FDM 17-60-1 Locating New Highway - Railroad Grade Crossings

May 2, 2003

1.1 Introduction

A highway railroad grade crossing is a point of conflict, and thus a safety concern. Because of this and the costs associated with providing appropriate warning, and of continuing maintenance, the number of crossings should be kept to a minimum.

The FRA has set a national goal of reducing the number of existing crossings by 25 percent. Therefore, whenever a project involves improving a crossing or its warning devices, designers should review nearby crossings to determine if they are candidates for consolidation. Where possible in urbanized areas, space crossings of main tracks one-half mile apart measured along the track. In rural areas, space crossings one or more miles apart.

1.2 Location Considerations

Locate crossings on tangent sections of highway and railroad track when reasonably possible. This avoids the profile problems induced by super elevation, assures maximum sight distances on approaches, and minimizes crossing length. The roadway and track should intersect as close to 90 degrees as possible. Large skew angles should be avoided since they restrict vision particularly for buses and trucks when the skew is left hand forward. Large skews are also problem for bicyclists and motorcyclists since tires may be caught in the flangeway. It may also be necessary to provide additional warning devices at crossings with large skew angles.

A small skew angle is desirable for sidewalks, since vehicles with small wheels (baby carriages wheel chairs, etc) traverse the crossing better when only one wheel at a time crosses the flangeway.

1.3 Roadways Paralleling Railroads

Distances between roadways and railroads that parallel each other should be consistent with existing or planned land use. Rules of thumb offered by the American Railway Engineering and Maintenance of Way Association (AREMA) for desirable distances are 2,000 feet for large industrial plants, 500 to 800 feet for small and medium plants, and 200 feet for residential, retail and commercial areas. This provides for expansion that allows rail service along both sides of the track(s).

1.4 Roadways Near Railroads

Special design or traffic control arrangements are required at crossings where the perpendicular distance between track centerline and the stop bar at the intersection of the paralleling roadway is less than 80 feet. The ideal minimum perpendicular distance between track centerline and the highway intersection STOP bar is between 100 and 125 feet.

FDM 17-60-5 Grade Crossing Design

November 16, 2004

5.1 Surveys and Plans

Survey operation and plan development should provide information on all roadway features along the highway and all railroad features along the railroad within 500 feet of a grade crossing. This includes:

1. Characteristics of the crossing (including type of surface, location and length of existing crossing material).
2. Crossing angle
3. Curve radii of railroad
4. Location of curves and spirals
5. Stationing along both railroad and roadway
6. Location of switches, frogs, track-side sign and signal masts, and other track features.
7. Profiles for both railroad (on each rail through grade crossings and where the track is superelevated) and roadway.
8. Cross sections (at least 100 feet along the railroad each side of the crossing).

9. Warning devices and systems in place.
10. Utilities
11. Existing roadway conditions (such as pavement, drainage structures, shoulder width and sidewalk and terrace dimensions).
12. Significant physical features (such as buildings, trees, brush, rock outcrops).
13. Sight distances. (See Form DT1589, FDM 17-25, Attachment 1.2)
14. Railroad drainage structures
15. Typical sections of highway and railroad (existing and proposed).
16. Right-of-way lines
17. Slope intercept lines
18. Highway intersection locations and intersection traffic control.

5.2 Visibility and Sight Distances

Avoid locating a grade crossing on or near a horizontal curve of either a track or highway. Where feasible remove obstructions that prevent the crossing from being visible to approaching motorists, Section 195.29(6) of the Wisconsin Statues requires;

1. the railroad to clear brush and trees from its right-of-way within at least 330 feet of a public crossing,
2. the highway authority to clear brush and trim trees within its right-of-way within 330 feet of a public crossing.

There are three sight distances critical to a well designed grade crossing. The first involves the distance required to stop a motor vehicle if a train is blocking the crossing. This distance is measured along the roadway and is referred to as distance [1] on page 2 of Form DT 1589, "Railroad Crossing Report" (see FDM 17-25, Attachment 1.2).

The second sight distance is the lateral visibility across the quadrants. After a driver realizes that a crossing is being approached, that driver must be able to look to the left and right, observe the approach of a train, proceed over the crossing or make a safe stop. This distance is referred to as [3] in page 2 of FDM 17-25, Attachment 1.2.

The third sight distance comes into effect when a vehicle has stopped at a crossing and is about to proceed. Before proceeding over the crossing, the driver must decide whether to wait or to advance based on vision along the track. This sight distance is measured along the track and depends on the train's approach speed and the time required for the motor vehicle to accelerate and clear the crossing. (Refer to AASHTO "Policy on Geometric Design of Highways and Streets," 2001, page 739, Exhibit 9-103, plus accompanying text.)

When any of these three sight distances are insufficient at a crossing, it is necessary to either:

- take measures to increase available sight distances (corner, stopping or clearing) by clearing, re-orientation of the crossing vertically or horizontally, or other means;
- establish a posted approach speed for the highway vehicle that provides adequate sight time and thus permits the safe passage over the crossing given the maximum speed of trains at the crossing;
- install automatic flashing light signals (with or without gates).

5.3 Profile

In order to avoid drivers losing control of their vehicles through "bottoming" or "vaulting", and to avoid low profile vehicles from hanging up on the crossing, the grade or profile of the roadway approaches must match the grade along and across the track. To match the grade along or parallel to the rails, it is necessary to remove the pavement crown. It may also be necessary to tilt or warp the pavement cross sections if there is a grade along the track, or if the roadway is on horizontal curve.

