

## CHAPTER SEVEN

## RAILROADS

SIGHT DISTANCES AT RAILROADS  
FOR UNSIGNALIZED CROSSING

7-1

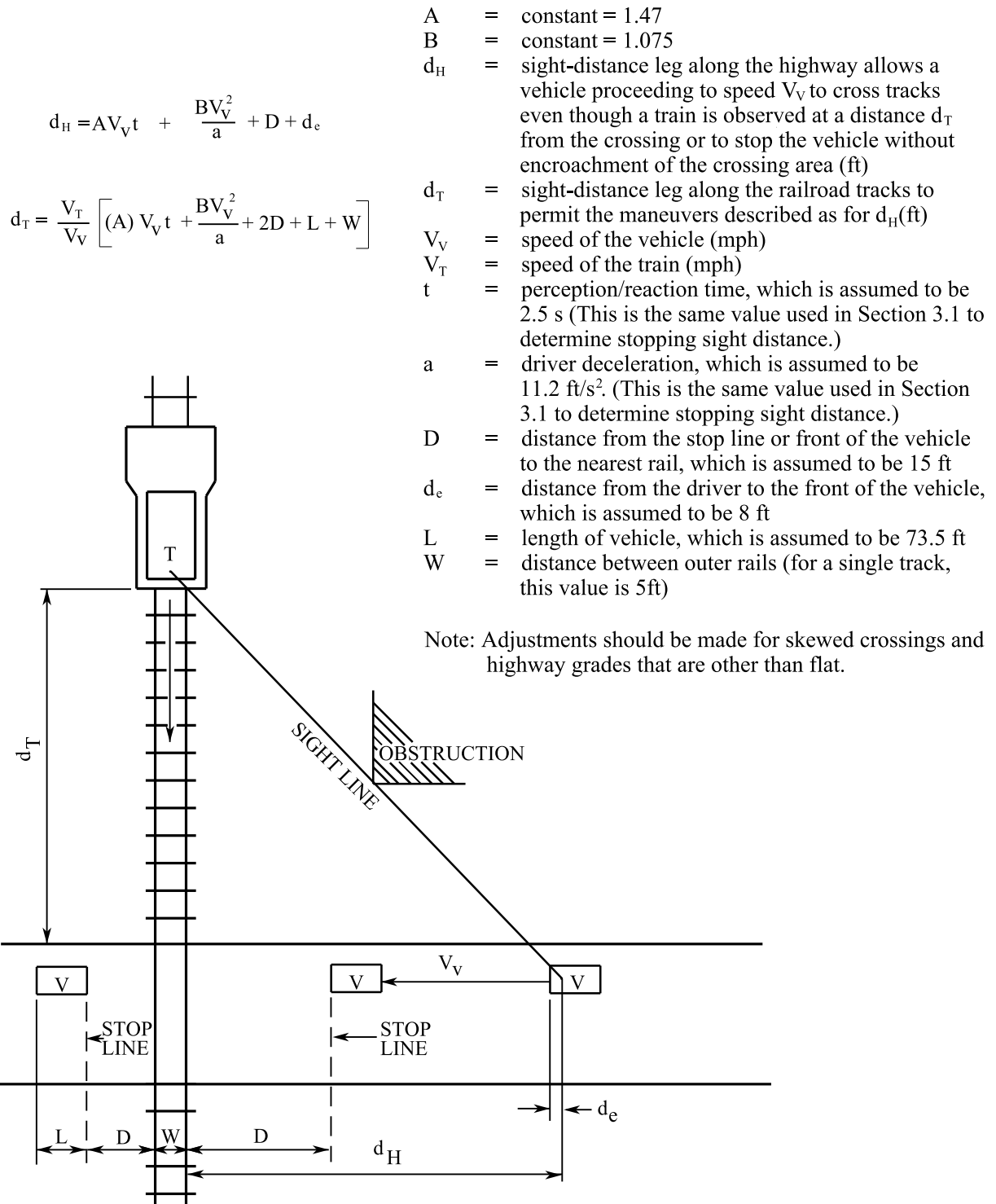
The sight distance at railroad crossings is of utmost importance. When the exposure index does not merit grade separations or railroad signals, Section 7-1F, Figure 1, to provide safe stopping sight distances. If physical barriers exist and it is not economically feasible to provide the required distances, it shall be discussed with the Assistant State Roadway Design Engineer.

