4-2-1 Restricted Locations June 2004

GENERAL

When justified by a traffic engineering study, traffic control signals provide benefits to intersection traffic operations and *may* provide some types of safety improvements as well. While certain benefits can be realized, there *may* be potential trade-offs caused by the installation of traffic control signals including increased delay and reduced mobility on the major approaches, as well as an increase of rear-end type crashes at an intersection.

POLICY

Traffic control signals at isolated, single-source, private access points **shall not** be allowed on the STH system for the following reasons:

1. Signals at isolated, private access points disregard the public interest and investment in STH highway facilities.
2. Private access points are limited to a width of 35 feet (per Trans 231). This width *may* not be great enough to accommodate the geometry required for adequate signalized intersection operations.
3. Signal infrastructure (i.e. detection, signal bases, pull boxes, conduit) *may* need to be installed outside of the public right-of-way.

In lieu of installing traffic signals on the STH system at private access points, other alternatives *may* include:

1. Development of adjacent local street systems to concentrate traffic from other generators and/or direct traffic to intersections that are already controlled by traffic signals or roundabouts
2. Implementation of access restrictions (i.e. right-in/right-out or median modifications), or
3. Use of standard side-street stop control.

Private access point intersections that are aligned with public street connections are not the focus of this policy and are generally not considered to be in conflict with the points made above. However in these cases, it is desirable to locate signal infrastructure within public right-of-way.

The limited number of traffic control signals installed at private access points on the STH system prior to the adoption of this policy will continue to be operated by WisDOT until they are removed, replaced by other forms of intersection traffic control, or jurisdictionally transferred to local government agencies.

SUPPORT

In addition to a traffic engineering study that is performed to justify signal installations at a specific location, other factors *should* be considered. System and access issues also need to be considered when deciding whether signals are appropriate. Examples of these issues are indicated below:

1. Type of facility being proposed for signalization (i.e. it is generally not desirable to signalize expressways or high-speed bypasses around communities)
2. Signal spacing for progressive traffic flow along a corridor
3. Treatment of consolidated access points
4. Connectivity of the access point to the local roads network
5. Relative safety implications
6. Signal maintenance and operation implications.

Other guidance in this topic area *may* be found in the Traffic Impact Analysis (TIA) Guidelines Manual, Highway Access Management Reference Guide, Administrative Rules Trans 233 and Trans 231, State Highway Maintenance Manual Chapter 91, Facilities Development Manual Chapters 7 and 11, TRB Access Management Manual, and NCHRP Report 348 Access management Guidelines for Activity Centers.

If signals are to be installed at public street connections that are aligned with private access points, from a

systems perspective, it *may* be desirable to have a portion or all of the private drive dedicated as a public street. There are several reasons for this:

- Provides system consistency for connectivity to local network
- Allows for access control on the subject approach, near the signalized intersection
- Signal infrastructure placement and signal maintenance considerations
- Will allow for greater control of features that *may* reduce sight distance (such as on-premise signing or landscaping)
- *May* provide greater design flexibility for intersection capacity.

When driveways are dedicated as public streets to meet the objectives of effective access and signal systems management, local agreements that are designed to cover or share the additional operations and maintenance costs for the additional infrastructure, *should* be considered.

4-2-4 Flashing Operations May 2011

GENERAL

Reference is made to the MUTCD, Secitons 4D.28, 4D.29, 4D.30, and 4D.31, and Wisconsin State Statute 346.37, 346.39, and 346.40.

There are four types of flashing operations for traffic control signals: start-up flash, emergency flash, program flash, and manual override flash. Each of these conditions are described briefly below:

1. New signal start-up flash operation is used to acclimate motorists to the revised form of intersection traffic control at a given location prior to initiating steady stop-and-go mode operation.
2. Emergency flash operation *may* be caused by controller malfunction, utility service disruption, or physical damage to the installation (such as a pole knock-down).
3. Program (time-of-day) flash operation is generally limited to use at pre-timed signal installations where no actuation exists to detect vehicles and provide variable green time based on actual approach demand. This type of flash operation is used during off-peak hours (for example, from 10 PM to 6 AM) to reduce intersection delay at pre-timed signals.
4. Manual override flash operation *may* be used by law enforcement officers that assume intersection traffic control associated with special events or incidents.

In addition to flash operation, two flash modes are used: red-red or yellow-red flash.

POLICY

New Signal Installation Start-Up Flash Operation

At newly installed signals that have just become operational, consideration *should* be given to using flash-mode operations if the intersection was open to traffic during construction. This is used to acclimate motorists to the revised form of intersection traffic control at a given location prior to initiating steady stop-and-go mode operation.

Engineering judgment **shall** be used to determine the need for and duration of flash-mode operations. Consideration *should* also be given to the location of the signal and type of motorists that use the route. For example, along a commuter route, new signals *may* be flashed for a length of time between Monday and Friday. Similarly, new signals along a tourist route can be flashed during a weekend period.

Start-up flash for new signals *should* reflect the prior intersection traffic control condition. That is, if a signal is installed to replace a two-way STOP condition, a yellow-red flash mode *may* be used. If a signal is installed to replace an all-way STOP condition, a red-red flash mode *may* be used.