The grade along the center line of the roadway must match the grade across the rails. Thus, where the railroad is on tangent, the roadway grade would be flat. On horizontal railroad curves, the roadway grade would match the superelevation of the track.

WisDOT uses a 2’6” minimum approach section from the field side of the rails in the same plane as the rails, with a maximum deviation from the plane of 3-inches at distances 30-feet from the near rail as shown in Attachment 5.1.

Attachment 5.1 illustrates this allowable grade variation for the roadway approach to a grade crossing. At multiple track crossings, particularly on higher speed roads, it is highly desirable that all rails be in the same plane. To avoid a rough riding crossing and possible loss of vehicle control, the stair step effect of tracks in different planes must be avoided. Consider negotiating with the railroad to raise tracks in order to achieve this. Lowering tracks is usually not feasible. Also refer to the SDD 13B1 entitled "Pavement Details for Railroad Approach".

This 3-inch deviation from the plane is derived from an empirically developed “comfort factor” formula for the driver that has been an AASHTO and AREMA standard for many years. This maximum 3” deviation avoids “vaulting “ or “bottoming” that divert a drivers attention, or worse, cause a loss of vehicle control.

The formula is: $L = \frac{AV^2}{46.5}$ or $k = \frac{V^2}{46.5}$

Where:

L_c = length of crest
L_s = length of sag
D = total length
A = algebraic difference in grades
V = posted speed
$k = \frac{\text{length}}{\text{algebraic difference in grades}}$

With the deviation of 3-inches in 27.5-feet[1], this results in a minimum “K” value of 15.13 for both sag and crest vertical curves. A greater value may be required based on the design speed of the highway.

If these minimum conditions do not provide adequate head light sight distance, consider providing fixed source lighting at the crossing.

5.4 Track Raises

5.4.1 Initiated By Railroad

The railroad may desire to raise, undercut or otherwise adjust its track when rehabilitating the line or reballasting the track. When this is done, the railroad must meet the existing roadway alignment in a manner which will assure a smooth ride across the track. Track raise work by the railroad is usually coordinated with the roadway authority. Indeed the AREMA Manual recommends the railroad obtain approval of the highway authority for any grade changes. However, when rail/roadway work cannot be coordinated, the condition created by a track raise is typically a temporary one.

When tracks are raised, construction of reverse vertical curves is typically required. Attachment 5.2 provides information on the profile transition required and is consistent with Attachment 5.1. To use Attachment 5.2, first determine the roadway posted speed and the vertical distance “H” between the original existing roadway elevation and the top of rail after the track raise. The total distance D is the required transition distance on each side of the outside rails of a crossing. Note that the sag portion of the transition requires the longer length to provide desirable driver comfort and safety.

5.4.2 Initiated by WisDOT

Sometimes a highway improvement project may call for changing the highway profile at a grade crossing or raising the railroad track profile where a new grade crossing is established. At other times a railroad may want to raise the track through a grade crossing for its own purposes. Unless there are extenuating circumstances, a track raise may be built into the design.

The following table may serve as a guide for planning purposes during preliminary design. Contact the region railroad coordinator (RRC) and the railroad early in the design process to decide on the amount of track raise before detailed design is undertaken.

[1] 30-feet from the rail minus 2.5 feet of tangent required outside of the rail.

Track Raise (inches)	Use When
0	No track raise can be tolerated by highway or railroad design or physical considerations.
1	Size of rail through the crossing will not be increased and only a skin lift of ballast is needed for track surfacing
2 - 3	Size of rail through the crossing will be increased and only a skin lift of ballast is needed for track surfacing
4 - 6	Site conditions such as a sag in the track profile, improved highway profile or increased track stability (with or without an increase in rail size) make a more substantial track raise desirable.
> 6	Although not common, this may be required for adjusting the highway profile or to rehabilitate the railroad track.

The greater the raise, the longer the track runoff and thus the greater the costs for track work. The cost of track raises that are provided solely for the benefit of the railroad is to be borne by the railroad.

5.5 Approaches

When designing concrete pavement approaches to a crossing, keep in mind that the railroad company requires room to work when the track structure or crossing surface need repair. For this reason provide an asphaltic surfacing approach between the end of the concrete and the beginning of the crossing material. Pavement structure in the “devils strip” area between multiple tracks requires special consideration for adequate asphalt compaction; avoid using concrete in the area. Refer to SDD 13B1.

In order to discourage motorists from passing around crossing gates, consider providing at least 100 feet of vertical face median curb at the following approaches:

- to rail lines with speeds exceeding 35 mph
- to crossings which have gates included in the active crossing warning devices.

Begin the vertical face curb at a point 12 feet from the track centerline.

5.6 Welded Rails

Welded rail shall be used through the crossing area, including shoulders and sidewalks, in order to reduce maintenance and to maintain a smooth crossing. On railroad lines with light weight rails, use heavier rail (minimum of 115 lbs./yd.) through the crossing. If guard or flange rails are used in the crossing, they also need to be continuous through the crossing. Rail joints shall be not less than 25 feet outside or beyond the ends of the crossing.

5.7 Drainage and Crossing Stability

Poor drainage is recognized as one of the leading causes of rapid crossing deterioration and early failure. Take all reasonable measures to channel water away from a grade crossing and to prevent it from flowing into the track structure. These measures may include raising the grade line of the track, lowering the grade line of the roadway approaches, special ditching along roadway and railroad, trench drains at the crossing quadrants, underdrains, curb and gutter, storm sewer systems, sealing of the flangeways with a railroad approved filler, etc. Cutting under the highway approaches at the same time the railroad is cutting out its subgrade at the crossing eliminates the frost shear zone at the limits of the ballast.

