Signing Overview & Engineering Sign Studies

Course Outline

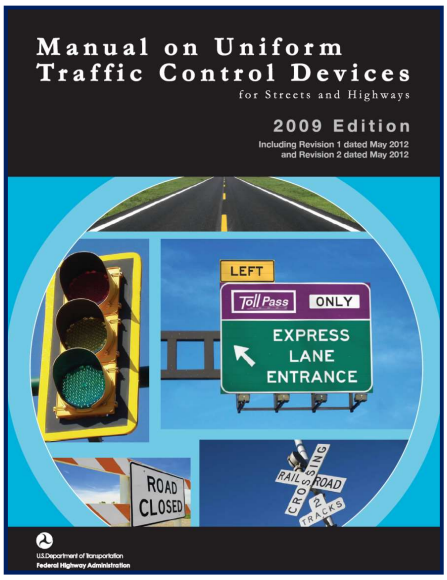
- Overview of the MUTCD
- Engineering Studies & Requirements
- Proper Sign Location; Height, and Lateral Offset
- Sign Consistency; Size & Placement
- Stop and Yield Sign Warrants
- Advisory Speed Plaques & Curve Speed Studies
- Specialty Warning Signs, are they allowed?
- School & Pedestrian Crossing Signs

Overview of the MUTCD

Manual on Uniform Traffic Control Devices

aka

The MUTCD



2009 MUTCD

- The Manual on Uniform Traffic Control Devices (MUTCD) shall be recognized as the national standard
- For all traffic control devices installed on any street, highway, bikeway, or private road open to public travel

Section 1A.01 Purpose of Traffic Control Devices

- Promote highway safety and efficiency
- By providing for the orderly movement of all road users
- On streets, highways, bikeways, and private roads open to public travel throughout the Nation

Section 1A.01 Purpose of Traffic Control Devices

- Traffic control devices
  - Notify road users of regulations
  - Provide warning and guidance
  - Uniform and efficient operation
  - Minimize the occurrences of crashes

Section 1A.02 Principles of Traffic Control Devices

- To be effective, a traffic control device should meet five basic requirements:
  - A. Fulfill a need
  - B. Command attention
  - C. Convey a clear, simple meaning
  - D. Command respect from road users
  - E. Give adequate time for proper response.

Section 1A.02 Principles of Traffic Control Devices

- Design, placement, operation, maintenance, and uniformity are aspects that should be carefully considered
  - In order to maximize the ability of a traffic control device to meet the five requirements

Section 1A.13 Definitions of Headings, Words, and Phrases in this Manual

When used in this Manual, the text headings of Standard, Guidance, Option, and Support shall be defined as follows:

A. Standard

- **A statement of required, mandatory, or specifically prohibitive practice regarding a traffic control device.**
- **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.**

Section 1A.13 Definitions of Headings, Words, and Phrases in this Manual

B. 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.*

Section 1A.13 Definitions of Headings, Words, and Phrases in this Manual

C. Option

- A statement of practice that is a permissive condition and carries no requirement or recommendation.
- Option statements sometime 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.

Section 1A.13 Definitions of Headings, Words, and Phrases in this Manual

D. Support

- An informational statement that does not convey any degree of mandate, recommendation, authorization, prohibition, or enforceable condition.
- Support statements are labeled, and the text appears in unbold type.
- The verbs “shall,” “should,” and “may” are not used in Support statements.

MUTCD Text Format

Section 2A.12 Symbols

Standard:

01 **Symbol designs shall in all cases be unmistakably similar to those shown in this Manual and in the “Standard Highway Signs and Markings” book (see Section 1A.11).**

Support:

02 New symbol designs are adopted by the Federal Highway Administration based on research evaluations to determine road user comprehension, sign conspicuity, and sign legibility.

03 Sometimes a change from word messages to symbols requires significant time on public education and transition. Therefore, this Manual sometimes includes the practice of using educational plaques to accompany new symbol signs.

Guidance:

04 *New warning or regulatory symbol signs that are difficult to understand by the public should be accompanied by an educational plaque.*

Option:

05 Educational plaques may be left in place as long as they are in serviceable condition.

06 State and/or local highway agencies may conduct research studies to determine road user comprehension, sign conspicuity, and sign legibility.

“SHALL” & “SHOULD”

- Keep in mind that the STANDARD statement is a requirement.
- Case law suggests that failure to comply with SHOULD directives can be "evidence" of negligence
  - When considered alongside the totality of all the other evidence in a case that might support a Plaintiff's verdict.
- What this means is, if there is a Guidance statement or SHOULD, that directive had better be followed or there is a good chance a case could be lost.

Engineering Studies & Requirements

Section 1A.09 Engineering Study and Engineering Judgment

Support:

01 Definitions of an engineering study and engineering judgment are contained in Section 1A.13.

Standard:

02 **This Manual describes the application of traffic control devices, but shall not be a legal requirement for their installation.**

Section 1A.09 Engineering Study and Engineering Judgment

Guidance:

03 *The decision to use a particular device at a particular location should be made on the basis of either an engineering study or the application of engineering judgment. Thus, while this Manual provides Standards, Guidance, and Options for design and applications of traffic control devices, this Manual should not be considered a substitute for engineering judgment. Engineering judgment should be exercised in the selection and application of traffic control devices, as well as in the location and design of roads and streets that the devices complement.*

Section 1A.09 Engineering Study and Engineering Judgment

Guidance:

04 *Early in the processes of location and design of roads and streets, engineers should coordinate such location and design with the design and placement of the traffic control devices to be used with such roads and streets.*

05 *Jurisdictions, or owners of private roads open to public travel, with responsibility for traffic control that do not have engineers on their staffs who are trained and/or experienced in traffic control devices should seek engineering assistance from others, such as the State transportation agency, their county, a nearby large city, or a traffic engineering consultant.*

Section 1A.09 Engineering Study and Engineering Judgment

Support:

06 As part of the Federal-aid Program, each State is required to have a Local Technology Assistance Program (LTAP) and to provide technical assistance to local highway agencies. Requisite technical training in the application of the principles of the MUTCD is available from the State's Local Technology Assistance Program for needed engineering guidance and assistance.

