ATTACHMENT NO. 9
Joint RRLRT & Signals #2

National Committee on Uniform Traffic Control Devices

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TECHNICAL COMMITTEE:	**Railroad and Light Rail Transit and Signals Technical Committees**
TOPIC:	**Draft Recommendation - Traffic signal preemption for grade crossings**
STATUS/DATE OF ACTION:	Recommended to send to sponsors as a draft recommendation at the June 2013 National Committee Meeting by the by the Railroad and Light Rail Transit Committee and the Signals Technical Committee
Technical Committee Vote:	RRLRT – Unanimous FOR Signals – Unanimous FOR
Transmitted to Sponsors:	July 2013
Council Approval:	June 28, 2014
ORIGIN OF REQUEST:	RRLRT
AFFECTED SECTIONS OF MUTCD:	**Various definitions and various sections in Part 8**

SUMMARY:

The purpose of these proposed changes is to update the existing MUTCD standards, guidance, and options for traffic signal preemption for grade crossings to incorporate current capabilities, technology, and practice. This includes the addition of provisions for the use of queue cutter signals at grade crossings. It also includes preemption features and operation for specified busways in addition to light rail transit. Additional information regarding BRT and busways will be provided in a new Chapter 8E.

The changes are extensive as preemption for grade crossings has remained largely untouched through previous editions of MUTCD. The state of the practice has changed considerably following the tragic crash between a train and school bus in Illinois in 1995. These changes are considered of highest priority by the RRLRT TC to bring MUTCD into compliance with current practice and to promote consistent design where applicable. In many cases, the proposed changes serve to clarify and guide the successful implementation of preemption and interconnection through additional support information. While the proposed changes are extensive, the need for preemption remains a

Guidance condition. It is the intent of the Technical Committees to allow for site specific engineering to be conducted by a Diagnostic Team. The Diagnostic Team must reach a consensus on the various elements of traffic control devices and their application. The proposed changes support various elements which may be used at a given location and provide Standards, Guidance and Options in order to provide for uniform application of the devices.

DISCUSSION:

The RRLRT Technical Committee initiated work on these changes in 2008 and to date, there have been three requests for comments sent to sponsors. In 2011, the RRLRT Technical Committee presented a previous version of revisions to preemption for grade crossings to the National Committee Council. The item received extensive discussion and was tabled to allow for coordination with the Signals Technical Committee.

This draft recommendation has been developed through a series of conference calls between several STC members and several RRLRT members plus follow-up discussions of the two technical committees at recent National Committee meetings. It represents hundreds of man-hours of work and has been debated in detail by the RRLRT Technical Committee over the last four years.

This draft recommendation includes major changes to what currently exists in Part 8. The amount of new, relocated, and deleted text makes it impractical to use underline and strike through text to show the changes to the current MUTCD language. Therefore, except for changes to existing MUTCD definitions, additions, relocations, and deletions are not color coded or otherwise identified. However, changes to existing definitions are shown with red underline (red underline) for new text and red double strike through (red double strikethrough) for deleted text.

Items sent to Sponsors for review are joint technical committee recommendations that will presented to the National Committee Council for action at the National Committee meeting in June of 2014. This is now a final recommendation at this point. Due to its complexity and since it is being developed jointly by the Railroad and Light Rail Transit Technical Committee and the Signals Technical Committee, sponsors were asked to review and provide comments to assist the technical committees in developing the final recommendation. The two technical committees reviewed the comments received and made changes based on the comments, These recommendations willnow be forwarded to FHWA as a recommended change to the MUTCD as approved by The National Committee Council.

Traffic signal preemption for grade crossings is a complex topic. While most traffic signal operations are governed only by the traffic signal controller unit and associated traffic signal equipment, preemption for grade crossings is also governed by the railroad signal system. Active railroad signal systems include lights and may also include gates. If equipped with gates, the gates may be only on approach lanes or they may be four-quadrant gates covering approach and departure lanes. As with traffic signal controller units, the capabilities of railroad signal systems vary based on the age and sophistication of the equipment.

Since the overall operation of preemption for grade crossings is influenced by separate control systems typically owned and operated by separate agencies, it is important that that specific compliance dates or “trigger points” be specified for various items included in the recommendation. It may be necessary to replace the traffic signal controller unit and related equipment, the railroad signal system control equipment, or both in order to comply with the operation described in this draft recommendation. Therefore, while it is not anticipated that such compliance dates or “trigger points” would be included in the MUTCD text, they should be included in the recommendation to FHWA.

Comments are requested concerning whether or not compliance dates or "trigger points" should be included in the recommendation to FHWA as well as any recommendations on what the compliance dates or "trigger points" should be.

