MDOT
Michigan Department of Transportation

GUIDELINES FOR HIGHWAY-RAILROAD GRADE CROSSINGS

MDOT GUIDELINES

FOR HIGHWAY-RAILROAD GRADE CROSSINGS

These guidelines are a compilation of relevant information, specifications, and standards to be referenced when making determinations regarding public highway-railroad grade crossings. Users of this document are advised to contact the Michigan Department of Transportation's (MDOT) Rail Safety Section at 517-373-8235, for further guidance and assistance with public highway-railroad grade crossing issues.

This document has been prepared, reviewed, and published in accordance with appropriate State of Michigan and MDOT rules for dissemination of public information.

TABLE OF CONTENTS

INTRODUCTION

Traffic control systems for highway-railroad grade crossings include all signs, traffic signals, railroad warning devices, pavement markings, illumination devices, and any necessary supporting equipment at the crossing and along the approaches. The function of the traffic control system is to permit reasonably safe and efficient operation of both highway and railroad traffic at highway-railroad grade crossings.

Traffic control systems should be consistent with the design, installation, and application of the information contained in the current Michigan Manual on Uniform Traffic Control Devices (MMUTCD), and/or applicable federal and state laws and regulations. The traffic control systems and practices described herein are intended for use both in new installations and at locations where existing components are replaced or upgraded, consistent with federal and state laws and regulations.

The Michigan Department of Transportation (the Department) is vested by law with regulatory and enforcement authority to review all public highway-railroad grade crossings and to require any improvements, adjustments, relocations, closures, or other changes as may be reasonably required in the interest of public welfare and safety.

As of 2016, there were approximately 28 railroad companies in the state of Michigan, operating over approximately 4,650 public highway-railroad grade crossings and shared-use paths. About half of the crossings are equipped with active warning devices consisting of flashing-light signals, roadway gates or a combination of these devices.

For purposes of installation, operation, and maintenance of traffic control systems at highway-railroad grade crossings, it is recognized that the crossing of the highway and railroad tracks is situated on right-of-way available for the joint use of both highway traffic and railroad traffic. Consequently, this requires joint responsibility in the traffic control function between road authorities and railroads.

In compliance with Public Act (P.A.) 354 of 1993 (Michigan's Railroad Code of 1993), the selection of devices to be installed at a highway-railroad grade crossing is evaluated by a diagnostic study team comprised of knowledgeable individuals representing the Department, the roadway authorities with jurisdiction, the operating railroads, and other relevant affected parties as appropriate on a case-by-case basis. Diagnostic study teams perform a review of conditions at existing or proposed highway-railroad crossings and provide input to assist the Department with its determination concerning safety needs at each crossing.

This document provides an overview of typical practices and devices used at highway-railroad grade crossings throughout the state. These guidelines are based upon proven and sound safety management principles and are intended to ensure consistent and reasonable crossing safety determinations. Definitions are provided to establish a better understanding of common highway-railroad terminology. In addition to providing users with detailed information about recent traffic control system innovations for highway-railroad grade crossings, many source documents and related content, such as traffic control for crossings in construction zones, are referenced and linked electronically. Future updates to these guidelines will be published as necessary.

DEFINITIONS

Active Traffic Control Devices – traffic control devices located at or in advance of highway-railroad grade crossings, such as flashing-light signals, automatic gates and similar devices, which are activated either automatically or manually to warn highway users about the approach or presence of a train.

Advance Preemption – the notification of an approaching train that is forwarded to the highway traffic signal control unit (or assembly) by the railroad equipment in advance of the activation of the railroad warning device.

Advance Preemption Time – the period of time that is the difference between the required maximum highway traffic signal preemption time and the minimum warning time required for the activation of the railroad warning devices.

Automatic Gate – a barrier that is lowered across the roadway when a train is approaching or occupying the crossing.

Bell (Gong) – a mechanical or electronic device that produces a repeated ringing or clanging sound at a highway-railroad grade crossing upon the approach of a train.

Cantilevered Signal Structure – a structure that is rigidly attached to a vertical pole to provide overhead support of signal devices.

Clear Storage Distance – the distance available for vehicle storage measured from a point six feet from the rail nearest the intersection to the intersection stop line, or the normal stopping point on the highway. At skewed highway-railroad grade crossings and intersections, the six-foot distance should be measured perpendicular to the nearest rail either along the center line or edge line of the highway, as appropriate, to obtain the shorter distance. Where exit gates are used as part of a four-quadrant gate system, the distance available for vehicle storage is measured from the point where the rear of the vehicle would be clear of the exit gate arm. In cases where the exit gate arm is parallel to the track(s) and is not perpendicular to the highway, the distance is measured either along the center line or edge line of the highway, as appropriate, to obtain the shorter distance.

Department – Michigan Department of Transportation (MDOT).

Diagnostic Study Team Review (DSTR) – a group of knowledgeable individuals from the Department, road authorities, railroads, and other relevant affected parties who meet and, using highway-railroad grade crossing safety management principles, evaluate conditions at proposed or existing crossings and assist the Department in making determinations concerning safety needs.

Emergency Notification System (ENS) Sign – contains information for road users to notify the railroad company about emergencies or malfunctioning traffic control devices at crossings. The sign shall include the USDOT Number/National Inventory Number and the railroad emergency contact phone number.

Engineering Judgment – the evaluation of available pertinent information and the application of appropriate principles, standards, guidance, and practices as contained in this manual and other sources for the purpose of deciding upon the applicability, design, operation, or installation of traffic control devices. An engineering judgment shall be formulated 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.

Engineering Study – the comprehensive analysis and evaluation of available pertinent information, and the application of appropriate principles, standards, guidance and practices as contained in this guideline and other sources for the purpose of deciding upon the applicability, design, operation, or installation of traffic control devices. 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.

Equipment Housing – a box, cabinet, or bungalow used to shelter hardware elements required to control the operation of active traffic control devices or train control systems.

FHWA – Federal Highway Administration.

Flagger (Watchperson) – a qualified railroad employee who is on the ground at a highway-railroad grade crossing to signal to highway users the impending movement of a train or other railroad on-track equipment over the crossing.

Flashing-Light Signals – a warning device consisting of two red signals arranged horizontally that are activated to flash alternately when a train is approaching or present at a highway-railroad grade crossing.

FRA – Federal Railroad Administration.

Highway – a general term denoting a public right-of-way for purposes of travel by vehicle, bicycle, pedestrian and/or non-motorized traffic, including the entire area within the right-of-way.

Highway-Railroad Grade Crossing – the general area where a highway and a railroad right-of-way cross at the same level. This area includes the railroad tracks, the highway and the traffic control devices for highway traffic traversing that area. *Also see Public Grade Crossing.*

Highway User – a motor vehicle operator, bicyclist, pedestrian, or person with a disability(s) using a special device, traveling within any portion of the highway.

Interconnection – an electrical connection between active railroad warning device systems for activation or between an active railroad system and the highway traffic signal controller for the purpose of preemption.

Mainline Track – a track extending through yards and between stations, upon which trains are operated by timetable or train order, or both, or the use of which is governed by block signals.

Median – the area between two roadways of a divided highway measured from edge of traveled way to edge of traveled way.

Michigan Manual on Uniform Traffic Control Devices (MMUTCD) – a document that constitutes the prescribed standards of design, construction, and application of traffic control devices for use on the roads within the state of Michigan.

National Inventory Number (NI#) – unique number assigned to each highway-railroad grade crossing, by the Federal Railroad Administration (FRA), which designates its location. *Also known as USDOT#.*

Passive Traffic Control Devices – traffic control devices, including signs, markings and other devices, located at or in advance of highway-railroad grade crossings to indicate the presence of a crossing, but are not activated upon the approach or presence of a train.

Preemption – the transfer of normal operation of highway traffic signals to a special control mode.

Pre-signal – supplemental highway traffic signal faces operated as part of the highway intersection traffic signal system, located in a position that controls traffic approaching the highway-railroad grade crossing in advance of the intersection.

Public Grade Crossing – a highway-railroad grade crossing where the roadway is under the jurisdiction of and maintained by a public authority and open to public travel. All roadway approaches must be under the jurisdiction of the public roadway authority, and no roadway approach may be on private property.

Public Road – any road or street that has been dedicated and constructed in accordance with law under the jurisdiction of and maintained by a public authority and open to public travel.

Queue Clearance Time – the time required for the design vehicle of maximum length stopped just inside the minimum track clearance distance to start up and move through and clear the entire minimum track clearance distance. If pre-signals are present, this time shall be long enough to allow the vehicle to move through the intersection, or to clear the track if there is sufficient clear storage distance. If a four-quadrant gate system is present, this time shall be long enough to permit the exit gate arm to lower after the design vehicle is clear of the minimum track clearance distance.

Rail Equipment – rail-mounted maintenance equipment or rail car(s) that are either stationary or moving on any track without a locomotive.

Railroad – a person, partnership, association, or corporation, their respective lessees, trustees, or receivers, appointed by a court, or other legal entity operating in this state either as a common carrier for hire or for private use as a carrier of persons or property upon cars operated on stationary rails and includes any person, partnership, association, corporation, trustee, or receiver appointed by a court or any other legal entity owning railroad tracks.

Retroreflective – a property of a surface that allows a large portion of the light coming from a point source to be returned directly back to a point near its origin.

Road Authority – an agency having jurisdiction over public streets and highways. Road authorities include the Department, other state agencies or federal, county, city and village governmental agencies or other public institutions recognized by legislation as having responsibility for the construction, repair, and maintenance of public highways.

Roadway – that portion of a highway improved, designed, or ordinarily used for vehicular travel and parking lanes, but exclusive of the sidewalk, berm, or shoulder even though such sidewalk, berm, or shoulder may be used by persons riding bicycles or other human-powered vehicles. In the event a highway includes two or more separate roadways, the term roadway as used herein shall refer to any such roadway separately, but not to all such roadways collectively.

Shared-Use Path – a path with a minimum width of 10 foot that is physically separated from vehicular traffic by an open space or barrier, and either within the highway right-of-way, or within an independent alignment. Shared-use paths are used by bicyclists, pedestrians, skaters, users of manual and motorized wheel chairs, joggers, and other authorized users.

Side Track – an auxiliary track that typically runs parallel to the mainline track.

Sidewalk – that portion of a highway between the curb line or the lateral line of a roadway and the adjacent property line, or on easements of private property, that is paved or improved and intended for use by pedestrians. A sidewalk has a minimum width of four feet.

Simultaneous Preemption – notification of an approaching train, forwarded to a highway traffic signal controller and the railroad active warning devices for activation of both systems at the same time.

Spur Track (Industrial Track) – as distinguished from a side track, a spur track or industrial track, of indefinite length, extending away from a main line.

Stop Line – a solid white pavement marking line extending across approach lanes to indicate the point at which a stop is intended or required to be made.

Track Circuitry – a system of electronic and/or audio frequencies typically carried in the rails on the railroad approach to a highway-railroad crossing, used to detect the presence or approach of railroad equipment and to trigger the operation of an active warning device system.

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

Traffic Control Device – a sign, signal, marking, or other device used to regulate, warn or guide traffic, placed on, over or adjacent to a street, highway, pedestrian facility, or shared-use pathway by authority of a public agency having jurisdiction.

Train – one or more locomotives coupled, with or without cars, that operates on rails or tracks and to which all other traffic must yield the right-of-way by law at highway-railroad grade crossings.

Traveled Way – the portion of the roadway for the movement of vehicles, exclusive of the shoulders, berms, sidewalks, and parking lanes.

USDOT Number (USDOT #) – *see National Inventory Number.*

Wayside Equipment – the signals, switches and/or control devices for railroad operations located as stand-alone components or contained within one or more equipment housings along the railroad right-of-way and/or on railroad property.

PASSIVE HIGHWAY-RAILROAD TRAFFIC CONTROL DEVICES

Passive traffic control systems, consisting of signs and pavement markings, identify and direct attention to the location of a highway-railroad grade crossing to permit highway users to take appropriate action. Signs and pavement markings are to be in conformance with the current Michigan Manual on Uniform Traffic Control Devices (MMUTCD).

No sign shall be located in the center of an undivided roadway except in an island with barrier curbs installed in accordance with the general requirements of the current MMUTCD, with a minimum clearance of two feet from the face of each curb to the nearest edge of the sign.

If a pedestrian route is provided, sufficient clearance from warning device signs and supports should be maintained for pedestrian travel.

All signs used in highway-railroad grade crossing traffic control systems shall be retroreflectorized to show the same shape and color to an approaching motorist by both day and night as described in the current MMUTCD.

In the event a highway-railroad grade crossing or its roadway approaches contain unique elements, such as curves, hills, or unusual intersecting roadway configurations, special word or symbol warning signs may be appropriate. Modification of existing warning signs or creation of special warning signs should be in compliance with the directives of the current MMUTCD section covering "Other Warning Signs." A custom made symbol sign will need Federal Highway Administration (FHWA) approval prior to installation.

Crossbuck (Rl5-1) and Number of Tracks Signs (R15-2)

Federal and state laws require signs to be placed at all crossings of public highways with railroad tracks. The Crossbuck sign (R15-1), shall be retroreflective white with the words "RAILROAD CROSSING" in black lettering. At a minimum, one Crossbuck sign shall be used on each highway approach to every highway-railroad grade crossing, alone or in combination with other traffic control devices.

Where physically feasible and visible to approaching traffic, the Crossbuck sign shall be installed at a minimum of 12 feet from the centerline of the nearest track on the right side of the highway on each approach to a highway-railroad grade crossing. Where restricted sight distance or unfavorable highway geometry exists on an approach to a highway-railroad grade crossing, an additional Crossbuck sign shall be installed on the left side of the highway, possibly placed back-to-back with the Crossbuck sign for the opposite approach, or otherwise located so that two Crossbuck signs are displayed for that approach.

If there are two or more tracks between the Crossbuck signs, the number of tracks shall be indicated on a supplemental Number of Tracks sign (R15-2) mounted below the Crossbuck sign. All signs shall be mounted and positioned as shown in the drawings. When state or federal funds are used for installation of passive signs, an approved breakaway post is required.

At passive highway-railroad grade crossings, white retroreflective sheeting shall be applied to the back of the sign blades and front and back of the sign support. A strip of retroreflective white material, not less than two inches in width (Department standard is six inches), shall be used on the back of each Crossbuck blade for the length of each blade, except where Crossbuck signs have been installed back-to-back.

A strip of retroreflective white material not less than two inches in width (Department standard is three inches), shall be used on the front and back of each support from the bottom of the Crossbuck sign (or Number of Tracks sign or Emergency Notification System (ENS) sign) to within two feet above the edge of the roadway. Exceptions to this requirement would be: on the front of the supports where a STOP (R1-1) or YIELD (R1-2) sign, or on the back side of supports for Crossbuck signs installed on one-way streets.

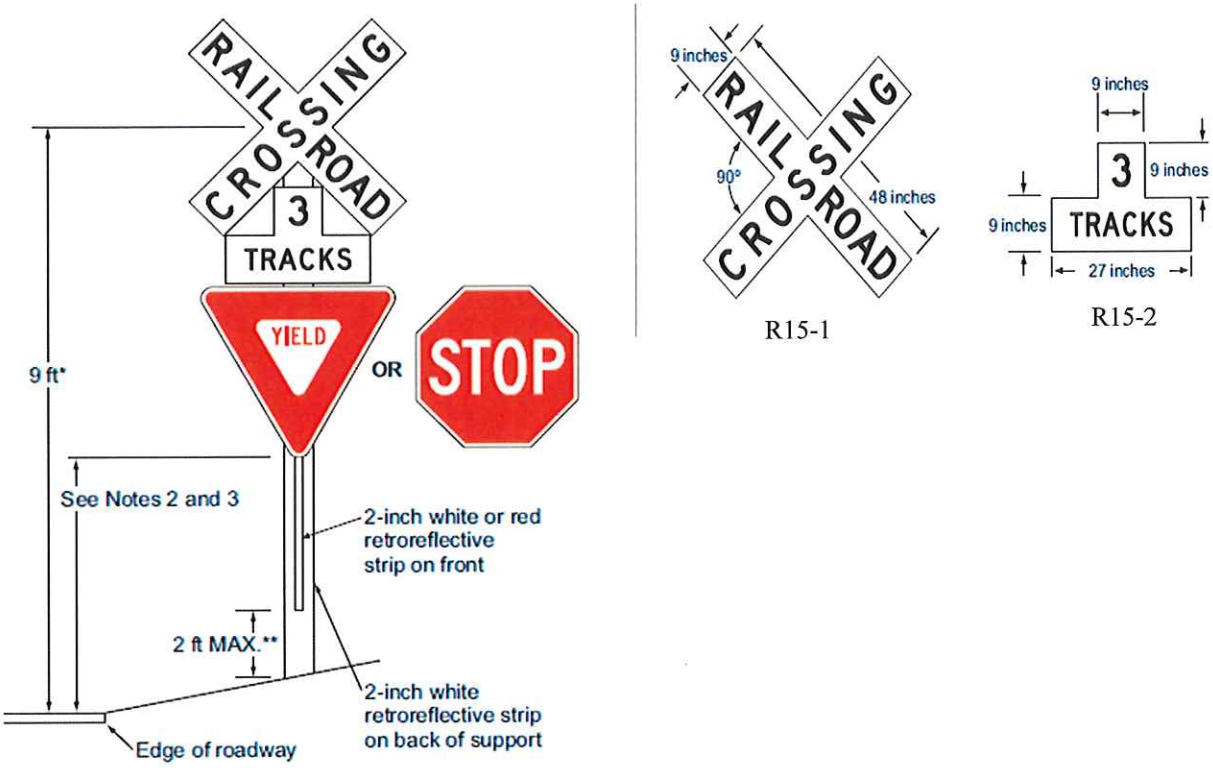
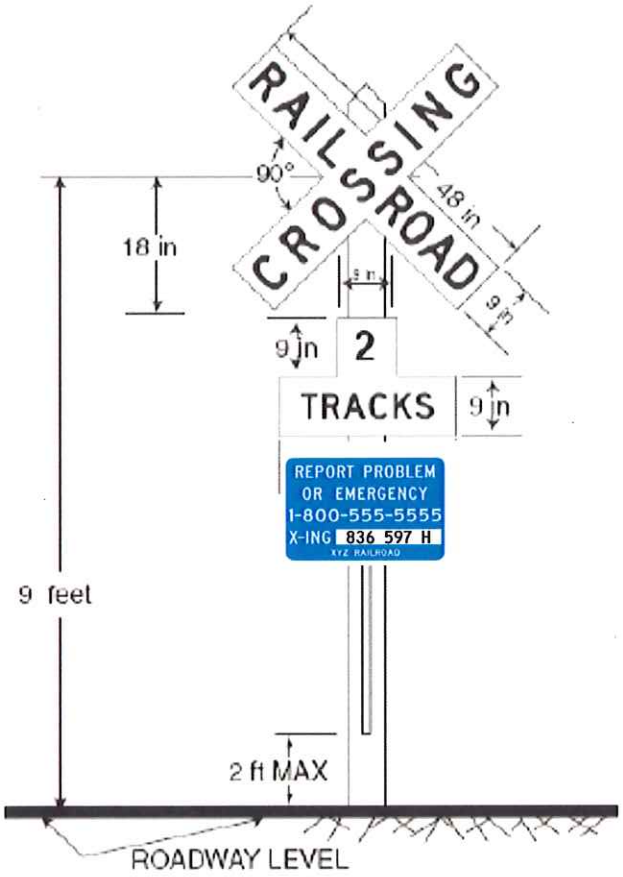


Figure 1: Crossbuck Signs (from 2011 MMUTCD)

Emergency Notification System (ENS) Sign (I-13)

Federal guidelines require the installation of Emergency Notification System (ENS) signs and National Inventory (NI) numbers at every crossing (CFR49, Subpart 234.311). The signs should be installed at least four feet off the ground, on the device closest to vehicles, and facing road users approaching a highway-railroad grade crossing. ENS signs should be installed at all highway-railroad grade crossings to provide information to road users so they can notify the railroad company regarding emergencies or malfunctioning traffic control devices. The sign shall include, at a minimum, the USDOT grade crossing inventory number and the emergency contact telephone number. The sign shall be retroreflective with a white legend and border on a blue background, positioned so as to not obstruct any traffic control devices or limit the view of rail traffic approaching the crossing.

