A. Purpose

This Manual Part recommends functional/operating guidelines for an interconnection to provide notification to a highway traffic signal controller or other traffic control device from a grade crossing warning system.

B. Warning Devices

1. For grade crossing warning devices, see Manual Part 3.1.1 Recommended Guidelines for Grade Crossing Warning Devices.


C. General

1. For grade crossing warning systems interconnected with highway traffic signals, System Design Time minus Equipment Response Time shall not exceed 50 seconds.

2. The highway agency or authority with jurisdiction and the regulatory agency with statutory authority, if applicable, jointly determine the need and selection of devices at a grade crossing. This includes the need for preemption, type of preemption, time interval for any advance preemption, exit gate clearance time and exit gate operating mode (see Manual Part 3.1.15, Recommended Functional/Operating Guidelines for Control of Automatic Grade Crossing Warning Systems). Refer to 2009 MUTCD Section 8A.01 and 8C.09 for additional information. As a part of any preemption needs study, a thorough evaluation should be conducted of all site specific parameters including traffic signal operating sequences and timing, use of pre-signals or queue-cutter signals, railroad warning devices, warning times and impact of train operations on warning times.

2-3. At locations where a highway intersection not controlled by traffic signals is located at or near a grade crossing with or without active warning devices and vehicle queues build inside of the Minimum Track Clearance Distance (MTCD), installation of a highway traffic signal and/or railroad active warning devices should be considered by the highway agency or authority with jurisdiction and the regulatory agency with statutory authority, if
applicable. See 2009 MUTCD Section 4C.10, Warrant 9 Intersection Near a Grade Crossing for specific information. Interconnection and preemption of the traffic signal controller should then be provided if it falls within the requirements of MUTCD. Refer to 2009 MUTCD Section 8C.09 for additional information.

3.4. When a traffic control signal or other traffic control device is interconnected to a grade crossing warning system, a label should be installed in the traffic signal controller cabinet and the railroad warning system enclosure advising maintenance personnel of the interconnection. The label should provide contact information for both the public agency responsible for the traffic signal and the railroad maintenance facility. An example of such a label was developed by the USDOT Technical Working Group and is depicted in Figure 3110-1.

D. Definitions

1. Advance Preemption – Notification of 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 devices.

2. Advance Preemption Time (APT) - The period of time that is the difference between the required Maximum Highway Traffic Signal Preemption Time and the Prescribed Warning Time.

3. Cantilevered Signal Structure – A cantilevered signal structure is a structure that is rigidly attached to a vertical pole and is used to provide overhead support of signal units.

4. Clear Storage Distance (CSD) – The distance available for vehicle storage measured between 6 ft. from the rail nearest the intersection to the intersection STOP Line or the normal stopping point on the highway. At skewed crossings and intersections, the 6 ft. distance shall be measured perpendicular to the nearest rail either along the centerline, or edge line of the highway, as appropriate, to obtain the shorter distance. Where exit gates are used, 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/or not perpendicular to the highway, the distance is measured either along the centerline or edge line of the highway, as appropriate, to obtain the shorter distance.

5. Design Vehicle – The longest vehicle permitted by statute of the road authority (State or other) on that roadway.
65. Interconnection – The electrical connection between the railroad active warning system and the highway traffic signal controller assembly for the purpose of preemption.

76. Maximum Highway Traffic Signal Preemption Time – The maximum amount of time needed following initiation of the preemption sequence for the highway traffic signals to complete the timing of the Right-of-Way Transfer Time, Queue Clearance Time and Separation Time.

87. Minimum Track Clearance Distance (MTCD) – For standard two-quadrant warning devices, the minimum track clearance distance is the length along a highway at one or more railroad tracks, measured from the highway stop line, warning device or 12 ft. perpendicular to the track centerline, to 6 ft. beyond the track(s) measured perpendicular to the far rail, along the centerline or edge line of the highway, as appropriate, to obtain the longer distance. For four quadrant gate systems, the minimum track clearance distance is the length along a highway at one or more railroad tracks, measured either from the highway stop line or entrance warning device, to 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/or not perpendicular to the highway, the distance is measured either along the centerline or edge line of the highway, as appropriate, to obtain the longer distance.

