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 Rail Safety Section 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 Michigan Department of Transportation rules for dissemination of public information.

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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 Michigan Manual of Uniform Traffic Control Devices (MMUTCD), industry publications 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, consistent with federal and state laws and regulations.

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

As of 2008, there were approximately 28 railroad companies in the State of Michigan, operating over approximately 4,800 public highway-railroad grade crossings. 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 a 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 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 Michigan Department of Transportation, 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.

The purpose of this document is to provide road authorities, railroads and any other prospective diagnostic study team participants with an overview of typical practices and devices used at highway-railroad grade crossings throughout the state. The guidelines presented herein are based upon proven and sound safety management principles, and they are intended to serve as a convenient reference to ensure consistent and reasonable crossing safety determinations.

This edition of the guidelines has been reorganized and indexed to improve usability, and the guidelines now contain a new set of definitions intended to establish a better understanding of common highway-railroad grade crossing terminology. In addition to providing users with more 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 now referenced and linked electronically. Future upgrades and additions to these guidelines will be published periodically as necessary to keep the guidelines current with the latest and best information available.
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 controller 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 activation of the railroad warning devices.

Automatic Gates - 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. Bells/gongs may be mounted alone, or in combination with other active warning devices.

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.

Diagnostic Study Team Review - 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.

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 manual 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 by a railroad or road authority to shelter any or all of the hardware elements required to control the operation of active traffic control devices or train control systems.

**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.

**Highway** - a general term for 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** - the electrical connection between the railroad active warning 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 of 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 Tag (NI tag)** - a small sign (or stenciled marking) installed and maintained by the railroad at every public highway-railroad grade crossing. The NI tag contains a unique National Inventory number for each crossing. National Inventory numbers are assigned and tracked by the Federal Railroad Administration. The NI tag sign may also include supplemental emergency contact information for the railroad.

**Non-Motorized Pathway** - a pathway outside the traveled way and physically separated from motorized vehicular traffic by an open space or barrier, and either within the highway right-of-way, or within an independent alignment. Non-motorized pathways are used by bicyclists, pedestrians, skaters, horseback riders, users of manual and motorized wheel chairs, joggers, etc., and other authorized motorized and non-motorized users.
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 which 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. (new FHWA definition - 2009)

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) which 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 upon 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.

Side Track - a track auxiliary 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.

Simultaneous Preemption - notification of an approaching train, forwarded to the highway traffic signal controller unit or assembly and the railroad active warning devices at the same time.

Spur Track - as distinguished from a side track, a spur track is of indefinite length, extending out 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.

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

General Information
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 of 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 2 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 retroreflective 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” (Section 2C.54 of the 2005 MMUTCD). A custom made symbol sign will need Federal Highway Administration (FHWA) approval prior to installation.

Crossbuck (R15-1) and Number of Tracks (R15-2) Signs
Federal and State laws require signs to be placed at all crossings of public highways with railroad tracks. Federal guidelines also require the use of National Inventory tags at every crossing.

The railroad crossing sign, commonly identified as the Crossbuck (R15-1) sign, 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. If there are two or more tracks between the Crossbuck signs, the number of tracks shall be indicated on a supplemental Number of Tracks (R15-2) sign of an inverted “T” shape mounted below the Crossbuck signs. All signs shall be mounted and positioned as shown in the drawings on the following pages.

When active highway-railroad traffic control devices are not used, white retroreflective sheeting shall be applied to the back of the sign blades and front and back of the sign support. When state or federal funds are used for installation of passive signs, an approved breakaway post is required.

Per the current MMUTCD, a strip of retroreflective white material, not less than 2 inches in width (Department standard is 6 inches), shall be used on the back of each blade of each Crossbuck sign for the length of each blade, at all highway-railroad grade crossings, except those where Crossbuck signs have been installed back-to-back.

Per the current MMUTCD, a strip of retroreflective white material, not less than 2 inches in width (Department standard is 3 inches), shall be used on each support at passive highway-railroad grade crossings for the full length of the front and back of the support from the Crossbuck sign or Number of Tracks sign to within 2 feet above the edge of the roadway, except on the side of those supports where a STOP (R1-1) or YIELD (R1-2) sign or flashing lights have been installed, or on the back side of supports for Crossbuck signs installed on one-way streets.
Where physically feasible and visible to approaching traffic, the Crossbuck sign shall be installed on the right side of the highway on each approach to a highway-railroad grade crossing. Where restricted sight distance or unfavorable highway geometry exist 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.