RECOMMENDED CHANGES TO THE MUTCD

CHAPTER 8C. FLASHING-LIGHT SIGNALS, GATES, AND TRAFFIC CONTROL SIGNALS

Section 8C.09 Traffic Control Signals at or Near Highway-Rail Grade Crossings

Standard:

01 **Except as provided in the option below, traffic control signals shall not be used instead of flashing-light signals to control road users at a highway-rail grade crossing.**

Option:

02 Traffic control signals may be used instead of flashing-light signals to control road users at industrial highway-rail grade crossings and other places where the maximum speed of trains is 10 m.p.h. or less.

Standard:

03 **The appropriate provisions of Part 4 relating to traffic control signal design, installation, and operation shall be applicable where traffic control signals are used to control road users instead of flashing-light signals at highway-rail grade crossings.**

Section 8C.10 Preemption of Traffic Control Signals at Grade Crossings

Support:

01 Traffic signal preemption for grade crossings is a complex topic which requires very specific understating of both traffic signals and grade crossing warning systems. While most traffic signal operations are governed only by the traffic signal controller unit and associated traffic signal equipment, preemption for grade crossings is also governed by the railroad warning system. Active railroad warning systems include flashing light signals and may include automatic gates as well as varying types of train detection equipment. When the two systems are interconnected to each other for the purpose of preemption, a third system is created. It is the third system which requires thorough understanding of the design and operating parameters in order to provide proper operation of the preemption system.

02 The Federal Railroad Administration (FRA) has issued two documents which provide additional information relating to preemption of traffic signals near grade crossings. The first document is Technical Bulletin S-12-01, Guidance Regarding the Appropriate Process for theInspection of Highway-Rail Grade Crossing Warning System Pre-emption Interconnections with Highway Traffic Signals The second document is Safety Advisory 2010-02 which addresses Signal Recording Devices for Highway-Rail Grade Crossing Active Warning Systems that are Interconnected with Highway Traffic Signal Systems.

Guidance:

03 *If a grade crossing is equipped with a flashing-light signal system and is located within 200 feet of any traffic control signal or hybrid beacon, the traffic control signal or hybrid beacon should be provided with preemption in accordance with Part 4.*

04 *Coordination with the flashing-light signal system, examples of which may include queue detection, a queue cutter signal, blank-out signs, preemption, or other alternatives should be considered for traffic control signals or hybrid beacons located farther than 200 feet from the highway-rail grade crossing. Factors to be considered should include traffic volumes, highway vehicle mix, highway vehicle and train approach speeds, frequency of trains, presence of midblock driveways or unsignalized intersections, traffic backed up from a nearby downstream*

railroad crossing and the likelihood of vehicular queues extending into the Minimum Track Clearance Distance.

05 *The highway agency or authority with jurisdiction and the regulatory agency with statutory authority, if applicable, should jointly determine the preemption operation and the timing of traffic control signals interconnected with highway-rail grade crossings adjacent to signalized highway intersections.*

06 *If a traffic control signal or hybrid beacon is installed near a grade crossing with passive traffic control devices and traffic is likely to queue onto the tracks, an active grade crossing warning system should be installed at the grade crossing to provide a means to preempt the traffic control signal or hybrid beacon in order to clear vehicles from the Minimum Track Clearance Distance upon approach of a train.*

07 *If a traffic control signal is interconnected with a flashing light signal system, the flashing light signal system should be provided with automatic gates unless a diagnostic team determines otherwise.*

Support:

08 If the Preemption Clearance Interval displays a green to vehicles to clear the MTCD, automatic gates can prevent additional vehicles from being drawn into the MTCD.

Guidance:

09 *The highway agency or authority with jurisdiction, and the regulatory agency with statutory authority, if applicable and the railroad or LRT operator should jointly inspect and verify the preemption operation, the amount of warning time and/or advanced preemption time being provided by the railroad warning system and the timing of traffic control signals interconnected and/or coordinated with flashing-light signals no less than once per year.*

Support:

10 Section 4D.27 includes a recommendation that traffic control signals that are adjacent to highway-rail grade crossings and that are coordinated with the flashing-light signals or that include railroad preemption features be provided with a back-up power supply.

Guidance:

11 *When a backup power supply is installed for a traffic control signal that is interconnected with a grade crossing, the backup power supply should provide for a minimum operating period sufficient to allow the implementation of alternative traffic control measures during a power outage.*

Standard:

12 **Information regarding the type of preemption and any related timing parameters shall be provided to the railroad company so that the railroad company can design the appropriate train detection circuitry.**

13 **If preemption is provided, unless otherwise determined by a diagnostic team, the normal sequence of traffic control signal indications shall be preempted upon the approach of through trains to provide a preemption clearance interval of adequate duration to minimize the likelihood of vehicles not having sufficient time to clear the minimum track clearance distance prior to the arrival of the train.**

14 **Where a flashing light signal system is in place at a grade crossing, any traffic control signal faces or hybrid beacon signal faces installed within 50 feet of any rail shall be**

preempted upon the approach of a train. The signal faces that control movements across the grade crossing shall display RED indications in accordance with Section 4D.27 in order to avoid conflicting indications with the flashing light signal system.

