” approach) is the recommended method.

In either case, the installation needs to temporarily supplement the program with a visual nighttime inspection (Method A) in order to ease into the selected program. For example, if Method C is selected and some sign installation dates are not available, start to track the new installation dates but also replace obvious problem signs based on visual nighttime inspections. Similarly, if Method D is selected, signs that are scheduled for some future blanket replacement period should be routinely inspected at night until all signs are replaced the first time.

However, in the short-term, installations may elect to use Method A as their starting point and then start building a sign inventory database with the goal of ultimately converting to Method C. In this case, the inventory should be complete with replacement dates, sign sizes, type material, etc.

Exhibit 2.20: Sign Replacement Programs

Methods	Advantages	Disadvantages
A. Visual Nighttime Inspection. Inspect all signs at night by a trained sign inspector, driving at normal speeds and using low-beams. The inspector should be 60 or older and should evaluate the signs from the normal viewing distance. The vehicle should be a 2000 model year or newer SUV or pick-up truck. Replace defective and marginally-acceptable signs.	✓ Helps evaluate sign orientation issues and other distractions	✓ Requires a trained, nighttime sign inspector ✓ Subjective and inaccurate ✓ Requires a frequent review ✓ Requires some type of inventory to document the signs that are acceptable, marginal, or defective
B. Measured Sign Retroreflectivity. Periodically measure the retroreflectivity of sign backgrounds and retroreflective legends. Replace the individual signs with substandard retroreflectivity values.	✓ Minimizes prematurely replacing signs	✓ Requires a retroreflectometer ✓ Extremely labor intensive ✓ Potential hazards if climbing ladders ✓ Requires an inventory to document the retroreflectivity readings
C. Expected Sign Life. Replace individual signs based on the age of the sign and the expected sign life. To track the installation date, maintain a sign inventory or identify the year of installation on the back of the signs.	✓ Simple	✓ Requires an inventory or a sign-dating system ✓ If using a sign-dating system, inspectors need to search for the target year signs
D. Blanket Sign Replacement. Replace all signs on the installation or area within the installation at the same time using the previous replacement date and the expected sign life. (A variation could be, replace all STOP signs in Year #1, Speed Limit signs in Year #2, other regulatory signs in Year #3, etc.)	✓ May reduce the mixing of old and new signs ✓ Lowest labor costs	✓ May prematurely replace some signs installed between blanket replacement cycles; e.g., signs that replaced signs damaged in crashes ✓ Special funding may be needed if the effort is base wide
E. Control Signs. Replace individual signs based on measured retroreflectivity of signs that represent the general population of signs purchased and installed in the same basic time frame. The control signs can either be installed in the field or in another location such as in a maintenance yard, but should face south in the northern hemisphere.	✓ Provides for year-to-year differences in materials	✓ Requires a retroreflectometer and a sign inventory ✓ The number of control signs could be extensive since multiple signs should be installed to represent all color combinations from different groups of sign purchases ✓ Evaluating the retroreflectivity of all control signs could be very labor intensive

With reference to Exhibit 2.20, purchasing a retroreflectometer should be unnecessary if your installation is using:

- ✓ Method A; i.e., visual nighttime inspection; or
- ✓ Methods C or D and your "expected sign life" is based on the sheeting manufacturer's warranty or information provided by a reliable outside source such as your state DOT. (Installations should retain documentation regarding their information source.)

"First Things, First"

Prior to implementing a major sign replacement program, it is very important to review existing signs to make sure that they are appropriate instead of merely replacing them with the same type of sign. For example:

- ✓ Are the speed limits and advisory speeds appropriate?
- ✓ Did traffic volumes change so much that the STOP signs are now on the major roads instead of on the minor roads?
- ✓ Are there any obsolete signs; e.g., 2-WAY, 3-WAY, or 4-WAY plaques?
- ✓ Are the advance warning signs located at an appropriate distance from the hazard in accordance with Table 2C-4 in the current *MUTCD*?
- ✓ Are all of the signs necessary? For example, why would you need railroad crossing signs if the tracks were removed or paved over?
- ✓ Do you need a larger sign? For example, the *MUTCD* now requires 36"x36" STOP signs on multi-lane approaches, and on any approach to a multi-lane road with a speed limit of 45 mph or higher. Also, on multi-lane roadways, 36"x36" is now the minimum size for Curve and Turn signs.
- ✓ Can some signs be relocated to spread them out to improve the driver's ability to "read" the signs?
- ✓ Are the signs located in advance of the entry control facility (ECF) in accordance with the standards?

2.2 Regulatory Signs, Barricades, and Gates

Regulatory signs, barricades, gates, and other barriers inform drivers of traffic laws, regulations, or restrictions, for which they can be cited by law enforcement agencies. In light of the enforcement aspect, it is essential that the signs be readily visible and understandable.

Regulatory signs are typically black-and-white rectangular signs, but several exceptions exist as noted in Exhibit 2.1. The most common exceptions to the color and shape rules are the STOP and YIELD signs, which are designed to be unique, and thereby quickly recognized without the need to read the signs.

2.2.1 STOP and YIELD Signs

There are many situations on military installations where unnecessary STOP signs exist, or where the STOP signs are on the major road instead of being on the minor road. These situations waste both time and energy.

One of the most obvious situations where regulatory signs are needed is at intersections. The big question is, "What type of traffic control should be provided?" This answer is addressed in detail in Chapter 4 of Better Military Traffic Engineering (SDDCTEA Pamphlet 55-17), and is, therefore, not addressed in this pamphlet.

The normal application of STOP (R1-1) signs is at intersections where the minor legs of the intersection have STOP signs, and the two opposing approach legs with the major movement do not have any traffic control signs. Therefore, the number of STOP signs is normally two less than the number of approaches to the intersection.

In most cases, the major and minor roadways are obvious, but in some cases it may be necessary to document the traffic volumes and the turning movements at the intersection during the peak hours.

YIELD (R1-2) signs can be installed in lieu of STOP signs when it is not always necessary for everyone to stop as outlined in Section 2B.09 of the *MUTCD*. However, YIELD signs should only be used when sight distance is such that drivers approaching the YIELD sign have a good view of approaching vehicles on the cross street.

YIELD (R-2) signs are also used on all approaches to a roundabout.

Whenever possible, STOP and YIELD signs should be placed at a location where approaching drivers have a clear view of the signs. For example, at intersections with a large corner radius, the sign does not need to be placed near a stop or yield line, but the *MUTCD* does recommend that the signs be placed no farther than 50 feet from the edge of the pavement of the intersecting roadway.

Where Should You Stop at an Intersection?

The actual location where drivers are to stop at an intersection with a STOP sign is normally defined in the state's vehicle code. Typically, the law requires that a driver stop at any clearly designated stop line or, if a line is not present, before entering a crosswalk or, if no crosswalk is present, then at a point nearest the intersecting roadway where the driver has a clear view of approaching traffic on the intersecting roadway before entering. Therefore, the location of the STOP sign is generally not a factor.

If it is determined that STOP signs are installed on the wrong approaches, it is generally best to temporarily create a multi-way stop control intersection for about 6 weeks and then to use the suggested "Two-Step Procedure to Change the Multi-way Stop Control to Two-Way Stop Control" as discussed on the next page.

2.2.2 Multi-way Stop Control

Multi-way stop control should never be used in an attempt to reduce vehicle speeds. However, when used, the ALL-WAY plaque should always be used below each STOP sign.

Some installations have installed extra STOP signs for speed control, but traffic studies indicate that drivers have a natural tendency to travel even faster than normal between these extra STOP signs, and they also have a greater tendency to not stop at STOP signs that are perceived as unnecessary. Therefore, warrants are established in Section 2B.07 of the *MUTCD* for multi-way stop applications, and any unwarranted STOP signs should be removed.

When all approaches to an intersection are controlled by STOP signs, an ALL WAY (R1-3P) plaque should always be used below each of the STOP signs. Installations should no longer use the obsolete 2-WAY, 3-WAY, and 4-WAY plaques since they do not tell drivers if any of the approaches do not have a STOP sign.

R1-1 &
R1-3P

If it is determined that an intersection with multi-way stop control should be changed to two-way stop control, the suggested procedure is highlighted on the next page.

Are Multi-way Stop Intersections Safer?

Studies show that both the number of crashes and injuries at multi-way stop intersections are generally lower than at signalized intersections and at intersections with conventional stop control. However, studies also suggest that multi-way stop intersections tend to encourage higher midblock speeds and a disregard for STOP signs in general, and the end result of using multi-way stop intersections is likely an overall increase in the number of crashes.

On the other hand, the crash and injury rates for roundabouts are almost identical to that of multi-way stop intersections and with no known negative spillover effects.

Two-Step Procedure to Change Multi-way Stop Control to Two-Way Stop Control

1. On the "change day," remove the STOP (R1-1) signs, any Stop Ahead (W3-1) signs, any inappropriate plaques, and stop lines on the appropriate approaches, and install a CROSS TRAFFIC DOES NOT STOP (W4-4P) plaque under each of the remaining STOP signs. A battery-operated flashing red light can also be attached to the top of the remaining STOP signs for additional emphasis.
2. Approximately 6 weeks after removing the STOP signs, remove the W4-4P plaques and any flashing red lights.

The combination of a STOP (R1-1) sign and the CROSS TRAFFIC DOES NOT STOP (W4-4P) sign is an unusual color combination. The MUTCD also includes other similar plaques (see W4-4aP and W4-4bP).

2.2.3 In-Street and Overhead Pedestrian Crossing Signs

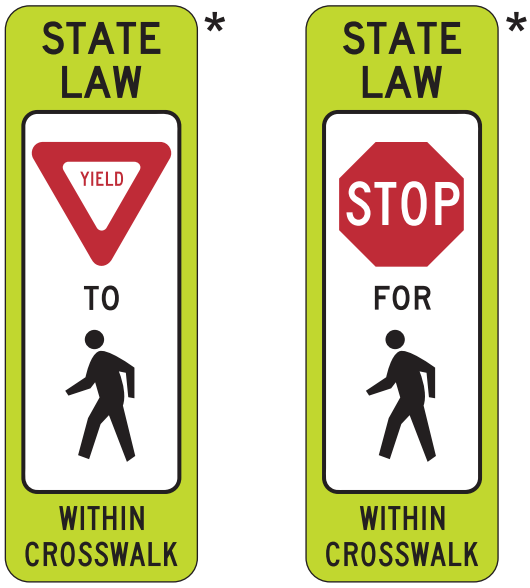
The Vehicle Code in most states requires drivers to yield to pedestrians in the crosswalks. Therefore, the R1-6a and R1-9a signs should only be used in states that require drivers to stop for pedestrians within the crosswalk.

Many highway agencies are using the In-Street Pedestrian Crossing (R1-6 or R1-6a) sign on the road at marked midblock crosswalks on low-speed roadways. These double-sided signs may be placed on the road within several feet of a marked crosswalk to create an "in-your-face" reminder to drivers that there may be pedestrians in the crosswalk, and that drivers are required to yield to or stop for these pedestrians. The signs also tend to slow the traffic because they reduce the lane width and are in close proximity to vehicles.

Depending upon the state Vehicle Code, states will generally allow either the R1-6 sign or the R1-6a sign. If military installations are not sure of the specific state requirements, someone should review the matter with the state department of transportation (DOT). Installations are also encouraged to ask the DOT if they have a list of approved devices that need to be used.

General recommendations include the following:

- ✓ Use these signs only on roadways with a speed limit of 35 mph or less, and with lanes at least 10 feet wide.
- ✓ Use only at marked midblock crosswalks.
- ✓ Use the appropriate sign to correspond to the requirements of the applicable state vehicle code.
- ✓ Place the sign near the crosswalk, either on the center line, on a lane line, or on a median island.



R1-6 R1-6a

R1-9

R1-9a

*The legend STATE LAW is optional

The Overhead Pedestrian Crossing (R1-9 and R1-9a) signs may be placed over the roadway at the crosswalk.

The R1-6, R1-6a, R1-9, and R1-9a signs may have either a yellow, fluorescent yellow, or fluorescent yellow-green background. In addition, the words STATE LAW may be eliminated from these signs.

2.2.4 STOP WHEN FLASHING – DO NOT PROCEED (R1-7a-TEA) Sign

The STOP WHEN FLASHING – DO NOT PROCEED (R1-7a-TEA) sign may be used whenever traffic must be temporarily stopped with some regularity to ensure the safety of motorists. Applications could include planes taxiing across a roadway, explosive testing, missile launching, rifle range, etc.

When used, the sign should be installed at a safe location in advance of the activity. Flashing red lights must be attached above the sign and activated from an oversight position in sufficient time to ensure that no one is within the activity area.

R1-7a-TEA

2.2.5 Speed Limit Signs

No one wants a citation for exceeding a speed limit, especially if they feel that they did not have adequate advance notice. Therefore, it is important to have signs installed at the appropriate locations to avoid entrapment.

Section 9.1 in SDDCTEA's Pamphlet 55-17, Better Military Traffic Engineering, provides the methodology used to determine the appropriate speed limit. Therefore, this section will only address the types, sizes, and placement of regulatory speed limit signs.

The standard size Speed Limit (R2-1) sign is 24 by 30 inches, and generally should be placed at the following locations:

- ✓ At the beginning of new speed limits
- ✓ After major intersections
- ✓ At meaningful intermediate locations within long sections of roadway

The *MUTCD* does not contain any maximum spacing requirements for Speed Limit signs, but some states have unique requirements in order to enforce speed limits under their vehicle code. In the absence of any specific state spacing requirements, installations are encouraged to use maximum 1-mile spacing for speed limits of 35 mph or lower, and maximum 3-mile spacing for higher speed limits. However, avoid placing a sign immediately in advance of a curve or turn, an intersection, railroad crossing, etc.

W3-5

Sometimes, speed limit signs do not produce the desired effects. Typically these speed limits are problematic because the road was either designed to a higher design speed which encourages higher speeds, or because there is an observed lack of enforcement.

Possible solutions include:

- ✓ Increase enforcement.
- ✓ Install long speed humps which are designed for the specific speed limit (if the criteria in Pamphlet 55-15 are satisfied).
- ✓ Allow on-street parking to effectively narrow the roadway.

Advance Notice of Speed Reductions

When a speed is reduced at the beginning of a side road or at any location where all traffic must either stop or turn to enter the section of road with the reduced speed limit, signs providing advance notice of the restriction should not be necessary. However, at other locations where the speed reduction is 10 mph or greater, military installations are encouraged to erect advance notice signs showing the new reduced speed limit. The only acceptable sign for this purpose is the Speed Reduction (W3-5) sign as discussed in Section 2.3.5.

Boundary Speed Limit Signs

Some military installations have determined that the whole installation or at least a large portion of the installation (e.g., residential or industrial areas) should have the same basic speed limit. In these situations, it is possible to install a single sign assembly after entering either the installation or the "restricted area" instead of the more costly option of constantly placing Speed Limit (R2-1) signs throughout. In these situations, install one of the following plaques above the R2-1 sign:

- ✓ RESIDENTIAL (R2-5cP)
- ✓ BASE (R2-5hP-TEA)
- ✓ INSTALLATION (R2-5iP-TEA)

However, if there are any portions within the "restricted area" with a different regulatory speed limit, then an UNLESS OTHERWISE POSTED (R2-5P) plaque should also be mounted below the R2-1 sign as illustrated.

Since it is essential that every driver see these "*boundary speed limit signs*," installations are encouraged to use the larger, 30"x36" Speed Limit (R2-1) sign. In addition, if there is more than one travel lane on the approach, a second sign assembly is recommended to the left of the left lane; e.g., within a median, or if this is not possible, install a second sign assembly at least 250 feet beyond the first sign assembly.

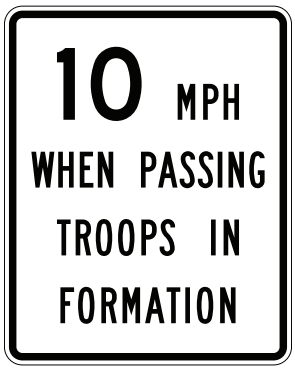
R2-5hP-TEA, R2-1, & R2-5P

Moreover, when leaving an area with "*boundary speed limit signs*," it is essential that signs be installed for the new speed limit. See a sample installation in the graphic in Section 2.2.9.

If "*boundary speed limit signing*" is not recognized by the state or host nation, then enforcement will have to be under DoD regulations or administrative procedures established by installation commanders as discussed in Section 1.3.

When Passing Troops Speed Limit

Another unique type of speed limit is the 10 MPH WHEN PASSING TROOPS IN FORMATION (R2-1a-TEA) sign, which is for use along roadways where troops periodically walk in formation on the roadway. Enforcement typically will be under DoD regulations or administrative procedures discussed in Section 1.3.



R2-1a-TEA

2.2.6 Turn Prohibition Signs

Some typical sign messages are:

- ✓ No Right Turn (R3-1).
- ✓ No Left Turn (R3-2).
- ✓ NO TURNS (R3-3).
- ✓ No U-Turn (R3-4).
- ✓ No U-Turn/No Left Turn (R3-18).

Place turn prohibition signs where the driver who is most likely to make that turn can easily see the sign. For example, at unsignalized intersections, post-mount the signs on the appropriate side of the roadway. And at signalized intersections, the ideal location is:

- ✓ Near the left overhead traffic signal for No Left Turn, No U-Turn, and the No U-Turn/No Left Turn signs.
- ✓ Near the right overhead traffic signal for No Right Turn signs.
- ✓ Between the signals or near both the left and the right overhead traffic signal for the NO TURNS sign.

R3-1

R3-2

R3-3

R3-4

R3-18

2.2.7 Part-Time Restrictions

It is not always necessary to have full-time restrictions or prohibitions, especially for turn prohibitions, special speed zones, and reversible-lane operations. Under these situations, a sign that is visible only when the restriction is in effect is the easiest to understand. These signs could be either of the following types:

- ✓ An electronic blank-out sign, where a single sign message is either illuminated or it is "blanked out;" or
- ✓ The whole sign, or a portion of the sign, is capable of being changed, commonly called a changeable message sign (CMS).

However, when funds are not available or conditions do not warrant the above expense, supplementary plates may be mounted below the regulatory sign. One of the most effective supplemental plaques is the WHEN FLASHING (S4-4P) plaque if used in conjunction with a yellow flashing light. This message leaves no doubt in the driver's mind as to when the regulation is in effect.

If a flashing light is also impracticable, a supplementary plaque showing the applicable times of the restriction (similar to the S4-1P plaque) may be installed below the regulatory sign. The plate shows the hours during which the regulation is in effect. The hours should be shown in civilian time, not military time. This combination is not as effective as the other options because motorists sometimes do not have enough time to read and understand the complete message, or may not have an available clock or watch.

R2-1 & S4-4P

R3-2 & S4-1P

R11-4b-TEA

2.2.8 ROAD CLOSED Sign

The ROAD CLOSED (R11-2) sign may be used to mark roads or gates that have been closed either on a permanent or on a part-time basis. The sign should be erected at or near the center of the roadway and on or above a barricade that closes the roadway. Except within work areas (i.e., construction, maintenance, or utility work areas), the barricade should have three alternating red-and-white, striped retroreflective rails that are a minimum of 48 inches in length, and 8 to 12 inches high (see section 2.2.18). The minimum size ROAD CLOSED sign is 48 by 30 inches because it is the last sign the driver will see before he must stop or turn.

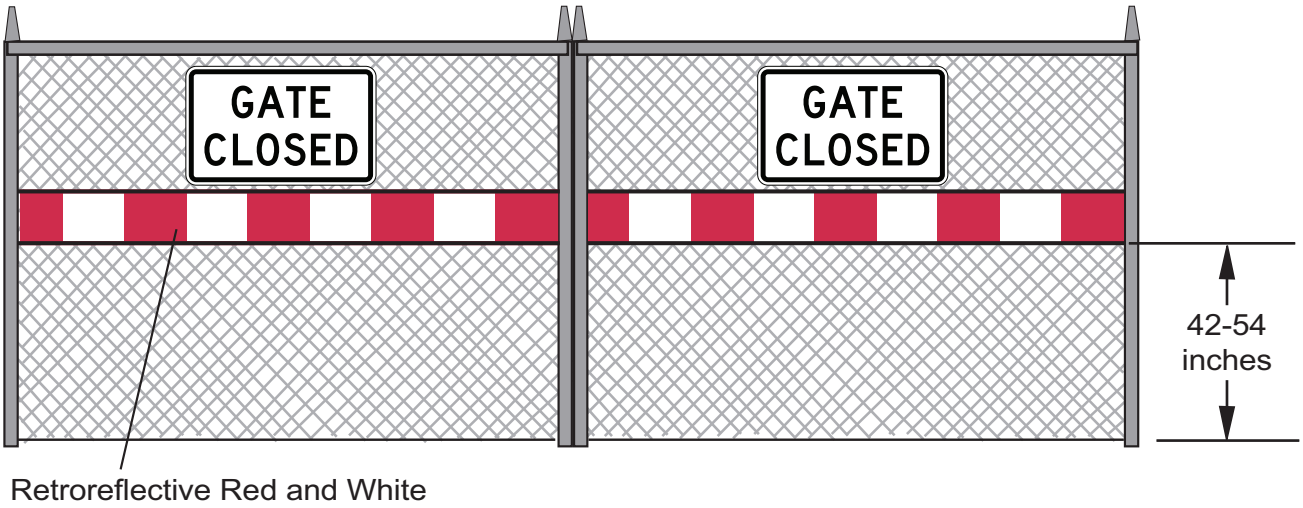
R11-2

When appropriate, the GATE CLOSED (R11-2g-TEA) sign may be used in place of the R11-2 sign. (See Section 2.2.20 for information on gates.)

When a road closure occurs on what would otherwise be a continuous roadway, especially if the speed limit is greater than 25 mph, a ROAD CLOSED AHEAD (W20-3) sign or a GATE CLOSED AHEAD (W20-3g-TEA) sign may be appropriate (see Section 2.3.8).

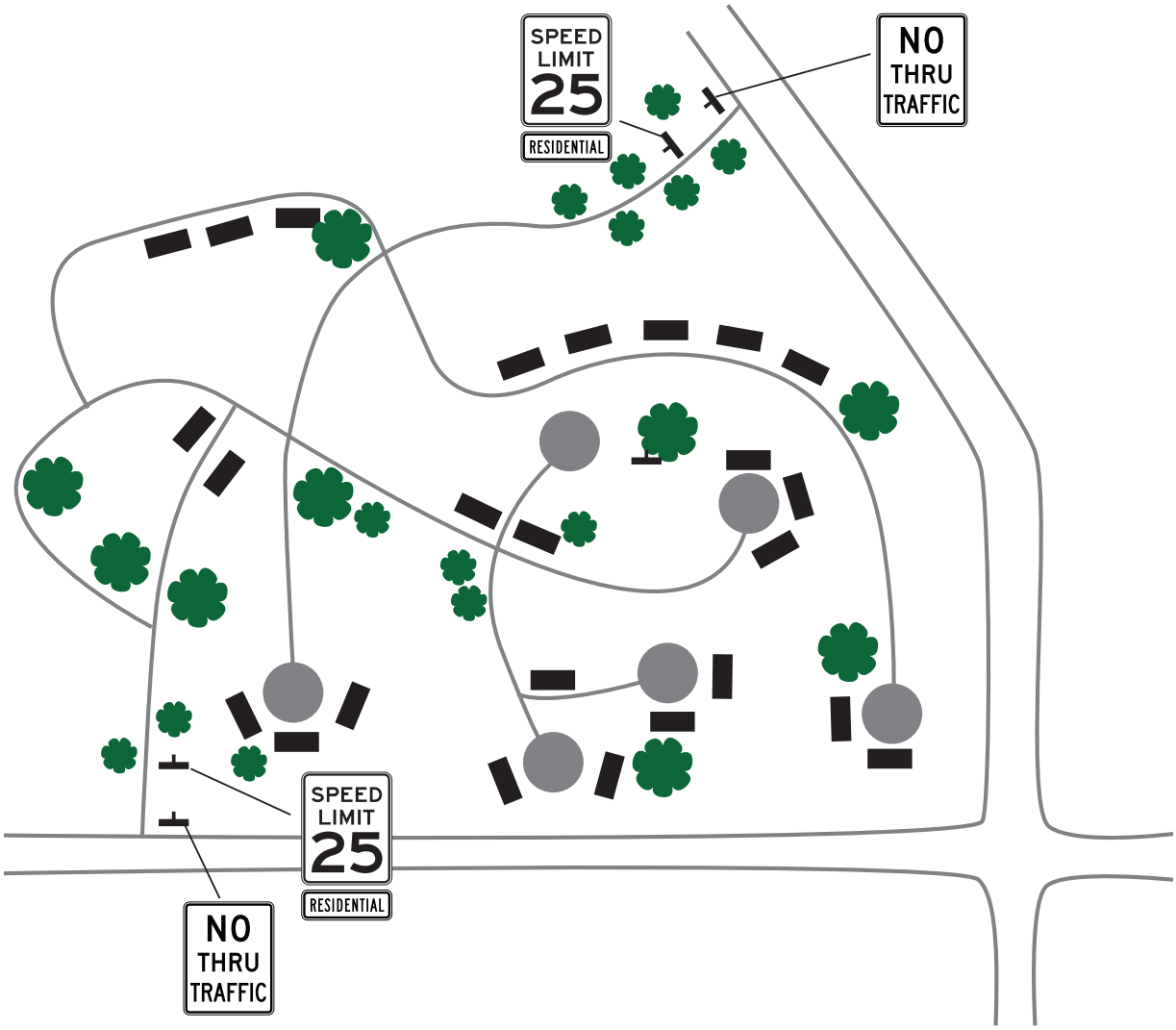
R11-2g-TEA

On some access roads to gates that are open only during certain periods, especially if it is several miles to the gate, a destination sign should be used to advise motorists of gate hours. The sign should be placed at a point where it will prevent needless travel when the gate is closed. Hours should be shown in civilian time, not military hours. The sign should have white lettering on a green background (see Section 2.4.3).



2.2.9 NO THRU TRAFFIC Sign

The NO THRU TRAFFIC (R11-4a-TEA) sign may be used to prohibit traffic from using a residential street or other safety-sensitive roadways as through streets. This sign is placed primarily at or near the boundary of these sensitive areas used as shortcuts by commuter traffic.



2.2.10 Reversible Lane Signs

When the majority of traffic flows in one direction during part of the day and in the opposite direction during another part of the day, it may be possible to make a reversible-lane providing the roadway has a total of three or more travel lanes. However, when a reversible lane is established, it creates a potential for additional mistakes by drivers, and it is therefore critical that the traffic control be established correctly.

The best traffic control scenario is the use of overhead "lane-use control signals" which display as a minimum the combination of a steady RED X, a steady YELLOW X, and a steady DOWNWARD GREEN ARROW. In addition, it is possible to also have WHITE TWO-WAY LEFT TURN ARROWS and WHITE ONE-WAY LEFT TURN ARROWS.

If using fiber optics or LEDs for the signals, it is possible to have a single signal section with more than one indication superimposed on top of each other, but if separate signal sections are used, they need to be arranged in the order indicated in Exhibit 2.21. However, the design and operation of signals requires the expertise of a professional engineer, and is not addressed herein.

FHWA requires overhead lane control signals anytime that two or more lanes are reversed. However, when only one lane is reversed, it is possible to use a combination of overhead and ground-mounted signs as listed in Exhibit 2.22.

Exhibit 2.21: The Relative Order of Overhead Lane-Use Control Signals

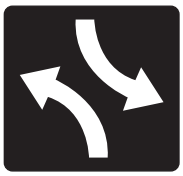
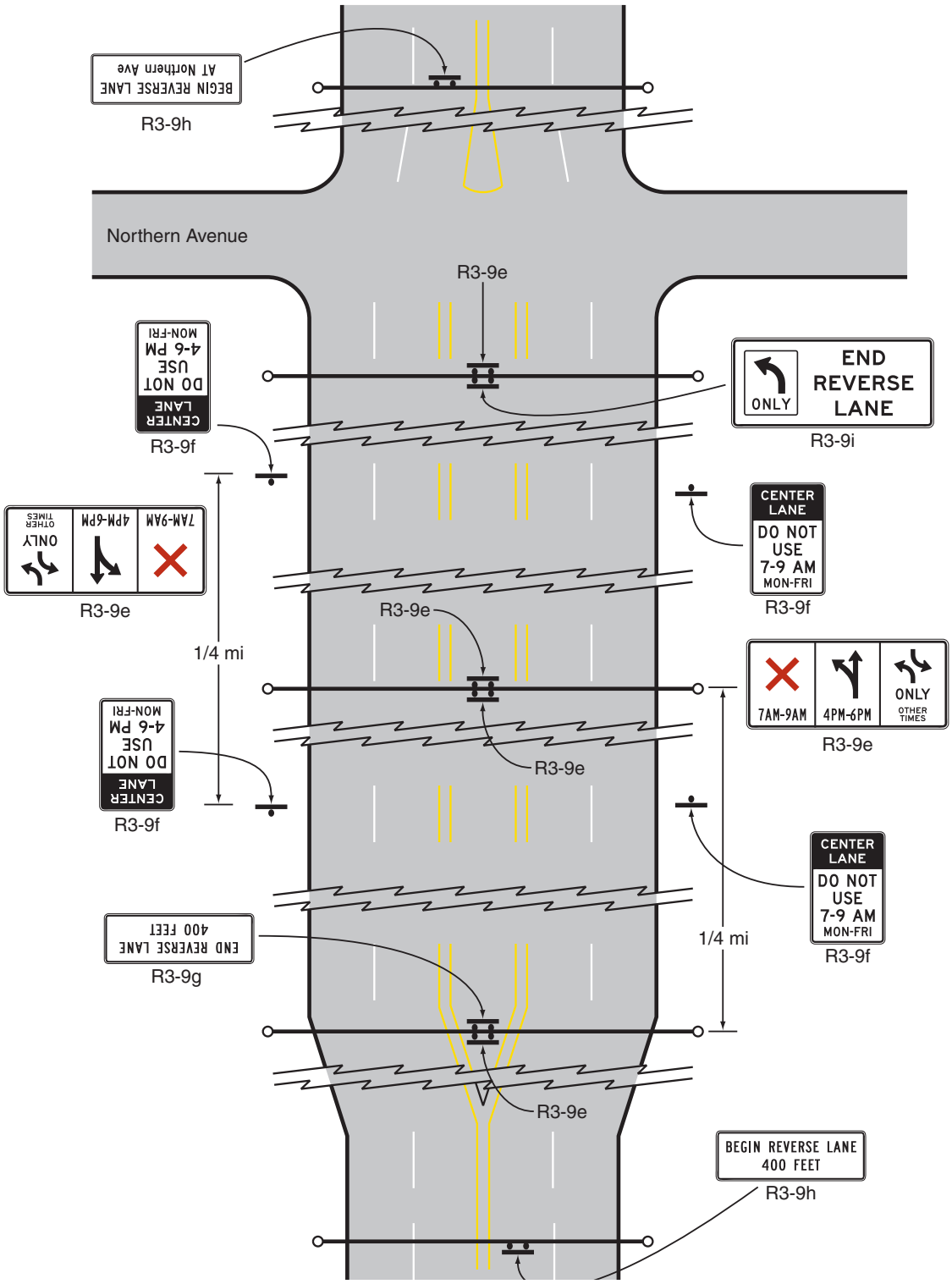
Red X	Yellow X	Green Downward Arrow	White Two-Way Arrows	White Arrow
				

Exhibit 2.22: Reversible Lane Control Signs



Source: FHWA, MUTCD

2.2.11 Parking Signs

The *MUTCD* contains many different types of no parking signs. When applicable, the preferred sign should include the international "no parking symbol" as in the R7-2a sign.

R7-2a

Orientation

Although most traffic signs are installed approximately perpendicular to the edge of the roadway (see Section 2.1.11), most no parking signs erected beside a travel lane should be installed at an angle of not less than 30 degrees nor more than 45 degrees with the edge of the road, so that the signs would face drivers if drivers are looking toward the parking side of the roadway. This unusual orientation:

- ✓ makes the signs more visible to the driver that wants to park, but less disruptive to the through driver; and
- ✓ enhances understanding of left and right arrows on signs.

Reserved Parking for Persons with Disabilities

For reserved parking for persons with disabilities, it is necessary to install the Reserved Parking for Persons with Disabilities (R7-8) sign for each parking stall.

When installed in parking lots, the sign should generally be installed at the front of the reserved parking space. If the parking space is a van accessible site, the R7-8P sign shall be installed below the R7-8 sign. To improve visibility of the sign when a driver pulls into the space, the bottom of the sign assembly may be as low as 5 feet above the pavement.

Additional information regarding ADA requirements in parking lots is addressed in Section 3.2.14.

R7-8

R7-8P

Emergency Snow Routes

In an effort to facilitate snow removal, installation officials may designate some roads as snow emergency routes and prohibit parking under emergency declarations. The standard sign for this application is the Emergency Snow Route (R7-203) sign, but the message on the bottom part of the sign may vary as necessary, and include alternate type messages such as NO PARKING DURING DECLARATIONS, NO PARKING DURING EMERGENCIES, etc.

R7-203

On designated snow emergency routes, the sign is recommended following "major intersections," and at intervals up to 1,500 feet in built-up areas or 2 miles in rural areas. The definition of "major intersection" is generally defined as an intersection with another road that has an average workday traffic (AWDT) volume of 500 or more vehicles.

2.2.12 Signal-Related Signs

When traffic signals are installed, signing is normally designed as part of the signal design, and frequently requires special sign mounting hardware. The important thing is to ensure that the signs are at the proper alignment, and are replaced as necessary. Three of the most common signs are illustrated.

R10-10

R10-11

R10-12

2.2.13 AUTHORIZED VEHICLES ONLY Sign

The AUTHORIZED VEHICLES ONLY (R 5-11) sign may be used to identify roadways that are closed to the public. Since the (R5-11) sign is somewhat nebulous, another option is the GOVERNMENT VEHICLES ONLY (R5-11g-TEA) sign.

When used, erect the sign on the right side of the road or on both sides of the road at the point where the restriction applies, which should always be at an intersection or where unauthorized vehicles can turn to avoid the restricted area.

R5-11

R5-11g-TEA

2.2.14 Truck Route Signs

Many military installations establish truck routes, especially routes for trucks transporting explosives or other hazardous materials. By design, these routes typically avoid the more populated areas of installations in an attempt to reduce exposure.

Signs in the *MUTCD* that are designed for this purpose include the TRUCK ROUTE (R14-1) and the Hazardous Material Route (R14-2) signs. If a military installation establishes a route, then the appropriate sign should be installed either in advance of or immediately beyond major intersections or at intermediate locations along the route. If a route turns at an intersection, the sign should always be installed in advance of the intersection and an appropriate arrow plaque should be used beneath the route marker (see Exhibit 2.23).

It is important to note that the establishment of a truck route or a hazardous materials route does not imply that these vehicles cannot go on other roads. Therefore, if an installation wants to prohibit these vehicles on another roadway, it is necessary to install a Hazardous Material Prohibition (R14-3) sign at the beginning of a road where vehicles have an opportunity to take an alternate route. The R14-3 sign would generally be installed within 25 to 50 feet after the intersection, and it must be visible to truck drivers that may be about to turn onto the roadway.

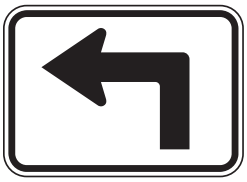
Typical signs and plaques used for truck routes are illustrated in Exhibit 2.23.

Exhibit 2.23: Truck Signs

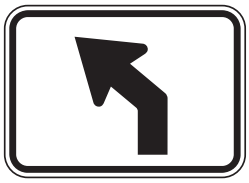
R14-1

R14-2

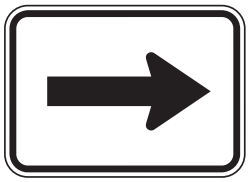
R14-3



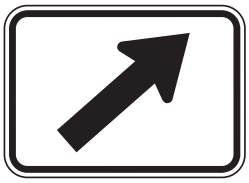
M5-1



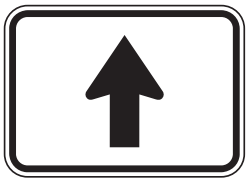
M5-2



M6-1



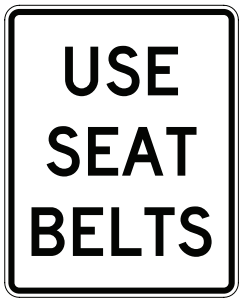
M6-2



M6-3

2.2.15 USE SEAT BELTS Sign

The USE SEAT BELTS (R16-1b-TEA) sign may be used to emphasize that wearing safety belts is mandatory. Perhaps the best place to install the R16-1b-TEA sign is immediately after the gate since some drivers remove their seat belts to make it easier to produce personal identification when entering the installation and a reminder at this location could be helpful.



R16-1b-TEA

R16-5a-TEA

2.2.16 USE PARKING LIGHTS AT GATES Sign

In an effort to reduce glare for security personnel at entry control facilities (ECF), the USE PARKING LIGHTS AT GATE (R16-5a-TEA) sign may be used in advance of ECFs to request motorists to use their parking lights.

2.2.17 Radio and Cell Phone Prohibition Signs

Some military installations have restrictions on the use of cell phones while driving. In that situation, the NO CELL PHONE WHILE DRIVING (R22-1-TEA) sign may be installed for inbound traffic in the vicinity of the gate, and at select locations within the installation.

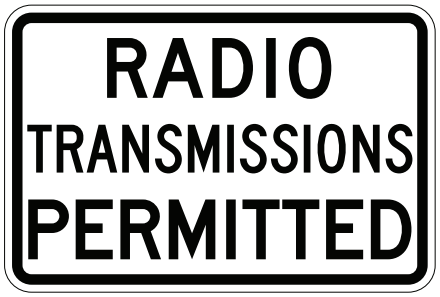
On the other hand, military installations sometimes have localized restrictions on the use of two-way radios and cell phones in the proximity of explosives or other sensitive areas. When this condition exists, the TURN OFF 2-WAY RADIO AND CELL PHONE (R22-2-TEA) sign or the NO RADIO TRANSMISSIONS (R22-3-TEA) sign may be installed in advance of applicable locations. The RADIO TRANSMISSIONS PERMITTED (R22-4-TEA) sign should be used to inform drivers when the prohibition no longer applies.

These signs are illustrated on page 2-61 and are included in Appendix A.

R22-1-TEA

R22-2-TEA

R22-3-TEA



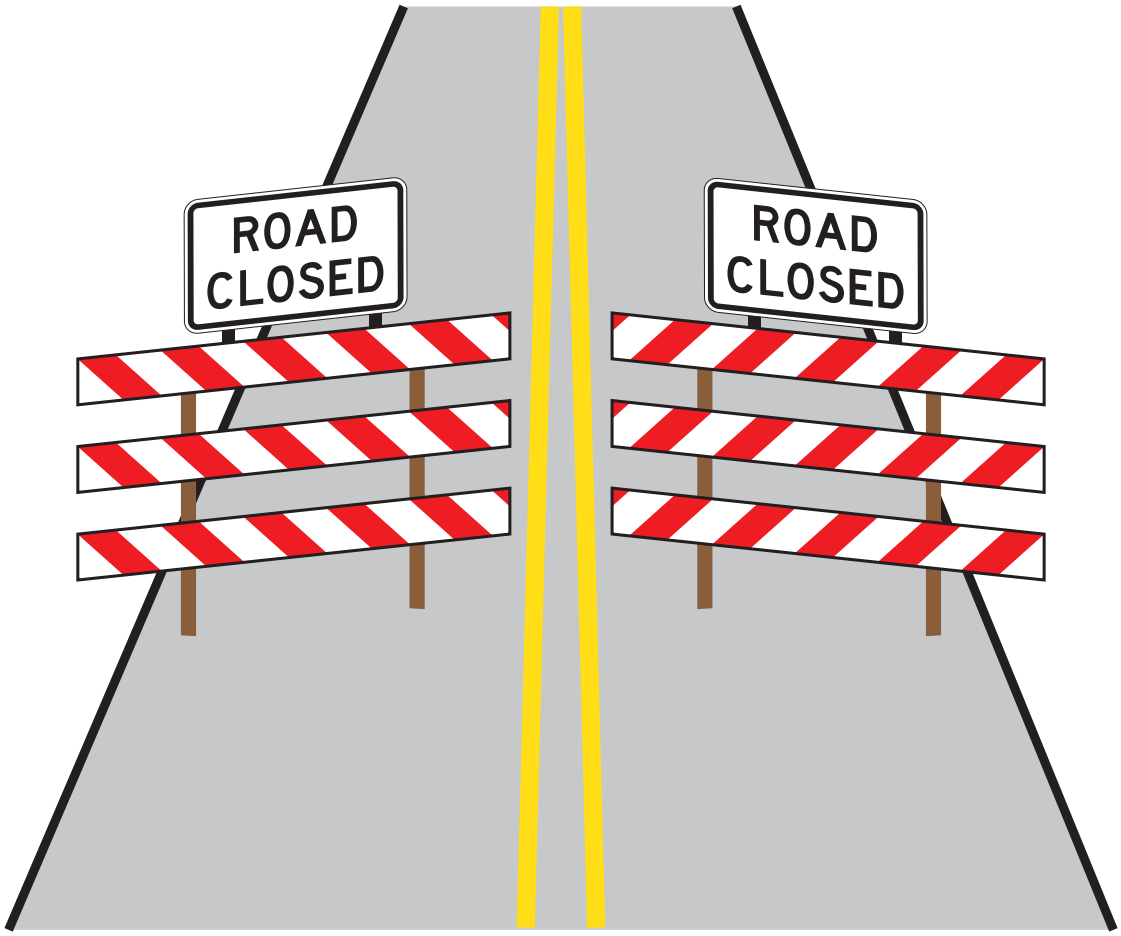
R22-4-TEA

2.2.18 Barricades

As noted in Section 2.3.16, barricades can be used in lieu of the End-of-Road markers. When used, barricades should have retroreflective rails, and except for the red-and-white color, they should comply with the design details in Section 6F.68 of the *MUTCD*. Always use an appropriate warning sign in advance of an "End-of-Roadway Barricade" to warn of the road closure since the barricade is a formidable object. The Road Closed (W20-3) sign would generally be appropriate.