Program (Time-of-Day) Flash Operation

Pre-timed signals on the STH system *may* use program (time-of-day) flash operations but *should* be scheduled for upgrade to semi-actuation, at a minimum. Traffic signals on the STH system that are fully or semi-actuated **shall not** use program (time-of-day) flash operations. Actuated signals can detect and respond to actual demand on conflicting approaches; efficiencies gained by this type of operation at a pre-timed signal do not necessarily exist at an actuated signal. In addition, the transition out of flash operation to steady stop-and-go operations *may* be a time of potential confusion to motorists.

Traffic signals on the STH system that are interconnected with rail-grade crossing systems **shall not** use

program (time-of-day) flash operations.

Emergency Flash Operation & Manual Override Flash Operation

Regardless of whether program flash operation is used at a particular installation, the flash mode must be determined for emergency and manual override situations. The bullet points below discuss these two modes:

1. Red-red (R-R) flash mode is prescribed for most signalized intersections, as this mode tends to reflect motorist expectancy. On multilane highways, this type of operation will benefit motorists on the side road since clearance distances can be large.
2. Yellow-red (Y-R) flash mode *may* be appropriate at signals where overall intersection volumes are relatively light and the proportions of mainline volumes significantly exceed those on the side road. This rule of thumb reflects a consideration for intersection delay and maintaining priority based on route significance. However, driver expectancy may be violated causing drivers to unnecessarily stop on yellow, thereby creating a potential safety hazard for other drivers and negating the potential delay reduction.

Even if an isolated intersection meets the broad volume criteria above for yellow-red flash mode, other signalized intersections along a corridor *may* dictate the type of flash mode that *should* be used. For example, if adjacent signalized intersections use a red-red flash mode, driver expectancy *may* determine that any additional signals in the immediate area operate in the same manner; regardless of this generalized volume criteria.

SUPPORT

Whether a signal is operating in steady stop-and-go mode, R-R or Y-R flashing mode, or non-operable (dark) mode, driver expectancy *should* be considered. Careful engineering judgment *should* be used to balance the needs of safety, efficiency and motorist expectancy.

4-2-5 Vehicle Clearance Intervals — May 2006

GENERAL

Reference is made to the MUTCD Section 4D.10.

According to State Statute 346.37(1)(b), “When shown with or following the green, traffic facing a yellow signal **shall** stop before entering the intersection unless so close to it that a stop *may not* be made in safety.”

The purpose of the YELLOW vehicle clearance interval is to inform drivers of an impending change in right-of-way assignment. Yellow clearance intervals are normally three to six seconds in duration.

The purpose of the ALL-RED clearance interval is to allow vehicles to travel through an intersection that have lawfully entered during the yellow clearance interval. It *may* also provide a brief period of separation time between opposing movements. All-red clearance intervals normally do not exceed three seconds in duration.

POLICY

By the WisMUTCD, all traffic signal installations **shall** display a yellow indication following every green interval. In addition, by this policy, state-owned signal installations **shall** operate with an all-red clearance interval for mainline and side street intersection through-vehicle movements. All-red clearance intervals *may* be used for other intersection movements, such as protected left turns.

Fundamentally, there are three ways that yellow and all-red clearance intervals are developed: timing derived by kinematic principles, uniform timing, and rule of thumb. As a statewide organization, WisDOT routinely operates signals adjacent to various jurisdictions that *may* have differing perspectives about signal timing methodology. In the interest of providing uniform conditions to the extent possible, all methods are considered acceptable but *may* have greater applicability in certain situations or within specific areas of the state.

Kinematic Method

Develops a clearance interval duration based on driver behavior and physical principles. Clearance interval timing based on this method can be calculated for each intersection movement by using the following formula:

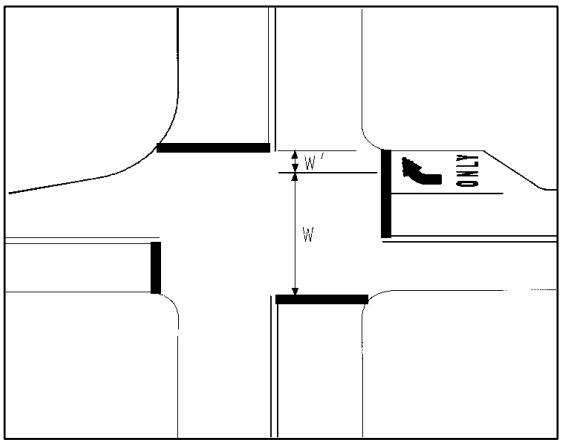
$$CT = prt + \frac{v}{2a+2Gg} + \frac{L+w}{v}$$

$$= \text{yellow portion} + \text{all-red portion}$$

Where:

CT = clearance time (*may* be rounded up to nearest 0.5 second)
prt = driver perception-reaction time (usually 1.0 second)
v = vehicle approach speed (feet per second, vehicle approach speed *should* be based on the posted speed, or the 85-percentile speed if data is available)
a = average vehicle deceleration rate (usually 10 to 15 feet per second^2, 10 to 12 fps^2 recommended)
g = acceleration due to gravity (32 fps^2)
G = approach grade (expressed as decimal)
L = vehicle length (usually 20 feet)
w = intersection width (measured in feet from the near-side stop bar, see "w" diagram below)

Figure 1. Recommended Intersection Width ("w") Determination



Intersection width measured from approach stop bar to center of conflicting vehicle lane on the far side of the intersection. Width *may* also include distance from center of far lane to the outside edge of the traveled way (w + w^l).