Figure 2: ENS Signs (I-13)



STOP (R1-1) or YIELD Signs (R1-2)

The responsible road agency with jurisdiction and in accordance with the 2011 MMUTCD chapter 8, may use STOP (R1-1) or YIELD (R1-2) signs at highway-railroad grade crossings without active traffic control devices. **By December 31, 2019, the FHWA is requiring STOP or YIELD signs to be installed at all passive crossings.** A Stop sign shall be validated by an engineering study. Signs may be installed either on the same support as the Crossbuck sign or on a separate support at a point where the highway vehicle is to stop, or as near to that point as practical. Stop Ahead (W3-1) or Yield Ahead (W3-2) Advanced Warning signs shall also be installed if the criteria for their installation given in the current MMUTCD is met.

R1-1 W3-1 R1-2 W3-2

Figure 3: STOP, Stop Ahead, YIELD, and Yield Ahead

DO NOT STOP ON TRACKS Sign (R8-8)

Where the potential for vehicles to stop on railroad tracks is high, a DO NOT STOP ON TRACKS sign (R8-8) should be used. The sign should be located on the right-hand side of the highway on either or both sides of the railroad track(s) at a highway-railroad grade crossing, depending upon which side provides better visibility to approaching drivers. On divided highways, multi-lane and one-way roadways, an additional sign should be placed on the left-hand side of the highway to improve visibility of the message.

Figure 4: R8-8

TRAINS MAY EXCEED 80 MPH Sign (W10-8)

Where trains are permitted to travel at speeds exceeding 80 mph, TRAINS MAY EXCEED 80 MPH sign (W10-8) should be installed facing road users approaching a highway-railroad grade crossing. If used, the sign should be installed between the Advanced Warning sign (W10-1) and the highway-railroad grade crossing on all approaches to the crossing. The road authority with jurisdiction at the crossing shall determine if the sign will be utilized.

Figure 5: W10-8

Low Ground Clearance Signs (W10-5, W10-5P)

If highway profile conditions are sufficiently abrupt to create a potential hang-up situation for long wheelbase vehicles or for trailers with low ground clearance, the Low Ground Clearance sign (W10-5) should be installed in advance of a highway-railroad grade crossing. Because this symbol might not be readily recognizable by the public, the Low Ground Clearance warning sign (W10-5P) shall be accompanied by an educational plaque, with the text "LOW GROUND CLEARANCE." The educational plaque shall remain in place for at least three years after the initial installation of the Low Ground Clearance sign. The road authority with jurisdiction at the crossing shall determine if the sign will be utilized.

Figure 6: W10-5 with W10-5P

EXEMPT Signs (R15-3P, W10-1aP)

When authorized by MDOT, a supplemental EXEMPT sign with a white background may be used below a Crossbuck sign or Number of Tracks sign, and a supplemental EXEMPT sign with a yellow background may be used below the grade crossing Advance Warning sign. The use of Exempt signs at railroad crossings allow school buses and hazardous material vehicles to avoid having to stop at the crossing. A Diagnostic Study Team Review **is required** for installation of the signs.

R15-3P W10-1aP

Figure 7: Exempt signs

Advance Warning Signs (W10 Series)

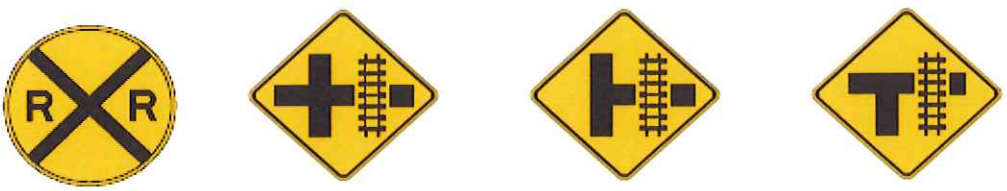
A highway-railroad grade crossing advance warning sign (W10-1) shall be used on each highway in advance of every highway-railroad grade crossing, except in the following circumstances:

1. On an approach to a highway-railroad grade crossing from a T-intersection with a parallel highway if the distance from the edge of the track to the edge of the parallel roadway is less than 100 feet and W10-3 signs are used on both approaches of the parallel highway, or
2. On low-volume, low-speed highways crossing minor spurs or other tracks that are infrequently used and are flagged by train crews, or
3. In business districts where active highway-railroad grade crossing traffic control devices are in use, or
4. Where physical conditions do not permit even a partially effective display of the sign, or
5. Where an adjacent highway-railroad grade crossing exists within 200 feet down-highway from the subject crossing.

Placement of the advance warning sign shall be in accordance with Table 1:

If the distance between the railroad tracks and a parallel highway, from the edge of the tracks to the edge of the parallel roadway, is less than 100 feet, W10-2, W10-3, or W10-4 signs shall be installed on each approach of the parallel highway to warn road users making a turn that they will encounter a highway-railroad grade crossing soon after making a turn, and a W10-1 sign for the approach of the tracks shall not be required to be between the tracks and the parallel highway.

Where there is a distance of 100 feet or more between the railroad and the parallel highway, a Wl0-1 sign should be installed in advance of the railroad crossing and the W10-2, W10-3, or W10-4 signs on the parallel highway would not be necessary. However, if the W10-2, W10-3, or W10-4 signs are used, the signs should be placed in accordance with the guidelines for Intersection Warning signs in Table 2C-4 of the 2011 MMUTCD.



W10-1 W10-2 W10-3 W10-4

Figure 8: Advance Warning Signs

Highway-Railroad Grade Crossing Pavement Markings

All highway-railroad grade crossing pavement markings shall consist of an X, the letters RR, a no passing marking (bidirectional undivided highways where centerline markings are used), and certain transverse lines. Identical markings shall be placed in each approach lane on all paved approaches to highway-railroad grade crossings where grade crossing signals or gates are located, and at all other highway-railroad grade crossings with paved approaches where the posted or statutory highway speed is 40 mph or greater.

Pavement markings shall not be required at highway-railroad grade crossings where the posted or statutory highway speed is less than 40 mph or in urban areas if an engineering study indicates that other installed devices provide suitable warning and control. When justified by engineering judgment, supplemental pavement marking symbol(s) may be placed between the advanced warning sign and the highway-railroad grade crossing.

The design of highway-railroad grade crossing pavement markings shall be essentially as illustrated in Figure 9 and Figure 10. The symbols and letters are elongated to allow for the low angle at which they are viewed. All markings shall be retroreflective white except for the no-passing markings, which shall be retroreflective yellow.

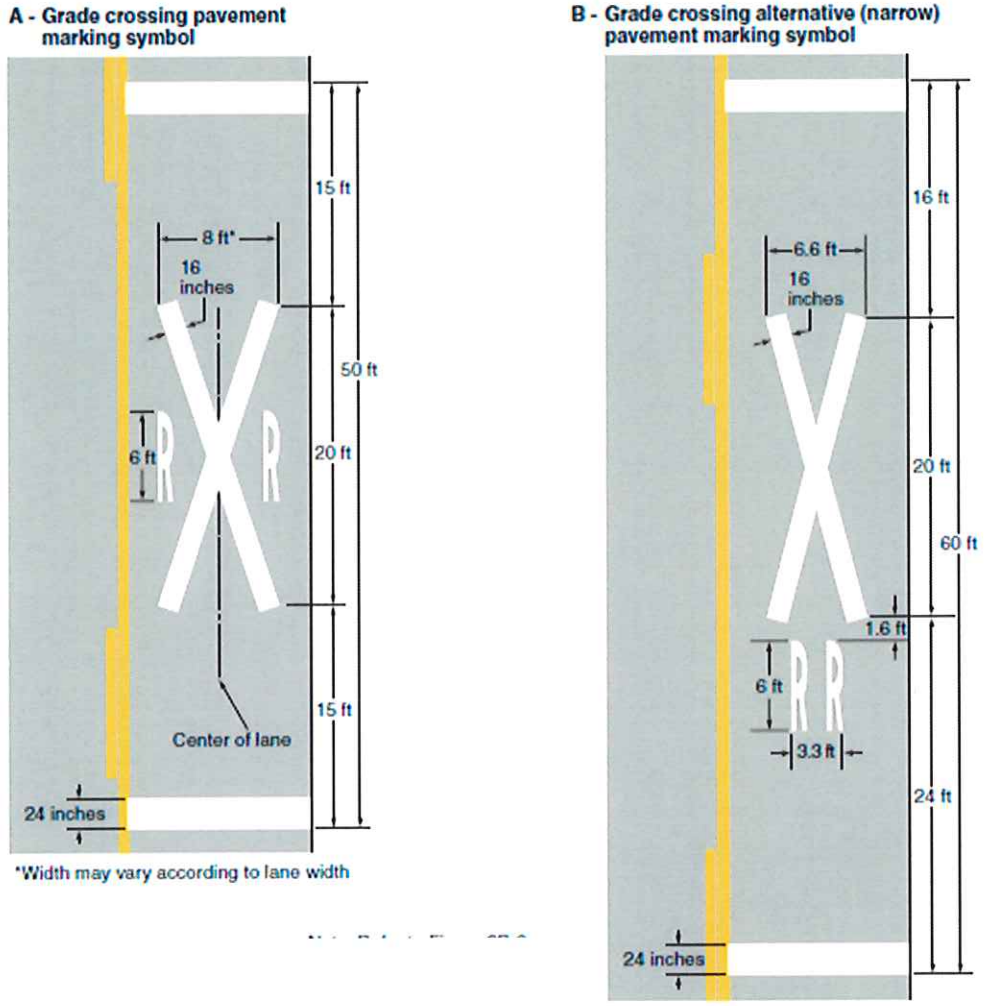


Figure 9: Grade Crossing Pavement Markings
(2011 MMUTCD, Figure 8B-7)

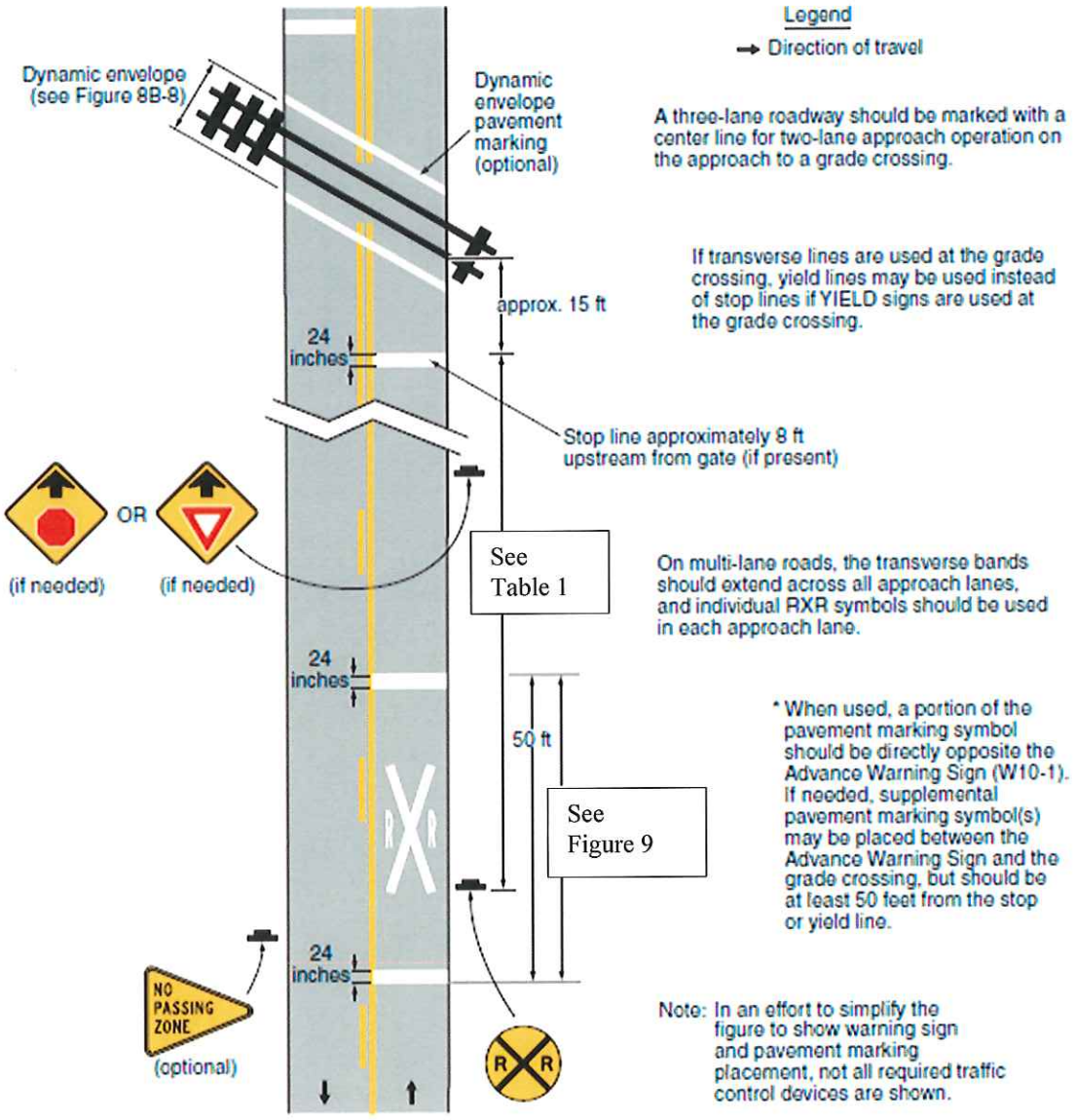


Figure 10: Placement of Warning Signs and Pavement Markings at Grade Crossings
(2011 MMUTCD, Figure 8B-6)

Table 1: Guidelines for Advance Placement of Warning Signs

(2011 MMUTCD, Table 2C-4)

Posted or 85th Percentile Speed	Advance Placement Distance[1]								
	Condition A: Speed reduction and lane changing in heavy traffic[2]	Condition B: Deceleration to the listed advisory speed (mph) for the condition							
		0[3]	10[4]	20[4]	30[4]	40[4]	50[4]	60[4]	70[4]
20 mph	225 ft	100 ft[6]	N/A[5]	-	-	-	-	-	-
25 mph	325 ft	100 ft[6]	N/A[5]	N/A[5]	-	-	-	-	-
30 mph	460 ft	100 ft[6]	N/A[5]	N/A[5]	-	-	-	-	-
35 mph	565 ft	100 ft[6]	N/A[5]	N/A[5]	N/A[5]	-	-	-	-
40 mph	670 ft	125 ft	100 ft[6]	100 ft[6]	N/A[5]	-	-	-	-
45 mph	775 ft	175 ft	125 ft	100 ft[6]	100 ft[6]	N/A[5]	-	-	-
50 mph	885 ft	250 ft	200 ft	175 ft	125 ft	100 ft[6]	-	-	-
55 mph	990 ft	325 ft	275 ft	225 ft	200 ft	125 ft	N/A[5]	-	-
60 mph	1,100 ft	400 ft	350 ft	325 ft	275 ft	200 ft	100 ft[6]	-	-
65 mph	1,200 ft	475 ft	450 f	400 ft	350 ft	275 ft	200 ft	100 ft[6]	-
70 mph	1,250 ft	550 ft	525 ft	500 ft	450 ft	375 ft	275 ft	150 ft	-
75 mph	1,350 ft	650 ft	625 ft	600 ft	550 ft	475 ft	375 ft	250 ft	100 ft[6]

[1]The distances are adjusted for a sign legibility distance of 180 feet for Condition A. The distances for Condition B have been adjusted for a sign legibility distance of 250 feet, which is appropriate for an alignment warning symbol sign. For Conditions A and B, warning signs with less than 6-inch legend or more than four words, a minimum of 100 feet should be added to the advance placement distance to provide adequate legibility of the warning sign.

[2]Typical conditions are locations where the road user must use extra time to adjust speed and change lanes in heavy traffic because of a complex driving situation. Typical signs are Merge and Right Lane Ends. The distances are determined by providing the driver a PRT of 14.0 to 14.5 seconds for vehicle maneuvers (2011 AASHTO Policy, Exhibit 3-3, Decision Sight Distance, Avoidance Maneuver E) minus the legibility distance of 180 feet for the appropriate sign.