NOTE: Section 7-1F, Figure 1 is based on conditions of a 65' truck crossing a single set of tracks at 90°. This allows for a margin of safety for conditions using other design vehicles. If it is determined by the designer that a small number of trucks will be using the facility, consideration may be given to reducing the sight distance.

For Additional Information See:

- A. Roadway Standard Drawings, Std. No. 1205.11 - Pavement Markings for Railroad Crossings
- B. Chapter 18 of The Policy and Procedure Manual.
- C. Railroad-Highway Grade Crossing Handbook "Report No. FHWA - TS - 86 - 215, September, 1986"
- D. A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS (2011), Ch 9.
- E. For Federal Highway-Rail Grade Crossing Relevant web links, go to: "<http://safety.fhwa.dot.gov/xings/>".

FIGURE 1  
Railroad - Highway Grade Crossings



CASE A: MOVING VEHICLE TO SAFELY CROSS OR STOP AT RAILROAD CROSSING

REV. DATE: 07/22/13  
REV. NO. 8

FIGURE 1

Moving Vehicle to Safely Cross or Stop at Railroad Crossings

$$d_T = AV_T \left[ \frac{V_G}{a_1} + \frac{L + 2D + W - d_a}{V_G} + J \right]$$

where:

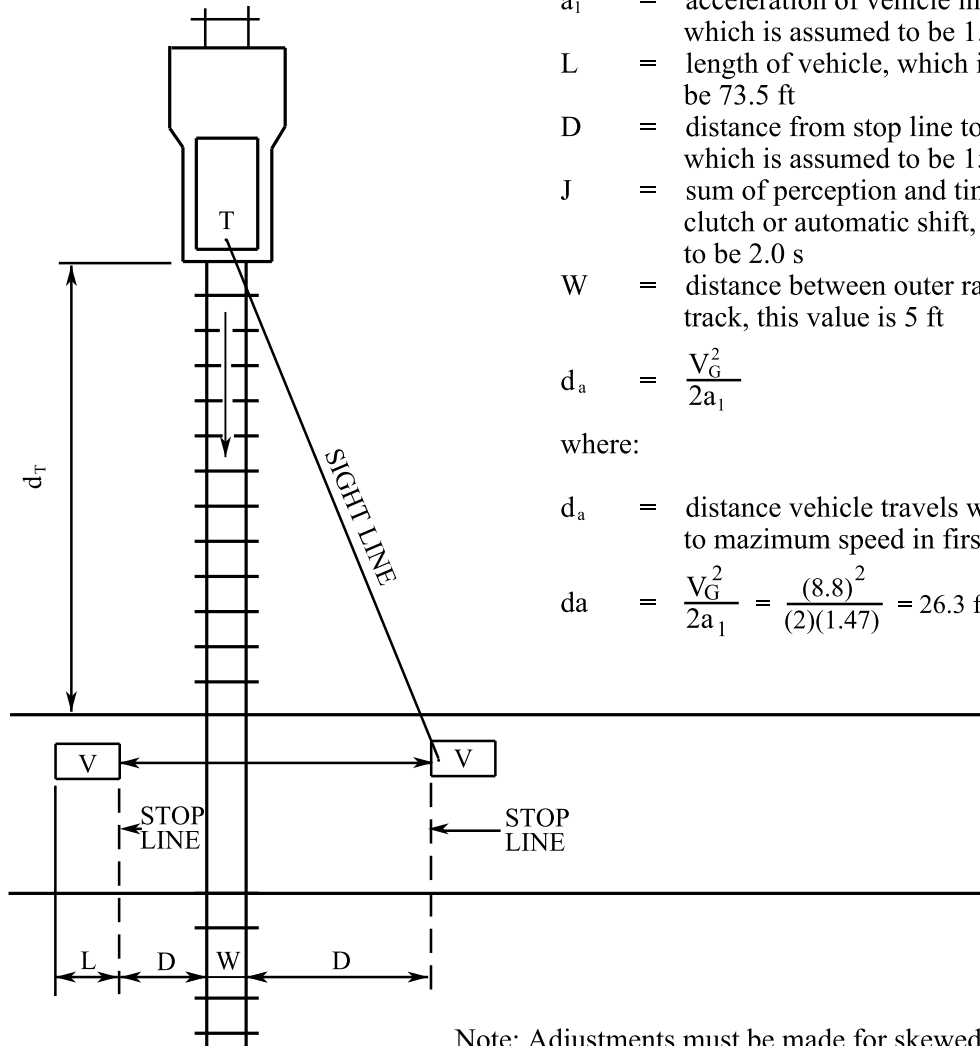
- $d_T$  = sight distance leg along the railroad tracks for the departure maneuver (ft)
- A = constant = 1.47
- $d_T$  = sight distance leg along railroad tracks to permit the maneuvers described as for  $d$  (ft)
- $V_T$  = speed of train (mph)
- $V_G$  = maximum speed of vehicle in first gear, which is assumed to be 8.8 ft/s
- $a_1$  = acceleration of vehicle in first gear, which is assumed to be 1.47 ft/s
- L = length of vehicle, which is assumed to be 73.5 ft
- D = distance from stop line to nearest rail, which is assumed to be 15 ft
- J = sum of perception and time to activate clutch or automatic shift, which is assumed to be 2.0 s
- W = distance between outer rails for a single track, this value is 5 ft