Do not use the End-of-Road Barricade at any location where it could be hit on an end unless it has been crash tested at that angle and determined to be crash worthy at the prevailing traffic speed.

Exhibit 2.24: End-of-Roadway Barricade

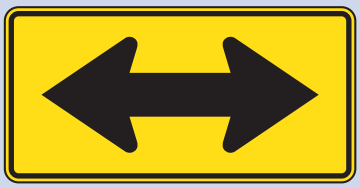


2.2.19 Bollards

SDDCTEA does not recommend the use of bollards, but if existing bollards are not removed, they should be retroreflective and highly visible. The recommended delineation is four alternating 6-inch wide bands of retroreflective sheeting wrapped around the bollard, beginning with a red band at the top, then alternating colors one adjacent to the next one.

T-Intersections

By definition, T-intersections are not end-of-roadway situations since there are alternate vehicular paths. Therefore, at T-intersections, consider using a 48"x24" Two-Direction Large Arrow (W1-7) sign on the far side of the through roadway facing traffic on the stem of the T-intersection. Only use the larger 60"x30" sign if it is very unlikely that a vehicle on the through roadway could hit the edge of the W1-7 sign.



2.2.20 Gates

Gates on military installations need to be formidable devices; therefore, it is essential that the gates are highly visible and that drivers have adequate advance warning.

Gates are common at military installations to physically prevent road users from proceeding past a particular point without authorization. Gates on military installations may include the following:

1. Railroad Grade Crossing Style. An arm or a physical fence that is moved from a vertical to a horizontal position similar to railroad grade crossing gate to effectively block motor vehicles. The gate may be stiffened and the outer end may lock into place.
2. Swinging Gate. A fence that is rotated on a vertical support from a position that is parallel to traffic to a position that is perpendicular to traffic.
3. Gate on Rollers. A fence on rollers that is perpendicular to traffic and that retracts to open and extends to close.

Since gates are formidable devices, it is essential that they be clearly visible day and night. When activated, gates shall be retroreflective from both directions. The grade of sheeting shall be a minimum of a Type III material (see Section 2.1.8).

Safety Issues for Swinging Gates

✓ When open, the gate supports should be a minimum of 2 feet from the face of the curb or the edge of the pavement.

✓ When swinging gates are in the open position; i.e., parallel to the flow of traffic, they should be rotated to the downstream direction from the perspective of traffic in the lane adjacent to the gate support in order to minimize the possibility of the gate spearing an errant vehicle. Therefore, on a two-way roadway, both gates would be rotated clockwise to open them, and when open they would be pointing in opposite directions.

Section 2B.68 of the *MUTCD* requires gates to have a horizontal strip of retroreflective sheeting on both sides of the gate, with the bottom of the strip 42 to 54 inches above the road surface. The *MUTCD* now requires that the sheeting have vertical stripes, alternately red and white, at 16-inch intervals measured horizontally.

Technically, a strip of retroreflective sheeting is not required on the back side of a gate on a one-way road, but on military installations a back-to-back installation is recommended to avoid problems with a wrong-way driver, especially in the event that an unauthorized person was trying to avoid the normal traffic pattern.

The strips of retroreflective sheeting should extend the full width of the gate and be a minimum of 8 inches high. On fence-type gates, military installations are encouraged to apply the sheeting to a substrate such as aluminum, fiberglass, or wood, and then bolt the "rail" to the gate.

There are two safety issues with the above gate. First, in accordance with the recent change in the *MUTCD*, at least one fully retroreflective horizontal rail with alternating red and white vertical stripes (see illustration on page 2-52) is required on each gate. Second, the vertical gate supports should be set back at least 2 feet from the edge of the roadway. In addition, military installations are encouraged to use ROAD CLOSED signs instead of the STOP signs.

The rolling fence at the above ECF should have at least one fully retroreflective horizontal rail with alternating red and white vertical stripes. The rail will help drivers visually determine if the gate is closed, or if one or two in-bound lanes are open.

2.2.21 Active Vehicle Barriers (AVBs)

There are a variety of active vehicle barriers (AVBs) designed to stop a potential threat. Section 8.6 of Pamphlet 55-15 (Traffic and Safety Engineering for Better Entry Control Facilities) includes the following six devices:

1. Nets
2. Wedges
3. Bollards
4. Crash beams
5. Spikes
6. Portable barriers

For a variety of reasons, SDDCTEA does not recommend the last three AVBs listed above for the following reasons:

- ✓ The objections to crash beams are basically operational issues, but if used, military installations should add a red-and-white strip of retroreflective sheeting to the beams similar to the description for gates in Section 2.2.20. The sheeting should be on a flat vertical surface of the beam to improve the performance of the retroreflective sheeting.
- ✓ SDDCTEA also does not recommend spikes, which are sometimes called "tire treadles" or "tire shredders" because they do not physically stop vehicles since vehicles can be driven on deflated tires or, in fact, vehicles may have solid or foam-filled tires. Visibility of spikes is another concern since there is no good way of providing a substantial amount of retroreflectivity on the spikes. Therefore, if spikes are used, military installations are encouraged to use a SEVERE TIRE DAMAGE (R5-29P-TEA) sign below a DO NOT ENTER (R5-1) sign on both sides of the roadway in the wrong-way direction, and a DO NOT BACK UP – ONE-WAY TIRE TREADLE (R5-30-TEA) sign on both sides of the roadway in the normal direction of traffic.

✓ SDDCTEA does not recommend the use of portable barriers because of operational issues except in very low-volume situations. However, if used, these devices should also have red-and-white retroreflective sheeting similar to gates in Section 2.2.20.

Bollards are not very visible to motorists and they are not continuous. Because they are not continuous, bollards will not stop pedestrians, bicycles, and motorcycles. If bollards are used as an AVB they must be delineated. The recommended delineation is defined in Section 2.2.19.

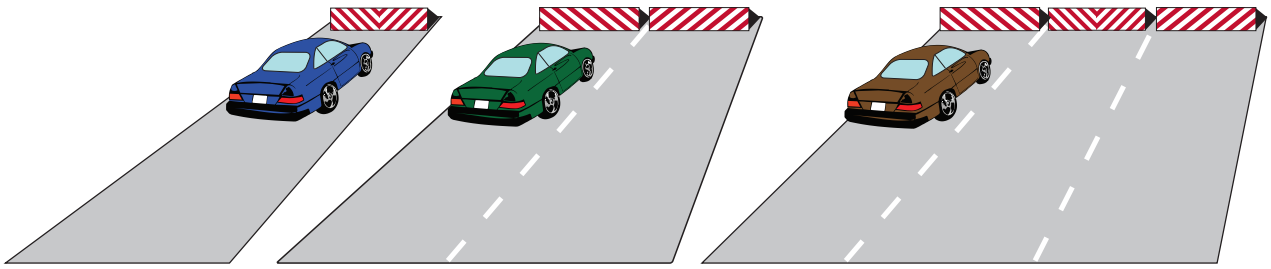
Wedges are typically the most common type of AVB. Historically, wedges have used diagonal, red-and-white retroreflective stripes similar to what is used on barricades. However, since they are not designed to be driven around, a more appropriate marking is to treat it like a gate and to use the delineation with vertical stripes, alternately red-and-white, at 16-inch intervals measured horizontally. The minimum height of the retroreflective strip is 8 inches.

If a net is used as an AVB, contact SDDCTEA for assistance in obtaining proper delineation.

2.2.22 Miscellaneous Barriers

As noted in Section 2.3.6, military installations sometimes establish chicanes to control travel speeds near entry control facilities (ECFs). SDDCTEA discourages the use of barriers in the roadway due to roadway safety reasons. Although very formidable (perhaps the ultimate regulatory device), sometimes short sections of barrier; e.g., concrete barrier, are used to create a chicane or a serpentine roadway. In these situations, the preferred delineation is to use red-and-white diagonally striped horizontal strips of retroreflective sheeting similar to the rails on barricades in Section 2.2.18. When used, the stripes should point downward toward the side that traffic should flow on.

Because retroreflective sheeting loses its effectiveness when viewed from large angles, barrier used in a chicane should not be rotated more than 45 degrees from being perpendicular to the approaching drivers.



One Lane | Two Lanes | Three Lanes

2.3 Warning Signs

Warning signs alert drivers to traffic or road conditions ahead. In this context, very few warning signs can be justified in low-speed, built-up areas on military installations. In these situations, the principal use is to warn the motorist that he or she is approaching a checkpoint or an active vehicle barrier.

In more rural settings, additional warning signs may be warranted for a variety of things, including unexpected turns and curves, STOP signs with poor visibility, pedestrian crossings, large animals, low aircraft, tank crossings, etc. Warning signs should be installed only where they will aid a large number of drivers. They should not be used where an alert driver would be aware of the situation.

2.3.1 Placement

The placement of warning signs must allow these drivers sufficient time to see the sign, understand the intent, identify the potential hazard, decide what action must be taken, and then perform any necessary maneuver. Exhibit 2.25, which is derived from Table 2C-4 of the *MUTCD*, provides minimum recommended sign placement distances for warning signs.

When using Exhibit 2.25, note that Condition A is only for those situations where motorists may have to change lanes in heavy traffic. Applicable signs using Condition A include:

- ✓ Merge (W4-1).
- ✓ Lane Reduction Transition (W4-2L, W4-2R).
- ✓ Entering Roadway Merge (W4-5).
- ✓ RIGHT LANE ENDS (W9-1).

The advance placement distances for Condition B are typically smaller than the values used in the past. However, remember that these are minimum advance distances.

For Stop Ahead, Yield Ahead, Signal Ahead and Intersection Warning signs, use the advance distance for the "0 mph" advisory speed because some drivers may wish to turn at the intersection or may need to stop due to other stopped or turning traffic. For example, the minimum advance distance for a warning sign for a potential stop condition is 175 feet on a 45-mph roadway.

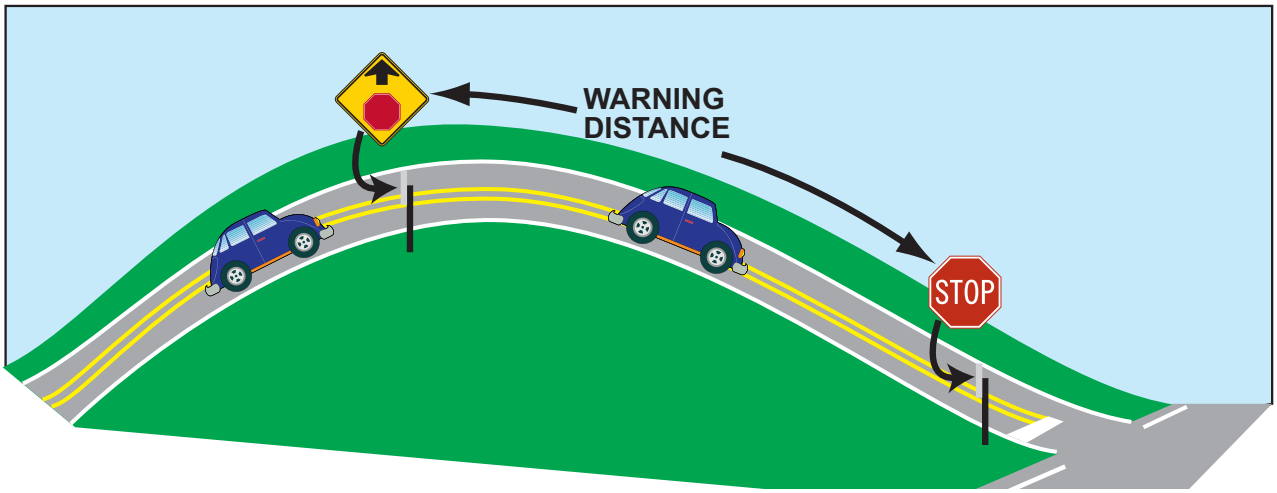


Exhibit 2.25: Guidelines For Advance Placement of Warning Signs

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 speed (mph) for the condition							
		0[3]	10[4]	20[4]	30[4]	40[4]	50[4]	60[4]	70[4]
20 mph	225 ft	100 ft[6]	N/A[5]						
25 mph	325 ft	100 ft[6]	N/A[5]	N/A[5]					
30 mph	460 ft	100 ft[6]	N/A[5]	N/A[5]					
35 mph	565 ft	100 ft[6]	N/A[5]	N/A[5]	N/A[5]				
40 mph	670 ft	125 ft	100 ft[6]	100 ft[6]	N/A[5]				
45 mph	775 ft	175 ft	125 ft	100 ft[6]	100 ft[6]	N/A[5]			
50 mph	885 ft	250 ft	200 ft	175 ft	125 ft	100 ft[6]			
55 mph	990 ft	325 ft	275 ft	225 ft	200 ft	125 ft	N/A[5]		
60 mph	1,100 ft	400 ft	350 ft	325 ft	275 ft	200 ft	100 ft[6]		
65 mph	1,200 ft	475 ft	450 ft	400 ft	350 ft	275 ft	200 ft	100 ft[6]	
70 mph	1,250 ft	550 ft	525 ft	500 ft	450 ft	375 ft	275 ft	150 ft	
75 mph	1,350 ft	650 ft	625 ft	600 ft	550 ft	475 ft	375 ft	250 ft	100 ft[6]

Notes:

1. The distances are adjusted for a sign legibility distance of 180 feet for Condition A. The distances for Condition B 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.
2. 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. Typical signs are Merge and Right Lane Ends. The distances are determined by providing the driver a PRT of 14.0 to 14.5 seconds for vehicle maneuvers (2004 AASHTO Policy, Exhibit 3-3, Decision Sight Distance, Avoidance Maneuver E) minus the legibility distance of 180 feet for the appropriate sign.
3. 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 2004 AASHTO Policy, Exhibit 3-1, Stopping Sight Distance, providing a PRT of 2.5 seconds, a deceleration rate of 11.2 feet/second^2, minus the sign legibility distance of 180 feet.
4. Typical conditions are locations where the road user must decrease speed to maneuver through the warned condition. Typical signs are Turn, Curve, Reverse Turn, or Reverse Curve. The distance is determined by providing a 2.5 second PRT, a vehicle deceleration rate of 10 feet/second^2, minus the sign legibility distance of 250 feet.
5. No suggested distances are provided for these speeds, as the placement location is dependent on site conditions and other signing. However, the alignment warning sign should be installed in advance of the curve and at least 100 feet from any other signs.
6. The minimum advance placement distance is listed as 100 feet to provide adequate spacing between signs.

Source: FHWA, MUTCD

2.3.2 What is an Advisory Speed?

Within this pamphlet there are several references to the term "advisory speed." The term is defined in Section 1.5 but it is important to know that the advisory speed is a recommended safe speed. However, this speed is relative, since a speed that is safe or comfortable for a driver of a car may not be safe or comfortable for a truck driver; and the safe or comfortable speed for a driver of a sports car may not be safe or comfortable for the driver of a family sedan. Therefore, an advisory speed is only a suggested relative term.

W1-2 & W13-1P

The most common application of an advisory speed is with the Advisory Speed (W13-1P) plaque installed below a Turn (W1-1) or Curve (W1-2) sign, but technically you can install a W13-1P plaque below any warning sign.

The safe speed on a curve or turn can be determined by one of the following three methods:

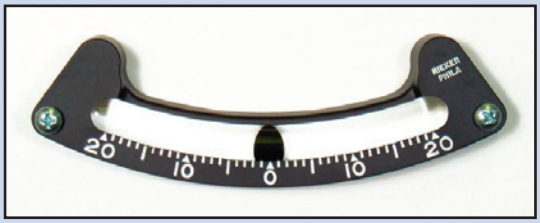
1. Drive the curve with a ball-bank indicator as discussed below.
2. Determine the "85th percentile speed" of passenger cars on the curve or turn.
3. Drive the curve several times in a typical passenger car and determine the highest comfortable speed.

On the recommendation of a qualified traffic engineer, advisory speed plaques may be used at other locations such as below intersection signs like a Cross Road (W2-1) or Side Road (W2-2) sign, or whenever the engineer determines that there may be a limited sight distance problem.

Regardless of the application or methodology, do not use an advisory speed unless it is less than the posted speed limit or an unposted statutory speed limit.

Ball-Bank Indicator

A ball-bank indicator measures the combination of centrifugal force and vehicle body roll in degrees. To determine the advisory speed with a ball-bank indicator, mount the instrument on the dash of a typical passenger vehicle and align it so that it provides a "zero reading" when the occupants are in the vehicle and the vehicle is on a perfectly level surface. Have a technician record the ball-bank reading as the vehicle travels at a uniform speed around the turn or curve in the center of the lane. The goal is to determine the highest multiple of 5 mph that produces a maximum ball-bank reading of 12 degrees at speeds of 35 mph or greater, 14 degrees at speeds of between 25 and 30 mph, and 16 degrees at speed of 20 mph or less.



Model 1023W1 Ball Bank Indicator, Courtesy of Rieker, Inc., ©2002-2006 Rieker® All Rights Reserved.

2.3.3 Horizontal Alignment Signs (W1-Series)

There are a variety of horizontal alignment signs that can be used in conjunction with pavement markings and delineation to inform drivers of a change in the roadway alignment. As with all signs, uniformity of application is necessary to provide a consistent message to drivers.

Horizontal alignment signs are not recommended if drivers can safely drive the road at the speed limit, or if the road is a low-volume, local road type facility. However, as a minimum, military installations are encouraged to install horizontal alignment signs on all roads with an average workday traffic volume (AWDT) of at least 1,000 vehicles in accordance with Exhibit 2.26.

Exhibit 2.26: Suggested Application of Horizontal Alignment Signs

Type of Horizontal Alignment Sign	Difference Between Speed Limit and Advisory Speed*		
	5 mph	10 mph	15 mph or greater
Turn (W1-1), Curve (W1-2), Reverse Turn (W1-3), Reverse Curve (W1-4), Winding Road (W1-5), and W1-10 series	Recommended	Required	Required
Advisory Speed Plaque (W13-1P)	Recommended	Required	Required
Chevron Alignment (W1-8) or One-Direction Large Arrow (W1-6)	Optional	Recommended	Required
* These recommendations apply to all roads with an AWDT volume in excess of 1,000 vehicles			

Some of the most common signs used for changes in horizontal alignment are illustrated below.

W1-1L

W1-2L

W1-3L

W1-4L

W1-5R

W1-6

W1-8

Note that the first five signs have either an "L" (for left) or a "R" (for right) as the suffix at the end of the sign code. Frequently, these signs are referenced without the suffix so that a single designation such as the Turn (W1-1) sign includes both the W1-1L and the W1-1R signs. Signs with an "L" indicate that the first turn is to the left, and those with an "R" indicate that the first turn is to the right. The "L" signs and the "R" signs are mirror images of each other.

The W1-6 and W1-8 signs can be rotated clockwise or counterclockwise 180 degrees to accommodate either direction; therefore, there is no need for a suffix.

The Chevron Alignment (W1-8) sign may be used for additional emphasis and guidance within a change in horizontal alignment, and may be used as an alternate to standard delineation. When used, place the W1-8 signs on the outside of the turn or curve at approximately a right angle to approaching traffic. The bottom of W1-8 signs may be mounted at the substandard height of 4 feet above the nearest edge of pavement to provide additional visual impact.

It is important to note that the difference between the W1-1 and W1-2 signs, and the W1-3 and the W1-4 signs is the severity of the change in horizontal alignment. If the "advisory speed" is less than 30 mph, the Turn (W1-1) sign or the Reverse Turn (W1-3) sign should be use; but if the "advisory speed" is 30 mph or greater, the Curve (W1-2) sign or the Reverse Curve (W1-4) sign should be used as appropriate.

For sharper curves and turns, two separate sign posts are generally used to install W1-8 signs on two-lane, two-way roadways; but for flatter curves, it generally is acceptable to mount back-to-back signs on the same post, with the signs oriented perpendicular to the highway centerline.

Exhibit 2.27 shows the recommended spacing of the W1-8 signs based on two different methods: (1) the advisory speed on the curve; or (2) the radius of the curve.

Exhibit 2.27: Methods to Determine Spacing of Chevron Alignment Sign

Method 1: Based on the Advisory Speed (mph)	Method 2: Based on the Curve Radius (feet)	Sign Spacing (feet)
15 or less	Less than 200	40
20 to 30	200 to 400	80
35 to 45	401 to 700	120
50 to 60	701 to 1,250	160
More than 60	More than 1,250	200

Source: FHWA, Table 2C-6, MUTCD

2.3.4 Intersection Warning Signs (W2-Series)

Warning signs may be used to warn drivers of the presence of an intersection and the possibility of turning or entering traffic. Some of the most common W2-series signs are illustrated.

Restraint should be exercised so as not to over use these signs; therefore, they should only be used for hidden intersections or major intersections. If a warning sign is deemed necessary, instead of using a W2-1, W2-2, or W2-3 sign, all of which depicts a straight-through roadway alignment, it may be more appropriate to use a Stop Ahead (W3-1) sign, Yield Ahead (W3-2), or Signal Ahead (W3-3) sign.

The Circular Intersection (W2-6) sign is designed for application at both traffic circles and at the newer "roundabouts." Although optional, the ROUNDABOUT (W16-17P) plaque or the TRAFFIC CIRCLE (W16-12P) plaque may be added below the W2-6 sign as appropriate.

Although roundabouts are similar to the older traffic circles, there are differences both in the physical design and in the traffic control which improves both capacity and safety. In order to qualify as a roundabout, each approach to the circular intersection must have:

1. a YIELD sign, and
2. a splitter island designed to slow traffic and to deflect all vehicles to the right to ensure that they travel counterclockwise around the central island.

In lieu of using a ROUNDABOUT (W16-17P) or the TRAFFIC CIRCLE (W16-12P) plaque, consider using an Advisory Speed (W13-1P) plaque or a black-on-yellow Advance Street Name (W16-8P) plaque below the Circular Intersection (W2-6) sign.

W2-1

W2-2

W2-3

W2-4

W2-5

W2-6

W16-12P

W16-7P

2.3.5 Advance Traffic Control Signs (W3-Series)

The four most common advance traffic control signs are illustrated.

The Stop Ahead (W3-1), Yield Ahead (W3-2), and Signal Ahead (W3-3) signs should be used if the sight distance to the STOP (R1-1) sign, YIELD (R1-2) sign, or a minimum of two signal faces are not visible in sufficient time. Exhibit 2.28 provides minimum sight distance values that trigger the need for these signs. However, when an advance traffic control sign is warranted because of insufficient sight distance, the physical location of the sign should conform to the guidelines in Exhibit 2.25, where the advance distance is the appropriate "0-mph value" under Condition B, when measured from the intended stopping location.

The Speed Reduction (W3-5) should only be used if both of the following apply:

1. The speed reduction is 10 mph or greater, and
2. The speed reduction begins at a location other than at the beginning of a side road or at an intersection where all traffic must either stop or turn to enter the section of road with the reduced speed limit.

W3-1

W3-2

W3-3

W3-5

Exhibit 2.28: Warrants for Advance Warning Signs

85th-Percentile Speed (mph)	Continuous Sight Distance to the Traffic Control Device is Less Than (feet)	
	STOP or YIELD Sign*	Signal Faces**
25	155	215
30	200	270
35	250	325
40	305	390
45	360	460
50	425	540
55	495	625
60	570	715

* From Table 6C-2 of the *MUTCD*.

** From Table 4D-2 of the *MUTCD*. These values are slightly greater than the minimum SSD values, presumably because signals are located beyond the stop lines.

2.3.6 Entry Control Facility Signs

There are several unique warning signs that are frequently used at entry control facilities (ECFs) in accordance with SDDCTEA's Pamphlet 55-15 (entitled, *Traffic and Safety Engineering for Better Entry Control Facilities*). The first and only unique warning signs approaching the ECF are generally either the CHECK POINT (W3-10a-TEA) sign, or in the event of a multi-lane or high-speed approach, the larger CHECKPOINT (__) FEET—BE PREPARED TO STOP (W3-10b-TEA) sign.

After the checkpoint, additional warning signs are frequently used for motorists as they approach an active vehicle barrier (AVB). These signs include the ACTIVE BARRIER (W3-3a-TEA) sign and the BARRIER ACTIVATED WHEN FLASHING (W3-3b-TEA) sign. As the sign suggests, the second sign is always used with flashing lights that would be activated prior to the physical activation of the AVB.

W3-10a-TEA

W3-10b-TEA

Chicanes are sometimes used as a security measure approaching and leaving ECFs in order to physically slow traffic and help contain potential threats. This can be accomplished by the use of serpentine roadways, or in some cases the creation of an obstacle course. Therefore, special signs such as the Winding Road Chicane (W1-5Ra-TEA) sign may be used. Depending on the path, the mirror image of the W1-5Ra-TEA sign may be more appropriate (i.e., the W1-5La-TEA sign, where motorists first turn to the left as they begin the serpentine roadway).

W1-5Rb-TEA

W3-3a-TEA

W3-3b-TEA

2.3.7 Advance Street Name (W16-8P, W16-8aP) Plaques

Advance Street Name (W16-8P, W16-8aP) plaques may be used below an intersection warning sign (e.g., W2-1, W2-2, W2-3, W2-4, and W2-5) or an advance traffic control sign (e.g., W3-1, W3-2, and W3-3). To improve legibility of the street name, use Highway Gothic, mixed-case legend.

W16-8P

W16-8aP

2.3.8 Gate and Road Closures

External guide signs should always identify hours of operation for gates that are closed on a routine basis during the work week as discussed in Section 2.4.3. However, it is also desirable to install advance warning signs on any through road approach to these gates. The GATE CLOSED AHEAD (W20-3g-TEA) sign would normally be appropriate.

There are also situations where roads are closed on a somewhat random basis, perhaps because of explosives testing, missile launching, rifle range, etc. In these situations, the ROAD CLOSED AHEAD (W20-3) sign as used in the *MUTCD* may be appropriate, except that the color should be black-on-yellow instead of black-on-orange.

In both situations, it is desirable to install an Hours (W16-20P-TEA) plaque below the warning sign. Other options include folding or removing the advance sign or using a WHEN FLASHING (W16-13P) plaque.

W20-3 &
W16-20-TEA

W20-3g-TEA &
W16-20-TEA

2.3.9 Pedestrian (W11-2) Sign

Pedestrian (W11-2) signs should only be used where pedestrians are unexpected. Therefore, the W11-2 sign should only be used for midblock crossings or crosswalks and not for crosswalks at intersections.

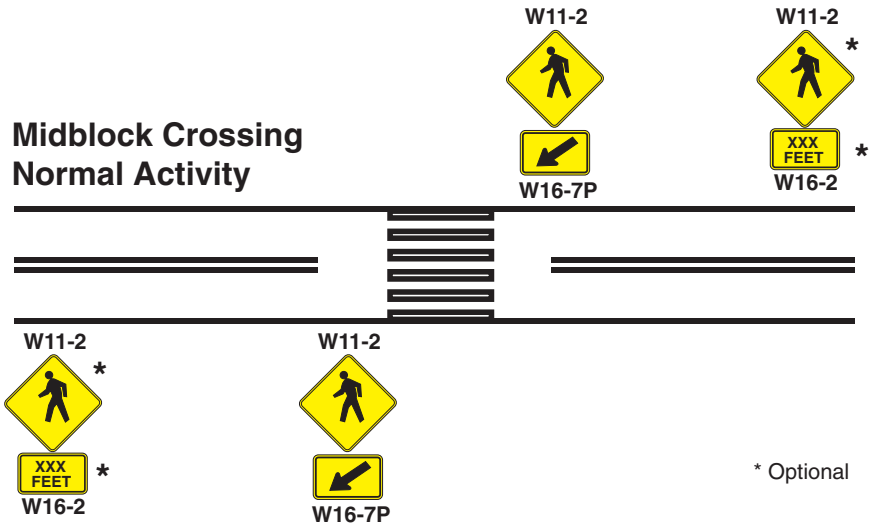
At marked midblock crosswalks, the Pedestrian (W11-2) sign with a downward pointing arrow (W16-7P) plaque should generally be installed at the crosswalk. If the speed limit is greater than 25 mph, a pedestrian (W11-2) sign with a Distance (W16-2P) plaque may be warranted as an advance warning sign, especially if there are sight obstructions.

> As noted in Section 3.2.13, marking midblock crosswalks should be done very carefully since studies suggest that by themselves, marked crosswalks frequently do more harm than good from a safety perspective, perhaps because they give pedestrians a false sense of security.

As noted in Section 2.2.3, the In-Street Pedestrian Crossing (R1-6 or R1-6a) signs may be placed on the roadway at marked midblock crosswalks providing the general recommendations are satisfied. At unmarked midblock crossings, the W11-2 sign may be installed in advance of the known crossing areas with an appropriate distance plaque beneath the W11-2 sign (e.g., W16-2P or W16-4P as illustrated in the *MUTCD*).

As a final note, pedestrian signs and their plaques can use the fluorescent yellow-green background. Therefore, instead of yellow or fluorescent yellow retroreflective sheeting material, these signs can be made from the yellow-green material, but installations should avoid mixing the two colors within the same vicinity.

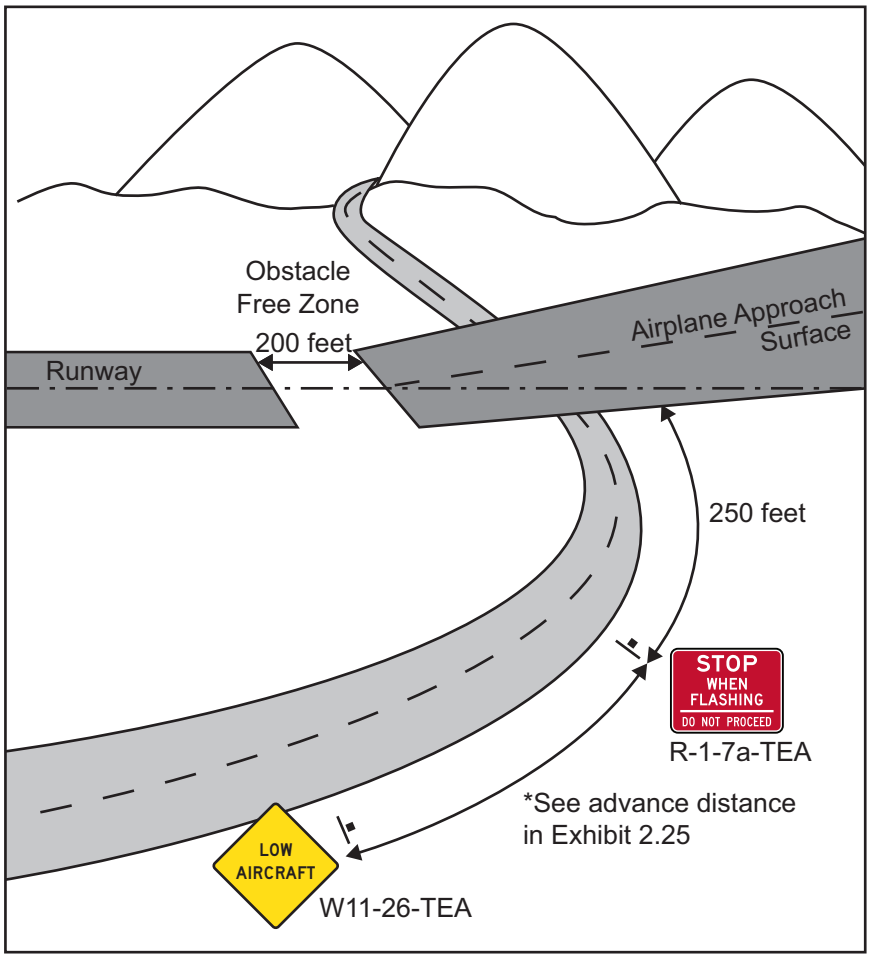
> Studies show that unusual signs such as larger sizes, substandard mounting heights, and unusual sign colors, all produce higher conspicuity. However, as the unusual becomes commonplace, the devices lose their attention-getting abilities. Therefore, FHWA has limited the use of the fluorescent yellow-green color to the following warning-type signs – required for school signs, and optional for pedestrian and bicycle signs.



2.3.10 LOW AIRCRAFT (W11-26-TEA) Sign

The LOW AIRCRAFT (W11-26-TEA) sign should be used in advance of a runway when the sudden appearance or noise from a low-flying aircraft might startle an otherwise unsuspecting driver. Since the area of influence is variable, the W11-26-TEA sign should generally be installed about 500 feet in advance of the point of maximum impact, which typically would be from the center of the crossing.

W11-26-TEA W11-27-TEA W11-28-TEA W11-29-TEA



2.3.11 TAXIWAY (W11-27-TEA) Sign

The TAXIWAY (W11-27-TEA) sign is designed to alert drivers when an aircraft taxiway either crosses or runs adjacent to the roadway.

2.3.12 TANK CROSSING (W11-28-TEA) Sign

The TANK CROSSING (W11-28-TEA) sign may be used to alert drivers to the possible presence of heavy armament vehicles that may cross the roadway. This is especially important because tank operators have restricted visibility and may not see other oncoming vehicles.

2.3.13 HAZARDOUS CARGO CROSSING (W11-29-TEA) Sign

The HAZARDOUS CARGO CROSSING (W11-28-TEA) sign may be used to warn drivers that there may be trucks hauling hazardous materials crossing the roadway.

2.3.14 Playground (W15-1) Sign

If a playground exists near the roadway and children are apt to run onto the roadway, a Playground (W15-1) sign may be installed in advance of the access area. When used, the sign may have a yellow or fluorescent yellow-green color, but the goal should be to use the same color for the same type of sign whenever the sign is used.

W15-1

2.3.15 SPEED HUMP (W17-1) Sign

A speed hump is an acceptable traffic-calming measure. However, the short, 2- to 4-foot long speed bumps are not acceptable because they can cause extensive vehicle damage, loss of control for cyclists, and ejection of fire truck personnel. Moreover, some people have determined that the faster a vehicle travels, the lower the pain level.

In an effort to slow traffic in congested areas, some installations have installed speed humps as a traffic-calming measure. These humps provide gradual vertical deflections of 3 to 4 inches within a 12- to 20-foot section of highway. In some cases, upward and downward slopes are each about 6 feet long, but an 8- or 10-foot flat section is created on the top for a pedestrian crosswalk.

In either situation, the SPEED HUMP (W17-1) sign is appropriate, but an Advisory Speed (W13-1P) plaque should always be added below the sign with the suggested safe speed.

W17-1

2.3.16 Object Markers

Object markers are small warning signs but without a word message or a pictorial representation of a traffic control message.

Object markers are somewhat unique traffic control devices. Historically, most transportation agencies considered object markers to be markings, probably because they frequently supplement pavement markings. However, for purposes of this pamphlet, object markers are classified as warning signs since FHWA uses that classification in their 2009 *MUTCD* (see Sections 2C.63, 2C.64, 2C.65, and 2C.66).

Most object markers look like signs. In reality, they are not that much different than the Chevron Alignment (W1-8) sign, because they serve a similar purpose. Where Chevron Alignment signs warn drivers of curves, object markers warn drivers of nearby objects.

Figure 2C-13 in the *MUTCD* shows several types of object markers, including markers with either three or nine yellow or red circular retroreflectors that are a minimum of 3 inches in diameter. These circular devices are typically acrylic retroreflectors that are very bright when viewed at an angle perpendicular to the marker, but they have almost no retroreflectivity when viewed at an angle of 30 degrees or more from normal.

Therefore, military installations are encouraged not to use object markers with circular acrylic retroreflectors because the object markers frequently are not visible to drivers – for example, when turning at intersections, traveling around sharp turns and curves, and at any location where the markers become misaligned. For that reason, Exhibit 2.29 only shows the recommended object markers, all of which use retroreflective sheeting material.

These object markers are frequently grouped into the following four basic types:

- ✓ Type 1 - OM1-3
- ✓ Type 2 - OM2-2H and OM2-2V
- ✓ Type 3 - OM3-L, OM3-C, and OM3-R
- ✓ Type 4 - OM4-3

Exhibit 2.29: Recommended Object Markers

Markings for Objects in the Roadway

Objects within the roadway include bridge piers and channelizing islands, and these can be marked with either a Type 1 or Type 3 object marker. If using the Type 3 marker, use the OM3-L marker on the left side of the intended travel path and the OM3-R marker on the right side of the intended travel path. If traffic can pass on either side of the object, use the OM-3C object marker. Wherever possible, align the inside edge of a marker with the inside edge of the object, and install the bottom of the marker at an elevation 4 feet above the near edge of the traveled way.

If object markers or other signs need to be installed within a concrete median or channelizing island, military installations are encouraged to use a steel square post (as illustrated in Exhibit 2.19) within a 4-inch diameter, dirt-filled, hole in the concrete. The holes can be formed during construction of new medians or islands during construction by using a vertical hollow plastic pipe to create the hole, or a hole can be drilled after construction. In either case, the anchor should extend no more than about 1 inch above the top of the median or channelizing island.

Markings for Objects Adjacent to the Roadway

Objects adjacent to the roadway should be marked with either a Type 2 or Type 3 object marker. Exhibit 2.30 shows a typical installation involving both Type 2 and Type 3 object markers. Note that a Type 3 object marker is used on each end of the bridge abutments with the diagonal lines sloping down toward the side of the marker that vehicles should pass on.

Type 2 object markers are excellent for warning of the presence of linear objects such as guard rail on the approach to bridges or the parapet on long bridges, especially when these obstructions are within 8 feet of the travel way. Wherever possible, also align these markers with the inside edge of the object and install the bottom of the marker at an elevation 4 feet above the near edge of the traveled way.

Typical spacing of Type 2 object markers would be 35 to 50 feet on short sections and greater spacings for long sections of linear objects.

Type 2 object markers and post-mounted delineation are essentially the same. In fact Section 3.3.1 shows the OM2-2V and OM2-2H object markers being used for post-mounted delineation, although it recommends the use of flexible delineator posts. The difference is essentially one of application – if used in conjunction with an object we would call it an object marker, but if used merely to keep nighttime drivers on the road we would consider it delineation.

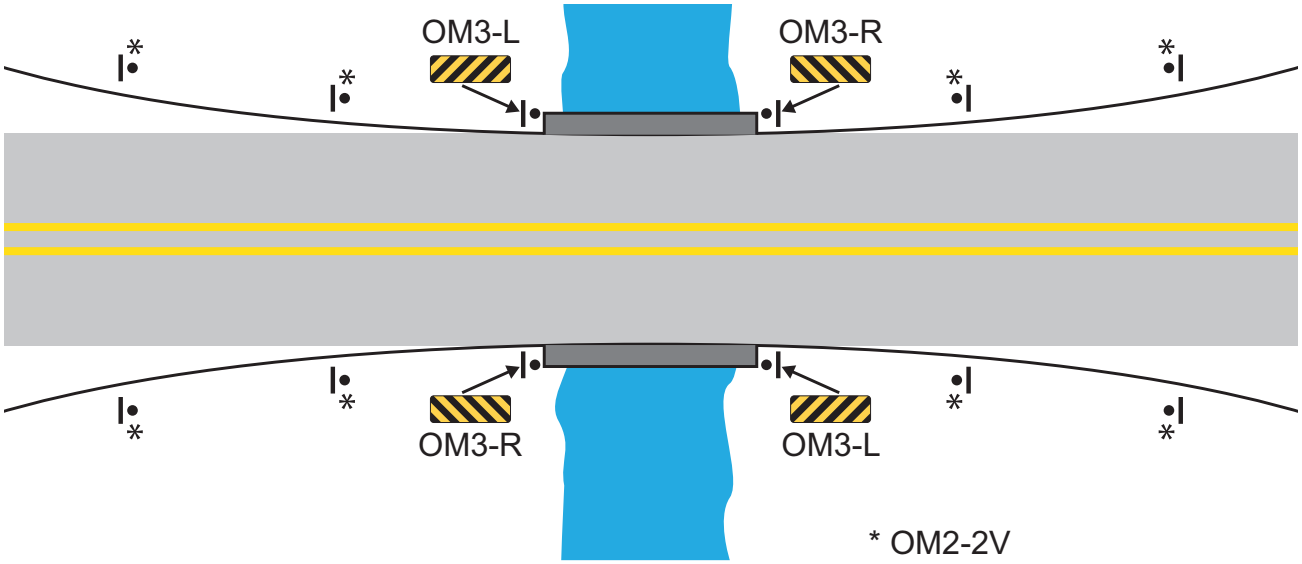
Therefore, if OM2-2V markers are used to warn motorists of a raised concrete right-turn island, most highway engineers would consider them to be object markers, whereas if used within dirt or grass to warn of the edge of the pavement most highway engineers would consider it as delineation.

End-of-Roadway Markers

End-of-Roadway (OM4-3) object markers warn road users of the end of a dead-end roadway where there are no other alternative vehicular paths.

To increase the target value, use a series of three or more of the End-of-Roadway (OM4-3) markers across the end of the roadway. However, a preferred option is to place a red-and-white Type III barricade across the end of the roadway as discussed in Section 2.2.18.

Exhibit 2.30: Common Use of Object Marker



2.3.17 Slow-Moving Vehicle Emblem

Although technically not a traffic sign, the Slow-Moving Vehicle Emblem is intended as a unique identifier for attachment to vehicles which, by design, always move slowly (25 mph or less) on the public roads. The emblem measures 16”x14,” and should be mounted on the center of the back of all slow-moving equipment at a height of 2 to 6 feet above the ground.