When used, variables within the formula above *may* need to be adjusted for various applications and for different intersection movements. For example, in the case of left-turns, driver perception-reaction times *may* be shorter and/or vehicle approach speeds lower.

As stated above, the upper limit of the yellow and all-red clearance intervals are typically 6 and 3 seconds, respectively. Longer clearance interval times *may* breed driver noncompliance that can actually degrade intersection safety benefits. Excessively long clearance interval times will also reduce the efficiency of signal operations. The lower limit of the yellow clearance interval is typically 3 seconds.

For isolated state-owned signals that can be considered outside the influence of established timing practices of adjacent jurisdictions (for purposes of driver expectancy), it is desirable to use the kinematic method of determining vehicle clearance intervals.

For given approach speeds and gradients, the table below indicates YELLOW CLEARANCE INTERVALS calculated by the equation above (considering a lower deceleration rate of 10 fps^2).

Table 1. Yellow Clearance Intervals at Deceleration Rate of 10 fps^2

Approach	Approach Grade								
Speed (mph)	+4%	+3%	+2%	+1%	0%	-1%	-2%	-3%	-4%
25	2.6	2.7	2.7	2.8	2.8	2.9	3.0	3.0	3.1
30	3.0	3.0	3.1	3.1	3.2	3.3	3.4	3.4	3.5
35	3.3	3.3	3.4	3.5	3.6	3.7	3.7	3.8	4.0
40	3.6	3.7	3.8	3.8	3.9	4.0	4.1	4.3	4.4
45	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.7	4.8
50	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.1	5.2
55	4.6	4.7	4.8	4.9	5.0	5.2	5.3	5.5	5.6
60	4.9	5.0	5.1	5.3	5.4	5.6	5.7	5.9	6.1
65	5.2	5.4	5.5	5.6	5.8	5.9	6.1	6.3	6.5

Gray-shaded values fall outside typical time intervals indicated. Use only as

needed and at the direction of the regional traffic engineer.

For given approach speeds and gradients, the table below indicates YELLOW CLEARANCE INTERVALS calculated by the equation above (considering a higher deceleration rate of 15 fps^2)

Table 2. Yellow Clearance Intervals at Deceleration Rate of 15 fps^2

Approach Speed (mph)	Approach Grade								
	+4%	+3%	+2%	+1%	0%	-1%	-2%	-3%	-4%
25	2.1	2.2	2.2	2.2	2.2	2.3	2.3	2.3	2.3
30	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.6	2.6
35	2.6	2.6	2.6	2.7	2.7	2.8	2.8	2.8	2.9
40	2.8	2.8	2.9	2.9	3.0	3.0	3.0	3.1	3.1
45	3.0	3.1	3.1	3.2	3.2	3.3	3.3	3.4	3.4
50	3.3	3.3	3.3	3.4	3.5	3.5	3.6	3.6	3.7
55	3.5	3.5	3.6	3.6	3.7	3.8	3.8	3.9	3.9
60	3.7	3.8	3.8	3.9	3.9	4.0	4.1	4.1	4.2
65	3.9	4.0	4.1	4.1	4.2	4.3	4.3	4.4	4.5

Grey-shaded values fall outside typical time intervals indicated. Use only as needed and at the direction of the regional traffic engineer.

For given intersection widths and approach speeds, the table below indicates ALL-RED CLEARANCE INTERVALS calculated by the equation above.

Table 3. All-Red Clearance Intervals

Approach Speed (mph)	Intersection Width (ft)								
	24	36	48	60	72	84	96	108	120
25	1.2	1.5	1.9	2.2	2.5	2.8	3.2	3.5	3.8
30	1.0	1.3	1.5	1.8	2.1	2.4	2.6	2.9	3.2
35	0.9	1.1	1.3	1.6	1.8	2.0	2.3	2.5	2.7
40	0.7	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
45	0.7	0.8	1.0	1.2	1.4	1.6	1.8	1.9	2.1
50	0.6	0.8	0.9	1.1	1.3	1.4	1.6	1.7	1.9
55	0.5	0.7	0.8	1.0	1.1	1.3	1.4	1.6	1.7
60	0.5	0.6	0.8	0.9	1.0	1.2	1.3	1.5	1.6
65	0.5	0.6	0.7	0.8	1.0	1.1	1.2	1.3	1.5

Gray-shaded values fall outside typical time intervals indicated. Use only as needed and at the discretion of the region traffic engineer.

Uniform Timing

Assigns a standardized duration for the clearance interval regardless of location. In this case, times *may* be based on the type of movement being made. For example, based on higher vehicle speeds, a through movement on a mainline approach *may* have a longer yellow clearance time then for a side street through movement or for a protected left-turn.

This method *may* be used when a state-owned signal is located in close proximity to signals operated in this manner by another jurisdiction. The purpose being, to address driver expectancy issues. However, assigning a single clearance interval value for all intersections and intersection movements is not recommended.

