

## CHAPTER 3

# RECOMMENDATIONS

### 3.1 OBJECTIVES

In Chapter 2, major requirements for crossing safety were identified. Because these requirements are valuable in defining recommended TCDs to improve safety at passive crossings, they are discussed below in more detail, and the specific criteria for a TCD recommendation are identified. The four recommendations that follow are based on these criteria.

#### 1. Drivers must understand the need to search.

The search requirements are different for passive crossings than for active crossings. At an active crossing, the driver is primarily responsible for monitoring the signal indication. At a passive crossing, the driver must recognize the crossing, locate any train using the tracks, and decide if there is sufficient clear space to cross safely. Because the responsibility is different for active versus passive crossings, drivers need to be made aware that they are approaching a passive crossing and that the decision to stop or proceed rests in their hands. Drivers need to know when the onus is on them to make a decision. The existing W10-1 sign alone does not make the needed distinction between active and passive crossings or the different driver responsibilities. The recommendation must therefore provide a way to readily distinguish between active and passive crossings well in advance.

#### 2. The approach must induce appropriate slowing and search behaviors so that drivers know when and how much to slow, as well as where and when to search.

The crossbuck alone does not appear to be well understood by drivers. The sign-comprehension testing revealed that although drivers do understand that some action is required at crossings, there is confusion about what action is most appropriate. Only 21 percent of the study group indicated “stop for train” as the appropriate response; 31 percent indicated “stop for tracks” as the appropriate response. The correct action is to stop only if there is a train approaching or within the crossing such that there is not enough time to cross the tracks safely. This is very similar to the way a yield-controlled highway intersection operates. The recommended TCDs must convey this Yield message.

#### 3. Barriers to adequate search must be minimized including reducing intentional conflicts that com-

pete for the driver’s attention (e.g., traffic, rough crossings, off-roadway distractions, up-road signals, etc.). Drivers must be alerted to any problems in searching for and acquiring information (e.g., sight distance limitations, skewed crossings, etc.).

The current method to warn drivers of these additional conflicts is limited. Although the *MUTCD* contains warning signs for many conflicts, there is no common method for informing drivers of crossings with an exceptional number of search barriers without resorting to sign clutter.

#### 4. Improvements to assist drivers in meeting their responsibilities are needed. Motorists are not getting enough relevant information that translates into overt action. Information is not being communicated in a direct and usable form. This ineffective communication often results in confusion about a sign’s meaning or the action required.

The objective of the recommendation is to provide the driver with the necessary information to make an informed, safe, crossing of the tracks while staying within the limits of the amount of information that the driver can process. TCDs that meet this objective will be readily understood and must adequately describe the situation at the crossing. The current system of crossbuck and advance crossing sign (W10-1) does not provide a complete description of the crossing, the associated traffic control, or the driver’s responsibilities.

### 3.2 RECOMMENDED TCDs

In view of the shortcomings associated with the current TCDs, a broad range of new proposed TCDs was evaluated through the task analysis, focus groups, and comprehension and preference testing. The final phase of the analysis focused on signs. Generally, crossings that justify more active TCDs would most likely qualify for standard flashers and gates. Furthermore, many passive crossings are on roads that do not have high-quality pavement or geometrics, which limits the effectiveness of changes to the pavement markings. As previously mentioned, the proposed signs were identified from published literature, observed use, and suggestions from the expert community. The initial alternatives were critiqued by the expert panel, and the final sign program is described below.

**3.2.1 Passive Crossings**

The selected TCD treatment at passive crossings includes a Yield sign or, if conditions warrant, a Stop sign (normally mounted under the crossbuck) at all passive crossings. Figure 5 shows the typical arrangements and the regulatory signs used. The crossbuck is retained to inform drivers of the presence of the rail crossing. Mounting the Yield or Stop sign under the crossbuck is preferred because the Yield or Stop sign is more definitely associated with the crossing. The Yield sign would be the default traffic control, conveying the Yield to Trains message that the crossbuck was intended to convey. Stop signs would only be installed after an engineering study. The recommended criteria for Stop signs are described in Section 3.2.2.

The location of the Yield or Stop sign is also based on the *MUTCD* specifications for locations of crossbucks and Yield or Stop signs. A crossbuck is required to be located a minimum of 12 ft from the centerline of the nearest track. Stop and Yield signs are normally required to be located a minimum of 12 ft from the tangent of a crossroad. Stop lines at crossings are placed a minimum of 15 ft from the nearest rail. These various specifications are all located within 5½ ft of each other. Multiple signposts will increase maintenance costs and may create confusion among drivers depending on the location of the additional sign.

The *MUTCD* currently specifies that the center of a crossbuck should be located a minimum of 9 ft above the edge of the travel way and that the crossbuck extends 18 in. below its center leaving 7.5 ft between the bottom of the crossbuck and

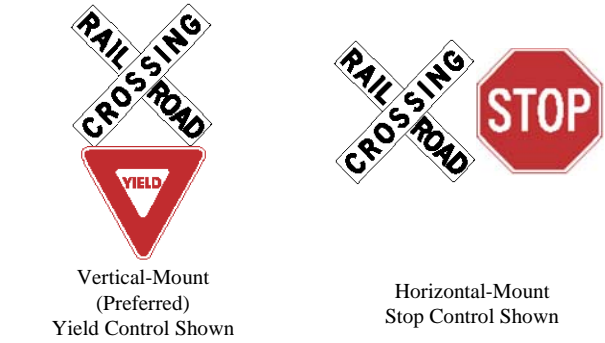


Figure 5. Recommended regulatory signs at passive crossings.

the roadway. The *MUTCD* requires that regulatory (and warning) signs in rural areas should be a minimum of 5 ft above the roadway. It is therefore possible to retrofit properly installed rural crossbucks with standard 30 in. Stop or Yield signs without remounting the crossbuck provided the R15-2 auxiliary sign showing the number of tracks is not required. Where the auxiliary sign is required, the crossbuck may be raised by 18 in. to accommodate all the signs.

In urban areas, the minimum elevation for regulatory signs is 7 ft. The additional 2-ft elevation is to prevent pedestrians and parked vehicles from obscuring the sign. In these cases, the crossbuck may be raised by 24 in. If the additional height creates a problem with visibility of the crossbuck, the crossbuck and the Yield or Stop sign may be installed side by side. Figure 6 shows some typical installations.

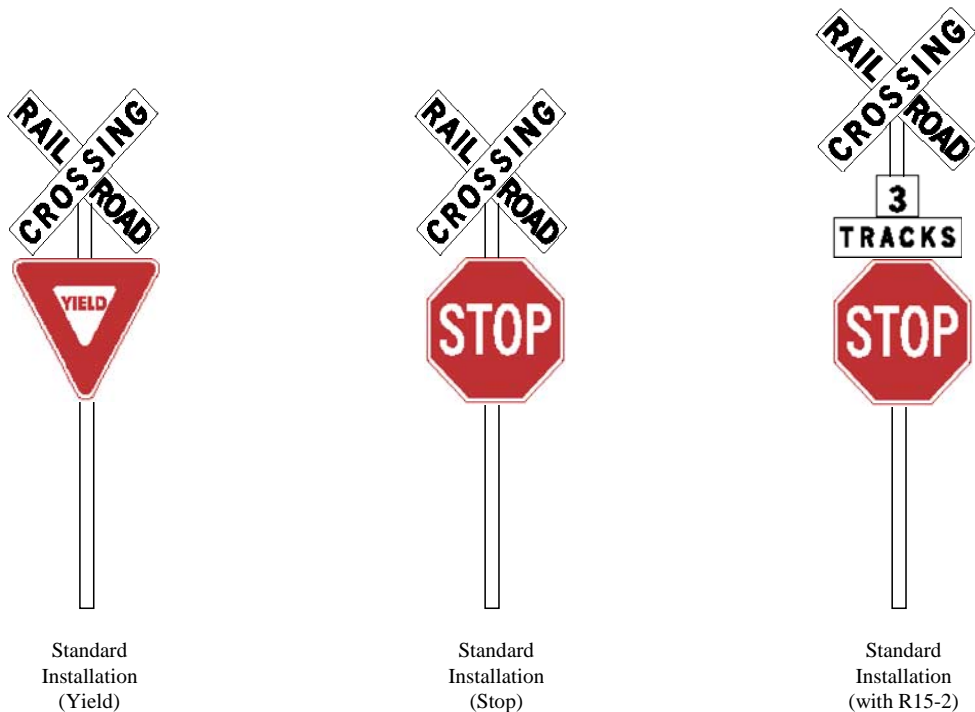


Figure 6. Typical installations of recommended regulatory signs.