The center triangle is fluorescent yellow-orange, but it is not retroreflective, while the dark red is highly retroreflective. As a result, under headlight illumination at night, the emblem appears as a hollow red triangle.

The emblem can be purchased from a number of safety equipment suppliers.

2.4 Guide Signs

Guide signs provide information for highway routes, street names, destinations, distances, available services, and points of interest. Military installations are encouraged to use a frequent display of street name signs and destination signs to keep unfamiliar road users informed of their route and location.

At most military installations, guide signing is inadequate and should be upgraded as soon as possible. Too often, tall ladder-type destination signs are used to guide motorists, and these signs have too many messages for drivers to safely read. Of utmost importance is the replacement of these ladder-type signs with a visitor guidance system that includes larger street name signs, and large-lettered destination signs generally having no more than three destinations.

Even with the best directional signs, it is impossible to assist every unfamiliar driver find their facility. Therefore, visitor centers and gate houses should have printed maps available for distribution upon request.

2.4.1 General Design Criteria

Guide signs are normally rectangular, with the sign width as the longer dimension. All guide signs should have white lettering, arrows, and borders. The background color should typically be green, except:

- ✓ motorist service signs should have a blue background color, and
- ✓ cultural or recreational interest signs may have a brown background color.

Guide signs must be legible to approaching drivers. Where speeds or volumes are high, larger signs are required. At locations where traffic is moving slowly or must stop, smaller signs may be used.

The *Standard Highway Signs and Markings* (*SHSM*) Book currently does not contain as many design details for guide signs as it does for regulatory and warning signs, probably because guide signs are typically one-of-a-kind designs. Therefore, it is no surprise that there is a great diversity in the design of guide signs on a state-to-state basis. Fortunately, there is a consortium of transportation agencies and software manufacturers working with FHWA to help standardize the designs.

On military installations, guide signs primarily consist of the following:

- ✓ Destination signs to the installation and the specific gates.
- ✓ Destination signs to internal facilities (e.g., visitors' center, credit union, and major buildings).
- ✓ Street name signs.
- ✓ On-premise signs and building number signs.

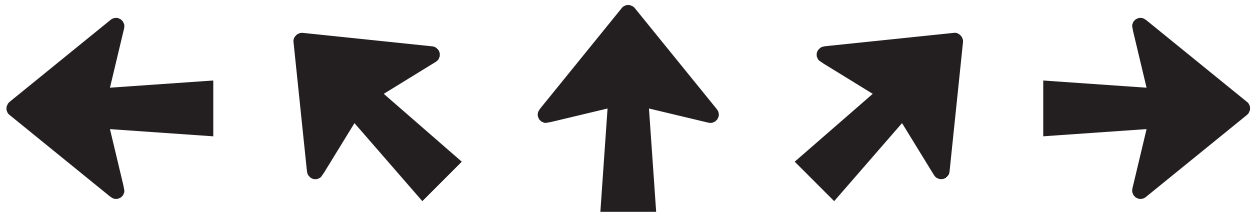
Many guide signs have arrows to show direction, and the arrows can be rotated at various angles as appropriate. When used on guide signs on conventional highways, the preferred arrow design is FHWA's Type B arrow. Exhibits 2.31 and 2.32 provide additional details.

A maximum of three destinations should generally be included on a given sign, although a header line may also be included. The minimum recommended legend size for the names of destinations is as follows:

Exhibit 2.31: Recommended Legend Sizes

Speed Limit	Words & Numbers (Inches)	Nominal Arrow (Inches)
25 mph or less	4	6x6
30 mph or higher*	6	9x9
* Except not applicable on multi-lane roadways with a speed limit greater than 40 mph.		

Exhibit 2.32: Typical Orientations of the Type B Arrow



2.4.2 Lettering Style

Historically, the names of cities and other destinations, streets, and buildings used on guide signs on conventional highways have been in all capital letters ("uppercase legends"), whereas the names used on freeways have been in "mixed-case" (the combination of capital letters and "lowercase lettering letters"). However, names in mixed-case lettering is legible from a greater distance than names in all capital letters because mixed-case lettering has ascending and descending letterforms that aids word recognition. Therefore, beginning with the 2009 *MUTCD*, FHWA now requires the use of mixed-case lettering for all names used on guide signs.

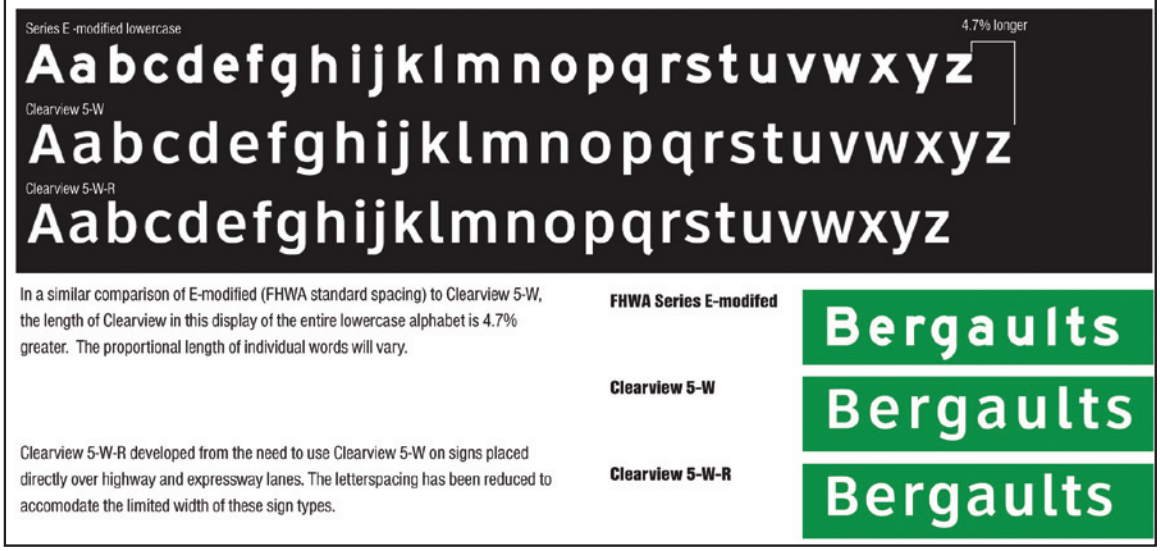
The *MUTCD* currently defers to the *SHSM Book* for the design of uppercase letters (capitals), lowercase letters, numerals, route shields, and spacing. The standard alphabet currently is a Gothic-style alphabet which was developed in the 1940's and 1950's, and it is frequently referred to as "Highway Gothic."

However, a new font or typeface called "Clearview" was recently developed to improve legibility, especially legibility when using some of today's "brighter" retroreflective sheeting materials. Unlike the Highway Gothic fonts, the Clearview font uses variable stroke widths which creates larger internal openings within letters, which assists drivers with poorer vision and helps to reduce the effects of halation or overglow at night. On September 2, 2004, FHWA issued interim approval for the optional use of the Clearview font for white legend on all guide signs (see http://*MUTCD*.fhwa.dot.gov/pdfs/ia_clearview_font.pdf).

Research shows that names using the Clearview mixed-case legends generally have a 12 percent greater legibility distance than names using the Highway Gothic mixed-case. Moreover, studies also show that the combination of mixed-case legend and the Clearview 3W font has a 29 percent greater legibility distance than all uppercase legend using the Highway Gothic Series D font, with the same basic size sign.

Since the Clearview font is approved, military installations are encouraged to use it for all mixed-case lettering on guide signs. Mixed-case lettering should not, however, be used for any special action messages such as 500 FEET, LEFT AT SIGNAL, NEXT RIGHT, etc.

Figure 18. FHWA Series E-modified Compared to Clearview 5-W



There are six different font series in both Highway Gothic and in Clearview. With reference to Exhibit 2.33, fonts within a given row are generally considered equivalent of each other. The bolder series in the bottom three rows are generally reserved for freeways. Within military installations, the suggested font is Clearview Series 2W (or Highway Gothic Series C) for Street Name signs, and Clearview Series 3W (or Highway Gothic Series D) for destination signs. However, if signs made with these fonts would be too big, the fonts above these can be used.

Exhibit 2.33: Highway Gothic vs. Clearview

Highway Gothic	Clearview	Preferred Clearview Font
B	1W	
C	2W	← Street Names
D	3W	← Destinations
E	4W	
E-Modified	5W	
F	6W	

Spacing for Clearview should conform to the criteria in FHWA's "Clearview Typeface Supplement" at http://*MUTCD*.fhwa.dot.gov/pdfs/clearfont/CTSEng.pdf, and in the spacing charts in Appendix B of this manual. Spacing between letters are calculated exactly the same as illustrated in the 2004 Edition of the *SHSM Book*; i.e., the spacing by using a combination of a "right margin" associated with the first of two letters and a "left margin" associated with the second letter (see Section 2.1.4 and Exhibit 2.4).

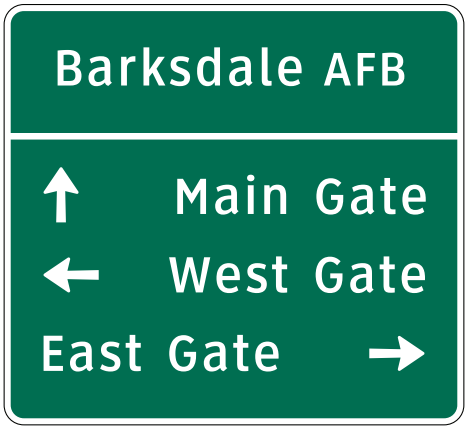
Unlike lowercase Highway Gothic legend, the height of the lowercase Clearview legend is approximately 82 percent (instead of 75 percent) of the height of the uppercase legend. Therefore, when using Clearview fonts, disregard references in the *MUTCD* to the specific height of lowercase legend or to lowercase legend being 3/4 of the height of uppercase letters.

To avoid the above problem, this pamphlet uses a single dimension to specify the height of mixed-case legend; e.g., 6" 3W, instead of two separate values such as 6"/4.5" D.

2.4.3 Destination Signs when Approaching the Base

When approaching a military installation, the advance signs need to identify the name of the installation, and direct motorists toward the proper gate. If there is more than one gate, the destination signs would be similar to the following, where destinations straight ahead would be identified first, and then those destinations to the left, and then the ones to the right. If more than one destination is in the same direction, the closest one should be above the other.

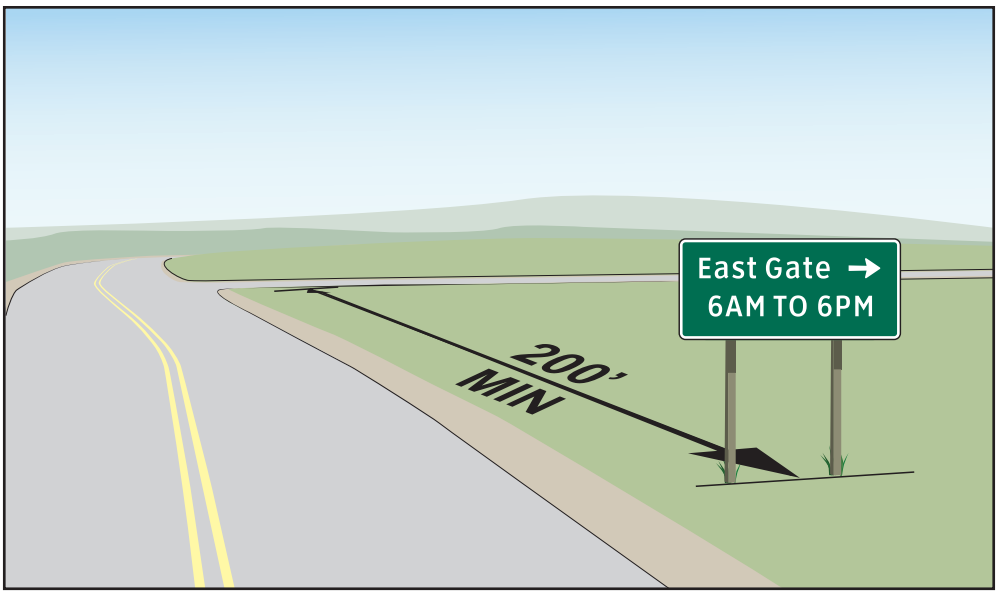
D1-4b-TEA



D1-4c-TEA

If a gate is not open at all times and the gate is some distance from the roadway, the hours of operation should be included on the signs as illustrated below. See the D1-5a-TEA sign standard (page A-33).

If trucks are required to use a special gate, the destination sign could include the words "NO TRUCKS" after the gate name, or a special black-on-white sign could be installed in advance of the destination sign with a message such as "ALL TRUCKS USE WEST GATE."



Since these signs will frequently be on public highways, it probably will be necessary to work with the local transportation department to either have them install the signs or to authorize the military installation to install the signs on their roadways.

2.4.4 Destination Signs on the Base

Destinations signs should be limited to three lines of legend and should be used to direct visitors to facilities that generate significant visitor traffic. When used, the signs should be located at least 200 feet in advance of an intersection where a turn is required.

D1-1-TEA

D1-2-TEA

D1-3-TEA

2.4.5 Street Name Signs

Unacceptable Street Name signs are common on military installations. Typical issues include very small legend, and non-retroreflective legend and background. In addition, better legibility can be obtained by using mixed-case legends.

At minor intersections, one Street Name sign facing each approach is permissible; but at major intersections, military installations are encouraged to install Street Name signs on diagonally opposite corners so that they will be on the far right-hand and near left-hand corners of the intersection for traffic on the major street. The signs are normally double-sided so that they can be read in both directions of travel.

All Street Name signs should have white, mixed-case legend. The recommended background color is green; however, blue, brown, or black background colors are permissible; but it is desirable to have the colors consistent throughout the military installation, or at least throughout a unique area within the installation. The standard legend is 6 inches high, except 8-inch legend should be used on multi-lane roads with a speed limit over 40 mph and 4-inch legend may be used for roads with a speed limit of 25 mph or less. Sign borders may be eliminated to reduce the size of the signs.

Street Name signs are usually installed on their own sign post, but they may be placed above a STOP or YIELD sign.

Special hardware is available to mount the sign blades from their bottom edge so that both sides of the sign are clearly visible to approaching drivers.

If signs are mounted above a STOP or YIELD sign, everyone is encouraged to mount the one with the name of the cross street on the top so that the unique shape of the STOP or YIELD sign is not compromised.

Common Abbreviations

Except for very short names, the common abbreviations such as “Rd,” “St,” “Dr,” “Ave,” or “Blvd” should not be used unless not using them creates confusion with a nearby street or destination; e.g., there is both a York Road and a York Street.

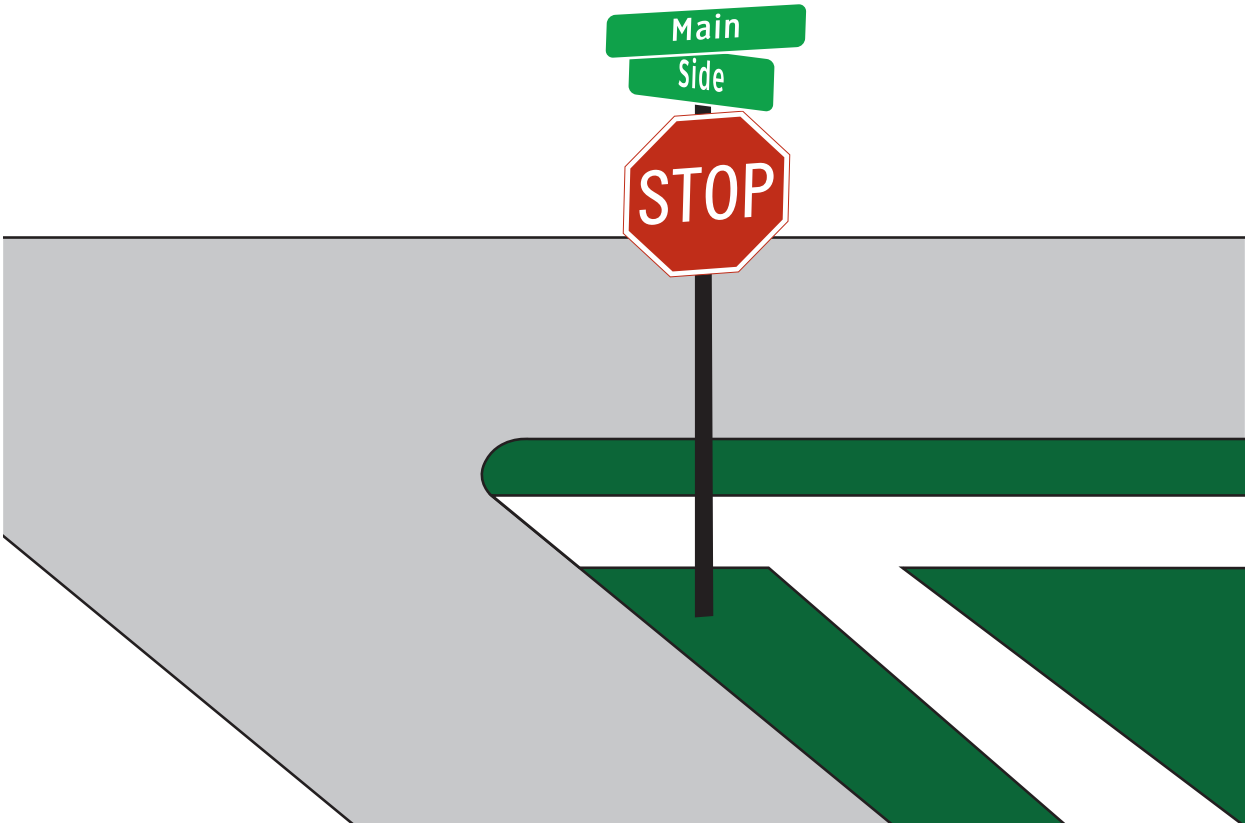
Confusion is of greater concern with Two-Line Street Name (D3-2-TEA) signs since they use directional arrows. For example, street names such as:

- ✓ “Market” could be mistaken as a destination sign giving directions to a “market,” and
- ✓ ”Patterson” could be mistaken as a destination sign for a nearby city or town by that name.

Therefore, military installations should be sensitive to these potential problems.

D3-1-TEA

D3-2-TEA



The signs may also be mounted overhead or cantilevered from an existing support. If cantilevered, the signs should always be cantilevered toward the intersection so that the Street Name sign for the crossing street is clearly visible and not hidden by the other Street Name sign.

If street name signs are mounted overhead, the *MUTCD* recommends using minimum 12-inch mixed-case legends.

2.4.6 Guide Signs at Entry Control Facilities (ECFs)

At entry control facilities (ECFs), overhead signs or signals are frequently used for lane control. If signals are used, the signal heads should be similar to the RED X or the GREEN DOWNWARD ARROW signals illustrated in Exhibit 2.21.

However, the preferred option is to use large lane assignment signs as illustrated in Exhibit 2.34. The M4-29-TEA sign is for installation about one-half mile in advance of the ECF. The other four signs (i.e., the M4-30-TEA, M4-31-TEA, M4-32-TEA, and M4-33-TEA) are for overhead installation on the canopy over the ECF or for installation in advance of the ECF. The overhead signs should generally be the sign faces on changeable message signs that are remotely controlled so that lanes can be opened and closed as necessary.

Exhibit 2.34: ECF Lane Assignment Signs

M4-29-TEA

M4-30-TEA

M4-31-TEA

M4-32-TEA

M4-33-TEA

In addition to these lane assignment signs, other signs that are commonly used in advance of the ECF include:

- ✓ USE PARKING LIGHTS AT GATE (R16-5a-TEA)
- ✓ ACTIVE BARRIER (W3-3A-TEA)
- ✓ BARRIERS ACTIVATED WHEN FLASHING (W3-3b-TEA)
- ✓ CHECK POINT (W3-10-TEA)
- ✓ CHECKPOINT ___ FT – BE PREPARED TO STOP (W3-10b-TEA)

2.4.7 On-Premise Signs

Larger buildings on military installations should generally have On-Premise (D35-1-TEA) signs designed to identify the building number and the name of the building. Additional information such as the street address may also be appropriate. The design of the D35-1-TEA signs may vary as necessary.

When used, the signs should be installed about 30 feet from the edge of the road, frequently in a front lawn of the facility, and should have legend on both sides of the sign.

D35-1-TEA

Building Number (D35-2-TEA) signs are for attachment to buildings to identify the building number. It is recommended that the sign be installed at a height of about 8 feet above the base of the building, but care must be taken to ensure that the sign is not hidden by the landscaping.

The design of the D35-2-TEA sign may vary as necessary. Military installations should use retroreflective sheeting for these signs because it is more durable than non-retroreflective materials and retroreflectivity would greatly enhance visibility of the sign during a nighttime emergency.

D35-2-TEA

2.4.8 Directional Signs at Base Exit

When exiting a military installation, it is desirable to have signs to show directions to nearby numbered traffic routes and cities to help orient unfamiliar drivers. If these signs are along a public highway, the military installation should discuss the issue with the local or state transportation agency to determine responsibility.

Chapter 3
Markings

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3.1 General

Most people understand the term "pavement markings," but most transportation agencies use the shorter but more encompassing term, "markings." "Markings" include not only pavement markings such as center lines, edge lines, stop lines, pavement legends and arrows; but also delineators, channelizing devices, islands, and rumble strips.

Like traffic signs and other traffic control devices, markings should always conform to the Federal Highway Administration's (FHWA's) *Manual on Uniform Traffic Control Devices* (*MUTCD*). Specifically, Part 3 of the *MUTCD* addresses markings, and is available at http://*MUTCD*.fhwa.dot.gov/pdfs/2009/part3.pdf.

Markings frequently supplement signs or traffic signals to provide guidance on roadway alignment, no-passing zones, turn restrictions, and stopping or yielding locations.

3.2 Pavement Markings

Pavement markings are the only traffic control device that is visible to drivers without taking their eyes off the road.

"Pavement markings" are the most common type of "marking" and, as the name suggests, they are on the pavement; i.e., the physical surface of a roadway or shoulder.

Pavement markings may be categorized into two primary groups:

1. Longitudinal markings help facilitate vehicle guidance and location.
2. Transverse markings provide regulatory, warning, and guidance information to the motorist. Transverse markings include word and symbol markings, arrows, stop lines, yield lines, crosswalk lines, speed measurement markings, speed hump markings, parking space markings, etc.

Both types of pavement markings provide vital information to the vehicle operator. Therefore, they must be uniform in design, position, and application.

3.2.1 Materials

Common types of materials used in the United States for pavement markings include the following:

- ✓ Waterborne paint
- ✓ Preformed (cold) thermoplastic
- ✓ Hot thermoplastic
- ✓ Tape
- ✓ Epoxy
- ✓ Methyl methacrylate (MMA)
- ✓ Polyurea

For longitudinal lines, waterborne paint with embedded glass beads is the most popular and cost-effective pavement-marking material.

Waterborne paint is essentially a latex paint, and while it is generally the least durable of the above materials, in most cases the better waterborne paints will last at least 2 years.

On the other hand, preformed thermoplastic is the most common material for application of transverse markings and other labor-intensive markings.

Not all pavement-marking materials are compatible with each other or with some road surfaces. However, both paint and thermoplastic can be applied over any of the other common materials with the exception of tape.

Inlaid blocks, bricks, and metal strips should never be used for pavement markings.

The Most Durable Materials

Waterborne paint is the most cost-effective pavement marking material, but the Texas Transportation Institute determined that the most durable pavement marking materials are:

- ✓ thermoplastic on bituminous pavements; and
- ✓ either thermoplastic or epoxy on Portland cement pavements (epoxy is not used for legends).

3.2.2 Application of Waterborne Paint

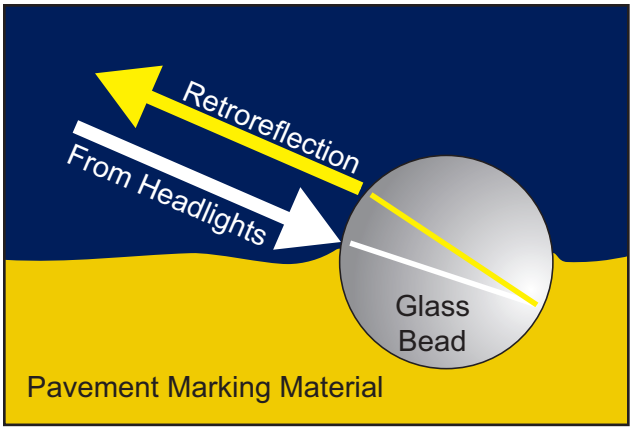
Waterborne paint with embedded glass beads is the most popular and cost-effective pavement-marking material for longitudinal lines.

Waterborne paints are generally applied at a wet thickness of at least 15 mils (i.e., 0.015 inch). Therefore, if you do the math, one gallon of paint is needed for every 321 feet of 4-inch wide line. In reality, there would be a small amount of overspray so a gallon of paint may not go quite that far.

Waterborne paints are typically heated to approximately 130°F prior to application to improve the bond with the pavement and to reduce the drying time.

All pavement markings need to be retroreflective to make them visible at night. To make them retroreflective, paint and most other pavement-marking materials rely on round glass beads embedded into the surface of the pavement marking material. When a vehicle's headlights illuminate a glass bead, the light:

1. Refracts or bends as it enters the bead;
2. Reflects off the backside of the bead if this part of the bead is embedded in the pavement marking material;
3. The reflected light becomes the color of the pavement marking material and again refracts as it leaves the glass bead; and
4. Returns to the general vicinity of the headlights and the driver.



It is essential that the proper type and quantity of glass beads are immediately added to the freshly-applied paint before it solidifies. Specify at least 7 pounds of glass beads for every gallon of paint. If the beads have insufficient embedment, traffic will dislodge the beads, and if they are embedded too much they will not reflect. Research shows that 60 percent embedment should be the goal. Therefore, the application is critical.

After application of paint, traffic should be kept off the paint until tires driven on the line do not track paint onto the road. Typical track-free dry time is about 2 minutes. If the lines are driven on too soon, in addition to tracking the paint on the road, glass beads can be pressed so deeply into the wet paint that they are no longer retroreflective.

Important Application Conditions

- ✓ The pavement must be dry and free of dirt, dust and other contaminants, including poorly adhered old markings.
- ✓ The air temperature must be above the dew point and at least 40°F.
- ✓ No serious threat of rain within the next 4 hours.

The performance of pavement marking materials is dependent on the type of road surface, the quality of the application, and winter maintenance. Some materials work better in the colder adverse weather conditions than other products, but there is no guarantee that these materials will be the best in the warmer climates. Therefore, military installations are encouraged to review their material specifications with the local state department of transportation.

Pavement markings should be inspected annually to ensure that they are in acceptable condition.

3.2.3 Minimum Retroreflectivity

As noted in Section 2.1.8, in 1993 congress directed the U.S. Secretary of Transportation to revise the *MUTCD* to include minimum levels of retroreflectivity for both traffic signs and pavement markings. After the congressional mandate, FHWA sponsored extensive research on the retroreflectivity needs of drivers for both signs and pavement markings. After extensive research, FHWA adopted minimum retroreflectivity values for most types of traffic signs in 2007.

Although FHWA has not adopted minimum retroreflectivity for pavement markings, on April 22, 2010, FHWA did publish a proposed change to Section 3A.03 of the *MUTCD* which includes minimum retroreflectivity values for pavement markings as included in Exhibit 3.1. As proposed, these minimum values would only apply to center lines, lane lines, and edge lines, and only when these longitudinal lines are either required or recommended in the *MUTCD* (see Exhibit 3.2).

FHWA is also proposing several ways to manage minimum retroreflectivity similar to the methods for traffic signs that are outlined in Section 2.1.17. However, maintaining acceptable retroreflectivity for pavement markings will be a challenge because of the concerns noted on the next page.

To help meet minimum retroreflectivity values in Exhibit 3.1, consider the following:

1. Because the minimum retroreflectivity value of 250 mcd/m^2/lux for two-way roads with only center line markings will be difficult to maintain, when center lines are required on roads with a speed limit of 55 mph or higher, always also install edge lines.
2. Consider using raised retroreflective pavement markers (RRPMs) to supplement the longitudinal lines, thereby eliminating the minimum retroreflectivity requirements as noted in the first exception in Exhibit 3.1.

Exhibit 3.1: Proposed Minimum Maintained Retroreflectivity Values for Center Lines, Lane Lines and Edge Lines*

Road Category	Posted Speed (mph)		
	≤ 30	35-50	≥ 55
Two-lane roads with center line markings only**	n/a	100	250
All other roads**	n/a	50	100

* Measured at standard 30-meter geometry in units of mcd/m^2/lux.

** Exceptions:

- ✓ When RRPMs supplement or substitute for a longitudinal line (see Section 3B.13 and 3B.14 in the *MUTCD*), minimum pavement marking retroreflectivity levels are not applicable as long as the RRPMs are maintained so that at least three are visible from any position along that line during nighttime conditions.
- ✓ When continuous roadway lighting assures that the markings are visible, minimum pavement marking retroreflectivity levels are not applicable.

Concerns with any Future Minimum Retroreflectivity Values

1. Most markings are “manufactured” on location under varying temperature and humidity conditions, applied over existing surfaces that may be less than ideal (e.g., rough texture due to surface treatment, oil contaminants, etc.), and sometimes vehicles drive on the markings before they are cured, all of which have a negative effect on the retroreflectivity.
2. Some properly-applied markings deteriorate much faster than other markings because vehicles frequently ride on or cross over the markings (e.g., longitudinal lines in heavy weaving areas, around curves, and at intersections). In addition, the asphalt in bituminous roadways sometimes bleeds and the material may track onto the markings, causing discoloration and loss of retroreflectivity.
3. Snowplows, sanding, chemicals, and tire studs and chains cause markings to deteriorate very quickly during the winter months within many areas, and blowing sand may also cause similar problems in other areas.
4. If markings wear out during the winter, it may not be possible to replace them for several months.

3.2.4 Longitudinal Pavement Markings

The primary role of longitudinal pavement markings is to provide continuous alignment guidance.

Longitudinal markings are the primary source of information for positioning vehicles on the roadway. As illustrated in Exhibit 3.2, these longitudinal markings include:

- ✓ Center lines, which separate opposing flows.
- ✓ Edge lines that delineate the edge of the roadway.
- ✓ Lane lines, which are between lanes of traffic traveling in the same direction.

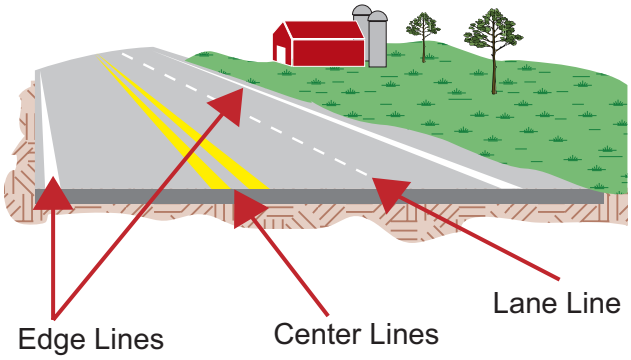


Exhibit 3.2 also contains guidelines on when to install these lines. Most military installations already install more longitudinal lines than are required in accordance with the *MUTCD*; but once installed, it is very important to maintain these longitudinal markings to ensure that the markings are continuously visible along the roadway. Maintaining quality longitudinal pavement markings is especially important in areas where longitudinal construction joints do not coincide with the longitudinal pavement markings, because when markings become worn and are no longer highly retroreflective, drivers tend to follow the construction joints, especially at night when the roads are wet.

Longitudinal markings should have a minimum width of 4 inches, although wider lines are helpful both day and night. The basic types of longitudinal markings are illustrated in Exhibit 3.3, and typical dimensions for pavement markings are shown in Exhibit 3.4. Center line pavement markings for two-way no-passing zones should always be solid, double-yellow longitudinal lines. Therefore, a single solid yellow line, as illustrated, should not be used in the center of a two-lane roadway.

Exhibit 3.2: Required and Recommended Longitudinal Lines

Type	Required	Recommended
Center Lines	✓ On all paved urban arterials and collectors that have a travel width of 20 feet or more and an AWDT of 6,000 vehicles or greater ✓ On all paved two-way roads with three or more traffic lanes	✓ On paved urban arterials and collectors that have a travel width of 20 feet or more and an AWDT of 4,000 vehicles or greater ✓ On all paved rural arterials or collectors with a travel width of 18 feet or more and an AWDT volume of 3,000 or greater ✓ On other roads where an engineering study indicates a need
Lane Line	✓ On all freeways and Interstate highways	✓ On all roads with two or more travel lanes in the same direction
Edge Lines	✓ On all freeways and expressways ✓ On all paved rural arterials with a travel width of 20 feet or more and an AWDT of 6,000 vehicles or greater	✓ On all paved rural arterials and collectors with a travel width of 20 feet or more and an AWDT of 3,000 vehicles or greater ✓ On other paved streets and highways where an engineering study indicates a need for edge lines

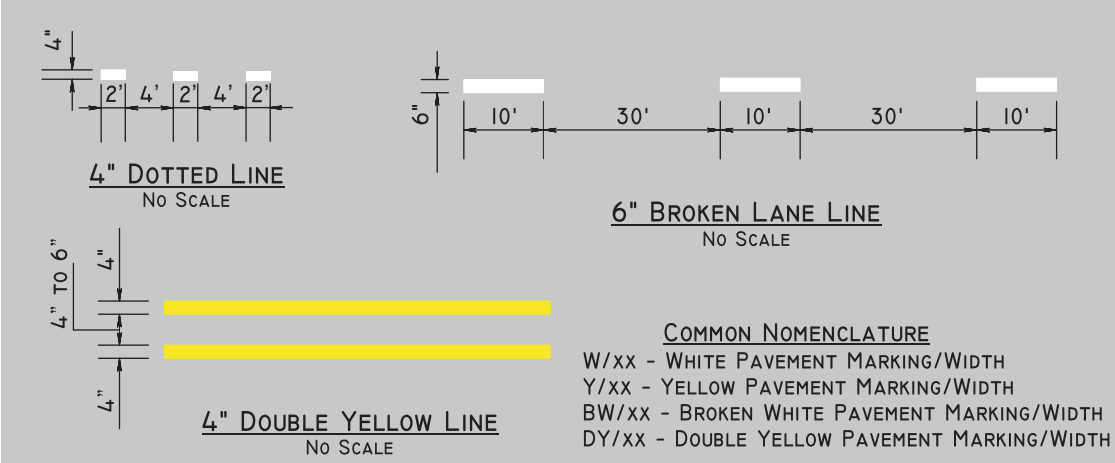
Source: FHWA, MUTCD

Exhibit 3.3: Primary Longitudinal Pavement Markings

Solid Yellow Line	The solid yellow line indicates a no-passing zone applying to traffic with the solid line to its immediate left. Used alone, a single solid yellow line is only used to define the median of a freeway or divided roadway, or left edge of a one-way roadway.
Double Solid Yellow Line	A double solid yellow line divides lanes of traffic flow in opposing directions where passing is prohibited in both directions.
Broken Yellow Lines	A broken yellow line defines the center of a two-lane, two-way roadway where passing is permitted in both directions.
Combination Single Solid/Broken Yellow Line	This combination is used when passing is permitted in one direction (adjacent the broken yellow line), and prohibited in the other (adjacent the solid yellow line).
Broken White Lines	A broken white line is used to delineate lanes for travel in the same directions. Lane changing is permitted.
Solid White Line	A solid white line is used to mark the right edge of the roadway, and to mark lanes for travel in the same direction where lane changing is discouraged. Its normal application is as a lane line on multi-lane approaches to intersections and, particularly, to delineate left- and right-turn lanes.
Double Solid White Line	The double solid white line may be used between travel lanes in the same direction where crossing the double line is prohibited. For example, the double solid white line may be used on a bridge to prevent lane changing.
Dotted Lines	The dotted line delineates the extension of pavement markings through an intersection or interchange area. It should be the same width and color as the line it extends.

Source: FHWA, MUTCD

Exhibit 3.4: Typical Dimensions of Longitudinal Pavement Markings



3.2.5 No-Passing Zone Pavement Markings

When center line markings are used, establish no-passing zones at all vertical or horizontal curves where the passing sight distance is less than the values specified in Exhibit 3.5. When measuring sight distance, the height of the driver's eye and the oncoming vehicle are both assumed to be 3.5 feet above the road surface as indicated in Exhibit 3.6.

Exhibit 3.5: Minimum Passing Sight Distance

85th-Percentile or Posted or Statutory Speed Limit (mph)	Minimum Passing Sight Distance (feet)*
25	450
30	500
35	550
40	600
45	700
50	800
55	900
60	1,000
65	1,100
70	1,200

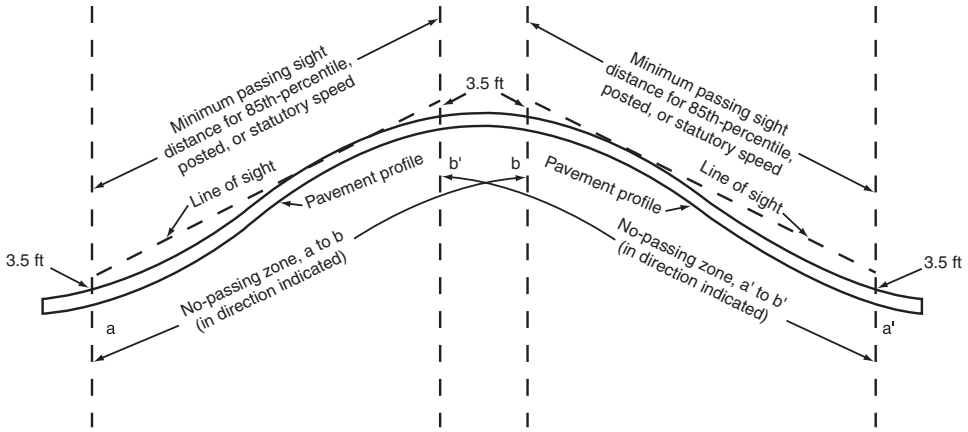
* Measure passing sight distance between two points that are 3.5 feet above the pavement.

Exhibit 3.6: Determining Limits of No-Passing Zones at Curves

Legend

➡ Direction of travel

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

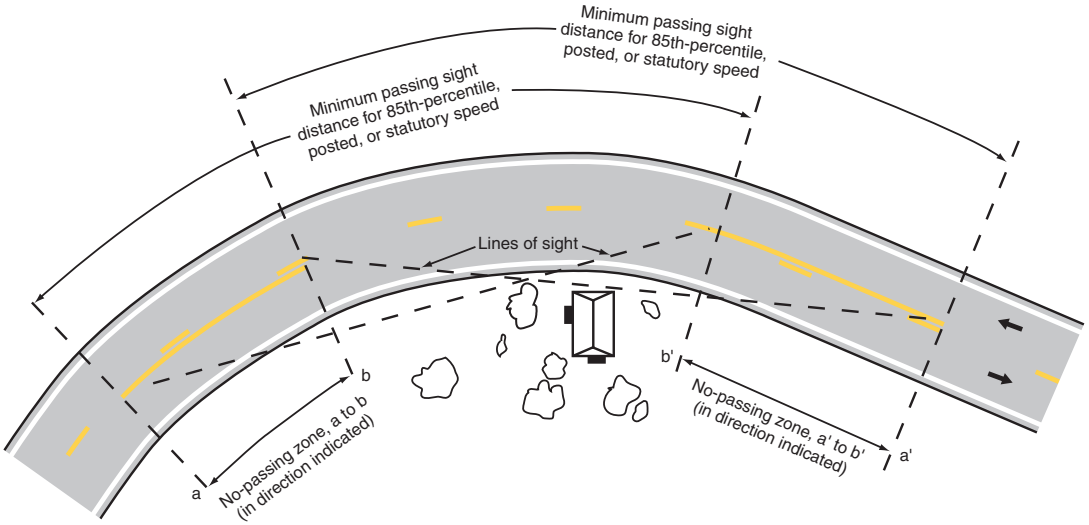
b, b' End no-passing zone

Sight distance again exceeds minimum

Profile View

Note: No-passing zones in opposite directions may or may 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 may or may not overlap, depending on alignment

Source: FHWA, MUTCD

Additional Locations for No-Passing Zones

1. In advance of an obstruction such as a bridge support pillar, a channelizing island, or a pedestrian safety zone, that separates the two lanes of traffic.
2. In advance of and on or within, any narrow bridge, tunnel or underpass; and in advance of any one-lane bridge or section of highway.
3. In advance of a STOP (R1-1), YIELD (R1-2) sign, or traffic signal.
4. In advance of an intersection with a major roadway where passing is undesirable due to the high number of crossing or turning movements.
5. In advance of a highway-rail grade crossing.
6. In advance of and within a school zone.
7. In areas where an analysis of vehicle crashes shows an unusually high number of passing-related crashes.
8. In areas where the roadside development includes many driveways and intersections where passing would create frequent potential conflicts.
9. At locations where the roadway width is very restrictive, shoulders are nonexistent or in poor condition, or obstacles are close to the roadway.
10. In areas where traffic volumes are very heavy and there would be limited opportunities for motorists to pass other vehicles.
11. Where a passing zone would otherwise be less than 400 feet in length.
12. Where engineering judgment indicates that allowing passing is undesirable because a better passing area exists farther ahead.

NOTE: If establishing a no-passing zone because of Items 1 through 6, suggest using a minimum length of no-passing zone in advance of the physical feature that is 50 percent of the distances in Exhibit 3.5.

3.2.6 White Lane Line Pavement Markings and Warrants

Use lane line markings on all multi-lane roadways, to delineate the separation of adjacent travel lanes going in the same direction of travel.