Guidance:

15 *Where a flashing light signal system is in place at a grade crossing, the operation of any flashing yellow beacon installed within 50 feet of any rail should be considered by a Diagnostic Team to determine whether the operation of the beacon should be terminated during the approach and passage of the train.*

Standard:

16 **The preemption special control mode shall be activated by a supervised preemption interconnection using fail-safe design principles between the control circuits of the grade crossing warning system and the traffic signal controller unit. The approach of a train to a grade crossing shall de-energize the interconnection or send a message via a fail-safe data communication protocol, which in turn shall activate the traffic signal controller preemption sequence. This shall establish and maintain the preemption condition during the time the grade crossing warning system is activated, except that when automatic gates are used, the preemption condition shall be terminated at the point the automatic gates are energized to start their upward movement.**

Support:

17 A supervised preemption interconnection is one that incorporates both a normally-open and a normally-closed circuit from the grade crossing warning system to verify the proper operation of the interconnection.

18 An example of a fail-safe data communication protocol for preemption is IEEE 1570.

19 In lieu of supervision, a double-break preemption interconnection circuit which utilizes two normally-closed circuits that open both the source and return energy circuits may be used.

20 A preemption interconnection may incorporate both supervision and double-break circuits.

Guidance:

21 *Where no active devices exist at the grade crossing but train detection circuits are present, the operation of the preemption interconnection should be treated as if active devices exist at the crossing.*

22 *Where no active devices exist at the grade crossing but train detection circuits are present, the preemption operation should be determined by a diagnostic team.*

23 *Where left turns are allowed from the approach that crosses the track and a delayed or impeded left turn movement could prevent vehicles from clearing the track, a protected left turn movement should be provided during the preemption clearance interval if green indications are displayed for track clearance.*

24 *The decision to implement simultaneous or advance preemption should include consideration of the Right-of-Way Transfer Time, Queue Clearance Time and the Separation Time in order to determine the Maximum Preemption Time. These time periods should be compared to and verified with the operation of the grade crossing traffic control devices in order to evaluate the operation of the traffic control signal and the preemption operation. These factors should be considered 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.*

Support:

25 Preemption time variability occurs when the traffic signal controller enters the preemption clearance interval with less than the maximum design Right-of-Way Transfer Time or the speed of a train approaching the grade crossing varies.

26 The time interval between the initiation of advance preemption and operation of the warning system for a train will decrease in the event train speed is increasing.

Guidance:

27 *Where preemption is used and gates are present, an analysis of a gate descending upon vehicles should be conducted.*

28 *If simultaneous preemption is used, an analysis of extended grade crossing warning times should be conducted as this condition is frequently encountered with simultaneous preemption operation.*

29 *If advance preemption is used, an analysis of preemption operation and sequencing should be conducted to identify preemption time variability. The analysis should include the condition requiring the longest period of time to enter the preemption clearance interval and the condition requiring the least amount of time to enter the preemption clearance interval.*

Support:

30 The condition requiring the least amount of time to enter the preemption clearance interval occurs when the currently displayed indications are the same as the preemption clearance interval indications.

Standard:

31 **Where automatic gates are present and the preemption clearance interval displays green indications, the preemption sequence shall be designed such that the green indications are not terminated until the automatic gate(s) that control access over the crossing toward the intersection is/are fully lowered.**

Support:

32 The following are two examples of mutually exclusive methods to resolve preemption time variability:

1. Gate Down – Gate down circuitry is utilized to provide a means to hold the traffic signal controller sequence in the preemption clearance interval until the gate(s) controlling access over the grade crossing approaching the signalized intersection is/are down.
2. Timing Correction – Timing correction is utilized to resolve Preemption Time Variability by adding the Right-of-Way Transfer Time to the preemption clearance interval in the traffic signal controller unit and setting a fixed maximum period of time between the start of advance preemption and the operation of the flashing light signals.