### 3.2.2 Warrants for Stop Signs

With the recommendation that Stop signs be an optional element of the sign system at passive crossings, additional guidance on the application of Stop signs is necessary. The current *MUTCD* provides only minimal guidance on the placement of Stop signs at crossings. For passive crossings with two or more trains per day, installation of a Stop sign is at the discretion of the responsible highway agency. For other passive crossings, the *MUTCD* recommends an engineering study. Although a detailed analysis of the effects of Stop signs was not practical, the following discussion provides more specific guidelines based on the results of the literature review and input from the expert panel.

The blanket application of Stop signs to a particular class or type of roadway is *not* recommended. Without a specific hazard related to the crossing, the compliance with the Stop sign is expected to be poor. There is also the increased risk of rear-end collisions associated with a high noncompliance rate. These effects are extrapolated from the performance of Stop signs at intersections. The principle is that by limiting the use of Stop signs, those signs that are installed command greater attention and respect.

To warrant a Stop sign, the crossing would have to meet one or more of the following conditions:

- The line of sight from an approaching highway vehicle to an approaching train is restricted such that approaching vehicle traffic is required to substantially reduce speed;
- Maximum train speed is equal to or greater than 30 mph;
- Train movements exceed four per day, 5 or more days per week;
- The rail line is used by passenger trains;
- The rail line is regularly used to transport a significant quantity of hazardous material; and
- The highway crosses two or more tracks, particularly where both tracks are main tracks or one track is a passing siding that is frequently used.

Stop signs would not be used where the average daily traffic of the crossing highway is 2,000 vehicles or more. The engineering study must show that the Stop sign would improve traffic safety at the site. The engineering study must include an evaluation of active controls at the crossing. Because the objective is to limit the use of Stop signs to locations where they are clearly appropriate, state and local highway agencies would have the power to set more stringent standards than those described above based on their local experience and judgment.

### 3.2.3 Advance Signs—Passive Crossings

The analysis also identified the need for additional driver information on the type of traffic control in advance of the

crossing. This information is not conveyed by the existing Grade Crossing Advance Warning Signs (W10 series). The analysis identified two options for the advance signing. Each has advantages and either would provide a marked improvement in the driver information system. Only one of these options would be selected for implementation.

#### 3.2.3.1 Option 1—Supplemental Plate

In the supplemental-plate option, the information on the presence of a passive crossing would be conveyed by the use of a supplemental plate under the W10-series sign as shown in Figure 7. Typical installations are shown in Figure 8.

In the same manner as highway intersections, at which visibility to the Yield or Stop sign at the crossing is not sufficient for drivers to properly respond to the TCD, a Yield Ahead or Stop Ahead sign would be placed between the W10-1 sign and the crossing. Placement of the Yield Ahead or Stop Ahead sign would be governed by Table 2C-4 in the



Figure 7. Supplemental plaque for passive crossings—Option 1.

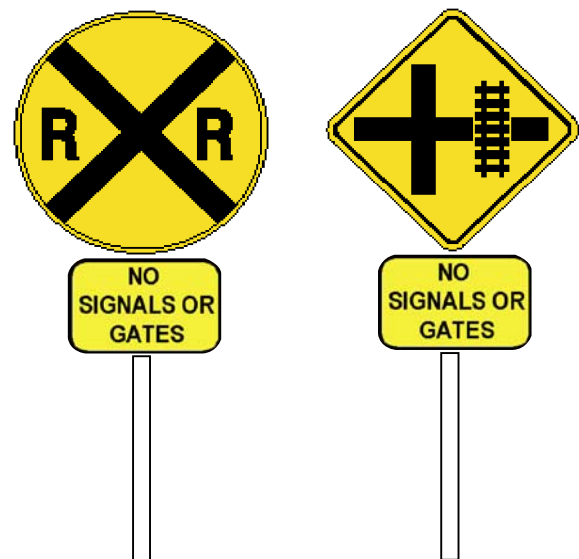


Figure 8. Typical installations: Option 1.

*MUTCD*. Where a Yield Ahead or Stop Ahead sign is used, the W10-1 sign would be placed prior to the Yield Ahead or Stop Ahead sign. The minimum spacing between the Yield Ahead or Stop Ahead sign and the W10-1 sign assembly can be calculated with the equation

$$D = 3.65V,$$

where

$D$  = the distance in ft, and

$V$  = the 85th-percentile speed in mph.

This equation is derived from the perception-reaction time (PRT) needed for a driver to see and comprehend each sign set. The *MUTCD* recommended a PRT of 2.5 s for a potential stop condition. Placement of the W10-1 sign assembly would be governed by the larger of the requirements of Table 2C-4 or the equation described above.

### 3.2.3.2 Option 2—Yield Ahead or Stop Ahead Sign

In this second option, a Yield Ahead or Stop Ahead sign would be mounted under the W10-1 sign regardless of the sight distance to the crossing. A typical installation is shown in Figure 9. Yield Ahead and Stop Ahead signs would not be installed in conjunction with the W10-2, W10-3, or W10-4 signs because of the potential for driver confusion regarding the location of the Yield or Stop sign. Assuming that an appropriate location is available for the sign assembly, the



Figure 9. Typical installation: Option 2.

Yield Ahead or Stop Ahead sign would be located on the side road in conjunction with the W10-1 sign.

### 3.2.3.3 Comparison of Option 1 and Option 2

Both Option 1 and Option 2 are advantageous because they provide direct information about the type of crossing (with associated driver responsibilities) and are distinct from the advance signing for active crossings (as will be discussed in Section 3.2.4). Each option has advantages, and the project team was unable to recommend one option as clearly preferred over the other.

Option 1 has the advantage of providing a very direct and well understood (by English-literate drivers) message that there are no signals or gates. Because a meaningful number of drivers approach rail-highway grade crossings with the expectation that there will be some form of active-warning device, directly addressing this perception is desirable. Although Option 1 relies on a text message, the active-passive distinction in advance signing is still available to the nonliterate because the advance warning sign for the active case (discussed in Section 3.2.4) has a distinct icon. However, relative to Option 2, the distinction may not be as clear for the non-English-literate drivers. Implementation of Option 1 is relatively straightforward because the supplemental plaque can be mounted beneath existing W10 signs without raising some of the issues of consistency with current practice that are raised with Option 2.

Option 2 has the several advantages. It does not rely on text messages; the supplemental plaques for all three crossing types (i.e., yield, stop, or active) have icons. It directly portrays the specific type of crossing including the distinction between Stop-controlled and Yield-controlled crossings. Although the stop-versus-yield distinction is not as critical as the active-versus-passive distinction, there are still different driver requirements on approach. Because the advance and at-crossing signs share common elements (e.g., the Yield or Stop icon), the two devices may serve to function better as a system, reinforcing each other. Option 2 also eliminates the need for a separate Yield Ahead or Stop Ahead sign for those sites at which visibility to the crossing is limited, which creates the benefits of requiring fewer sign assemblies in advance of the crossing and of providing more adequate space for any additional warning signs required (as discussed below). However, Option 2 also has some disadvantages relative to Option 1. One of these disadvantages is the potential installation problem associated with placing two full-size warning signs on the same post. This type of installation has no formal precedent in the *MUTCD*, and the minimum mounting height requirements (5 ft rural and 7 ft urban) will create unusually tall sign assemblies. Another disadvantage is that the supplemental plaque used in conjunction with the W10-1 sign is not

appropriate for the W10-2, W10-3, or W10-4 signs (where the track is parallel to the roadway and the crossing occurs after a turn onto an intersecting roadway). Because of the intersection intervening between the present roadway and the rail-highway grade crossing, the Yield Ahead or Stop Ahead message on the W10 sign would be ambiguous. Some passive crossings near intersections, therefore, may not include any supplemental information signs on one approach or may need to use a text message (as in Option 1).

