

Signs

As defined by Section 1A.01 of the *MUTCD*, “the purpose of traffic control devices, as well as principles for their use, is to promote highway safety and efficiency by providing for the orderly movement of all road users on streets and highways throughout the nation...Traffic control devices notify road users of regulations and provide warning and guidance needed for the safe, uniform, and efficient operation of all elements of the traffic stream.”

Signs are a principal means for regulating, warning, and guiding traffic. However, to be effective, signing must meet these *MUTCD* requirements:

- fulfill a need
- command attention of drivers
- convey a clear and simple meaning
- command respect of road users
- provide adequate time for proper response

To meet these requirements, due consideration must be given to the following elements with regard to signs:

- *Design*—color, shape, size, lettering, retroreflectivity, and legibility.
- *Placement*—sign location in relation to motorists and the subject to which the message applies.
- *Operation*—consistent service by the sign in meeting traffic needs.
- *Maintenance*—adequate attention to assure the sign remains visible and functional.
- *Uniformity*—consistent appearance and application to achieve consistent driver perception and response.

These topics will be discussed throughout this manual to demonstrate the importance of understanding and applying *MUTCD* concepts and requirements to achieve maximum benefits for users of our public transportation system.

Sign Types

Signs can be divided into three basic types, as defined by the *MUTCD*:

- *Regulatory*—advise road users of laws, regulations, or legal requirements. Regulatory signs require official action to be enforceable.
- *Warning*—alert drivers of conditions that could be hazardous on or adjacent to the roadway.
- *Guide*—provide directional and navigational information. An important element of the guidance system is street name signs. These signs may not always receive sufficient consideration and are further discussed in the article “Guide Signs” (C7) in this manual.

Two additional groups can be added to these major types:

- *Motorist Information*—provide drivers with information about services, businesses, attractions, and facilities near the roadway.
- *Emergency Management*—control, direct, and guide traffic in response to an emergency.

Visibility

To meet basic *MUTCD* requirements and provide maximum effectiveness for road users, information presented on signs, whether legend or symbols, must be legible and understandable. Traffic speed, weather and light conditions, sight distance, and driver age directly affect the legibility and clarity of a sign message. To address these factors, sign design must consider overall sign dimensions, lettering size, color, contrast, and retroreflectivity. For effective use, signs must be positioned relative to the driver’s cone of vision and located in a position that allows adequate response time.

Sections 2B.03, 2C.04, and 5A.03 of the *MUTCD* provide minimum dimensions for regulatory and warning signs, but some flexibility is allowed with guide signs in consideration of message variability. The Federal Highway

Administration's *Standard Highway Signs* provides basic design guidelines and requirements for most signs used on public roadways. For uniformity and effectiveness, it is important to follow the precepts in these reference documents. Please refer to Part 2, "Signs," and Part 5, "Traffic Control Devices for Low-Volume Roads," in the the *MUTCD* for recommendations on sign size.

Consider these recommendations, from Section 2A.14 of the *MUTCD*, when determining the size and layout of all signs:

- use one inch of letter or symbol height for each 40 feet of anticipated daytime viewing distance and 30 feet for nighttime viewing
- the space above and below the message should equal one-half of the message height
- use this same minimum spacing between lines of the message
- allow adequate spacing from the ends of message lines to sign borders
- if these recommendations cannot be met with common sign dimensions, use a larger sign, regardless of type

These recommendations will have more positive effects on visibility at night than during daylight viewing, particularly with high-performance sign sheeting. If adequate sign dimensions and/or lettering size and spacing are not used in sign design, legibility at night will be adversely affected.

These design factors can be as important as sheeting type and retroreflectivity in providing readable sign messages during reduced light conditions. The introduction of fluorescent colors in recent years has enhanced the performance of signing in the twilight hours and heavily overcast conditions. Fluorescent colors are more effective than standard colors in these lighting conditions.

The effectiveness of sign visibility can be verified through periodic inspections, both day and night. These activities are discussed elsewhere in this manual.

Sign Sheeting

Irregular locations for sign installations, such as left-hand placements, overhead, and high or extended lateral mountings, may result in less projected light reaching the sign face during night conditions. For example, a right-hand mounted sign may receive about 100% of projected light from vehicle headlights, while a similar sign on the left side of the roadway may receive only about 25% of light from the same source. This discrepancy occurs because vehicle headlights are usually pointed downward and to the right.