98. Prescribed Warning Time (Minimum Warning Time) – For through train movements, prescribed warning time is the least amount of time active warning devices shall operate prior to the arrival of a train at a highway-rail grade crossing. This time is the sum of MT plus CT and is the time to be tested to comply with the requirements of 49 CFR §234.259. See Manual Part 3.3.10 Recommended Instructions for Determining Warning Time and Calculating Minimum Approach Distance for Grade Crossing Warning Systems for additional information.

10.9. Monitored Interconnected Operation – An interconnected operation that has the capability to be monitored by the railroad and/or highway authority at a location away from the grade crossing.

11. Preemption – The transfer of normal operation of traffic signals to a special control mode.

12. Pre-Signal – Traffic control signal faces that control traffic approaching a grade crossing in conjunction with the traffic control signal faces that control traffic approaching a highway-highway intersection beyond the tracks. Pre-signals are typically used where the clear storage distance is insufficient to store one or more design vehicles. Supplemental near-side traffic control
signal faces for the highway-highway intersection are not considered pre-signals. However, the traffic signal operation and signal face visibility must be closely reviewed for potential conflicting signal indications when the warning system is activated.

4312. Queue Clearance Time (QCT) – The time required for the design vehicle of maximum length stopped just inside the MTCD to start up and move through and clear the entire MTCD. If pre-signals are present, this time shall be long enough to allow the vehicle to move through the intersection, or to clear the tracks if there is sufficient CSD. 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 MTCD.

4413. Queue Cutter Signal – Traffic control signal faces that control traffic approaching a grade crossing where vehicles queue to the point they are stopped within the minimum track clearance distance. The queuing is usually from a highway-highway intersection located greater than 200’ beyond the tracks.

4514. Right-of-Way Transfer Time (RWTT) – The maximum amount of time needed for the worst-case condition prior to display of the track clearance green interval. This includes any railroad or highway traffic signal control equipment time to react to a preemption call, and any traffic control signal green, pedestrian walk and clearance, yellow change, and red clearance intervals for conflicting traffic.

15. Separation Time (ST) – The component of Maximum Highway Traffic signal Preemption Time during which the MTCD is clear of vehicular traffic prior to the arrival of the train.

16. Simultaneous Preemption – Notification of an approaching train is forwarded to the highway traffic signal controller unit or assembly and railroad active warning devices at the same time.

17. Track Clearance Green Interval (TCG) – The portion of the traffic signal sequence when the RWTT has completed and green signal indications are displayed to roadway users in order to clear the MTCD.

E. Operation

1. The interconnection shall conform to Manual Part 16.30.10 Recommended-Vital Circuit Design Guidelines for Highway Traffic Signal Interconnection. Where gates are utilized, enhanced interconnection circuitry and traffic signal preemption programming (internal or external to the traffic signal controller unit) should be considered to prevent the traffic signal from
leaving the clear track green interval until the appropriate gate arm(s) is/are fully lowered.

2. The determination to implement simultaneous or advance preemption should be closely evaluated by the highway agency or authority with jurisdiction and the regulatory agency with statutory authority, if applicable. It is necessary to calculate the right-of-way transfer time, queue clearance time (based on the proper design vehicle and grade of the roadway) and the separation time in order to determine the Maximum Highway Traffic Signal Preemption Time. Note that these intervals and the resulting time are required regardless of whether simultaneous or advance preemption operation is implemented as they are based on traffic signal minimum timing, vehicle acceleration and physical distances along the roadway.

In many cases, the amount of time determined required will may necessitate the installation of additional equipment by the highway agency or circuitry by the railroad, and may result in increased complexity. Therefore, it is recommended that the highway authority review all timing requirements with the railroad in order to provide the required functionality in an effective manner. In the U.S., see 2009 MUTCD Section 8A.02 which states:

“Standard:

Traffic control devices, systems, and practices shall be consistent with the design and application of the Standards contained in this Manual.

Before any new highway-rail grade crossing traffic control system is installed or before modifications are made to an existing system, approval shall be obtained from the highway agency with the jurisdictional and/or statutory authority, and from the railroad company.”