Either Option 1 or Option 2 would represent an advance over current practice when used as part of the TCD system recommended in this section. Because the argument for one option over the other is not clear, both have been put forth as suggestions that may be considered over the implementation process (as will be discussed in Section 3.3). However, only one of these options ultimately should be selected to carry forward—they are not intended to be alternatives for the practitioner to choose between. A single standard practice should be implemented.

#### 3.2.3.4 Other Warning Signs

In some cases, there may be special conditions at the crossing that warrant additional warning signs. Circumstances that warrant an advance warning sign may include the following:

- Low ground clearance (see W10-5 in Figure 10).
- Sight distance along the tracks is less than the clearing sight distance.
- High-speed trains (see W10-8 in Figure 11).
- Tracks separated by more than 20 ft and less than 90 ft (90 ft is sufficient to store one WB-50 vehicle between the tracks). A modified W10-11a sign may be used.
- Uneven tracks or rough crossings.



W10-5

Figure 10. Low ground clearance.



W10-8

Figure 11. High-speed trains.

- Bumps, dips, or other abrupt changes in highway profile. The W8 series of signs may be applied.
- Steep hills. The Hill sign (i.e., W7-1) may be used.

Where an additional warning sign is used, it should be placed between the advance crossing (W10-1) sign and the crossing unless a Yield Ahead or Stop Ahead sign is installed, in which case the warning sign should be placed between that sign and the crossing.

#### 3.2.4 Advance Signs—Active Crossings

In addition to the above-described signs distinguishing passive crossings, the analysis also identified a need to identify active crossings. The identification of both active and passive crossings is consistent with the objective of providing definitive guidance to drivers approaching the crossing.

Of the active advance crossing signs evaluated, the sign shown in Figure 12 was the consensus choice as the standard. This sign would be mounted directly under the W10-series sign as a supplemental plaque as shown in Figure 13. The signal-lights icon makes the sign immediately distinguishable from the supplemental plaque for passive crossings even for those drivers who are illiterate in English. Drivers will be able to tell well in advance of the crossing what type of control is at the crossing and what actions are required of them.



Figure 12. Supplemental plaque for active crossings.

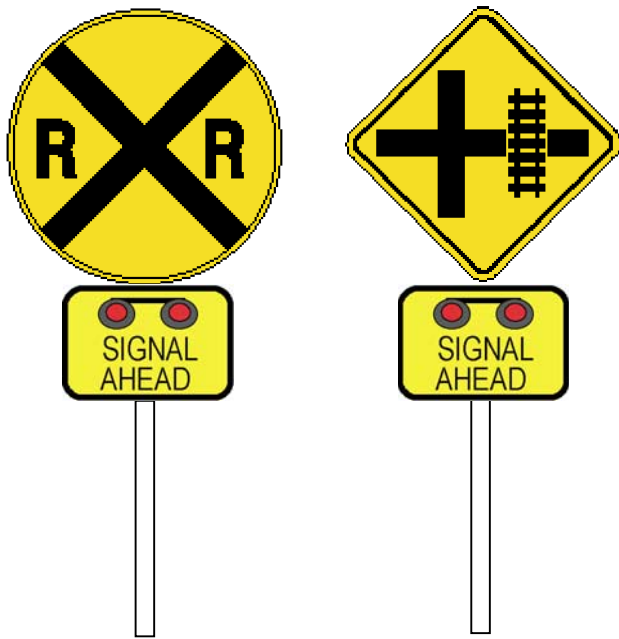


Figure 13. Typical installations: proposed W10-12 sign.

Although the sign legend is new, supplemental plaques with varying messages are commonly employed on highways, and no driver-education effort is expected to be necessary.

### 3.2.5 Conformity of Recommended Signs to Objectives

The recommended TCDs provide a system of signs for passive railroad-highway grade crossings that together serve well to meet the requirements for a more-effective warning system. The system, under either Option 1 or Option 2, has three primary components: (1) an at-crossing sign assembly that indicates a specific regulatory control condition; (2) a railroad advance warning sign assembly, which discriminates active from passive crossings; and (3) a provision for warnings regarding specific site factors, where appropriate, to be located between the crossing and the railroad advance warning sign assembly. Figure 14 illustrates this system for the Yield-control situation. In addition, Option 1 would require separate Yield Ahead or Stop Ahead signs under conditions in which the visibility of the crossing is limited.

The proposed sign system appears to serve well the objectives described above. A definitive legal traffic control is associated with each crossing that is distinct from the control imposed at an active crossing. Under Option 1, the associated Yield Ahead and Stop Ahead signs provide notice of the types of actions that will be required of the driver at the crossing in cases in which the Yield or Stop sign alone is not visible for the distance specified in *MUTCD* Section 2 C.05. Under Option 2, the Yield Ahead or Stop Ahead sign is always presented. Most of the system uses existing signs that do not

require special driver-education activities for general public understanding. Although the legends on the supplemental plates are new, there is no generally recognized symbol for passive or active crossings, and the signs had good comprehension scores. The driver-education effort associated with the supplemental plaques is expected to be minimal. Potential confusion between two signs with the same meaning during the transition period will also be avoided. A more detailed comparison of the recommendation with identified deficiencies is shown in Table 7.

## 3.3 IMPLEMENTATION PLAN

This research has culminated in a recommendation for TCDs at passive crossings, that is, crossings without traffic signals, flashing signals, or gates. If the recommendation is accepted by the profession and by those responsible for installing and maintaining these devices, an implementation plan will be necessary. This section of the report discusses the elements of that plan.

### 3.3.1 Research Product

The primary recommendation from this research contains the following:

1. All railroad-highway grade crossings that do not warrant train-activated devices should have a Yield sign (*MUTCD* R1-2) placed under the crossbuck sign (*MUTCD* R15-1) unless conditions warrant the use of the Stop sign (*MUTCD* R1-1).
2. The conditions that would warrant a Stop sign include the following:
  - The line of sight from an approaching highway vehicle to an approaching train is restricted such that approaching vehicle traffic is required to substantially reduce speed;
  - Maximum train speed is equal to or greater than 30 mph;
  - Train movements exceed four per day, 5 or more days per week;
  - The rail line is used by passenger trains;
  - The rail line is regularly used to transport a significant quantity of hazardous material;
  - Average daily traffic is less than 2,000 vehicles;
  - The highway crosses two or more tracks, particularly where both tracks are main tracks or one track is a passing siding that is frequently used; and
  - Installation of a Stop sign would not occasion a more-dangerous situation than would exist with a Yield sign.
3. If Option 1 is chosen, a supplemental sign is to be placed under the advance warning sign (*MUTCD* W10-1) for all crossings where either a Yield or Stop sign is used.