Signs mounted in these nonstandard locations, such as No Passing pennants and some rural street name signs, may need a higher performance sheeting for adequate visibility at night.

Sheeting material is available in both standard and fluorescent colors. Fluorescent colors improve visibility during certain daylight hours. Sign colors with different meanings have been adopted to promote consistent understanding by drivers. The following table, from Section 1A.12 of the *MUTCD*, lists available sign colors and the purpose of each.

Sign color and purpose

Yellow	General warning
Red	Stop or prohibition
Blue	Motorist services guidance and evacuation route
Green	Indicated movements permitted, direction guidance
Brown	Recreational and cultural interest guidance
Orange	Temporary traffic control
Black	Regulation
White	Regulation
Fluorescent	
Yellow-Green	School zones, pedestrian, and bicycles
Purple	Unassigned
Light Blue	Unassigned
Coral	Unassigned

Several types of sign sheeting are available, including:

1. *ASTM Type I*—medium retroreflective sheeting, also known as “engineering grade”; featuring enclosed lens glass bead sheeting
2. *ASTM Type II*—medium-high intensity retroreflective sheeting, known as “super engineering grade”; also featuring enclosed lens glass beads
3. *ASTM Type III*—high intensity, retroreflective sheeting, known as “high intensity”; typically two layers with encapsulated glass beads
4. *ASTM Type IV*—high intensity, typically unmetalized microprismatic retroreflective element material; also known as “high performance”
5. *ASTM Type V*—metalized microprismatic material, known as “super high intensity”
6. *ASTM Type VI*—vinyl-backed microprismatic material; known as “elastomeric high intensity”; used for many roll-up sign designs as well as highly visible apparel
7. *ASTM Type VII (Iowa)*—microprismatic, very high intensity, retroreflective sheeting, known as “diamond grade” or “high performance”

Specifications for these sheetings are described in ASTM D 4956-95, which has also been adopted by the FHWA and many agencies. All of these sheetings, with the exception of Type VI, can be obtained with pressure sensitive, heat-activated backings for easy application.

With more expensive sheeting and capabilities of computerized cutting of letters, there may be incentive to use a technique called “nesting,” by which many more letters can be cut from a given dimension of sheeting by rotating individual letters to fit more closely. While this technique may seem more efficient, caution should be used with certain sheeting types. Some microprismatic sheetings may not provide consistent luminance for desired night visibility when letters are rotated prior to cutting. Agencies that manufacture signs should be aware of this concern and discuss the potential effects of rotation on luminance characteristics of specific sheeting with vendors prior to using this process.

Cost, performance, and service life vary with each of these sheeting types. For instance, Type III sheeting is about four times brighter and costs about three times as much as Type I, with a service life of up to twenty years, compared to an estimated seven years with Type I. By contrast, Type VII sheeting can cost up to four times that of Type I, but provide from six to fourteen times the brightness. Service life for Type VII may be up to twenty years. These factors must all be considered when selecting the most appropriate sheeting type for the performance desired.

Starting with a higher performance sheeting will result in more visibility over a greater period of time, thus meeting minimum retroreflectivity requirements longer. Brighter sign messages also permit agencies more latitude in placement locations, as visibility will remain satisfactory even at wider viewing angles. For instance, high-intensity sheeting retains good legibility from a 30 degree viewing angle at night. With some Type VII sheeting, this satisfactory viewing angle increases to 60 degrees. This may be particularly important with No Passing pennants and certain street name signs. Life-cycle costing should always be considered in these decisions. Always be sure to check product warranty, shelf life, and retroreflectivity with the vendor prior to making purchase decisions. The following is a list of sign sheeting vendors:

3M Corporation - Traffic Control Materials Division

3M Center Bldg. 225-5S-08
St. Paul, MN 55144-1000
(800) 553-1380
www.3M.com/tcm

Nippon Carbide Industries (USA), Inc.