[3]Typical condition is the warning of a potential stop situation. Typical signs are Stop Ahead, Yield Ahead, Signal Ahead, and intersection warning signs. The distances are based on the 2011 AASHTO Policy, Exhibit 3-1, Stopping Sight Distance, providing a PRT of 2.5 seconds, a deceleration rate of 11.2 feet/second^2, minus the sign legibility distance of 180 feet.

[4]Typical conditions are locations where the road user must decrease speed to maneuver through the warned condition. Typical signs are Turn, Curve, Reverse Turn, or Reverse Curve. The distance is determined by providing a 2.5 second PRT, a vehicle deceleration rate of 10 feet/second^2, minus the sign legibility distance of 250 feet.

[5]No suggested distances are provided for these speeds, as the placement location is dependent on site conditions and other sign placement. An alignment warning sign may be placed anywhere from the point of curvature up to 100 feet in advance of the curve. However, the alignment warning sign should be installed in advance of the curve and at least 100 feet from any other signs.

[6]The minimum advance placement distance is listed as 100 feet to provide adequate spacing between signs.

Stop Lines

The stop line should be a transverse line at a right angle to the traveled way at a point where a vehicle is to stop or as near to that point as possible. The stop line should be placed no closer than 15 feet from the nearest rail. Stop lines shall be installed on paved roadways where the speed limit is 40 mph or greater.

ACTIVE HIGHWAY-RAILROAD TRAFFIC CONTROL DEVICES

Active traffic control devices inform highway users of the approach or presence of trains or rail equipment on or near highway-railroad grade crossings. When active traffic control devices are used at highway-railroad grade crossings, state law and federal guidelines require that the STOP ON RED SIGNAL sign (R15-5), Emergency Notification System sign (I-13), Crossbuck sign (R15-1), and Number of Tracks sign (R15-2P), where appropriate, shall be used in accordance with the current MMUTCD.

R15-5 I-13 R15-1 R15-2P

Figure 11: STOP ON RED SIGNAL sign, ENS signs, Crossbuck sign, and Number of Tracks sign

Whenever active traffic control devices are installed at any highway-railroad grade crossing, the track circuitry shall be arranged that for every train or switching movement over the crossing, the active traffic control device shall be in operation for a period of not less than 20 seconds or more than 60 seconds in advance of the train movement reaching the nearest established curb line or highway shoulder and the devices shall continue to operate until the train movement has passed the established curb line or shoulder on the far side of the highway.

No active traffic control device shall be located in the center of an undivided roadway except on an island with barrier curbs installed in accordance with the general requirements of the current MMUTCD.

At highway-railroad grade crossings with curbs, active traffic control devices shall be placed with a horizontal clearance of two feet from the face of curb to the nearest edge of any signal component. When a cantilever is included, there shall be a vertical clearance of 17 feet between the crown or high point of the road and the lowest component of the cantilevered signal structure.

At highway-railroad grade crossings without curbs, active traffic control devices shall be placed with a horizontal clearance of two feet from the edge of the shoulder to the nearest edge of any signal component, with a clearance of at least six feet from the edge of the traveled way.

At highway-railroad grade crossings with shoulders or parking lanes that would require a post-mounted flashing-light signal to be installed with a horizontal clearance of more than 10 feet from the edge of the traveled way to the nearest edge of any signal component, flashing-light signals on cantilever arms shall be added to enhance visibility.

At highway-railroad grade crossing locations with active warning devices where two or more single tracks are within 100 feet of each other, American Railway Engineering and Maintenance-of-Way Association (AREMA) standards (3.1.10, 3.1.11, and 3.3.10) for device placement, track clearance timing and flasher delay should be consulted.

If a pedestrian route is present, sufficient clearance from warning device supports, posts, and mechanisms should be provided for pedestrian travel. Specific placement, dimension and clearance information is provided on the drawings and descriptions that accompany each type of active warning device installation on the following pages. Modifications to the typical installation/configurations will be handled on a case-by-case basis with guidance from the MDOT Office of Rail.

Equipment Housings

Where practical, equipment housings should provide a lateral clearance of at least 30 feet from the edge of highway and, where railroad property and conditions allow, at least 25 feet from the nearest rail. Adequate clearance should be provided from the railroad tracks in order to reduce sight distance obstruction to motorists of an approaching train and to reduce the possibility of damage to the housed equipment.

Stop Lines for Flashing Lights Only

When a stop line is used at a flashing light signal (no gates) location, it should be a transverse line at a right angle to the traveled way. The stop line should be placed approximately five feet in advance of the flashing lights or as near to that point as practical, but no closer than 15 feet in advance of the nearest rail. Stop lines shall be installed on paved roadways with active traffic control devices. If an interconnected traffic signal is adjacent to the crossing, then the stop line guidance for traffic signals shall be used and the railroad stop line shall be omitted.

Flashing-Light Signals (Post-Mounted)

A system of post-mounted flashing-light signals may be used in lieu of existing Crossbuck signs, STOP or YIELD signs, bells, or manual warning at a highway-railroad grade crossing when any of the following conditions are met or exceeded:

1a. The New Hampshire Index (NHI) exposure factor exceeds the preceding five-year average NHI exposure factor of passive crossing crash locations statewide **or** the National Cooperative Highway Research Program Report 50 Accident Prediction Formula calculation exceeds 0.02 (See Appendix A for indices and formulae) **or** the crossing has train speeds equal to or in excess of 65 mph*, **and**

1b. the highway approach sight distance (dH) or the triangular quadrant sight distance are restricted for the actual train and vehicular traffic speeds in accordance with the table given in Appendix B.

2. The crossing has had two or more vehicle/train crashes in the last five years, which may be susceptible to correction by the installation of flashing-light signals.

Criteria 1a and 1b are used together with the **"and"** condition.
Criteria 2 may be used independently.

*Note: An FRA report dated August 2000 regarding the assessment of risk for high-speed rail grade crossings indicates that "… risk to highway users saturates at train speeds around 65 mph…."

When a highway-railroad grade crossing with Crossbuck signs, STOP or YIELD signs, bells, or manual warning does not meet the above criteria, but the railroad and road authority agree that the crossing should be upgraded with active warning devices, the Department may concur with the request.

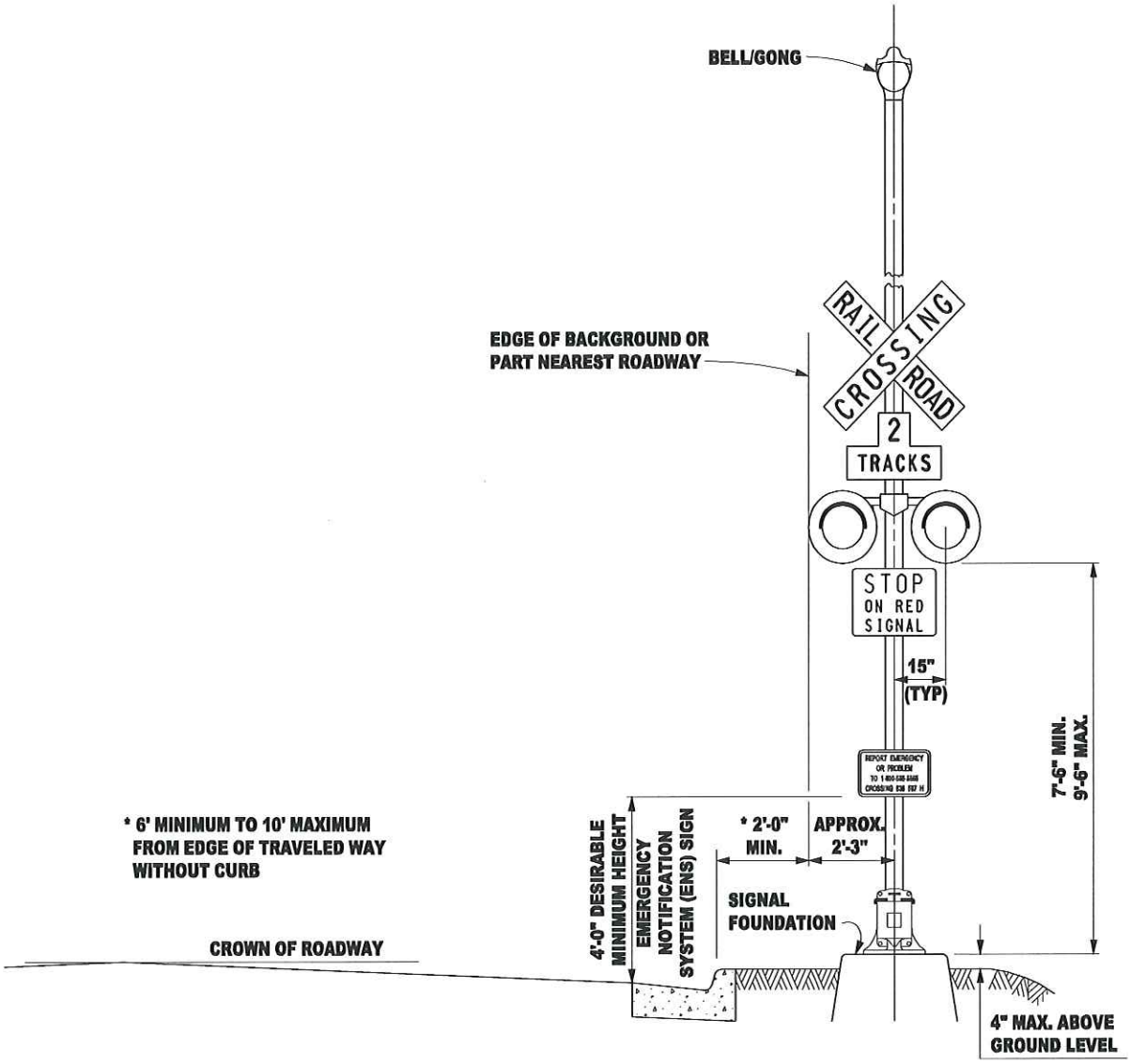


Figure 12: Typical Components and Configuration of Post-Mounted Flashing-Light Signals

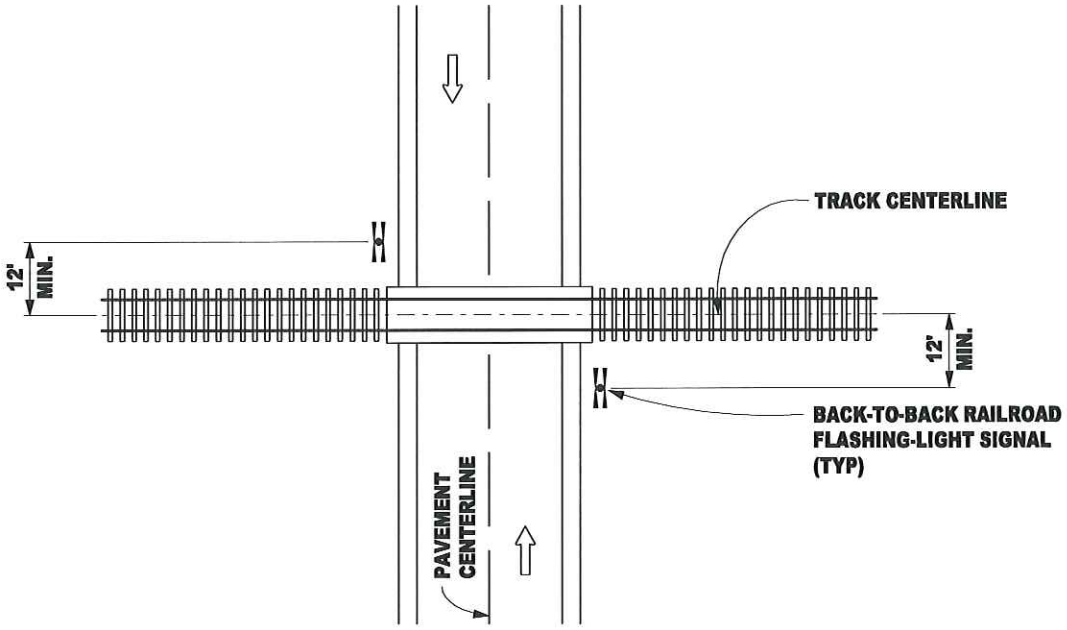


Figure 13: Typical Installation of Flashing-Light Signals

Auxiliary Flashing-Light Signals (Side-Lights)

Additional pairs of flashing-light signals may be installed for side roads or other accesses intersecting the highway near a highway-railroad grade crossing, for horizontal or vertical curves, or for other special circumstances, such as angle of approaches, grades, structures, etc.

The auxiliary flashing-light signals may be attached to the post-mounted flashing-light signals by a cross-arm, bracket extension, by use of a taller post assembly, or installed on separate posts as determined by the diagnostic study team.

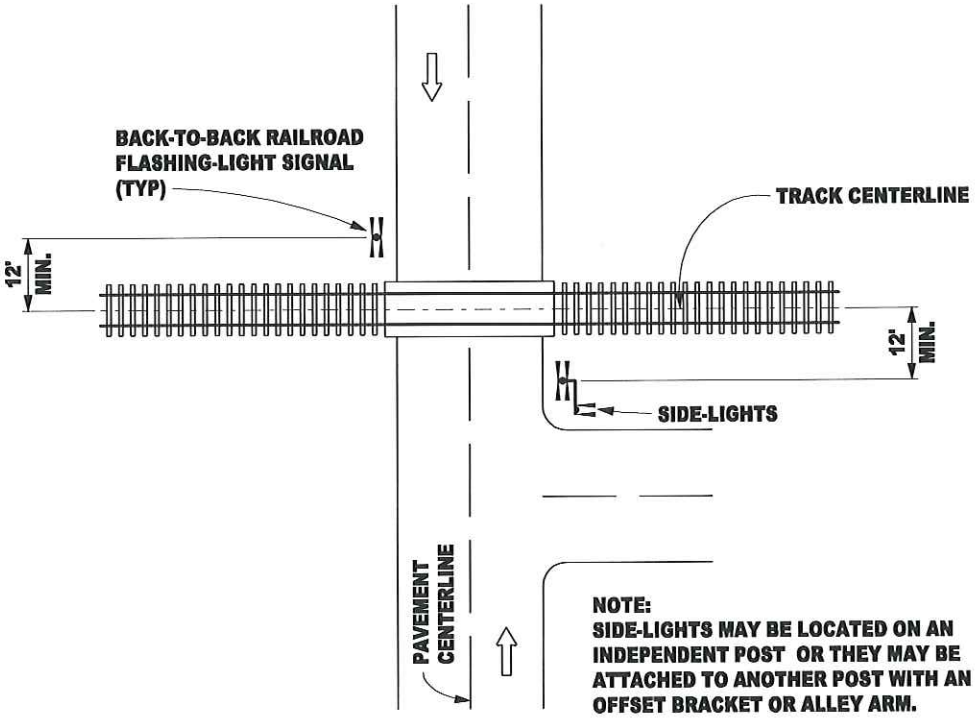


Figure 14: Typical Auxiliary Side-Light Installation

Flashing-Light Signals on Cantilever Arms

A system of cantilevered flashing-light signals can be used to supplement post-mounted flashing-light signals at highway-railroad grade crossings where improved visibility for approaching traffic is required. Cantilevered flashing-light signals may be appropriate when any of the following conditions exist:

1. There are two or more lanes of traffic moving in any one direction, or
2. Visibility of the post-mounted flashing-light signals is obscured by seasonal or permanent obstructions, including parked vehicles situated within the required stopping sight distance (dH) shown in Appendix B, or
3. Horizontal or vertical curves on the highway approaches obscure a clear view of the post-mounted flashing-light signals within the required stopping sight distance (dH) shown in Appendix B for an approaching vehicle and the addition of flashing-light signals on cantilever arm(s) over the roadway will provide sufficient visibility for the required stopping sight distance, or

4. Other distraction factors are present that tend to divert motorists' attention from the post-mounted flashing-light signals. These may include conflicting vehicular traffic patterns, pedestrian activity, commercial signing, etc. (Note: cantilevers and their flashing-light signals should not distract from or obstruct nearby highway traffic signals and vice versa), or
5. Highways with shoulders or parking lanes that would require a post-mounted flashing-light signal to be installed with a horizontal clearance of more than 10 feet from the edge of the traveled way to the nearest edge of any signal component.

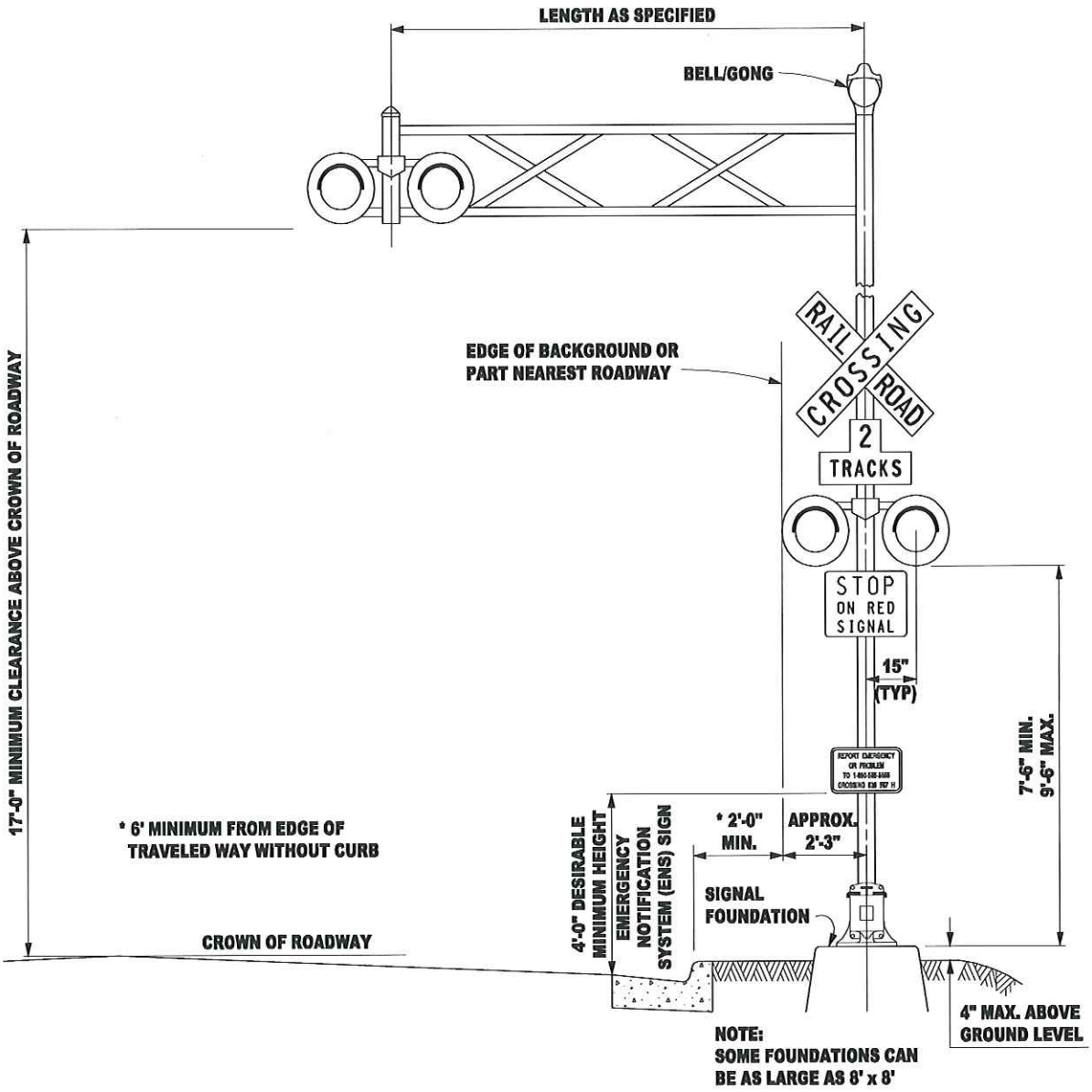


Figure 15: Typical Components and Configuration of Flashing-Light Signals on Cantilever Arms

The following are guidelines for flashing-light signals on cantilever arms and their placement over the roadway for various highway geometrics.