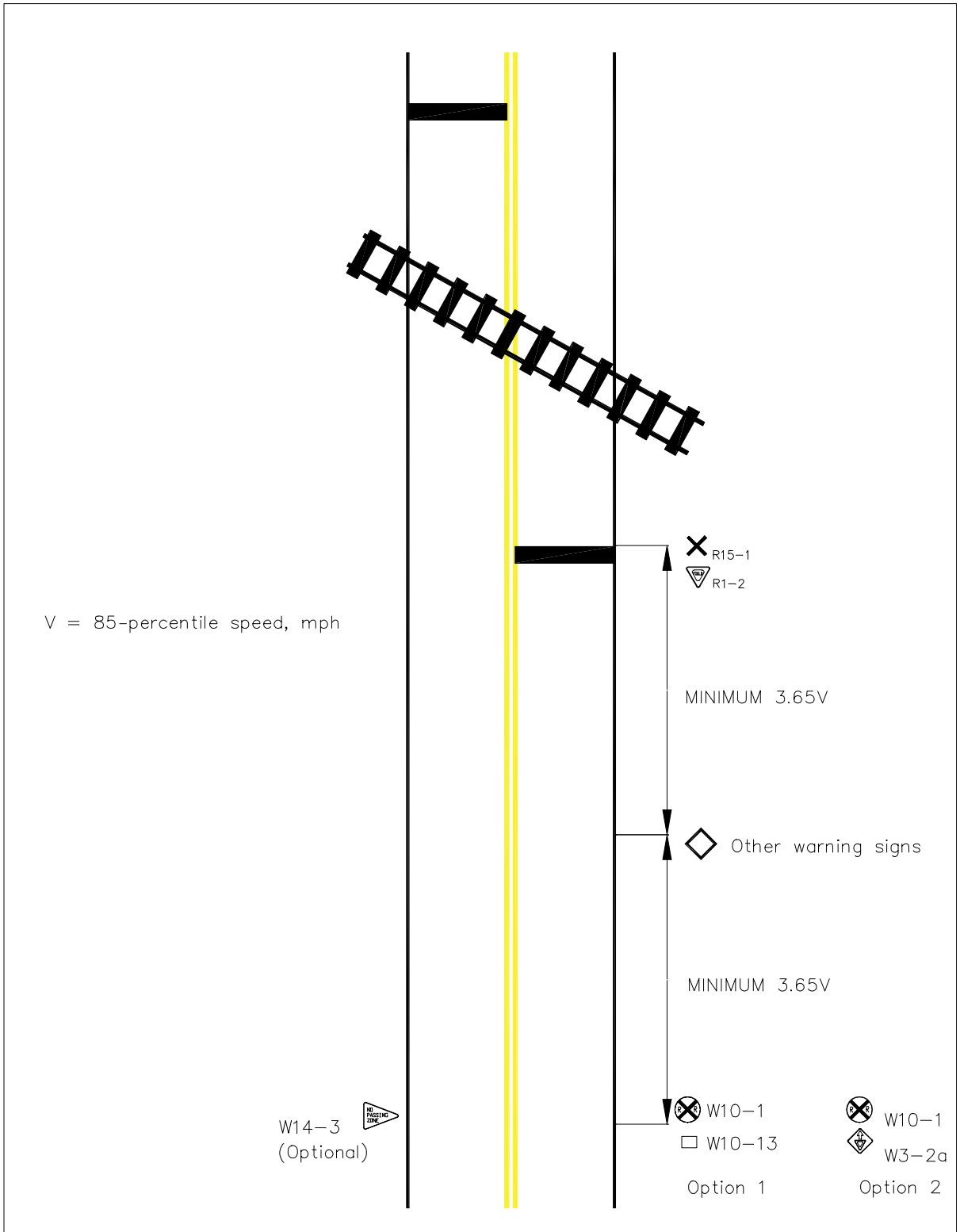


Figure 14. Recommended TCD system (yield-control).

**TABLE 7 Effect of recommended signs on identified deficiencies**

Deficiency	Effect
Crossbuck lacks conspicuity	Yield (or Stop) adds red color, greater retroreflective surface area, and icons with high target value
Some people do not understand that the crossbuck indicates the point of the intersection of the roadway and track	People know Yield (or Stop) is located at the intersection
Poor comprehension of regulatory meaning of crossbuck	Meaning of Yield (or Stop) is well understood
Crossbuck fails to distinguish driver requirements for active vs. passive crossings	Presence of Yield (or Stop) indicates passive crossing
Stop–look–listen fallacy	Clearly distinguishes when mandatory stop is required; Yield does not imply stop
Potential for vehicle–vehicle conflicts	Use of Yield unless Stop is warranted
Difficult to distinguish active vs. passive crossings on approach	Well-understood distinct advance signs for Yield, Stop, or active crossing
Lack of a clear indication of need and responsibility to search	Yield is understood to mean search for conflicting vehicles
Failure to induce appropriate slowing	Yield is understood to require slowing
Ineffective for non-English-literate drivers	Well-understood icons for Yield, Stop; also an icon for active-crossing signal
Problems of transition to new system, public understanding, conflicting systems	System is based on adding existing regulatory sign and supplemental panels to current signs
Coping with special demands, unusual features	Advance signing for hazards, under well-defined conditions of presentation

That sign should read No Signals or Gates. The use of Stop Ahead (*MUTCD* W3-1a) and Yield Ahead (*MUTCD* W3-2a) signs should be limited to locations at which sight distance to the crossings is limited.

- If Option 2 is chosen, all passive crossings would have a Yield Ahead or Stop Ahead sign mounted under the advance warning sign.

**3.3.2 Proposed Changes to the *MUTCD***

The adoption of this recommendation will require a change to the *MUTCD*. What changes are necessary is discussed below under the relevant sections of the *MUTCD* (the Millennium Edition) (1). Where the different advance signing options require different *MUTCD* text, the text sections are shown by option.

**3.3.2.1 *MUTCD* Section 8B.02, Highway-Rail Grade Crossing Sign (R15, R15-2)**

The authors are recommending that a Yield sign be used with the crossbuck sign as a standard treatment and that the Yield sign be replaced with a Stop sign if there are warranting conditions. This usage changes the use of a Yield or Stop

sign to a standard (i.e., shall) requirement from its current optional (i.e., may) level.

Although the research team believes that the Yield or Stop sign should be under the crossbuck sign on the same post, it recognizes that allowing the option of placing either sign on its own post in proximity to the crossbuck sign will facilitate widespread implementation. There will be differences across the country with respect to this aspect of the Yield or Stop sign use; however, it is not believed to be so critical as to mandate that the Yield or Stop sign be placed on the same post as the crossbuck sign. As long as the Yield or Stop sign is placed close to the crossbuck, driver comprehension and behavior should be the same as if the Yield or Stop sign were placed on the same post with the crossbuck sign.

Based on the above statements, Section 8B.02 would be revised by the insertion of the following.

**Standard:**

[Option 1:]

If no active traffic control systems, described in Chapter 8D, are present, a YIELD (R1-2) sign or STOP (R1-1) sign shall be installed. Yield Ahead (W3-1a) or Stop Ahead (W3-2a) Advance Warning signs shall also be installed if the criteria for their installation given in Section 2C.26 are met. A STOP sign may be used only if the criteria in Section 8B.07 are met.

[Option 2:]

If no active traffic control systems, described in Chapter 8D, are present, a YIELD (R1-2) sign or STOP (R1-1) sign shall be installed. A STOP sign may be used only if the criteria in Section 8B.07 are met.

**Guidance:**

The YIELD or STOP sign may be placed either directly under the Crossbuck (or the Number of Tracks Sign, if used) or on a separate post. Placing the YIELD or STOP sign under the Crossbuck is the preferred method and should be used where practical. YIELD or STOP signs on separate posts shall be placed as close to the Crossbuck as practical and at the same height.

*MUTCD* Figure 8B-1 would be replaced by the figure shown in Figure 15. Essentially, this revised figure recognizes that if the Yield or Stop is used on the same post, then the 2.8-m height to the center of the crossbuck will need to be increased to allow adequate vertical clearance to the Yield or Stop sign.

**3.3.2.2 *MUTCD* Section 8B.03, Highway-Rail Grade Crossing Advance Warning Signs (W10 Series)**

The authors have concluded that the motorist needs advance warning as to whether there are active devices. The recommendation for accomplishing this warning is to have a supplemental plaque that would be placed under the advance warning sign. Two options—Options 1 and 2—have been put forth.