The normal broken white lane line should become a solid white line in advance of any intersection controlled by a traffic signal, STOP sign, or YIELD sign. The length of the solid line should generally be at least 150 feet.

Also use solid lane lines to separate through lanes from left or right turn lanes, in which case the length of the solid line should be approximately two-thirds the length of the full width turn lane.

Solid white lane line markings should also be used to separate through lanes from auxiliary lanes such as uphill truck lanes and any preferential lanes. Military installations are encouraged to use wider lane lines, such as 8-inch wide lines, to emphasize the fact that something is unusual in these areas.

3.2.7 Longitudinal Pavement Markings at Opposing Left-Turn Lanes

Opposing left-turn lanes can create sight distance problems for drivers if vehicles are in both turn lanes at the same time. A positive offset between the opposing turn lanes can reduce the number of crashes, and this offset can frequently be accomplished by narrowing the travel lanes.

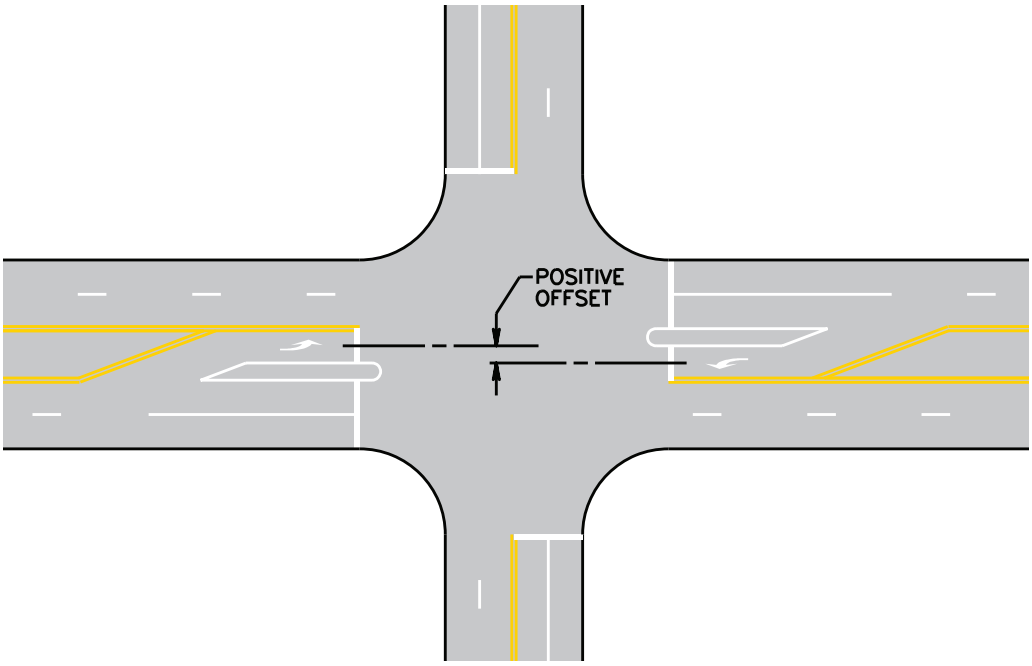
When opposing left-turn lanes exist at an unsignalized intersection or at a signalized intersection where vehicles are allowed to turn left on a "green ball," a sight distance problem frequently exists for drivers in a left-turn lane if another vehicle is in the opposing left-turn lane. This sight distance problem can be reduced if a positive offset exists between the opposing left-turn lanes as indicated in Exhibit 3.7.

A study at intersections in Wisconsin suggests that a positive offset reduces the total number of crashes at an intersection by 34 percent[1]. Therefore, military installations are encouraged to incorporate positive offset whenever possible. Research also suggests that the minimum desirable positive offset is 2 feet for passenger cars and 3.5 feet if truck traffic is involved.

Reconstructing intersections to improve sight distance can be costly; however, where pavement width allows, use solid lines to form a buffer island between the left-turn lane and the adjacent through lane similar to the depiction in Exhibit 3.7. Sometimes it is feasible to use reduced lane widths through the intersection to accommodate the creation of a painted island. For example, if there is one 12-foot wide through lane and a 12-foot wide left-turn lane in each direction, a 3.5-foot positive offset can be achieved by reducing each lane to a width of 10.83 feet.

[1]Safety Evaluation of Offset Improvements for Left-Turn Lanes (FHWA-HRT-09-035), http://www.tfhrc.gov/safety/pubs/09035/09035.pdf

Exhibit 3.7: Positive Offset at Opposing Left-Turn Lanes



3.2.8 Extensions Through Intersections

Sometimes a dotted extension line is required or may be optional through an intersection. These dotted lines are sometimes affectionately called "puppy tracks," and as shown in Exhibits 3.3 and 3.4, these dotted lines typically should be 2 feet long with 4 feet between the line segments. These dotted lines should be at least as wide as the lines that they extend.

In accordance with the *MUTCD*, dotted extension lines are mandatory for double turn lanes in order to emphasize the need for vehicles in adjacent lanes to turn into the proper lane and to help vehicles from sideswiping other turning vehicles (see Exhibit 3.8). Dotted extension lines may also be used at offset intersections where a through lane does not line up with the receiver lane on the far side of the intersection.

3.2.9 Lane Reduction Transition Markings

Section 3B.09 of the *MUTCD* discusses lane reductions from two directional lanes to one directional lane, with several different scenarios identified in Figure 3B-14 of the *MUTCD*.

Exhibit 3.9 illustrates a typical situation. Essentially, the added marking is an edge line even when edge lines are not provided on the balance of the road. It is important to keep in mind that the value "d" is the advance warning sign distance for "Condition A" in Exhibit 2.25.

Exhibit 3.8 Extensions for Double-Turn Lanes

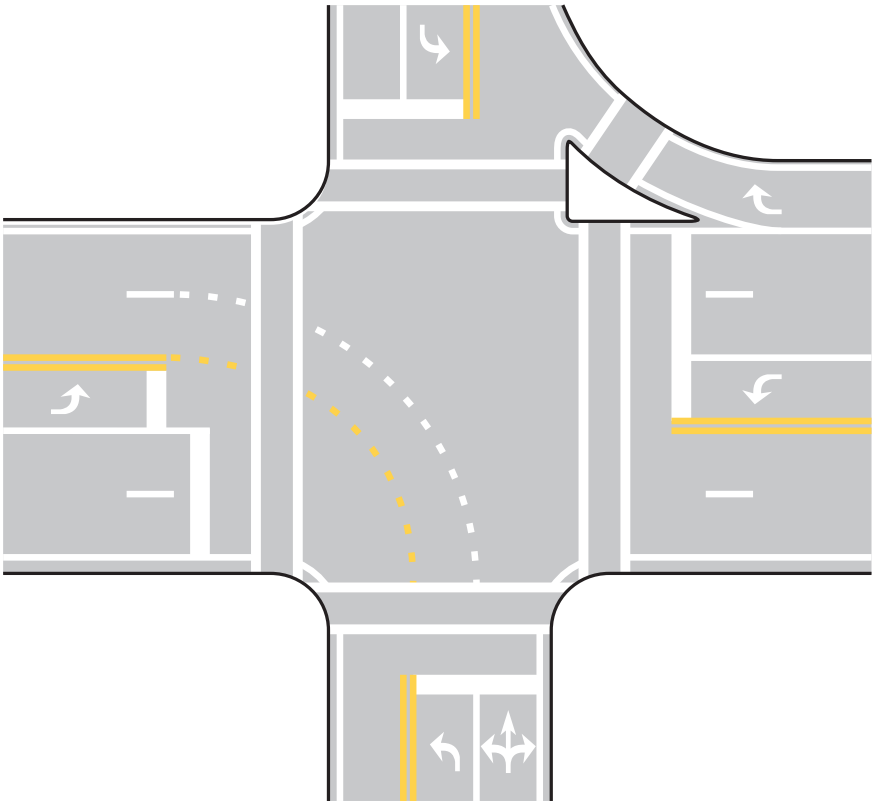
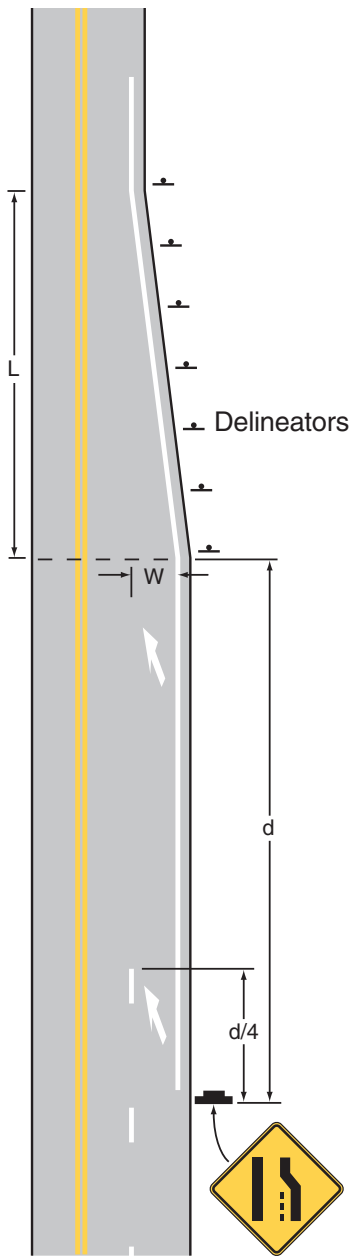
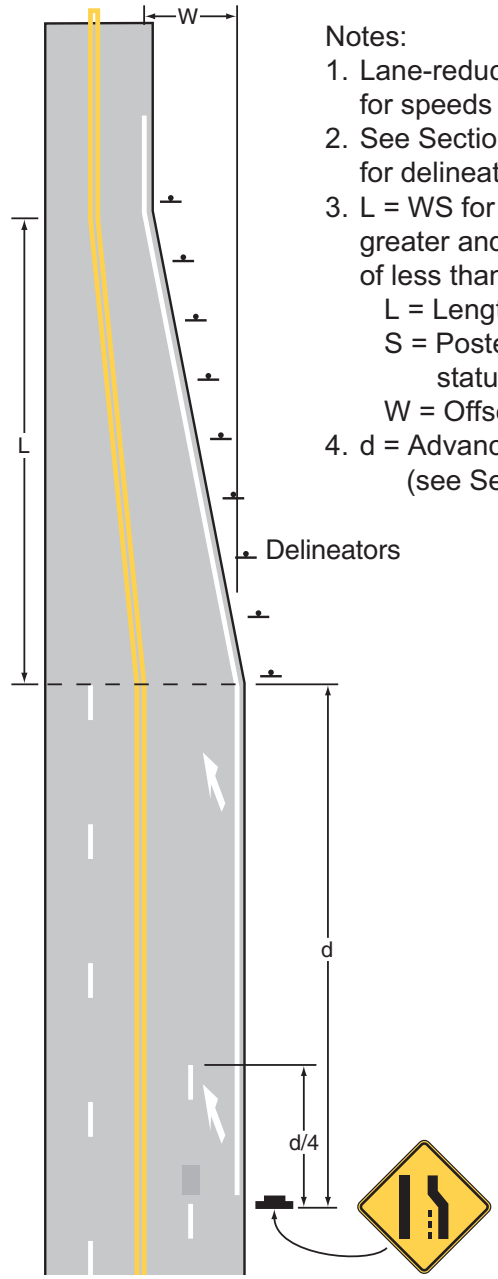


Exhibit 3.9: Typical Lane Reduction Marking

A – Lane reduction



B – Lane reduction with lateral shift to the left



Notes:

1. Lane-reduction arrows are optional for speeds of less than 45 mph
2. See Section 3F.04 in the *MUTCD* for delineator spacing
3. L = WS for speeds of 45 mph or greater and $L = WS^2/60$ for speeds of less than 45 mph, where:
   L = Length of taper in feet
   S = Posted, 85th-percentile, or statutory speed in mph
   W = Offset in feet
4. d = Advance warning distance (see Section 2C.05 in the *MUTCD*)

Source: FHWA, MUTCD, Figure 3B-14

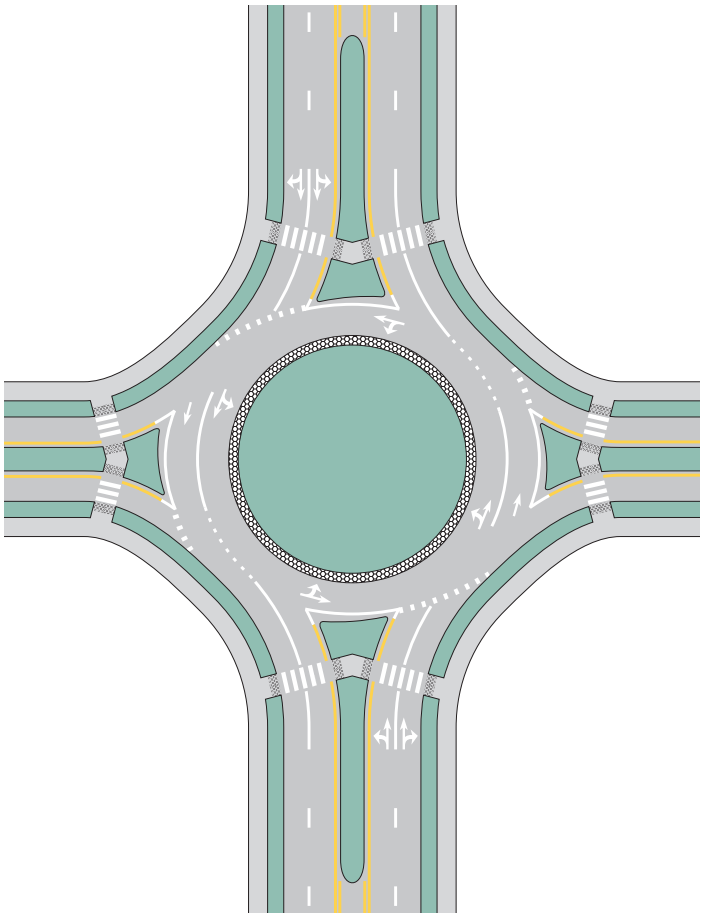
3.2.10 Markings for Roundabouts

Section 2.3.4 discusses the differences between traffic circles and roundabouts. Because roundabouts provide additional capacity, safety, and many other environmental benefits that are not provided by traffic circles, they are becoming more popular in the United States. However, roundabouts should always be designed by an experienced professional, and the designer should provide a recommended pavement marking plan for the more complex designs. FHWA has also added a Chapter 3C in the *MUTCD*, which includes 15 different examples of roundabouts and the proper application of pavement markings.

If an approach to a roundabout has more than one lane, advance lane-assignment pavement marking arrows should be used on that approach to clearly inform drivers which lane to be in as they enter the roundabout. In these cases, the roundabout is classified as a multi-lane roundabout, and both pavement marking arrows and lane lines will normally be required within at least part of the circulatory roadway. If drivers are in the proper lane on the approach to the roundabout, they should not have to cross over any longitudinal lane lines as they maneuver around the roundabout (see Exhibit 3.10).

SDDCTEA can provide assistance with the design and pavement marking plan for roundabouts.

Exhibit 3.10: Spiral Curves on a Multi-Lane Roundabout



Source: FHWA, MUTCD, Figure 3C-4

3.2.11 Transverse Markings

Transverse markings may indicate a command to stop at an intersection, to advise caution for pedestrians that may be in a crosswalk, or to advise against travel within boundaries defined by crosshatching or painted islands. Transverse markings include:

- ✓ Stop lines and yield lines
- ✓ Words and symbol markings
- ✓ Crosshatch markings
- ✓ Crosswalks
- ✓ Parking spaces

3.2.12 Stop and Yield Lines

Improper placement of stop and yield lines is problematic.

Stop and yield lines should be between 4 and 30 feet from the near edge of the intersecting roadway, and at the location where motorists should stop or yield.

Stop Lines

Stop lines should be used at signalized intersections, and they may also be used to show the preferred stopping location at STOP (R1-1) signs and at Stop Here For Pedestrians (R1-5b or R1-5c) signs.

At intersections with STOP signs, there is a tendency to place these lines too far back from the edge of the intersecting roadway, frequently at a location where drivers do not have a clear line of sight to proceed safely. For example, if the van in the following picture was stopped at the stop line, the driver's line of vision would be blocked by the trees on the left side of the road. Other common sight obstructions include on-premise signs, utility poles, mailboxes, signal controller cabinets, road embankments, etc.

Because even the proper placement of the stop line does not mean that drivers will stop at that location, it is always best to remove the sight obstruction whenever possible.

The stop line is about 35 feet from the near edge of the cross street. If drivers stop at the stop line, their line of sight would be blocked by the line of trees.

Therefore, it is important to review sight distance when selecting the location of the stop lines.

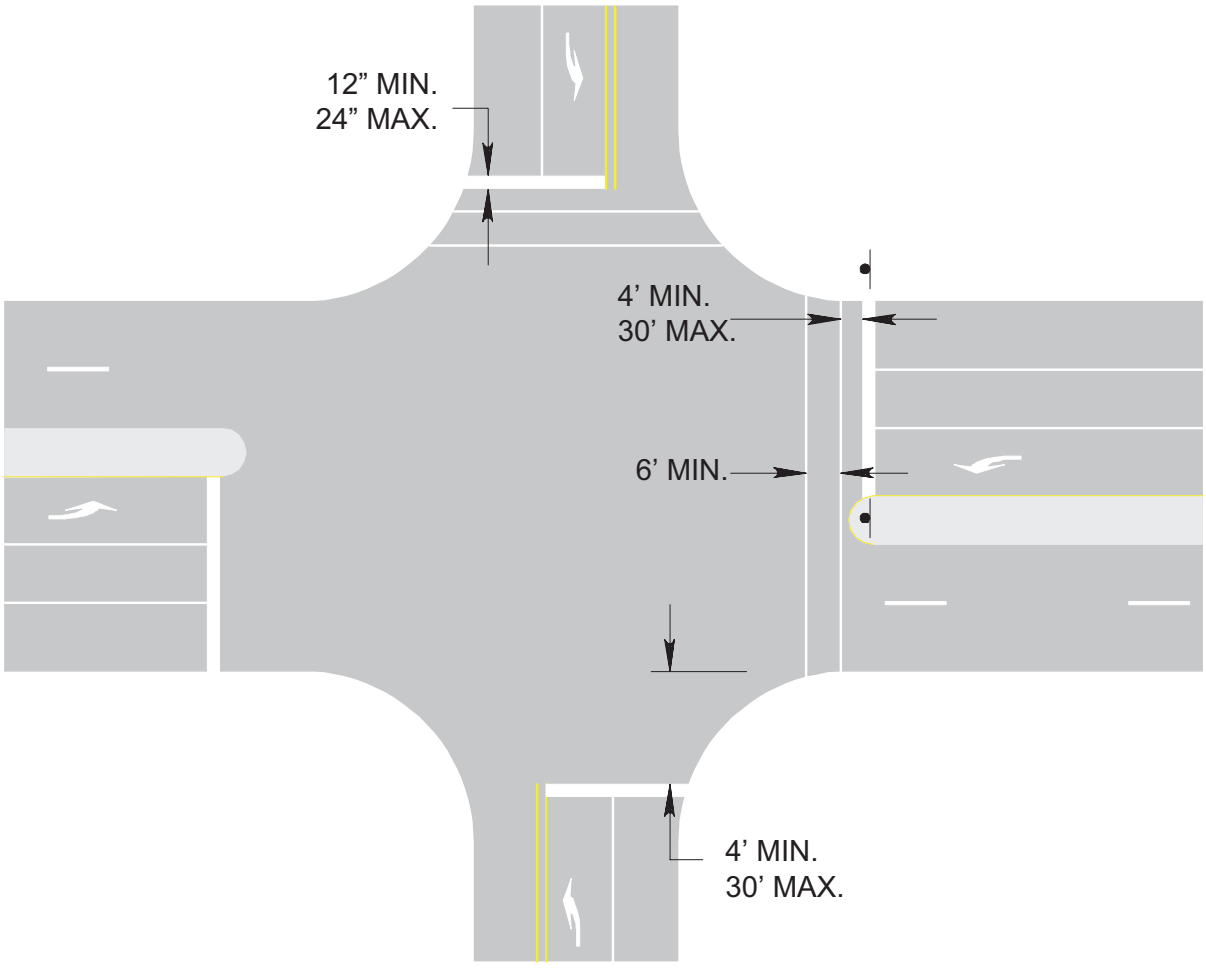
Ideally, stop lines should be set back a sufficient distance from the intersection to accommodate trucks turning into the approach roadway. At signalized intersections, the location of the lines should be adjusted to accommodate the trucks so they can clear a queue of vehicles stopped at the stop line. A staggered stop line is depicted in Exhibit 3.8.

Moreover, if the stop line for the left lane(s) is pulled back farther than the stop line for the right lane, the staggered stop line also improves sight distance for any driver that may be trying to make a right-turn-on-red.

From a safety standpoint, sight distance is probably more important than accommodating the trucks. Therefore, before placing stop lines at non-signalized intersections, it is important to review sight distance between the driver and an approaching vehicle. When measuring intersection sight distance, make the assumptions that the driver's eyes will be at a location about 8 to 10 feet behind the proposed stop line and at an elevation of 3.5 feet above the road surface, and that the approaching vehicle will be 3.5 feet high.

Other design details are illustrated in Exhibit 3.11.

Exhibit 3.11: Stop Line Placement

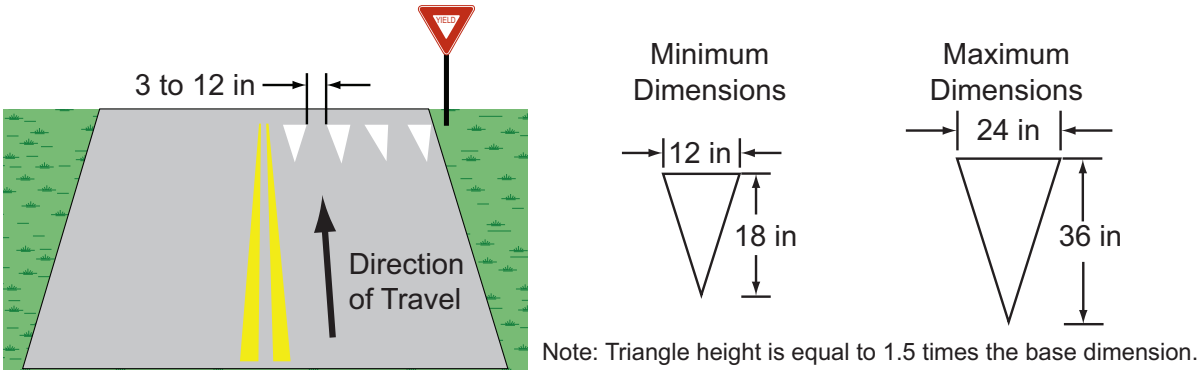


Yield Lines

Prior to the year 2000, the solid stop lines were used at both STOP and YIELD signs. However, the *MUTCD* now requires yield lines to be similar to the type used in Europe, consisting of a series of white isosceles triangles sometimes referred to as "shark's teeth." The row of white triangles should extend across the lane to indicate the location at which drivers are to stop if necessary. The orientation of the triangles resembles a YIELD sign, where each triangle should have a base of 12 to 24 inches, and a height equal to 1.5 times the base. The space between the triangles should be 3 to 12 inches.

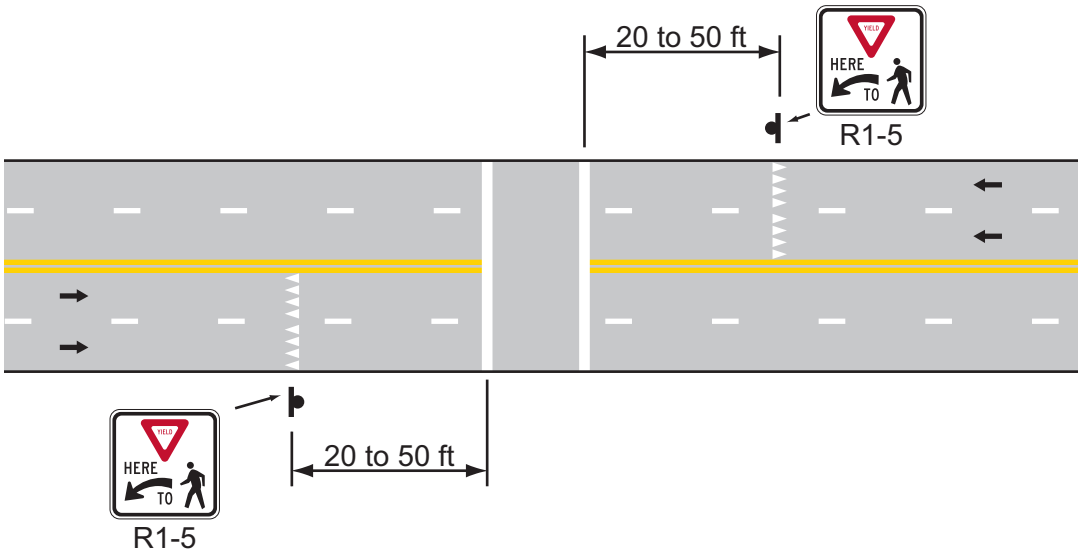
Yield lines may supplement YIELD signs as illustrated in Exhibit 3.12 or Yield Here to Pedestrians (R1-5 or R1-5a) signs as illustrated in Exhibit 3.13. Determining their location at intersections is similar to determining the location of stop lines.

Exhibit 3.12: Typical Yield Line Details



Note: Triangle height is equal to 1.5 times the base dimension.

Exhibit 3.13: Optional Use of Yield Lines at Unsignalized Midblock Crosswalks



3.2.13 Crosswalk Markings

Crosswalk markings are problematic because despite the fact that most people believe they are helpful, in reality their presence frequently increases the number of vehicle-pedestrian crashes.

Crosswalk markings are common at intersections. Exhibit 3.14 illustrates the three types of crosswalk markings commonly used in the United States. Although any of these three types are acceptable, it is desirable not to mix the types.

The minimum effective width of a marked crosswalk is 6 feet, as measured between the inside edge of any transverse markings. The table included in Exhibit 3.14 also shows some key design elements.

Some highway agencies use bricks or pavers between the two white crosswalk lines. Although these roadway materials are acceptable, it is extremely important that the bricks or pavers do not become misaligned and create safety problems for pedestrians.

There are also decorative pavement marking materials that are commercially available to simulate brick, pavers, flagstone, etc. However, in accordance with Section 3G.01 of the *MUTCD*, these materials would not be acceptable if they use white or yellow colors designed to warn or regulate traffic, or if any of the colors are retroreflective. In addition to these prohibitions, some of the patterns and colors are so "busy" that if a pothole were to develop in the crosswalk, a pedestrian may not even see it. Therefore, military installations are discouraged from using any decorative pavement marking materials.

Midblock crosswalks (i.e., not at an intersection) are especially problematic, perhaps because marking the crossing sometimes provides a false sense of security to the pedestrians. In fact, research at 1,000 locations in 16 states indicates that just adding crosswalk markings at known midblock crossing areas generally decreased pedestrian safety. Therefore, before installing a new crosswalk, an engineering study is needed to determine whether the location is suitable for a marked crosswalk.

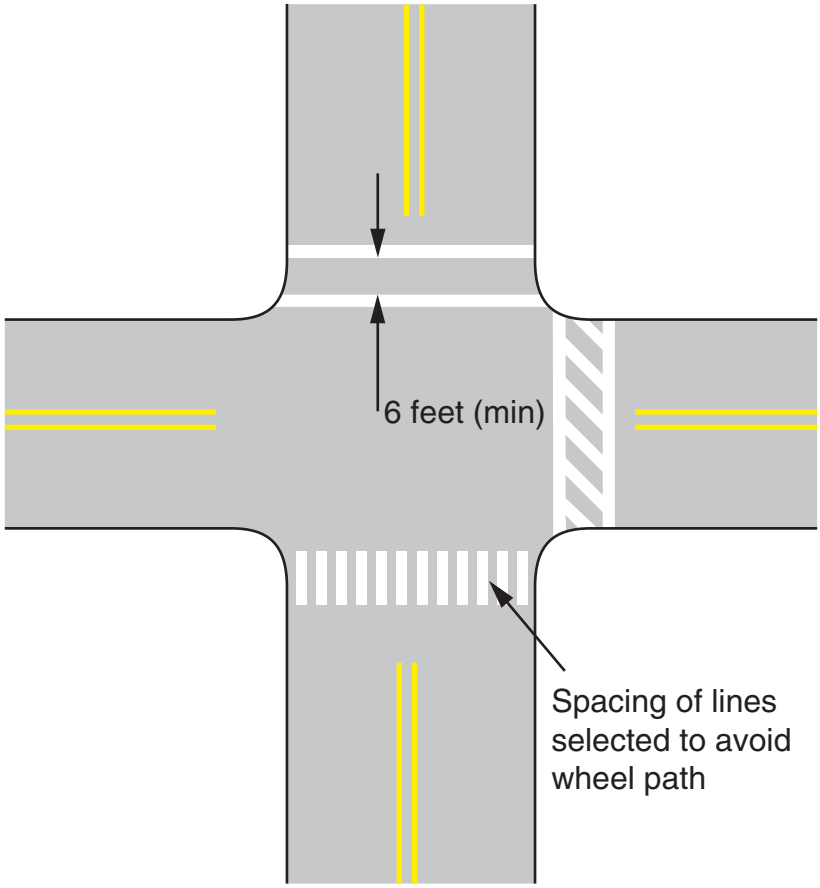
The study should consider traffic and pedestrian volumes, vehicle mix, vehicle speeds, sight distance, and other factors. The engineer should also consider providing raised medians or islands, reducing the street width, adding other traffic calming measures, and installing pedestrian-type signs, street lighting, etc.

At new crosswalks, it is necessary to install curb cuts, curb ramps, and detectable warning surfaces in accordance with the "Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)."

New marked crosswalks alone, without other substantial measures to reduce speeds, shorten the crossing distance, enhance driver awareness of crossing, or provide active warning of pedestrian presence, should not be installed across uncontrolled roadways with:

- ✓ four or more travel lanes; and
- ✓ a speed limit greater than 40 mph; and
- ✓ AWDT volume greater than 12,000 vehicles without a raised median or pedestrian refuge, or an AWDT volume greater than 15,000 vehicles with a raised median or pedestrian refuge

Exhibit 3.14: Types of Crosswalk Markings



Type of Crosswalk Markings	Width of Transverse Markings	Width of Stripes
Standard – Solid White Crosswalk Lines	6-24 inches	n/a
Diagonal Stripes	optional, but 6-24 inches if used	12-24 inches*
Piano Keys – Longitudinal Stripes	optional, but 6-24 inches if used	12-24 inches*
** with gaps of 12-60 inches between stripes*		

3.2.14 Parking Space Markings

Military installations may be involved in the layout of parking lots and on-street parking areas. Parking space markings should be white in color and a minimum of 4 inches wide.

Military installations are encouraged to use retroreflective markings for all parking space markings although it may be unnecessary in parking lots with overhead lighting.

Within parking lots, the recommended minimum dimensions for parking spaces are 9 feet wide and 17.5 feet long for the typical 90 degree parking angle. Suggested dimensions for other geometries are included in the *Traffic Engineering Handbook* (see Section 1.4).

Parallel parking spaces along streets should be 8 feet wide by 22 to 26 feet in length, except the first and last stall may be as short as 20 feet. Use care to maintain adequate setbacks from intersections, driveways, crosswalks, fire hydrants, etc. Typical parking prohibition setback distances are as follows:

- ✓ Fire Hydrants – 15 feet.
- ✓ Crosswalk at intersection – 20 feet.
- ✓ Stop sign, traffic signal, or flashing beacon – 30 feet.
- ✓ Railroad crossing – 50 feet.
- ✓ Fire station entrance – 20 feet.

Angle Parking

Although installations generally like angle parking because it provides approximately twice as many parking spaces as provided by parallel parking, there are safety concerns because of limited sight distance when patrons are backing out of the stalls. This is especially difficult when there is a mix of vehicles such as small cars and large SUVs.

Therefore, only consider angle parking along streets where the following criteria are satisfied:

1. The parking maneuver area equals or exceeds the appropriate distance indicated in Exhibit 3.15.
2. Parked vehicles do not adversely affect the available intersection sight distance.
3. Additional travel lanes are not required for the existing traffic volumes to achieve a satisfactory level of operation.
4. Pedestrian/bicycle activity is minimal within the parking maneuver area.

Exhibit 3.15: Diagonal Parking Minimum Maneuver Area

Parking Angle (degrees)*	Minimum Parking Maneuver Area (feet)**
45	30
60	37
90	43

* The angle that vehicles on the nearest travel lane need to turn to the right or to the left to pull into the center of a parking stall.

** The perpendicular distance between the nearest edge of the closest travel lane, and the front end of the parking stall.

Reserved Parking and ADA Requirements

The Americans with Disabilities Act, 36 CFR Part 1191 (see http://www.access-board.gov/ada-aba/final.pdf) establishes the minimum number of required accessible parking spaces, based on the total number of spaces in the parking facility. Therefore, make certain that each parking facility provides at least the minimum number of designated accessible parking spaces as indicated in Exhibit 3.16.

Exhibit 3.16: Minimum Designated Accessible Parking Spaces

Total Number of Parking Spaces Provided in Parking Facility	Minimum Number of Required Accessible Parking Spaces*
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 to 300	7
301 to 400	8
401 to 500	9
501 to 1,000	2 percent of the total
1,001 and over	20, plus 1 for each 100, or fraction thereof, over 1,000
* At least one of every six designated accessible parking spaces shall be van accessible.	

Source: American with Disabilities Act

The designated accessible parking spaces should be located to provide the most convenient access to entranceways or to the nearest curb cut. Every parking lot shall have at least one designated disabled parking space designed to accommodate a passenger van, and there shall be a minimum of one such space for every six or fraction of six required designated accessible parking spaces.

Accessible parking spaces shall be designed as follows:

1. Car parking spaces shall be a minimum of 8 feet wide and van parking spaces, except as noted in No. 3, shall be a minimum of 11 feet wide.
2. A minimum 5-foot wide access aisle shall be adjacent to one of the sides of each parking space, except it shall be on the passenger side of van parking spaces if using angled parking spaces.

3. As an alternate to Nos. 1 and 2, van parking spaces may be 8 feet wide if the access aisle is at least 8 feet wide; thereby reducing the total width requirements if two van parking spaces share a common access aisle (i.e., 24 feet instead of 27 feet).
4. If angled parking is used, the minimum dimensions shall be measured at a right angle across the widths.
5. Access aisles shall not overlap a vehicular travelway.
6. Access aisles shall be marked to discourage unauthorized use, where the preferred method is 6-inch white diagonal crosshatching.

A common practice in some locales has been to paint the entire parking space blue, but this is not a recommended practice because painted surfaces may be slippery when wet. Therefore, use only the symbol illustrated in Figure 3B-22 of the *MUTCD* and detailed in the "Pavement Marking Chapter" of the *Standard Highway Signs and Marking Book (SHSM)*. Without the optional border and blue background, the standard size accessible parking space marking would measure about 24 inches wide by 28 inches high; and with the blue background and white border (as illustrated below), it would measure about 38 inches square.

The preferred location for the symbol is near the entrance to the parking space so that drivers can see the symbol before starting to turn into the stall.

Blue lines may supplement the white parking stall markings, but only on the reserved parking space side of the white markings. If used, blue lines should be a minimum of 4 inches wide and adjacent to the white lines.

3.2.15 Pavement Word and Symbol Markings

Details for pavement word and symbol markings are included in the "Pavement Marking Chapter" of the *SHSM Book*. Because these words and symbols are viewed from a very low angle, words and symbols are stretched or elongated so that they look normal from a low viewing angle.

The use of word-type pavement messages is frequently called "horizontal signing," and it is an effective way to communicate with drivers providing the markings are visible. Therefore, installations are encouraged to use pavement word and symbol markings to supplement traditional regulatory, warning, and directional signs.

Thermoplastic is the recommended material for pavement words and symbol messages.

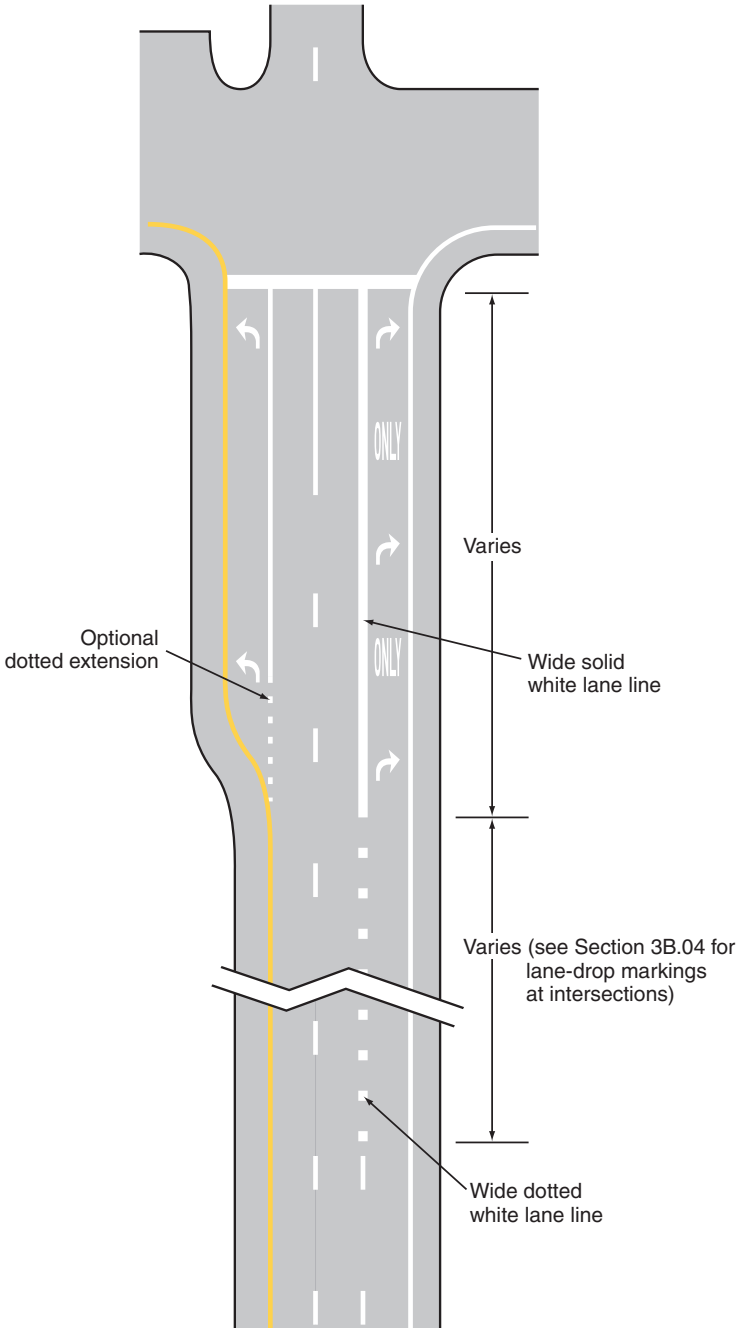
Words and symbols shall conform to Figures 3B-16 through 3B-31 in the *MUTCD*. The standard height of word messages is 8 feet on all types of roads, except "SCHOOL" is 10 feet high. A maximum of three lines of message may be used. When two or three lines of message are used, they are to be read in the direction of travel; i.e., motorists read the messages as they encounter them.

Except for the opposing arrows of a two-way left-turn lane marking (see Figure 3B-7 in the *MUTCD*), successive lines of a message should be spaced at four to ten times the legend height (i.e., a typical spacing of 32 to 80 feet).

Perhaps the most common of these markings is the turn arrow. In most cases, the turn arrow is used by itself, but whenever the required turn is not obvious, the word "ONLY" should be used as illustrated in Exhibit 3.17.

Other common word and symbol markings include the railroad crossing symbol, and the word messages "STOP AHEAD" and "PED XING."

Exhibit 3.17: Example of Turn Arrows



Source: FHWA, MUTCD

3.2.16 Crosshatch Markings

Crosshatch markings are both time-consuming and expensive to install. Therefore, military installations are encouraged to take a very conservative approach in their use.