Section 1A.13 Definitions of Headings, Words, and Phrases in this Manual

- Engineering Judgment
- Engineering Studies

Engineering Judgment

Engineering Judgment—the evaluation of available pertinent information, and the application of appropriate principles, provisions, and practices as contained in this Manual and other sources, for the purpose of deciding upon the applicability, design, operation, or installation of a traffic control device. Engineering judgment shall be exercised by an engineer, or by an individual working under the supervision of an engineer, through the application of procedures and criteria established by the engineer. Documentation of engineering judgment is not required.

NOTE:

Even though the definition states documentation is not required, documentation of engineering judgment is strongly encouraged

Engineering Studies

Engineering Study—the comprehensive analysis and evaluation of available pertinent information, and the application of appropriate principles, provisions, and practices as contained in this Manual and other sources, for the purpose of deciding upon the applicability, design, operation, or installation of a traffic control device. An engineering study shall be performed by an engineer, or by an individual working under the supervision of an engineer, through the application of procedures and criteria established by the engineer. An engineering study shall be documented.

Section 2A.03
Standardization of Application

Guidance:

02 *Signs should be used only where justified by engineering judgment or studies, as provided in Section 1A.09.*

03 *Results from traffic engineering studies of physical and traffic factors should indicate the locations where signs are deemed necessary or desirable.*

04 *Roadway geometric design and sign application should be coordinated so that signing can be effectively placed to give the road user any necessary regulatory, warning, guidance, and other information.*

The Traffic Engineering Study

Only a qualified individual, or an individual working under the direct supervision of someone who is qualified, will perform an engineering study.

Qualified Individual = Engineer

All engineering studies must be documented.

Traffic Engineering Study Components:

- The following data, at a minimum but not limited to, should be incorporated into an engineering study performed by a qualified individual:
  - **Crash History** – The crash history of the proposed location for the traffic control devices should be researched. This information may be obtained from the State DOT.

  - **Measurements** – Record all applicable measurements that may apply to the installation of the proposed traffic control device.

  - **MUTCD** – Always refer to the most recent adopted edition of the MUTCD and the State Supplement to the MUTCD for pertinent information involving the proper installation of all traffic control devices.

- Roadway Geometrics
  - **Alignment** – How do the horizontal tangents and curves pertain to the intersection or location in question.
  - **Profile** – How does the vertical aspect of the road, including crest and sag curves, and the straight grade lines connecting them affect the location in question.
  - **Cross section** – How does the cross section affect the location. Position and number of vehicle and bicycle lanes and sidewalks, along with their cross slope or super elevation. Cross sections also show drainage features, pavement structure and other items outside the category of geometric design.

  - **Photos** – Photos of the location of the proposed traffic control device should be incorporated into the study. Take photographic documentation of the proposed location for the traffic control device as evidence the sign is warranted. (example: blind intersection due to a hill, etc.)
  - **Traffic Counts** – Conduct a traffic count to determine if the traffic control device is warranted and/or to ensure the proper location of said traffic control device.

- **Documentation** – Document and present to the Governing Body all information found during the engineering study when requesting a resolution for the installation of a traffic control device or a related need for an engineering study.

Engineering Study Primary Considerations

- Traffic volumes, crash history, traffic speed and capacity reports, among others
  - Should first be taken to ensure the traffic control device is warranted and will not cause unnecessary traffic inefficiencies or additional safety concerns.

Engineering Study Primary Considerations

- Emotional responses to crashes can prompt a request for adding a control device.
- For example:
  - A crash at a particular intersection may lead to a request to the city or county to add a stop sign or some other type of traffic control device to increase safety and help prevent a similar crash from occurring in the future.
- Not all crashes can be prevented with a sign.

Engineering Study Primary Considerations

- It is important to understand that public pressure is not reason enough to add traffic control devices.
- Before adding or removing a device
  - Steps should be taken to make sure there is a legitimate need to install (or uninstall) the device.

Engineering Study Primary Considerations

- The same steps should be taken to remove a traffic control device as are done to add a device.

Engineering Study Primary Considerations

- Traffic Engineering Studies take time.
  - 3, 6, or even 12 months.
  - May need to collect data during a local festival, harvest, during the school year or other pattern that affects traffic flow.

The Engineering Study Process

- Understand Basic MUTCD Guidance:
  - Objective's of Traffic Control Devices
  - Requirements to be Effective
  - Engineering Study Process Usage
  - Effectiveness of Traffic Control Devices

The Engineering Study Process

- Understand:
  - Specific Location Characteristics
  - System Characteristics
  - Agency Policies

Understanding the Engineering Study Process

- Decide/Document:
  - What is the problem/issue to be addressed?
    - Safety
    - Speed
    - Congestion
  - Identify the applicable guidelines
    - MUTCD
    - State Supplement to the MUTCD
    - Local Agency

Understanding the Engineering Study Process, Con't.