Hardpan refers to the subsoils below the ballast which at most locations have been compacted by many years of train operations. Avoid work that would disturb the hardpan. This is particularly important where poorly drained parent soils such as clays, silts and loams are present in the subgrade.

LIST OF ATTACHMENTS

Attachment 5.1 Examples of Allowable Roadway Grade Variation

Attachment 5.2 Runout Distance D on Approach to Track

FDM 17-60-10 Railroad Design Considerations

May 2, 2003

10.1 General

Railroad design practices are generally based on those recommended by the American Railway Engineering and Maintenance of Way Association (AREMA). The AREMA manual is available online to WisDOT employees.

The individual railroad companies have also developed standards and design practices of their own. These include construction of railroad track, structures, highway-railroad grade crossings and grade crossing signals. Subject to concurrence by the RHS, facilities which are the responsibility of the railroad for maintenance and operation shall conform to the specifications and design standards used by the railroad in its normal practice.

Railroad design standards for a particular line or location will affect the percent of grade, length of vertical curves, amount of superelevation between rails on curves, length of tangent between curves and length of spirals on curves. Also generally specified are the shape and cross section of the railroad roadbed, the depth of ballast under the ties, the size and type of ties, and type and weight of rail.

In the construction of an at-grade crossing, for instance, the railroad will generally require a minimum of 115-lb. rail, but may be heavier depending on the existing weight of the approach rails. There are to be no rail joints in the crossing; welded rail is required. These design features are advantageous to the highway user by eliminating weak spots through the crossing and are generally accepted for reimbursement by the WisDOT for distances up to 39 feet beyond the crossing limits where a public participation in crossing costs is authorized.

10.2 Clearance Considerations

The minimum statutory horizontal clearance to the centerline of tangent track is 8’-6”. Railroads prefer a minimal twelve feet to provide working space for train crews. Section 192.31(3) of the Wisconsin Statues requires 23 foot minimum vertical clearance unless a lesser distance is approved by the Commissioner of Railroads. Lesser clearances may be approved for a number of reasons, such as existing structures on the line of track with lesser clearances, financial hardship if street intersections or driveways would require major reconstruction, or a structure is on a line with little prospect of double-stacked container cars being hauled.

Title 23 Code of Federal Regulations appendix to Part 646, Subpart B, Paragraph 646.212(a)(3) limits federal funding on highway overhead structures to horizontal clearances of 20 feet between the track centerline and the face of the abutment embankment slope at rail elevation, and to vertical clearances of 23 feet unless greater clearances are more cost effective. See FDM 17-40-40 for more details.

Industry practice is to reference horizontal clearances from the centerline of track and vertical clearances above the top of rail (the high rail on super elevated track).

10.3 Statutory Clearances

Wisconsin statutory clearance requirements are found in 192.31 WS (vertical), and 192.53 WS (horizontal), and are interpreted in OCR administration rules OCR 3.14, 3.15, and 3.16. Horizontal clearances are to be compensated 1 inch per degree of curve. Exemptions for lesser clearances may be approved by the OCR after petition and a finding that a reduced clearances will not endanger safety and is in the public interest.

10.4 Clearances Desired by Railroad

Railroads generally prefer minimum horizontal clearances of 18 to 25 feet and minimum vertical clearances of 23 feet.

10.5 Temporary Clearances

During construction it is sometimes necessary to encroach on desirable clearances. In such cases 12 feet 0 inches horizontal and 21 feet 0 inches vertical may be permitted. In tight situations, lesser horizontal clearance may be permitted since the maximum rail car and engine width used in unrestricted interchange service is 10 feet 8 inches. (5’-4” each side of the track centerline)

In order to consider a railroad’s design practices and WisDOT policy, planners and designers must discuss any highway design proposals affecting railroad facilities with RHS staff. As a general policy in adjusting railroad facilities, it is the intent of the WisDOT to keep the railroad whole.

The adjustment of railroad facilities is generally performed by railroad personnel or a continuing contractor retained by the railroad at actual cost without profit to the railroad. Railroad work performed in conjunction with highway improvements is to be performed in essentially the same manner and with the same materials as if the work were performed by the railroad company for railroad company purposes.

FDM 17-60-15 Signing at Crossings

May 2, 2003

15.1 Introduction

Warning devices at grade crossings may consist of any or all the following:

1. Crossbuck signs
2. Advance warning signs
3. Pavement markings
4. Stop signs/yield signs
5. Flashing light signals - side of road
6. Flashing light signals - elevated cantilevers
7. Highway traffic signals

In general, items 1, 2 and 3 above are required at every public crossing. However, advanced warning signs and pavement markings may be omitted at certain crossings in urban areas and at minor crossings where they would not be appropriate. See Chapter VIII of the MUTCD.

Marking and signing of the highway is the responsibility of the maintaining highway authority, except that the railroad is responsible for the railroad crossing signs (cross bucks) and may also be responsible for furnishing the advance warning signs for county and town roads covered under 1 and 2 above.