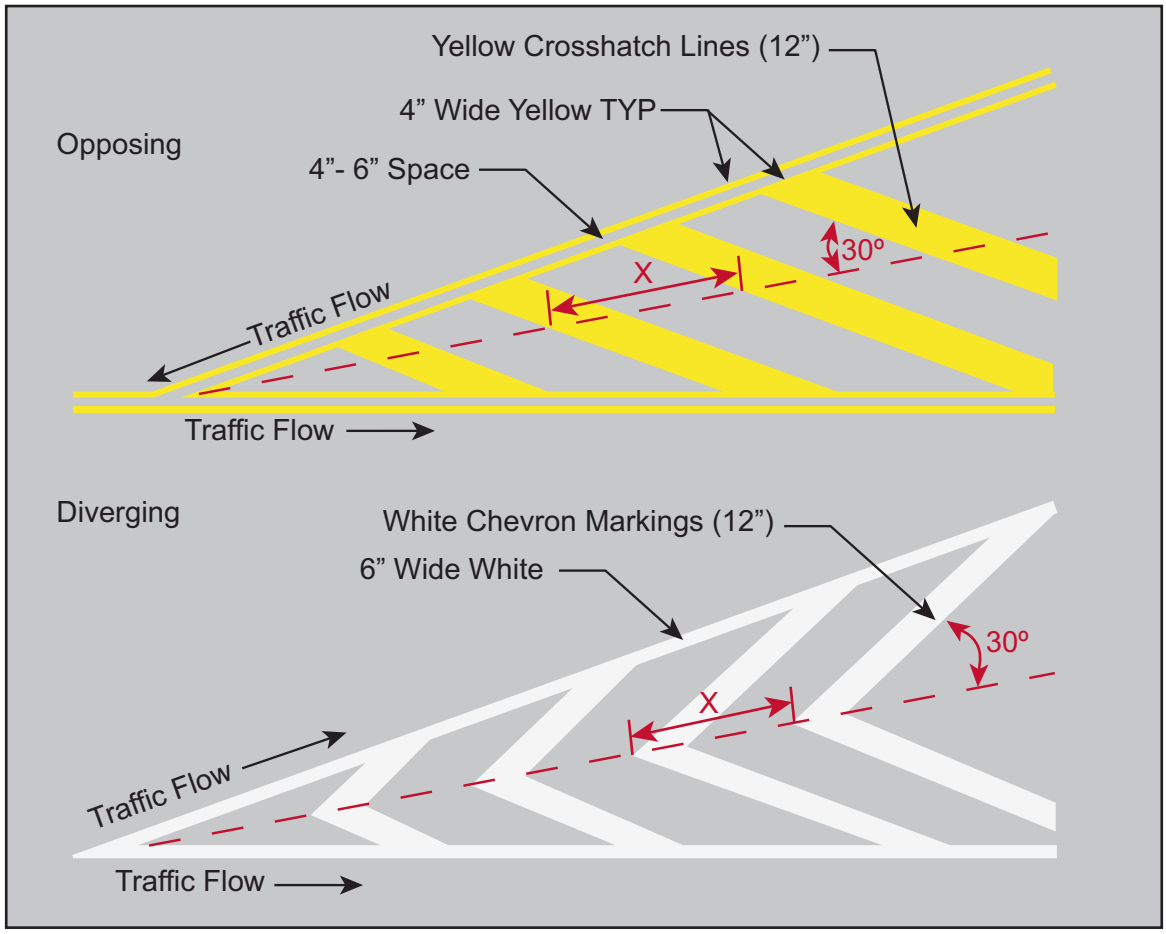
Crosshatch markings may be used to discourage travel on certain paved areas, such as shoulders, gore areas, buffer areas approaching and around obstructions in the roadway, within painted channelizing islands, and in buffer areas separating preferential travel lanes and other travel lanes.

When crosshatch markings are used in paved areas on the left side of the roadway or in areas that separate opposing directions of traffic, they shall be yellow diagonal markings; and when crosshatch markings are used on the right side of the roadway or in areas that separate traffic going in the same direction they shall be white. However, in areas that separate traffic flows in the same general direction, the white markings shall be chevron markings, with the point of each chevron facing toward approaching traffic. These two types of crosshatch markings and their proper orientation are illustrated in Exhibit 3.18.

Crosshatch markings are always optional in the *MUTCD* with the exception that white chevron markings should be used within buffer areas to separate preferential lanes from other travel lanes (see Paragraph 04 of Section 3D.02, and Drawing A in Figure 3D-2 of the *MUTCD*).

Although these markings may be helpful to drivers, the installation is both time-consuming and expensive. Therefore, military installations are encouraged to take a very conservative approach in their use. Moreover, when used, military installations are encouraged to use 12-inch wide lines at a 30-degree angle as illustrated in Exhibit 3.19.

Exhibit 3.18: Typical Crosshatch Markings



* Where “X” is a function of the speed: 24 feet for speeds below 30 mph, 36 feet for speeds of 30 to 45 mph, and 48 for speeds over 45 mph. In addition, if these markings are used over an extensive length, “X” should be increased to 100 feet or more.

Two common problems on military installations are the improper color and the improper orientation of the lines. Therefore, if using crosshatch markings, consider the following:

- ✓ Use yellow markings on the left side of one-way roads and between opposing travel lanes.
- ✓ Use white markings on the right side of a travel lane or when traffic is going the same direction on both sides of the markings.
- ✓ Angle the markings in the proper direction. Think of diagonal lines as physical barriers, which if hit would deflect an errant vehicle back into the proper travel path.

3.2.17 Do Not Block Intersection Markings

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 may cause vehicles to stop within the intersection and impede other traffic entering the intersection.

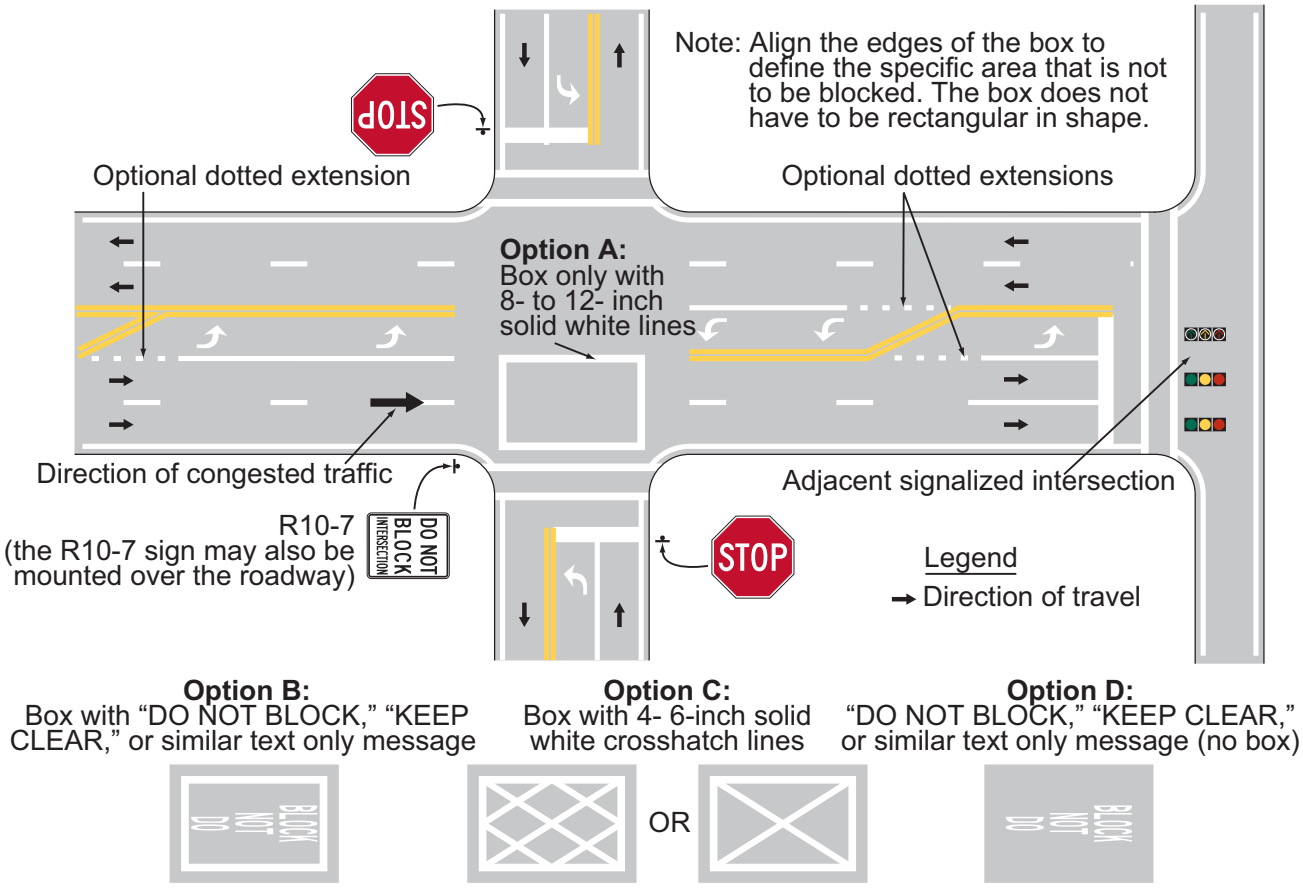
If used, the Do Not Block Intersection Markings should consist of 8-inch or 12-inch solid white lines that outline the area of the intersection as illustrated in Exhibit 3.19.

The box should envelop the area normally enclosed within the extension of the edge lines or centerlines. A minimum of 4 feet should exist between any crosswalks and the box.

Do not use "Do Not Block Intersection Markings" unless accompanied by one or more DO NOT BLOCK INTERSECTION (R10-7), DO NOT STOP ON TRACKS (R8-8), or similar signs.

Wrong color and wrong angle

Exhibit 3.19: Do Not Block Intersection Markings



Source: FHWA, MUTCD

3.2.18 Speed Hump Markings

A speed hump is a raised surface on the roadway that is typically 3 to 4 inches in height, and typically either 12 or 22 feet in length. Speed humps are the most popular traffic calming measure used in the United States, likely because they are effective in reducing speeds at minimal cost. However, military installations are discouraged from using speed humps on any roadway with a speed limit of 35 mph or higher.

The most common speed hump is 12 feet in length and generally consists of a 6-foot incline followed by a 6-foot decline. The longer and more effective design is the same except it has a 10-foot long elevated section between the incline and the decline. The latter type is also called a "speed table," and is sometimes used for an elevated crosswalk.

To effectively warn approaching traffic, all speed humps should have pavement markings that comply with the *MUTCD*, specifically Sections 3B.25 and 3B.26, and Figures 3B-29, 3B-30, and 3B-31.

3.2.19 Eradication of Pavement Markings

When traffic patterns change, it is important to remove the old pavement markings and apply new ones in the proper location. Although grinding has been used to remove old markings, this process creates permanent scars that will frequently exist for the life of the pavement. Therefore, unless the pavement will be overlaid, grinding should not be used.

Similarly, painting over the old markings with black paint is not acceptable because eventually the original line will again be visible. In addition, black painted lines can be compelling during the day and on a wet night they are often more visible than the real pavement markings.

The preferred eradication method to remove old markings is high-pressure water blasting.

3.3 Delineation

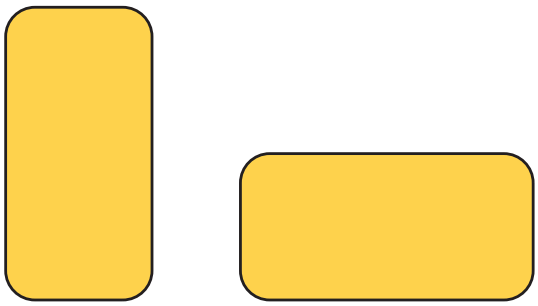
Pavement markings are useful during both the day and night, but delineation as used along roadways essentially provides only guidance at night.

3.3.1 Post-Mounted Delineators

Delineators installed on posts consist of a retroreflective device with a minimum dimension of 3 inches, and installed with the top of the "retroreflector" about 4 feet above the elevation of the near edge of the roadway. The two most common methods are:

1. The OM2-2V or OM2-2H markers in Exhibit 3.20 illustrate one type of delineator consisting of yellow sheeting affixed to a metal or plastic substrate and then attached to a steel or wood post.
2. A flexible delineator post, which includes a 3-inch wide by 12-inch high strip of retroreflective sheeting affixed near the top of a plastic or fiberglass post that is about 5.5 feet in length.

Exhibit 3.20: Delineators



OM2-2V OM2-2H

The preferred method is the flexible delineator post. The main advantage is that the flexible delineator post is much less likely to damage an errant vehicle. Moreover, the flexible delineator post can typically receive five to ten hits before it needs replaced, making it the more economical option.

Normal lateral placement is 2 to 8 feet from the outer edge of the shoulder, or from the edge of the roadway if shoulders are not present. Delineators should generally be white in color, except they should be yellow if on the left side of a one-way road or in the center of a divided highway.

If used on tangent sections of roadway, delineators should be spaced at uniform distances of 200 to about 528 feet apart. However, on curves, the spacing should be less, with the suggested spacing as indicated in Exhibit 3.21.

Exhibit 3.21: Delineator Spacing on Horizontal Curves

Radius of Curve (feet)	Approximate "S" Spacing (feet)*
50	20
115	25
180	35
250	40
300	50
400	55
500	65
600	70
800	80
1,000	90

* The "S" spacing is the recommended spacing on the curve. Immediately 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.

Chevron Alignment (W1-8) signs (as discussed in Section 2.3.3) can also serve as delineation, since they provide both daytime and nighttime guidance. When the W1-8 signs are used, there is no reason to use post-mounted delineators at the same location.

3.3.2 Raised Pavement Markers

Retroreflective Raised Pavement Markers (RRPMs)

Section 3.2.3 notes that retroreflective raised pavement markers (RRPMs) can be used to supplement pavement markings such as painted longitudinal lines. As such, the RRPMs assist drivers by providing improved nighttime visibility, especially when the roads are wet and the standard pavement marking lines may be covered with a film of water. If using RRPMs, the color of the retroreflectors should always be the same color as the pavement markings, except they shall be red when facing wrong-way traffic.

RRPMs can be used in snow zones, but they are more costly. Snowplowable models typically are partially embedded into the roadway and have metal rails that lift the snowplow blade up and over the retroreflectors. The life expectancy of RRPMs is about 2 or 3 years.

Non-Retroreflective Raised Pavement Markers (RPMs)

Some southern states use a combination of RRPMs and non-retroreflective raised pavement markers (RPMs) in lieu of "painted" longitudinal lines. Most non-retroreflective RPMs are ceramic markers, where the color should always be the same as the color of the line that they are substituting.

Except for the ease of eradication, there probably are few advantages in using non-retroreflective RPMs. However, if they are used, it is important that they be placed at short intervals, and that the number and spacing of the retroreflective units be installed in accordance with state standards so that drivers clearly know if it is a solid line or a broken line.

Raised pavement markers

3.4 Channelizing Devices

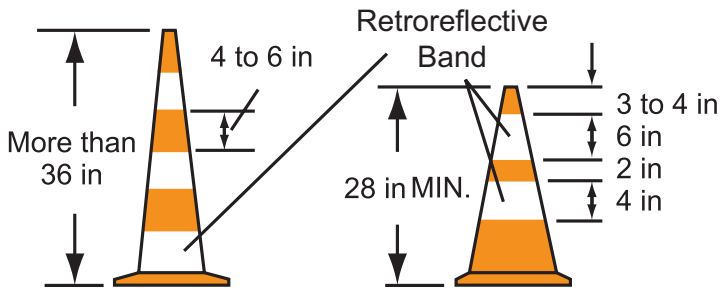
Use channelizing devices to gently shift traffic away from a closed lane. Common problems include using transitions that are too short and without enough channelizing devices.

Channelizing devices, such as traffic cones and vertical panels, may be used to guide traffic when closing travel lanes at entry control facilities or at other locations. They may also be used to emphasize lane closures.

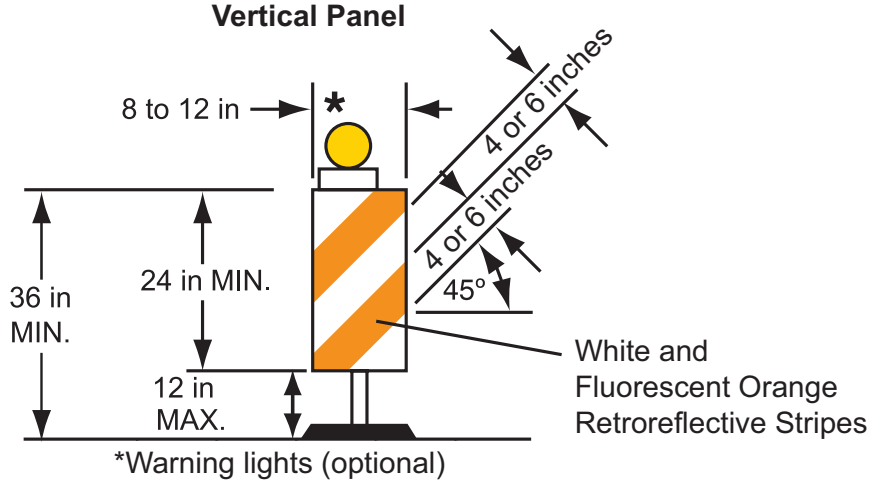
The *MUTCD* allows the color of the devices to be orange as used in construction, or the same color as the pavement marking that they are substituting. Since using both white and yellow colors is problematic, all military installations are encouraged to use the orange color as illustrated in Exhibit 3.22.

Exhibit 3.22: Recommended Channelizing Devices

Cones



Vertical Panel



Source: FHWA, MUTCD

There are advantages and disadvantages of the two types of channelizing devices.

Advantages of traffic cones:

- ✓ The same cone can be used on either the left or the right side of the traffic because they do not imply direction (e.g., the vertical panel with diagonal stripes like the one in Exhibit 3.22 should only be used on the right side of traffic).
- ✓ When not in use, they will nest one on top of the other.

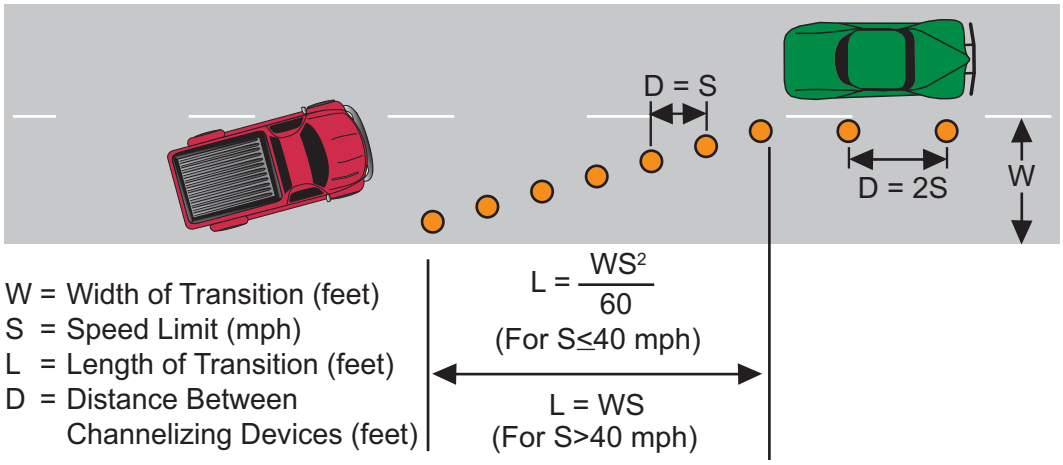
Advantages of vertical panels:

- ✓ They are more visible at night because they have a much larger area of retroreflective sheeting.

Within transitions, the distance between channelizing devices in feet should be equal to the posted speed limit in miles per hour. For example, if the posted speed limit is 25 mph, the maximum spacing within transitions should be 25 feet. At other locations, such as adjacent to closed lanes, the distance between channelizing devices in feet may be double the speed limit in miles per hour.

When closing a lane or shifting traffic, it is important to use a gradual transition. As illustrated in Exhibit 3.23, the length of the transition is a function of the width of the lane shift and the speed limit. However, if the speeds are consistently lower than the speed limit, for example in the vicinity of the entry control facility, it is possible to use the prevailing speed instead of the speed limit when calculating the transition length.

Exhibit 3.23: Taper Lengths

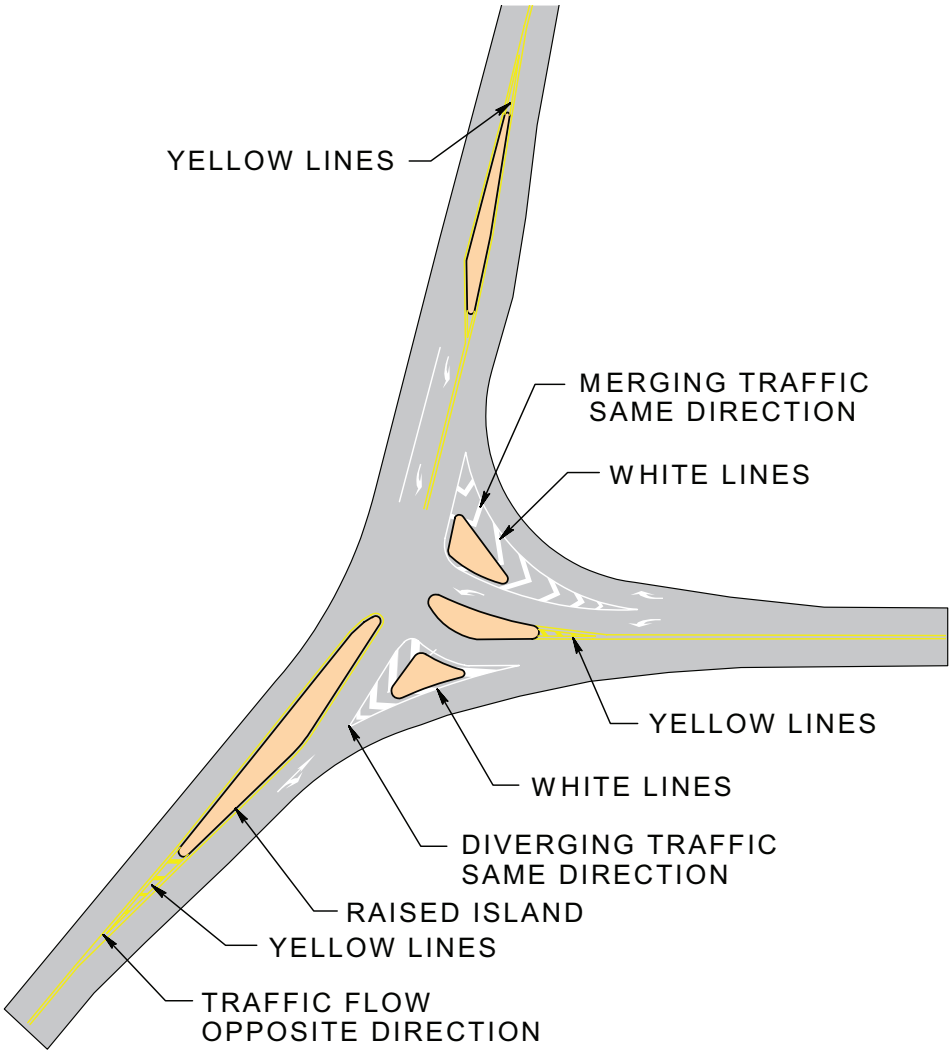


3.5 Islands

As used herein, an island is the defined area between traffic lanes for control of vehicular movements or for pedestrian refuge. Within an intersection area, a median or an outer separation of a turning movement is also an island.

Exhibit 3.24 depicts an intersection with five islands. Note that the crosshatching and chevron markings are optional, but if used, the three crosshatched areas in the middle of the road would be yellow and the two areas with chevrons would be white.

Exhibit 3.24: An Intersection with Several Islands



Appendix A

Standard TEA Signs

Regulatory Signs	Sign Code	Page No.
STOP WHEN FLASHING – DO NOT PROCEED	R1-7a-TEA	A-1
10 MPH WHEN PASSING TROOPS IN FORMATION	R2-1a-TEA	A-2
BASE	R2-5hP-TEA	A-3
INSTALLATION	R2-5iP-TEA	A-4
GOVERNMENT VEHICLES ONLY	R5-11g-TEA	A-5
SEVERE TIRE DAMAGE	R5-29P-TEA	A-6
DO NOT BACK UP – ONE-WAY TIRE TREADLE	R5-30-TEA	A-7
GATE CLOSED	R11-2g-TEA	A-8
NO THRU TRAFFIC	R11-4a-TEA	A-9
ROAD CLOSED FOR PT	R11-4b-TEA	A-10
USE SEAT BELTS	R16-1b-TEA	A-11
USE PARKING LIGHTS AT GATE	R16-5a-TEA	A-12
NO CELL PHONE WHEN DRIVING	R22-1-TEA	A-13
TURN OFF 2-WAY RADIO AND CELL PHONE	R22-2-TEA	A-14
NO RADIO TRANSMISSIONS	R22-3-TEA	A-15
RADIO TRANSMISSIONS PERMITTED	R22-4-TEA	A-16

Warning Signs	Sign Code	Page No.
Winding Road Chicane	W1-5Lb-TEA & W1-5Rb-TEA	A-17
ACTIVE BARRIER	W3-3a-TEA	A-18
BARRIER ACTIVATED WHEN FLASHING	W3-3b-TEA	A-19
CHECK POINT	W3-10-TEA	A-20
CHECKPOINT (____) FT – BE PREPARED TO STOP	W3-10b-TEA	A-21
LOW AIRCRAFT	W11-26-TEA	A-22
TAXIWAY	W11-27-TEA	A-23
TANK CROSSING	W11-28-TEA	A-24
HAZARDOUS CARGO CROSSING	W11-29-TEA	A-25
Applicable Hours	W16-20P-TEA	A-26
GATE CLOSED AHEAD	W20-3g-TEA	A-27

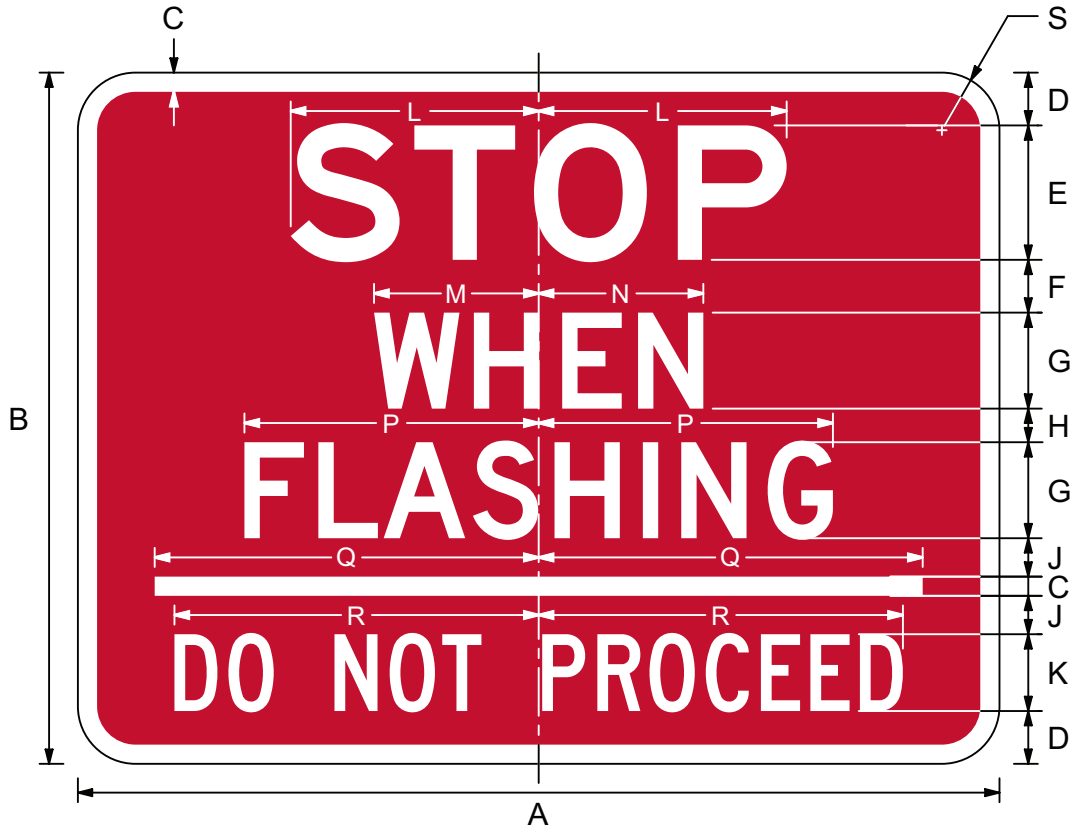
Appendix A
Standard TEA Signs

Guide Signs	Sign Code	Page No.
Single-Line Destination	D1-1-TEA	A-28
Two-Line Destination	D1-2-TEA	A-29
Three-Line Destination	D1-3-TEA	A-30
Installation Approach with Two Gates	D1-4b-TEA	A-31
Installation Approach with Three Gates	D1-4c-TEA	A-32
Gate Destination with Hours of Operation	D1-5a-TEA	A-33
Single-Line Street Name	D3-1-TEA	A-34
Two-Line Street Name	D3-2-TEA	A-35
On-Premise Building Name and Number	D35-1-TEA	A-36
Building Number	D35-2-TEA	A-37
ECFpass Advance Lane Assignment	M4-29-TEA	A-38
ECFpass Overhead Lane Assignment	M4-30-TEA	A-39
Open Overhead Lane Control	M4-31-TEA	A-40
Closed Overhead Lane Control	M4-32-TEA	A-41
Visitors This Lane Overhead Lane Control	M4-33-TEA	A-42

R1-7a-TEA

STOP WHEN FLASHING – DO NOT PROCEED

The STOP WHEN FLASHING – DO NOT PROCEED (R1-7a-TEA) sign may be used whenever traffic must be temporarily stopped with some regularity to ensure safety, and red flashing lights are attached and can be activated from an oversight position. Applicable operations could include planes taxiing across a roadway, explosive testing, missile launching, rifle range, etc. When used, the sign should be installed at a safe location in advance of the activity, and activated in sufficient time to ensure that no one is within the activity area.



A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S
48	36	1	2.75	7E	2.75	5D	1.75	2	4C	12.92	8.81	8.36	15.34	20	18.97	3

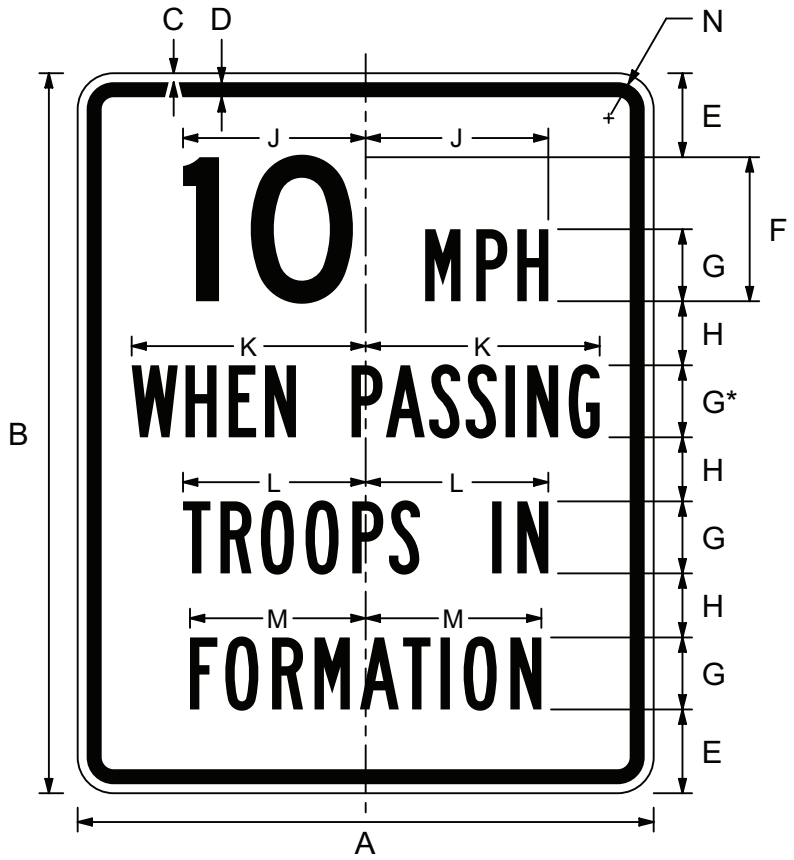
COLORS:

BORDER & LEGEND – WHITE (RETROREFLECTIVE)
BACKGROUND – RED (RETROREFLECTIVE)

R2-1a-TEA

10 MPH WHEN PASSING TROOPS IN FORMATION

The 10 MPH WHEN PASSING TROOPS IN FORMATION (R2-1a-TEA) sign may be used along roads where troops periodically walk in formation on the roadway and the military installation has a regulation specifying the maximum speed limit in these situations. The posted speed limit should reflect whatever speed is specified in the regulation.



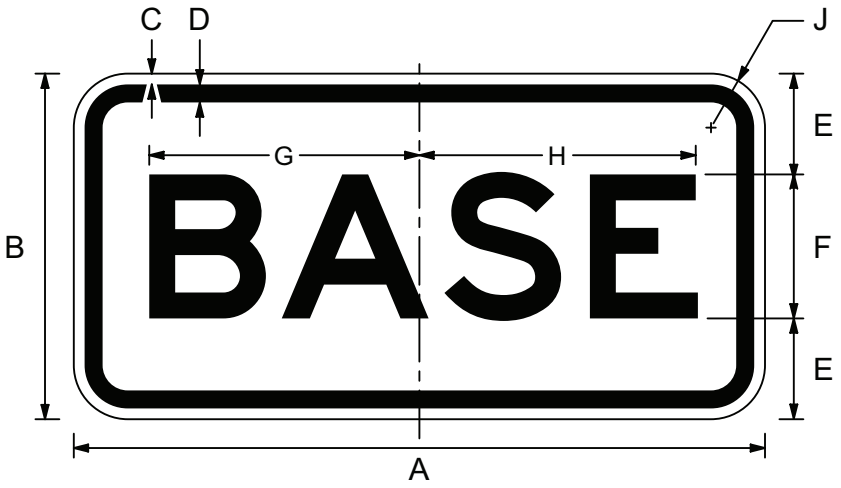
A	B	C	D	E	F	G	H	J	K	L	M	N
24	30	.38	.62	3.5	6D	3B	2.67	7.61	9.75	7.61	7.32	1.5

*Reduced spacing 15%

COLORS:
BORDER & LEGEND - BLACK
BACKGROUND - WHITE (RETROREFLECTIVE)

R2-5hP-TEA
BASE PLAQUE

The BASE (R2-5hP-TEA) plaque may be used above a Speed Limit (R2-1) sign at the entrance to a military installation when the boundary speed limit signing concept is used. In lieu of the word “BASE,” other words such as “POST” or “BARRACKS” may be used.

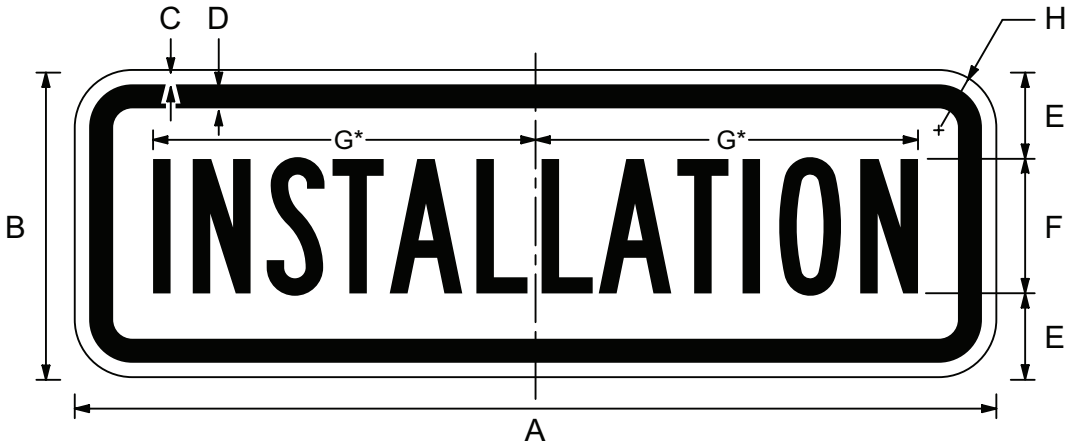


	A	B	C	D	E	F	G	H	J
C	24	12	.38	.62	3.5	5E	9.38	9.68	1.5
	36	15	.62	.88	3.5	8E	15.01	15.49	1.5

COLORS:
BORDER & LEGEND - BLACK
BACKGROUND - WHITE (RETROREFLECTIVE)

R2-5iP-TEA
INSTALLATION PLAQUE

The INSTALLATION (R2-5iP-TEA) plaque may be used above a Speed Limit (R2-1) sign at the entrance to a military installation when the boundary speed limit signing concept is used. If appropriate, use the BASE (R2-5hP-TEA) plaque in lieu of this sign due to the shorter message.



	A	B	C	D	E	F	G	H
C	24	8	.38	.62	2.25	3.5B	9.96*	1.5
	36	12	.62	.88	3.5	5B	14.3	1.5

*Reduced spacing 25%

COLORS:
BORDER & LEGEND - BLACK
BACKGROUND - WHITE (RETROREFLECTIVE)

R5-11g-TEA

GOVERNMENT VEHICLES ONLY

The GOVERNMENT VEHICLES ONLY (R5-11g-TEA) sign may be used at entrances to driveways and roadways that are only open to government vehicles as opposed to all vehicles on the installation. If the restriction starts at a location other than the beginning of the road or driveway, the preferred mounting for the R5-11g-TEA sign is on a Type III barricade that is placed close to the traveled way for added emphasis.

A	B	C	D	E	F	G	H	J	K	L	M	N
30	24	.5	.75	3.5	4C	2.5	12.70	12.94	10.32	5.44	5.68	1.5

* Reduced spacing 50%

COLORS:

BORDER & LEGEND –BLACK

BACKGROUND – WHITE (RETROREFLECTIVE)

R5-29P-TEA

SEVERE TIRE DAMAGE

The SEVERE TIRE DAMAGE (R5-29P-TEA) sign may be used in the wrong-way direction of a one-way roadway that has a set of tire treadles. When used, the R5-29P-TEA sign should be mounted below a DO NOT ENTER (R5-1) sign that is installed adjacent to or in advance of the tire treadle.

A	B	C	D	E	F	G	H	J	K	L	M
30	24	.75	3.5	4E	2.5	11.34	6.30	6.18	12.29	12.53	1.5

COLORS:

BORDER & LEGEND – WHITE (RETROREFLECTIVE)

BACKGROUND – RED (RETROREFLECTIVE)

R5-30-TEA

DO NOT BACK UP – ONE-WAY TIRE TREADLE

The DO NOT BACK UP – ONE-WAY TIRE TREADLE (R5-30-TEA) sign may be used adjacent to a tire treadle to instruct drivers not to back up.

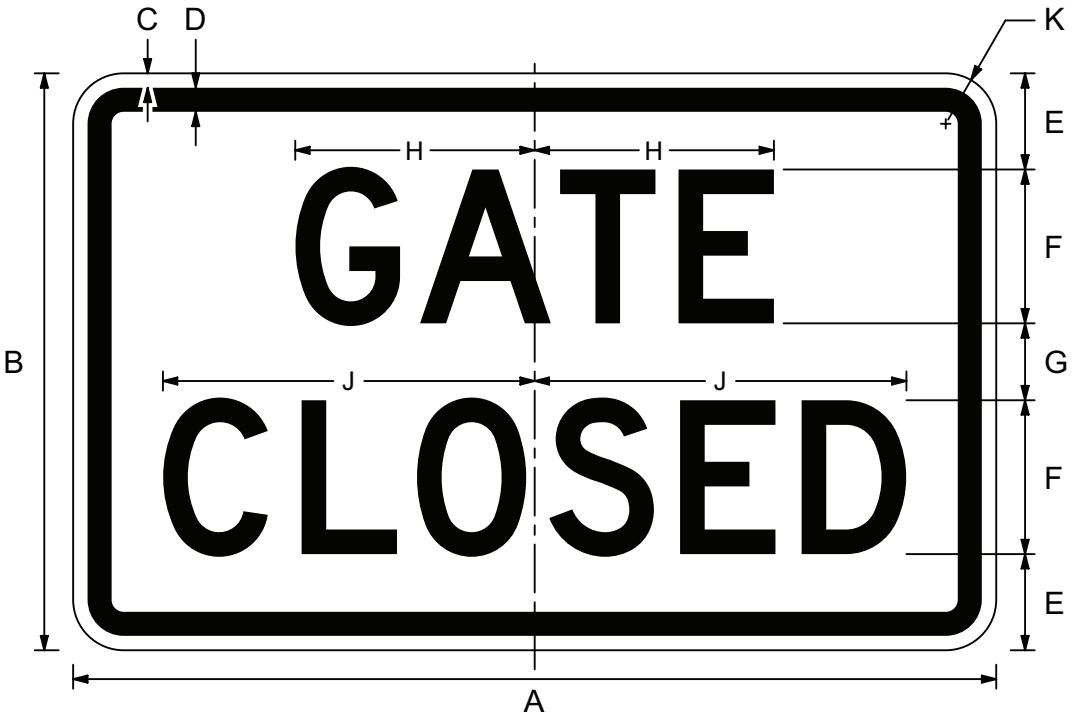
A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S
30	.5	.75	2.7	5D	2.5	1.85	.75	3C	1.65	10.08	10.48	12.18	10	7.11	12.06	1.88

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – WHITE (RETROREFLECTIVE)

R11-2g-TEA

GATE CLOSED

The GATE CLOSED (R11-2g-TEA) sign may be attached to a gate when the gate is not on a normally-used through road. When used, the R11-2g-TEA sign should be mounted at a height of 5 feet above the roadway with three horizontal barricade rails below the sign, each of which shall have vertical stripes alternately red and white at 16-inch centers when measured horizontally.