4. Where advance preemption is utilized, a thorough analysis of preemption operation and sequencing should be conducted throughout the range of anticipated railroad warning times and traffic signal right-of-way transfer times. The preemption operation must be designed to accommodate the wide variability that may be encountered. This is to prevent the traffic signal from leaving the track clearance green interval prior to the lowering of the gates. Typically, this can occur when the traffic signal controller unit enters the track clearance green interval with very little or no right-of-way transfer time and/or the approaching train is decelerating. Refer to Manual Part 16.30.10, Recommended Vital Circuit design for Highway Traffic Signal or Other Traffic Control Device Interconnections. The following are two
examples of mutually exclusive methods which may be implemented to address and resolve variability:

a. Gate Down – Gate down circuitry is utilized to provide a means to hold the downstream traffic signal controller unit in the track clearance green interval until the gate(s) controlling access over the grade crossing approaching the signalized intersection is/are down. This does not affect Pre-Signals or traffic signals governing traffic on to the crossing.

Any additional track clearance green time necessary would complete its timing following the receipt of the gate down confirmation signal.

Island circuit occupancy shall release the track clearance green interval in the event a gate is broken or is not fully lowered.

b. Timing Correction – Timing correction is utilized to resolve Right of Way Transfer Time (RWTT) variability by adding the RWTT time to the track clearance green interval in the traffic signal controller unit. In addition, a timing circuit should be employed to maintain a maximum time interval between the initiation of advance preemption and operation of the warning system for a train move where speed is decreasing (it should be noted however, that this time interval would decrease in the event train speed is increasing).

Use of gate down typically results in more consistent warning system operating times where timing correction starts the warning system operation early in order to maintain the specified advance preemption time interval. Each of these methods utilizes different means to overcome variability and may not be suited for a specific application. It is important to note that timing correction may create the appearance of false activations and/or extended warning time where trains decelerate or stop within the approach to the grade crossing (i.e. station stops, switching movements, code change points, etc.) and should be closely studied to determine suitability in rail operations. Each method should be closely evaluated to determine the impact on the operation of the warning system and highway traffic signal.

5. When a highway intersection controlled by traffic signals is interconnected with a grade crossing equipped with four quadrant gates, advance preemption should be considered since additional operating time is required for the exit gates (EGCT - exit gate clearance time). In the majority of cases, EGCT and Maximum Preemption Time run concurrently as a function of queue clearance time. It is critical that adequate time is provided for right-of-way transfer time, queue clearance time, separation time and exit gate clearance time. See Manual...
Part 3.1.10 Recommended Instructions for Determining Warning Time and Calculating Minimum Approach Distance for Highway-Rail Grade Crossing Warning Systems to determine exit gate operating times.

6. Where exit gates are proposed, an engineering study as referenced in MUTCD Section 8C.06 should be conducted to establish the type of exit gate control circuitry employed. The study should consider the need for vehicle intrusion detection devices to ensure exit gates are not lowered until vehicles are clear of the MTCD under all modes of traffic signal operation including flashing operation of highway traffic signals. See Manual Part 3.1.15, Recommended Functional/Operating Guidelines for Control of Automatic Grade Crossing Warning Systems, to determine exit gate operating modes and Manual Part 3.3.10, Recommended Instructions for Determining Warning Time and Calculating Minimum Approach Distance for Grade Crossing Warning Systems, to determine exit gate operating times.

7. Advance or simultaneous preemption should be provided by a constant warning time control device. On approaches where restarts occur from trains stopping or switching, preemption requirements should be reviewed, as restarts could result in reduced or no advance time. If constant warning time devices are not suited for a given application, such as electrified territory or approaches where shunting is erratic due to accumulation of rust or foreign material, fixed or non-motion sensing track circuits or alternative means of train detection may be necessary. When fixed track circuits are used, provisions should be made to time out or cancel operation of the warning devices and preemption in the event a train stops within the approach to an interconnected grade crossing for an extended period of time in order to restore normal traffic signal operation.

When preemption is canceled or timed out due to an extended stop, provision should be made to re-initiate preemption and reactivate the warning devices upon resumption of train operations. The re-initiation circuit may utilize a pushbutton, radio restart, train to wayside communications, or other means as may be applicable. A combination of restart circuitry and railroad operating rules may be utilized to ensure that a time interval for both preemption and minimum warning time is provided, before the train reaches the highway crossing.