R15-1  
(drilled for 90-degree mounting)



R15-2

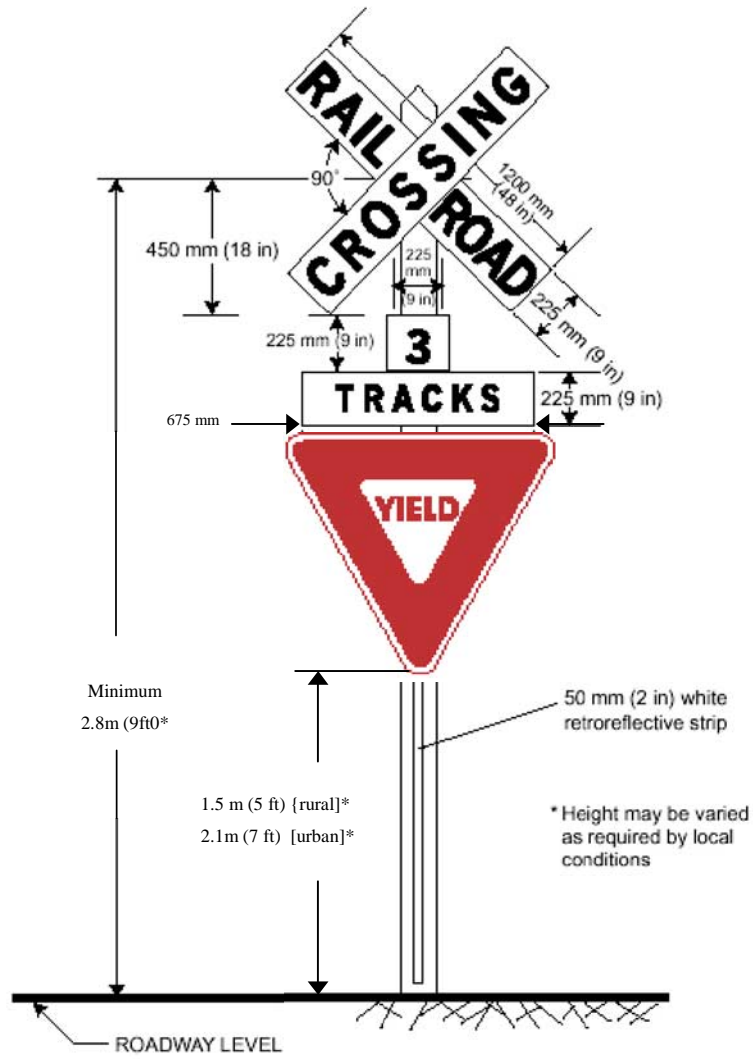


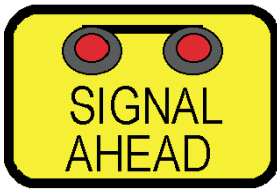
Figure 15. Highway-rail grade crossing (crossbuck) sign.

Section 8B.03 would be modified by the insertion of the following. *MUTCD* Sections 8B.12 and 8B.13 would be deleted because they would be superseded by this recommendation.

**Standard:**

[Option 1:]

All W10-1, W10-2, W10-3, or W10-4 signs shall be used in conjunction with a supplemental plaque that describes the type of traffic control at the crossing. If there are active controls, the Active Control (W10-12) sign shall be used. If there are no active controls, the Passive Control (W10-13) sign shall be used.



W10-12

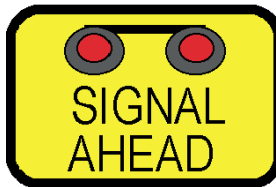


W10-13

If a Yield Ahead or Stop Ahead sign is installed on the approach to the crossing, the W10-1 sign and supplemental plaque shall be installed in advance of the Yield Ahead or Stop Ahead sign. The minimum distance between the signs shall be defined by the formula  $D=3.65V$ , where  $D$  is the distance in feet and  $V$  is the 85th-percentile speed in miles per hour. The Yield Ahead or Stop Ahead sign shall be located in accordance with Table 2C-4 or the procedure described above.

[Option 2:]

All W10-1 signs installed in advance of a crossing without active controls shall include below the W10-1 sign a Yield Ahead (W3-1a) or a Stop Ahead (W3-2a) sign, depending on whether a Yield or Stop sign is installed at the crossing.



W10-12

If there are active controls at the crossing, the Active Control (W10-12) supplemental plaque shall be used in conjunction with the W10-1, W10-2, W10-3, or W10-4 signs.

### 3.3.2.3 *MUTCD* 8B.07, STOP or YIELD Signs at Highway-Rail Intersections

To adopt the recommendation stated above, it will be necessary to rewrite this *MUTCD* section focusing on the criteria for Stop signs.

The following is the suggested wording.

### Section 8B.07 STOP Signs at Highway-Rail Intersections

Guidance:

Where warranted by an engineering study, STOP signs may be installed at highway-rail intersections in accordance with Section 8B.02. Conditions that shall be considered include:

- A. The line of sight from an approaching highway vehicle to an approaching train is restricted such that approaching vehicle traffic is required to substantially reduce speed;
- B. Maximum train speed is equal to or greater than 30 mph;
- C. Train movements exceed four per day, 5 or more days per week;
- D. The rail line is used by passenger trains;
- E. The rail line is regularly used to transport a significant quantity of hazardous material;
- F. The highway crosses two or more tracks, particularly where both tracks are main tracks or one track is a passing siding that is frequently used.

The engineering study must verify that installation of a STOP sign will not occasion a more-dangerous situation than would exist with a YIELD sign. The engineering study shall include an evaluation of active controls at the crossing.

**Standard:**

A STOP sign shall not be installed at any crossing with active traffic control systems or at crossings averaging more than 2,000 highway vehicles on an average day.

Option:

A state or local highway agency, at its discretion, may impose stricter requirements for STOP signs than those described in this section.

### 3.3.3 Product Audience

The audience for this report and product are the agencies responsible for the installation and maintenance of the recommended TCDs. For a vast majority of crossings, the responsible agencies are state and local highway agencies; other stakeholders include the railroad industry, the public utility commissions that have control over railroad operations, and the state legislatures that can alter state vehicle codes.

FHWA is the only agency that can change the *MUTCD* and, therefore, is a critical audience. However, a change will not take place until there is appropriate rulemaking and public comment. Although changes to the *MUTCD* can be recommended by any person or agency, most changes are generated through the activities of NCUTCD. Within NCUTCD, there is a Railroad/Light Rail Transit Grade Crossing Technical Committee, which initially reviews recommended changes and passes the changes on to the full committee.

### 3.3.4 Assessment of Implementation Impediments

There are several impediments to successful implementation. First, the professional community and FHWA will have

to agree to the proposed change to the *MUTCD*. Resistance is likely because there are no empirical studies to show that using the devices will affect motorist behavior and forestall crashes at crossings. The recommendations are based on limited studies of motorist understanding and preferences, previous research, analytical assessments, and opinions of experts who are not unanimous. Although the researchers believe the recommendations are based on sound analytical assessment of all the input, the community may require more-empirical evidence of the merit of the recommendation.

The second impediment will be the resistance of highway agencies, especially those in local and less-populated areas, to accept the requirement to add new signs because of the additional costs for installation and maintenance. If an existing passive-device crossing has no Yield or Stop sign, then it will require the installation and maintenance of two new signs (i.e., one at each approach). The cost for each sign installed is approximately \$200, \$400 for each crossing. Also, an additional plaque will have to be counted with each W10-1 sign and with W10-2, W10-3, and W10-4 signs under Option 1. The service life for these signs is at least 10 years, so these additional costs would be repeated within that cycle. Agencies with limited funds will argue that even this modest increase cannot be absorbed within their budgets. One way to overcome this financial impediment is set a compliance date that is several years away. This timeframe would allow agencies to install the needed signs over a period of years and minimize the impact to their operating budgets.

There are also two legal issues associated with implementation. The first of these issues is the enforceability of the Yield and Stop signs at the crossings. Most state vehicle codes follow the model Uniform Vehicle Code (UVC) very closely. Section 11-403 of the UVC states that when faced with a Stop sign, a driver must come to a full stop; when faced with a Yield sign, a driver must “. . . slow down to a speed reasonable for the existing conditions and, if required for safety to stop, shall stop. . . .” The application of these rules of the road at grade crossings is not specifically mentioned in the UVC. In UVC Section 15-109, state and local highway agencies are given authority to “. . . erect stop and yield signs to designate through highways, or to designate intersections or other roadway junctions at which vehicular traffic on one or more of the roadways should yield or stop and yield before entering the intersection or junction.” Unless a grade crossing is considered a junction, there is no provision within the UVC for installing these signs at the crossing. Furthermore, the conditions for stopping or yielding noted in UVC Section 11-403 refer to an intersection of two roadways and yielding to a *vehicle*, which, as defined by the UVC, does not include a train. So, one could argue that motorist violation of Stop and Yield signs at grade crossings is not enforceable because these signs are not authorized at these locations, there is no rule of the road that applies to these signs at grade crossings, or both. The implication is that changes to state vehicle laws may be necessary for enforcing Yield and Stop

signs at grade crossings. Changes to the UVC would also be helpful.