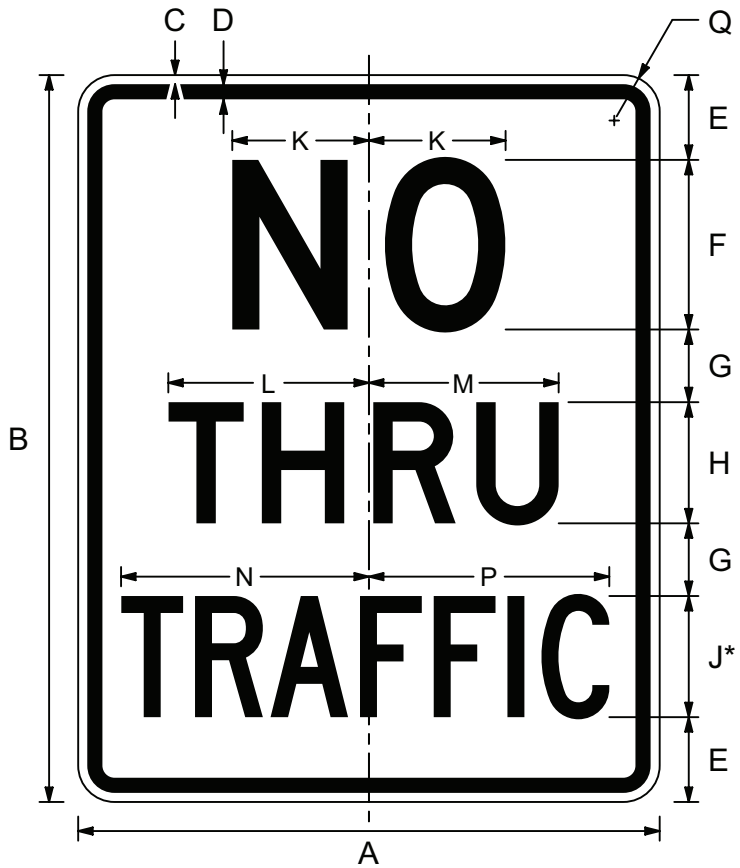
A	B	C	D	E	F	G	H	J	K
48	30	.75	1.25	5	8D	4	12.45	19.33	1.88

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – WHITE (RETROREFLECTIVE)

R11-4a-TEA

NO THRU TRAFFIC

The NO THRU TRAFFIC (R11-4a-TEA) sign may be used at the beginning of a road that goes through a congested or residential area when the road could frequently be used as a shortcut by motorists when the military installation has determined that safety can be enhanced by issuing an appropriate regulation. When used, it should be posted immediately after the intersection at the beginning of the applicable road.



A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q
24	30	.38	.62	3.5	7D	3	5D	5C	5.64	8.28	7.83	10.22	9.92	1.5

*Reduced spacing 30%

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – WHITE (RETROREFLECTIVE)

R11-4b-TEA

ROAD CLOSED FOR PT

The ROAD CLOSED FOR PT (R11-4b-TEA) sign may be used to prohibit vehicular traffic during hours of physical training when the activity requires the prohibition of traffic for safety reasons. When used, the R11-4b-TEA sign should be placed at the ends of the restriction where vehicles can turn to avoid the area.

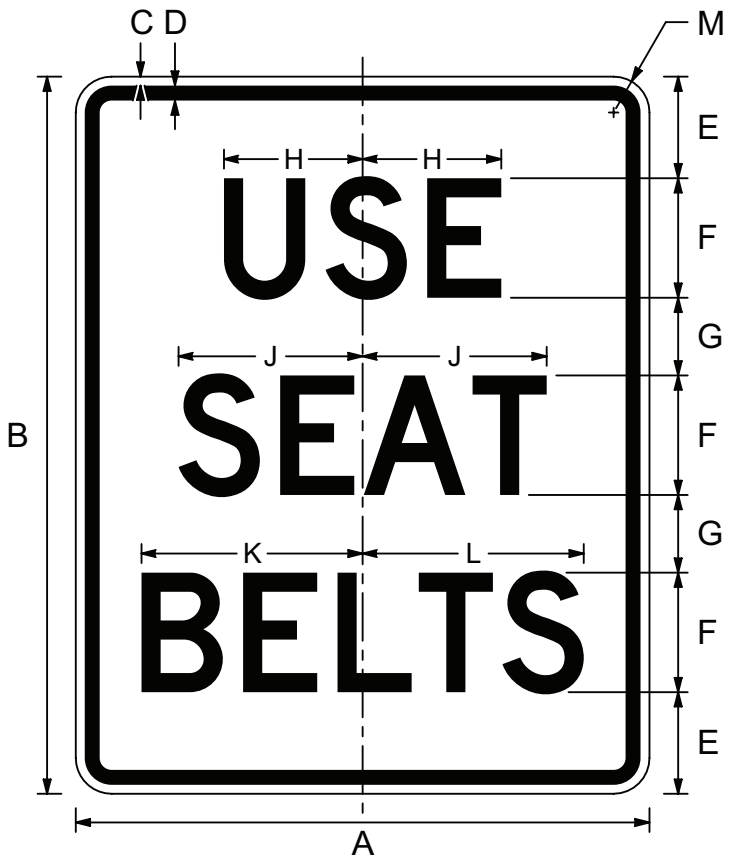
A	B	C	D	E	F	G	H	J	K	L	M	N	P
36	48	.62	.88	4.86	6D	3.35	.88	10.06	14.5	13.42	12	Var	2.25

COLORS:
BORDER & LEGEND - BLACK
BACKGROUND - WHITE (RETROREFLECTIVE)

R16-1b-TEA

USE SEAT BELTS

The USE SEAT BELTS (R16-1b-TEA) sign may be used to remind drivers that they must wear their seat belts. This is especially applicable after an entry control facility (ECF) where occupants sometimes remove their seat belt to produce personal identification.



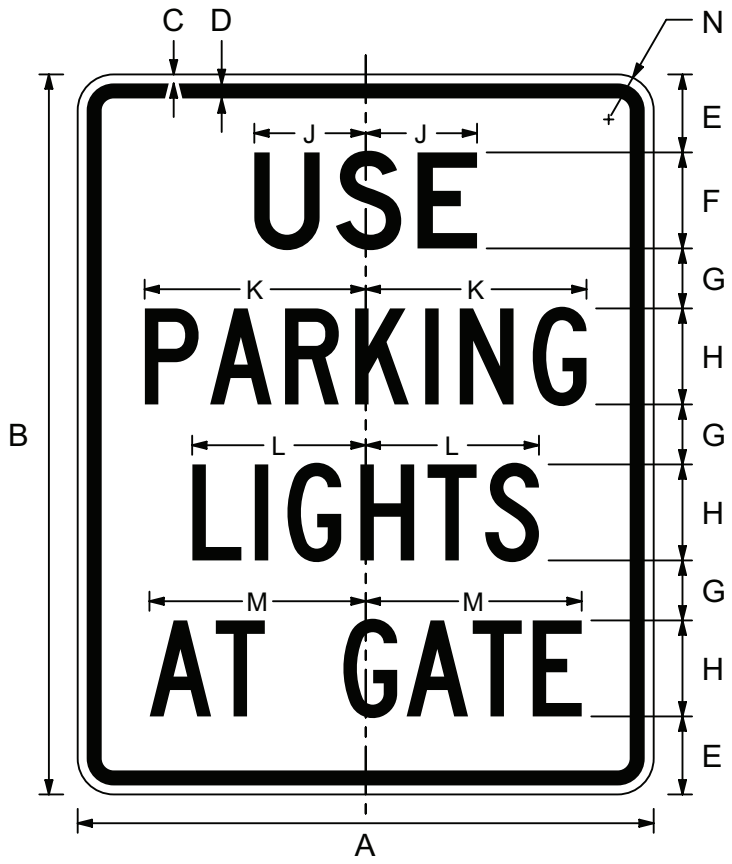
A	B	C	D	E	F	G	H	J	K	L	M
24	30	.38	.62	4.25	5D	3.25	5.8	7.7	9.08	9.43	1.5

COLORS:
BORDER & LEGEND –BLACK
BACKGROUND – WHITE (RETROREFLECTIVE)

R16-5a-TEA

USE PARKING LIGHTS AT GATE

The USE PARKING LIGHTS AT GATE (R16-5a-TEA) sign may be used on the approach to an entry control facility (ECF) when headlights are known to create difficulties for ID checkers. When used, the sign shall be installed about 500 feet from the ECF providing overhead street lighting is provided.



A	B	C	D	E	F	G	H	J	K	L	M	N
24	30	.38	.62	3.25	4D	2.5	4C	4.64	9.2	7.22	9.00	1.5

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – WHITE (RETROREFLECTIVE)

R22-1-TEA

NO CELL PHONE WHEN DRIVING

The NO CELL PHONE WHEN DRIVING (R22-1-TEA) sign may be used on a military installation if the officials determine that drivers are prohibited from using cell phones on military roads. When authorized, the sign may be mounted either inside or outside of each gate, with normal spacing intervals between other traffic signs.

If there is also a ban on all radio transmissions; e.g., due to the presence of explosives, use either the TURN OFF 2-WAY RADIO AND CELL PHONE (R22-2-TEA) sign or the NO RADIO TRANSMISSIONS (R22-3-TEA) sign in lieu of this sign.

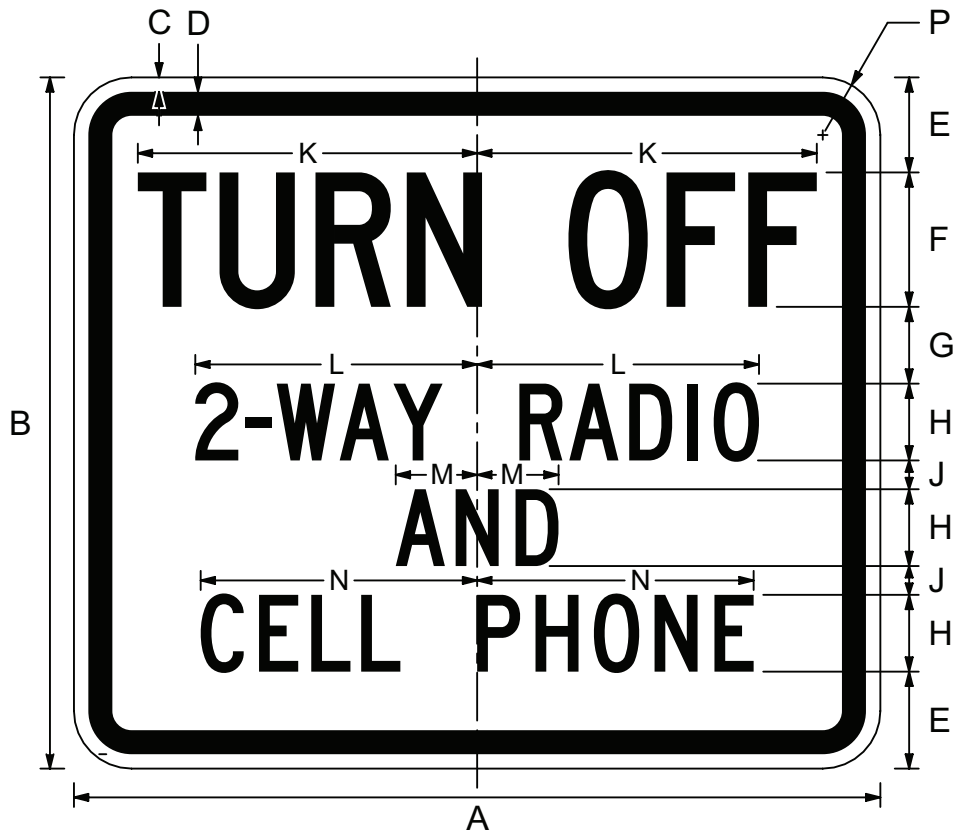
A	B	C	D	E	F	G	H	J	K	L	M	N
36	.62	.88	4	6E	2.5	6D	2.5E	7.14	9.24	12.61	13.14	2.25

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – WHITE (RETROREFLECTIVE)

R22-2-TEA

TURN OFF 2-WAY RADIO AND CELL PHONE

The TURN OFF 2-WAY RADIO AND CELL PHONE (R22-2-TEA) sign may be used on a military installation if the officials determine that drivers should be prohibited from using two-way radios and cell phones due to the presence of sensitive materials. When used, the sign should be installed about 1,000 feet before the sensitive area.



A	B	C	D	E	F	G	H	J	K	L	M	N	P
42	36	.75	1.25	5	7C	4	4C	1.5	18.71	13.91	4.24	13.49	3

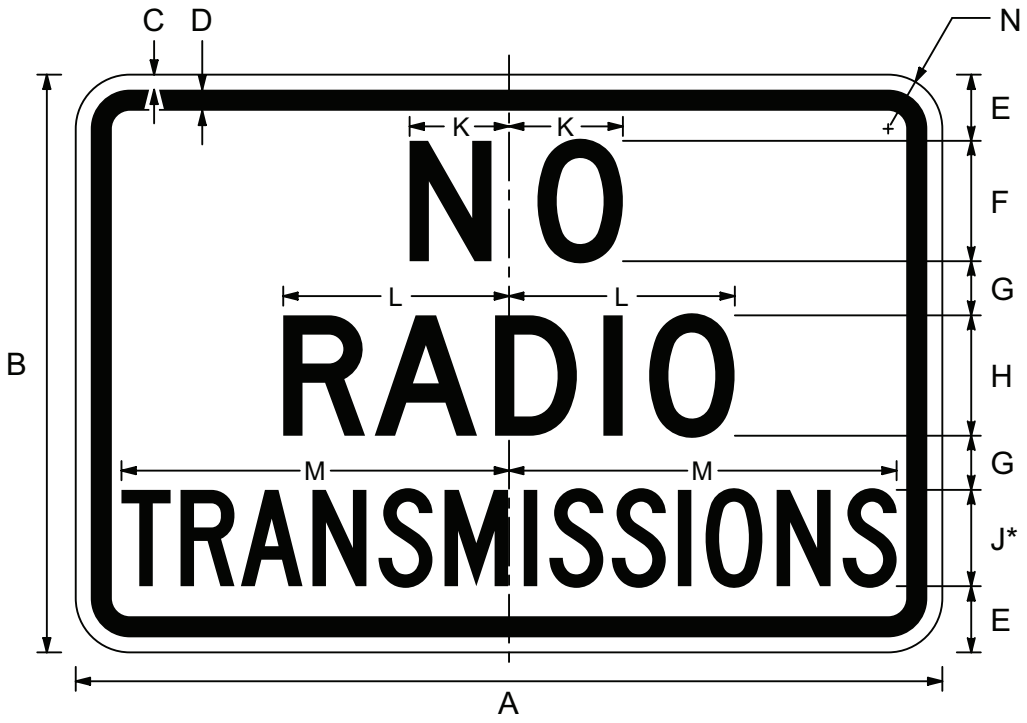
COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – WHITE (RETROREFLECTIVE)

R22-3-TEA

NO RADIO TRANSMISSIONS

The NO RADIO TRANSMISSIONS (R22-3-TEA) sign may be used when radio transmissions would create unnecessary hazards because of the presence of things such as explosives or sensitive electronics. The restriction is designed to prohibit the use of two-way radios, walkie-talkies, and cell phones.

When the R22-3-TEA sign is used, the RADIO TRANSMISSIONS PERMITTED (R22-4-TEA) sign should also be used as appropriate.



A	B	C	D	E	F	G	H	J	K	L	M	N
36	24	.88	.62	2.75	5E	2.25	5D	4C	4.70	9.38	15.17	1.5

*Reduced spacing 50%

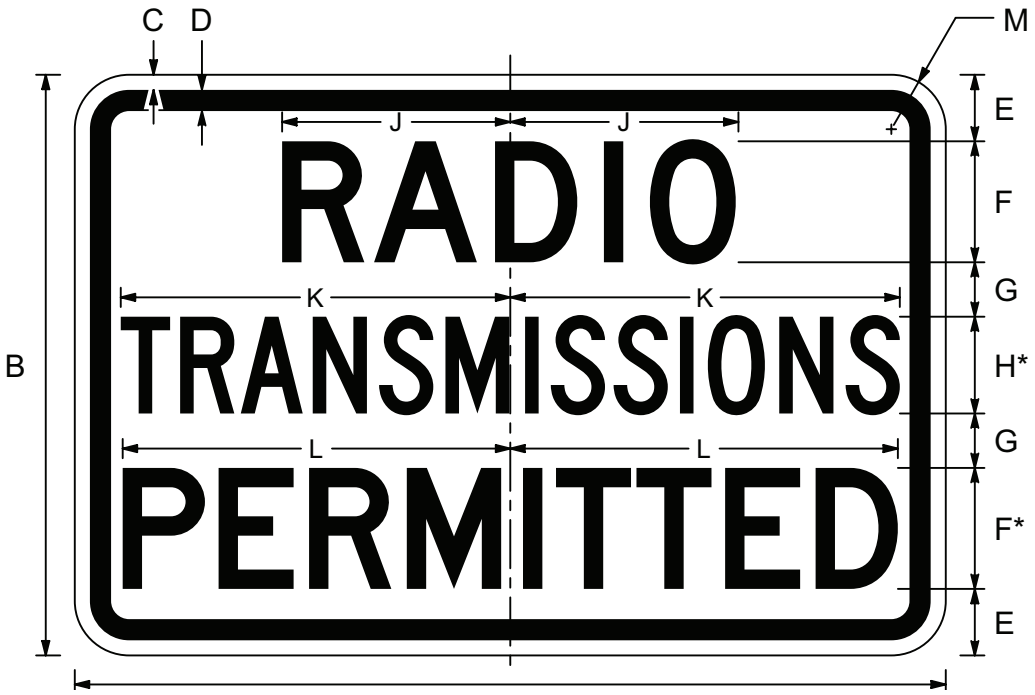
NOTE: The first line is now E Series and the last line has 50% reduction in spacing

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – WHITE (RETROREFLECTIVE)

R22-4-TEA

RADIO TRANSMISSIONS PERMITTED

The RADIO TRANSMISSIONS PERMITTED (R22-4-TEA) sign may be used in conjunction with restrictions posted with the TURN OFF 2-WAY RADIO AND CELL PHONE (R22-2-TEA) sign or the NO RADIO TRANSMISSIONS (R22-3-TEA) sign to identify those locations where it is again safe to make radio transmissions.



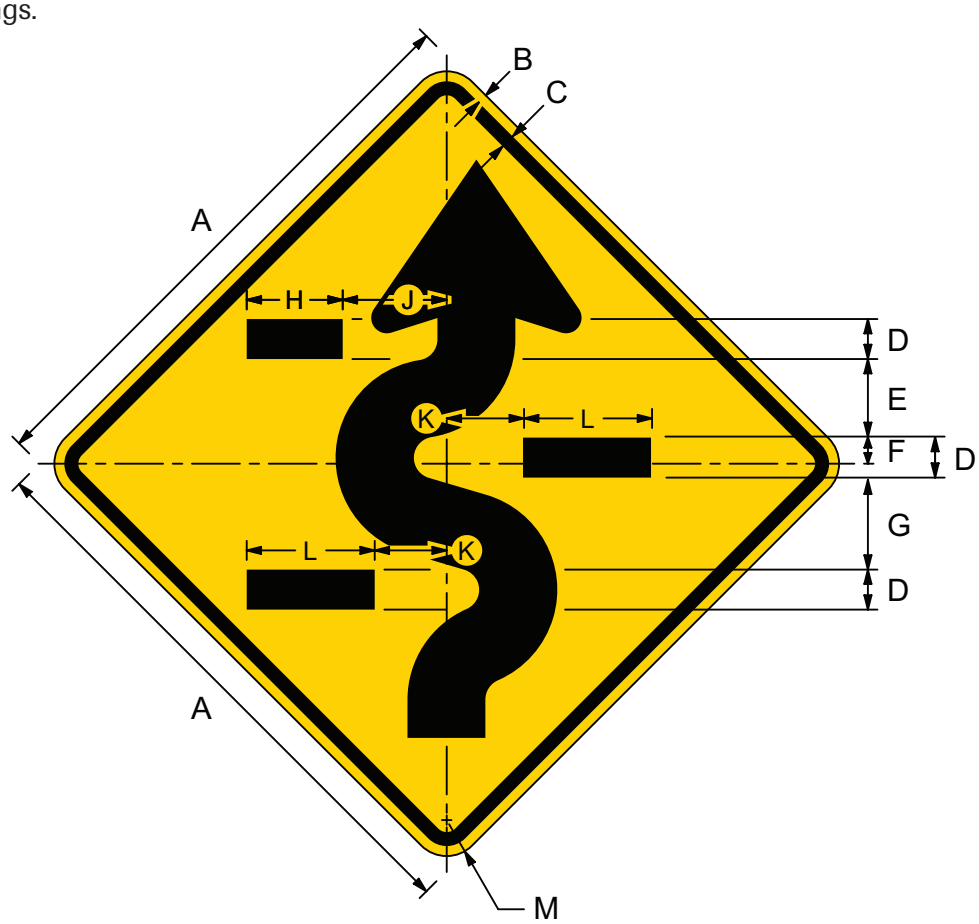
A	B	C	D	E	F	G	H	J	K	L	M
36	24	.62	.88	2.75	5D	2.25	4C	9.38	15.17	15.23	1.5

*Reduced spacing 50%

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – WHITE (RETROREFLECTIVE)

W1-5Lb-TEA & W1-5Rb-TEA
WINDING ROAD CHICANE

The Winding Road Chicane (W1-5Lb-TEA or W1-5Rb-TEA) sign may be used to warn drivers that they are approaching a serpentine roadway with barriers designed to slow traffic. When used, an Advisory Speed (W13-1P) plaque should always be used below the sign to show the suggested safe speed. Because of the inherent hazards involving formidable objects in the roadway, the use of barriers to create a chicane should be considered a temporary solution until a more permanent solution can be constructed. The W1-5Lb-TEA and W1-5Rb-TEA signs are FHWA's W1-5L and W1-5R signs, respectively, but with the three additional barrier markings. The dimensions are limited to sign basics and the size and location of the three markings.



	A	B	C	D	E	F	G	H	J	K	L	M
C	36	.62	.88	2.5	4.91	1.63	5.75	6	6.5	4.5	8	2.25
	48	.75	1.25	3.35	6.52	2.18	7.65	8	8.67	6	10.67	3

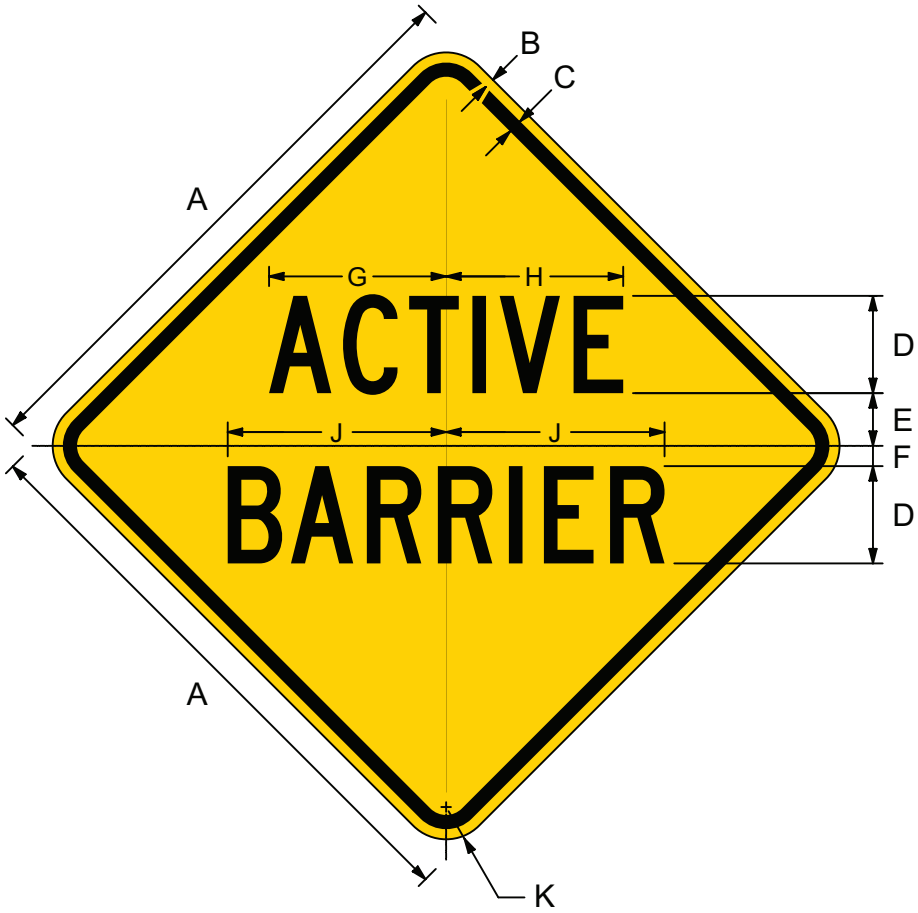
NOTE: This sign is the W1-5Rb-TEA sign, because the first curve is to the right. The W1-5Lb-TEA sign is the mirror image of this sign.

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – YELLOW (RETROREFLECTIVE)

W3-3a-TEA

ACTIVE BARRIER

The ACTIVE BARRIER (W3-3a-TEA) sign may be used to warn drivers that they are approaching an active vehicle barrier (AVB). The W3-3a-TEA sign should normally be the first sign in a series of signs for drivers as they approach the active vehicle barrier. A Distance (W16-2P or W16-2aP) plaque may be installed below the W3-3a-TEA sign to advise drivers of the distance to the AVB.



A	B	C	D	E	F	G	H	J	K
36	.62	.88	6C	3.75	1.25	11.1	10.75	13.47	2.25

COLORS:

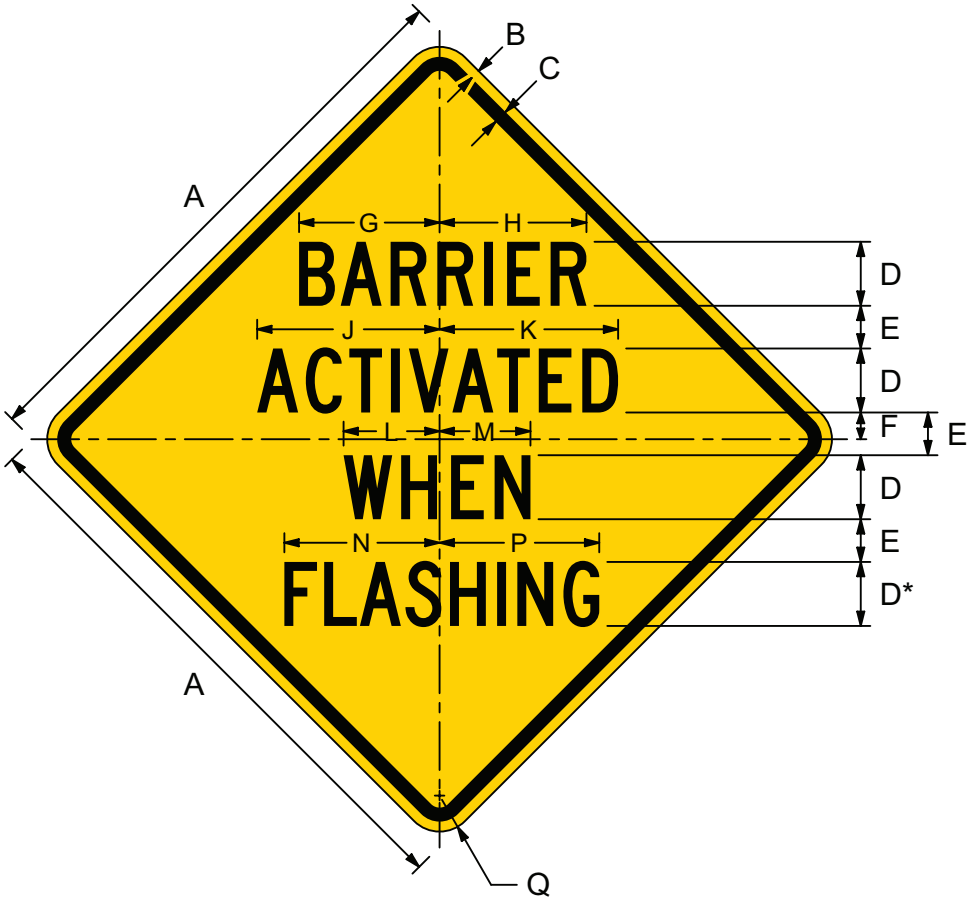
BORDER & LEGEND – BLACK

BACKGROUND – YELLOW (RETROREFLECTIVE)

W3-3b-TEA

BARRIER ACTIVATED WHEN FLASHING

The BARRIER ACTIVATED WHEN FLASHING (W3-3b-TEA) sign may be used to warn drivers that they are approaching an active vehicle barrier (AVB) which is activated when the lights are flashing. The W3-3b-TEA sign would normally be the last sign in a series of signs for drivers as they approach the AVB, and would normally be about 100 feet in advance of the stop bar where drivers are to stop.



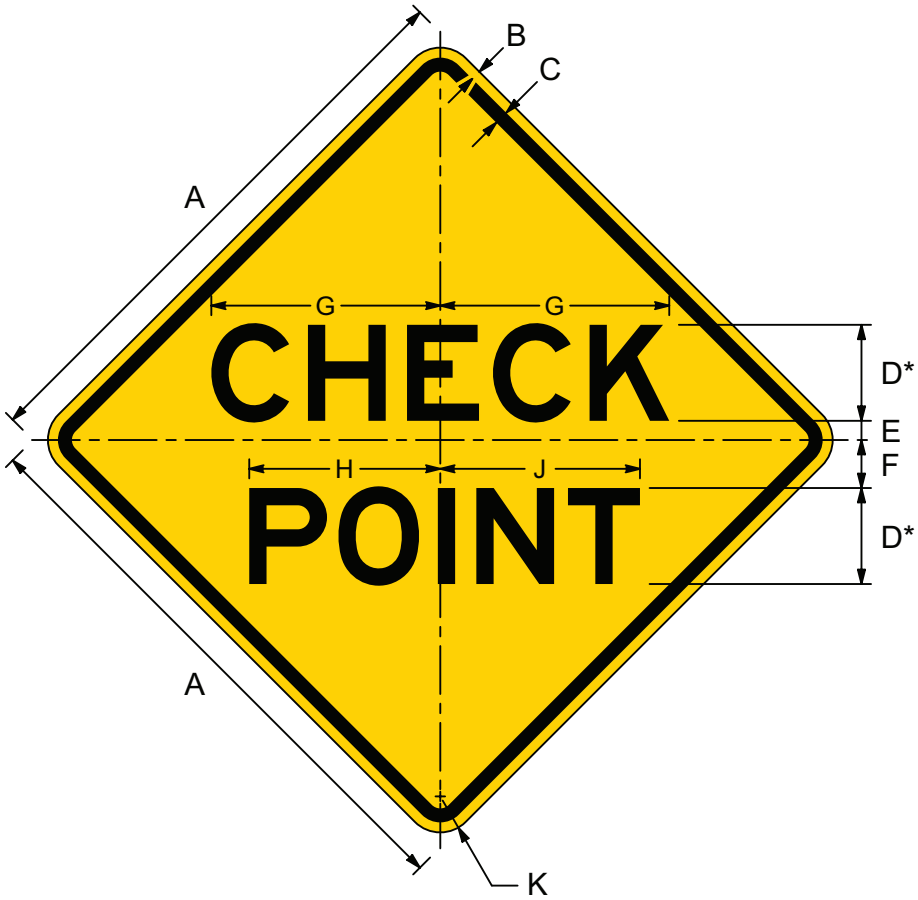
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q
C	36	.62	.88	4C	2.67	1.67	8.78	9.18	11.40	11.16	6.00	5.68	9.70	9.98	2.25
	48	.75	1.25	5D	3.00	2.00	13.00	13.67	17.28	16.93	8.81	8.36	14.55	14.97	3

*Reduced spacing 20%

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – YELLOW (RETROREFLECTIVE)

W3-10-TEA
CHECK POINT

The CHECK POINT (W3-10-TEA) sign may be used to warn drivers that they are approaching a military checkpoint. The W3-10-TEA sign would normally be the first sign in a series of signs for drivers as they approach the checkpoint in accordance with the signing defined in SDDCTEA's *Traffic and Safety Engineering for Better Entry Control Facilities* (Pamphlet 55-15). A Distance (W16-2P) plaque may be installed below the W3-10-TEA sign to advise drivers of the distance to the checkpoint.



A	B	C	D	E	F	G	H	J	K
36	.62	.88	6E	1.2	3	14.31	11.94	12.48	2.25

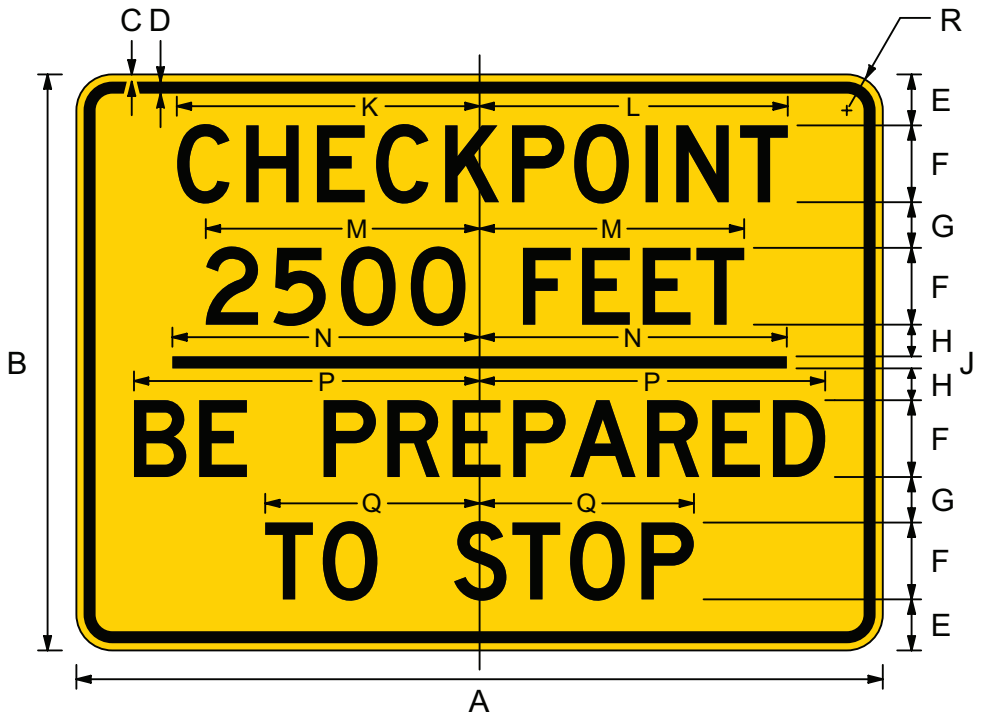
*Reduced spacing 15%

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – YELLOW (RETROREFLECTIVE)

W3-10b-TEA

CHECKPOINT (___) FEET—BE PREPARED TO STOP

The CHECKPOINT (___) FEET—BE PREPARED TO STOP (W3-10b-TEA) sign may be used to warn drivers that they are approaching a military checkpoint. The W3-10b-TEA sign is intended for use only on high-speed multi-lane approach roadways when the smaller CHECK POINT (W3-10a-TEA) sign is considered to be too small. This sign would normally be the first sign in a series of signs for drivers as they approach the checkpoint in accordance with the signing defined in SDDCTEA's Traffic and Safety Engineering for Better Entry Control Facilities (Pamphlet 55-15).



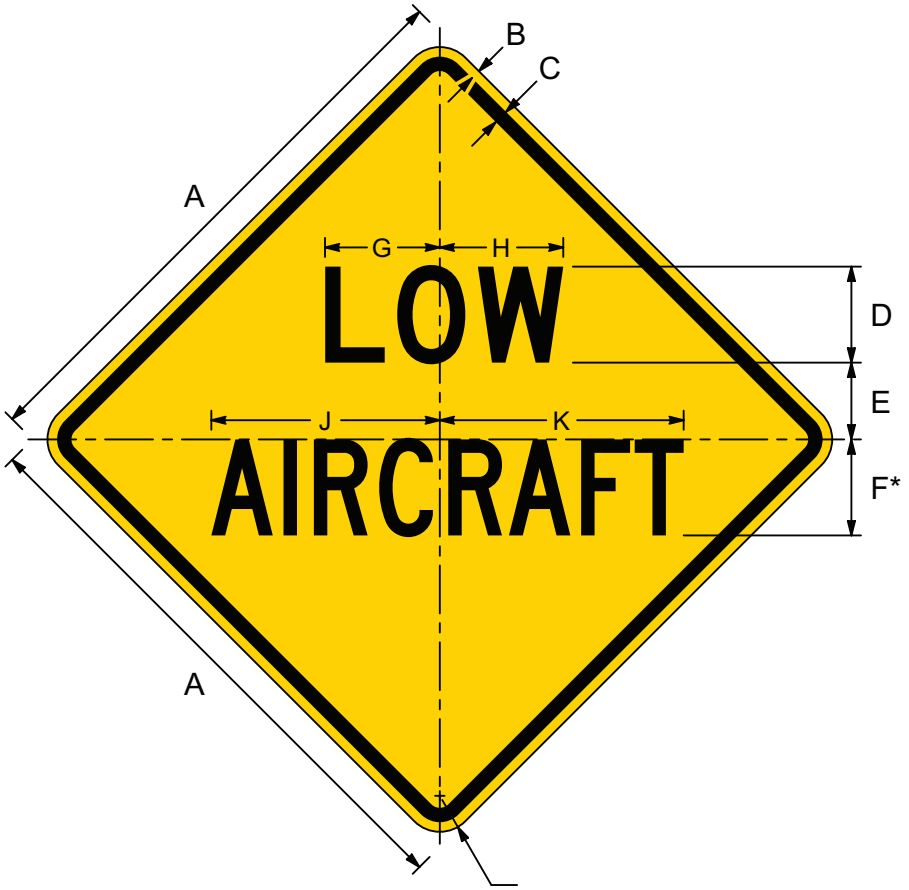
A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
84	60	.75	1.25	5.31	8D	4.75	3.31	1.25	31.54	32.10	Var.	32	35.52	22.33	3.75

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – YELLOW (RETROREFLECTIVE)

W11-26-TEA

LOW AIRCRAFT

The LOW AIRCRAFT (W11-26-TEA) sign may be used to warn drivers that there may be low-flying aircraft, so that no one is surprised due to the sudden noise or appearance of the aircraft.



A	B	C	D	E	F	G	H	J	K	L
30	.5	.75	5D	4	5C	5.98	6.43	11.90	12.70	1.88

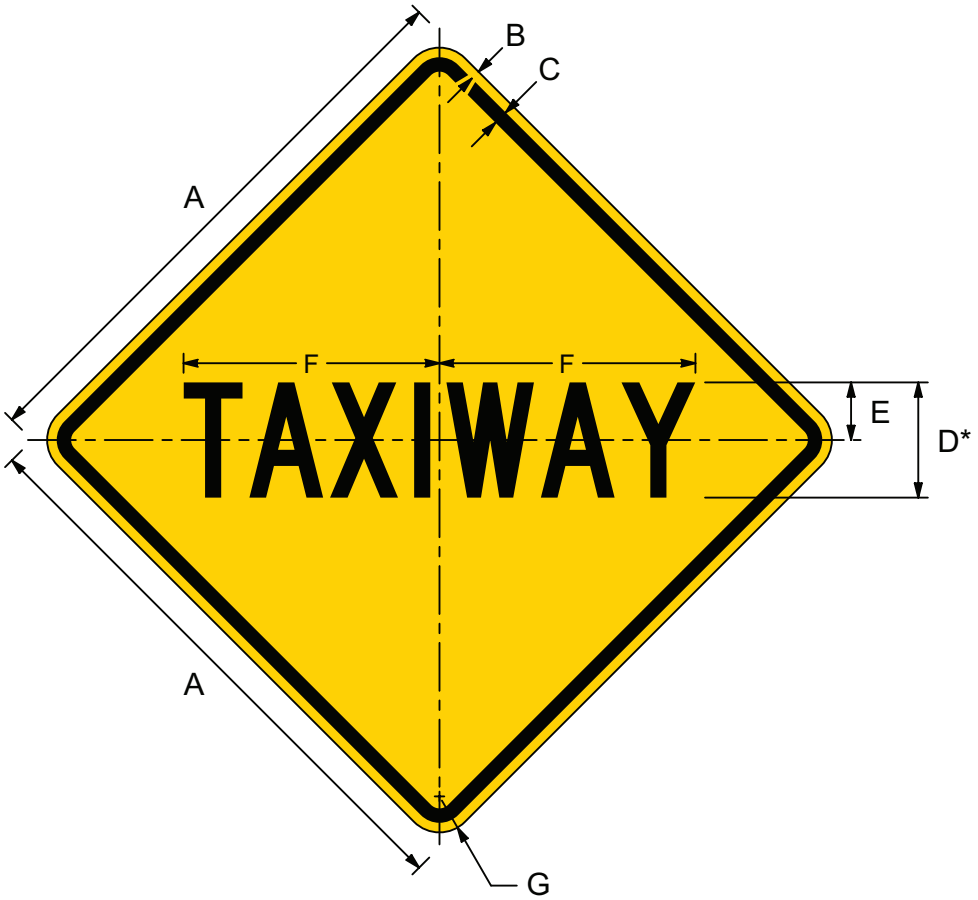
*Reduced spacing 20%

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – YELLOW (RETROREFLECTIVE)

W11-27-TEA

TAXIWAY

The TAXIWAY (W11-27-TEA) sign may be used to warn drivers that there may be aircraft crossing or running along side of the road.