STOP (R1-1) or YIELD (R1-2) Signs
At the discretion of the responsible road agency with jurisdiction, STOP (R1-1) or YIELD (R1-2) signs may be used at highway-railroad grade crossings that have two or more trains per day and are without active traffic control devices. Two or more trains per day means an average of two or more trains per day operating over a highway-railroad grade crossing for a 12-month period prior to the installation of the STOP or YIELD control sign.

For other highway-railroad grade crossings with passive warning devices, STOP or YIELD signs may be used based on an engineering study. However, the use of STOP signs at passive crossings should be limited to unusual conditions, where requiring all vehicles to make a full stop is deemed essential by an engineering study. The engineering study should take into consideration factors such as highway and train traffic characteristics (including volume, speed and number of tracks), collision history, sight distance to the approaching train and the need for active traffic control devices.

If a STOP or YIELD sign is installed at a highway-railroad grade crossing, it may be installed on the Crossbuck post or on a separate post at a point where the vehicle is to stop, or as near to that point as practical.
For all highway-railroad grade crossings where STOP or YIELD signs are installed, the placement shall conform to the requirements in the current MMUTCD. 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.

**DO NOT STOP ON TRACKS (R8-8) Sign**
Where the potential for vehicles to stop on railroad tracks is high, a DO NOT STOP ON TRACKS (R8-8) sign 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.

**TRAINS MAY EXCEED 80 MPH (W10-8) Sign**
Where trains are permitted to travel at speeds exceeding 80 mph, a TRAINS MAY EXCEED 80 MPH (W10-8) sign should be installed facing road users approaching a highway-railroad grade crossing. If used, the sign should be installed between the Advanced Warning (W10-1) sign and the highway-railroad grade crossing on all approaches to the crossing. The location should be determined based on specific site conditions.

**Low Ground Clearance**

**Highway-Railroad Grade Crossing (W10-5) Sign**
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 Highway-Railroad Grade Crossing (W10-5) sign 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 Highway-Railroad Grade Crossing warning sign 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 W10-5 sign.

**Advance Warning Signs (W10 Series)**
A highway-railroad grade crossing advance warning (W10-l) sign 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 highway-railroad grade crossing advance warning sign shall be in accordance with Part 2 of the current MMUTCD. (see examples provided on the next page)

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 100 feet or more between the railroad and the parallel highway, a W10-1 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 current MMUTCD.

![Highway-Railroad Grade Crossing Pavement Markings](https://via.placeholder.com/150)

**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 (two-lane 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 the following drawings. 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.
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 approximately 8 feet from the gate (if present), but no closer than 15 feet from the nearest rail.

EXAMPLE OF PLACEMENT OF WARNING SIGNS AND PAVEMENT MARKINGS AT HIGHWAY-RAILROAD GRADE CROSSINGS (MI)

On multi-lane roads, the transverse bands should extend across all approach lanes, and individual RR symbols should be used in each approach lane.

* If needed, supplemental pavement marking symbols may be placed between the advance warning sign and the crossing, but should be at least 50 ft. from the stop line.

Note: In an effort to simplify the figure to show warning sign and pavement marking placement, not all required traffic control devices are shown.

Markings for highway-railroad crossing grade crossing shall be placed in accordance with the current MUTCD. Positioning of the "RR" symbols and transverse lines shall vary according to the posted speed of traffic, as set forth in the following table.

<table>
<thead>
<tr>
<th>POSTED SPEED (MPH)</th>
<th>DISTANCE &quot;L&quot; (FT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 AND BELOW</td>
<td>250</td>
</tr>
<tr>
<td>40-45</td>
<td>400</td>
</tr>
<tr>
<td>50-55</td>
<td>550</td>
</tr>
<tr>
<td>60 AND ABOVE</td>
<td>750</td>
</tr>
</tbody>
</table>

From 2005 MUTCD Figure BB-6
ACTIVE HIGHWAY-RAILROAD TRAFFIC CONTROL DEVICES

General Information
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 requires that the Crossbuck (R15-1) sign, STOP ON RED SIGNAL (R15-5b) sign and Number of Tracks (R15-2) sign (where appropriate) shall be used in accordance with the current Michigan Manual of Uniform Traffic Control Devices (MMUTCD). Federal guidelines also require the use of National Inventory tags at every crossing.