$$d_a = \frac{V_G^2}{2a_1}$$

where:

- $d_a$  = distance vehicle travels while accelerating to maximum speed in first gear (ft)

$$d_a = \frac{V_G^2}{2a_1} = \frac{(8.8)^2}{(2)(1.47)} = 26.3 \text{ ft}$$



Note: Adjustments must be made for skewed crossings.  
Assumed flat highway grades adjacent to and at crossings.

CASE B: DEPARTURE OF VEHICLE FROM STOPPED POSITION TO CROSS SINGLE RAILROAD TRACK

Train Speed (mph)	Case B Departure from Stop	Case A Moving Vehicle							
		Vehicle Speed (mph)							
	0	10	20	30	40	50	60	70	80
		Distance Along Railroad from Crossing, $d_T$ (ft)							
10	255	155	110	102	102	106	112	119	127
20	509	310	220	203	205	213	225	239	254
30	794	465	331	305	307	319	337	358	381
40	1019	619	441	407	409	426	450	478	508
50	1273	774	551	509	511	532	562	597	635
60	1528	929	661	610	614	639	675	717	763
70	1783	1084	771	712	716	745	787	836	890
80	2037	1239	882	814	818	852	899	956	1017
90	2292	1394	992	915	920	958	1012	1075	1144
		Distance along Highway from Crossing, $d_H$ (ft)							
		69	135	220	324	447	589	751	931

Required design sight distance for combination of highway and train vehicle speed;  
65-ft truck crossing a single set of tracks at 90°

**NOTE:**

See chapter 7-1, Figure 1 for “Case A” – MOVING VEHICLE TO SAFELY CROSS OR STOP AT RAILROAD CROSSING and Chapter 7-1, Figure 2 for “Case B” – DEPARTURE OF VEHICLE FROM STOPPED POSITION TO CROSS SINGLE RAILROAD TRACK.

FOR ADDITIONAL INFORMATION, SEE A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS (2011), Ch, 9.



**TRACK CLEARANCE REQUIREMENTS ON CURB AND GUTTER  
PROJECTS PERPENDICULAR TO A RAILROAD**7-2

When curb and gutter is being constructed on a project that crosses a railroad, the curb and gutter should be terminated 13'-6" from the centerline of the nearest rail of the tracks. The distance is measured perpendicular from the centerline of the rail to the face of curb. In switching areas where obstructions would be a hazard to trainmen, more than 13'-6" may be required. The termination of the curb and gutter shall be discussed on the field inspection and with the railroad companies if unusual conditions exist.

**TRACK CLEARANCE REQUIREMENTS ON CURB AND GUTTER  
PROJECTS PARALLEL TO A RAILROAD**7-3

When it is necessary to construct curb and gutter parallel and in close proximity to a railroad, the location of the curb and gutter in relation to the nearest rail should be discussed with the Utility Agent in the Right of Way Branch.

GUARDRAIL TREATMENT AT RAILROAD SIGNAL CROSSING

7-4

For design speeds less than or equal to 50 mph, longitudinal guardrail should not be used, specifically for signal masts, unless the guardrail is otherwise warranted. On projects with design speeds of 55 mph or greater, guardrail or an attenuator should be used around the signal mast. This requirement applies only to major new construction, reconstruction, or RRR projects. This guardrail requirement does not apply to spot safety installations.

Ring type guardrail can be used at locations where there is heavy industrial traffic and where required by the Railroad.