- Identify possible alternatives
  - In cases there will be multiple choices
- Identify the evaluating criteria
  - Effectiveness
  - Cost (first and ongoing maintenance)
  - Potential Impacts
  - Consistency
- Implementation

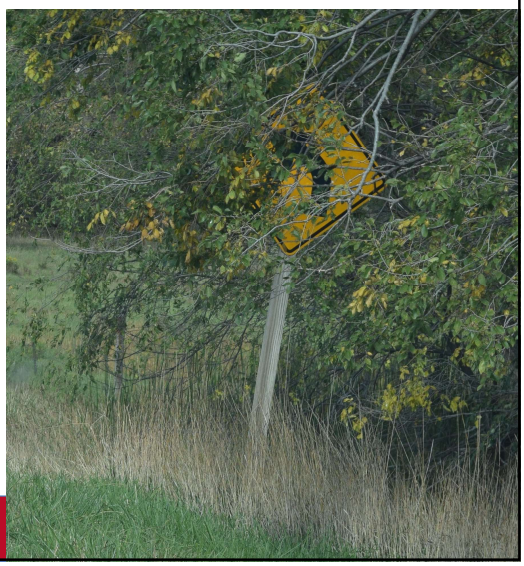
Engineering Study References

- Minnesota's Best Practices for Traffic Sign Maintenance/ Management Handbook
  - https://www.dot.state.mn.us/stateaid/trafficsafety/retroreflectivity/mndot-traffic-sign-maint-man-small.pdf
- Kansas LTAP Fact Sheet – *"Steps for Adding or Removing Traffic Control Devices"*
  - http://www2.ku.edu/~kutc/pdffiles/LTAPFS11-Trafficdevices.pdf

Proper Sign Location
Height and
Lateral Offset

Section 1A.04 Placement and Operation of Traffic Control Devices

- Placement of a traffic control device should be within the road user's view so that adequate visibility is provided



- **Sight Distance** – Ensure that unobstructed sight distance is available for the proposed traffic control device; if not, remove the obstruction.

Section 1A.04 Placement and Operation of Traffic Control Devices

- Traffic control devices should be placed and operated in a uniform and consistent manner
- Unnecessary traffic control devices should be removed

Section 1A.04 Placement and Operation of Traffic Control Devices

- The fact that a device is in good physical condition
  - Should not be a basis for deferring needed removal or change

Responsibility

Section 1A.07 Responsibility for Traffic Control Devices

Standard:

01 **The responsibility for the design, placement, operation, maintenance, and uniformity of traffic control devices shall rest with the public agency or the official having jurisdiction, or, in the case of private roads open to public travel, with the private owner or private official having jurisdiction. 23 CFR 655.603 adopts the MUTCD as the national standard for all traffic control devices installed on any street, highway, bikeway, or private road open to public travel (see definition in Section 1A.13). When a State or other Federal agency manual or supplement is required, that manual or supplement shall be in substantial conformance with the National MUTCD.**

Section 1A.08. Authority for Placement of Traffic Control Devices

Standard:

03 **All regulatory traffic control devices shall be supported by laws, ordinances, or regulations.**

Section 2A.05 Classification of Signs

Standard:

01 Signs shall be defined by their function as follows:

A. Regulatory signs give notice of traffic laws or regulations.

B. Warning signs give notice of a situation that might not be readily apparent.

C. Guide signs show route designations, destinations, directions, distances, services, points of interest, and other geographical, recreational, or cultural information.

Section 2A.06 Design of Signs

Standard:

All symbols shall be unmistakably similar to, or mirror images of, the adopted symbol signs, all of which are shown in the "Standard Highway Signs and Markings" book (see Section 1A.11). Symbols and colors shall not be modified unless otherwise provided in this Manual.

Section 2A.09 Shapes

Standard:

01 Particular shapes, as shown in Table 2A-4, shall be used exclusively for specific signs or series of signs, unless otherwise provided in the text discussion in this Manual for a particular sign or class of signs.

Section 2A.10 Sign Colors

Standard:

01 The colors to be used on standard signs and their specific use on these signs shall be as provided in the applicable Sections of this Manual. The color coordinates and values shall be as described in 23 CFR, Part 655, Subpart F, Appendix.

Figure 2A-2. Examples of Heights and Lateral Locations of Sign Installations

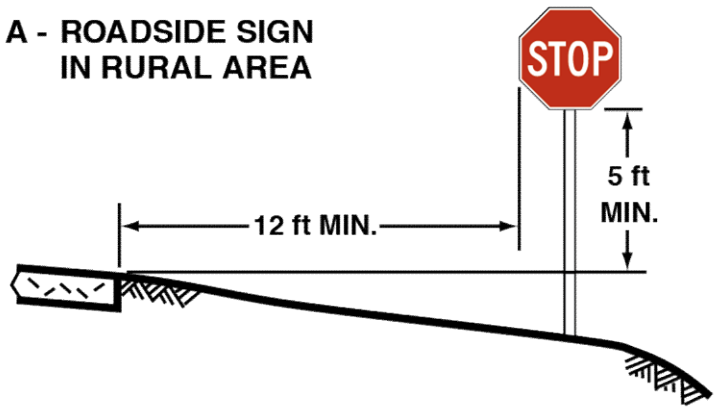


Figure 2A-2. Examples of Heights and Lateral Locations of Sign Installations

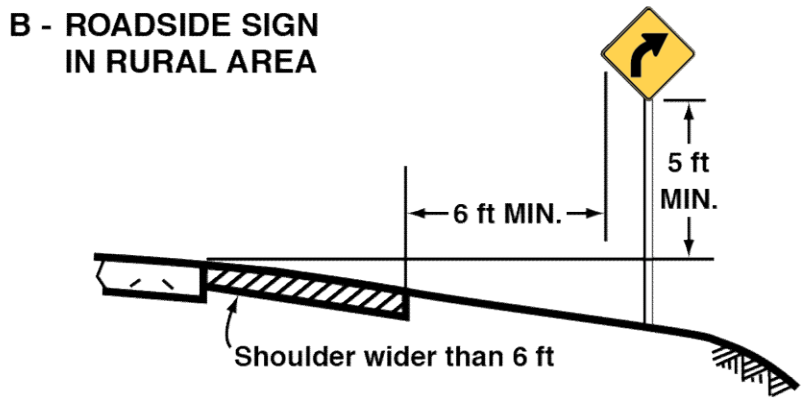
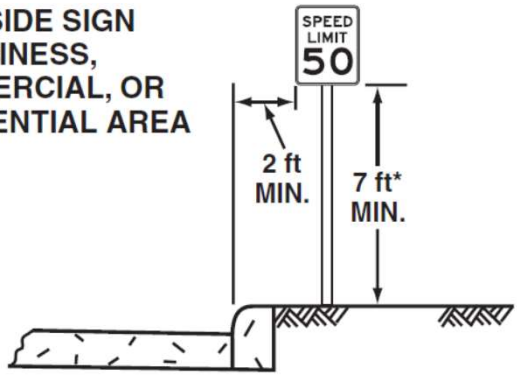