The second legal issue is that of maintenance and liability. According to the *Compilation Of State Laws And Regulations On Matters Affecting Highway-Rail Crossings (29)*, installing and maintaining crossbucks are usually the responsibility of the railroad while installing and maintaining the Stop and Yield signs are usually the responsibility of the state or local government. There are some exceptions, particularly at private crossings, but this is the general rule. Any legal liability related to the signs usually devolves upon the party responsible for erecting and maintaining the sign. This divided responsibility will impede implementation of the recommendation that the Yield or Stop sign be placed on the same post as the crossbuck. Under the recommendation, the signs could be mounted side by side, but this is not considered optimal. In some cases, regulatory change would be sufficient to establish a uniform maintenance-and-liability responsibility. In other cases, changes to state law would be required.

### 3.3.5 Potential Leadership

The most logical institution for taking leadership is NCUTCD starting with the Railroad/Light Rail Transit Grade Crossing Technical Committee. The recommendation from this report should be reviewed and discussed within the Technical Committee, and if found acceptable as is or as revised, should be passed forward to the full committee.

There are other institutions that will have an interest in the recommendation:

- AASHTO,
- American Railway Engineering and Maintenance-of-Way Association,
- National Association of County Engineers,
- American Association of Railroads,
- FRA, and
- FHWA.

These institutions are represented on NCUTCD.

### 3.3.6 Implementation Activities and Criteria for Judging Implementation Progress

Successful implementation means adoption, or adoption with appropriate modification, of the recommendation into the *MUTCD* and eventual installation of the recommended TCDs by the agencies. The procedure for changing the *MUTCD* has been discussed above, and the best approach would be through the workings of NCUTCD.

As stated previously, there may be reluctance for NCUTCD to recommend the changes and for FHWA to accept changes in the *MUTCD* without empirical evidence of the changes' merit. It may be advisable, therefore, to conduct experimentation with

the recommended device. Yield and Stop signs are being used at some crossings already, so it is not a new treatment. However, it may be advisable for several local jurisdictions or even one or more states to implement the recommendation at all appropriate crossings. Driver behavior studies could be conducted at a sample of crossings, and all crossings could be monitored for crash occurrence. This experimentation

may need to be extended for a number of years especially given the relatively low frequency of crashes at passive-device crossings.

The criteria for judging the progress of the implementation will be the number of crossings that are changed to the recommended devices over time and the change in crash occurrence.

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## CHAPTER 4

# CONCLUSIONS AND SUGGESTED RESEARCH

### 4.1 CURRENTLY USED AND PREVIOUSLY SUGGESTED TCDS FOR PASSIVE RAIL-HIGHWAY GRADE CROSSINGS

The following conclusions regarding current or innovative practices were reached during the research.

- Current TCDS (in particular, the W10-1 advance warning sign and the R15-1 crossbuck) have not been designed with a systematic attempt to match the information requirements to support appropriate driver behavior. There are known shortcomings to TCD practice that have not been adequately addressed.
- Despite their long use, W10-1 advance warning signs and R15-1 crossbucks only seem to convey the general idea of “railroad crossing,” but not more specific meanings. There are substantial misperceptions among the driving public regarding the meaning, location, and use of these signs. A meaningful minority of people believe that mandatory stops are required at passive crossings (the “stop-look-listen” rule) even though almost no one does this.
- A meaningful number of people believe that all public rail-highway grade crossings have active TCDS or that passive crossings exist only under special circumstances. From the focus groups, it was found that drivers feel it is particularly important to inform them explicitly when there are no signals or gates at a crossing; they do not feel current practice does this.
- Although previous research has amply demonstrated shortcomings with current practice, there has not been a great deal of rigorous empirical research evaluating the various alternatives that have been suggested. There have been a number of suggestions for changes in terms of crossbuck design, supplementary information panels, use of intersection regulatory control devices, changes to advance warning signage, and other modifications. Although some of these proposals may be promising, there is no definitive demonstration of meaningful benefits from them.

### 4.2 PROPOSED MODIFICATIONS TO CURRENT RAIL-HIGHWAY TCD SYSTEMS

Chapter 3 provided specific recommendations for modifications to the TCD system for rail-highway grade crossings.

The recommendations were based on a number of conclusions regarding desirable features and requirements for an effective TCD system. These conclusions included the following:

- The distinction between active and passive crossings should be made in advance of the crossing at the point of the railroad advance warning sign. The type of crossing should be made explicit for both classes of crossing.
- Drivers must understand on the approach to a passive crossing that they are responsible for visual search to detect conflicting train traffic.
- Regulatory requirements at the crossing should be made explicit at the point of the crossing.
- The R15-1 crossbuck does not have particularly good conspicuity, so its attention-getting value should be enhanced.
- Stop signs should not be the typical (i.e., the default) treatment at passive crossings. A yield condition is preferred unless warrants for the use of a Stop are met.
- Although the W10-1 and the R15-1 devices do not work particularly alone, they can be made more effective through the use of supplementary plaques. Entirely new signs are not required to meet driver information requirements.
- Some site conditions may warrant additional warning signs in order to better convey to the motorist the presence of conditions that should influence driver approach and search.

### 4.3 SUGGESTED RESEARCH

Several needs for continued research are evident from the present study. An obvious limitation to this project was that it was not of a scale to permit a field evaluation of the recommended TCD systems. Other issues relate to refinements of the system and to determination of optimal warrants for use of particular devices. Suggested research areas follow.

#### 4.3.1 Field Evaluation of Recommended TCD Systems

The recommended TCD systems put forth in this report as alternatives to current standard practice should be field

implemented and formally evaluated. This evaluation should include safety effects, operational effects, implementation and maintenance issues, and enforcement and liability concerns. The safety evaluation should include the potential for vehicle-vehicle conflicts, as well as for vehicle-train collisions. Because one intent of the proposed TCD system is to provide the driver with a reliable means of discerning active and passive crossings, it is most appropriate to evaluate the treatment for a region or corridor rather than at isolated sites, and the study area should include active crossings, Stop-controlled passive crossings, and non-Stop-controlled passive crossings.

#### **4.3.2 Warrants for the Use of Stop and Yield Signs**

There remains controversy over the extent to which it is desirable to use Stop signs at rail-highway grade crossings and over the warrants that should govern Stop-sign use. The same issue may be raised for Yield signs if they are not part of the standard TCD system. Although there has been previous work regarding Stop signs, the ongoing controversy shows that the work has not been definitive. Studies often failed to include appropriate consideration of vehicle-vehicle conflicts and operational effects, in addition to other methodological shortcomings. Furthermore, the extent to which the Yield message and sign become incorporated into typical practice may influence warranting criteria for the use of a Stop sign. It may be beneficial to conduct a study of sufficient scale to help resolve questions about the effectiveness of Stop signs under various conditions and to develop detailed warrants for their use.

#### **4.3.3 Additional Warning Elements**

The major elements of the TCD system for rail-highway grade crossings include the advance warning sign, pavement markings, and the crossbuck array. The recommendations for

an improved system include a provision for additional signing to alert the driver about certain site features that may bear on appropriate driver behavior. These features may include line-of-sight restrictions, rough crossings, or high-speed trains. In addition, there are countermeasure treatments, short of installing gates and signals, that may prove helpful at appropriate sites—for example, illumination, rumble strips, or enhanced delineation. Additional research could determine whether proposed signing practices for site features are optimal and effective. It could also develop specific site criteria for the use of warning signs, as well as for other potential countermeasures.

#### **4.3.4 Effects of Intersection TCDs on Compliance**

Part of the debate regarding the use of highway-highway intersection regulatory signs (especially Stop signs) at the rail-highway grade crossing has to do with compliance effects. Proponents of the use of such highway-intersection TCDs argue that the rail-highway application would benefit from the (presumably) better comprehension of, and compliance with, highway intersection-related TCDs. Opponents argue that broad use of these regulatory devices for applications with low compliance will degrade respect for the devices at all applications. Because Stop signs and other regulatory devices are so widespread and critical in intersection traffic control, there is a potential for severe traffic safety consequences even if there is only a minor amount of generalized disrespect. Therefore, this is an important issue in considering the net safety benefit of changing rail-highway grade crossing practice with respect to intersection regulatory signs. There is little direct empirical support bearing on this issue. It may prove a very difficult problem to research because it is a traffic-*system* issue and may involve only very small effects at any given intersection site. However, if appropriate research methodologies can be found, the question remains an important one to address.