No active traffic control device 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.

At highway-railroad grade crossings with curbs, active traffic control devices shall be placed with a horizontal clearance of 2 feet from the face of each 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 2 feet from the edge of the shoulder to the nearest edge of any signal component, with a clearance of at least 6 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’ of each other, 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 provided, sufficient clearance from warning device supports, posts, and mechanisms should be maintained for pedestrian travel.

Specific placement, dimension and clearance information is provided within the drawings and descriptions that accompany each type of active warning device installation as detailed on the following pages.

Deviation from these parameters will be handled on a case-by-case basis as determined by MDOT’s Freight Services and Safety Division.
Track Circuity
Adapted from PA 354 of 1993 (the Railroad Code of 1993): Whenever active traffic control devices are installed at any highway-railroad grade crossing, they shall be so 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.

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.

Criteria for Installation of Post-Mounted Flashing-Light Signals
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 exposure factor exceeds 4,000 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 car/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: a Federal Railroad Administration 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 to post-mounted flashing-light signals, the Department may concur with the request.
TYPICAL COMPONENTS AND CONFIGURATION OF POST-MOUNTED FLASHING-LIGHT SIGNAL

- Edge of background or part nearest roadway
- 6\" minimum to 30\" maximum from level of traveled way without curb
- 2\" - 0\" min. approx. 3\" - 5\"
- Signal foundation
- 4\" max. above ground level
Criteria for Installation of Auxiliary Flashing-Lights (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 or bracket extension, or they may be installed on separate posts as determined by the diagnostic study team.
Criteria for Installation of 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;

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 \( (d_H) \) shown in Appendix B;

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 \( (d_H) \) 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;

4. Other distraction factors are present which 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).

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

**Two-Lane, Two-Way Roads (Cantilever Option)**

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 Michigan Manual of Uniform Traffic Control Devices.*

**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.
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.
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.

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.
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.
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.

**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.

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 with flashing-light signals and has had two or more car/train crashes in the last five years which 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: a Federal Railroad Administration 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 which 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.
TYPICAL COMPONENTS AND CONFIGURATION OF FLASHING-LIGHT SIGNALS AND GATES
(OPTIONAL CANTILEVER SHOWN)
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 Federal Highway Administration’s *Railroad-Highway Grade Crossing Handbook*. 

**TYPICAL INSTALLATION OF FLASHING-LIGHT SIGNALS WITH ROADWAY GATES**

**GATE LOCATION FOR SKewed CROSSINGS**
Traffic Signal Device Components Used in Proximity to Highway-Railroad Grade Crossings: Considerations for Application

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) so as 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 Federal Highway Administration’s *Railroad-Highway Grade Crossing Handbook*.

**Special Application:** Traffic control signals may be used instead of flashing-light signals to control road users at highway-railroad grade crossings of spur tracks and other places where train movements are very slow, such as in switching operations. Traffic control signals shall not be used instead of flashing-light signals to control road users at highway-railroad grade crossings of mainline tracks.

**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, where the intersection traffic control signals are preempted by the approach of a train, all existing turning movements toward the crossing should be prohibited during the signal preemption sequences. A blank-out or changeable message sign and/or appropriate highway traffic signal indication or other similar type sign may be used to prohibit turning movements toward the highway-railroad grade crossing during preemption.
SPECIAL CIRCUMSTANCES AT HIGHWAY-RAILROAD GRADE CROSSINGS

Stop and Flag Procedures: Criteria for Use, Description
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 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.)

Stop and Flag Procedures
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 fusee.

Illumination at Highway-Railroad Grade Crossings
If an engineering study determines 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)

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 Michigan Manual of Uniform Traffic Control Devices to prohibit parking near the crossing.
Work Zone Traffic Control for Highway-Railroad Grade Crossings
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 to 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) 335-2592 to request a preliminary review of any proposed work that would impact the crossing. Further details regarding railroad coordination for proposed road projects is available at the following location:


Abandoned or Discontinued Use of Tracks
Per P.A. 354 of 1993 (MCL 462.307 of the Railroad Code of 1993), where a railroad track at a highway-railroad grade crossing has been abandoned or its use discontinued 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.