Rule of Thumb

Assigns a standardized duration for the clearance interval based on vehicle approach speed, the type of movement being made, or roadway classification. For example, mainline and side street movements *may* have the following yellow clearance interval durations:

Approach speed <30 mph = 3 seconds
Approach speed between 30-50 mph = 4 seconds
Approach speed >50 mph = 5 seconds
Protected left turns = 3 seconds

The interval times are for demonstrative purposes only. Similarly, though, all-red clearance times *may* be

categorized.

This method *should* typically be used when a state-owned signal is located in close proximity to signals operated by another jurisdiction using this method to address driver expectancy issues.

SUPPORT

Even nationally, there is no clear consensus on appropriate methodology for determining vehicle clearance times ("Determining Vehicle Signal Change and Clearance Intervals", ITE, August 1994). According to ITE, "Divergent and strongly held positions are common when vehicle signal change interval lengths are discussed. Some believe that a common interval length is best, while others believe that uniform yellow change interval lengths are wrong….". This finding was verified more recently in an ITE document titled *Signal Timing Practices and Procedures – State of Practice* dated March 2004.

The kinematic methodology is typically the most desirable unless driver expectancy would be better served through the use of the other principals described above.

As stated above, since WisDOT signals routinely operate near locally owned installations, the intent *should* be uniformity across an appropriate area or along a specific corridor. As such, proper coordination with other jurisdictions *should* take place. If a crash or red light running problem exists, vehicle clearance intervals *should* be verified and, if needed, reasonably extended.

4-2-8 Battery Backup Systems May 2006

GENERAL

The recent application of LED traffic signal indications, which consume less power than conventional incandescent lamps, has made battery-powered energy backup systems feasible. However, it is recognized that, because of the cost of such systems, that gradual deployment at strategic signalized intersection locations is appropriate.

Factors that *may* influence the placement of battery backup systems are: proximity of other transportation systems, intersection geometry, traffic volumes, corridor (i.e. progressive movement) considerations, or safety considerations.

POLICY

Location Criteria

Signalized intersection locations that meet the criteria below **shall** be equipped with a battery backup system capable of maintaining signal operation, as defined and prioritized below:

1. RR interconnected installations, or
2. Single point urban interchanges, or
3. Intersections with triple-left turn lanes.

Signalized operations *should not* need to be modified in order to reduce energy requirements or extend service time. Rather than introducing modified signal operations or displays, signals that function with battery backup systems with low power reserves *may* go into flashing operation.

Intersections and roadway lighting **shall not** be connected to battery backup systems.

SUPPORT

Battery backup systems are expected to maintain safe and efficient traffic operations at critical signalized intersections during power outages. Of particular concern are intersections that are near railroad grade crossings (for preemption) and geometrically complex intersections.

Besides providing potential benefits to traffic safety and operations, the use of battery backup systems *may* allow increased response times by electrical personnel, which could provide an advantage in light of increased signal infrastructure and associated maintenance demands.

4-2-20 Emergency Vehicle Preemption February 2013

GENERAL

The following applies to the installation and operation of emergency vehicle preemption (EVP) systems involving traffic control signals owned and operated by the department.

POLICY

Statutory Provisions

347.255 Auxiliary lamps on emergency vehicles used to actiate traffic control signal preemption devices. (1) An authorized emergency vehicle described in ss.340.01 (3)(a), (c), (g) or (l) *may* be equipped and operated with lamps designed and used solely to activate official traffic control signal pre-emption devices. (2) The lamps authorized for use under this section *may* be any color and *may* be flashing, oscillating, rotating or pulsating. (3) No operator of an authorized emergency vehicle *may* use such lamps except when responding to an emergency call, when pursuing an actual or suspected violator of the law or when responding to, but not when returning from, a fire alarm.

The above does not preclude actuation by means of devices other than lamps.

Eligibility

Any local government unit, agency, or organization having responsibility for providing emergency services is eligible to request an EVP system.

Request Procedure

The local unit **shall** make the request in writing to the department. The following information *should* be included in the request:

1. Location of proposed EVP systems
2. Location of emergency facilities (fire station, police station, etc.) where vehicles will be departing from and description of the route to be provided with a preemption system
3. Listing or estimate of number of vehicles to be outfitted
4. Brand/model of equipment being requested.

Approval

1. The department **shall** review each request and respond in writing to the local unit as to the approval or denial of the request.
2. The department *may* deny any request that it deems would have an overall negative impact on the traveling public.
3. If the local agency is requesting a brand/model of EVP other than the department standard, the request must include a discussion about compatibility with neighboring agencies along the same corridor.
4. For approved requests, an official EVP System Agreement **shall** be prepared and approved by the department and the local unit. Template is included at the end of this policy. This policy **shall** be included as a supplement to the agreement. Any special terms or conditions beyond the scope of this policy **shall** be included as a supplement to the agreement. Any special terms or conditions beyond the scope of this policy **shall** be stipulated in the agreement.
5. The department *may* allow an indicator light that is intended to confirm o the driver of an emergency vehicle that the preemption signal has been received. The use of this device does not preclude the need of the vehicle operator to rely on the signal indications for assigned intersection right-of-way. Requests for EVP confirmation lights *should* be reviewed on a case-by-case basis, and are subject to the following conditions:
    a. The department *may* deny any request for confirmation lights that it deems would have an overall negative impact on traffic safety or operations.
    b. EVP confirmation lights **shall** only be installed at signalized intersections where:
        i. Signal(s) on the STH system are embedded in a locally-owned system that is also equipped with confirmation lights. This implies consideration for route continuity.
        ii. Or, multiple emergency vehicles have the potential to respond on conflicting

approaches to and from different points of origin. These conditions will typically exist in large urban areas where there are multiple precincts in the same municipality.