15.2 Railroad Crossing Signs

Signing refers to Items 1 thru 4 above

1. Railroad Crossing Crossbuck Sign - A railroad crossing sign is required at each approach to a railroad-highway grade crossing. The placement and maintenance of the railroad crossing sign, commonly referred to as the crossbuck, is the responsibility of the railroad (Section 192.29(5) of the Wisconsin Statutes). Standards for the signs are found in the MUTCD Section 8B.02. The crossbuck is post mounted and placed in conformance with the MUTCD on each approach roadway. The backside of the cross-buck and both sides of the post are also reflectorized to increase its visibility to the motorist. Where there are automatic train activated railroad crossing signals, the cross-buck is fastened to the signal mast.
2. Railroad Advance Warning Sign - A railroad advance warning is required on each approach to a railroad-highway grade crossing. Standards for the signs are found in the MUTCD Section 8B.03. The railroad company is to furnish to the county the signs for crossings on local roads outside of the corporate limits of a city or village [Section 195.286(1) of the Wisconsin Statutes]. The county is responsible for installing the signs on its highway system and delivering the signs intended for town road crossings to the towns for the towns to install on their highway systems. The WisDOT, cities, and villages are responsible for furnishing and installing the signs on their respective systems. Standards for sign and the sign installation are found in the MUTCD. Signs are to be placed on both sides of the roadway when part of a divided or one-way facility, or when the roadway curve to the right restricts the view of the right-hand sign at night.

Exceptions to installing the signs follow:

1. If the distance between the railroad tracks and the parallel highway, from the edge of the track to the edge of the highway, is less than 100 ft (30m), the W10-2, W10-3, or W10-4 signs shall be used on the parallel highway to warn road users making a turn that they will encounter a highway-rail grade crossing soon after making the turn.
2. On low-volume, low-speed highways crossing minor spurs or other tracks that are infrequently used and are flagged by train crews.
3. In business districts where active highway-rail grade crossing traffic control devices are in use.
4. Where physical conditions do not permit even a partially effective display of the sign.

Placement of the highway-rail grade crossing advance warning signs (W10 series may be based on prevailing speeds rather than the posted speed limits. The following criteria may be used to further define the conditions under which the highway-rail grade crossing advance warning signs (W10 series) may be omitted:

1. The crossing is in a business district of a city or village, and

2. Active warning devices are in use, and
3. The highway speed limit is 25 mph or less

15.3 Pavement Markings

Projects involving the installation of railroad crossing signals or crossing surfaces are not acceptable to FHWA until the highway approaches to the crossing are properly striped and marked with the railroad crossing symbol and the highway advance grade crossing railroad warning signs are installed, if required by the MUTCD. Exceptions to this requirement are to be approved at the time the Agreement work is authorized.

Information on marking and signing is located in the MUTCD 8(b)16.

Pavement markings shall be placed in each approach lane on all paved approaches to highway-rail grade crossings where signals or automatic gates are located, and at all other highway-rail grade crossings where the posted or statutory highway speed is 40 mph (60 km/h) or greater.

Pavement markings shall not be required at highway-rail grade crossings where the posted or statutory highway speed is less than 40 mph (60 km/h), or in urban areas, if an engineering study indicates that other installed devices provide suitable warning and control.

Exceptions to the placement of pavement markings include the following.

1. Crossings of rail lines which are subject to abandonment within three years.
2. Crossings of minor spur tracks which average fewer than two trains a day over a 30-day period and which have train speeds of 15 mph or less.
3. Crossings in urban areas where vehicular traffic at the crossing is controlled by traffic control signals due to an adjacent roadway intersection.
4. Crossings where the approach distance is less than 250 feet in rural areas and less than 100 feet in urban areas.
5. Active warning devices are not present, and the highway speed limit or prevailing speeds are 35 mph or less, or
6. The track is a minor spur and trains operate at 15 mph or less.

The pavement markings may be placed under one of the following arrangements:

1. By state forces.
2. By separate contract, usually including other signing and marking locations.
3. By the local highway authority.
4. By the railroad by sub-contract to the Agreement
5. As part of the Traffic Control Plan on companion highway improvement projects.

Special consideration needs to be made for placement of the stop bar at highway -highway intersections when the intersections are so close to a rail-highway crossing that storage space between the track and intersection is limited. Placement should be as close to the near intersecting lane as safely possible.

15.4 Stop Signs and Yield Signs

The use of stop signs or yield signs at crossings with only passive warning (ie: crossbucks) is permitted. For roadways with normal highway traffic volumes, refer to the MUTCD 8B.07. For low volume roadways see MUTCD 5F.04. The OCR may order the installation of stop signs. However, Wis. Statues, do not give highway jurisdictions the authority to install YIELD signs. At this time only the OCR may order the installation of YIELD signs.

Railroads encourage local roadway authorities to erect stop or yield signs at passive crossings on roadways in their jurisdictions. This has been done on the premise of increasing safety at the crossing and to lessen the liability of both the railroad and the local unit in the event of an accident. DOT and OCR are attempting to change Wis. Statues to install “yield” signs on all passive crossings that do not have “stop” signs. So, while such signing is not yet widespread, it is expected that many additional crossings will be so signed in coming years.

15.5 “Tracks Out of Service” Signs

The ABANDONED railroad crossing sign is being phased out in favor of the “TRACKS OUT OF SERVICE” sign. However this sign should be used with caution. Occasionally railroads operate trains over an abandoned line or a work train may be used to remove rail materials. Before such signs are installed the highway authority should

confer with the railroad owning the tracks. The WisDOT policy identifies an abandoned crossing when all three of the following conditions are met:

1. Track is abandoned in accordance with Section 85.09(3)W.S.
2. No state or local interests exist in retaining rail service on the line.
3. Tracks are physically removed so a train cannot enter the crossing from the feeder track.