RAIL GRADE SEPARATION GUIDELINES

7-5

The grade separation guidelines are based on use of an exposure index which is the product of the number of trains per day and the projected average daily highway traffic at the end of the design period. Unless information to the contrary is available, such as a pending abandonment of the railroad, the number of trains at the end of the design period should be assumed to be the same as at present.

Separations should be constructed in RURAL areas when the exposure index is 15,000 or more.

Separations should be constructed in URBAN areas when the exposure index is 30,000 or more.

Where two alignments are under consideration and one would make separation feasible, the separation should be considered as one factor favoring adoption of such alignment. It is realized that topography, right-of-way costs, construction costs or other features of the physical situation may make separation impractical even though the index is above the figure set. In this case, the Secretary of the Department of Transportation shall have final authority in decisions to create new at-grade crossings. For additional information, see the Policy and Procedure Manual, Policy 18/2.

**GUIDELINES FOR MEDIAN SEPARATION AT HIGHWAY/ RAILWAY  
AT-GRADE CROSSING**

7-6

To protect the safety of the traveling public and the security and integrity of critical rail-highway at-grade junctures every effort should be made to discourage at grade rail crossings. The addition of travel lanes to existing at grade crossings should be avoided unless recommended by an engineering study. However, if after coordinating with the Rail Division, it is determined an at-grade crossing cannot be avoided or eliminated, and a median separation is deemed necessary and appropriate, the following guide should be used.

The intent of this guide is to establish the desirable conditions for the uniform and consistent layout and construction of median separations where it has been determined that a median separation is appropriate. This guide/design tool should be utilized with sound engineering judgment, sound design, and attention to costs.

The NCDOT Rail Division should be included in negotiations and decisions regarding at grade rail crossings. Decisions made regarding railroad crossings shall protect the traveling public, will be sensitive to the needs of the railroad and should be based on the best information and practices available.

Projects programmed in the Transportation Improvement Program (TIP) which may result in creating a new highway-railway at-grade crossing or affecting an existing crossing shall be coordinated with the Rail Division in the early project planning process. The Rail Division will be actively involved in all scoping meetings held by the Planning and Environmental Branch that have the potential to involve or affect an existing or proposed railroad crossing.

Division and local projects involving a railroad crossing will be coordinated with the Rail Division. It will be the responsibility of the Division Engineer to initiate contact and advise the Rail Division early in the process to determine the appropriate crossing treatment for the site conditions.