3136 E. Victoria St.
Rancho Dominguez, CA 90221
(800) 821-4264

Avery Dennison

250 Chester St.
Painesville, OH 44077
(800) 435-8088

American Decal & Manufacturing Company

4100 W. Fullerton Ave.
 Chicago, IL 60639
 (773) 489-4700
 reflective@americandecal.com

Stimsonite Corporation

Purchased by Avery Dennison
 7542 N. Natchez Ave.
 Niles, IL 60648
 (847) 647-7717
 www.stimsonite.com

Reflexite North America

1001 4th St.
 Sacramento, CA 95819
 (916) 739-6903

Nazdar Company

8501 Hedge Lane Terrace
 Shawnee, KS 66227
 (800) 767-9942

The table below presents information for various sheeting types.

Common sign sheeting materials

Sheeting Material	Possible Use	Advantages	Disadvantages
Painted	Commercial/home use only, not intended for roadways	Very inexpensive	Short life
Nonreflective	School zones, work zones only in operation during daylight hours	Minimal expense	Limited uses
Enclosed Lens (Engineer Grade)	Low-speed work zones, speed limits, no parking zones, areas that require little reflectivity	Lowest initial cost	Shorter life
Encapsulated Lens (High Intensity)	Warning signs, keep right, stop, speed limits on arterials, no passing zones, signal ahead, areas that require very good reflectivity	High reflectivity, good life	Moderate initial cost
Prismatic (Diamond Grade)	Interstate work zones, street name signs, warning signs, areas where hazards or high speeds exist during dark hours	Extremely high reflectivity, long life	High initial cost

Sign Substrate

The substrate or backing is the material that gives rigidity to signs. Various materials are available for this purpose, including steel, aluminum, wood, plastics, and fiber glass, each with particular features. The table below lists various materials that can be used for sign substrates.

After considering the features of substrate materials, an agency may wish to select different types for various applications or simply use the same material for all signs. Most agencies use aluminum for a majority of signs and other materials in special situations. Some rural agencies use steel substrate for most sign applications. As with sheeting, substrate materials

selected should be the most cost-effective over the anticipated service life. Practicality can also be a consideration. Sign trucks or storage shelves designed for aluminum signs can be overstressed with the greater weight of steel or wood.

For local fabrication, substrates can be purchased in various precut forms. Large agencies may purchase material in rolls or large sheets and cut shapes in-house. Smaller jurisdictions may obtain substrate material precut, especially with odd-shaped signs such as Stop, No Passing, Railroad Crossing, and School Crossing signs. Prepunched holes are advisable since these are usually cleaner than drilled holes.

Sign substrate materials

Material	Advantage(s)	Disadvantage(s)	Possible Applications
Steel	Very strong, resistant to gunshots, moderate initial cost	Heavy material, tends to rust, little scrap value	Rural roadways, park areas, parking lots
Aluminum	Moderately strong, long life, cost-effective, high scrap value, low weight	Susceptible to gunshots, high initial investment	General roadway signage, overhead signs on freeways or signal mast arms, street name signs
Wood	Moderately strong, moderate life, comes in large sizes, medium weight	Can warp and delaminate	Large temporary signs, information signs, specialty signs
Plastics	Low weight, moderately strong, low initial cost, no corrosion	Brittle in cold weather, poor rigidity when thin, ultraviolet light degradation, sheeting material may not adhere to some types	Parking lots, temporary signs, indoor signage, areas around water
Fiber Glass	Medium weight, no corrosion, good rigidity	Must handle with gloves, brittle in cold weather, can delaminate	Parking lots, temporary signs, indoor signage, areas around water

Substrates can also be obtained in various thicknesses. A small increase in substrate thickness can have a significant effect on cost while adding little to the service life of signs. Typical thickness of street signs, for instance, is 0.080 inches. Larger signs or those exposed to high wind loadings may be increased in thickness to 0.100 inches for added rigidity. The mounting system used for signs can affect the substrate decision as well (one-post vs. two-post, strap mounting, etc.). These design elements need to be considered using life-cycle costing along with other sign features.