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**APPENDIX**

**SIGN DESIGNS AND LAYOUTS USED FOR FOCUS GROUP DISCUSSIONS**

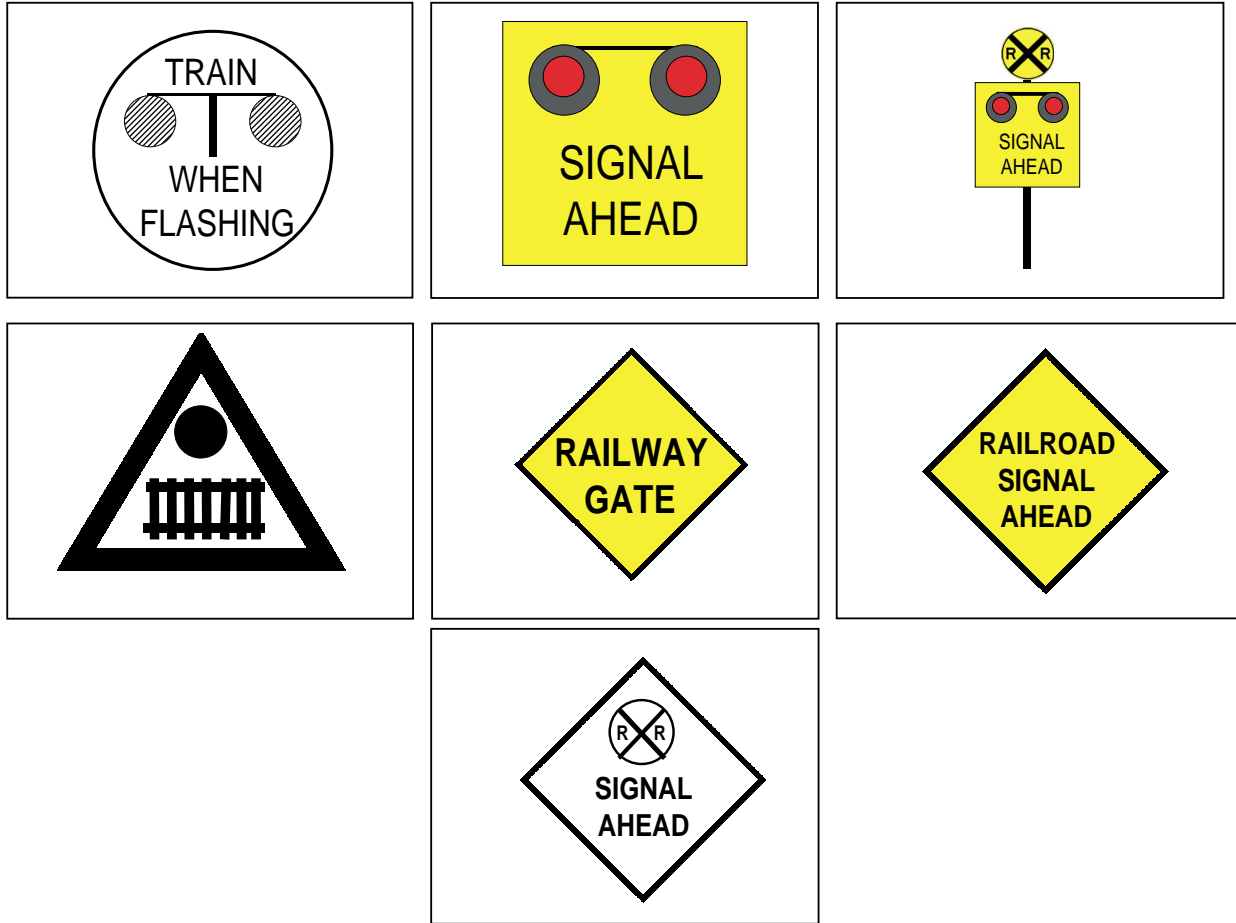


Figure A-1. Alternative active-crossing signs indicating the presence of an active warning device (lights, bells, and/or gates).

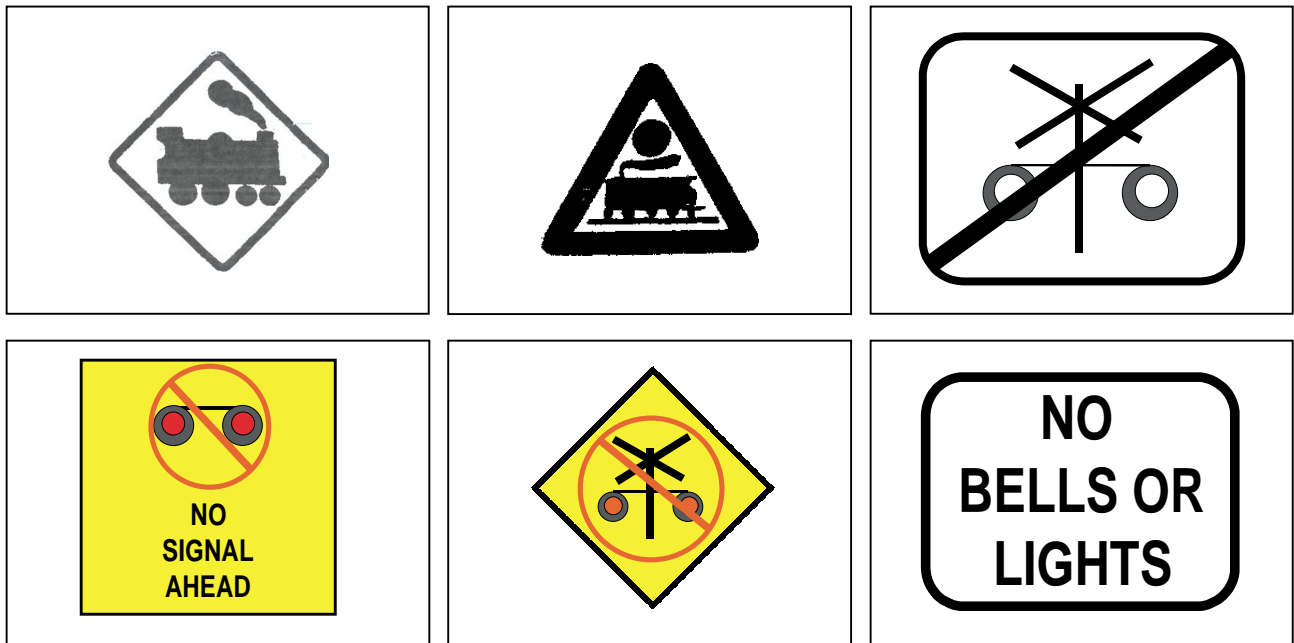


Figure A-2. Alternative passive-crossing signs indicating the lack of an active warning device (lights, bells, and/or gates).