8. Where station stops occur within or just outside of approaches to grade crossings interconnected with highway traffic signals, a diagnostic review of train operations must be conducted to analyze the effects of acceleration from the station on the required warning time, including any additional clearance time for simultaneous preemption or advance time for preemption as this time could be shortened by the acceleration of the departing train.
This review should be conducted jointly by the highway authority, the railroad and operators of the passenger or commuter rail system (if different from the railroad responsible for design of the signal system). In many cases, a continuous activation or a gate hold down circuit may be necessary if the station stop occurs in close proximity to the interconnected crossing. In other cases, where the distance from the station stop to the interconnected crossing is greater, it may be necessary to implement a remote start system which activates the preemption timing sequence prior to departure from the station.

9. Where an interlocking is located within or just outside of the approach to a grade crossing interconnected with highway traffic signals, a thorough study of train operations must be conducted to analyze the effects of starting a stopped train on the required warning time, including any additional clearance time for simultaneous preemption or advance time for preemption, as this time could be shortened by the motion of the starting train.

10. Where “Island Only” circuits are utilized at grade crossings interconnected with highway traffic signals whenever advance preemption is provided, an additional circuit may be utilized to provide adequate time for advance preemption prior to the time the warning devices are activated. Special instructions or operating rules must be provided to train crews in order to advise of the proper operation of the warning devices.

11. It should be noted that because of the failsafe design criteria of the grade crossing warning control system, any failure would result in a continuous preemption of the traffic signal controller, without a train present, until the problem is diagnosed and equipment repaired.

12. After the train clears the grade crossing, preemption shall be canceled at the time the entrance gates start to raise (crossing circuit energizes) where two quadrant gates are utilized. Where four quadrant gates are utilized, preemption shall be canceled at the time the exit gates start to raise (crossing circuit energizes). This is necessary to permit the traffic signal controller unit to see an interruption in the preemption request in the event another train approaches the grade crossing as the gates are raising.

13. Where advance preemption is utilized at multiple track grade crossings, second train logic shall be provided to prevent gates from rising when advance preemption is requested on another track (crossing circuit energizes, advance preemption circuit remains de-energized).
14. Evaluation of traffic control signal equipment should be made to ensure the ability to return to the start of the preemption sequence or retime the entire track clearance green interval, as appropriate, in the event of a momentary loss of the preemption request, such as the arrival of a second train.

15. Where traffic signals are operated in a flashing mode during the preemption dwell interval (period following track clearance green), consideration should be given to providing an island circuit interconnection in addition to the other interconnection circuits. This will permit the authority responsible for the operation of the traffic signal to delay the entry into the flashing interval until after the train occupies the island circuit.

16. Where advance preemption is utilized, traffic signal health monitoring should be considered to lengthen the railroad warning time in the event the traffic signal is unable to display the track clearance green interval. The warning time may be increased up to the amount of advance preemption time provided, as determined by the diagnostic team.

17. Where grade crossing warning systems are utilized and interconnected with other traffic control devices, backup power should be provided by the public agency. If backup power is furnished, it should be provided for all interconnected devices including traffic signals, advance warning flashers, blank-out signs or other devices.

18. Where more than one railroad controls the operation of a grade crossing warning system and a traffic signal interconnection is provided, a single interconnection point should be provided for the traffic signal controller unless otherwise specified by the agency responsible for the traffic signal.
WARNING!
Highway-Rail Grade Crossing
Warning System and Highway Traffic Signals are Interconnected.

BEFORE MODIFICATION is made to any operation which connects to or controls the timing of an active railroad warning system and/or timing and phasing of a traffic signal the appropriate party(ies) shall be notified and, if necessary, a joint inspection conducted.

U.S. DOT/AAR Crossing Number: ________________________________

1. Highway Agency: ___________________________________________
   Phone Number: _____________________________________________

2. Railroad: _____________________________________________
   Phone Number: _____________________________________________

3. Other: _____________________________________________________
   Phone Number: _____________________________________________

Figure 3110-1: WARNING LABEL (from Appendix E – Implementation Report of the USDOT Grade Crossing Safety Task Force, June 1, 1997, USDOT)