6. EVP equipment that has the ability to discriminate between individual responding vehicles **shall not** be used.
7. In the event that it comes to the attention of the department that the preemption is being misused, such as by unauthorized vehicles, or that the municipality is not using or intends to abandon the system, the department *may* notify the municipality of the situation. If the matter is not resolved and corrected, the department reserves the right to set about removing the equipment. The scheduled date of removal of the equipment is indicated in item 5 below.

Installation & Maintenance

1. Department forces **shall** perform the installation, maintenance, modification, or removal of the EVP system equipment that is located at the traffic signal. Generally, this equipment would include the receiving device (mounted on the mast arm or signal head), the phase selector (in the control cabinet), confirmation light, and any miscellaneous cables and wiring needed to operate and power the portion of the EVP system located at the signal.
2. The local unit will be responsible for the installation of the emitting devices in authorized vehicles.
3. The department **shall** maintain a reasonable inventory of spare parts for the department's selected standard equipment in order to service the EVP system equipment located t the traffic signal. If the local agency is requesting equipment other than the standard equipment, the local agency **shall** be responsible for maintaining and providing a reasonable inventory. Specify which in the agreement.
4. When notified, department forces will respond to correct suspected failures or breakdowns, or perform requested modifications in the EVP system equipment at the traffic signal.
5. Upon the department's request, the local unit will be responsible for verifying the working status of the EVP system by performing a field test using an emergency vehicle equipped with an EVP emitter device. The local unit is responsible for periodically checking the EVP equipment.
6. If used, the syle and type of confirmation lights on state- and locally-owned signals within each municipality **shall** be standardized. Confirmation lights **shall** be a LED 120 VAC white directional light that fits into a PAR 38 socket.
7. In the event of a construction project, EVP service **shall** be maintained at any intersection with permanent EVP agreements. In addition, EVP equipment may be installed, if requested by a local unit, at any additional signals within the construction project itself, or on a designated detour route in the event of a road closure.

Operation/Phase Timing

1. The department **shall** determine the phasing and timing of the preemption sequencing with input from the local unit. There are three key features that must be considered when determining how the preemption will operate:
    a. Left turn phasing (protected, protected/permissive, or permissive only)
    b. Signal head configuration for left-turning movement (shared vs. exclusive head)
        i. Shared heads: include both circular indications and arrow indications (used by through and turning vehicles)
        ii. Exclusive heads: arrow indications only (used solely by turning vehicles)
    c. Style of preemption sequencing (common greens vs. exclusive greens)
        i. Common greens: indicates opposing through phases both have a green ball. The corresponding left turn phases are permissive only.
        ii. Exclusive greens: indicates only one through movement and its corresponding left turn phase have the green ball/arrow.
2. The department offers the following operational guidance based upon the combination of those three key features identified above:
    a. Protected only left turns

i. Exclusive head **shall** operate with exclusive greens for the safety and ease of turning of the preempting vehicle

b. Permissive only left turns

i. Shared head

1. Common greens *may* be used

2. Exclusive greens *may* be used if an all-red period is introduced or a W25-2 sign is installed.

ii. Exclusive head:

1. **Shall** operate with common greens since a green left turn arrow is not available for use with exclusive greens

c. Protective/permissive left turns

i. Shared head

1. Common greens: *may* be used

2. Exclusive greens *may* be used if an all-red period is introduced or a W25-2 sign is installed

ii. Exclusive head

1. Common greens *may* be used

2. Exclusive greens *may* be used

3. Any exceptions to the guidance in item 2 above **shall** be included as part of the special terms or conditions of the agreement.

4. If used, the operation of confirmation lights on state- and locally-owned signals **shall** be standardized such that the approach being preempted has a steady indication. Approaches with secondary calls **shall** flash. The flash rate **shall not** be between 5 and 30 flashes per second to avoid frequencies that might cause seizures.

Driver Training

1. The local unit **shall** be responsible for training the emergency services personnel on the proper operation of the system.

2. This training *should* provide clear understanding of these items:

a. The definition of an authorized emergency vehicle at the beginning of this policy

b. The conditions when preemption *may* be used

c. The use of preemption does not remove the responsibility of the vehicle operator from determining whether or not it is safe to enter the intersection

d. The operator cannot assume that the preemption has gone into effect; the operator must rely on the traffic signal indication

e. The proper operation of the activating device located on the vehicle.