15.6 "Exempt" Signs

The EXEMPT crossing signs are installed by the agency having jurisdiction for the maintenance of the highway. EXEMPT signs are placed on the same post as the railroad crossing advance warning sign and on the post with the cross buck sign. Detail on signing is contained in Chapter VIII of the MUTCD.

For the legal basis of the above, refer to Sections 195.285, 196.26, and 346.45, Wisconsin Statutes.

See FDM 17-45-25 for more guidance on establishing an exempt crossing.

FDM 17-60-20 Warning Devices and Systems

May 16, 2006

20.1 Introduction:

Active Warning Devices consist of :

- Wig Wags (only a few remain in service)
- Flashing Light Signals: (Including wig wags)
  - Side of the Road (See Attachment 20.1)
  - Cantilever – extending out over the roadway above the approach traffic lanes.
- Gates, which extend over the approach roadway.
- Highway Traffic Control Signals

There are, however many components which enhance the operation of these active warning devices, and that, primarily, is the purpose of this section.

20.2 Train Activated Signals

Train activated signals are installed to warn the motorist of the presence or approach of a train where passive signing is determined to be inadequate for safety and the convenience of the public.

1. Flashing Lights - The current standard for railroad flashing light signals is a 12-inch diameter red light emitting diode (LED) lamp unit. The lamps are mounted in pairs. For a two-lane roadway, the signals are mounted back to back on a mast located on each side of the road. There are front lights (on the right) and back lights (on the left) of each approach roadway. For multi-lane roadways, including authorized parking lanes within the vehicle stopping sight distance of the crossing, additional flashing light units cantilevered over the traffic lanes are required. The arrangement of flashing-light signals is based on the concept of having a minimum of two sets of flashing-light signals visible to all lanes of approaching traffic.

   On roadways of divided highways and on one-way streets, either a single cantilevered signal or a side-of-road signal installed on each side of the roadway are acceptable for two-lane approaches. One or two cantilevered signals are required when there are more than two approach lanes, and when a shoulder width exceeds eight feet.

2. A single cantilevered signal These may also be employed under certain conditions.
3. Roadway Gates - Where train activated warning devices are required, automatic gates with flashing light signals may also be installed under certain conditions.

20.3 Control Equipment

In combination with the warning devices it is necessary to supply equipment that sends out a signal upon the approach of a train to activate the warning devices. The railroad normally selects this equipment consistent with its standard designs and practices, the WisDOT reviews for adequacy, and the OCR approves the design and electrical circuit plan.

See the RHS Railroad Coordination Handbook for more detailed information.

20.4 Placement of Signs and Signals

In the interest of public safety, railroad signal supports should be placed as far as practicable from the edge of

the traveled way without adversely affecting the effectiveness of the sign or signal faces.

Normally the outside edge of signs, including both the advance warning signs and the cross-bucks, should not be closer than six feet from the edge of the shoulder, or, if no shoulder exists, 12 feet from the edge of the traveled way. In urban areas, a distance of two feet between the face of curb and the edge of the sign is appropriate.

Curb heads and other highway appurtenances shall not extend above the gutter pan or natural ground elevation within 12 feet of the track centerline.

Flashing lights are to be mounted on a post (or mast) or cantilever. On through highways and streets there should be a minimum of two signal units facing each direction of traffic approaching the crossing.

When cantilevers are used, the flashing lights should be mounted over the center of the right traveled lane for two lane roadways. As noted earlier, cantilevers should be used if the side of the road signal is more than 12'-3" from the edge of the travel lane. On four-lane roadways, the flashing lights should be mounted as close as practical to the middle or the inside or left lane. If cost or space are an issue with placement, then the flashing lights need only enter the inside or left lane. This also applies to the placement of flashing light signals in areas with parking lanes, the flashing lights should be mounted in the center of the travel lane but are only required to be somewhere over the lane. Cantilevered signals are to ensure that traffic in travel lanes can view the flashing lights without obstruction from high profile vehicles in adjoining lanes. The bottom of the flashing lights on cantilevers is to be a minimum of 17 feet and not more than 19 feet above the crown point of the roadway. On divided highways, consider installing side or road signals in the median rather than cantilevers, unless there are reasons to keep the median clear (such as the median being on the outside of the horizontal curve) or there are space problems (such as utilities) occupying the normal or effective signal location.

Signal supports along a street with curbs should be placed a minimum of 4'-3" from the face of the curb to the center of the signal support post. Where there is no curb, the center of the signal support post should be placed a minimum of 4'-3" from the shoulder line or a minimum of 8'-3" from the edge of the traveled way, whichever is greater, but no less than 20'-3" from the centerline of roadway in either case (See Attachment 20.1).

When new signals are installed, or existing signals are repositioned, sidewalks should be constructed or reconstructed around and outside the signal base. When sidewalk space is limited, a standard sidewalk width of five feet may be attained by adjusting the signal support location one-foot in either direction. In rare instances, a sidewalk width reduced to four feet within the area of the signal may be necessary. The inside edge of the sidewalk is to be constructed no closer than 2'-6" from the center of a side-of-road signal support or cantilevered signal support, and no closer than 3'-0" from the center of a gated signal support. See Attachment 20.1. Adjustment is also necessary when utility poles interfere with a motorist's sight line to a signal.

For the general location of railroad signals other than the lateral clearance provided above, refer to Part 8 of the MUTCD.