A	B	C	D	E	F	G
30	.5	.75	6C	3	13.33	1.88

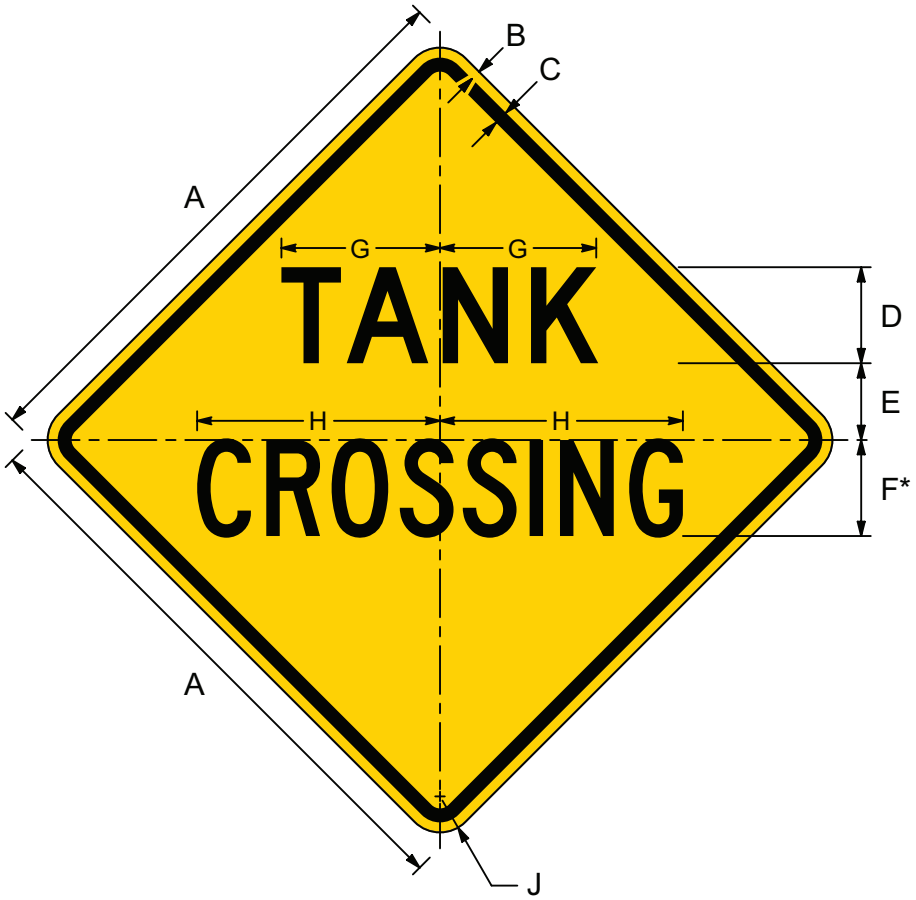
*Reduced spacing 40%

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – YELLOW (RETROREFLECTIVE)

W11-28-TEA

TANK CROSSING

The TANK CROSSING (W11-28-TEA) sign may be used to warn drivers that there may be military tanks crossing the road, so that no one is surprised due to the sudden noise or appearance of a tank.



A	B	C	D	E	F	G	H	J
30	.5	.75	5D	4	5C	8.26	12.65	1.88

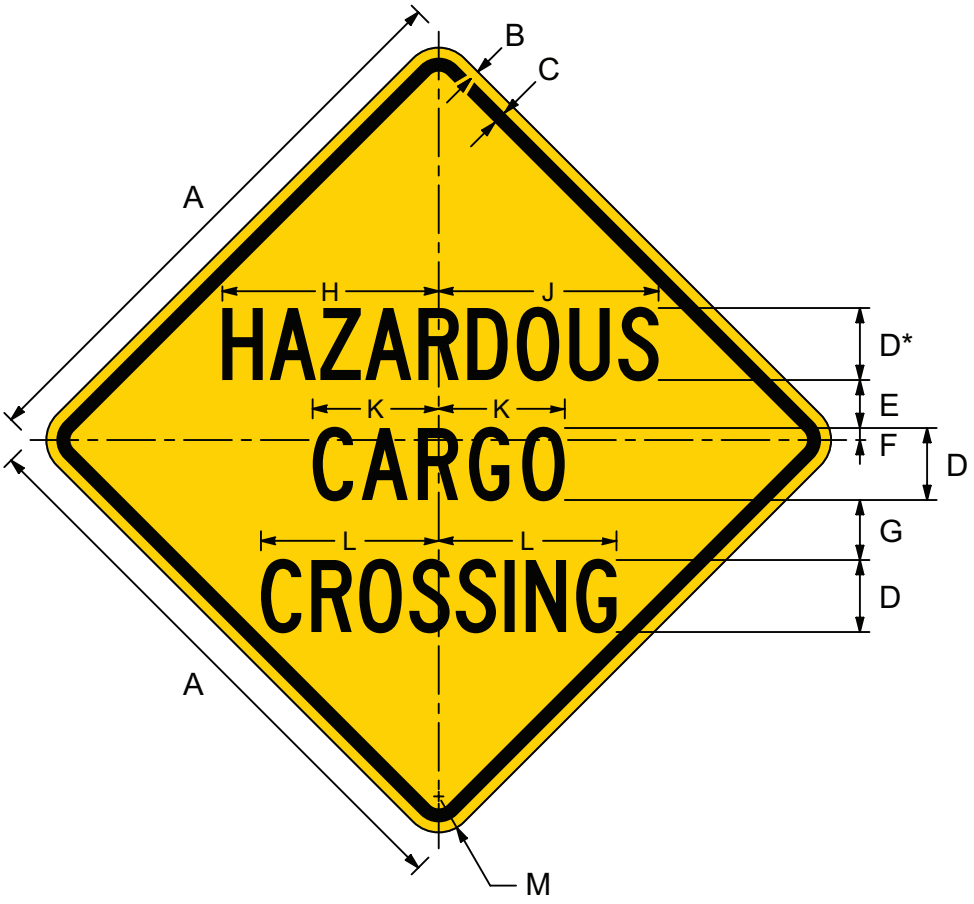
*Reduced spacing 20%

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – YELLOW (RETROREFLECTIVE)

W11-29-TEA

HAZARDOUS CARGO CROSSING

The HAZARDOUS CARGO CROSSING (W11-29-TEA) sign may be used to warn drivers that there may be trucks crossing the road with hazardous cargo. The larger size sign should be used on multi-lane roadways.



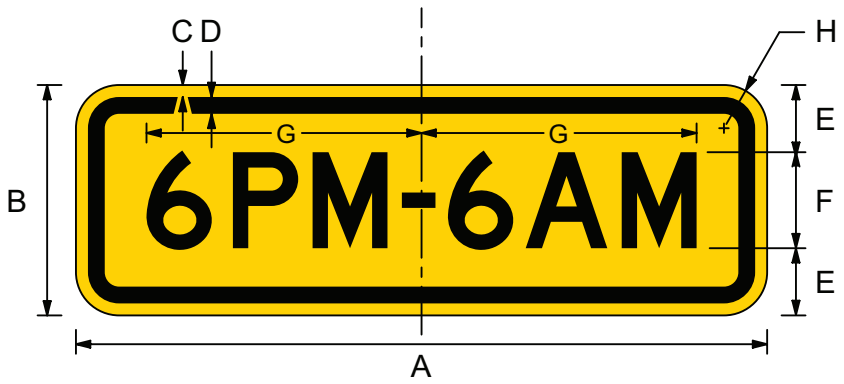
	A	B	C	D	E	F	G	H	J	K	L	M
C	36	.62	.88	4.5C	3	.75	3.75	13.52	13.74	7.88	11.11	2.25
	48	.75	1.25	6C	4	1	5	18.02	18.32	10.5	14.82	3

*Reduced spacing 30%

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – YELLOW (RETROREFLECTIVE)

W16-20P-TEA
APPLICABLE HOURS

The Applicable Hours (W16-20P-TEA) plaque may be used below any warning sign to identify the effective hours of the message.



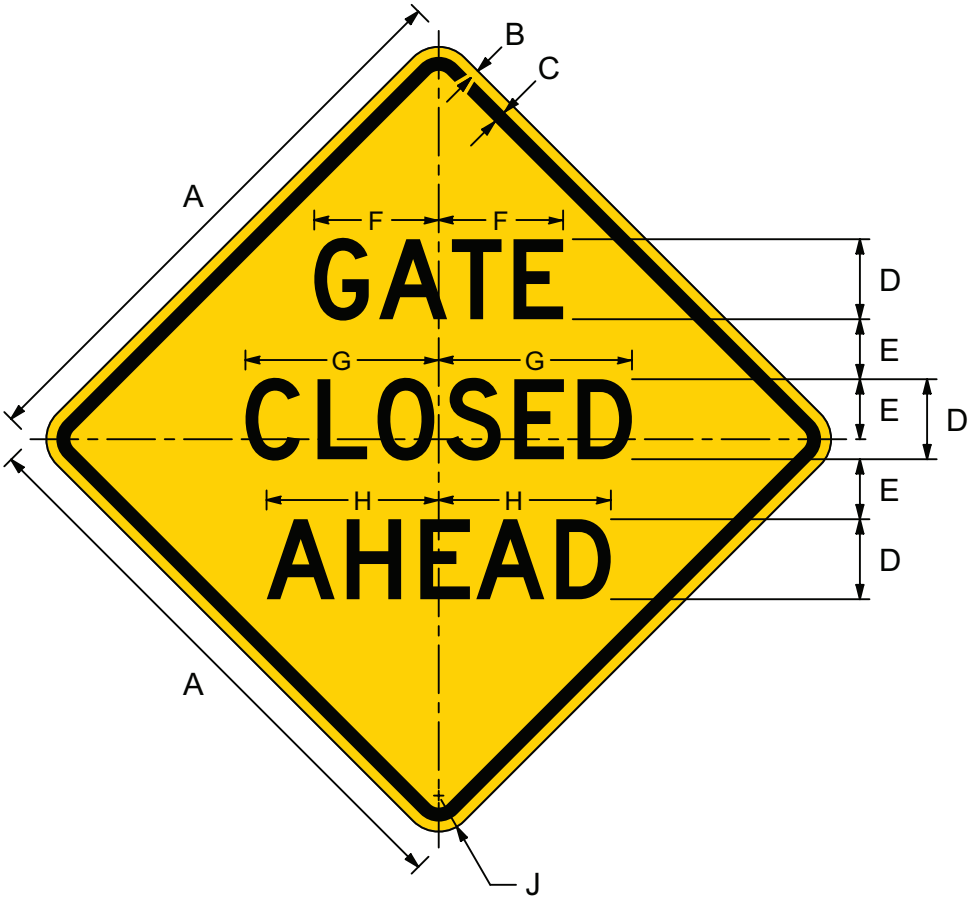
	A	B	C	D	E	F	G	H
C	36	12	.62	.88	3.5	5D	Var.	1.5
	48	18	.75	1.25	5.5	7D	Var.	1.88

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – YELLOW (RETROREFLECTIVE)

W20-3g-TEA

GATE CLOSED AHEAD

The GATE CLOSED AHEAD (W20-3g-TEA) sign may be used to warn drivers that a gate may be closed ahead. If the gate closure is a regular scheduled event, the times when the gate is closed should be included, either in place of the word AHEAD or on a SCHEDULED TIME (W20-3gP-TEA) plaque beneath the W20-3g-TEA sign. The larger size sign should be used on multi-lane roadways.



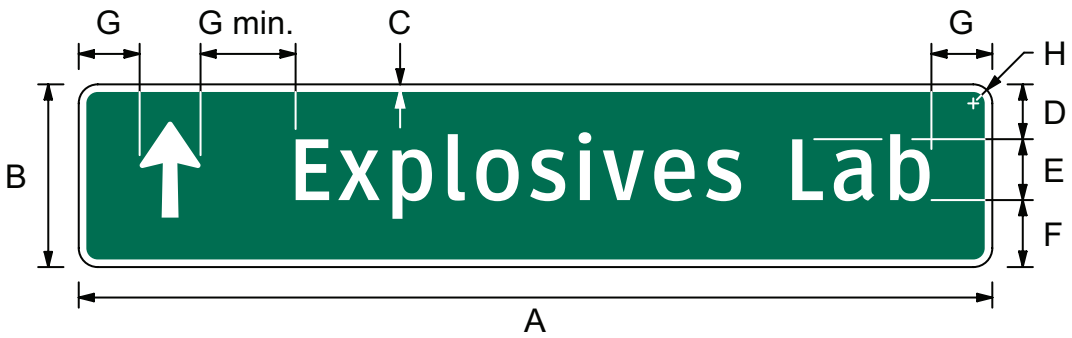
	A	B	C	D	E	F	G	H	J
C	36	.62	.88	5D	3.75	7.78	12.08	10.76	2.25
	48	.75	1.25	7D	4.75	10.89	16.92	15.06	3

COLORS:
BORDER & LEGEND – BLACK
BACKGROUND – YELLOW (RETROREFLECTIVE)

D1-1-TEA
SINGLE-LINE DESTINATION

The Single-Line Destination (D1-1-TEA) sign may be used within a military installation to provide directions to a major traffic generator.

On conventional highways, the standard legend is 6 inches in height, except 4-inch legend may be used on roads with a speed limit less than 30 mph.



	A	B	C	D	E	F	G	H
	Var*	12	.5	3.6	4” 3W	4.4	4	1.5
C	Var*	18	.75	5.4	6” 3W	6.6	6	1.88

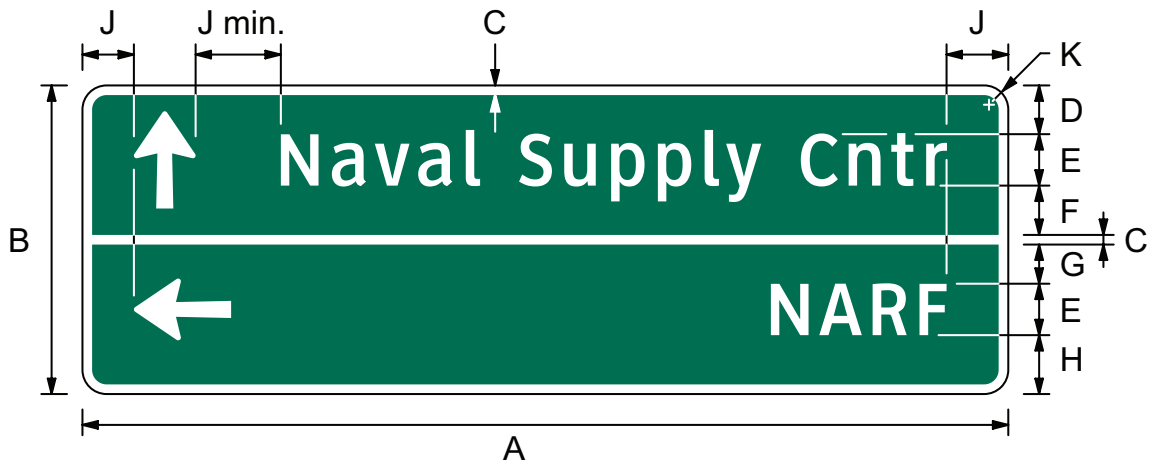
*Based on the length of the message, but rounded upward to a multiple of 6 inches

COLORS:
BORDER & LEGEND – WHITE (RETROREFLECTIVE)
BACKGROUND – GREEN (RETROREFLECTIVE)

D1-2-TEA
TWO-LINE DESTINATION

The Two-Line Destination (D1-2-TEA) sign may be used within a military installation to provide directions to two major traffic generators.

On conventional highways, the standard legend is 6 inches in height, except 4-inch legend may be used on roads with a speed limit less than 30 mph.



	A	B	C	D	E	F	G	H	J	K
	Var*	24	.75	3.79	4” 3W	3.84	3.04	4.58	4	1.88
C	Var*	30	1	4.15	6” 3W	4.35	3.15	5.35	6	1.88

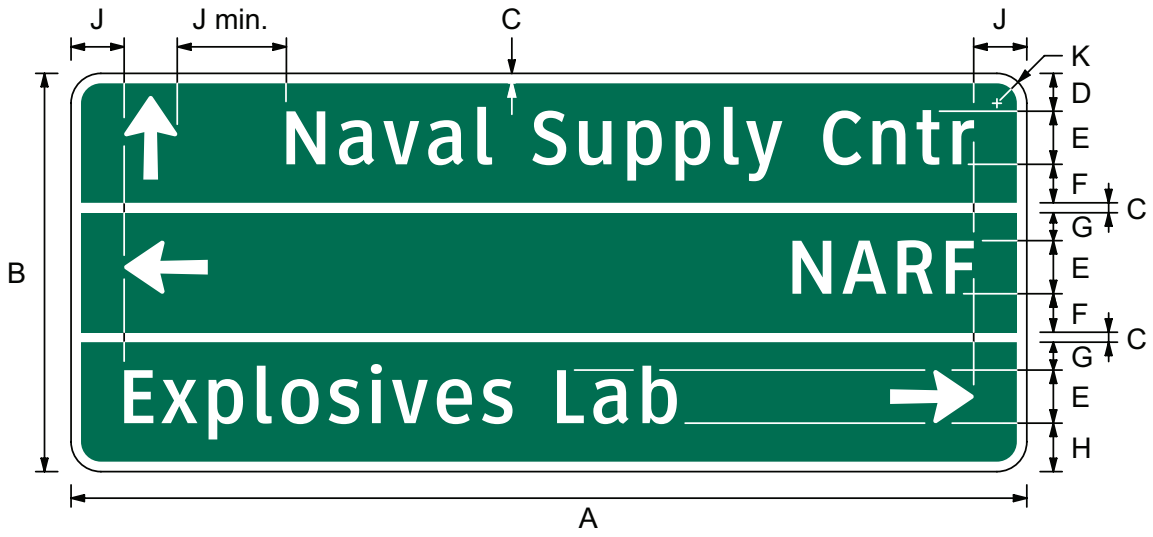
*Based on the length of the message, but rounded upward to a multiple of 6 inches

COLORS:
BORDER & LEGEND – WHITE (RETROREFLECTIVE)
BACKGROUND – GREEN (RETROREFLECTIVE)

D1-3-TEA
THREE-LINE DESTINATION

The Three-Line Destination (D1-3-TEA) sign may be used within a military installation to provide directions to three major traffic generators.

On conventional highways, the standard legend is 6 inches in height, except 4-inch legend may be used on roads with a speed limit less than 30 mph.



	A	B	C	D	E	F	G	H	J	K
	Var*	30	.75	2.85	4" 3W	2.9	2.1	3.65	4	2.25
C	Var*	42	1	3.74	6" 3W	3.93	2.73	4.94	6	3

*Based on the length of the message, but rounded upward to a multiple of 6 inches

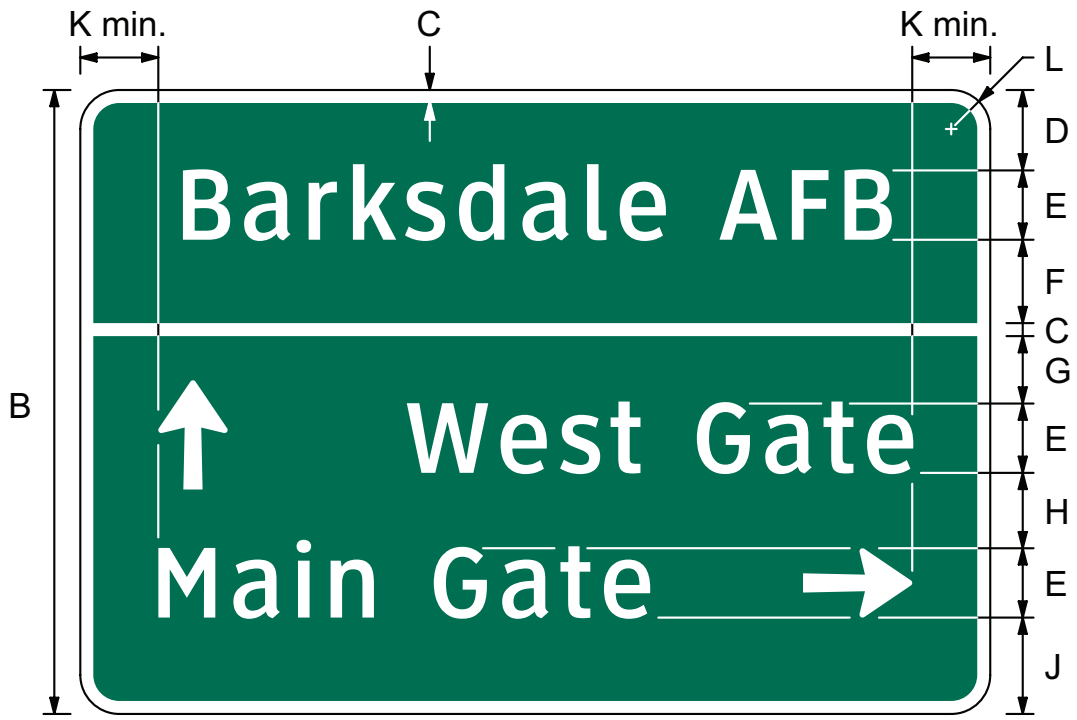
COLORS:
BORDER & LEGEND – WHITE (RETROREFLECTIVE)
BACKGROUND – GREEN (RETROREFLECTIVE)

D1-4b-TEA

INSTALLATION APPROACH WITH TWO GATES

The Installation Approach with Two Gates (D1-4b-TEA) sign may be used on the approach to a military installation when directions are provided for two gates.

On conventional highways, the standard legend is 6 inches in height, except 4-inch legend may be used on roads with a speed limit less than 30 mph. Larger and bolder legends should be used on expressways and freeways.



	A	B	C	D	E	F	G	H	J	K	L
	Var*	36	.75	4.64	4" 3W	4.81	3.89	4.35	5.56	4	2.25
C	Var*	48	1	5.7	6" 3W	6.1	4.7	5.4	7.1	6	3

*Based on the length of the message, but rounded upward to a multiple of 6 inches

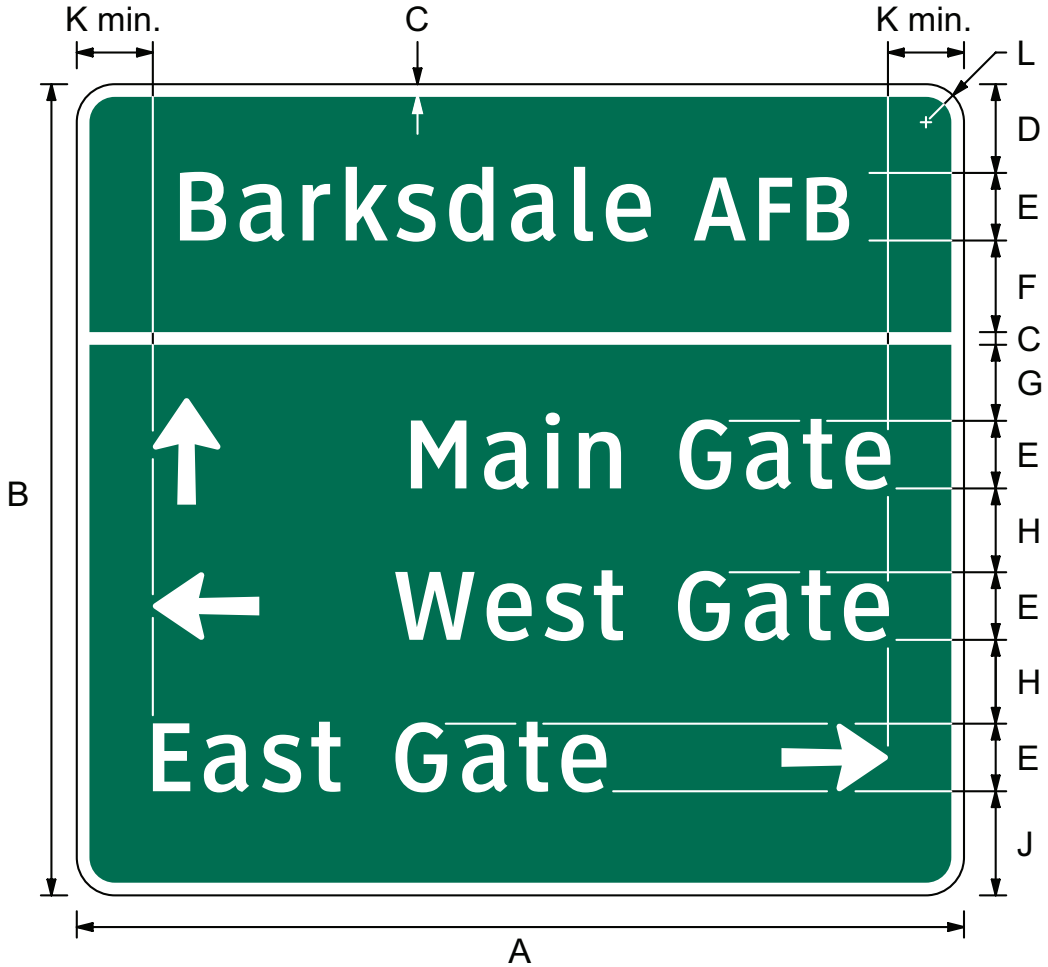
COLORS:
BORDER & LEGEND – WHITE (RETROREFLECTIVE)
BACKGROUND – GREEN (RETROREFLECTIVE)

D1-4c-TEA

INSTALLATION APPROACH WITH THREE GATES

The Installation Approach with Three Gates (D1-4c-TEA) sign may be used on the approach to a military installation when directions are provided for three gates.

On conventional highways, the standard legend is 6 inches in height, except 4-inch legend may be used on roads with a speed limit less than 30 mph. Larger and bolder legends should be used on expressways and freeways.



	A	B	C	D	E	F	G	H	J	K	L
	Var*	48	.75	5.25	4” 3W	5.42	4.5	4.96	6.16	4	2.25
C	Var*	60	1	5.8	6” 3W	6.2	4.8	5.5	7.2	6	3

*Based on the length of the message, but rounded upward to a multiple of 6 inches

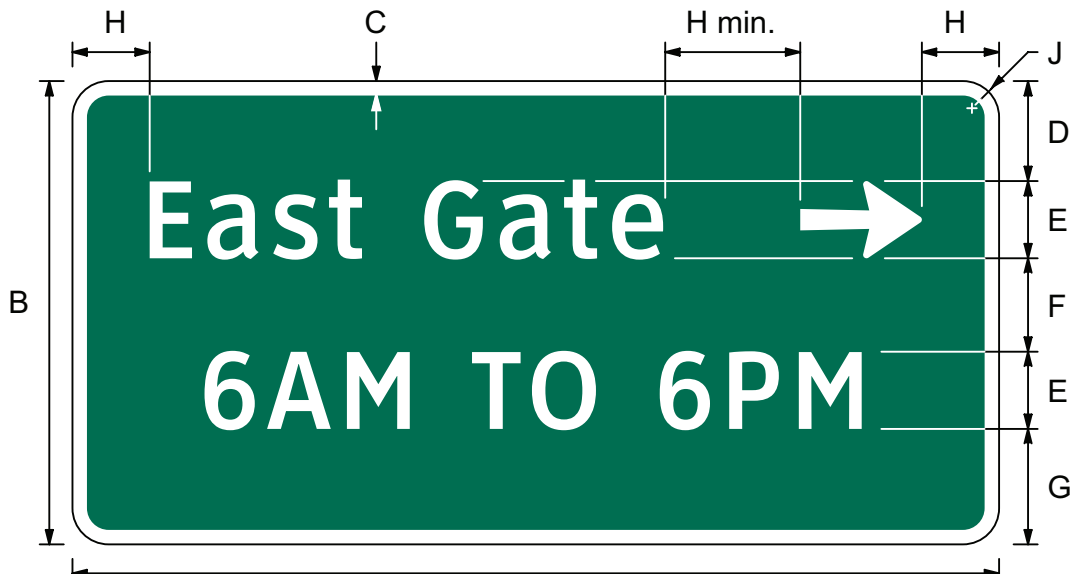
COLORS:
BORDER & LEGEND – WHITE (RETROREFLECTIVE)
BACKGROUND – GREEN (RETROREFLECTIVE)

D1-5a-TEA

GATE DESTINATION WITH HOURS OF OPERATION

The Gate Destination with Hours of Operation (D1-5a-TEA) sign may be used on the approach to a military installation to provide both directions to and hours of operation of a major traffic generator.

On conventional highways, the standard legend is 6 inches in height, except 4-inch legend may be used on roads with a speed limit less than 30 mph.



	A	B	C	D	E	F	G	H	J
	Var*	24	.75	5.18	4” 3W	4.84	5.98	4	1.88
C	Var*	30	1	5.73	6” 3W	5.34	6.93	6	1.88

*Based on the length of the message, but rounded upward to a multiple of 6 inches

COLORS:
BORDER & LEGEND – WHITE (RETROREFLECTIVE)
BACKGROUND – GREEN (RETROREFLECTIVE)

D3-1-TEA

SINGLE-LINE STREET NAME

The Street Name (D3-1-TEA) sign may be used to identify street or road names to assist unfamiliar motorists find their destination. Except for very short names, the common abbreviations Rd, St, Ave, Blvd, etc., should generally not be used unless not using them would create confusion with a nearby street name or destination.

On conventional highways, the standard legend is 6 inches in height, except: 8-inch legend should be used on multi-lane roads with a speed limit over 40 mph; 12-inch legend should be used on overhead signs; and 4-inch legend may be used on roads with a speed limit less than 30 mph. To reduce the size of the signs, the border may be eliminated.

	A	B	C	D	E	F	G
	Var*	9	.5	2	4” 2W	3	1.5
C	Var*	13.5	.5	3.05	6” 2W	4.45	1.88
	Var*	18	.75	4.05	8” 2W	5.95	2.25
	Var*	24	.75	4.6	12” 2W	7.4	2.25

If Not Using a Border:

	A	B	C	D	E	F	G
	Var*	8	-	1.5	4” 2W	2.5	1.5
C	Var*	12	-	2.3	6” 2W	3.7	1.88
	Var*	16	-	3.05	8” 2W	4.95	2.25
	Var*	18	-	1.6	12” 2W	4.4	2.25

*Based on the length of the message, but generally rounded upward to a multiple of 3 inches

COLORS:
BORDER & LEGEND – WHITE (RETROREFLECTIVE)
BACKGROUND – GREEN (RETROREFLECTIVE)

D3-2-TEA
TWO-LINE STREET NAME

The Two-Line Street Name (D3-2-TEA) sign may be used to identify street or road names at an intersection where the street or road name changes. Except for very short names, the common abbreviations Rd, St, Ave, Blvd, etc., should not be used unless not using the abbreviation creates confusion with a nearby street name or destination.

On conventional highways, the standard legend is 6 inches in height, except: 8-inch legend should be used on multi-lane roads with a speed limit over 40 mph; 12-inch legend should be used on overhead signs; and 4-inch legend may be used on roads with a speed limit less than 30 mph. To reduce the size of the signs, the border may be eliminated.

	A	B	C	D	E	F	G	H
	Var*	16	.5	2	4” 2W	3	3	1.88
C	Var*	24	.5	3	6” 2W	4.55	4.45	1.88
	Var*	32	.75	4.1	8” 2W	6	5.9	2.25
	Var*	44	1	4.6	12” 2W	8	7.4	2.25

If Not Using a Border:

	A	B	C	D	E	F	G	H
	Var*	15	-	1.5	4” 2W	3	2.5	1.88
C	Var*	22	-	2.5	6” 2W	3.55	3.95	1.88
	Var*	28	-	2.55	8” 2W	5	4.45	2.25
	Var*	36	-	1.6	12” 2W	6	4.4	2.25

*Based on the length of the message, but generally rounded upward to a multiple of 3 inches

COLORS:
BORDER & LEGEND – WHITE (RETROREFLECTIVE)
BACKGROUND – GREEN (RETROREFLECTIVE)

D35-1-TEA

ON-PREMISE BUILDING NAME AND NUMBER

The On-Premise Building Name and Number (D35-1-TEA) sign may be used to assist visitors and non-familiar personnel identify the buildings. Typical placement would be in the front lawn, approximately 30 feet from the edge of the roadway. If the sign is oriented perpendicular to the direction of travel, the sign should generally be double-sided so that it can be read in both directions.

Other colors, styles, and formats may be used but uniformity within a military installation is encouraged. The sign may be mounted as low as 2 or 3 feet providing it is not hidden by vegetation.

A	B	C	D	E	F	G	H	J	K	L
Var*	36	1	5	8” 3W	6	6” 3W	4	3” 2W	4	2.25

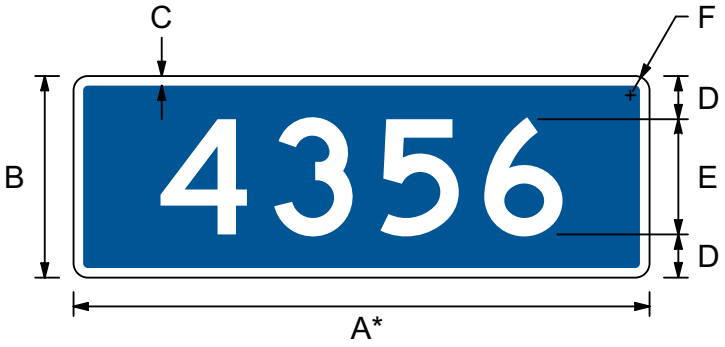
*Based on the length of the longest line of message

COLORS:
BORDER & LEGEND – WHITE (RETROREFLECTIVE)
BACKGROUND – GREEN, BLUE, OR BROWN (RETROREFLECTIVE)

D35-2-TEA
BUILDING NUMBER

The Building Number (D35-2-TEA) sign may be attached to a building to identify the building number.

Other colors, styles, and formats may be used as necessary, but uniformity within a military installation is encouraged. The sign would generally be attached to the building at a height of about 8 to 10 feet.



A	B	C	D	E	F
Var*	18	1	4.5	12" 3W	1.5

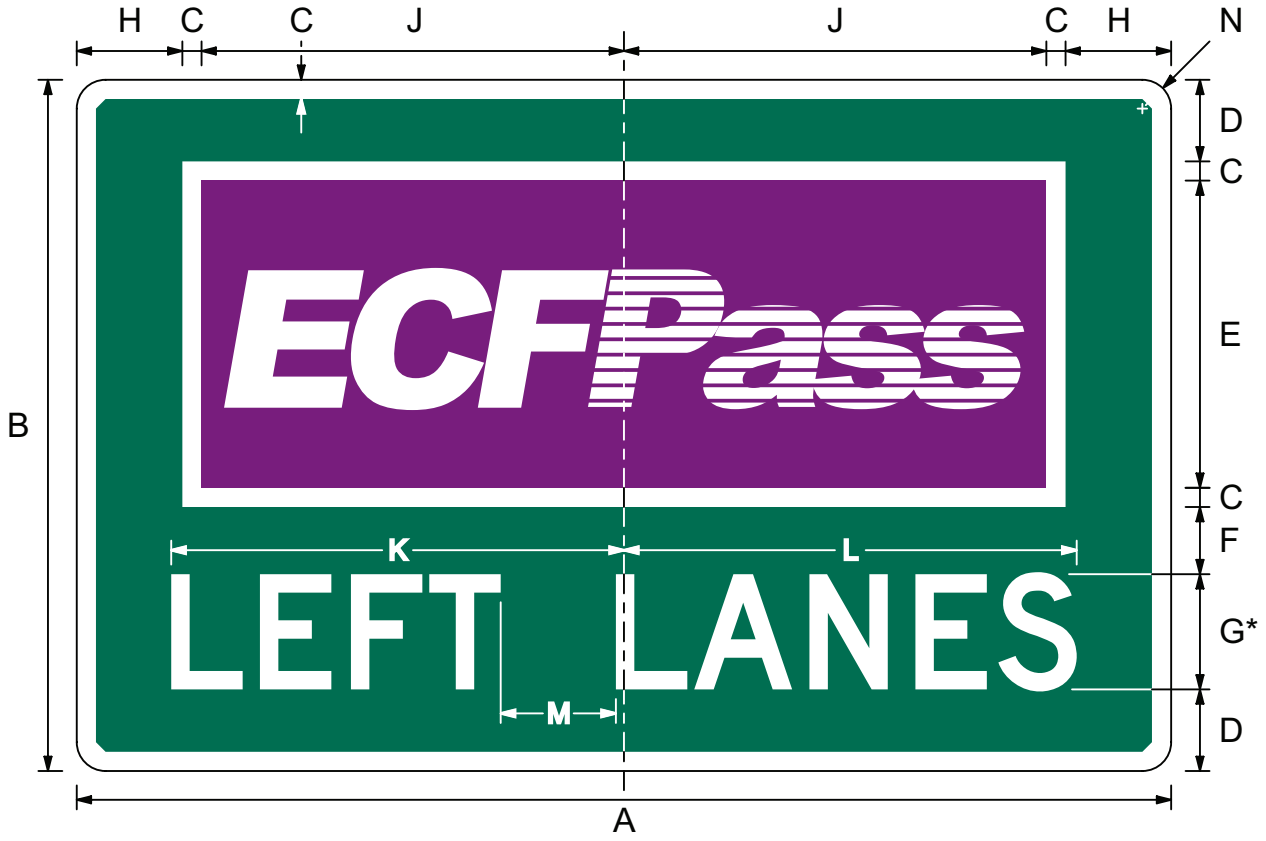
*Based on the length of the building number

COLORS:
BORDER & LEGEND – WHITE (RETROREFLECTIVE)
BACKGROUND – GREEN, BLUE, OR BROWN (RETROREFLECTIVE)

M4-29-TEA

ECFpass ADVANCE LANE ASSIGNMENT

The ECFpass Advance Lane Assignment (M4-29-TEA) sign is for use in advance of an ECF where automated processing lanes are used, in order to inform drivers of the presence and location of the automated lanes. When feasible, the M4-29-TEA sign should be located about one-half mile in advance of the ECF.



A	B	C	D	E	F	G	H	J	K	L	M	N
114	72	2	8.5	32	7	12D	11	44	42.87	43.71	7	3

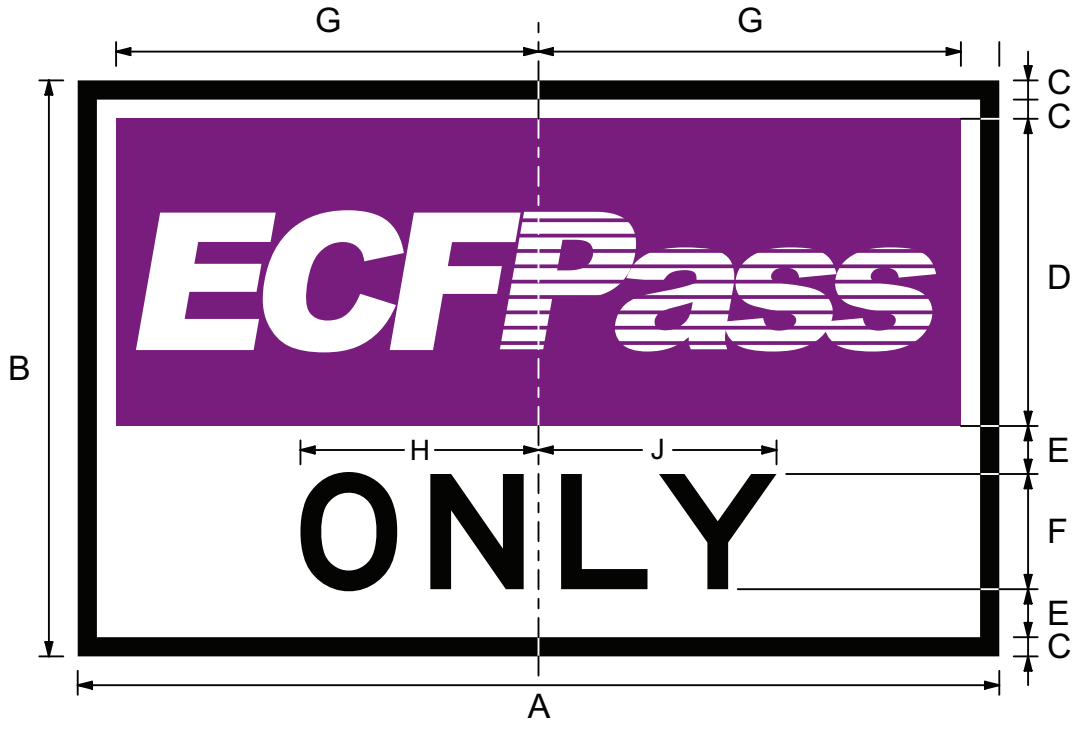
*Decrease spacing 25%

COLORS:
BORDER & LEGEND – WHITE (RETROREFLECTIVE)
PICTOGRAPH – PURPLE AND WHITE (RETROREFLECTIVE)
BACKGROUND – GREEN (RETROREFLECTIVE)

M4-30-TEA

ECFpass OVERHEAD LANE ASSIGNMENT

The ECFpass Overhead Lane Assignment (M4-30-TEA) sign is designed for use above an ECF lane, either on the canopy or overhead prior to the canopy. Whenever possible, ECFpass lanes should be on the left. To accommodate fluctuations in traffic volumes, the sign should use rotating drum or other technologies to change the message as necessary.