Cost

1. The most common source of funding for a complete EVP system has been local funds or federal urban funds. However, EVP equipment at the traffic signal and installation may also be funded as part of an improvement project, provided it is incidental to the improvement. Please see Program Management Manual 3-25-5 to determine the most appropriate source of funding.

2. The local municipality **shall** be responsible for all costs associated with the emitting devices for is authorized vehicles.

3. The department **shall** be responsible for all material, equipment, labor, training, and incidental costs associated with maintaining, operating, modifying, or removing the EVP system at the traffic signal unless nonstandard EVP system equipment is used. When nonstandard equipment is installed, the local unit **shall** be responsible for maintaining and supplying spare inventory to the department.

4. Any cost associated with the continuance of service of an EVP system on temporary signals or aon a temporary route during a construction project **shall** be borne by the project.

WISCONSIN DEPARTMENT OF TRANSPORTATION

Emergency Vehicle Pre-emption (EVP) System Agreement

This is a binding agreement between the Wisconsin Department of Transportation and the

_____

This agreement stipulates the terms and conditions for use of Emergency Vehicle Pre-Emption (EVP) systems at the state-owned traffic control signal located at the intersection of

_____

in the _____ of _____

Description of route: _____

_____

Listing of estimated number of vehicles to be outfitted: _____

_____

Inventory of spare EVP equipment shall be provided by WisDOT/Local Agency.

The Department's Policy for *Use of Emergency Vehicle Pre-emption (EVP) Systems at State-Owned Traffic Control Signals is hereby* made a part of this agreement (copy attached). The following special terms or conditions also apply to this agreement:

ACCEPTED FOR THE _____
Local Government

BY _____ DATE _____

TITLE _____

APPROVED BY THE WISCONSIN DEPARTMENT OF TRANSPORTATION

BY _____ DATE _____

TITLE _____

4-2-34 Preemption of Traffic Signals Near Railroad Grade Crossings October 2023

GENERAL

Reference is made to the WisMUTCD, Section 4D.27 and Section 8C.09.

POLICY

When to Preempt

Preemption *should* be provided for traffic signals within 200 feet of a grade crossing and *should* be considered for traffic signals more than 200 feet from a crossing. The determination on when to preempt any traffic signal located near a railroad grade crossing *should* be made based upon the likelihood of a queue extending across the tracks or through the intersection. Traffic engineering calculations, traffic simulation modeling, and field observations may be used to determine the queuing probability.

For all new traffic signals installed within at least 200 feet of a grade crossing, the signal investigation study (TSDM 2-1-1) **shall** include an analysis of the queueing between the signalized intersection and the grade crossing and provide a recommendation regarding railroad preemption. This recommendation **shall** be sent to the Railroads and Harbors Section for final determination.

For an existing traffic signal located within at least 200 feet of a grade crossing, a queueing analysis and/or

review of the adequacy of the existing preemption, when appropriate, **shall** be performed as part of project scoping. The region **shall** send their analysis and recommendations to the Railroads and Harbors Section for final determination.

Preemption Timing

According to WisMUTCD Section 8C.09, if preemption is provided, the normal sequence of traffic control signal indications **shall** be preempted upon the approach of trains to avoid entrapment of highway vehicles on the highway-rail grade crossing.

Once it is determined that preemption is needed, WisDOT's Guide for Determining Time Requirements for Traffic Signal Preemption at Highway-Rail Grade Crossings form (Figure 1) **shall** be completed and **shall** be included as an attachment to the railroad project submittal package (RPSP) (see FDM 17-20-10).

Section 2 of WisDOT's Guide for Determining Time Requirements for Traffic Signal Preemption at Highway-Rail Grade Crossings covers Right-of-Way Transfer Time Calculations.

Right-of-Way Transfer Time

Right-of-way transfer time is the maximum amount of time needed prior to display of the preemption clearance interval. The amount of right-of-way transfer time required for any intersection can be reduced by utilizing different minimum green, walk and don't walk times during the transition to the track clearance phase. These values are programmed in the controller for use only during a railroad preemption.

Minimum green times *should* be at least five seconds to allow drivers time to perceive and react to green light and begin to move before the traffic signal turns yellow.

According to WisMUTCD Section 4D.27, during the transition into preempted control, the preemption sequence **shall not** shorten or omit the yellow change interval and any red clearance interval that follows.

Additionally, according to WisMUTCD Section 4D.27, pedestrian WALK and/or pedestrian change intervals *may* be shortened or omitted in order to begin the track clearance interval earlier. Omitting the WALK interval is standard practice, however omitting the pedestrian change interval (FLASHING DON'T WALK) is not recommended, and only done in rare, short-term circumstances. To reduce the right-of-way transfer time, FLASHING DON'T WALK may be reduced to a value equal to the crossing distance from face of curb to face of curb divided by a walking speed of 4 feet per second (fps).

Second Train Re-Service Considerations

Where a railroad crossing has more than one through track, special consideration must be given to operation of the warning devices and traffic signal when a second train follows the first train.

Preemption Circuitry

For all state-owned traffic signals operating with railroad preemption, the preemption circuitry **shall** be designed to, at a minimum, include a supervisory and gate down circuit in addition to the advance or simultaneous preemption. Additional circuits such as advanced pedestrian preemption and traffic signal health circuits may be used based on a case-by-case basis.