Cantilevers for Two-Lane, Two-Way Roads

For most two-lane, two-way roadways, post-mounted flashing-light signals will normally be installed without cantilevers if a highway-railroad grade crossing is to be signalized. Supplemental flashing-light signals suspended on a cantilever arm will not normally be required for such crossings, but their usage may be appropriate if they meet any of the previous criteria.

In some cases, for two-lane, two-way roadways, post-mounted flashing-light signals with a single cantilever arm on one side of the crossing may be considered adequate with the flashing-light signals on the cantilever arm positioned over the center of the road.

NOTE: The typical installation drawings that follow for cantilever and flashing-light signal placement over the roadway also show roadway gates. This is for illustrative purposes only to depict the proper traffic lane coverage for gates when they are required. For the location of signal and gate foundations in relation to the track and road, refer to the current MMUTCD.

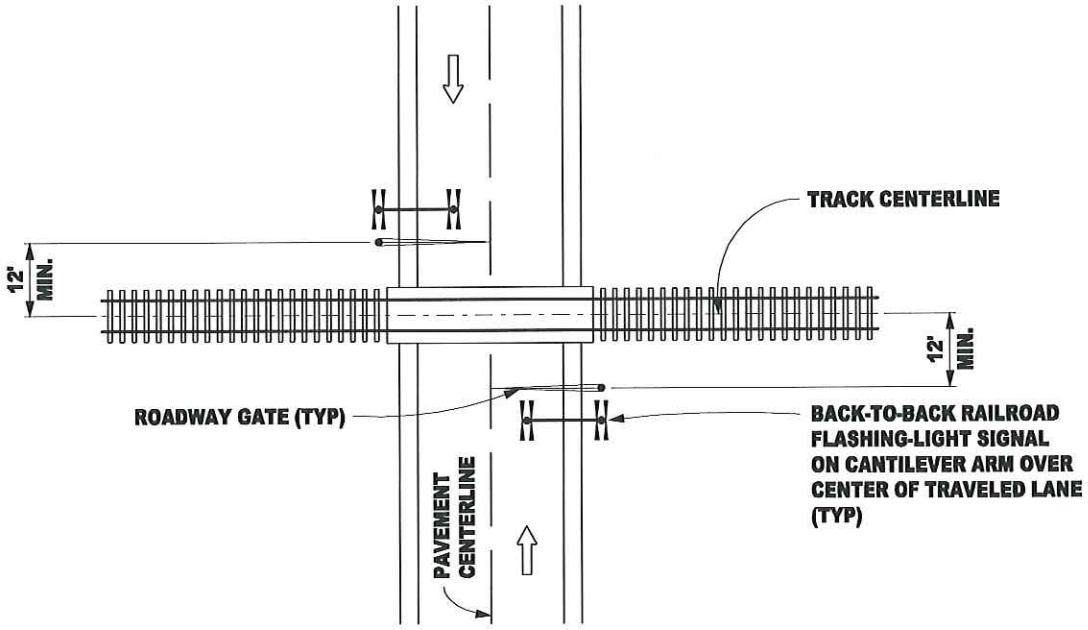


Figure 16: Typical Two-Lane, Two-Way Roadway Installation

Cantilevers for Three-Lane, Two-Way Roads with a Center Left-Turn Lane

For three-lane, two-way roads with a center left-turn lane, post-mounted flashing-light signals will normally be installed without cantilevers if a crossing is to be signalized. If left-turn moves can be made adjacent to the crossing, the post-mounted flashing-light signals may be supplemented with additional flashing-light signals suspended on cantilever arms that should be of such length to position the lights over the lane line between the left-turn lane and through-lanes.

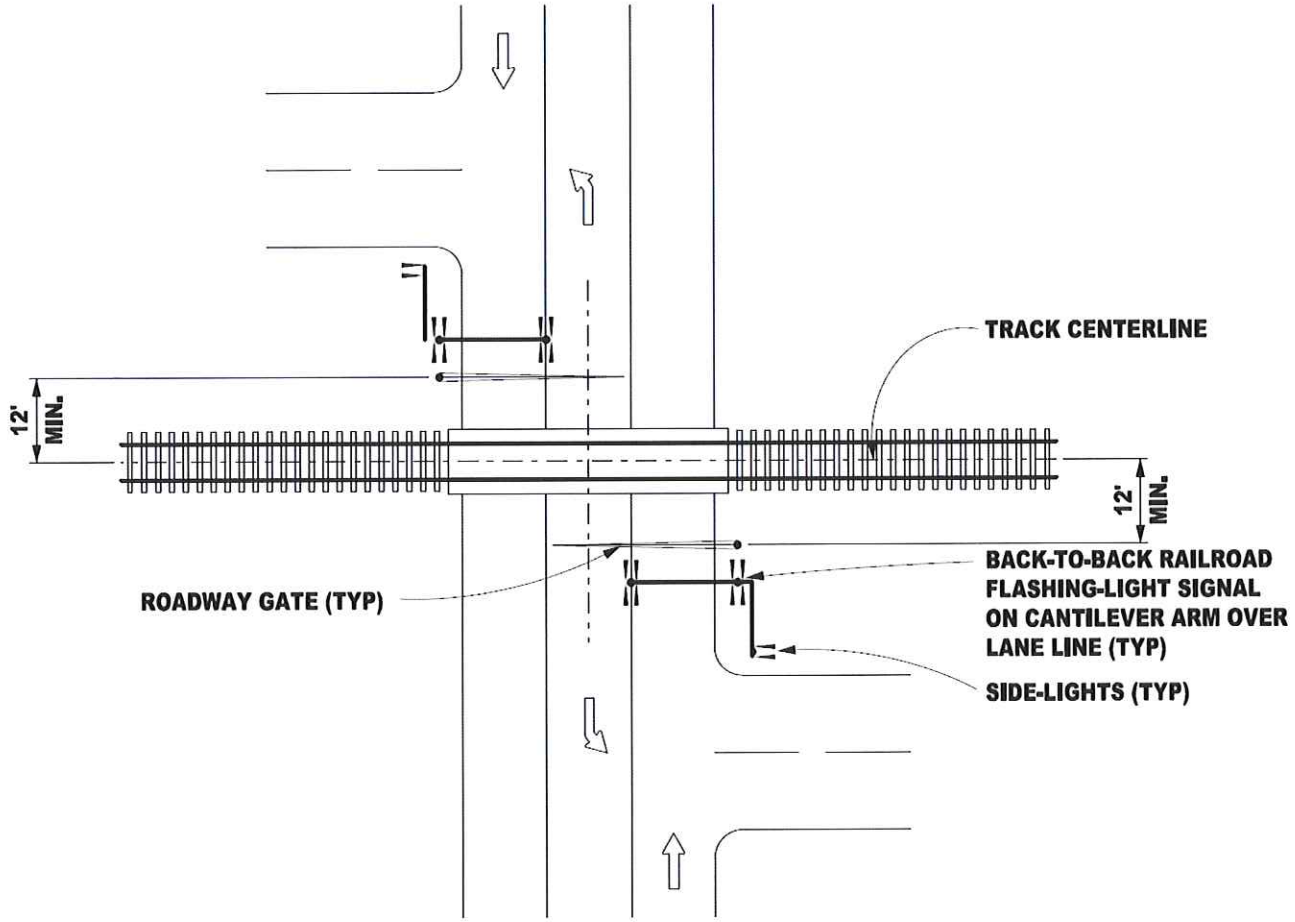


Figure 17: Typical Three-Lane, Two-Way Roadway with Center Left-Turn Lane Installation

Cantilevers for Four-Lane, Two-Way Roads

For four-lane, two-way roads, post-mounted flashing-light signals shall be supplemented with additional flashing-light signals suspended on cantilever arms that should be of such length to position the lights over the lane line that lies between the through-lanes in each direction.

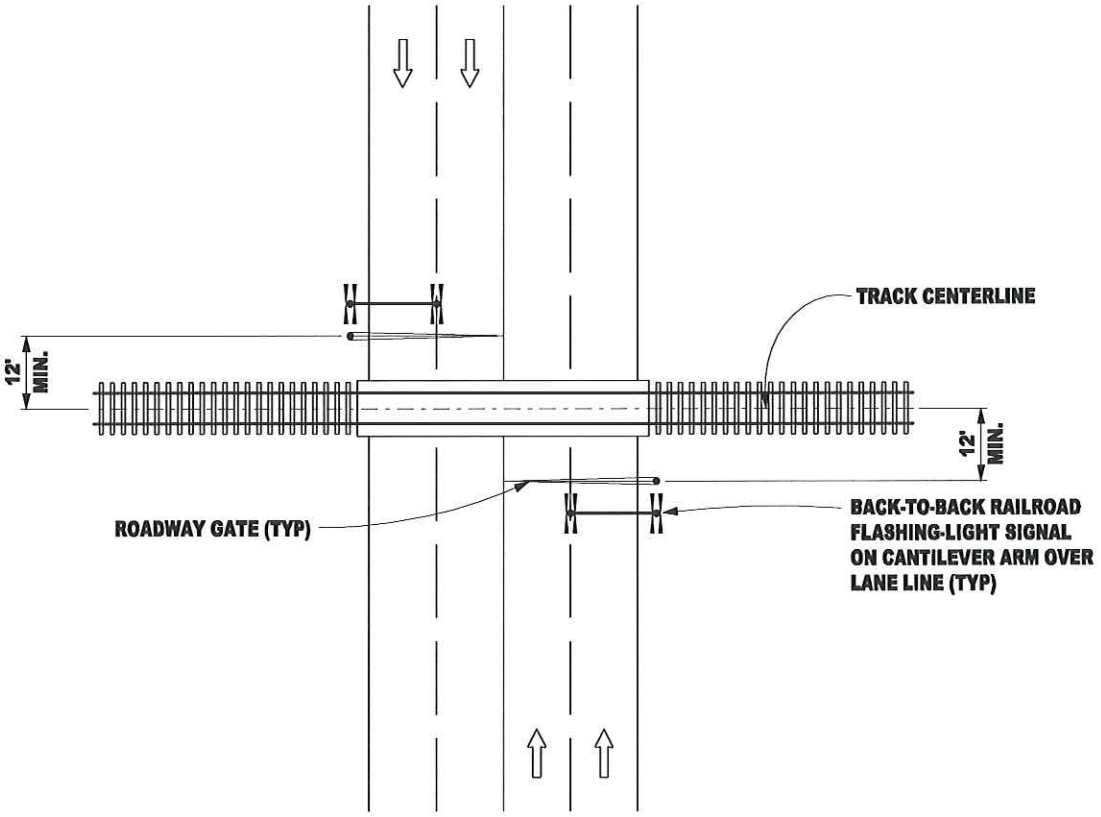


Figure 18: Typical Four-Lane, Two-Way Roadway Installation

Cantilevers for Five-Lane, Two-Way Roads with a Center Left-Turn Lane

For five-lane, two-way roads with a center left-turn lane, post-mounted flashing-light signals shall be supplemented with additional flashing-light signals suspended on cantilever arms that should be of such length to position the lights over the center of the interior through-lane in each direction. If left-turns can be made adjacent to the crossing, consideration should be given to positioning the lights over the lane line between the interior through-lane and the left-turn lane and adding additional lights over the lane line between the two through-lanes in each direction.

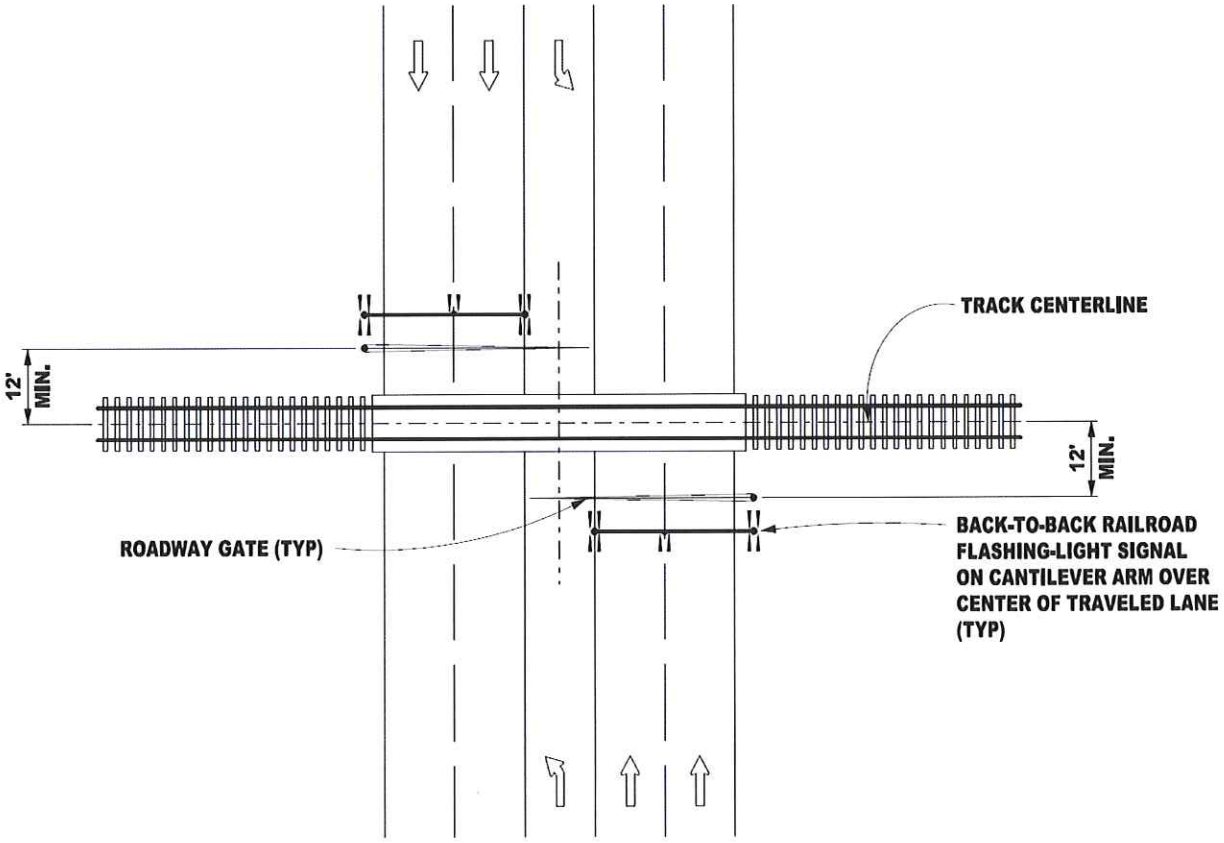


Figure 19: Typical Five-Lane, Two-Way Roadway with Center Left-Turn Lane Installation

Cantilevers for Multi-Lane, Boulevard or One-Way Roads (Options)

For two-lane, one-way roads, post-mounted flashing-light signals may be installed on the left and right-hand approaches to a highway-railroad grade crossing without cantilevers. The same left and right-side approach installation will apply on divided roadways when the median width provides proper lateral clearance for the signals. If the median width does not provide proper lateral clearance, post-mounted flashing-light signals installed on the right side of the roadway approach may be supplemented with additional flashing-lights suspended on cantilever arms that should be of such length as to position the lights over the lane line(s). Back-to-back flashing-lights can be utilized on the post-mounted flashing-light signals to accommodate pedestrian traffic.