Non-Motorized Trails, Shared-Use Paths & Pedestrians
Where a railroad track intersects with a non-motorized trail, shared-use path or other public pedestrian facility 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 non-motorized trails, shared-use paths and other pedestrian facilities can be located in the current MMUTCD. Additional information regarding non-motorized crossings can be found in the current edition of the Federal Highway Administration’s Railroad-Highway Grade Crossing Handbook.

In all cases, public agencies considering a project that includes a non-motorized trail or pedestrian crossing of a railroad track should contact MDOT’s Rail Safety Section at (517) 335-2592 to request a preliminary review of any proposed work that would impact the crossing.
OTHER 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 1 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 1 foot beyond the end of the ties, shall be surfaced with a material which 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 2 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 1 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 $760.00 for flashing signals on a single track, $830.00 for flashing signals and gates on a single track, $895.00 for flashing signals with cantilever arm on a single track, $1,215.00 for flashing signals with cantilever arm with gates on a single track, $1,230.00 for flashing signals and gates on multiple tracks, $1,630.00 for flashing signals with cantilever arms and gates on a multiple track, $725.00 for flashing signals on a multiple track, and $1,005.00 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.
REFERENCES


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 on-line application at the FRA Website), and the National Cooperative Highway Research Program (NCHRP) Report 50 Accident Prediction Formula. With FWHA approval, Michigan presently uses the 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 flashing-light signals with gates have a protection factor of 0.11. This means that when properly used, flashing-light signals and gates are more effective than a Crossbuck sign alone in preventing grade crossing crashes.

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 for Typical Traffic Control 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
0.30  Flashing-Light Signals
0.27  Flashing-Light Signals with Cantilever Arms
0.24  Flashing-Light Signals with Cantilever Arms and Traffic Signal Interconnect
0.11  Flashing-Light Signals with Roadway Gates
0.08  Flashing-Light Signals with Cantilever Arms and Roadway Gates
0.05  Flashing-Light Signals with Cantilever Arms, Roadway Gates, and Traffic Signal Interconnection

**NOTE:** The addition of warranted Motion Sensor or Predictor Circuitry further reduces the protection factor by 0.02.
# National Cooperative Highway Research Program

## Report 50 Accident Prediction Formula


Expected Accident Frequency = \( A \times B \times \text{Current Trains per Day} \)

### “A” FACTOR

**traffic volume / vehicles per day**

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### “B” FACTOR

**basic values for existing warning devices**

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<td>Gates, rural</td>
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### EXAMPLE:

**Urban area**

**Crossbucks**

5000 vehicles per day

5 trains per day

\[ \text{EAF} = .006516 \times 3.06 \times 5 = 0.10 \]

\[ \text{EAF} = 0.10 > 0.02 \]

Accident frequency is greater than 0.02. This would indicate need for higher type device. Try flashing lights \( B = 0.23 \)

\[ \text{EAF} = .006516 \times 0.23 \times 5 = 0.01 \]

**THEREFORE FLASHING LIGHTS ARE WARRANTED**

*Future ADT calculation = Current ADT x \((1+i)^n\) where \( i = \) rate of expected growth (avg .03) and \( n = \) number of years*
APPENDIX B
CLEAR VISION AREAS

Tables A and B of this appendix provide desirable dimensions for clear vision areas at highway-railroad grade crossings which 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).

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

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<td>613</td>
<td>628</td>
<td>646</td>
<td>666</td>
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<td>709</td>
</tr>
<tr>
<td>65</td>
<td>1563</td>
<td>655</td>
<td>643</td>
<td>643</td>
<td>651</td>
<td>664</td>
<td>681</td>
<td>700</td>
<td>722</td>
<td>744</td>
<td>768</td>
</tr>
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<td>70</td>
<td>1683</td>
<td>705</td>
<td>692</td>
<td>692</td>
<td>701</td>
<td>715</td>
<td>733</td>
<td>754</td>
<td>777</td>
<td>802</td>
<td>828</td>
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<tr>
<td>75</td>
<td>1803</td>
<td>756</td>
<td>742</td>
<td>742</td>
<td>751</td>
<td>766</td>
<td>786</td>
<td>808</td>
<td>833</td>
<td>859</td>
<td>887</td>
</tr>
<tr>
<td>80</td>
<td>1924</td>
<td>806</td>
<td>791</td>
<td>791</td>
<td>801</td>
<td>817</td>
<td>838</td>
<td>862</td>
<td>888</td>
<td>916</td>
<td>946</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Highway Vehicle Speed (mph)</th>
<th>Stop 25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
<th>55</th>
<th>60</th>
<th>65</th>
<th>70</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td>dH (feet)</td>
<td>23</td>
<td>175</td>
<td>220</td>
<td>269</td>
<td>324</td>
<td>383</td>
<td>447</td>
<td>515</td>
<td>589</td>
<td>667</td>
<td>751</td>
</tr>
</tbody>
</table>