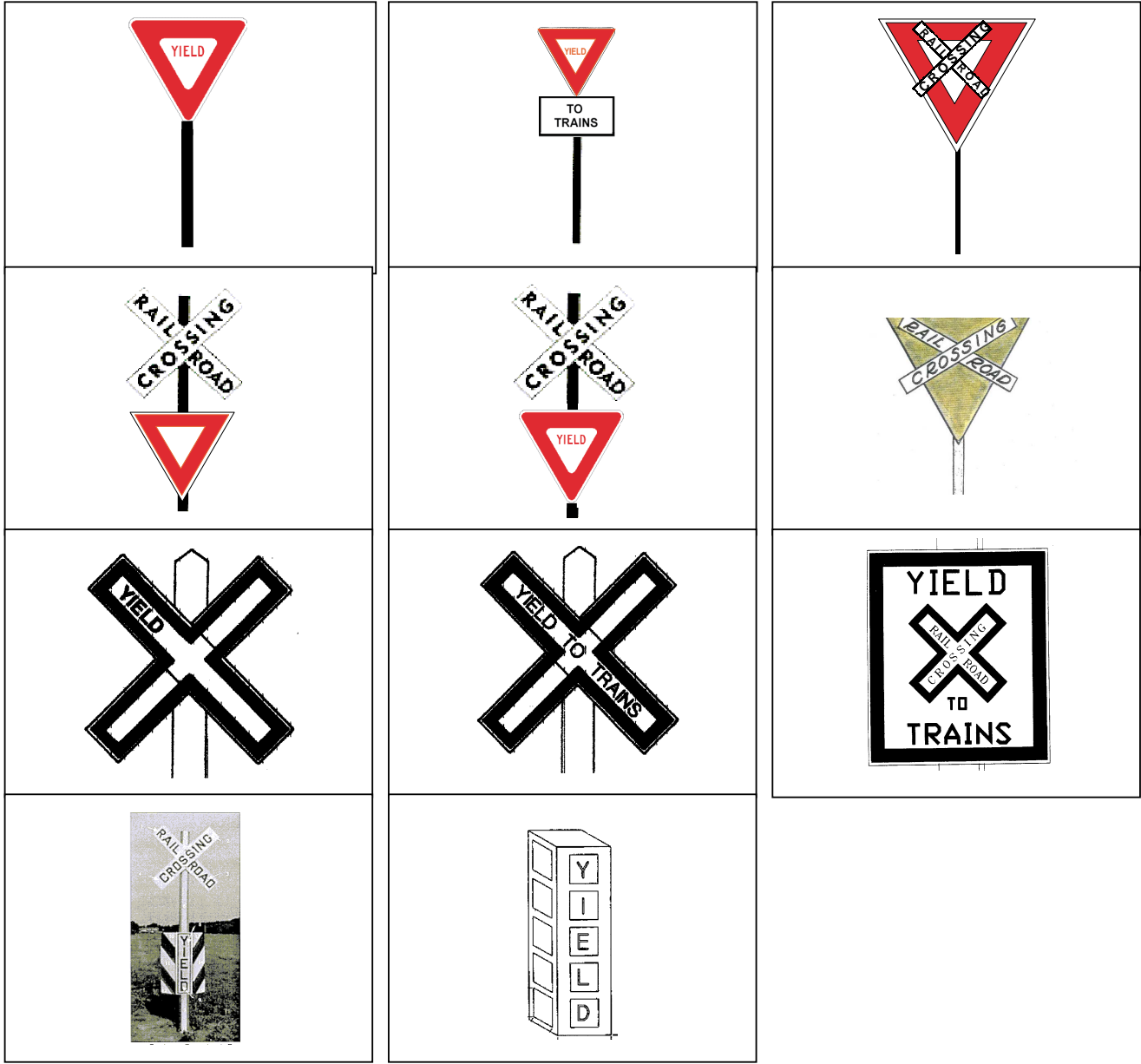


Figure A-3. Alternative Yield-message signs and sign configurations.

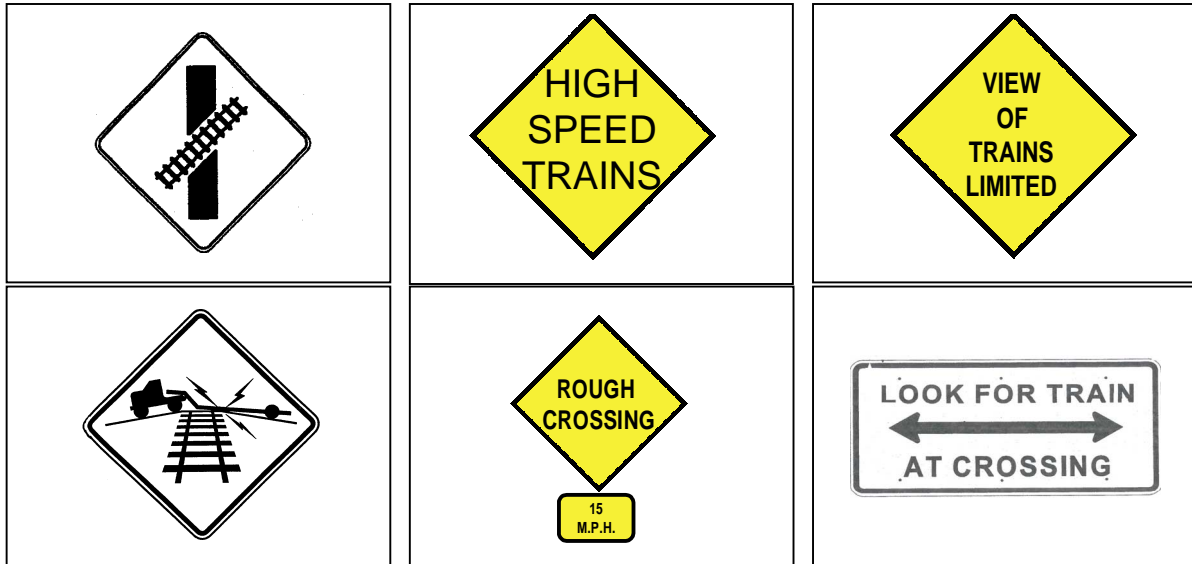


Figure A-4. Alternative signs indicating crossing features.

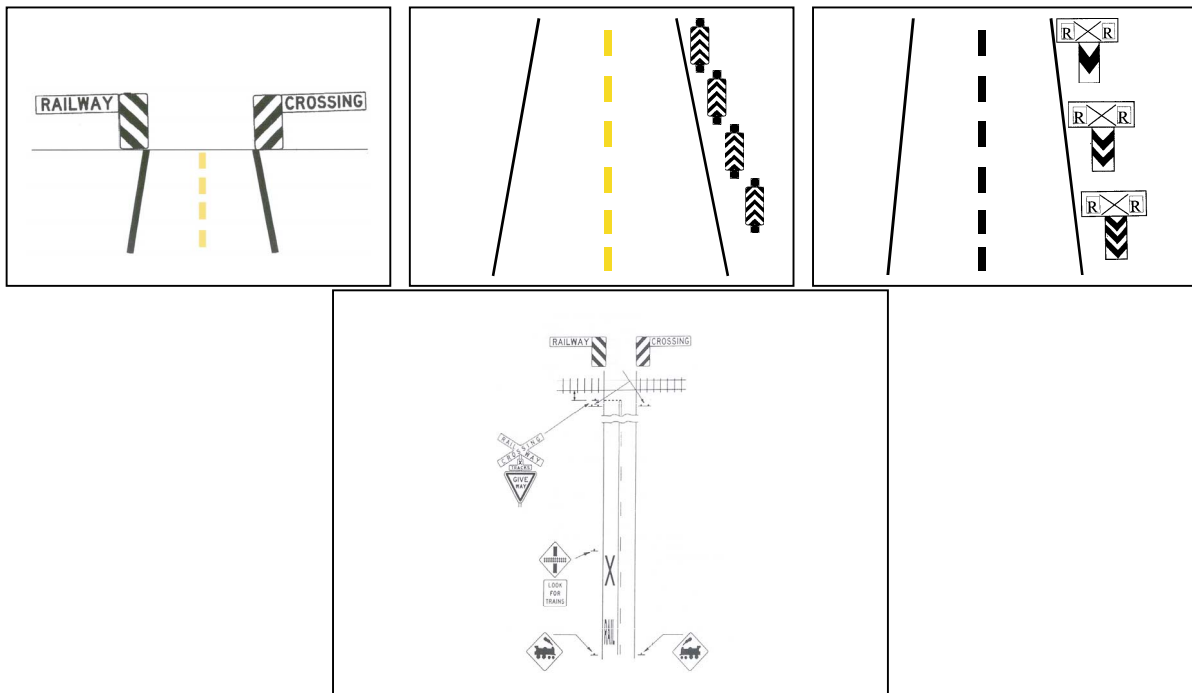


Figure A-5. Alternative zone concepts and crossing layouts.

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Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
U.S.DOT	United States Department of Transportation

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