Figure 2A-2. Examples of Heights and Lateral Locations of Sign Installations

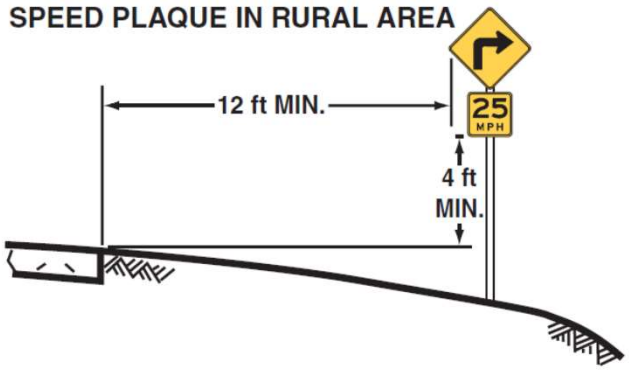
C - ROADSIDE SIGN IN BUSINESS, COMMERCIAL, OR RESIDENTIAL AREA



*Where parking or pedestrian movements are likely to occur

Figure 2A-2. Examples of Heights and Lateral Locations of Sign Installations

D - WARNING SIGN WITH ADVISORY SPEED PLAQUE IN RURAL AREA



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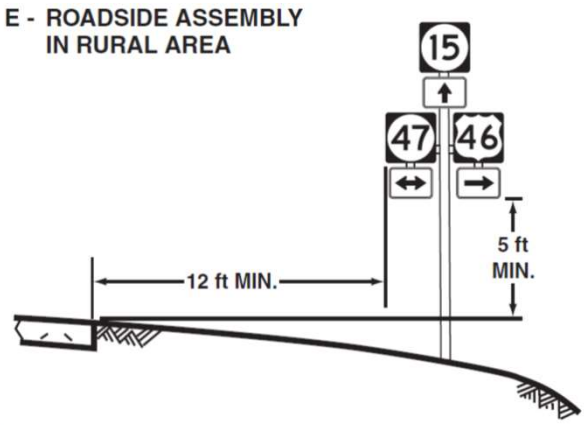

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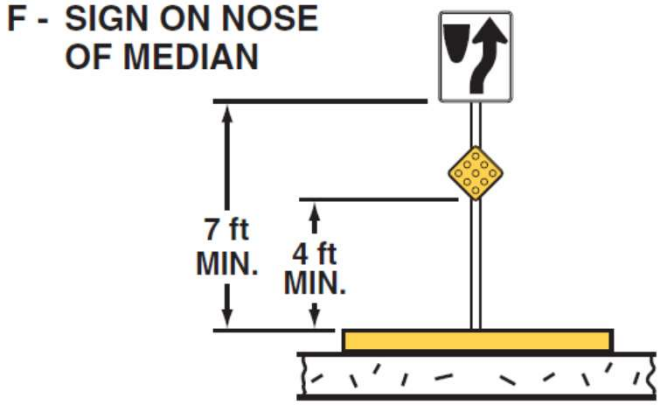

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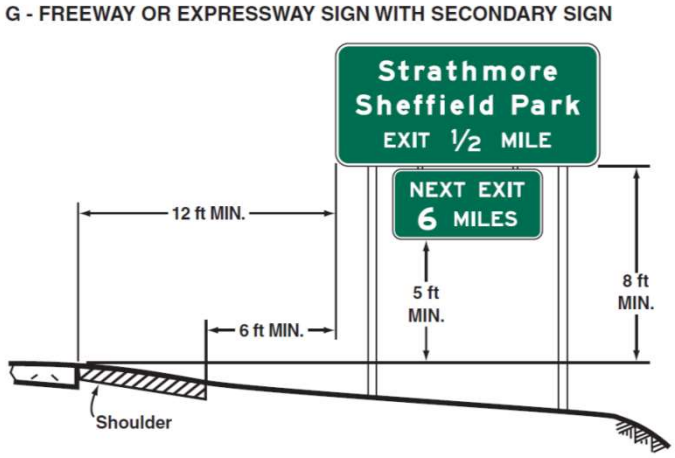
Figure 2A-2. Examples of Heights and Lateral Locations of Sign Installations



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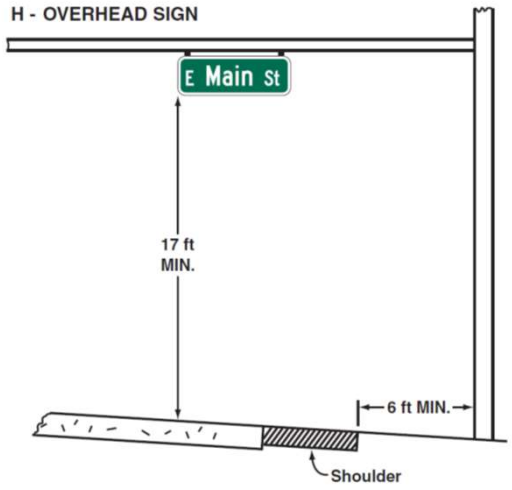
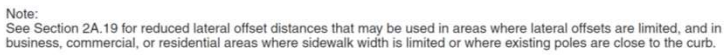


Figure 2A-2. Examples of Heights and Lateral Locations of Sign Installations

- Note:

See Section 2A.19 for reduced lateral offset distance that may be used in areas where lateral offsets are limited, and in business, commercial, or residential areas where sidewalk width is limited or where existing poles are close to the curb.