20.5 Protection of Signals

Breakaway bases for cantilevered flashing-light signals are not allowed. Energy-attenuating devices may be placed ahead of the signal supports for the protection of an out-of-control vehicle. However, beam guard in front of signal supports has the undesirable effect of channelizing an out-of-control vehicle into the path of a train. For this reason, beam guard should normally not be installed at signal supports unless required for other reasons. One such reason is to protect the signal from damage due to turning trucks if the signal location is adjacent to a commercial driveway. Beam guard placed in front or around signal posts is the responsibility of the highway authorities or may be ordered by the Commissioner of Railroads as a part of the signal installation.

Traffic guard posts made from rails and set in concrete are prohibited.

LIST OF ATTACHMENTS

Attachment 20.1 Flashing Light Signals, Side of Road - Rural and Urban Roadway

FDM 17-60-25 Pre-emption/Interconnects *May 2, 2003*

25.1 Preemption/Interconnection of Traffic Control Signals

Preemption of traffic control signals involves the coordinated operation of highway traffic signal equipment and railroad grade crossing warning systems so that the approach of a train will cause the traffic signals to permit roadway traffic to clear the crossing before the arrival of a train, or other appropriate phasing. Preemption generally is used when a signalized intersection exists within 200 feet of a grade crossing or traffic queues routinely back up over the crossing during at least a portion of the day. Information from the crossing warning

system as to the approach of a train always takes precedence over the normal operation of the traffic signal. Preemption is accomplished by interconnecting the control equipment of the two systems. The objective of preemption is, first, to permit all roadway traffic to clear the crossing before the train arrives and, second, to allow non conflicting roadway traffic to flow while the train is occupying the crossing. "No Turn" signs, blank out signs, and signal indications may be necessary to prevent motorists from turning toward the track during the train movement. Where feasible, the location, normal phasing, and timing of traffic signals in addition to traffic control signing near a railroad crossing should be designed so that vehicles are not caused to stop on the tracks even though no trains are present in the area. When a train has cleared the crossing, the traffic signals operate in a preset manner before resuming their normal operation.

The railroad installs a relay terminal for the highway authority at the railroad signal bungalow. The highway authority attaches the interconnect cable from the railroad terminal and connects the cable to the highway traffic signal controller.

An agreement similar to one for crossing warning devices is prepared for execution by the WisDOT, railroad and, when involving a local road, the local jurisdiction. A signal plan and sequence of operations is provided to the RHS by the region.

There are two types of preemptions, simultaneous preemption and advance pre-emption. See the MUTCD for definitions, descriptions and additional details. Also, the US DOT Report entitled “Guidance on Traffic Control Devices at Highway – Rail Grade Crossings “ provides additional guidance on traffic control devices at highway/railroad grade crossings. In many instances, a crossing gate may be required at the crossing to prevent vehicles from entering the track zone during the clear-out sequence.

There are two additional suggestions:

- Annual joint inspections involving all responsible parties. These are necessary to ensure satisfactory operation
- A cooperative process for making any changes in traffic or railroad signal timing. Changes shall involve all parities – no changes shall be made unilaterally.

FDM 17-60-30 Crossing Surface Types

July 5, 2005

30.1 General

Both railroad companies and highway authorities have a vested interest in railroad-highway grade crossings and their physical characteristics. For highway users, the railroad grade crossing creates a potential for delay and congestion. There is also a discontinuity in the roadway surface that may result in a rough ride which may increase the "wear and tear" to the highway vehicles. For railroads, the highway grade crossing creates a change in the normal track structure. Track maintenance at highway crossings, crossing signs and signals are all additional costs to the railroad.

For these reasons, it is important that each grade crossing be provided with the most suitable surface for the particular location and characteristics of railroad and highway traffic and with due consideration for the cost of construction and maintenance.

30.2 Current Standard Crossing Surface

The concrete-panel crossing is the standard crossing surface for rural State Trunk Highways and rural local roads when design speed equals or exceeds 35 miles per hour and when the design traffic volume exceeds 4,000 vehicles per day. In urban areas, the concrete-panel crossing is the standard crossing surface when the design traffic volume exceeds 7,000 vehicles per day or the exposure factor exceeds 20,000. Concrete panels may be installed at crossings where design traffic volumes are below these thresholds if the highway maintaining authority and the railroad agree to the upgrade, and the additional cost does not exceed the funds allocated for the project. The highway maintaining authority or railroad may also agree to fund the additional cost if project funds are unavailable.

Concrete panels may be installed at sidewalk, path, and trail crossings if the maintaining authority and railroad agree to their use and the additional cost does not exceed the funds allocated for the project. The maintaining authority or railroad may agree to fund the additional cost if project funds are unavailable. If sidewalks, paths, and trails are within one panel length of the concrete-paneled roadway crossing they are to have the concrete material extended through the facility.

30.3 Selecting A Crossing Surface

The Railroads & Harbors Section will consider the following items when selecting or approving the type of crossing surface:

1. The functional classification of the roadway and the normal operating speed of vehicles at the crossing.
2. The general classification of the rail line, maximum train speed, average daily number of trains, and annual gross tonnage over the crossing.
3. The volume, weight and speed of the various types of vehicular traffic, particularly as related to trucks and buses.
4. The nature of the subgrade.
5. Climatic conditions.
6. Costs to construct, maintain, and replace.
7. Desired riding quality of the surface.
8. Detour arrangements/routes.

WisDOT staff should see the Railroad Coordination Handbook for more detailed information.