* See Stop Line Section (page 10) to determine proper placement of Stop Lines

**NOTES:**

1. Information contained in this appendix is based on information from AASHTO's "A Policy on Geometric Design of Highways and Streets, 2004.” The highway vehicle is assumed to be a 65’ truck. Some simplification has been done to the modification factors which results in slightly conservative sight distances for multiple track and skewed crossings.

2. Values taken from Tables A and B may need to be modified if any of the following conditions exist: multiple tracks, skewed crossing angle, vertical or horizontal grades on the highway approaches. Modifications are outlined in the following text.

3. 23 feet down highway distance for a stopped vehicle represents the sum of the distance of 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.
Modification of Sight Distances $dT$ and $dH$

Modification for skewed and/or multiple tracks:

Because it takes longer for a highway vehicle to cross a skewed or multiple track highway-railroad grade crossing, modifications of sight distances may be necessary to allow the driver more time to safely cross the tracks.

**For the stopped condition:** the distance down the track ($dT$) may need to be increased by adding the following factor to the value of $dT$ taken from Table A:

$$V_T \times \frac{W}{6} \text{ where } V_T \text{ is the train speed and } W \text{ is the distance between outside rails measured along the highway.}$$

The distance down the highway ($dH$) does not require modification.

**For the moving condition:** the distance down the track ($dT$) may need to be increased by adding the following factor to the value of $dT$ taken from Table A:

$$V_T \times \frac{W}{V_V} \text{ where } V_T \text{ is the train speed, } W \text{ is the distance between outside rails measured along the highway and } V_V \text{ is the highway vehicle speed.}$$

The distance down the highway ($dH$) does not require modification.

**Example:**

Train speed ($V_T$) = 40 mph  
Highway vehicle speed = 50 mph  
Distance between outer rails ($W$) = 30’

Stopped condition:
Raw $dT$ = 962’ (from Table A)  
$dT = 962’ + (40 \times 30 / 6) = 1162’$  
$dH = 23’$ (from Table B)

Moving condition:
Raw $dT$ = 419’ (from Table A)  
$dT = 419’ + (40 \times 30 / 50) = 443’$  
$dH = 447’$ (from Table B)
Modification for grades (hills) on highway approaches:

For the stopped condition: no modification of \(d_T\) or \(d_H\) is necessary.

For the moving condition: because hills on a highway affect braking distance, the driver may need more or less distance to stop. Therefore, modification of sight distances is necessary.

The distance down the highway (\(d_H\)) may need to be modified by adding or subtracting the value obtained from Table C.

The distance down the track (\(d_T\)) may need to be modified by adding or subtracting the value obtained from Table C multiplied by \(V_T / V_V\) where \(V_T\) is the train speed and \(V_V\) is the highway vehicle speed.