Standard:

33 **Where Gate Down circuitry is used to resolve preemption time variability and a gate is broken or is not fully lowered, the crossing control circuits shall release the preemption clearance interval no earlier than when the train enters the crossing.**

34 **Where Timing Correction is utilized to resolve preemption time variability, a timing circuit shall be employed to maintain a maximum time interval between the initiation of advance preemption and operation of the warning system for a train movement where speed is decreasing.**

Guidance:

35 *When a highway intersection controlled by traffic control signals is interconnected with a grade crossing equipped with exit gates, advance preemption should be used due to the required additional operating time for the exit gates.*

36 *Where trains routinely stop and re-start within or just outside of approaches to grade crossings interconnected with traffic control signals, the effects of train operations on the preemption operation should be considered.*

37 *Traffic signal control equipment should be capable of providing immediate re-service of successive requests for preemption from the railroad warning devices, even if the initial preemption sequence has not completed. As appropriate, the traffic control equipment should be able to promptly return to the start of the preemption clearance interval at any time the demand for preemption is cancelled and then reactivated. The traffic signal control equipment should have the ability to provide this re-service from within any point of the preemption sequence.*

Standard:

38 **Where traffic control signals are programmed to operate in a flashing mode during the preemption dwell interval (period following preemption clearance interval for the duration of the activation of the preemption interconnection), the beginning of flashing mode shall be delayed until the railroad equipment indicates that the train has entered the crossing.**

Support:

39 Section 4C.10 describes the Intersection Near a Grade Crossing signal warrant that is intended for use at a location where the proximity to the intersection of a grade crossing on an intersection approach controlled by a STOP or YIELD sign is the principal reason to consider installing a traffic control signal.

40 Section 4D.27 describes additional considerations regarding preemption of traffic control signals at or near grade crossings.

Standard:

41 **At locations where conflicting preemption calls may be received to serve boats and trains, the Diagnostic Team shall determine which mode shall receive first priority when conflicting preemption calls occur. Where the boat and the train do not conflict, the Diagnostic Team shall determine the preemption sequence when the two preemption calls occur simultaneously. The Coast Guard or other appropriate authority that regulates the operation of the waterway shall be invited to participate on the Diagnostic Team and/or to provide input to the Diagnostic Team.**

Section 8C.11 Movements Prohibited During Preemption

Guidance:

01 *At a signalized intersection where the distance to a grade crossing is 100 feet or less and the intersection traffic control signals are preempted by the approach of a train, all movements from the signalized intersection approaching the grade crossing should be prohibited during the signal preemption sequences.*

Option:

02 All movements toward the track may be prohibited at a signalized intersection that has a clear storage distance of more than 100 feet.

03 A blank-out or changeable message sign and/or appropriate highway traffic signal indication or other similar type sign may be used to prohibit movements toward the grade crossing during preemption. The R3-1 and R3-2 signs shown in Figure 8C-1 may be used for this purpose.

Figure 8C-1 – Example of Blank-out Sign

Option:

04 A supplemental blank-out legend which displays the word "TRAIN" may be included as a part of the blank-out or changeable message sign. A supplemental blank-out legend which displays the symbol for a train or a light-rail transit vehicle may be included as a part of the blank-out or changeable message sign. See Section 2H-1 for train and LRT symbols.

Support:

05 Including the word "TRAIN" or a symbol for a train or light-rail transit vehicle as part of the blank-out or changeable message sign advises road users that the prohibition being displayed by the sign is in effect due to the presence of a train approaching or across a nearby rail grade crossing.

06 Rail operations can include the use of activated blank-out signs for turn prohibitions at grade crossings other than intersections controlled by a traffic control signal. The signs are typically used where a semi-exclusive or mixed-use alignment is within or parallel to the roadway where road users might turn across the tracks.

Guidance:

07 *An LRT-activated blank-out turn prohibition (R3-1a or R3-2a) sign should be used where:*

1. *there is no active warning system for the LRT grade crossing, and*
2. *vehicles travelling along a roadway would typically be permitted to turn left or right across tracks located within 100 feet of an adjacent roadway, and*
3. *the turning drivers are not controlled by a traffic signal.*

Section 8C.12 Pre-Signals at or near Grade Crossings

Guidance:

01 *If a highway-rail grade crossing is in close proximity to a signalized intersection and the clear storage distance is less than the design vehicle length, the use of pre-signals to control traffic approaching the grade crossing should be considered.*

02 *A pre-signal should be provided if a grade crossing equipped with flashing light signals but without automatic gates is within 200 feet of a signalized intersection.*

Option:

03 If used, the pre-signal faces may be located either upstream or downstream from the grade crossing in order to provide the most effective display to road users approaching the crossing.

Standard:

04 **If used, the pre-signals shall display a steady red signal indication during the preemption clearance interval portion of a signal preemption sequence to prohibit additional highway vehicles from entering the Minimum Track Clearance Distance.**

05 **Pre-signal faces shall not display green indications when the grade crossing flashing-light signal system is displaying flashing red indications.**

Guidance:

06 *Visibility-limited signal faces (see definition in Section 1A.13) should be considered at the intersection for the downstream signal faces that control any approach that is equipped with a pre-signal.*

07 *The traffic signal downstream of a pre-signal should be evaluated for measures during normal (non-preempted) signal phasing to prevent the queuing of left-turn vehicles across the Minimum Track Clearance Distance, such as additional left-turn lanes, reduced cycle length, split phasing, a lagging left-turn phase and/or extended green time.*

Option:

08 The duration of the extended green time may be adjusted by vehicle detection located between the pre-signal and the downstream signalized intersection.