FDM 17-60-35 Miscellaneous

May 2, 2003

35.1 Controlled Train Movements

The number of train-vehicle conflicts at highway rail grade crossings can sometimes be reduced by controlling or restricting train movements to times when roadway traffic volumes are low. This can be especially beneficial for crossings where the street has peak traffic during certain hours. In some situations, it may be possible to make arrangements with railroad officials to have their switching operations scheduled at such crossings during times of off-peak traffic. There are usually no public costs for such arrangements. The railroad benefits through fewer crossing crashes and through fulfilling its social responsibility and good will.

It is not realistic to expect railroads to restrict through train movements to off peak hours in all communities and at the same time properly serve the state's economy.

35.2 Lighting Crossings

Providing street lighting at a railroad crossing is another alternative to increase motorist awareness at railroad crossings with trains operating in darkness. Lighting can be effective where trains operate at night over a crossing that is obscured in some manner or the motorist is unaware of the presence of a train on the crossing. Trains switching across highways where lights of oncoming cars and trucks are visible over or under the rail cars due to adverse highway approach grades can be particularly hazardous. Preference should be given to locations where automatic warning devices are not present. Each railroad crossing shall be properly signed.

In areas of street lighting, the illumination should extend beyond the immediate crossing area. Care should also be taken so that the street lighting does not detract from the railroad crossing warning system due to over intensity of the lighting or the location of lighting supports. Street lighting units, if installed, should be placed on both sides of a crossing over the near right driving lanes.

Projects for lighting railroad crossings are eligible for Federal-Aid Safety funds. The responsibility of paying for the ten percent matching funds and cost of maintenance and electric service is usually borne by the local highway authority.

Background lights on property adjacent to the highway and streets can be particularly bothersome and confusing to motorists. This can sometimes be corrected to some extent through the help and assistance of local government zoning officials.

35.3 Other Safety Devices

There are a variety of other safety devices. Some are being developed and refined, some are in experimental use, but none are in wide use. In most cases there are several types or varieties of the devices, and any proposal for their use must be fully explored and evaluated by RHS, and probably the OCR and FHWA (for funding eligibility).

Some examples of such safety devices follow, although there are more and new ideas periodically proposed;

- Barrier gates, which require median barriers
    - Permanent (Curb and Gutter Medians)
    - Bolt Down (Rubber Curb with Delineators)

- Wayside Horns (horns at the crossing, oriented along the roadway)
- Remote Monitoring
- Vehicle Barriers/Arrestors
- Second Train Coming Systems
- Track Zone Detection
- Video/Photo Enforcement
- In-Vehicle Warning Devices
- “Active Crossbucks”

Any proposal to use federal funds on a warning device that does not conform to the MUTCD must first receive a waiver from the FHWA. Such a waiver requires an evaluation of the device to determine its effectiveness.

FDM 17-60-40 High-Speed Passenger Rail

May 2, 2003

Wisconsin is a partner in a nine-state effort to create a high-speed passenger rail network linking major Midwest population centers to a hub in Chicago. This project is known as the Midwest Regional Rail Initiative.

Wisconsin’s portion of this network (See Attachment 40.1) includes the Canadian Pacific Railroad Line from La Crosse to the Illinois State line linking the cities of Portage, Madison, Watertown and Milwaukee; and the Canadian National Railroad Line from Green Bay to Milwaukee, passing through Oshkosh.

Any and all crossings of these future high-speed passengers rail lines require special attention. Most crossings will require either closure, gates (or perhaps barrier gates) or will be grade separated. Any roadway improvement along this corridor must consider the future impacts of high-speed rail development. For example, if a project crosses the rail line on curve, the roadway plan should anticipate the probability of a flatter railroad curvature and probably changes in track super elevation. Vertical alignment may also change with future high-speed rail.

With the probable near-future development of high-speed rail, the goal in roadway design should be to preserve options for high-speed railroad development on these lines.

LIST OF ATTACHMENTS

Attachment 40.1 Midwest Regional Rail Initiative, Wisconsin's Portion

FDM 17-60-45 Transverse Facility Crossings

March 21, 2007

45.1 General

This procedure describes the railroad coordination activities that are needed during the development of a highway improvement project that requires constructing a transverse facility. A transverse facility is a feature that is built across railroad land. Examples of a transverse facility include:

- Sanitary sewer lines
- Storm sewer lines
- Water lines
- Electrical or communication cable (either above or below the tracks)

See Attachment 45.1 for decision tree matrix.

45.2 Public Utilities vs. Highway Appurtenances

It must first be determined whether the proposed installation is considered a public utility or a highway appurtenance.

45.2.1 Public Utility

The term “public utility” is defined in Administrative Rule PSC 132 (http://www.legis.state.wi.us/rsb/code/psc/psc132.pdf). In the context of this procedure this definition is applied to only those public utilities that construct their facilities under a WisDOT contract as a non-participating item.

Administrative rule PSC 132 allows public utility installations to cross railroad right-of-way and sets forth the procedures, conditions, requirements, responsibilities, and compensations to be paid for the construction of new facilities or the maintenance of existing facilities within a railroad right-of-way.

PSC 132 applies to utilities, storm sewers that are not part of the highway storm drainage system (such as

interceptor sewers), to water mains and to sanitary sewers. These and other facilities may occupy highway right of way per s. 86.16, stats but, per PSC 132, the railroad has the authority to charge a fixed $500 fee when crossing railroad right-of-way.

45.2.2 Highway Appurtenances

Highway appurtenances are not considered public utilities and therefore are exempt from the rules and fees set forth in PSC 132. Highway appurtenances include highway storm sewer systems, conduits for buried electrical cable for highway traffic signals or street lighting, or for overhead power wires required for street lighting or highway traffic signals.