A	B	C	D	E	F	G	H	J
96	60	2	32	5	12E	44	23.59	24.31

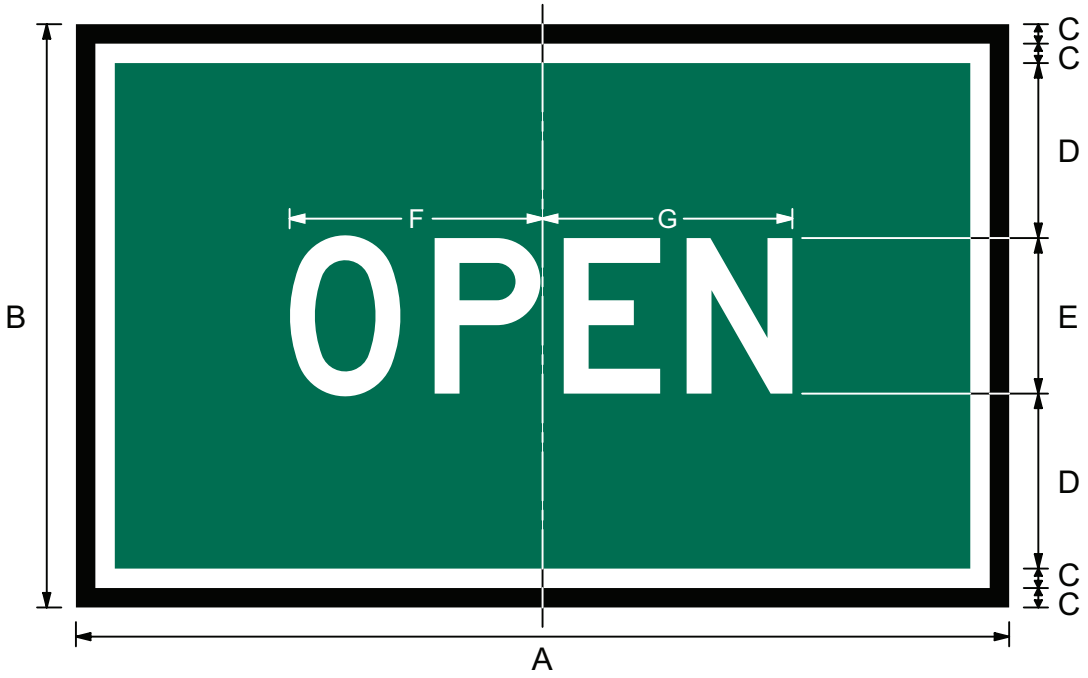
COLORS:

BORDER & LEGEND – BLACK
PICTOGRAPH – PURPLE AND WHITE (RETROREFLECTIVE)
BACKGROUND – WHITE (RETROREFLECTIVE)

M4-31-TEA

OPEN OVERHEAD LANE CONTROL

The OPEN Overhead Lane Assignment (M4-31-TEA) sign is designed for use above an ECF lane, either on the canopy or overhead prior to the canopy. To accommodate fluctuations in traffic volumes, the sign should use rotating drum or other technologies to change the message as necessary.



A	B	C	D	E	F	G
96	60	2	18	16D	26.02	25.7

COLORS:
LEGEND – WHITE (RETROREFLECTIVE)
BORDER – BLACK
BACKGROUND – GREEN (RETROREFLECTIVE)

M4-32-TEA

CLOSED OVERHEAD LANE CONTROL

The CLOSED Overhead Lane Assignment (M4-32-TEA) sign is designed for use above an ECF lane, either on the canopy or overhead prior to the canopy. To accommodate fluctuations in traffic volumes, the sign should use rotating drum or other technologies to change the message as necessary.

A	B	C	D	E	F
96	60	2	18	16D	38.67

COLORS:
LEGEND – WHITE (RETROREFLECTIVE)
BORDER – BLACK
BACKGROUND – RED (RETROREFLECTIVE)

M4-33-TEA

VISITORS THIS LANE OVERHEAD LANE CONTROL

The VISITORS THIS LANE Overhead Lane Assignment (M4-33-TEA) sign is designed for use above an ECF lane, either on the canopy or overhead prior to the canopy. To accommodate fluctuations in traffic volumes, the sign should use rotating drum or other technologies to change the message as necessary.

A	B	C	D	E	F	G	H	J	K	L
96	60	2	10	12E	5	39.50	39.14	41.64	41.28	5.5

*Decrease spacing 50%

COLORS:
LEGEND (TOP) – WHITE (RETROREFLECTIVE)
LEGEND (BOTTOM) – BLACK
BORDER – BLACK
BACKGROUND – WHITE & GREEN (RETROREFLECTIVE)

Appendix B
Standard Alphabets Spacing Charts

Series B 2000 . . . . . B-1

Series C 2000 . . . . . B-2

Series D 2000 . . . . . B-3

Series E 2000. . . . . B-4

Series EM 2000 . . . . . B-5

Series F 2000. . . . . B-6

Clearview 1-W B-7

Clearview 2-W B-8

Clearview 3-W B-9

Clearview 4-W B-10

Clearview 5-W B-11

Clearview 5-WR B-12

Clearview 6-W B-13

Measurements based on 4-inch uppercase letter height.

Character	Left (in.)	Width (in.)	Right (in.)
A	0.120	2.161	0.120
B	0.440	1.721	0.200
C	0.320	1.721	0.320
D	0.440	1.721	0.320
E	0.440	1.521	0.200
F	0.440	1.521	0.120
G	0.320	1.721	0.320
H	0.440	1.721	0.440
I	0.440	0.520	0.440
J	0.120	1.761	0.440
K	0.440	1.761	0.200
L	0.440	1.521	0.120
M	0.440	1.961	0.440
N	0.440	1.721	0.440
O	0.320	1.841	0.320
P	0.440	1.721	0.120
Q	0.320	1.841	0.320
R	0.440	1.721	0.200
S	0.200	1.721	0.200
T	0.120	1.521	0.120
U	0.440	1.721	0.440
V	0.120	1.881	0.120
W	0.120	2.561	0.120
X	0.200	1.881	0.200
Y	0.120	2.161	0.120
Z	0.200	1.721	0.200
a	0.120	1.481	0.280
b	0.320	1.481	0.200
c	0.200	1.481	0.080
d	0.200	1.481	0.320
e	0.200	1.481	0.120
f	0.120	0.920	0.080
g	0.200	1.441	0.240
h	0.320	1.441	0.280
i	0.320	0.520	0.320
j	0.000	0.920	0.320
k	0.320	1.601	0.080
l	0.320	0.520	0.320
m	0.320	2.361	0.280
n	0.320	1.441	0.280

Character	Left (in.)	Width (in.)	Right (in.)
o	0.200	1.481	0.200
p	0.320	1.481	0.200
q	0.200	1.481	0.320
r	0.320	1.041	0.080
s	0.120	1.280	0.080
t	0.000	1.200	0.000
u	0.280	1.441	0.320
v	0.080	1.721	0.080
w	0.080	2.241	0.080
x	0.000	1.841	0.000
y	0.080	1.841	0.080
z	0.120	1.441	0.120
1	0.200	0.840	0.440
2	0.200	1.721	0.200
3	0.120	1.721	0.200
4	0.200	1.961	0.320
5	0.320	1.721	0.200
6	0.120	1.721	0.320
7	0.200	1.721	0.320
8	0.200	1.721	0.200
9	0.320	1.721	0.200
0	0.320	1.841	0.320
&	0.200	2.962	0.120
!	0.440	0.520	0.440
“	0.440	1.561	0.440
#	0.320	2.521	0.320
$	0.200	1.721	0.200
¢	0.320	1.761	0.320
/	0.000	3.963	0.000
*	0.320	2.081	0.320
.	0.320	0.560	0.320
,	0.320	0.600	0.320
:	0.320	0.560	0.320
(	0.320	1.200	0.200
)	0.200	1.200	0.320
-	0.120	1.240	0.120
@	0.320	4.000	0.320
=	0.120	2.241	0.120
+	0.120	2.241	0.120
?	0.200	2.081	0.200

Series C 2000

Appendix B - Standard Alphabets Spacing Charts

Measurements based on 4-inch uppercase letter height.

Character	Left (in.)	Width (in.)	Right (in.)
A	0.120	2.561	0.120
B	0.440	2.241	0.240
C	0.360	2.241	0.360
D	0.440	2.241	0.360
E	0.440	2.041	0.240
F	0.440	2.041	0.120
G	0.360	2.241	0.360
H	0.440	2.241	0.440
I	0.440	0.560	0.440
J	0.120	2.041	0.440
K	0.440	2.241	0.240
L	0.440	2.041	0.120
M	0.440	2.642	0.440
N	0.440	2.241	0.440
O	0.360	2.361	0.360
P	0.440	2.241	0.360
Q	0.360	2.361	0.360
R	0.440	2.241	0.240
S	0.240	2.241	0.240
T	0.120	2.041	0.120
U	0.440	2.241	0.440
V	0.120	2.481	0.120
W	0.120	3.042	0.120
X	0.120	2.361	0.120
Y	0.120	2.561	0.120
Z	0.240	2.241	0.240
a	0.160	1.921	0.320
b	0.360	2.041	0.240
c	0.240	2.001	0.120
d	0.240	2.041	0.360
e	0.240	2.041	0.160
f	0.160	1.240	0.080
g	0.240	2.041	0.360
h	0.360	2.041	0.320
i	0.360	0.560	0.360
j	0.000	1.160	0.360
k	0.360	2.161	0.080
l	0.360	0.560	0.360
m	0.360	3.362	0.320
n	0.360	2.041	0.320

Character	Left (in.)	Width (in.)	Right (in.)
o	0.240	2.041	0.240
p	0.360	2.041	0.240
q	0.240	2.041	0.360
r	0.360	1.321	0.080
s	0.160	1.681	0.120
t	0.040	1.441	0.040
u	0.320	2.041	0.360
v	0.080	2.361	0.080
w	0.080	3.762	0.080
x	0.000	2.601	0.000
y	0.080	2.481	0.080
z	0.120	1.681	0.120
1	0.360	0.840	0.440
2	0.240	2.241	0.240
3	0.240	2.241	0.240
4	0.120	2.481	0.360
5	0.240	2.241	0.240
6	0.360	2.241	0.360
7	0.120	2.241	0.360
8	0.240	2.241	0.240
9	0.240	2.241	0.240
0	0.360	2.361	0.360
&	0.360	4.000	0.000
!	0.440	0.560	0.440
“	0.440	1.721	0.440
#	0.240	3.042	0.240
$	0.360	2.241	0.360
¢	0.240	1.961	0.120
/	0.000	4.083	0.000
*	0.320	2.081	0.320
.	0.160	0.640	0.160
,	0.160	0.640	0.160
:	0.160	0.640	0.160
(	0.360	1.200	0.160
)	0.160	1.200	0.360
-	0.120	1.401	0.120
@	0.360	4.000	0.360
=	0.120	2.601	0.120
+	0.120	2.601	0.120
?	0.240	2.441	0.240

Measurements based on 4-inch uppercase letter height.

Character	Left (in.)	Width (in.)	Right (in.)
A	0.120	3.402	0.120
B	0.480	2.723	0.200
C	0.400	2.723	0.400
D	0.480	2.723	0.400
E	0.480	2.481	0.200
F	0.480	2.481	0.120
G	0.400	2.723	0.400
H	0.480	2.723	0.480
I	0.480	0.640	0.480
J	0.120	2.561	0.480
K	0.480	2.802	0.200
L	0.480	2.481	0.120
M	0.480	3.122	0.480
N	0.480	2.723	0.480
O	0.400	2.842	0.400
P	0.480	2.723	0.120
Q	0.400	2.842	0.400
R	0.480	2.723	0.200
S	0.200	2.723	0.200
T	0.120	2.481	0.120
U	0.480	2.723	0.480
V	0.120	3.042	0.120
W	0.120	3.562	0.120
X	0.200	2.723	0.200
Y	0.120	3.442	0.120
Z	0.200	2.723	0.200
a	0.200	2.281	0.360
b	0.400	2.401	0.240
c	0.240	2.361	0.120
d	0.240	2.401	0.400
e	0.240	2.361	0.160
f	0.160	1.441	0.080
g	0.240	2.401	0.400
h	0.400	2.361	0.360
i	0.400	0.640	0.400
j	0.000	1.321	0.400
k	0.400	2.561	0.080
l	0.400	0.640	0.400
m	0.400	3.963	0.360
n	0.400	2.361	0.360

Character	Left (in.)	Width (in.)	Right (in.)
o	0.240	2.441	0.240
p	0.400	2.401	0.240
q	0.240	2.401	0.400
r	0.400	1.521	0.080
s	0.160	1.881	0.120
t	0.040	1.601	0.040
u	0.360	2.361	0.400
v	0.080	2.842	0.080
w	0.080	4.523	0.080
x	0.000	3.122	0.000
y	0.080	3.002	0.080
z	0.120	2.001	0.120
1	0.400	1.000	0.480
2	0.400	2.723	0.400
3	0.720	2.723	0.400
4	0.080	3.002	0.480
5	0.400	2.723	0.400
6	0.400	2.723	0.400
7	0.280	2.723	0.280
8	0.400	2.723	0.400
9	0.400	2.723	0.400
0	0.400	2.842	0.400
&	0.400	3.562	0.000
!	0.480	0.640	0.480
“	0.160	0.720	0.160
#	0.240	3.402	0.240
$	0.200	2.723	0.200
¢	0.400	2.441	0.280
/	0.000	4.123	0.000
*	0.320	2.161	0.320
.	0.160	0.720	0.160
,	0.160	0.720	0.160
:	0.160	0.720	0.160
(	0.400	1.321	0.160
)	0.160	1.321	0.400
-	0.120	1.401	0.120
@	0.400	4.003	0.400
=	0.480	1.921	0.480
+	0.120	2.682	0.120
?	0.280	2.601	0.280

Series E 2000

Appendix B - Standard Alphabets Spacing Charts

Measurements based on 4-inch uppercase letter height.

Character	Left (in.)	Width (in.)	Right (in.)
A	0.160	4.083	0.160
B	0.520	3.242	0.280
C	0.400	3.242	0.400
D	0.520	3.242	0.400
E	0.520	3.000	0.280
F	0.520	3.000	0.160
G	0.400	3.242	0.400
H	0.520	3.242	0.520
I	0.520	0.720	0.520
J	0.160	3.042	0.520
K	0.520	3.322	0.120
L	0.520	3.000	0.160
M	0.520	3.762	0.520
N	0.520	3.242	0.520
O	0.400	3.362	0.400
P	0.520	3.242	0.160
Q	0.400	3.362	0.400
R	0.520	3.242	0.280
S	0.280	3.242	0.280
T	0.160	3.000	0.160
U	0.520	3.242	0.520
V	0.160	3.682	0.160
W	0.160	4.243	0.160
X	0.280	3.482	0.280
Y	0.160	4.083	0.160
Z	0.280	3.242	0.280
a	0.200	2.441	0.320
b	0.360	2.481	0.240
c	0.240	2.481	0.120
d	0.240	2.481	0.360
e	0.240	2.481	0.160
f	0.160	1.521	0.080
g	0.240	2.481	0.360
h	0.360	2.481	0.320
i	0.360	0.720	0.360
j	0.000	1.200	0.360
k	0.360	2.401	0.080
l	0.360	0.720	0.360
m	0.360	4.163	0.320
n	0.360	2.481	0.320

Character	Left (in.)	Width (in.)	Right (in.)
o	0.240	2.561	0.240
p	0.360	2.481	0.240
q	0.240	2.481	0.360
r	0.360	1.841	0.080
s	0.160	2.441	0.120
t	0.040	1.841	0.040
u	0.320	2.481	0.360
v	0.080	2.842	0.080
w	0.080	3.842	0.080
x	0.000	2.922	0.000
y	0.080	3.082	0.080
z	0.120	2.561	0.120
1	0.400	1.200	0.520
2	0.280	3.242	0.280
3	0.280	3.242	0.280
4	0.160	3.762	0.400
5	0.280	3.242	0.280
6	0.400	3.242	0.400
7	0.160	3.242	0.400
8	0.280	3.242	0.280
9	0.280	3.242	0.280
0	0.400	3.362	0.400
&	0.400	3.602	0.000
!	0.520	0.720	0.520
“	0.520	2.041	0.520
#	0.240	3.482	0.240
$	0.400	3.242	0.400
¢	0.400	2.922	0.280
/	0.000	4.203	0.000
*	0.320	2.201	0.320
.	0.160	0.720	0.160
,	0.160	0.720	0.160
:	0.160	0.720	0.160
(	0.400	1.321	0.160
)	0.160	1.321	0.400
-	0.120	1.401	0.120
@	0.400	4.000	0.400
=	0.120	2.601	0.120
+	0.120	2.601	0.120
?	0.280	2.682	0.280

Measurements based on 4-inch uppercase letter height.

Character	Left (in.)	Width (in.)	Right (in.)
A	0.160	4.043	0.160
B	0.560	3.242	0.320
C	0.400	3.242	0.320
D	0.560	3.242	0.400
E	0.560	2.962	0.280
F	0.560	2.962	0.280
G	0.400	3.242	0.400
H	0.560	3.242	0.560
I	0.560	0.800	0.560
J	0.160	3.042	0.560
K	0.560	3.282	0.080
L	0.560	2.962	0.080
M	0.560	3.722	0.560
N	0.560	3.242	0.560
O	0.400	3.362	0.400
P	0.560	3.242	0.160
Q	0.400	3.362	0.400
R	0.560	3.242	0.280
S	0.440	3.242	0.440
T	0.160	2.962	0.160
U	0.560	3.242	0.560
V	0.160	3.682	0.160
W	0.160	4.243	0.160
X	0.280	3.482	0.280
Y	0.160	4.043	0.160
Z	0.280	3.242	0.280
a	0.440	2.642	0.800
b	0.800	2.642	0.440
c	0.440	2.642	0.440
d	0.440	2.642	0.800
e	0.440	2.642	0.440
f	0.400	1.681	0.440
g	0.440	2.642	0.800
h	0.800	2.642	0.800
i	0.800	0.800	0.800
j	0.080	1.481	0.800
k	0.800	2.642	0.440
l	0.800	0.800	0.800
m	0.800	4.403	0.800
n	0.800	2.642	0.800

Character	Left (in.)	Width (in.)	Right (in.)
o	0.440	2.722	0.440
p	0.800	2.642	0.440
q	0.440	2.642	0.800
r	0.800	2.000	0.160
s	0.360	2.642	0.440
t	0.360	2.081	0.480
u	0.800	2.642	0.800
v	0.360	3.082	0.360
w	0.360	4.083	0.360
x	0.440	3.202	0.440
y	0.360	3.402	0.360
z	0.480	2.722	0.480
1	0.480	1.200	0.560
2	0.440	3.242	0.440
3	0.120	3.242	0.400
4	0.120	3.722	0.560
5	0.440	3.242	0.440
6	0.400	3.242	0.400
7	0.240	3.242	0.400
8	0.400	3.242	0.400
9	0.400	3.242	0.400
0	0.400	3.362	0.400
&	0.400	3.602	0.400
!	0.560	0.800	0.560
“	0.560	2.281	0.560
#	0.400	3.522	0.400
$	0.440	3.242	0.440
¢	0.400	2.682	0.280
/	0.000	4.283	0.000
*	0.320	2.241	0.320
.	0.160	0.800	0.160
,	0.160	0.800	0.160
:	0.160	0.800	0.160
(	0.400	1.521	0.160
)	0.160	1.521	0.400
-	0.120	1.401	0.120
@	0.400	4.043	0.400
=	0.120	2.601	0.120
+	0.120	2.601	0.120
?	0.280	2.762	0.280

Series F 2000

Appendix B - Standard Alphabets Spacing Charts

Measurements based on 4-inch uppercase letter height.

Character	Left (in.)	Width (in.)	Right (in.)
A	0.160	4.563	0.160
B	0.560	3.762	0.400
C	0.400	3.762	0.280
D	0.560	3.762	0.400
E	0.560	3.242	0.400
F	0.560	3.242	0.400
G	0.400	3.762	0.400
H	0.560	3.762	0.560
I	0.560	0.760	0.560
J	0.160	3.322	0.560
K	0.560	3.762	0.160
L	0.560	3.442	0.160
M	0.560	4.323	0.560
N	0.560	3.762	0.560
O	0.400	4.203	0.400
P	0.560	3.762	0.400
Q	0.560	4.203	0.400
R	0.560	3.762	0.400
S	0.400	3.762	0.400
T	0.160	3.442	0.160
U	0.560	3.762	0.560
V	0.160	4.203	0.160
W	0.160	4.683	0.160
X	0.160	4.083	0.160
Y	0.160	4.563	0.160
Z	0.280	3.762	0.280
a	0.320	3.042	0.480
b	0.480	3.162	0.320
c	0.320	2.802	0.200
d	0.320	3.162	0.480
e	0.320	3.202	0.320
f	0.120	1.721	0.120
g	0.320	3.000	0.480
h	0.480	2.962	0.480
i	0.480	0.760	0.480
j	0.040	1.240	0.480
k	0.480	2.802	0.120
l	0.480	0.760	0.480
m	0.480	4.723	0.480
n	0.480	2.962	0.480

Character	Left (in.)	Width (in.)	Right (in.)
o	0.320	3.202	0.320
p	0.480	3.162	0.320
q	0.320	3.162	0.480
r	0.480	2.000	0.120
s	0.280	2.922	0.280
t	0.120	1.921	0.160
u	0.480	2.962	0.480
v	0.080	3.362	0.080
w	0.080	4.603	0.080
x	0.080	3.522	0.080
y	0.080	3.682	0.080
z	0.200	3.042	0.200
1	0.560	1.321	0.560
2	0.400	3.762	0.400
3	0.400	3.762	0.400
4	0.160	4.083	0.560
5	0.400	3.762	0.400
6	0.400	3.762	0.400
7	0.160	3.762	0.160
8	0.400	3.762	0.400
9	0.400	3.762	0.400
0	0.400	3.882	0.400
&	0.560	4.603	0.160
!	0.560	0.760	0.560
“	0.560	2.000	0.560
#	0.080	3.522	0.080
$	0.400	3.762	0.400
¢	0.320	3.000	0.200
/	0.000	4.283	0.000
*	0.280	2.241	0.280
.	0.280	0.760	0.280
,	0.280	0.760	0.280
:	0.280	0.760	0.280
(	0.400	1.361	0.120
)	0.120	1.361	0.400
-	0.160	1.401	0.160
@	0.400	4.000	0.400
=	0.160	2.601	0.160
+	0.160	2.601	0.160
?	0.400	3.362	0.400

Clearview 1-W

Measurements based on 4-inch uppercase letter height. Clearview is only authorized for white legends used for names on guide signs.

Character	Left (in.)	Width (in.)	Right (in.)
A	0.28	2.28	0.28
B	0.52	1.88	0.36
C	0.40	1.96	0.24
D	0.52	1.96	0.40
E	0.52	1.44	0.36
F	0.52	1.40	0.32
G	0.40	2.08	0.40
H	0.52	1.88	0.52
I	0.52	0.52	0.52
J	0.24	1.28	0.52
K	0.52	1.92	0.24
L	0.52	1.36	0.32
M	0.52	2.24	0.52
N	0.52	2.04	0.52
O	0.40	2.32	0.40
P	0.52	1.80	0.32
Q	0.40	2.32	0.40
R	0.52	1.84	0.40
S	0.28	1.80	0.36
T	0.20	1.68	0.20
U	0.52	1.92	0.52
V	0.28	2.12	0.28
W	0.32	3.20	0.32
X	0.20	2.08	0.20
Y	0.20	2.08	0.20
Z	0.28	1.72	0.28
a	0.36	1.88	0.40
b	0.52	1.84	0.40
c	0.40	1.68	0.28
d	0.40	1.84	0.52
e	0.40	1.84	0.40
f	0.28	1.24	0.24
g	0.40	1.84	0.52
h	0.52	1.76	0.52
i	0.44	0.64	0.44
j	0.00	1.08	0.44
k	0.52	1.72	0.28
l	0.52	0.80	0.32
m	0.52	2.92	0.52
n	0.52	1.76	0.52

Character	Left (in.)	Width (in.)	Right (in.)
o	0.40	1.92	0.40
p	0.52	1.84	0.40
q	0.40	2.00	0.36
r	0.52	1.16	0.28
s	0.28	1.64	0.32
t	0.24	1.24	0.32
u	0.52	1.76	0.52
v	0.28	1.88	0.28
w	0.32	3.08	0.32
x	0.24	1.88	0.24
y	0.28	1.88	0.28
z	0.32	1.40	0.32
1	0.16	1.16	0.52
2	0.20	1.68	0.32
3	0.20	1.68	0.40
4	0.28	1.96	0.32
5	0.28	1.64	0.36
6	0.40	1.84	0.36
7	0.24	1.68	0.24
8	0.40	1.92	0.40
9	0.36	1.84	0.40
0	0.40	2.04	0.40
&	0.48	2.16	0.28
!	0.44	0.64	0.44
“	0.40	1.44	0.40
#	0.40	2.24	0.40
$	0.36	1.68	0.36
¢	0.40	1.60	0.28
/	0.24	1.72	0.24
*	0.32	1.44	0.32
.	0.36	0.56	0.36
,	0.36	0.68	0.36
:	0.36	0.68	0.36
(	0.32	1.00	0.48
)	0.48	2.68	0.32
-	0.48	1.48	0.48
@	0.52	2.68	0.52
=	0.32	1.48	0.32
+	0.32	1.88	0.32
?	0.40	1.52	0.40

Clearview 2-W

Measurements based on 4-inch uppercase letter height. Clearview is only authorized for white legends used for names on guide signs.

Character	Left (in.)	Width (in.)	Right (in.)
A	0.28	2.76	0.28
B	0.56	2.28	0.40
C	0.44	2.44	0.28
D	0.56	2.40	0.44
E	0.56	1.80	0.44
F	0.56	1.72	0.40
G	0.44	2.56	0.44
H	0.56	2.32	0.56
I	0.56	0.60	0.56
J	0.24	1.60	0.56
K	0.56	2.36	0.24
L	0.56	1.64	0.28
M	0.56	2.80	0.56
N	0.56	2.52	0.56
O	0.44	2.84	0.44
P	0.56	2.20	0.36
Q	0.44	2.84	0.44
R	0.56	2.24	0.44
S	0.24	2.20	0.32
T	0.28	2.08	0.28
U	0.56	2.36	0.56
V	0.28	2.60	0.28
W	0.36	4.00	0.36
X	0.24	2.60	0.24
Y	0.20	2.56	0.20
Z	0.32	2.00	0.32
a	0.40	2.32	0.44
b	0.56	2.24	0.44
c	0.44	2.04	0.20
d	0.44	2.24	0.56
e	0.44	2.32	0.44
f	0.28	1.44	0.28
g	0.44	2.28	0.56
h	0.56	2.16	0.56
i	0.48	0.76	0.48
j	-0.04	1.32	0.48
k	0.56	2.12	0.24
l	0.56	0.96	0.32
m	0.56	3.64	0.56
n	0.56	2.16	0.56

Character	Left (in.)	Width (in.)	Right (in.)
o	0.44	2.40	0.44
p	0.56	2.24	0.44
q	0.44	2.48	0.36
r	0.56	1.40	0.28
s	0.28	1.96	0.32
t	0.28	1.44	0.32
u	0.56	2.16	0.56
v	0.24	2.32	0.24
w	0.32	3.80	0.32
x	0.16	2.32	0.16
y	0.24	2.32	0.24
z	0.28	1.72	0.28
1	0.24	1.36	0.60
2	0.32	2.08	0.48
3	0.28	2.04	0.44
4	0.28	2.44	0.36
5	0.36	2.04	0.44
6	0.44	2.28	0.40
7	0.32	2.04	0.36
8	0.44	2.36	0.44
9	0.40	2.28	0.44
0	0.48	2.52	0.48
&	0.44	2.64	0.24
!	0.56	0.76	0.56
“	0.48	1.72	0.48
#	0.48	2.72	0.48
$	0.44	2.04	0.44
¢	0.44	1.96	0.32
/	0.28	2.08	0.28
*	0.44	1.76	0.44
.	0.48	0.68	0.48
,	0.48	0.76	0.44
:	0.48	0.68	0.48
(	0.40	0.84	0.52
)	0.52	0.84	0.40
-	0.52	1.08	0.52
@	0.44	3.40	0.44
=	0.40	2.28	0.40
+	0.40	2.28	0.40
?	0.36	1.88	0.40

Clearview 3-W

Measurements based on 4-inch uppercase letter height. Clearview is only authorized for white legends used for names on guide signs.

Character	Left (in.)	Width (in.)	Right (in.)
A	0.24	3.32	0.24
B	0.60	2.72	0.36
C	0.44	2.88	0.24
D	0.60	2.84	0.44
E	0.60	2.20	0.36
F	0.60	2.12	0.32
G	0.44	3.04	0.44
H	0.60	2.72	0.60
I	0.60	0.68	0.60
J	0.24	1.88	0.60
K	0.60	2.72	0.20
L	0.60	2.04	0.28
M	0.60	3.28	0.60
N	0.60	2.92	0.60
O	0.44	3.32	0.44
P	0.60	2.60	0.44
Q	0.44	3.32	0.44
R	0.60	2.64	0.40
S	0.32	2.56	0.36
T	0.24	2.52	0.24
U	0.60	2.76	0.60
V	0.28	3.04	0.28
W	0.36	4.68	0.36
X	0.24	3.04	0.24
Y	0.20	3.04	0.20
Z	0.36	2.48	0.36
a	0.44	2.68	0.44
b	0.60	2.60	0.44
c	0.44	2.40	0.28
d	0.44	2.60	0.60
e	0.44	2.64	0.44
f	0.36	1.68	0.32
g	0.44	2.64	0.60
h	0.60	2.48	0.60
i	0.52	0.84	0.52
j	-0.16	1.52	0.52
k	0.60	2.48	0.24
l	0.60	1.12	0.32
m	0.60	4.12	0.60
n	0.60	2.48	0.60

Character	Left (in.)	Width (in.)	Right (in.)
o	0.44	2.80	0.44
p	0.60	2.60	0.44
q	0.44	2.84	0.36
r	0.60	1.64	0.32
s	0.32	2.32	0.36
t	0.24	1.72	0.40
u	0.60	2.44	0.60
v	0.24	2.72	0.24
w	0.32	4.24	0.32
x	0.24	2.72	0.24
y	0.24	2.76	0.24
z	0.36	2.12	0.36
1	0.20	1.60	0.60
2	0.28	2.44	0.44
3	0.24	2.44	0.44
4	0.28	2.84	0.32
5	0.36	2.44	0.44
6	0.48	2.60	0.40
7	0.28	2.48	0.32
8	0.44	2.68	0.44
9	0.40	2.64	0.48
0	0.44	2.92	0.44
&	0.44	3.08	0.24
!	0.60	0.88	0.60
“	0.48	1.92	0.48
#	0.44	3.12	0.44
$	0.40	2.40	0.40
¢	0.44	2.32	0.36
/	0.24	2.52	0.24
*	0.40	1.80	0.40
.	0.52	0.60	0.52
,	0.40	0.92	0.40
:	0.40	0.84	0.40
(	0.44	0.96	0.48
)	0.48	0.96	0.44
-	0.56	1.36	0.56
@	0.44	3.72	0.44
=	0.40	2.16	0.40
+	0.40	2.48	0.40
?	0.36	2.24	0.48

Clearview 4-W

Measurements based on 4-inch uppercase letter height. Clearview is only authorized for white legends used for names on guide signs.

Character	Left (in.)	Width (in.)	Right (in.)
A	0.28	3.48	0.28
B	0.72	2.84	0.48
C	0.56	3.04	0.36
D	0.72	3.00	0.56
E	0.72	2.36	0.52
F	0.72	2.24	0.52
G	0.56	3.20	0.56
H	0.72	2.88	0.72
I	0.72	0.72	0.72
J	0.32	1.96	0.72
K	0.72	2.92	0.28
L	0.72	2.16	0.36
M	0.72	3.44	0.72
N	0.72	3.08	0.72
O	0.56	3.48	0.56
P	0.72	2.72	0.52
Q	0.56	3.48	0.56
R	0.72	2.80	0.52
S	0.44	2.68	0.52
T	0.36	2.68	0.36
U	0.72	2.92	0.72
V	0.32	3.16	0.32
W	0.48	4.92	0.48
X	0.32	3.20	0.32
Y	0.28	3.24	0.28
Z	0.40	2.64	0.40
a	0.56	2.80	0.52
b	0.72	2.72	0.56
c	0.56	2.52	0.36
d	0.56	2.72	0.72
e	0.56	2.76	0.56
f	0.36	1.76	0.32
g	0.56	2.72	0.72
h	0.72	2.60	0.72
i	0.64	0.88	0.64
j	-0.12	1.64	0.64
k	0.72	2.64	0.28
l	0.72	1.20	0.40
m	0.72	4.28	0.72
n	0.72	2.60	0.72

Character	Left (in.)	Width (in.)	Right (in.)
o	0.56	2.92	0.56
p	0.72	2.72	0.56
q	0.56	3.00	0.48
r	0.72	1.72	0.36
s	0.44	2.40	0.48
t	0.36	1.84	0.48
u	0.72	2.56	0.72
v	0.32	2.84	0.32
w	0.40	4.40	0.40
x	0.28	2.88	0.28
y	0.32	2.88	0.32
z	0.40	2.28	0.40
1	0.28	1.68	0.72
2	0.36	2.56	0.52
3	0.32	2.60	0.52
4	0.32	2.96	0.36
5	0.44	2.56	0.52
6	0.52	2.72	0.48
7	0.36	2.60	0.36
8	0.56	2.80	0.56
9	0.48	2.72	0.52
0	0.56	3.08	0.56
&	0.52	3.20	0.32
!	0.64	0.92	0.64
“	0.56	2.04	0.56
#	0.52	3.24	0.52
$	0.44	2.52	0.44
¢	0.56	2.44	0.40
/	0.36	2.68	0.36
*	0.48	1.88	0.48
.	0.52	0.88	0.52
,	0.48	1.00	0.44
:	0.52	0.88	0.52
(	0.48	1.04	0.56
)	0.56	1.04	0.48
-	0.68	1.40	0.68
@	0.56	3.80	0.56
=	0.60	2.28	0.60
+	0.44	2.56	0.44
?	0.40	2.36	0.56

Clearview 5-W

Measurements based on 4-inch uppercase letter height. Clearview is only authorized for white legends used for names on guide signs.

Character	Left (in.)	Width (in.)	Right (in.)
A	0.36	3.76	0.36
B	0.80	3.04	0.60
C	0.64	3.28	0.44
D	0.80	3.24	0.64
E	0.80	2.56	0.56
F	0.80	2.44	0.52
G	0.64	3.48	0.64
H	0.80	3.08	0.80
I	0.80	0.80	0.80
J	0.32	2.24	0.80
K	0.80	3.12	0.36
L	0.80	2.36	0.48
M	0.80	3.68	0.80
N	0.80	3.32	0.80
O	0.64	3.72	0.64
P	0.80	2.92	0.48
Q	0.64	3.72	0.64
R	0.80	3.00	0.60
S	0.48	2.88	0.52
T	0.40	2.88	0.40
U	0.80	3.12	0.80
V	0.36	3.40	0.36
W	0.40	5.32	0.40
X	0.32	3.44	0.32
Y	0.28	3.52	0.28
Z	0.52	2.88	0.52
a	0.52	2.96	0.52
b	0.76	2.88	0.60
c	0.60	2.72	0.40
d	0.60	2.92	0.76
e	0.60	2.96	0.60
f	0.44	1.92	0.40
g	0.60	2.92	0.76
h	0.76	2.76	0.76
i	0.68	0.92	0.68
j	-0.12	1.76	0.68
k	0.76	2.84	0.28
l	0.76	1.28	0.44
m	0.76	4.52	0.76
n	0.76	2.76	0.76

Character	Left (in.)	Width (in.)	Right (in.)
o	0.60	3.08	0.60
p	0.76	2.92	0.60
q	0.60	3.20	0.48
r	0.76	1.84	0.40
s	0.44	2.56	0.52
t	0.36	1.96	0.44
u	0.76	2.72	0.76
v	0.28	3.04	0.28
w	0.32	4.64	0.32
x	0.24	3.08	0.24
y	0.28	3.12	0.28
z	0.48	2.44	0.48
1	0.40	1.80	0.80
2	0.48	2.76	0.64
3	0.44	2.80	0.64
4	0.48	3.16	0.52
5	0.60	2.76	0.64
6	0.64	2.92	0.60
7	0.40	2.84	0.40
8	0.64	2.92	0.64
9	0.60	2.92	0.64
0	0.68	3.28	0.68
&	0.64	3.44	0.40
!	0.72	1.00	0.72
“	0.56	2.16	0.56
#	0.56	3.44	0.56
$	0.48	2.72	0.48
¢	0.60	2.60	0.40
/	0.44	2.88	0.44
*	0.60	1.92	0.60
.	0.56	1.00	0.56
,	0.52	1.08	0.52
:	0.56	1.00	0.56
(	0.60	1.08	0.60
)	0.60	1.08	0.60
-	0.80	1.56	0.80
@	0.64	4.04	0.64
=	0.72	2.40	0.72
+	0.60	2.68	0.60
?	0.56	2.56	0.56

Clearview 5-WR

Measurements based on 4-inch uppercase letter height. Clearview is only authorized for white legends used for names on guide signs.

Character	Left (in.)	Width (in.)	Right (in.)
A	0.24	3.76	0.24
B	0.68	3.04	0.48
C	0.52	3.28	0.32
D	0.68	3.24	0.52
E	0.68	2.56	0.44
F	0.68	2.44	0.40
G	0.52	3.48	0.52
H	0.80	3.08	0.80
I	0.68	0.80	0.68
J	0.20	2.24	0.68
K	0.68	3.12	0.24
L	0.68	2.36	0.36
M	0.68	3.68	0.68
N	0.68	3.32	0.68
O	0.52	3.72	0.52
P	0.68	2.92	0.36
Q	0.52	3.72	0.52
R	0.68	3.00	0.48
S	0.36	2.88	0.40
T	0.28	2.88	0.28
U	0.68	3.12	0.68
V	0.24	3.40	0.24
W	0.28	5.32	0.28
X	0.20	3.44	0.20
Y	0.16	3.52	0.16
Z	0.40	2.88	0.40
a	0.40	2.96	0.40
b	0.64	2.88	0.48
c	0.48	2.72	0.28
d	0.48	2.92	0.64
e	0.48	2.96	0.48
f	0.32	1.92	0.28
g	0.48	2.92	0.64
h	0.64	2.76	0.64
i	0.56	0.92	0.56
j	-0.24	1.76	0.56
k	0.64	2.84	0.16
l	0.64	1.28	0.32
m	0.64	4.52	0.64
n	0.64	2.76	0.64

Character	Left (in.)	Width (in.)	Right (in.)
o	0.48	3.08	0.48
p	0.64	2.92	0.48
q	0.48	3.20	0.36
r	0.64	1.84	0.28
s	0.28	2.56	0.40
t	0.24	1.96	0.36
u	0.64	2.72	0.64
v	0.16	3.04	0.16
w	0.20	4.64	0.20
x	0.12	3.08	0.12
y	0.16	3.12	0.16
z	0.36	2.44	0.36
1	0.28	1.80	0.68
2	0.36	2.76	0.52
3	0.32	2.80	0.52
4	0.36	3.16	0.40
5	0.48	2.76	0.52
6	0.52	2.92	0.48
7	0.28	2.84	0.28
8	0.52	2.92	0.52
9	0.48	2.92	0.52
0	0.56	3.28	0.56
&	0.52	3.44	0.28
!	0.60	1.00	0.60
“	0.44	2.16	0.44
#	0.44	3.44	0.44
$	0.36	2.72	0.36
¢	0.48	2.60	0.28
/	0.32	2.88	0.32
*	0.48	1.92	0.48
.	0.44	1.00	0.44
,	0.40	1.08	0.40
:	0.44	1.00	0.44
(	0.48	1.08	0.48
)	0.48	1.08	0.48
-	0.60	1.56	0.60
@	0.52	4.04	0.52
=	0.60	2.40	0.60
+	0.48	2.68	0.48
?	0.44	2.56	0.44

Clearview 6-W

Measurements based on 4-inch uppercase letter height. Clearview is only authorized for white legends used for names on guide signs.

Character	Left (in.)	Width (in.)	Right (in.)
A	0.44	3.96	0.44
B	0.88	3.20	0.60
C	0.72	3.44	0.56
D	0.88	3.40	0.72
E	0.88	2.72	0.60
F	0.88	2.60	0.56
G	0.72	3.64	0.72
H	0.88	3.24	0.88
I	0.88	0.80	0.88
J	0.52	2.24	0.88
K	0.88	3.28	0.44
L	0.88	2.52	0.60
M	0.88	3.84	0.88
N	0.88	3.48	0.88
O	0.72	3.92	0.72
P	0.88	3.04	0.64
Q	0.72	3.96	0.72
R	0.88	3.16	0.56
S	0.52	3.04	0.60
T	0.48	3.08	0.48
U	0.88	3.28	0.88
V	0.44	3.52	0.44
W	0.52	5.64	0.52
X	0.40	3.64	0.40
Y	0.32	3.72	0.32
Z	0.60	3.04	0.60
a	0.68	3.12	0.60
b	0.88	3.04	0.72
c	0.72	2.88	0.52
d	0.72	3.04	0.88
e	0.72	3.08	0.72
f	0.48	2.04	0.44
g	0.72	3.04	0.88
h	0.88	2.92	0.88
i	0.80	0.96	0.80
j	-0.08	1.88	0.80
k	0.88	3.00	0.36
l	0.88	1.32	0.52
m	0.88	4.76	0.88
n	0.88	2.92	0.88

Character	Left (in.)	Width (in.)	Right (in.)
o	0.72	3.24	0.72
p	0.88	3.04	0.72
q	0.72	3.32	0.60
r	0.88	1.92	0.48
s	0.52	2.68	0.60
t	0.48	2.08	0.68
u	0.88	2.84	0.88
v	0.44	3.20	0.44
w	0.52	4.80	0.52
x	0.40	3.24	0.40
y	0.44	3.28	0.44
z	0.56	2.60	0.56
1	0.48	1.88	0.88
2	0.56	2.92	0.64
3	0.56	2.96	0.68
4	0.56	3.32	0.60
5	0.68	2.92	0.68
6	0.72	3.04	0.68
7	0.40	3.00	0.40
8	0.68	3.04	0.68
9	0.68	3.04	0.72
0	0.72	3.40	0.72
&	0.72	3.60	0.40
!	0.80	1.04	0.80
“	0.68	2.24	0.68
#	0.68	3.52	0.68
$	0.60	2.88	0.60
¢	0.72	2.72	0.48
/	0.52	3.08	0.52
*	0.60	1.96	0.60
.	0.64	1.04	0.64
,	0.56	1.12	0.64
:	0.64	1.04	0.64
(	0.72	1.16	0.68
)	0.68	1.16	0.72
-	0.80	1.68	0.80
@	0.72	4.20	0.72
=	0.72	2.56	0.72
+	0.64	2.76	0.64
?	0.56	2.72	0.72

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