Sign Consistency
Size and Placement

Engineering Sign Study Course

Engineering Sign Study Course

Stop and Yield Sign Warrants

Road/Street Signs

Regulatory signs:

A sign that gives notice to road users of traffic laws or regulations

Types of Regulatory Signs

R1-1

R1-2

R2-1

All regulatory signs require engineering studies/engineering judgment **AND** county board/city council resolutions prior to installation.

Section 2B.06 STOP Sign Applications

R1-1

R1-2

Guidance:

01 *At intersections where a full stop is not necessary at all times, consideration should first be given to using less restrictive measures such as YIELD signs (see Sections 2B.08 and 2B.09).*

02 *The use of STOP signs on the minor-street approaches should be considered if engineering judgment indicates that a stop is always required because of one or more of the following conditions:*

A. The vehicular traffic volumes on the through street or highway exceed 6,000 vehicles per day;

B. A restricted view exists that requires road users to stop in order to adequately observe conflicting traffic on the through street or highway; and/or

C. Crash records indicate that three or more crashes that are susceptible to correction by the installation of a STOP sign have been reported within a 12-month period, or that five or more such crashes have been reported within a 2-year period. Such crashes include right-angle collisions involving road users on the minor-street approach failing to yield the right-of-way to traffic on the through street or highway.

Section 2B.07
Multi-Way Stop Applications

Section 2B.07
Multi-Way Stop Applications

Support:

01 Multi-way stop control can be useful as a safety measure at intersections if certain traffic conditions exist. Safety concerns associated with multi-way stops include pedestrians, bicyclists, and all road users expecting other road users to stop. Multi-way stop control is used where the volume of traffic on the intersecting roads is approximately equal.

02 The restrictions on the use of STOP signs described in Section 2B.04 also apply to multi-way stop applications.

Guidance:

03 *The decision to install multi-way stop control should be based on an engineering study.*

Option:

05 Other criteria that may be considered in an engineering study include:

A. The need to control left-turn conflicts;

B. The need to control vehicle/pedestrian conflicts near locations that generate high pedestrian volumes;

C. Locations where a road user, after stopping, cannot see conflicting traffic and is not able to negotiate the intersection unless conflicting cross traffic is also required to stop; and

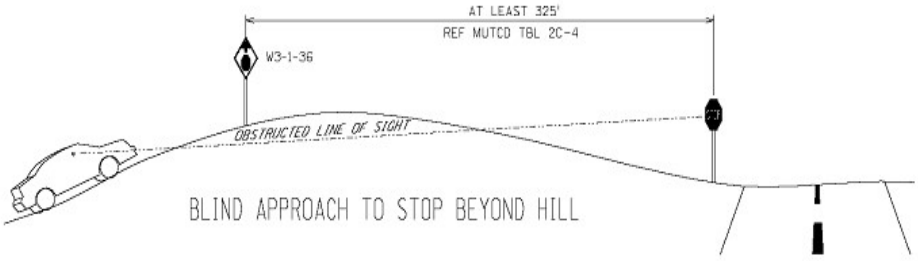
D. An intersection of two residential neighborhood collector (through) streets of similar design and operating characteristics where multi-way stop control would improve traffic operational characteristics of the intersection.

Section 2C.36 Advance Traffic Control Signs (W3-1, W3-2, W3-3, W3-4)

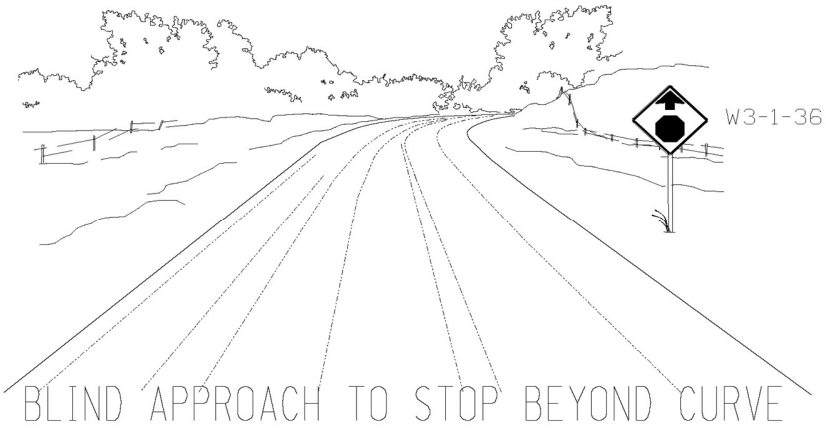
Standard:

01 The Advance Traffic Control symbol signs (see Figure 2C-6) include the Stop Ahead (W3-1), Yield Ahead (W3-2), and Signal Ahead (W3-3) signs. These signs shall be installed on an approach to a primary traffic control device that is not visible for a sufficient distance to permit the road user to respond to the device (see Table 2C-4).

W3-1



- If a stop sign cannot be seen on the approach from at least 250 feet (gravel) or 325 feet (paved county roads), then a W3-1 Stop Ahead sign should be used.
- The driver's line of sight height is 3.5 feet.



Engineering Sign Study Course

Section 2B.09 YIELD Sign Applications

Option:

01 YIELD signs may be installed:

A. On the approaches to a through street or highway where conditions are such that a full stop is not always required.

B. At the second crossroad of a divided highway, where the median width at the intersection is 30 feet or greater. In this case, a STOP or YIELD sign may be installed at the entrance to the first roadway of a divided highway, and a YIELD sign may be installed at the entrance to the second roadway.

Section 2B.09 YIELD Sign Applications

C. For a channelized turn lane that is separated from the adjacent travel lanes by an island, even if the adjacent lanes at the intersection are controlled by a highway traffic control signal or by a STOP sign.

D. At an intersection where a special problem exists and where engineering judgment indicates the problem to be susceptible to correction by the use of the YIELD sign.

E. Facing the entering roadway for a merge-type movement if engineering judgment indicates that control is needed because acceleration geometry and/or sight distance is not adequate for merging traffic operation.