**GUIDELINES FOR MEDIAN SEPARATION AT HIGHWAY/ RAILWAY  
AT-GRADE CROSSING (Continued)**

7-6

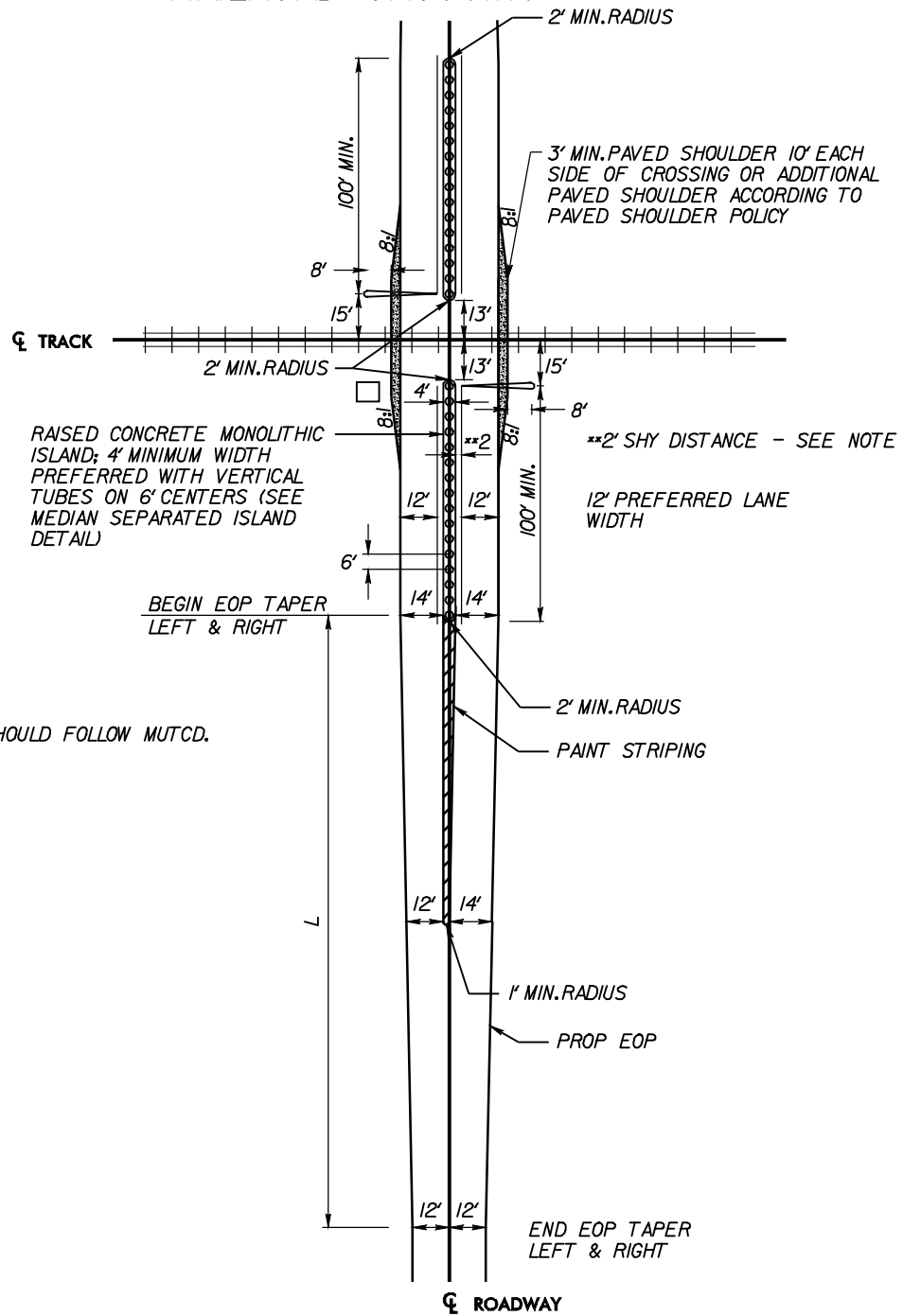
When an at grade railroad crossing is involved, it will be the responsibility of the Rail Division to research and obtain pertinent information from the railroad company such as number of trains, speed, and contact information for further coordination and provide it to the requesting party. It will also be the responsibility of the Rail Division to keep the appropriate Division Engineer informed