09 The pre-signal phase sequencing may be timed with an offset from the downstream signalized intersection where the pre-signal green indication terminates before the downstream signals such that the minimum track clearance distance and the clear storage distance is generally kept clear of stopped highway vehicles.

Support:

10 The storage area for left-turn and right-turn lanes at signalized intersections that are downstream from grade crossings sometimes extend from the signalized intersection back to and across the grade crossing. In such cases, drivers that are in the turn lane are required to make a straight-through movement when they cross the track(s) and then are required to make a turn when they reach the downstream signalized intersection.

Guidance:

11 A separate signal face for the left-turn lane and/or right-turn lane should be provided as a part of the pre-signal in addition to the signal faces provided for the through movement where both of the following conditions are met:

A. The storage area for the turn lane extends from the signalized intersection back to and across the grade crossing,

and

B. The green interval for the turning movement and the downstream intersection does not always begin and end simultaneously with the green interval for the adjacent through movement.

Standard:

12 All of the signal faces at a pre-signal shall be capable of displaying the following signal indications: CIRCULAR RED, CIRCULAR YELLOW, and straight-through GREEN ARROW. Left-turn GREEN ARROW, right-turn GREEN ARROW and CIRCULAR GREEN signal indications shall not be used in signal faces at a pre-signal.

13 If a separate signal face is provided at a pre-signal for a left-turn and/or right-turn lane that extends from the signalized intersection back to and across the grade crossing, the separate signal face shall be devoted exclusively to controlling traffic in the turn land and:

A. Shall be visibility-limited from the adjacent through movement,

or

A. **A LEFT LANE SIGNAL (R10-XX) sign or RIGHT LANE SIGNAL (10-XX) sign shall be mounted adjacent to the separate signal face controlling traffic in a single turn lane or in the turn lane that is farthest from the adjacent through lane(s) in multiple turn lanes are present for a particular turning movement, and a LEFT TURN LANE SIGNAL (R10-XX) sign or RIGHT TURN LANE SIGNAL (10-XX) sign shall be mounted adjacent to the separate signal face controlling traffic in the other turn lanes if multiple turn lanes are present for a particular turning movement.**

Support:

14 The provisions in Section 4D.13 regarding the lateral positioning of separate turn signal faces are applicable to the separate signal faces that are provided at pre-signals for a turn lane that extends from the signalized intersection back to and across the grade crossing.

[NOTE: Revisions will also be made to Paragraphs 11 and 12 in Section 4D.05 to allow the combinations of straight-through GREEN ARROW with CIRCULAR RED and with CIRCULAR YELLOW and CIRCULAR RED with CIRCULAR YELLOW from multiple signal faces at a pre-signal or a queue cutter signal.

Guidance:

15 *If a pre-signal is installed at an interconnected grade crossing near a signalized intersection, a STOP HERE ON RED (R10-6 or R10-6a) sign should be installed at the stop line.*

Option:

16 A "DO NOT STOP ON TRACKS" (R8-8) sign may be installed in conjunction with a pre-signal.

Standard:

17 **If pre-signals are used, a NO TURN ON RED (R10-11, R10-11a, or R10-11b) sign (see Section 2B.54) shall be installed for the approach that crosses the track in the direction of the signalized intersection.**

Option:

18 If traffic control signals must be located within close proximity to the flashing-light signal system, the traffic control signals may be mounted on the same overhead structure as the flashing-light signals.

Section 8C.13<u>Queue Cutter Signals at or near Grade Crossings</u>

Support:

01 A queue cutter signal is a traffic control signal used to reduce the likelihood of vehicles stopping within the Minimum Track Clearance Distance. A queue cutter signal is located at a grade crossing in a manner similar to a pre-signal but is operated independently from a downstream signalized intersection.

Option:

02 Queue cutter signal faces may be located either upstream or downstream from the grade crossing in order to provide the most effective display to road users approaching the crossing.

Standard:

03 All of the signal faces at a queue cutter signal shall be capable of displaying the following signal indications: CIRCULAR RED, CIRCULAR YELLOW, and straight-through GREEN ARROW. Left-turn GREEN ARROW, right-turn GREEN ARROW and CIRCULAR GREEN signal indications shall not be used in signal faces at a queue cutter signal.