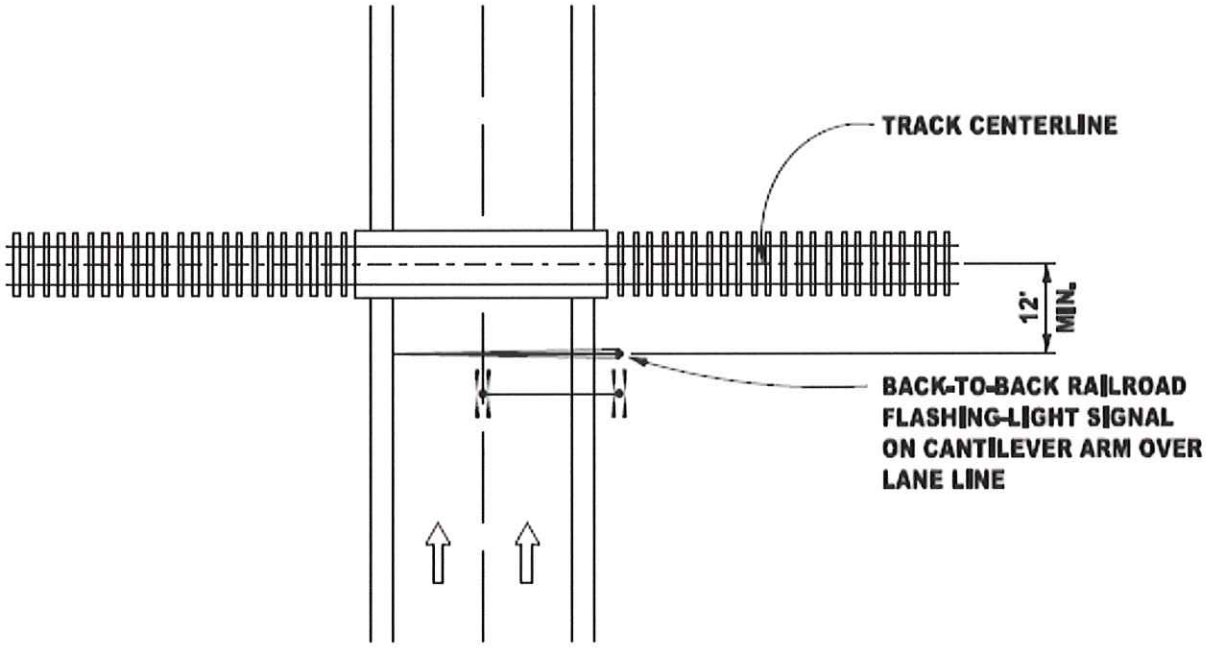


Figure 20: Typical Two-Lane, One-Way Roadway Installation

Cantilevers for Three-Lane, One-Way Roads

For three-lane, one-way roads, post-mounted side-of-street flashing-light signals shall be supplemented with additional flashing-light signals suspended on a cantilever arm that should be of such length to position the lights over the center of the center lane. Back-to-back flashing-lights can be utilized on the post-mounted flashing-light signals to accommodate pedestrian traffic.

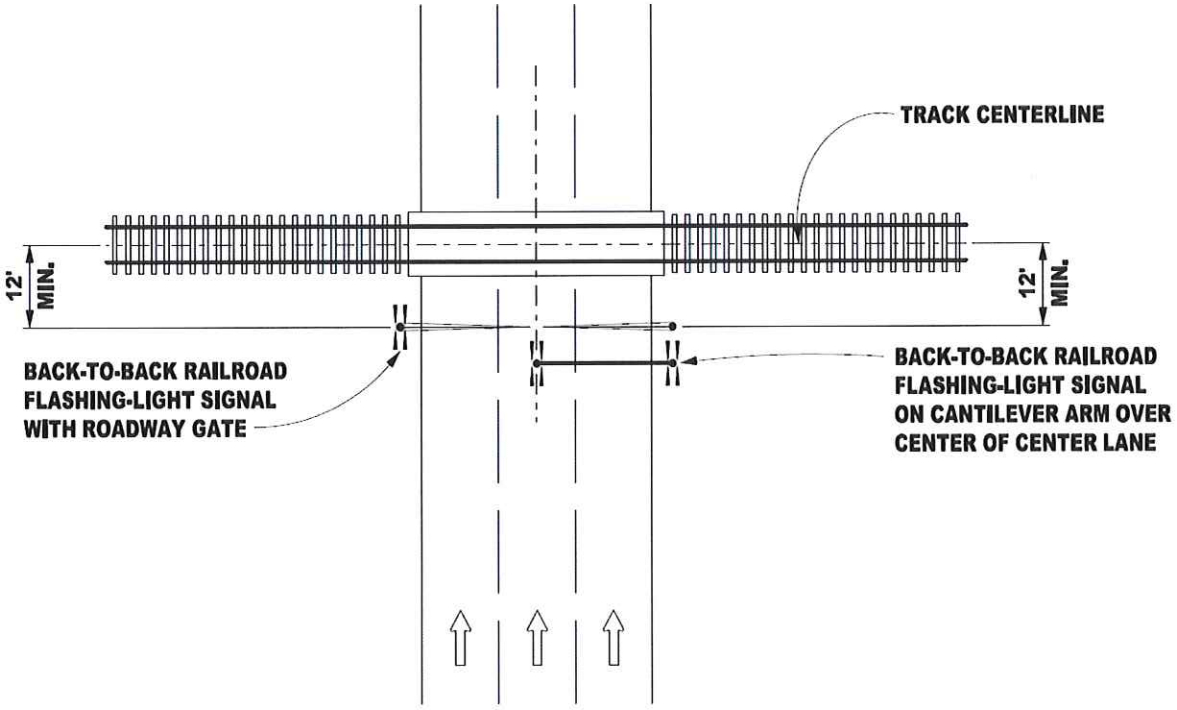


Figure 21: Typical Three-Lane, One-Way Roadway Installation

Cantilevers for Four-Lane, One-Way Roads

For four-lane, one-way roads, post-mounted flashing-light signals shall be supplemented with additional flashing-light signals suspended on cantilever arms that should be of such length to position the lights over the lane line between the outside lane and the adjacent interior lane on each side. Back-to-back flashing-lights can be utilized on the post-mounted flashing-light signals to accommodate pedestrian traffic.

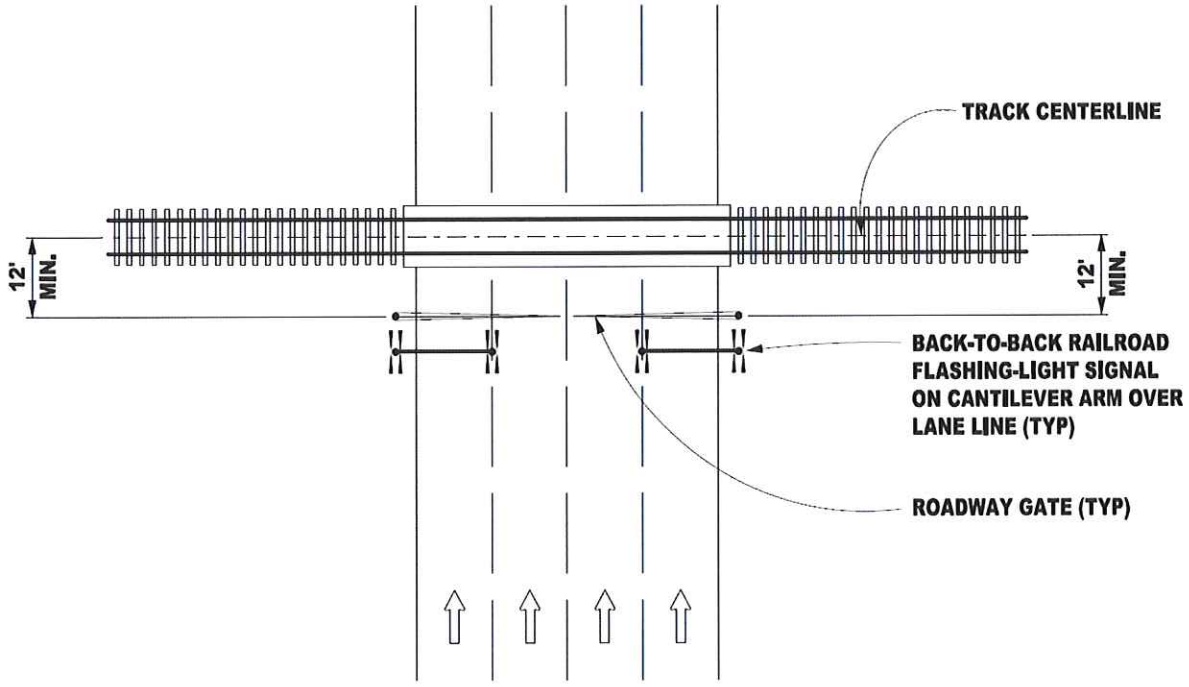


Figure 22: Typical Four-Lane, One-Way Roadway Installation

Criteria for Installation of Roadway Gates

Automatic roadway gates serve as a barrier across a roadway when a train is approaching or occupying a highway-railroad grade crossing. Roadway gates may consist of half, three-quarter, full or four-quadrant gate systems. Gate arms must cover 90 percent of the travelled approach lane(s).

A system of flashing-light signals with roadway gates may be recommended in lieu of existing Crossbuck signs, STOP or YIELD signs, bells, flashing-light signals or manual warning at a highway-railroad grade crossing when the criteria described for the installation of flashing-light signals are met or exceeded and any of the following conditions are met or exceeded:

1. The crossing contains multiple mainline railroad tracks where there is a possibility of simultaneous train movements over the crossing.

2. The crossing contains single track or multiple tracks where a moving or stopped train or rail equipment on or near a crossing can restrict the sight distances of a stopped motorist from observing another train approaching the crossing in accordance with the Table A in Appendix B.

3. The crossing is equipped or will be equipped with flashing-light signals and has had two or more car/train crashes in the last five years that may be susceptible to correction by the installation of roadway gates.

4. The crossing has restricted clearing sight distances down the track from a highway vehicle stopped position for actual rail traffic speeds in accordance with Table A in Appendix B. Additional consideration for roadway gates under this criterion may include any crossing that has a skewed angle of 70 degrees or less measured from the roadway center line.

5. The crossing has train speeds equal to or in excess of 65 mph. (Note: an FRA report dated August 2000 regarding the assessment of risk for high-speed rail grade crossings indicates that "…risk to highway users saturates at train speeds around 65 mph...")

A system of flashing-light signals with roadway gates should not be recommended at highway-railroad grade crossings where there are a high number of switching movements or unusual train or roadway operations that would cause undue or frequent unnecessary gate operations or cause highway vehicle entrapment on the crossing.

When a highway-railroad grade crossing with existing or proposed flashing-light signals does not meet the above criteria, but the railroad and road authority agree that the crossing should be equipped with roadway gates for extenuating reasons, the Department may concur with the request.

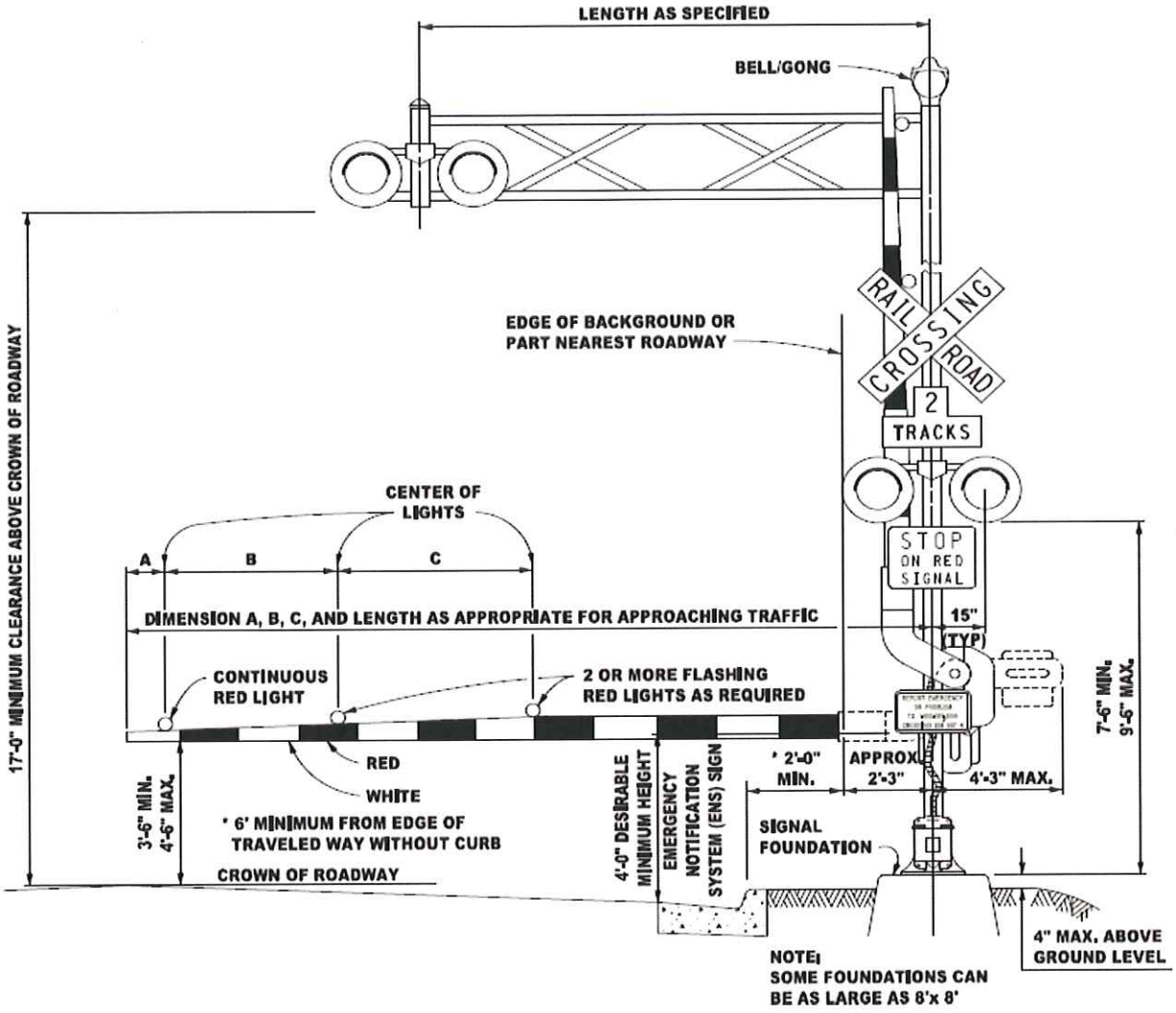


Figure 23: Typical Components and Configuration of Flashing-Light Signals and Gates
(Optional Cantilever Shown)

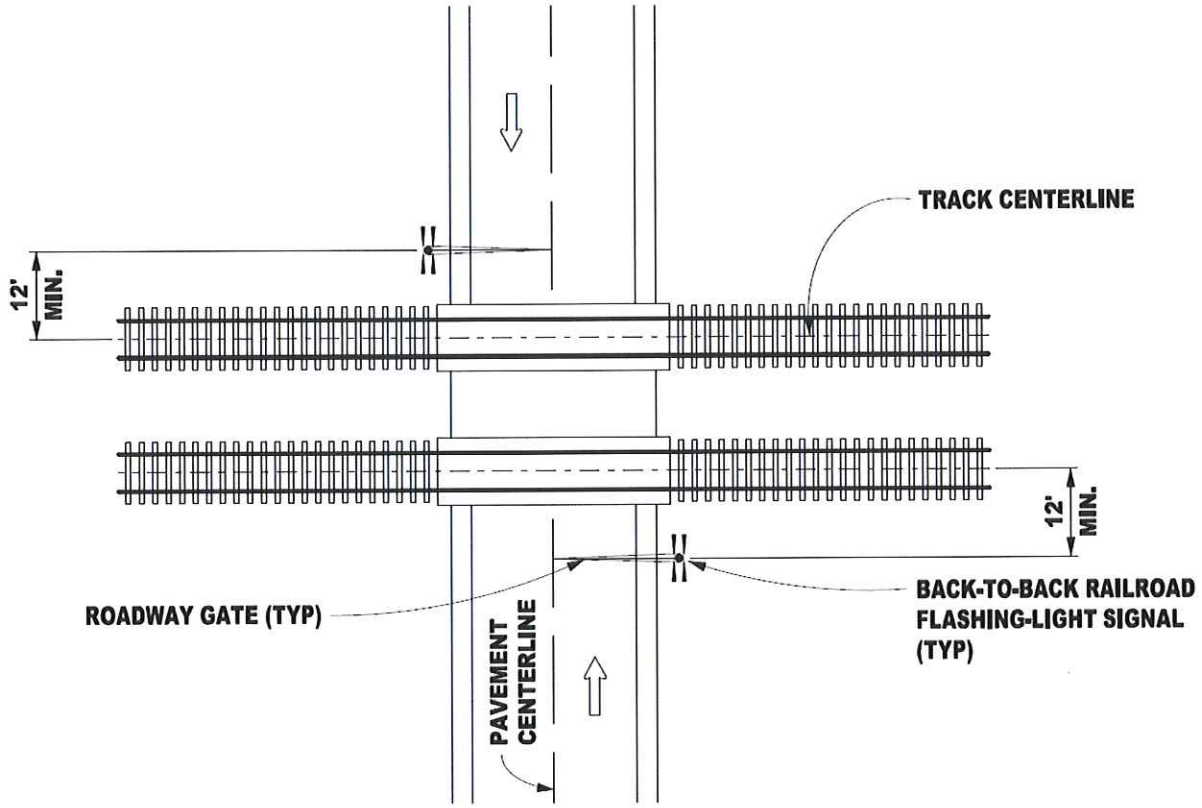


Figure 24: Typical Installation of Flashing-Light Signals with Roadway Gates

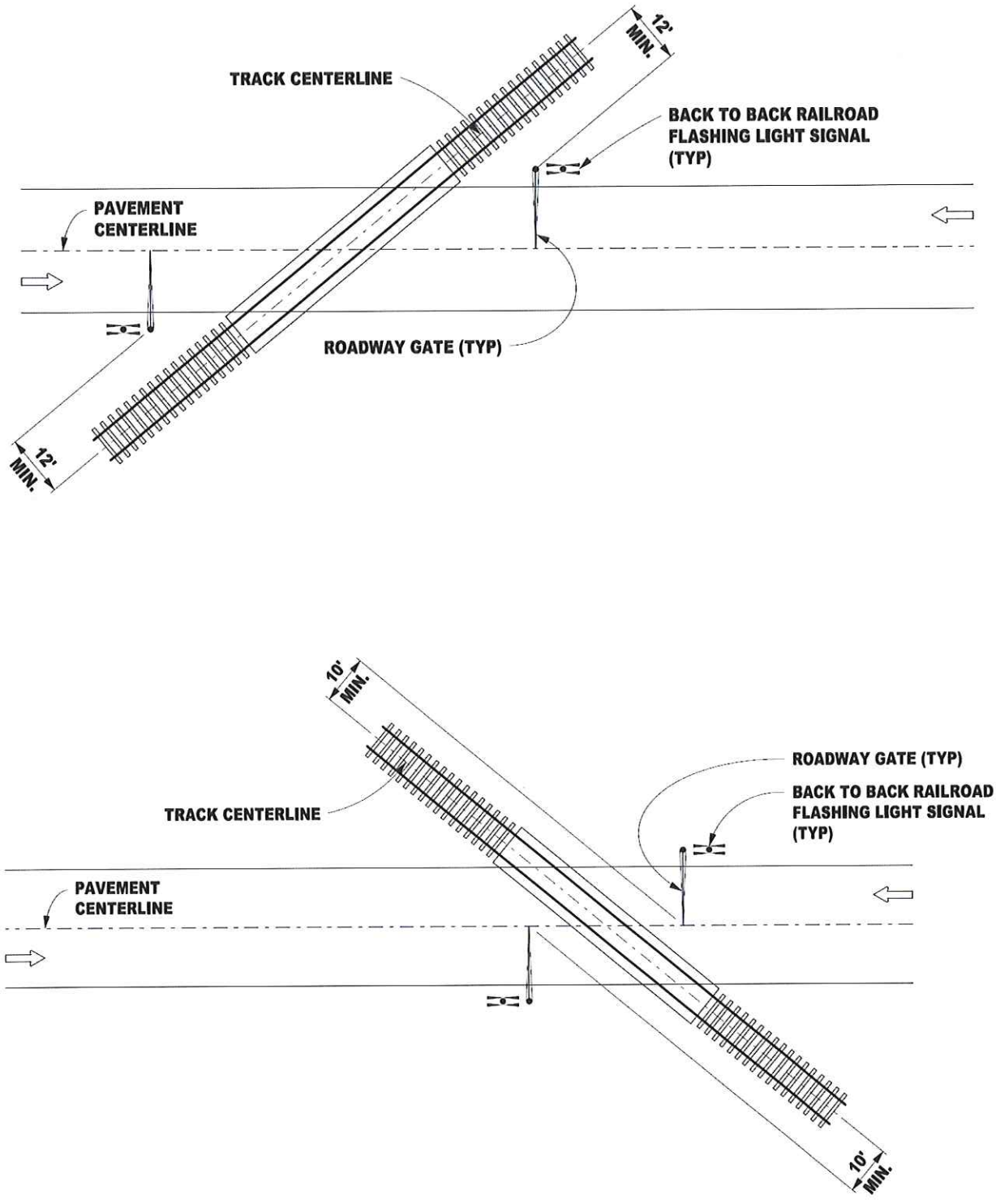


Figure 25: Gate Location for Acute (top) and Obtuse (bottom) Skewed Crossings

Stop Lines for Lights and Gates

The stop line should be a transverse line at a right angle to the traveled way at a point where a vehicle is to stop or as near to that point as possible. The stop line should be placed approximately eight feet from the gate, but no closer than 15 feet from the nearest rail. Stop lines shall be installed on paved roadways with active traffic control devices.