of any railroad work being planned in their area even if it does not involve a TIP project. Within the limits of a TIP project, the Rail Division will assist the appropriate railroad company in making decisions concerning the appropriate improvements to the rail crossing.

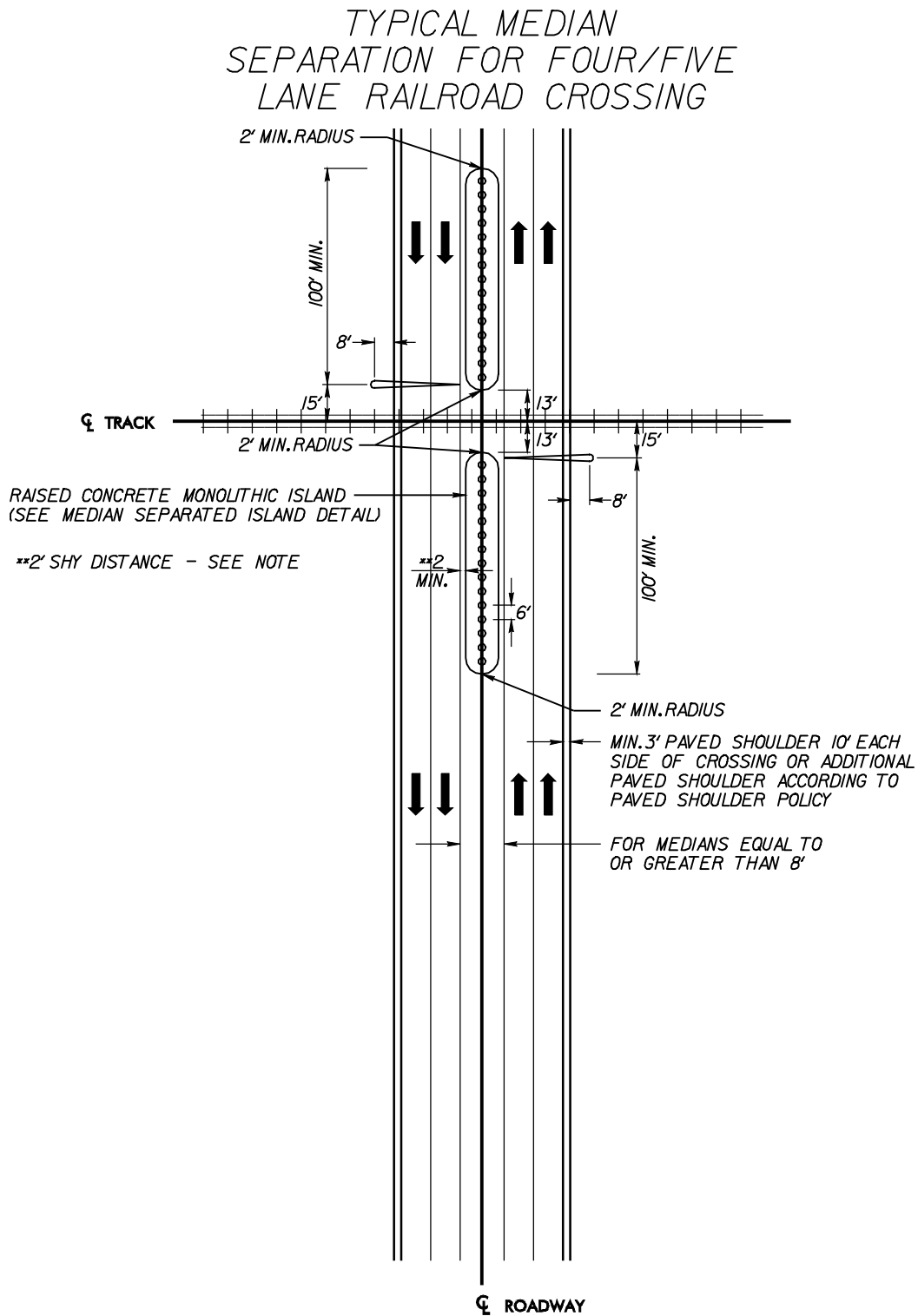
Median separations can be used to physically discourage drivers from driving around crossing gates when it has been determined a median separator is the appropriate treatment based on an engineering evaluation.