Joint Annual Railroad Preemption Inspection

Traffic signals with railroad preemption sequencing **shall** be inspected on an annual basis. Regional traffic engineers are responsible for ensuring that each state-maintained traffic signal is inspected.

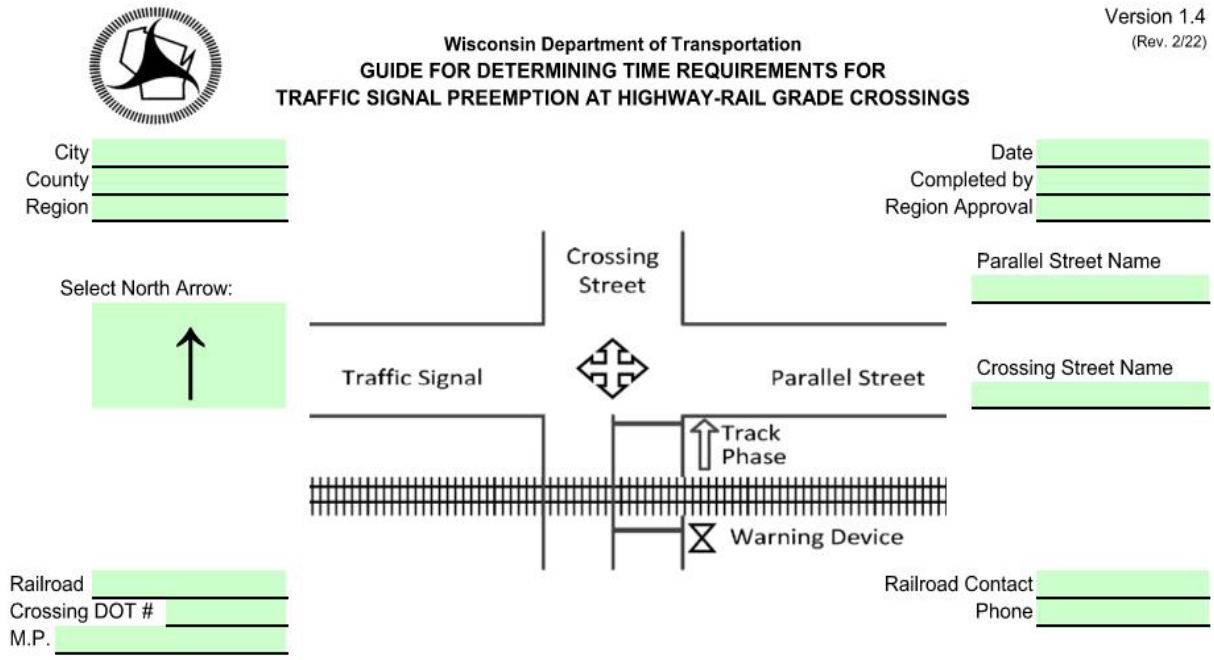
At a minimum, the preemption inspection team *should* consist of an individual representing the traffic signal operating agency and an individual representing the railroad authority. This cooperative approach is critical to the success of the inspection because the operation of railroad preemption systems is dependent on both the railroad and highway equipment.

A copy of the completed WisDOT Railroad Preemption Inspection Form (Figure 2) **shall** be filed with the Office of the Commissioner of Railroads in their Joint Inspection Report portal.

SUPPORT

Additional guidance on the subject can be found in *Preemption of Traffic Signals Near Railroad Grade Crossings 2nd Edition – A Recommended Practice of the Institute of Transportation Engineers*.

Figure 1. WisDOT Guide for Determining Time Requirements for Traffic Signal Preemption at Highway-Rail Grade Crossings (form)



Version 1.4
(Rev. 2/22)

Wisconsin Department of Transportation
GUIDE FOR DETERMINING TIME REQUIREMENTS FOR
TRAFFIC SIGNAL PREEMPTION AT HIGHWAY-RAIL GRADE CROSSINGS

City
County
Region

Date
Completed by
Region Approval

Select North Arrow:

Parallel Street Name

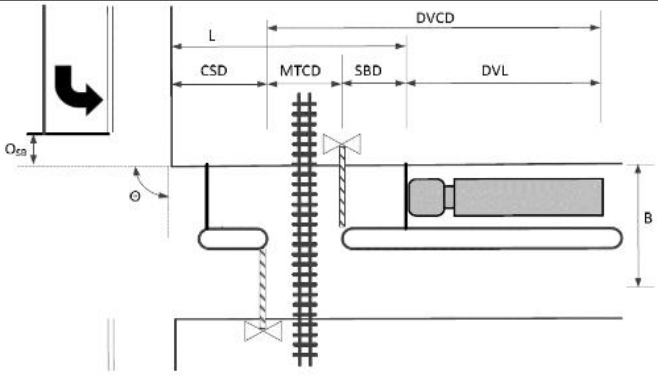
Crossing Street Name

Railroad
Crossing DOT #
M.P.

Railroad Contact
Phone

NOTE: After approval by the Region, a copy of this form, along with the traffic signal design sheets and the phasing diagrams for normal and preempted operation, shall be placed in the traffic signal cabinet. See Section 7 for traffic signal timings.