Facilities such as these are considered to be part of the highway and are allowed to cross the railroad pursuant to the highway easement without a permit and without payment of a fee to the railroad. The railroad, however, will be reimbursed for flagging costs and for railroad force work if required, such as pole line alterations and removal and replacement of track if open trenching is used for the facility installation.

45.3 State vs Private Railroad Corridors

To determine applicable installation rules it is necessary to determine whether the railroad corridor being crossed is owned by a private railroad company or by the State of Wisconsin.

45.3.1 State Owned Railroad Corridors

Public Utilities - All new and modifications to existing public utility installations on WisDOT-owned railroad property must follow the rules and procedures prescribed in Administrative Rule, Trans 29 (http://www.legis.state.wi.us/rsb/code/trans/trans029.pdf). This rule requires a permit issued by WisDOT Railroads & Harbors Section (RHS) for all public and private utility installations including: public and cooperative utilities, cable television companies and individuals desiring to install or maintain a utility facility on department railroad property. A fee is charged for the permit.

Highway Appurtenances - Highway projects that cross WisDOT owned railroad property are subject to the rules and procedures set forth in TRANS 29, but are not required to obtain a permit or pay a fee. Highway project managers must closely coordinate installations with RHS and the railroad operating on the corridor to ensure that train operations are not disrupted.

45.3.2 Privately Owned Railroad Corridors

Public Utilities - PSC 132.03 states “Unless otherwise agreed to by the parties and subject to sub. (2), a public utility which locates its facilities within the right-of-way of a railroad shall compensate the railroad $500 for each crossing. The payment shall be a one-time payment, in lieu of any license fees, to reimburse the railroad for expenses incurred by the railroad as a result of the construction of the facilities and, in the case of a private crossing, to compensate the railroad for the locating of the facilities within the right-of-way.”

PSC 132 applies on WisDOT projects where a public utility facility such as a sanitary sewer or a water main is to be constructed under a WisDOT contract as a non-participating item. In such situations, the Region Railroad Coordinator must confirm with the Region Utility Coordinator or the local utility that the utility has complied with PSC 132 before signing off on the PS&E submittal to central office.

Highway Appurtenances - Permission to cross is not required from a railroad for highway projects with installations crossing privately owned railroad corridors within a highway right of way. Each railroad has published standards for under-track and overhead crossings. The installation should be designed in accordance with reasonable standards set by the railroad or AREMA. Designers should obtain these standards and be guided by them in preparing the plan and specifications before submitting to the railroad. A copy of the plan and specifications for construction should be sent to the railroad with an opportunity to return comment.

See Attachment 45.2 for a sample letter notifying the railroad of the intended work and request for plan review.

If the railroad requests reasonable changes, it is the policy of the department that they be made; if the changes appear questionable, review with RHS.

45.4 Installation

45.4.1 Under-track crossings

Under-track crossings may be made by open trenching, directional boring, tunneling, auguring or jacking. The particular method to use depends on soil conditions, type of conduit material, size of conduit, depth of burial and requirements of the railroad. Working headers need to be placed far enough from the track to provide lateral support and temporary shoring is often required. Each railroad has its own specifications for installation. Open trenching is usually not permitted at heavily used mainline tracks.

45.4.2 Culvert installations

Culverts are a special case of under-track crossings. Occasionally a highway project alters drainage courses such that a new culvert is needed under a railroad line. The culvert location may be outside of a highway easement area. Wisconsin statutes S. 88.87 and S 88.88 require railroads to pass drainage through their embankments. WisDOT may design and pay for the necessary installation provided the railroad will grant a right of entry for the work and will maintain the new facility. OCR has jurisdiction in these matters and resolves disputes after petition and hearing. RHS will negotiate culvert crossing arrangements after receipt of plans, cross sections and supporting hydrological and hydraulic design data.

45.4.3 Aerial track crossings

In the rare instance that WisDOT would require aerial highway appurtenances such as highway lighting connections, typical aerial installation methods shall be used. The space between the track zone and the railroad property boundary lines shall be kept as free from obstructions as practicable. If an above-ground utility facility is permitted by the Railroad, it shall be located so as not to interfere with railroad operations or maintenance and may not be concealed by vegetation. It should be placed as close as practicable to an existing fence or to a railroad property boundary line.

The minimum vertical clearance for overhead electric power and communication lines above railroad property and the minimum horizontal and vertical clearances from bridges or from other railroad facilities shall conform to the Wisconsin state electrical code found in Ch PSC 114 , Wis. Adm. Code, and to s. RR 2.14 , Wis. Adm. Code.

45.4.4 Flagging

In addition to complying with reasonable railroad design standards, WisDOT will require the construction contractor to provide insurance and arrange and pay for a railroad flagger. The “Relations with Railroad Company” special provision is to be used.

45.5 References

Visit the following Internet sites for installation specifications:

Union Pacific Railroad (http://www.uprr.com/reus/pipeline/install.shtml)

Canadian National Railway (http://www.cn.ca/en/safety-crossing-utility-us.htm)

Burlington Northern and Santa Fe Railway (http://www.bnsf.com/markets/services/realestate/permitslicenses.html)

Canadian Pacific Railway, call 612-904-5994 for installation specs.

AREMA Practical Guide to Railway Engineering – Chapter 3.5

LIST OF ATTACHMENTS

Attachment 45.1	Transverse Facility Decision Process Flow Chart
Attachment 45.2	Sample Railroad Notification Letter