### TABLE C – Modification to \(d_H\) due to Approach Grade (Feet)

<table>
<thead>
<tr>
<th>Highway Grade %</th>
<th>Ascending to Crossing</th>
<th>2%</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
<th>55</th>
</tr>
</thead>
<tbody>
<tr>
<td>2%</td>
<td>0</td>
<td>-1</td>
<td>-2</td>
<td>-3</td>
<td>-5</td>
<td>-7</td>
<td>-10</td>
<td>-13</td>
<td>-17</td>
<td>-21</td>
<td></td>
</tr>
<tr>
<td>4%</td>
<td>-1</td>
<td>-2</td>
<td>-3</td>
<td>-5</td>
<td>-9</td>
<td>-13</td>
<td>-19</td>
<td>-25</td>
<td>-33</td>
<td>-40</td>
<td></td>
</tr>
<tr>
<td>6%</td>
<td>-1</td>
<td>-2</td>
<td>-4</td>
<td>-7</td>
<td>-13</td>
<td>-18</td>
<td>-26</td>
<td>-35</td>
<td>-46</td>
<td>-56</td>
<td></td>
</tr>
<tr>
<td>8%</td>
<td>-1</td>
<td>-3</td>
<td>-6</td>
<td>-10</td>
<td>-16</td>
<td>-23</td>
<td>-33</td>
<td>-45</td>
<td>-58</td>
<td>-71</td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td>-2</td>
<td>-4</td>
<td>-7</td>
<td>-11</td>
<td>-19</td>
<td>-27</td>
<td>-40</td>
<td>-53</td>
<td>-69</td>
<td>-84</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Highway Grade %</th>
<th>Descending to Crossing</th>
<th>2%</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
<th>55</th>
</tr>
</thead>
<tbody>
<tr>
<td>2%</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>11</td>
<td>15</td>
<td>20</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>4%</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>11</td>
<td>16</td>
<td>24</td>
<td>32</td>
<td>43</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>6%</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>10</td>
<td>18</td>
<td>26</td>
<td>38</td>
<td>52</td>
<td>69</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>8%</td>
<td>2</td>
<td>5</td>
<td>8</td>
<td>15</td>
<td>25</td>
<td>37</td>
<td>56</td>
<td>76</td>
<td>101</td>
<td>122</td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td>3</td>
<td>6</td>
<td>11</td>
<td>20</td>
<td>34</td>
<td>50</td>
<td>76</td>
<td>104</td>
<td>139</td>
<td>168</td>
<td></td>
</tr>
</tbody>
</table>

Example: Train speed (\(V_T\)) = 50 mph
Highway vehicle speed = 30 mph
2% uphill grade coming from south
3% downhill grade coming from north

Moving condition, coming uphill from south:
Raw \(d_H\) = 220’ (from Table B)
\(d_H = 220' + (-5)\) (from Table C) = 215’
Raw \(d_T\) = 494’ (from Table A)
\(d_T = 494' + [(50 / 30) x (-5) (from Table C)] = 486’

Moving condition, coming downhill from north:
Raw \(d_H\) = 220’ (from Table B)
\(d_H = 220' + 8\) (interpolated from Table C) = 228’
Raw \(d_T\) = 494’ (from Table A)
\(d_T = 494' + [(50 / 30) x 8 (interpolated from Table C)] = 507’
This information is to assist in the placement of lighting at highway-railroad grade crossings. In general, 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:

At least one luminaire shall be mounted on each side of the track at the highway-railroad grade crossing, and luminaires should 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 1 foot-candle (11 lux) of illumination on the vertical plane 5 feet from the centerline of track. 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 should 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 which 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 which 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 center line 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. Full cutoff luminaires are recommended where wayside train signals are used.

Poles holding luminaires should 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, approval must first be granted by the railroad.

**Suggested Design from “Seven Years into Illumination at Railroad-Highway Crossings”**

**Single Track Crossings:** Poles should be located approximately 25 feet from both the road and the centerline of the railroad track. 250 watt high pressure sodium luminaires should be placed at least 30 feet above the top of the rail, on arms which are six to 16 feet long. If a railroad signal system is involved, full cutoff luminaires are recommended.

**Multiple Track Crossings –** 400 watt high pressure sodium luminaires should 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 are recommended because 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.

If the utility company completes the installation, the design may be completed by the company to meet the general guidelines above.
Recommendations:

1) 250 watt high pressure sodium luminaire

2) 30 ft. mounting height

3) Photocell on lights

Considerations:

1) Source of payment for the energy needs to be worked out between the local government and the utility company/railroad/road authority.

2) If the utility company does the installation, they need the basics and they will finish the design.

Maintenance:
According to Mather, in 1990, the average monthly maintenance cost per luminaire/pole was $15. This includes electricity and maintenance activities. This cost was for lights that the road authority took ownership of after installation. Public-owned utilities were slightly less. Source of payment for the energy should be arranged between the involved parties.