Support:

04 While queue cutter signals and queue jumping signals have similar names, their purpose, design, and operation are quite different. Care must be taken to avoid confusion between queue cutter signals used in conjunction with a grade crossing and queue jumping signals used with transit operations.

Guidance:

05 *A STOP HERE ON RED (R10-6) sign should be installed at the stop line in conjunction with a queue cutter signal.*

Option:

06 A "DO NOT STOP ON TRACKS" (R8-8) sign may be installed in conjunction with a queue cutter signal.

07 If queue-cutter signal faces must be located within close proximity to the flashing-light signal system, the highway signal faces may be mounted on the same overhead structure as the flashing-light signals.

08 A queue cutter signals may be operated in one or all of the following modes:

Mode	Operation
Non-Actuated	In non-actuated mode, the queue cutter operates on a time of day plan based on anticipated downstream queues. This mode may replicate the functional operation of a pre-signal.
Actuated	In actuated mode, the queue cutter operation is dependent on downstream detection of a growing queue.
Variable	In variable mode, the queue cutter operation may use both actuated and non-actuated operation based on time of day, queue detection, a combination of the two or other means to limit the queue onto the MTCD

Support:

09 A pre-signal is generally used where the grade crossing is less than 200' from a downstream signalized intersection.

10 A non-actuated queue cutter signal is generally used where the grade crossing is greater than 200' from a downstream signalized intersection.

11 An actuated queue cutter signal is generally used where the grade crossing is greater than 400' from a downstream signalized intersection.

Guidance:

12 *Where a queue cutter signal operates in actuated mode based on vehicle presence detection, the queue detector should be located to provide adequate distance to detect a growing queue, permit the queue cutter signal to complete any programmed minimum green or yellow change time and then allow a design vehicle which lawfully enters during the yellow change interval to clear the minimum track clearance distance before the growing queue extends to the grade crossing.*

13 *A queue cutter signal that is equipped with downstream detection and that is displaying CIRCULAR RED indications should continue to display CIRCULAR RED indications after the downstream signal changes to green as long as the vehicle presence detection system detects a vehicular queue at the detection point on the departure side of the grade crossing.*

14 *Where a queue cutter signal operates in actuated mode based on vehicle presence detection, consideration should be given to the potential for turning movements between the grade crossing and the downstream signalized intersection which could create an intermediate queue of vehicles. Supplemental queue detectors should be considered to detect the formation of these queues to activate the queue cutter signal.*

15 *When a queue cutter signal is operated solely in non-actuated mode based on anticipated queues, consideration should be given to operating the queue cutter in flashing mode when its use in not required.*

16 *When operated on a non-actuated basis, a queue cutter signal should be coordinated with adjacent signals for progressive movement of traffic.*

Option:

17 A queue cutter signal operating in variable mode under non-actuated operation may use the queue detector to extend the duration of the red period until it has been determined that the queue is dissipating.

Standard:

18 A queue cutter signal shall be interconnected with a flashing light signal system.

19 If a queue cutter signal operates in flashing mode during certain times of the day, it shall still change to red whenever a call for preemption is received from the railroad flashing light signal system.

20 **A queue-cutter signal operating in actuated mode shall display a CIRCULAR GREEN indication except when it receives an actuation from the vehicle presence detection system or is preempted by the approach of a train. When it receives an actuation from the vehicle presence detection system, the queue-cutter signal shall finish timing any active minimum green interval if used, then display YELLOW indications during the yellow change interval followed by RED indications in accordance with Section 4D.26.**

21 **When a queue cutter signal is preempted by the approach of a train, it shall display YELLOW indications during the yellow change interval followed by RED indications in accordance with Section 4D.26 unless already displaying RED indications.**

22 **An actuated queue-cutter signal shall include a vehicle presence detection system located between the highway-rail grade crossing and the downstream signalized intersection. When queue lengths extend to the detection zone of the vehicle presence detection system, an actuation shall be sent to the queue-cutter signal.**

23 **When no preemption call is present and the queue length is such that no vehicles are detected in the detection zone of the vehicle presence detection system, the queue-cutter signal shall return the display of green indications.**

24 **The failure modes of the queue cutter signal control system and vehicle presence detection circuitry shall be evaluated and accounted for in the design of any such system. Because the purpose of the queue cutter signal system is to keep road users clear of the Minimum Track Clearance Distance, fail-safe design techniques shall be used in the system design. The vehicle presence detection system shall incorporate health monitoring and self-check operation to validate the proper functioning of the system. If the queue detector fails to properly self-check or the health circuit indicates a fault, the queue cutter signal shall transition to FLASHING RED until the normal functioning of the system can be restored.**

Guidance:

25 *GREEN indications should not be displayed during the operation of the flashing light signals.*

Section 8C.14 Beacons or LED enhanced signs used for Advance Warning at Grade Crossings

Option:

01 Warning beacons or LED enhanced sign may be used to supplement warning signs installed on an approach to grade crossings when additional emphasis is desired for the warning sign (see Section 4L.03). Refer to Section 2A.07 and Section 2A.15J for information regarding LED enhanced signs.