Section 2B.09 YIELD Sign Applications

Standard:

03 Other than for all of the approaches to a roundabout, YIELD signs shall not be placed on all of the approaches to an intersection.

Section 2B.10 STOP Sign or YIELD Sign Placement

Standard:

01 The STOP or YIELD sign shall be installed on the near side of the intersection on the right-hand side of the approach to which it applies. When the STOP or YIELD sign is installed at this required location and the sign visibility is restricted, a Stop Ahead sign (see Section 2C.36) shall be installed in advance of the STOP sign or a Yield Ahead sign (see Section 2C.36) shall be installed in advance of the YIELD sign.

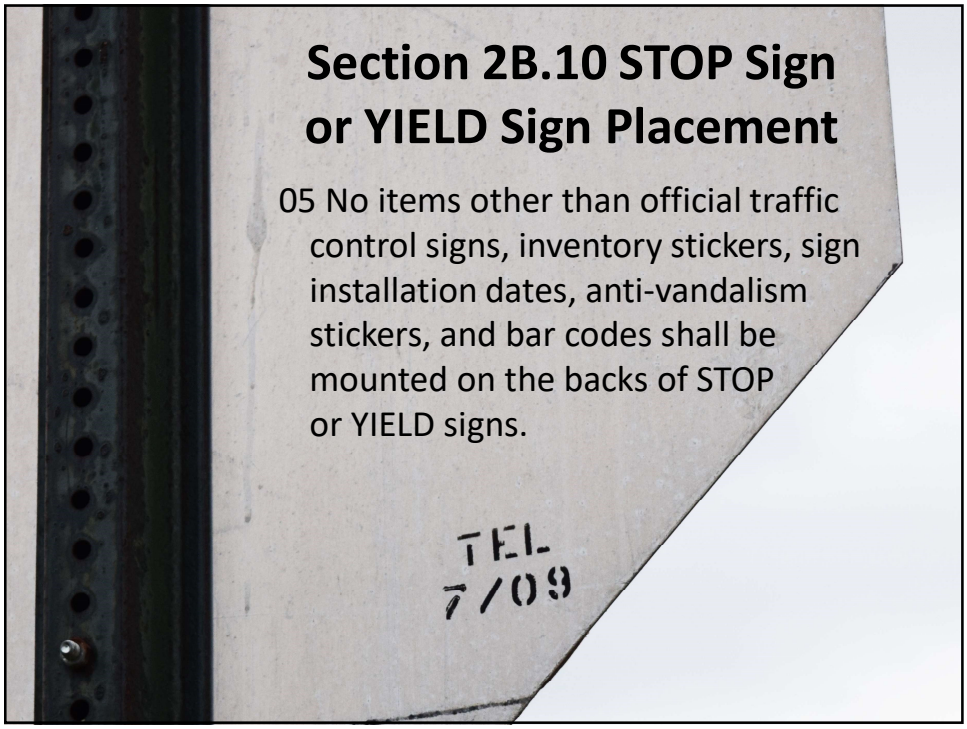
Section 2B.10 STOP Sign or YIELD Sign Placement

02 The STOP or YIELD sign shall be located as close as practical to the intersection it regulates, while optimizing its visibility to the road user it is intended to regulate.

03 STOP signs and YIELD signs shall not be mounted on the same post.

Section 2B.10 STOP Sign or YIELD Sign Placement

04 No items other than inventory stickers, sign installation dates, and bar codes shall be affixed to the fronts of STOP or YIELD signs, and the placement of these items shall be in the border of the sign.


Section 2B.10 STOP Sign or YIELD Sign Placement
05 No items other than official traffic control signs, inventory stickers, sign installation dates, anti-vandalism stickers, and bar codes shall be mounted on the backs of STOP or YIELD signs.
TEL
7/09


Section 2B.10 STOP Sign or YIELD Sign Placement
06 No items other than retroreflective strips (see Section 2A.21) or official traffic control signs shall be mounted on the fronts or backs of STOP or YIELD signs supports.
STOP

Advisory Speed Plaques
and
Curve Speed Studies

Advisory Speed

- What is ***Advisory Speed***?
  - It is a relative value that provides an adequate margin of safety and is reasonably comfortable for most drivers
  - It is NOT the safe speed for every vehicle and pavement condition

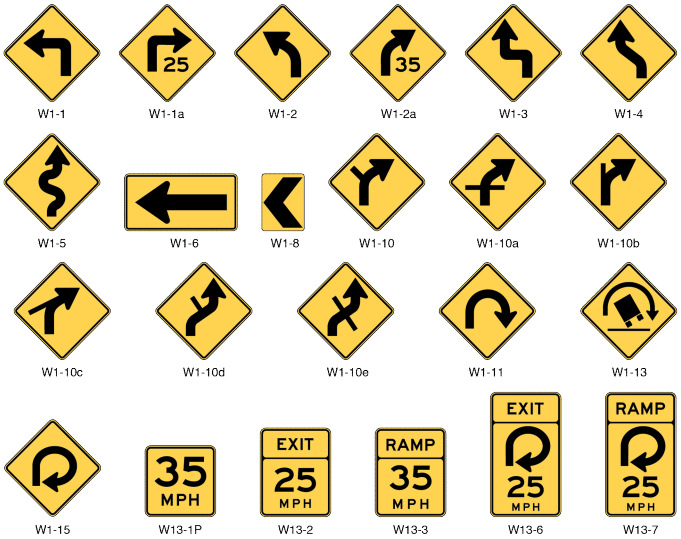
Advisory Speed

- Must have a consistent, uniform method of placing curve signs
- If posting is consistent, the traveling public will have a better understanding of how to drive when they see a particular sign