References:

www.iesna.org
MDOT TRAFFIC AND SAFETY NOTES

Note 105-Series Traffic Signs on Railroad Structures

Note 125-Series Railroad Crossbuck Signs
http://mdotwas1.mdot.state.mi.us/public/tands/Details_Web/mdot_note125b.pdf

Note 127-Series No Passing Control at Railroad Crossings

Note 148-Series Railroad Advance Warning Signs

Note 303-Series Railroad Grade Crossing Pavement Markings
http://mdotwas1.mdot.state.mi.us/public/tands/Details_Web/mdot_note303c.pdf

Note 903-Series Maintaining Traffic During Roadway Work at Railroad Crossings

Entire MDOT Traffic and Safety Notes Binder
http://mdotwas1.mdot.state.mi.us/public/tands/Details_Web/mdot_trafficandsafetynotes_full.pdf

ASSOCIATED HELPFUL LINKS

Michigan Manual of Uniform Traffic Control Devices (MMUTCD)

MMUTCD – Part 8 Traffic Controls for Highway-Rail Grade Crossings

MMUTCD - Part 10 Traffic Controls for Highway-Light Rail Transit Grade Crossings

Complete MMUTCD Manual
http://mdotwas1.mdot.state.mi.us/public/tands/Details_Web/mmudccompleteinteractive.pdf

Railroad-Related MDOT Pavement Marking Standards

PAVE-945-Series Intersection, Stop Line & Crosswalk Markings

PAVE-965-Series Railroad Grade Crossing Pavement Markings
**Railroad-Related MDOT Road Standard Plans**

R-28-Series Sidewalk Ramp and Detectable Warning Details  
[http://mdotwas1.mdot.state.mi.us/public/design/englishstandardplans/index.htm](http://mdotwas1.mdot.state.mi.us/public/design/englishstandardplans/index.htm)

R-112-Series Shoulder and Centerline Corrugations  
[http://mdotwas1.mdot.state.mi.us/public/design/englishstandardplans/index.htm](http://mdotwas1.mdot.state.mi.us/public/design/englishstandardplans/index.htm)

R-121-Series Track Crossings (crossing profiles, approach slopes, etc.)  
[http://mdotwas1.mdot.state.mi.us/public/design/englishstandardplans/index.htm](http://mdotwas1.mdot.state.mi.us/public/design/englishstandardplans/index.htm)

R-122-Series Railroad Crossing Signals  
[http://mdotwas1.mdot.state.mi.us/public/design/englishstandardplans/index.htm](http://mdotwas1.mdot.state.mi.us/public/design/englishstandardplans/index.htm)

**Railroad-Related MDOT Signs and Support Documentation**

SIGN-130-Series Railroad Crossing Sign  

MDOT Standard Highway Signs Book  
[http://mdotwas1.mdot.state.mi.us/public/tands/plans.cfm](http://mdotwas1.mdot.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)

MDOT Sight Distance Guidelines  

**Relevant Railroad and Vehicle Regulations**

Railroad Code of 1993 [MCL 462.101 – 462.451]; also known as Public Act 354  

Michigan Vehicle Code [MVC 257.674(1)(i)]; also known as Act 300 of 1949  

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](http://www.access.gpo.gov/nara/cfr/waisidx_03/23cfr646_03.html)
Railroad, Engineering, Highway and Safety Organizations

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

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

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

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

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

Operation Lifesaver
http://www.oli.org/

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

ISEA – International Safety Equipment Association
www.safetyequipment.org

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

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

MDOT Railroad Regulatory and Coordination Programs – Contact #s

Rail Safety Section – regulatory authority for all highway-railroad grade crossings in the state
517-373-0224

Trunkline Coordination Unit – project development for grade crossings on state-owned roads
517-335-2272

Local Grade Crossing Program – project development for grade crossings on local roads
517-373-9027

State-Owned Rail Lines – property management and development for state-owned rail lines
517-335-2589

Rail Passenger – project development and schedule coordination with Amtrak
517-241-4573
Providing the highest quality integrated transportation services for economic benefit and improved quality of life.

Electronic copy available at www.michigan.gov/mdottrailfreight

If you need this information in an alternative format, please contact the MDOT Office of Communications, P.O. Box 30050, Lansing, MI 48909-9791

Phone 517-373-2160, Web site: www.michigan.gov/mdot
TDD/TTY through the Michigan Relay Center: 800-649-3777

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