02 If used at or on approach to a grade crossing, a warning beacon or LED enhanced sign may operate continuously or be activated upon approach of a train.

Support:

03 Signs, such as a W10-1 through W10-6 and aW10-8 through W10-15 warn of physical conditions that exist whether or not a train is approaching or present. Therefore, a train activated warning beacon or LED enhanced sign does not provide any additional information about the physical conditions the signs warn about, but instead provides increased emphasis for the sign.

04 Other signs, such as a W3-4 BE PREPARED TO STOP sign, if used in advance of a grade crossing and equipped with a W16-14 WHEN FLASHING plaque, provide information that is typically not applicable except when a train is approaching or present. Likewise, a special word message (See Section 2A.06) TRAIN WHEN FLASHING or other similar message sign provides notice of a condition that does not exist when no train is approaching or present. If these signs are used, consideration must be given to the message displayed to motorists when the warning beacon or LED enhanced sign is not operating.

Standard:

05 If activated by the approach of a train, a warning beacon or LED enhanced sign that is used in conjunction with a sign that includes “when flashing” in either the sign legend or on a supplemental plaque shall be activated by a supervised preemption interconnection using fail-safe design principles between the control circuits of the grade crossing warning system and the warning beacon or LED enhanced sign (See Section 8C.10).

Support:

06 In the event of a system failure, the normal fault state for a train activated warning beacon or LED enhanced sign using a fail-safe interconnection would be for the beacon or LED enhanced sign to operate with no train present.

Option:

07 A warning beacon or LED enhanced sign that is activated by the approach of a train may continue to operate for a period of time following the passage of the train to permit the standing queue to start in motion.

Guidance:

08 *If a warning beacon or LED enhanced sign is activated by the approach of a train, it should begin its flashing operation prior to the beginning of operation of the flashing-light signals at the grade crossing based upon the travel time of a design vehicle between the location of the warning beacon or LED enhanced sign and the grade crossing.*

09 *If a warning beacon or LED enhanced sign is activated by the approach of a train, it should be capable of providing a minimum operating period sufficient to allow the implementation of alternative traffic control measures. A beacon or sign operated by commercial AC power should be provided with a back-up power system.*

Standard:

10 **If a warning beacon or LED enhanced sign is activated to indicate that a train is either approaching or present, one or both of the following shall be used in conjunction with the warning beacon or LED enhanced sign:**

1. **A (W16-13P) WHEN FLASHING plaque**

2. **A WHEN FLASHING message included in the legend of a word message sign.**

Section 8C.15 Traffic Control Signals at or Near Highway-LRT Grade Crossings

Support:

01 There are two types of traffic control signals for controlling vehicular and LRT movements at interfaces of the two modes. The first is the standard traffic control signal described in Part 4, which is the focus of this Section. The other type of signal is referred to as an LRT signal and is discussed in Section 8C.16.

Standard:

02 The provisions of Part 4 and Sections 8C.10, 8C.11, 8C.12 and 8C.13 relating to traffic control signal design, installation, and operation, including interconnection with nearby automatic gates or flashing-light signals, shall be applicable as appropriate where traffic control signals are used at highway-LRT grade crossings.

03 If traffic control signals are in operation at a crossing that is used bypedestrians, bicyclists, and/or other non-motorized road users, an audible device such as a bell shall also beprovided and shall be operated in conjunction with the traffic control signals.

Guidance:

04 *When a highway-LRT grade crossing equipped with a flashing-light signal system is located within 200 feet of an intersection or midblock location controlled by a traffic control signal or a hybrid beacon, the traffic control signal should be provided with preemption in accordance with Sections 4D.27, 8C.10, 8C.11, 8C.12 and 8C.13 .*

05 *Coordination with the flashing-light signal system should be considered for traffic control signals or hybrid beacons located more than 200 feet from the crossing. Factors to be considered should include traffic volumes, highway vehicle mix, highway vehicle and train approach speeds, frequency of trains, presence of midblock driveways or un-signalized intersections, traffic backed up from a nearby downstream railroad crossing and the likelihood of vehicular queues extending into the Minimum Track Clearance Distance.*

06 *If the highway traffic signal has emergency-vehicle preemption capability, it should be coordinated with LRT operation.*

07 *Where LRT operates in a wide median, highway vehicles crossing the tracks and being controlled by both near and far side traffic signal faces should receive a protected left-turn green indication from the far side signal face to clear highway vehicles from the crossing when LRT equipment is approaching the crossing.*

Option:

08 Green indications may be provided during LRT phases for highway vehicle, pedestrian, and bicycle movements that do not conflict with LRT movements.