- After the decision is made to add a median separation, the following details should be used/referenced as a guide for the consistent design layout and construction of the median separation treatment.
- The detail for median separation should be used in conjunction with the appropriate The American Railway Engineering and Maintenance of Way Association (AREMA) and The American Association of State Highway Transportation Officials (AASHTO) guidelines and standards for new construction on TIP projects or when additional improvements are warranted, recommended and justified (within program and site constraints).
- If speeds exceed 40 mph, an advisory speed of 40 mph should be posted on the advance warning sign as deemed necessary and recommended by the Division Traffic Engineer. Cases involving speeds greater than 40 mph should be handled on a case by case basis and design features and advisories developed through coordination with appropriate Regional and Division Traffic Engineers.
- Shy distances should be increased beyond the minimal 2 foot offsets when variations in alignment (vertical/horizontal) introduce more navigational factors to the operators.
- Minimum Design Criteria should only be utilized when conditions physically restrict the use of recommended/preferred design criteria

Please refer to the Rail Division's website <http://www.bytrain.org/safety> for additional information.

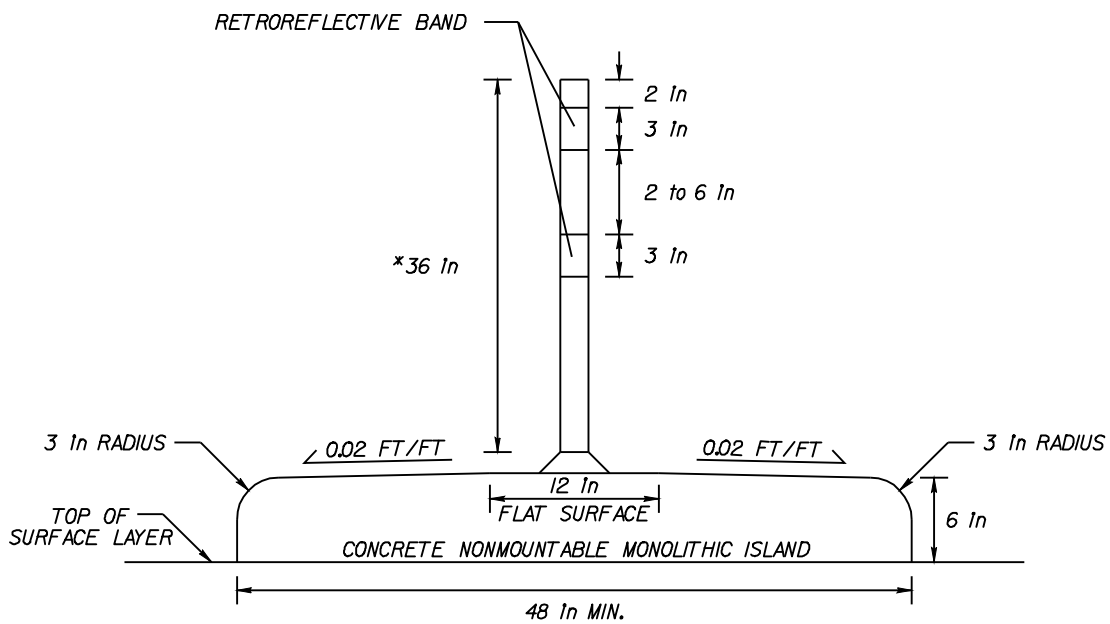
TYPICAL MEDIAN SEPARATION FOR TWO LANE RAILROAD CROSSING



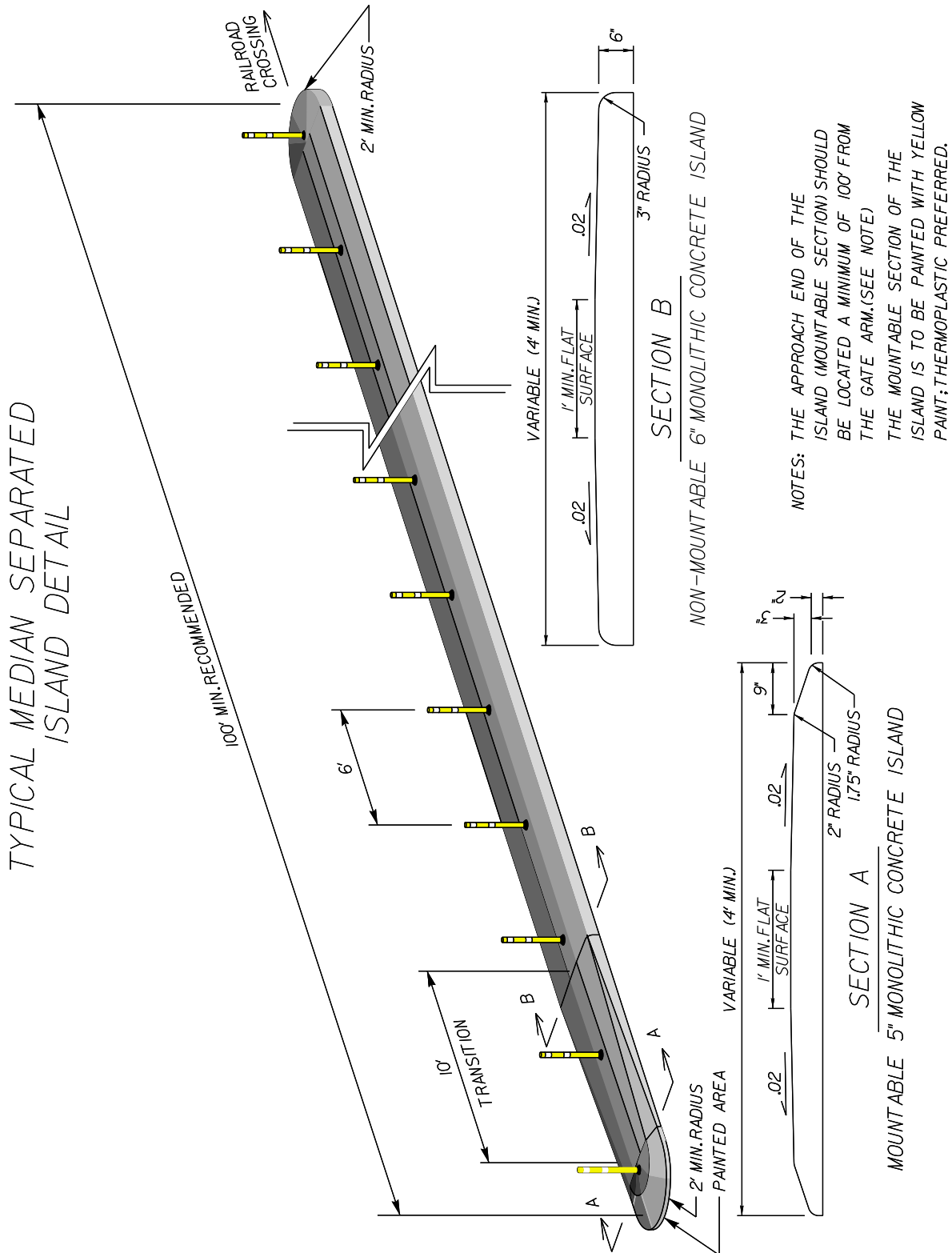




TYPICAL TUBULAR MARKER



\*36 in height may be reduced upon further coordination with the Rail Division if the crossing has a lot of use by oversized vehicles.