Orientation of Signs

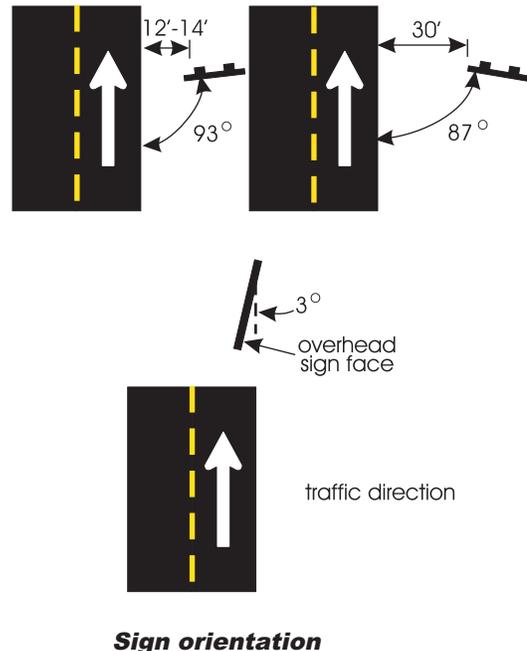
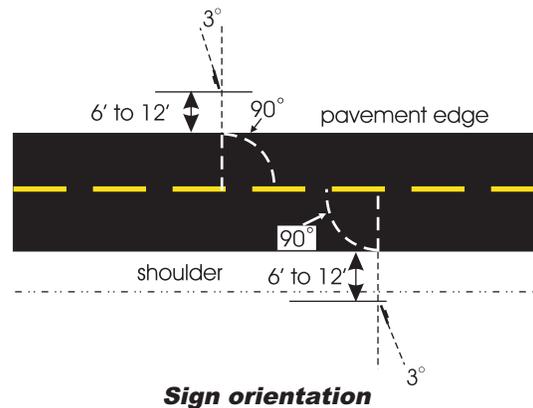
While adequate attention is usually paid to proper mounting height and location of signs, another important factor concerning night sign visibility is sometimes overlooked. This factor is the orientation of the sign face in relation to approaching traffic.

Normally signs should be installed at approximately right angles to approaching vehicles, but to minimize the effects of headlight glare, rotation of the sign face slightly away from the roadway is recommended. All sign sheeting has a glossy surface that can act as a mirror, making the message illegible. This action is even more important for signs with higher intensity sheeting. Section 2A.21 of the *MUTCD* recommends turning signs to avoid a mirror reflection for approaching traffic. For signs located near the roadway (less than 30 feet), the sign face should be turned about 3 degrees away from approaching traffic. A rotation of 3 degrees toward the road for signs installed farther than 30 feet from the roadway is suggested. For each additional 10 feet of offset, 1 degree less rotation is recommended.

On curved alignments, the angle of orientation should be determined from the direct line of approaching vehicles, not from the edge of the

road. For instance, small signs should be aligned approximately perpendicular to approaching vehicles when at a distance of about 250 feet from the sign. Overhead mounted signs should be rotated approximately 3 degrees upward to reduce potential glare and accumulation of dirt, snow, etc. Signs located on grades may be tilted from vertical to improve the viewing angle.

Please refer to the following illustrations for more information.



Warranties

Vendors furnish warranties in many forms and degree of detail. Some can be quite complex and difficult to understand. It is important to read all sign warranties carefully and question the vendor if unsure of details.

Consider the following questions pertaining to warranties:

- Is the specific performance level for sheeting stated or does the warranty simply describe the product as retroreflective?
- Is the color level specified?
- If failures occur, how are settlements made?
- Are materials, substrate, labor, etc. all covered?

Some warranties may not address these points adequately. It is important for jurisdictions to insist on detailed warranties to protect their investment in traffic control devices.

Recycling

Damaged and/or worn signs can be recycled at a considerable cost savings over replacement signs. In many cases, bent signs can be straightened. Old sheeting can be removed by grinding or water blast, although chemical removal is no longer an approved process in most areas due to environmental concerns. Caution must be used when grinding old sheeting from thin aluminum blanks. Sheeting removal by grinding 0.080-inch aluminum blanks more than once can result in signs with inadequate rigidity.

Placing new sheeting directly over old facing is generally not recommended by many manufacturers. Standard adhesives are designed for use with metals or wood and may not perform satisfactorily against the top film of old sheeting. Plastic substrates may pose particular problems with sheeting replacement. Both the plastic and adhesive must be compatible to perform well. Be sure to check any planned refacing practice with a sheeting manufacturer prior to undertaking the process.