Supplemental Grade Crossing Devices at Gated Locations

Highway or railroad authorities may install various supplemental safety measures to prevent vehicles from driving around downed gates at highway-railroad grade crossings. Supplemental devices may include four-quadrant gates, barrier wall systems, median islands, and/or median dividers or delineators. More information on these devices can be found in the current edition of the FHWA's *Railroad-Highway Grade Crossing Handbook.*

Two examples of median islands at highway-railroad grade crossings are given in the following two figures. Each location should be studied independently to determine the best configuration for the site.

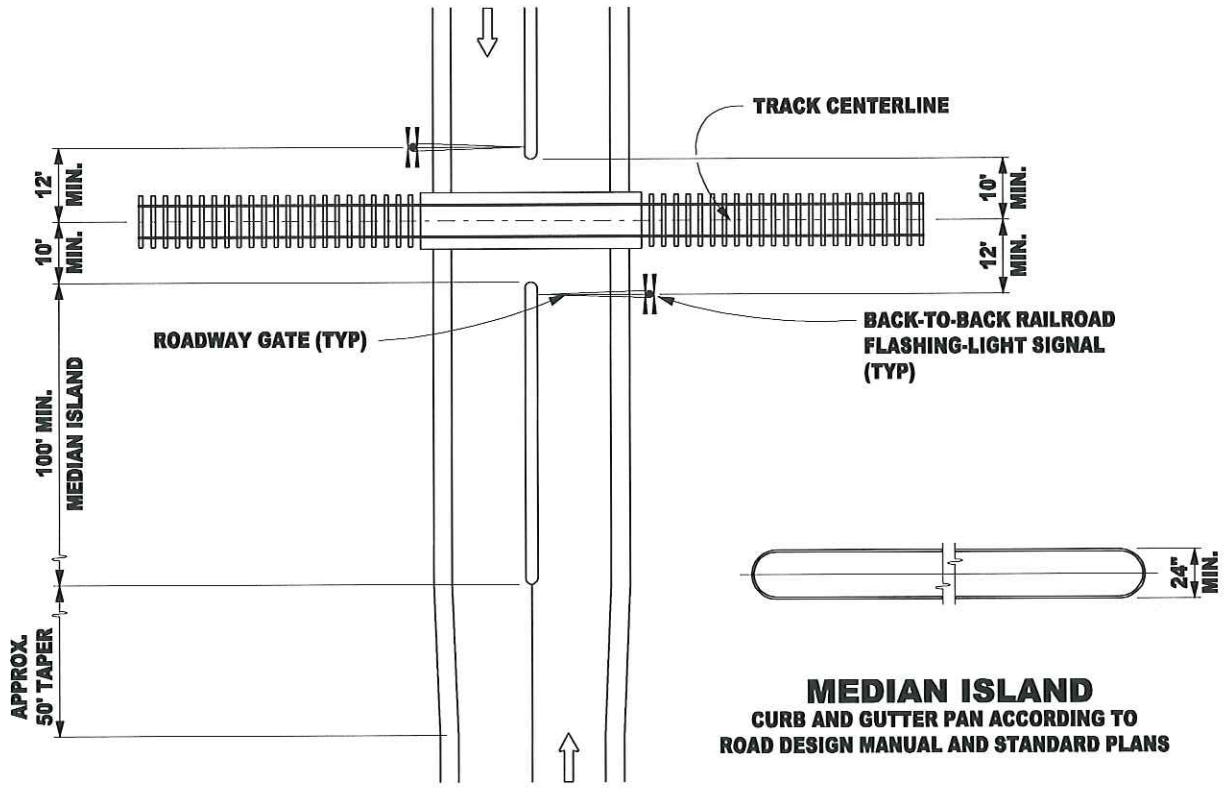


Figure 26: Typical Two-Lane, Two-Way Roadway with Narrow Median Island
(Posted Speed 45 mph and lower)

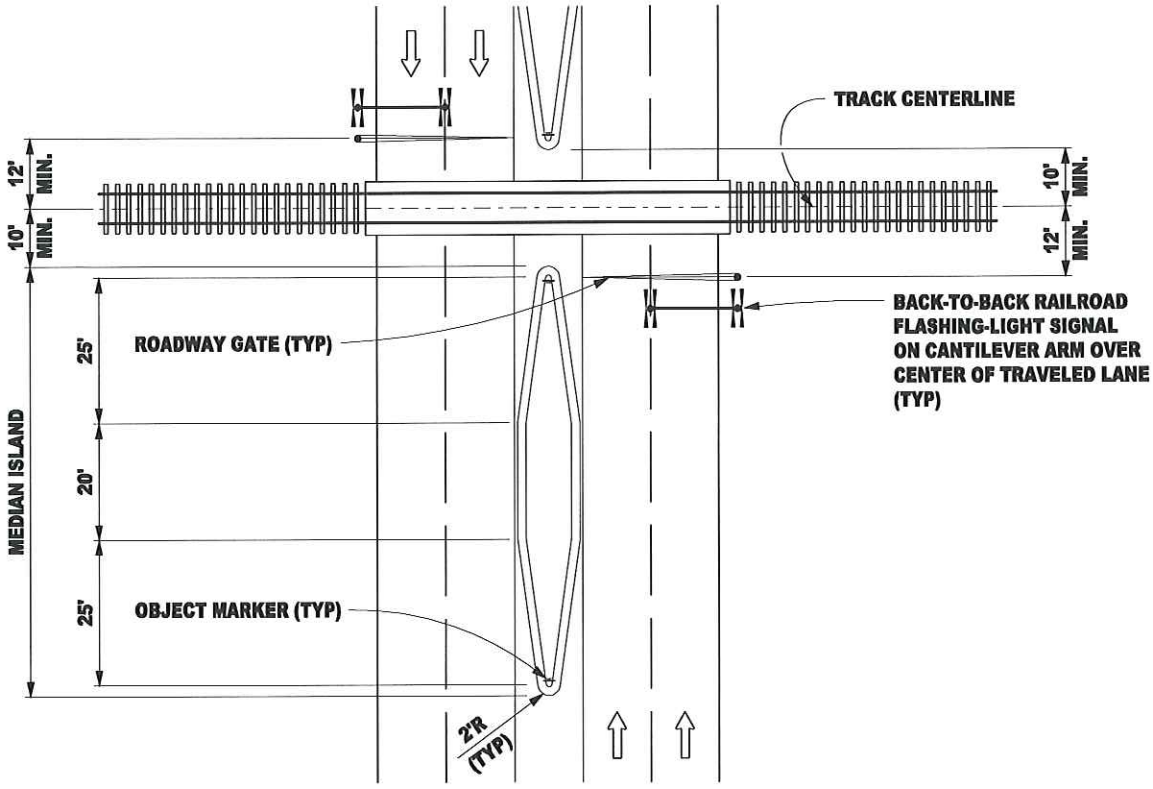


Figure 27: Typical Five-Lane, Two-Way Roadway with Wide Median Island

TRAFFIC SIGNAL DEVICE COMPONENTS

Criteria for Crossings Adjacent to Signalized Intersection

When a signalized highway intersection exists within 200 feet of a highway-railroad grade crossing, measured from the edge of track to the edge of the intersecting roadway, the railroad and traffic signal control equipment should be interconnected and the normal operation of the traffic signals controlling the intersection should be preempted to clear all vehicles from the crossing prior to a train occupying the crossing.

Interconnection is the physical link – typically a hardwire connection – between the railroad and the traffic signal controller. The preemption operation is a unique signal phasing sequence that is prompted when a train approaches the highway-railroad grade crossing near the signalized intersection. When a train approaches the highway-railroad grade crossing, the hardwire connection provides the communication link to the traffic signal controller, which in turn triggers the unique sequencing that will not only clear the crossing, but will also clear all conflicting vehicular moves at the intersection. The entire time a train is at the crossing, the traffic signal will continue to operate in the unique sequence (often flashing or solid red indications for particular approaches) to prevent vehicular traffic from coming into conflict with a train.

Sometimes, the clearance of the vehicular and pedestrian movements at the signalized intersection requires more than 20 seconds advance notice that a train is approaching. In those instances, there may be a need for advance preemption. This will entail moving rail detection further away from the highway-railroad grade crossing in order to provide the necessary time to clear all conflicts. Where multiple or successive preemption may occur from differing modes, train actuation should receive first priority and emergency vehicles second priority.

Care should be given to the placement of highway traffic signals to assure they do not block the view of railroad flashing-light signals. Similarly, railroad crossing equipment should not block the view of highway traffic signals. For more information on preemption, please review the current edition of the FHWA's *Railroad-Highway Grade Crossing Handbook.*

Stop Lines for Presignals or Interconnected Devices

If an interconnected traffic signal is adjacent to the crossing then the stop line guidance for the traffic signals shall be used and the railroad stop line shall be omitted.

Intersection Near a Grade Crossing

The Intersection Near a Grade Crossing traffic signal warrant (2011 MMUTCD, Section 4C.10, Warrant 9) is intended for use at a location where none of the conditions described in the other eight traffic signal warrants are met, but the proximity to the intersection of a grade crossing on an intersection approach controlled by a STOP or YIELD sign is the principal reason to consider installing a traffic signal.

Per the 2011 MMUTCD, Section 4C.10, the following guidance is provided; this signal warrant should be applied only after adequate consideration has been given to other alternatives or after a trial of an alternative has failed to alleviate the safety concerns associated with the grade crossing. Among the alternatives that should be considered or tried are:

A. Providing additional pavement that would enable vehicles to clear the track or would provide space for an evasive maneuver, or
B. Reassigning the stop controls at the intersection to make the approach across the track a non-stopping approach.

Per the 2011 MMUTCD, Section 8C.09, "If a highway-rail grade crossing is located within 50 feet (or within 75 feet for a highway that is regularly used by multi-unit highway vehicles) of an intersection controlled by a traffic control signal, the use of pre-signals to control traffic approaching the grade crossing should be considered."

The current MMUTCD should be consulted for further information when a signal is being installed near a highway-railroad grade crossing.

Use of Traffic Signals in Lieu of Active Warning Devices

In certain circumstances, traffic signals can be used instead of flashing-light signals. Per the 2011 MMUTCD, Section 8C.09, traffic signals may be used instead of flashing-light signals to control road users at industrial highway-rail grade crossings and other places where train movements are very slow, such as in switching operations. The MMUTCD also states that traffic signals shall not be used instead of flashing-light signals to control road users at a mainline highway-rail grade crossing.

Active Turn Restriction Signs

At a signalized intersection located within 200 feet of a highway-railroad grade crossing, measured from the edge of the track to the edge of the intersecting roadway and where the intersection traffic signals are preempted by the approach of a train, all existing turning movements toward the crossing should be prohibited during the signal preemption sequences.

At a non-signalized intersection located within 200 feet of a highway-railroad grade crossing, measured from the edge of the track to the edge of the intersecting roadway and where active warning devices are installed at the railroad crossing, all turning movements toward the crossing should be prohibited during the warning device activation. A blank-out or changeable message or other similar type of sign may be used to prohibit turning movements toward the highway-railroad grade crossing during activation.

SPECIAL CIRCUMSTANCES AT HIGHWAY-RAILROAD GRADE CROSSINGS

Stop and Flag Procedures

The Department may order a railroad, at the railroad's expense, to "Stop and Flag" a highway-railroad grade crossing for normal train service or when active traffic control devices may become inoperable, per the Railroad Code of 1993 Section 315(5).

Stop and Flag procedures in compliance with FRA guidelines at highway-railroad grade crossings may also be considered when the following conditions exist:

1. The track is primarily used for switching movements or other low-speed operations.

2. Vehicle traffic can be safely interrupted for the train movement by the train crew. (Vehicle volumes, speeds, and driver sight distances will be considered.)

3. The crossing is not equipped with active traffic control devices or STOP signs. (Except where active traffic control signal systems are manually activated with a push-button or hand thrown switch, or when the Stop and Flag procedure is part of a railroad's operating practice).

Before movement of a train or rail equipment is made over a highway-railroad grade crossing, a flagger should be stationed on the ground at the crossing to provide warning and control of highway traffic. Train or rail equipment movement over the crossing should only be made after all highway traffic has been stopped and the flagger has signaled the engineer or equipment operator to proceed. During daylight hours, the flagger shall use a red flag or lighted red fusee. During the hours from dusk to dawn and during periods of inclement weather or when visibility is reduced, the flagger shall use a lighted red fusee.

Overhead Lighting

If it is determined that better nighttime visibility of trains and a highway-railroad grade crossing is needed (for example, where a substantial amount of railroad operation is conducted at night, where train speeds are low and highway-railroad grade crossings are blocked for long periods, or crash history indicates that drivers experience difficulty in seeing trains or traffic control devices during hours of darkness), then illumination should be installed at or adjacent to the crossing. Types and location of luminaires for highway-railroad grade crossing illumination are contained in the American National Standards Institute's (ANSI) "Practice for Roadway Lighting RP-8" available from the Illuminating Engineering Society.

See Appendix C for further information on illumination.

Work Zone Traffic Control

Road construction projects that impact highway-railroad grade crossings pose many challenges. In particular, issues include advance coordination with the railroad for design review, analysis of impact on existing crossing warning devices, modification of surface type or width, special insurance and flagging concerns for the road contractor when working in proximity to the railroad tracks, and traffic control for the highway-railroad grade crossing during construction activity.

In all cases, road agencies considering a project that includes a highway-railroad grade crossing should contact MDOT's Rail Safety Section at 517-373-8235 or use the link below to request a preliminary review of any proposed work that would impact the crossing.

http://mdotcf.state.mi.us/public/webforms/public/1425.pdf

Parking Restrictions

Michigan Law (MVC 257.674(1) (i)) prohibits parking within 50 feet of the nearest rail at a highway-railroad grade crossing. Where on-street parking is allowed beyond the 50-foot distance, appropriate signs and pavement markings shall be placed in accordance with the current MMUTCD to prohibit parking near the crossing.

Abandoned Tracks

Per the Railroad Code 354 of 1993 (MCL 462.307), where a railroad track at a highway-railroad grade crossing has been abandoned through legal proceedings, the railroad, at its cost, shall remove the track and any active traffic control devices and restore the roadway surface in a manner satisfactory to the road authority. After track removal, the road authority, at its cost, shall remove all passive traffic control devices. The track and all traffic control devices shall be removed within one year of the abandonment. Until such removal is complete, the railroad and the road authority shall maintain it in accordance with this act.

Shared-Use Paths

Where a railroad track intersects with a shared-use path that is not part of the highway infrastructure at an existing public highway-railroad grade crossing, separate warning devices may be required for non-motorized traffic.

Warning devices for non-motorized traffic may include reduced dimension signs and pavement markings, as well as other specialty messages relevant to non-motorized traffic. Details for warning devices suitable for application at crossings of railroads with shared-use paths and other pedestrian facilities can be located in the current MMUTCD. Additional information regarding shared-use paths can be found in the current edition of the FHWA's *Railroad-Highway Grade Crossing Handbook* and the AASHTO *Guide for the Development of Bicycle Facilities 2012.*

When considering an appropriate shared-use pathway crossing design or safety treatment, there are a number of factors to consider, including but not limited to: train frequency and speed, location of the crossing, specific geometrics of the site (angle of the crossing, approach grades, sight distance), type of crossing surface, and nighttime illumination. A crossing treatment must also consider the broad range of users of a shared-use pathway as well as the different types of bicycles on the market today, such as: tandem bicycles, bicycles with trailers, adult trikes, cargo bicycles, recumbent, hand cycles for persons with mobility issues, etc., keeping in mind that these types of bicycles and operators may have mobility restrictions that make their ability to operate gates or navigate through certain designs difficult or impossible.

In all cases, entities considering a project that includes a shared-use path crossing should contact MDOT's Rail Safety Section at 517-373-8235 to request a preliminary review.