09 Traffic control signals may be installed in addition to four-quadrant gate systems and automatic gates at a highway-LRT crossing if the crossing occurs within a highway-highway intersection and if the traffic control signals meet the warrants described in Chapter 4C.

10 At a location other than an intersection, when LRT speeds are less than 25 mph, traffic control signals alone may be used to control road users at highway-LRT grade crossings only when justified by a Diagnostic Team.

Typical circumstances may include:

A. Geometric conditions preclude the installation of highway-LRT grade crossing warning devices.
B. LRT vehicles share the same roadway with road users.
C. Traffic control signals already exist.

Support:

11 Section 4D.27 contains information regarding traffic control signals at or near highway-LRT grade crossings that are not equipped with highway-LRT grade crossing warning devices.

12 Section 4C.10 describes the Intersection Near a Grade Crossing signal warrant that is intended for use at a location where the proximity to the intersection of a grade crossing on an intersection approach controlled by a STOP or YIELD sign is the principal reason to consider installing a traffic control signal.

Guidance:

13 *When a highway-LRT grade crossing exists within a signalized intersection, consideration should be given to providing separate turn signal faces (see definition in Section 1A.13) for the movements crossing the tracks.*

Standard:

14 **Separate turn signal faces that are provided for turn movements toward the crossing shall display a steady red indication during the approach and/or passage of LRT traffic.**

Section 8C.16 Use of Traffic Control Signals for Control of LRT Vehicles at Highway-LRT Grade Crossings

Standard:

01 **LRT movements in a semi-exclusive alignments at Highway-LRT grade crossings that are only equipped with traffic control signals shall be controlled by special LRT signal indications.**

Guidance:

02 *LRT traffic control signals that are used to control LRT movements only should display the signal indications illustrated in Figure 8C-3.*

Support:

03 Section 4D.27 contains information about the use of the signal indications shown in Figure 8C-3 for the control of exclusive bus movements at "queue jumper lanes" and for the control of exclusive bus rapid transit movements on semi-exclusive or mixed-use alignments.

Option:

04 Standard traffic control signals may be used instead of LRT traffic control signals to control the movement of LRT vehicles (see Section 8C.15).

Standard:

05 **If a separate set of standard traffic control signal indications (red, yellow, and green circular and arrow indications) or red, yellow or green transit signals are used to control LRT movements, the indications shall be positioned so they are not visible to motorists, pedestrians, and bicyclists (see Section 4D.12).**

06 **If the LRT crossing control is separate from the intersection control, the two shall be interconnected in accordance with Section 8C.10. The LRT signal phase shall not be terminated until after the LRT vehicle has cleared the crossing.**

Option:

07 LRT signals may be used at grade crossings and at intersections in mixed-use alignments in conjunction with standard traffic control signals where special LRT signal phases are used to accommodate turning LRT vehicles or where additional LRT clearance time is desirable.

Guidance:

08 LRT signal faces should be separated vertically or horizontally from the nearest highway traffic signal face for the same approach by at least 3 feet.

Section 8C.17 Grade Crossings Within or In Close Proximity to Circular Intersections

Support:

01 At circular intersections, such as roundabouts and traffic circles, that include or are within close proximity to a grade crossing, a queue of vehicular traffic could cause highway vehicles to stop on the grade crossing.

Standard:

02 **Where circular intersections include or are within 200 feet of a grade crossing, an engineering study shall be made to determine if queuing could impact the grade crossing. If traffic queues impact the grade crossing, provisions shall be made to clear highway traffic from the grade crossing prior to the arrival of rail traffic.**

Support:

03 Among the actions that can be taken to keep the grade crossing clear of traffic or to clear traffic from the grade crossing prior to the arrival of rail traffic are the following:

A. Elimination of the circular intersection,
B. Geometric design revisions,
C. Grade crossing regulatory and warning devices,
D. Highway traffic signals,
E. Traffic metering devices,
F. Activated signs, or
G. A combination of these or other actions.

Section 8C.18 Pedestrian and Bicycle Signals and Crossings at LRT Grade Crossings

Support:

01 See Chapter 8D for information regarding traffic control devices at Pathway grade crossings and at Sidewalk grade crossings

Standard:

02 **Pedestrian signals as described in Chapter 4E utilizing Upraised Hand and Walking Person symbols shall not be used at a pathway or sidewalk LRT grade crossing except as provided in the following option**.

Option:

03 A pedestrian signal may be used at a pathway or sidewalk LRT grade crossing where the movement of LRT vehicles is controlled by a traffic control signal.