Advisory Speed

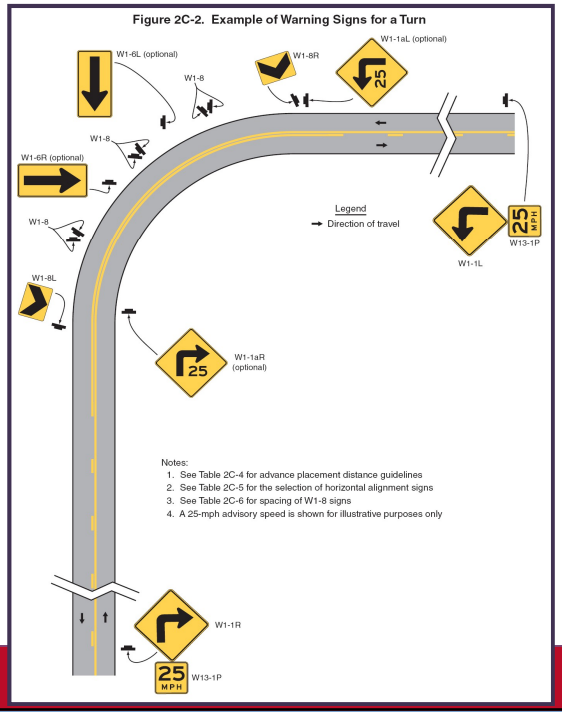
- It's called the *Manual on **Uniform** Traffic Control Devices*
- Uniformity may be the most important aspect of all signage, not just curve signs.

Figure 2C-1. Horizontal Alignment Signs and Plaques



Note: Turn arrows and reverse turn arrows may be substituted for the curve arrows and reverse curve arrows on the W1-10 series signs where appropriate.

Figure 2C-2. Example of Warning Signs for a Turn



Establishing Advisory Speeds

Curve speed studies should be performed by an engineer or someone working under an engineer's supervision.

- Procedures and criteria are established and reviewed by the engineer.
- Could be the Roadway Superintendent or employee of Roadway Department with an engineer's supervision.

Establishing Advisory Speeds

Guidance:

- The advisory speed **should** be determined based on free-flowing traffic conditions
- Because changes in conditions, such as roadway geometrics, surface characteristics, or sight distance, might affect the advisory speed, each location **should** be evaluated periodically or when conditions change

Section 2C.08 Advisory Speed Plaque (W13-1P)

Option:

The Advisory Speed (W13-1P) plaque **may** be used to supplement any warning sign to indicate the advisory speed for a condition

Standard:

The use of the Advisory Speed plaque for horizontal curves shall be in accordance with the information shown in Table 2C-5.

Table 2C-5. Horizontal Alignment Sign Selection

Type of Horizontal Alignment Sign	Difference Between Speed Limit and Advisory Speed				
	5 mph	10 mph	15 mph	20 mph	25 mph or more
Turn (W1-1), Curve (W1-2), Reverse Turn (W1-3), Reverse Curve (W1-4), Winding Road (W1-5), and Combination Horizontal Alignment/Intersection (W10-1) (see Section 2C.07 to determine which sign to use)	Recommended	Required	Required	Required	Required
Advisory Speed Plaque (W13-1P)	Recommended	Required	Required	Required	Required
Chevrons (W1-8) and/or One Direction Large Arrow (W1-6)	Optional	Recommended	Required	Required	Required
Exit Speed (W13-2) and Ramp Speed (W13-3) on exit ramp	Optional	Optional	Recommended	Required	Required

Note: Required means that the sign and/or plaque shall be used, recommended means that the sign and/or plaque should be used, and optional means that the sign and/or plaque may be used.

See Section 2C.06 for roadways with less than 1,000 ADT.

Section 2C.08 Advisory Speed Plaque (W13-1P)

Standard:

The Advisory Speed plaque shall also be used where an engineering study indicates a need to advise road users of the advisory speed for other roadway conditions

W13-1P

Section 2C.08 Advisory Speed Plaque (W13-1P)

Standard:

- **If used, the Advisory Speed plaque shall carry the message XX MPH**
- **The speed displayed shall be a multiple of 5 mph**
- **Except in emergencies or when the condition is temporary, an Advisory Speed plaque shall not be installed until the advisory speed has been determined by an engineering study**

Section 2C.08 Advisory Speed Plaque (W13-1P)

Standard:

- **The Advisory Speed plaque shall only be used to supplement a warning sign**
- **It shall not be installed as a separate sign installation**
- **The advisory speed shall be determined by an engineering study that follows established engineering practices**

Section 2C.08 Advisory Speed Plaque (W13-1P)

Support:

- Established engineering practices appropriate for determination of the recommended advisory speed for a horizontal curve:
  - An accelerometer that provides a direct determination of side friction factors
  - A design speed equation
- AND…

Ball-Bank Indicator

A traditional Ball-Bank Indicator using the following criteria:

Ball Bank Reading	Recommended Speed
16°	≤ 20 mph
14°	25-30 mph
12°	≥ 35 mph

Driver Behavior

- The MUTCD 2009 Edition mentions that research has shown that drivers often exceed existing posted advisory curve speeds by 7 to 10 mph (Sec. 2C.08)
- Advisory speeds determined by ball-bank values of 16, 14, and 12 degrees address such driver behavior

Ball-Bank Indicator Method

- Based on a set of field driving tests to record Ball-Bank Indicator (BBI) reading
- Using a BBI and a speedometer
- Varied criteria for establishing the curve advisory speed based on ball-bank indicator readings:
  - AASHTO's Geometric Design of Highways and Streets (2011)
  - MUTCD 2009 edition

BBI Method Benefits

- BBI Method determines the advisory speeds in the field
- Use of a vehicle equipped with a ball-bank indicator and an accurate speedometer
- Speedometer should be check using a calibrated radar gun or other method
- BBI is simply constructed, easy to operate
- Widespread acceptance as a **guide** to determine advisory speeds for changes in horizontal alignment

BBI Types: Manual

BBI Types: Electronic

BBI results are most consistent with a standard passenger car.