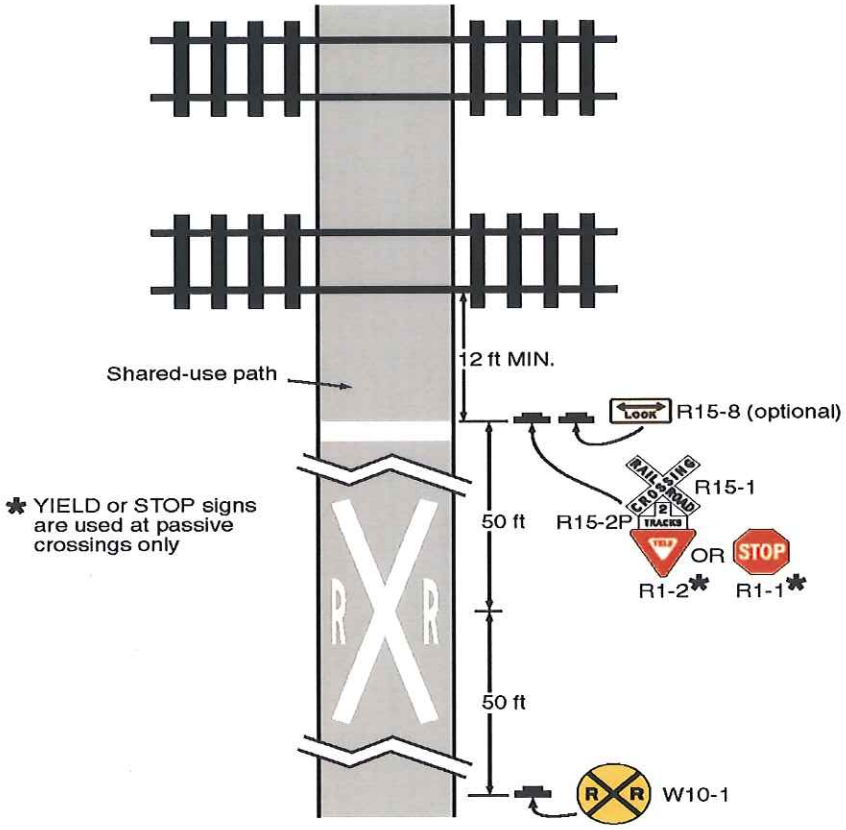


Figure 28: Warning Devices at Shared-Use Path Crossings

Flangeway Gaps

Flangeway gaps at pedestrian and shared-use at-grade rail crossings shall be 2 1/2 inches maximum on non-freight rail track and 3 inches maximum on freight rail track. These are the typical gaps required to allow passage of train wheel flanges. The flangeway gaps are wider than the maximum gap allowed for horizontal openings in other surfaces.

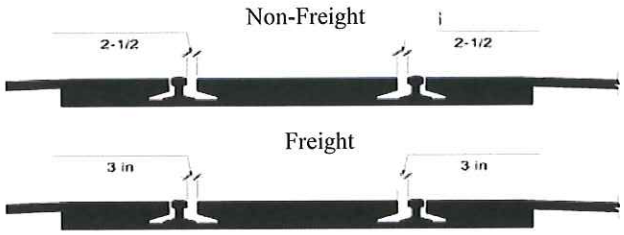


Figure 29: Flangeway Gaps

Detectable Warning Devices

At pedestrian at-grade rail crossings (including sidewalks and shared-use paths), American Disabilities Act (ADA) compliant detectable warning surfaces shall be located so that on each side of the railroad crossing there is a six-foot minimum and 15-foot maximum distance from the centerline of the nearest rail to the detectable warning devices.

The rows of truncated domes in a detectable warning surface shall be aligned to be parallel with the direction of wheelchair travel. Where pedestrian gates are provided, detectable warning surfaces shall be placed on the side of the gates opposite the rail. Detectable warning surfaces should contrast visually with adjacent walking surfaces, either light-on-dark or dark-on-light. See MDOT Standard Plan R-28 Series and the MDOT Qualified Products List for more information and options.

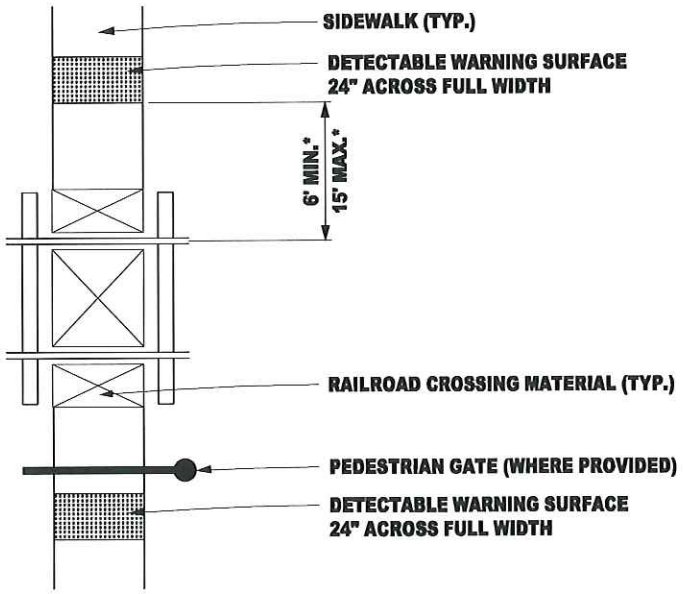


Figure 30: Detectable Warning at Railroad Crossings

GRADE CROSSING RELATED LAWS

Adapted from P.A. 354 of 1993 (THE RAILROAD CODE OF 1993)

New Crossings

If the location of a proposed highway-railroad grade crossing is found to be necessary, feasible, and may be made reasonably safe for a crossing at grade, the Department shall grant permission for the crossing. The Department shall require installation of such traffic control devices as, in its judgment, may be appropriate. When a highway-railroad grade crossing necessitated by a new roadway across an existing track is permitted, the Department shall simultaneously, after investigation and hearing, order the abolishment of one or more existing crossings having less than 100 vehicles a day within the same road authority jurisdiction.

The full cost of constructing a new street or highway across an existing railroad, or of a new railroad track or tracks across an existing street or highway, shall be borne by the party requesting the crossing. The cost of construction shall include the direct construction cost of the roadbed, track structure, grade crossing surface, pavement, traffic control devices, and drainage, including all material, labor, and services and other costs of construction.

Crossing Surfaces

The space between the rails, and for a distance outside of the rails of one foot beyond the end of the ties, shall be surfaced with a material that shall be as durable and as smooth as the adjacent street or highway surfacing. The crossing surface shall have minimum qualifications not inferior to wooden planks, and shall conform, as nearly as reasonably may be, to the configuration of the adjacent street or highway. In the case of streets and highways constructed or reconstructed after the effective date of this Act (January 14, 1994), the surfacing of planks or other material shall have a minimum length equal to the length between the established curb lines, or, in the absence of curb lines, equal to the length between the established shoulder lines of the street or highway plus two feet on each side of the street or highway.

A railroad owning tracks across a public street or highway at grade shall, at its sole cost and expense, construct and thereafter maintain, renew, and repair all railroad roadbed, track, and railroad culverts within the confines of the street or highway, and the streets or sidewalks lying between the rails, and for a distance outside the rails of one foot beyond the end of the ties. The road authority, at its sole cost and expense, shall construct or improve, if necessary, and thereafter maintain, renew, and repair the remainder of the street or highway.

Active Warning Device Maintenance Fees

After initial installation, all active traffic control devices, circuitry, and appurtenances at crossings shall be maintained, enhanced, renewed, and replaced by the railroad at its own expense, except that the road authority shall pay $1,271 for flashing signals on a single track, $1,978 for flashing signals and gates on a single track, $1,481 for flashing signals with cantilever arms on a single track, $2,389 for flashing signals with cantilever arms with gates on a single track, $2,257 for flashing signals and gates on multiple tracks, $2,398 for flashing signals with cantilever arms and gates on a multiple track, $1,269 for flashing signals on a multiple track, and $1,375 for flashing signals with cantilever arms on a multiple track annually for maintenance to the railroad for each crossing with active traffic control devices not covered by existing or future railroad-road authority agreements.

APPENDIX A

SAFETY INDICES USED TO ANALYZE CROSSING RISK

A variety of safety indices and crash prediction formulas have been in use nationally for years to assist in identifying highway-railroad grade crossings that should receive further analysis for possible safety project development. Examples listed in the FHWA's *Railroad-Highway Grade Crossing Handbook – Revised Second Edition* are the New Hampshire Index, the USDOT Accident Prediction Model (available as a free online application at the FRA website), and the National Cooperative Highway Research Program (NCHRP) Report 50 Accident Prediction Formula. With FWHA approval, Michigan presently uses a modified New Hampshire Index.

The New Hampshire Index uses train and highway traffic volumes with a simple protection factor multiplier. The protection factor is a number that varies according to the type of traffic control device that exists at a highway-railroad grade crossing. For example, a Crossbuck sign has a protection factor of 1.00, while 12-inch flashing-light signals with gates have a protection factor of 0.10. This means that when properly used, flashing-light signals and gates are more effective than a Crossbuck sign alone in preventing grade crossing crashes. The 2016 edition of the Guidelines contain an updated set of protection factors to more effectively address the risk reduction attained by increasing the size of lens on flashing-light signals or by interconnecting traffic signals.

Specific details for both the New Hampshire Index and the NCHRP Report 50 Accident Prediction model are included in this Appendix. The New Hampshire data provides an overview of current practice for ranking crossings and calculating exposure, while the NCHRP model provides a nationally recognized formula for crash prediction as well as factors to assist in calculating the effect of prospective warning device selection on future crash probability.

The New Hampshire Index is expressed as follows:

New Hampshire Index = (V)x(T)x(Pf)

where:

V = AADT (Annual average daily traffic)

T = Average daily train traffic

Pf= Protection factor

Protection Factors at Crossings with Passive Warning Devices

1.00 Crossbuck sign with or without a YIELD sign

0.80 Crossbuck sign with a STOP sign

0.75 Stop and Flag Procedures

Protection Factors at Crossings with Active Warning Devices

0.33 Flashing-Light Signals with any 8-inch lenses

0.30 Flashing-Light Signals with all 12-inch lenses

0.27 Flashing-Light Signals with Cantilever Arms and any 8-inch lenses

0.24 Flashing-Light Signals with Cantilever Arms and all 12-inch lenses

0.11 Flashing-Light Signals with Roadway Gates and any 8-inch lenses

0.10 Flashing-Light Signals with Roadway Gates and all 12-inch lenses

0.09 Flashing-Light Signals with Cantilever Arms and Roadway Gates and any 8-inch lenses

0.08 Flashing-Light Signals with Cantilever Arms and Roadway Gates and all 12-inch lenses

Protection Factors at Crossings with Traffic Signal Interconnections

0.10 Any Passive Warning Device with a Traffic Signal Interconnection

0.05 Any Active Warning Device with a Traffic Signal Interconnection

NCHRP Report 50 Accident Prediction Formula

Expected Accident Frequency = A x B x Current Trains per Day

Source: USDOT Railroad-Highway Grade Crossing Handbook-Revised Second Edition, August 2007.

FACTOR A Traffic Volume / Vehicles per Day	
10 yr. ADT*	FACTOR
250	.000347
500	.000694
1000	.001377
2000	.002627
3000	.003981
4000	.005208
5000	.006516
6000	.007720
7000	.009005
8000	.010278
9000	.011435
10000	.012674
12000	.015012
14000	.017315
16000	.019549
18000	.021736
20000	.023877
25000	.029051
30000	.034757

FACTOR B Basic Values for Existing Warning Devices	
DEVICE / DETAIL	FACTOR
Crossbucks, highway volume < 500/day	3.89
Crossbucks, urban	3.06
Crossbucks, rural	3.08
Stop signs, highway volume < 500/day	4.51
Stop signs	1.15
Wigwags (obsolete, not used in Michigan)	.61
Flashing-lights, urban	.23
Flashing-lights, rural	.93
Gates, urban	.08
Gates, rural	.19

* *Future ADT calculation = Current ADT x $(1+i)^n$ where i = rate of expected growth (avg. 0.03) and n = number of years*

Example:

Known Data: Urban area, Crossbucks, 5,000 vehicles per day, 5 trains per day

Solution: EAF = .006516 x 3.06 x 5 = 0.10
EAF = 0.10 > 0.02
Accident frequency is greater than 0.02.
This would indicate need for higher type device.
Try flashing-lights B = 0.23
EAF = .006516 x 0.23 x 5 = 0.01

Conclusion: Flashing-lights are warranted

APPENDIX B

CLEAR VISION AREAS

Tables A and B of this appendix provide desirable dimensions for clear vision areas at highway-railroad grade crossings that need to be considered, along with other factors, in determining crossing safety treatments. These clear vision areas are graphically shown in the drawings below. All quadrants of a crossing (or all approach quadrants of a one-way street) would ideally have these minimum clear vision areas.

Two clear vision areas need to be physically measured and investigated for each quadrant. The first is for a stopped highway vehicle condition (see drawing below). The distance down the track (dT) is taken from the shaded stopped condition column of Table A, while the distance down the highway will be the actual measured distance from the nearest rail to the driver's eye position while stopped behind the stop line (if one exists).

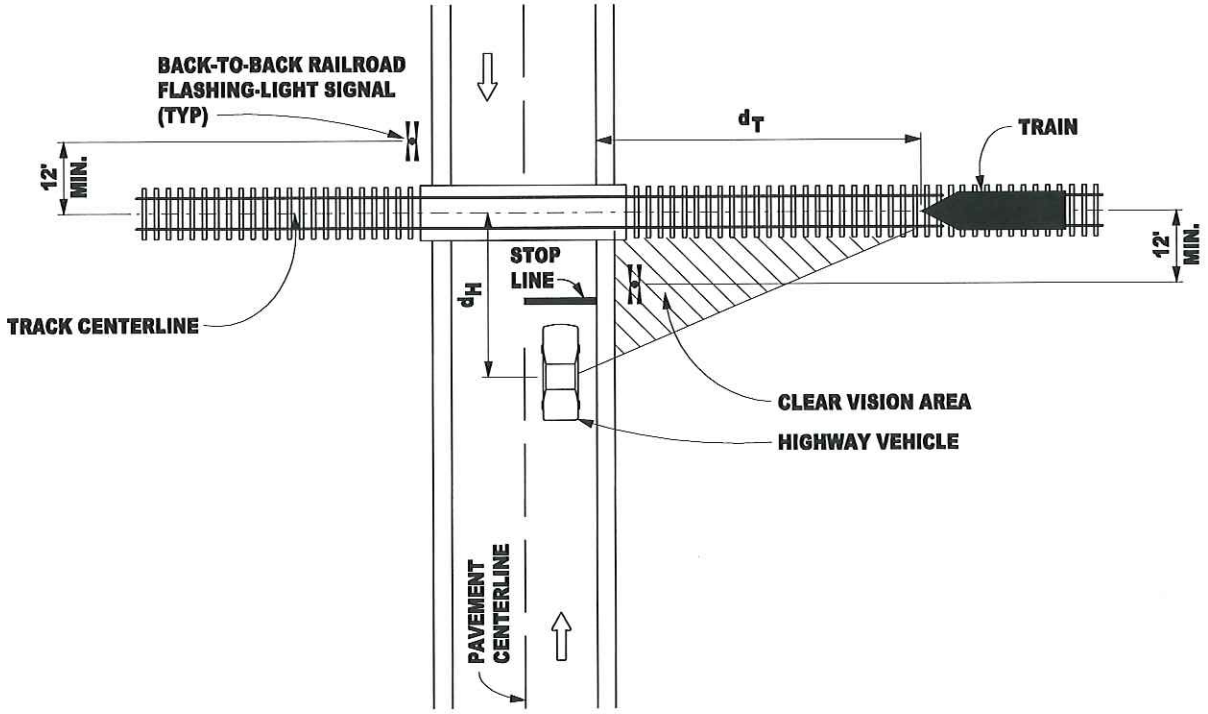


Figure 31: Clear Vision Area, Stopped Condition

The second clear vision area to be investigated is for a moving highway vehicle condition (see drawing below). The distance down the track (dT) is taken from Table A, using the posted highway speed and the maximum timetable train speed. The distance down the highway (dH) is obtained from Table B. A driver needs to be able to see the train and the crossing from a distance down the highway (dH). These moving vehicle clear vision areas apply to all quadrants of any crossing where highway vehicles are not required to come to a complete stop.