REV. DATE : 03/02/11  
 REV. NO. 7

GUIDELINES FOR MEDIAN SEPARATION AT HIGHWAY/ RAILWAY  
AT-GRADE CROSSING (Continued)

7-6

## Notes

Per Federal Railway Administration Code of Federal Regulations (49 CFR Appendix A to Parts 222-229) “Medians or channelization devices must extend at least 100’ from the gate arm, or if there is an intersection within 100’ of the gate, the median or channelization device must extend at least 60 feet from the gate arm.”

The preferred island length is 100’ from the gate; however higher traffic volumes or higher truck traffic may warrant that the island’s length be increased to a logical termination point such as the next intersection, drive etc. Any deviation below this minimum will be coordinated with the Rail Division.

The recommended and preferred island width is 4’ minimum. If coordinated with the Rail Division, the width may possibly be reduced to 2’ with vertical markers when improvements are warranted but there are constraints that prevent using the preferred width. When the island is less than 4’ wide, the island should be keyed in on the last layer of pavement surface course. When the island is 4’ wide or greater, it can be surface mounted on top of the pavement using spikes in accordance with the current Roadway Standard Drawings.

The minimum shy distance is 2’ as referenced in AASHTO. This should be increased to desirable/recommended values as conditions beyond minimum are encountered.

In multilane situations, where signals and gates are required in the median, the island width should be a minimum of 12’ with the appropriate shy distances.

A keep right sign shall be used on islands greater than or equal to 4’. Where 4’ is not available, a divided highway advisory sign should be placed on the approach shoulder.

To improve night visibility and navigation around the island, it is recommend using 3 reflective markers on the end cap of median or painting the end cap of median.

Drainage issues in conjunction with the island should be addressed according to design policy.

Resurfacing will reduce the effective island height. It may be necessary to readjust island to preserve non mountable 6” face.

GUIDELINES FOR MEDIAN SEPARATION AT HIGHWAY/RAILWAY  
AT-GRADE CROSSING (Continued)

7-6

**Minimum Lane and Shoulder Widths for Railroad Crossing Improvements\***

Use the following chart in conjunction with the above details when improvements are recommended, but funds are not available to improve the existing highway to the geometric standards desirable for reconstruction and new highway construction.

Design Speed	Current ADT	Arterial		Collector		Local	
		Lane Width	Shoulder	Lane Width	Shoulder	Lane Width	Shoulder
Under 50 mph (Level and Rolling terrain)	0 - 1000	11	4	10	3	10	3
	1000 - 2000	11	4	10	3	10	3
	over 2000	12	6	11	6	11	6
50 mph & over (Level and Rolling Terrain)	0 – 1000	11	4	11	3	10	3
	1000 –2000	12	6	11	4	11	3
	over 2000	12	6	11	6	11	6
Under 50 mph (Mountainous Terrain)	0 – 1000	10	3	10	3	10	3
	1000 –2000	11	3	10	3	10	3
	over 2000	12	6	11	6	11	4
50 mph and over (Mountainous Terrain)	0 – 1000	11	3	11	3	10	3
	1000 –2000	11	3	11	3	10	3
	over 2000	12	6	11	6	11	4

NOTES:

1. Shoulder dimensions indicate graded widths and include paved shoulder widths.
2. Where guardrail is to be installed, graded shoulder width must be increased by 3 feet.
3. Where truck traffic (TTST and Duals) volume exceeds 10% of current ADT, lane widths should be increased by 1' to a maximum of 12'. 12' lane width should be used on routes designated as part of the National Truck Network.
4. For current ADT less than 1000, paved shoulders are not recommended. For current ADT between 1000 – 3000, 2' paved shoulders are recommended. For current ADT over 3000, 4' paved shoulders should be used.

\*See Division of Highways, RRR Guide, April 2004, Page 14