How it Works

- As the vehicle is driven around the curve:
  - Superelevation
  - Lateral (centripetal) acceleration
  - Vehicle body roll
- Device detects and displays angle of change

How it Works: Manual

- The BBI is a curved glass tube filled with liquid
- A weighted ball floats in the glass tube
- The BBI is mounted in a vehicle
- As the vehicle travels around a curve, the ball floats outward in the curved glass tube
- The movement of the ball is measured in degrees of deflection

BBI Method for Success

- Normally a two-person operation
  - One person to drive
  - One person to record curve data and the ball-bank readings (not necessary for electronic BBI)
- Especially if advisory speeds are being determined for a series of curves
  - Winding roads
  - Reverse curves or turns

BBI Method for Success, con't.

- Multiple runs through the curve are required to get the correct advisory speed
- Reading the ball-bank indicator to determine the maximum degree of lean can be subjective

Obtaining Field Measurements

Equipment Setup

- To ensure proper results, it is critical that the following steps be taken before starting test runs with the BBI:
  - Inflate all tires to uniform pressure as recommended by the vehicle manufacturer
  - Calibrate the test vehicle's speedometer
  - Zero the ball-bank indicator

Obtaining Field Measurements

Vehicle Speedometer

- Confirmed with a speed gun and calibrated to ensure proper and consistent test results
- May time the vehicle over a measured distance (such as milepost spacing)
- Or, a moving radar unit can be used to measure speed

Obtaining Field Measurements

BBI Device

- Must be mounted in the vehicle so that it displays a 0° reading when the vehicle is stopped on a level surface

Obtaining Field Measurements

BBI Device– Con't

- The positioning of the BBI must be checked before starting any test
  - Stop the vehicle so the wheels straddle the centerline of a two-lane roadway on a tangent alignment (straightaway)
  - When the vehicle is essentially level, the BBI should read 0°

Obtaining Field Measurements

BBI Device– Con't

- The driver and recorder should be in the same position in the vehicle when the BBI is set to a 0° reading
- A shift in the load in the vehicle can affect the BBI reading

Obtaining Field Measurements

Measurement Procedure

- Start at a relatively low speed
- Drive through the curve at a constant speed
- Follow the curve alignment as closely as possible
  - In the center of the lane
- The reading on the ball-bank indicator is noted
  - The highest observed ball bank reading should be recorded

Obtaining Field Measurements

Measurement Procedure – Con't

- On each test run, test speed must be reached at a distance of at least ¼ mile in advance of the beginning of the curve
- Maintain the same speed throughout the length of the curve
- Make at least three test runs in each direction
- Will more accurately determine the BBI reading for any given speed

Obtaining Field Measurements

Measurement Procedure – Con't

- If the reading on the BBI for a test run does not exceed the MUTCD criteria:
  - Then the speed of the vehicle is increased by 5 MPH and the test is repeated
  - The vehicle speed is repeatedly increased in 5 MPH increments until the BBI reading exceeds the acceptable maximum

Determining the Advisory Speed

- The curve advisory speed is set at the highest test speed that does not result in a BBI reading greater than an acceptable level

Example

Trial	Driving Speed	BBI Reading
1	25 mph	6°
2	30 mph	8°
3	35 mph	10-12°
4	40 mph	13-15°

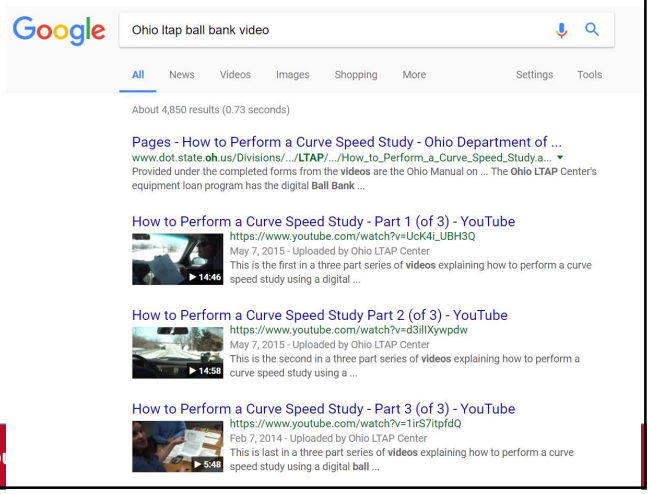
- The highest reading attained without exceeding 12° was 35 mph.
- The field measurement suggests posting an advisory speed of 35 mph for this curve.

Determining the Advisory Speed

- Factors to consider:
  - Roadway surface type and condition
  - Type of test vehicle used
  - Weather conditions at time of test
  - Type of vehicles using roadway
  - Cross-section of roadway
  - Is the advisory speed for a Curve or Turn?

Other Resources

- Ohio LTAP has great How-To Videos



Specialty Warning Signs

Specialty Warning Signs

The use of warning signs shall be based on an engineering study or on engineering judgment

Specialty Warning Signs

2C.02 - The use of warning signs shall be based on an engineering study or on engineering judgment

The use of warning signs should be kept to a minimum as the unnecessary use of warning signs tends to breed disrespect for all signs.

2C.03 - Word message warning signs other than those provided in this Manual may be developed and installed by State and local highway agencies.

School & Pedestrian Crossing Signs

Pedestrian Crossing

- Crosswalk lines eliminated
- PED XING sign eliminated

Downward arrow <u>shall</u> be placed at crossing location

Advance signs should be supplemented with AHEAD or XXX FEET. Do not over use this sign (sign pollution)

Section 2C.50
(Jan 17, 2011 compliance date)

Pedestrian Crossing

Fluorescent yellow-green color

Optional for pedestrian, bike, and playground signs

Section 2C.50

School Crossing

- Elimination of crosswalk lines.
- Required downward arrow at crossing assembly location
- Required Fluorescent yellow-green color

School Advance Crossing Assembly

OR 

OR 

Section 7B.11 & 7B.12

(Jan 17, 2011 compliance date)

Questions?