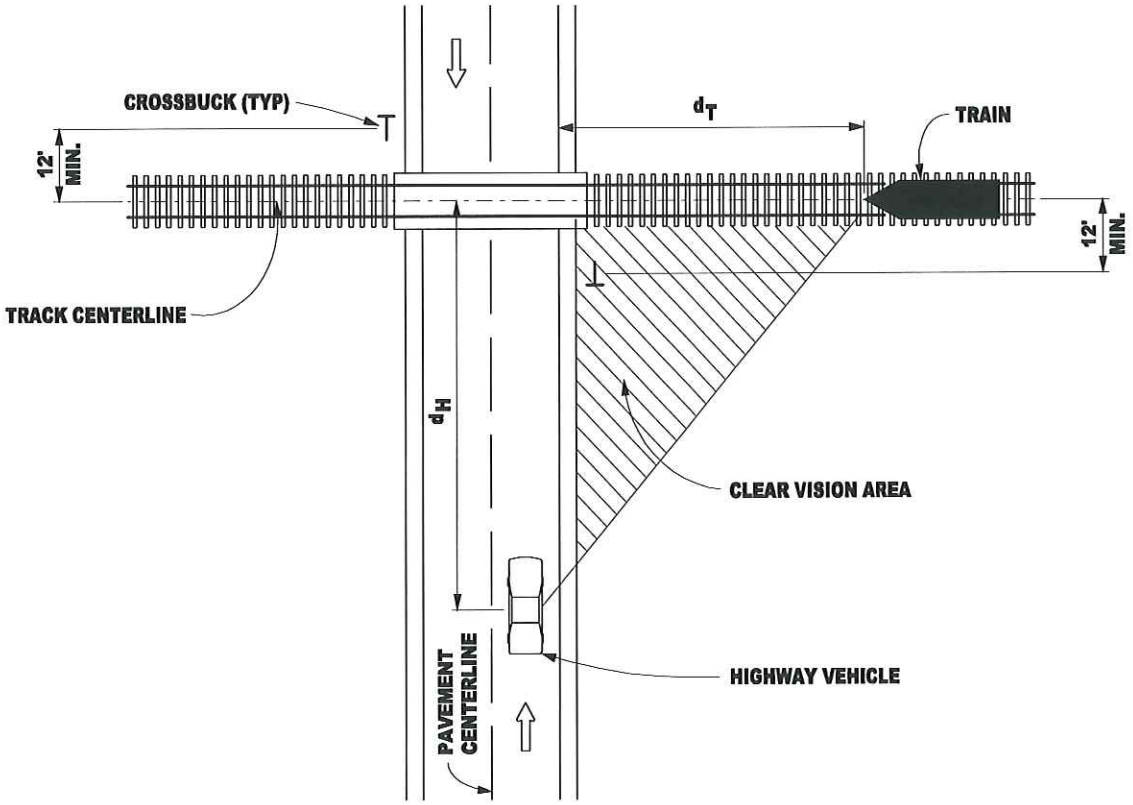


Figure 32: Clear Vision Area, Moving Condition

Table A – Distance (dT) Down Track (feet)

Pedestrian / Highway Vehicle Speed (mph)

Train Speed (mph)	Peds	Stop	25	30	35	40	45	50	55	60	65	70	75
10	179	255	104	102	101	102	104	106	109	112	116	119	123
15	268	382	156	153	152	153	156	160	164	169	174	179	185
20	357	509	208	203	203	205	208	213	219	225	232	239	246
25	446	637	260	254	253	256	260	266	273	281	290	299	308
30	536	764	312	305	304	307	312	319	328	337	347	358	370
35	625	891	365	356	355	358	364	373	382	393	405	418	431
40	714	1,019	417	407	405	409	416	426	437	450	463	478	493
45	804	1,146	469	458	456	460	468	479	492	506	521	537	554
50	893	1,273	521	509	507	511	520	532	546	562	579	597	616
55	982	1,401	573	559	557	562	572	585	601	618	637	657	678
60	1,071	1,528	625	610	608	614	624	639	656	675	695	717	739
65	1,161	1,655	677	661	659	665	676	692	710	731	753	776	801
70	1,250	1,783	729	712	709	716	728	745	765	787	811	836	862
75	1,339	1,910	781	763	760	767	780	798	820	843	869	896	924
80	1,428	2,037	833	814	811	818	832	852	874	899	927	956	986
85	1,518	2,164	885	865	861	869	884	905	929	956	985	1,015	1,047
90	1,607	2,292	937	915	912	920	936	958	983	1,012	1,042	1,075	1,109
95	1,696	2,419	989	966	963	972	989	1,011	1,038	1,068	1,100	1,135	1,170
100	1,786	2,546	1,041	1,017	1,013	1,023	1,041	1,064	1,093	1,124	1,158	1,194	1,232
105	1,875	2,674	1,094	1,068	1,064	1,074	1,093	1,118	1,147	1,180	1,216	1,254	1,294
110	1,964	2,801	1,146	1,119	1,115	1,125	1,145	1,171	1,202	1,237	1,274	1,314	1,355

Table B – Distance (dH) Down Highway (feet)

Highway Vehicle Speed (mph)	Peds	Stop	25	30	35	40	45	50	55	60	65	70	75
dH(feet)	20	23	175	220	269	324	383	447	515	589	667	751	839

NOTES:

1) Information contained in this appendix is based on AASHTO's *A Policy on Geometric Design of Highways and Streets, 2011*. The highway vehicle is assumed to be a 73.5-foot truck.

2) Values taken from Tables A and B may need to be modified if any of the following conditions exist: multiple tracks, skewed crossing angles, or vertical grades on the highway approaches.

3) A 23-foot distance down-highway for a stopped vehicle represents the sum of the distances from the nearest rail to the stop bar location or statutory vehicle stopping point (15 feet) and the position of the driver in relation to the front of the vehicle (8 feet). The latter is the AASHTO standard for a full-sized automobile.

4) Pedestrian values are based on a 3-foot-per-second pedestrian velocity and a 12-foot distance from the front of the detectable warning to the nearest track.

5) See the section on pavement markings on pages 10 - 12 for more information on the proper placement of stop lines.

APPENDIX C

ILLUMINATION AT RAILROAD CROSSINGS

The lighting should illuminate passive and/or active warning devices, the pavement surface and markings, and the presence or absence of a train in or approaching the crossing. Luminaires should be aligned toward the railroad tracks instead of the roadway. The figure below shows a recommended lighting configuration:

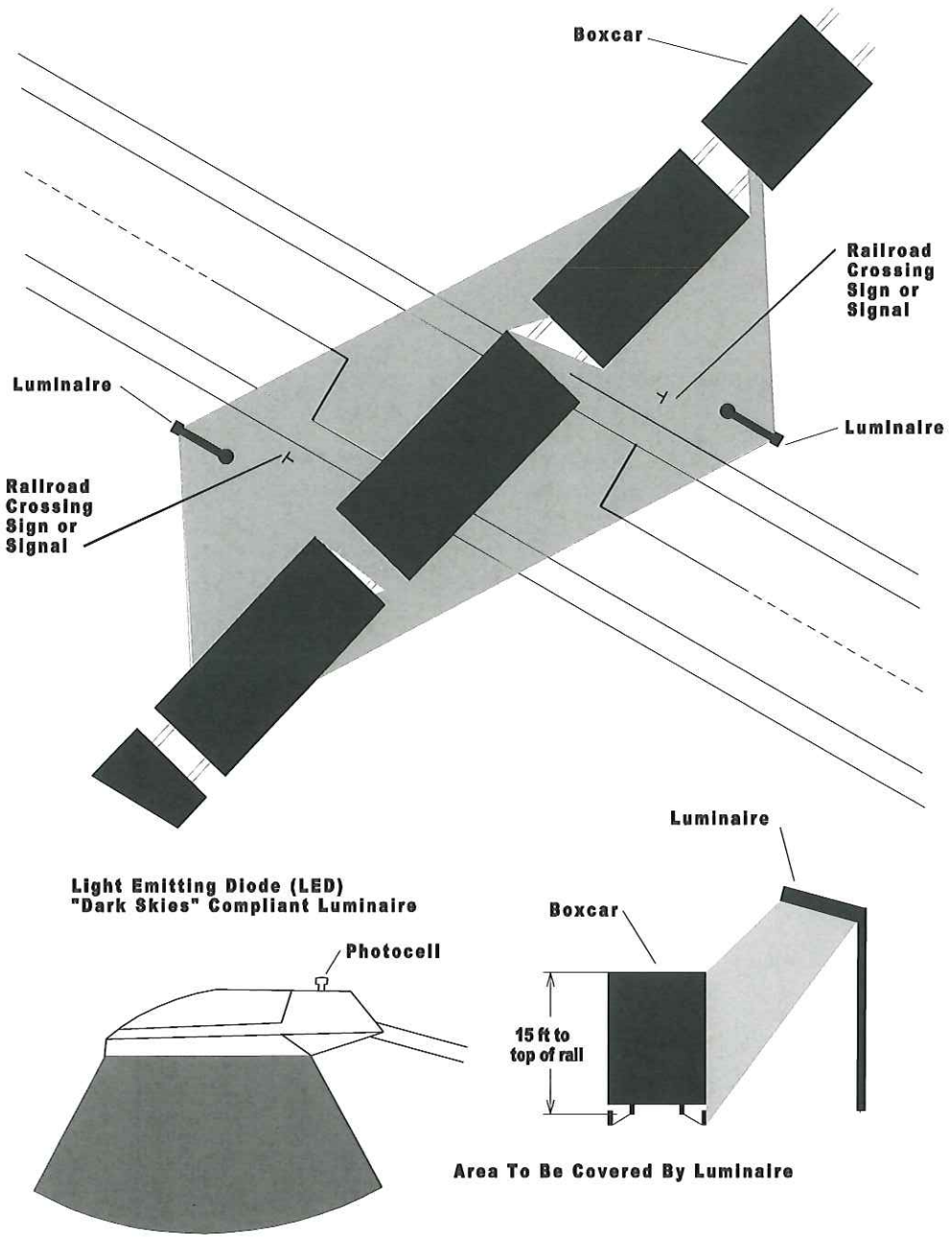


Figure 33: Illumination at Railroad Grade Crossing

At least one luminaire shall be mounted on each side of the track at the highway-railroad grade crossing, and luminaires must be located so that warning devices at the crossing will be directly illuminated.

Luminaires should be oriented toward the railroad track to provide at least one foot-candle (11 lux) of illumination on the vertical plane 5 feet from the centerline of track. The maximum permissible level of illumination and exact orientation of the luminaire will be determined on a case-by-case basis. Factors at the site, including the ambient level of nighttime illumination, need to be considered. The maximum level of illumination is related to the level of lighting on the roadway approaches. The level of illumination must be sufficient to alert drivers to the highway-railroad grade crossing ahead and to any railroad equipment occupying the crossing, but should not be so bright as to create a blinding effect for motorists in the area immediately beyond the crossing. Cutoffs will normally be used on luminaires to minimize this blinding effect.

Luminaires should illuminate an area along the track that is 50 percent wider than the traveled width of the road. For example, if the road is 20 feet wide, the roadway width plus 5 feet along the track on each side of the road should be illuminated. If the roadway is less than 20 feet wide, a minimum illumination of 5 feet down the track should be maintained. The illumination should cover a distance that is equal to the normal height of rail equipment (at least 15 feet above the top of the rail).

Support poles should be placed not less than 9 feet from the centerline of tangent track to maintain track clearance requirements.

Pole placement should be checked to ensure that the pole provides minimal obstruction of the motorist's view down the track. In addition, pole placement shall be such that it does not obstruct the train crew's view down the track and so that the luminaire is not confused with any wayside train signals. "Dark Skies" compliant luminaires are required where wayside train signals are used.

Poles holding luminaires shall be located so they can be maintained from the highway right-of-way.

Every effort should be made to locate luminaires and support poles external to the railroad right-of-way. If luminaires or poles are to be placed in the railroad right-of-way, prior approval must first be granted by the railroad.

If installed by utility company, basic direction shall be provided and the utility company will complete it to meet the general guidelines above.

Single-Track Crossings: Poles should be located approximately 25 feet from both the road and the centerline of the railroad track. Up to 200-watt LED luminaires will be placed at least 30 feet above the top of the rail, on arms that are six to 16 feet long. If a railroad signal system is involved, "Dark Skies" compliant luminaires are required.

Multiple-Track Crossings: Up to 300-watt LED luminaires will be placed at least 40 feet above the top of the rail. If there is a considerable distance between the tracks, it may be desirable to install a luminaire between the tracks. Semi-cut-off luminaires may be considered since they spread the light over a larger area of the crossing. This treatment is needed particularly at crossings of three or more tracks and/or crossings having severe angles of intersection.

Requirements:

1) LED-type luminaire
2) 30-foot – 0 inch minimum mounting height
3) Photocell inclusive luminaire

Maintenance: Source of payment for the future energy costs will be worked out between the local government and the utility company/railroad/road authority. Recent studies have shown that utilizing LED technology has significantly reduced maintenance costs.

Reference: "Roadway Lighting" RP-8, American National Standard, Illuminating Engineering Society (IES). www.iesna.org

APPENDIX D
ASSOCIATED LINKS

Michigan Manual on Uniform Traffic Control Devices (MMUTCD)
Part 8 Traffic Controls for Highway-Rail Grade Crossings and Highway-Light Rail Transit Grade Crossings
*http://*mdotcf.state.mi.us/public/tands/Details_Web/mmutcdpart8_2011.pdf

Complete MMUTCD Manual
http://mdotcf.state.mi.us/public/tands/Details_Web/mmutcdcompleteinteractive.pdf

Railroad-Related MDOT Pavement Marking Guidance
http://mdotcf.state.mi.us/public/tands/plans.cfm

Railroad-Related MDOT Road Plans
R-28-Series Sidewalk Ramp and Detectable Warning Details
R-30-Series Concrete Curb and Concrete Curb and Gutter
R-112-Series Shoulder and Centerline Corrugations
R-121-Series Track Crossings
R-122-Series Railroad Crossing Signals
http://mdotcf.state.mi.us/public/design/englishstandardplans/

Note 903-Series Maintaining Traffic During Roadway Work at Railroad Crossings
http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_note903b.pdf

Shared-Use Path and Pedestrian Crossing Links
Treatments Used at Pedestrian Crossings of Public Transit Rail Services -
http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_w63.pdf

Guidebook on Pedestrian Crossings of Public Transit Rail Services -
http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_175.pdf

Railroad-Related MDOT Signs and Support Documentation
Traffic Sign Design, Placement, and Application Guidelines
http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_signing_design_placement_application_guidelines.pdf

SIGN-130-Series Railroad Crossing Sign
http://mdotcf.state.mi.us/public/tands/Details_Web/sign-130-b.pdf

MDOT Sight Distance Guidelines
http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_sight_distance_guidelines.pdf

MDOT Standard Highway Signs Book
http://mdotcf.state.mi.us/public/tands/plans.cfm *(Expand "Traffic Signing" category, then select "Standard Highway Signs" and press the search button at bottom of left green column)*

Entire MDOT Traffic and Safety Notes Binder
http://mdotcf.state.mi.us/public/tands/Details_Web/mdot_trafficandsafetynotes_full.pdf

MDOT Office of Rail Standard Specifications for Railroad Work 2006
http://www.michigan.gov/documents/2006_MDOT_Railroad_Specifications_147841_7.pdf

MDOT Office of Rail Railroad Typical Plans 2006
http://www.michigan.gov/documents/2006_Railroad_Typicals_Plans_147844_7.pdf

Relevant Railroad and Vehicle Regulations

Railroad Code of 1993 [MCL 462.101 – 462.451]; also known as Public Act 354
http://legislature.mi.gov/doc.aspx?mcl-Act-354-of-1993

Michigan Vehicle Code [MVC 257.674(1) (i)]; also known as Act 300 of 1949
http://legislature.mi.gov/doc.aspx?mcl-chap257

CFR 23 – 646; Code of Federal Regulations (CFR) Title 23 – Highways
Chapter 1 – Federal Highway Administration, Department of Transportation, Part 646 – Railroads
http://www.access.gpo.gov/nara/cfr/waisidx_03/23cfr646_03.html

Railroad, Engineering, Highway and Safety Organizations

American Association of State Highway and Transportation Officials (AASHTO)
www.transportation.org

American Railway Engineering and Maintenance-of-Way Association (AREMA)
www.arema.org

American Short Line and Regional Railroad Association (ASLRRA)
www.aslrra.org

County Road Association of Michigan (CRA)
www.micountyroads.org

Federal Railroad Administration (FRA)
http://www.fra.dot.gov/

Institute of Transportation Engineers (ITE)
www.ite.org

International Safety Equipment Association (ISEA)
www.safetyequipment.org

Michigan Municipal League (MML)
www.mml.org

Michigan Railroads Association (MRA)
http://www.michiganrailroadsassociation.com/

National Committee on Uniform Traffic Laws and Ordinances (NCUTLO)
www.ncutlo.org

Occupational Safety and Health Administration (OSHA)
www.osha.gov

Operation Lifesaver (OLI)
National OLI - http://www.oli.org/
Michigan OLI - http://mi-ol.org/

Transportation Research Board (TRB)
www.nas.edu/trb

APPENDIX E
MDOT OFFICE OF RAIL CONTACT INFORMATION

Section/Unit Name	Function	Phone number
Rail Safety Section	Regulatory authority for all highway-railroad public grade crossings in the state	517-373-8235
Trunkline Coordination Unit	Project development for public grade crossings on state-owned roads	517-335-2272
Local Grade Crossing Program	Project development for public grade crossings on local roads	517-335-3054
State-Owned Rail Lines	Property management and development for state-owned rail lines	517-335-3577
Rail Passenger	Project development and coordination	517-335-2549

Website: http://www.michigan.gov/mdot/0,4616,7-151-11056_22444_56481---,00.html

APPENDIX F
Railroad Emergency Contact Numbers

Adrian & Blissfield Rail Road (ADBF),
Charlotte Southern Railroad (CHS),
Delray Connecting Railroad (DCON),
Jackson & Lansing Railroad (JAIL), and
Lapeer Industrial Railroad (LIRR),
(800) 555-2580

Amtrak
(517) 780-3716 Jackson
(269) 687-2200 Niles

Ann Arbor Railroad (AA)
(419) 726-3237 Hallett Tower
(888) 778-3237

Canadian National (CN),
Grand Trunk Western (GTW), and
Wisconsin Central (WC)
(248) 740-0321
(800) 465-9239

Conrail (CR)
(800) 937-5063

Coopersville & Marne Railway (CM)
(616) 784-7216

CSX Transportation (CSX)
(800) 232-0144

Escanaba & Lake Superior Railroad (ELS)
(906) 786-0693
(800) 200-2360

Grand Elk Railroad (GDLK)
(313) 261-6142 Dispatch (Watco)

Grand Rapids Eastern Railroad (GRE)
(866) 527-3495

Great Lakes Central Railroad (GLC)
(800) 622-7245, Ext. 105

Huron & Eastern Railway (HE)
(802) 527-3499
(866) 527-3499

Indiana Northeastern Railroad (IN)
(517) 439-4677
(517) 278-4614

Indiana & Ohio Railway (IO)
(800) 979-4958

Lake State Railway Company
(989) 393-9800 Press 0
(989) 757-7560

Lake Superior & Ishpeming (LSI)
(906) 475-4781

Marquette Rail (MQT)
(231) 845-9000
(866) 724-5911

Michigan Shore Railroad (MS)
(989) 797-5100
(866) 527-3499

Michigan Southern Railroad (MSO) and
West Michigan Railroad (WMI)
(309) 697-1400
(309) 369-4143
(800) 446-7245

Mid-Michigan Railroad (MM)
(989) 797-5100 Office
(866) 527-3499 After hours

Mineral Range Inc.
(906) 360-6849

Norfolk Southern Corp. (NS)
(800) 946-4744
(800) 453-2530

Southern Michigan Railroad Society, Inc.
(517) 263-1322

REFERENCES

1. 2011 Michigan Manual on Uniform Traffic Control Devices (MMUTCD)

2. Public Act 354 of 1993 (the Railroad Code of 1993)

3. *Railroad-Highway Grade Crossing Handbook, Revised Second Edition, August 2007* – Federal Highway Administration

4. Michigan Vehicle Code

5. *A Policy on Geometric Design of Highways and Streets, 2011* – American Association of State Highway and Transportation Officials (AASHTO)

6. American Railway Engineering and Maintenance-of-Way Association (AREMA)

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