SECTION 1: GEOMETRY DATA & DEFAULTS



CSD = Clear storage distance (ft)
MTCD = Minimum track clearance distance (ft)
SBD = Stop bar setback distance (ft)
DVL = Design vehicle length (ft)
L= Queue start-up distance, also stop-line distance (ft)
DVCD = Design vehicle clearance distance (ft)
O_{SB} = Offset distance to Left-turn stop bar (ft)
B = Distance from curb line to center of nearest lane receiving left turns (ft)
Θ = Angle of turn (degrees)

GEOMETRIC DATA FOR CROSSING

			Remarks
1.	Clear storage distance (CSD, feet).....	0	
2.	Minimum track clearance distance (MTCD, feet).....	17	
3.	Stop bar setback distance (SBD, feet).....	8	Enter "0" if no stop bar is present
4.	Width of receiving approach (B, feet).....	0	
5.	Offset distance of left turn stop bar (OSB, feet).....	0	
6.	Approach grade. % (0 if approach is on downgrade).....	5.0%	
7.	Angle of turn at Intersection (θ, degrees).....	90	

DESIGN VEHICLE DATA

8.	Select Design Vehicle from Dropdown		School Bus	
9.	Default design vehicle length (feet).....	9.	40	Based on Selected Design Vehicle
a.	Additional vehicle length, if needed (feet).....	9a.	0	Use only if "Other" Selected as Design Vehicle
10.	Total design vehicle length (DVL, feet).....	10.	40	L9 + L9a
11.	Centerline turning radius of design vehicle (R, feet).....	11.	35.4	Based on Selected Design Vehicle
12.	Passenger car vehicle length (LV, feet).....	12.	19	Default Value

Page 1

SECTION 2: RIGHT-OF-WAY TRANSFER TIME CALCULATION

			Remarks
Preempt verification and response time			
13. Preempt delay time (seconds).....	13.	0	Typically not used
14. Controller response time to preempt (seconds).....	14.	0.0	Manufacturer:
			Firmware Version:
15. Preempt verification and response time (seconds).....	15.	0.0	L13 + L14
Worst-case conflicting vehicle time			
16. Minimum green time during right-of-way transfer (seconds).....	16.	7	Value abjustable to meet local conditions
17. Other green time during right-of-way transfer (seconds).....	17.	0	
18. Yellow change time (seconds).....	18.	0.0	
19. Red clearance time (seconds).....	19.	0.0	
20. Worst-case conflicting vehicle time (seconds).....	20.	7.0	Sum of L16 through L19
Worst-case conflicting conflicting time			Remarks
21. Minimum walk time during right-of-way transfer (seconds).....	21.	0	0 is the default and recommended value
22. Pedestrian clearance time during right-of-way transfer (seconds).....	22.	0	
23. Vehicle yellow change time, if not included on line 22 (seconds).....	23.	0.0	
24. Vehicle red clearance time, if not included on line 22 (seconds).....	24.	0.0	
25. Worst-case conflicting pedestrian time (seconds).....	25.	0.0	Sum of L21 through L24
Worst-case conflicting vehicle or conflicting pedestrian time			Remarks
26. Minimum walk time during right-of-way transfer (seconds).....	26.	7.0	maximum of L20 and L25
27. Right-of-way transfer time (seconds):	27.	7.0	L15 + L26

SECTION 3: QUEUE CLEARANCE TIME CALCULATION

			Remarks
28. Are there left-turns towards the tracks? (Select Yes/No).....	28.	No	
29. Distance traveled by truck during left-turn (LTL, feet).....	29.	0	LTL = πRθ/180
30. Travel speed of left-turning truck (SLTT, mph).....	30.	10	Default Value
31. Distance required to clear left-turning truck from travel lanes on track clearance approach (feet).....	31.	0	Eqn: (L4 + L5 + L12 - L11) + L29 + L10
32. Additional time required to clear left-turning truck from travel lanes on track clearance approach (seconds).....	32.	0.0	Eqn: [(L31 * 3600) / (L30 * 5280) - L18 - L19
33. Worst-case Left Turning Truck time (seconds).....	33.	0.0	If L28 = 'Yes', use L32; otherwise use 0
34. Queue start-up distance, L (feet).....	34.	25	L1 + L2 + L3
35. Time required for design vehicle to start moving (seconds).....	35.	3.3	2 + (L34 ÷ 20)
36. Design vehicle clearance distance, DVCD (feet).....	36.	65	L2 + L3 + L10
37. Time for design vehicle to accelerate through DVCD (seconds).....	37.	11.9	Find value using Figure 3, given L36 & L8
38. Factor to account for slower acceleration on uphill grade.....	38.	1.000	Table 2 interpolation
39. Time for design vehcle to accelerate through DVCD (seconds).....	39.	11.9	Adjusted for grade
40. Queue clearance time (seconds).....	40.	15.2	L33 + L35 + L39

SECTION 4: MAXIMUM PREEMPTION TIME CALCULATION

			Remarks
41. Right-of-way transfer time (seconds).....	41.	7.0	Line 27
42. Queue clearance time (seconds).....	42.	15.2	Line 40
43. Desired minimum separation time (seconds).....	43.	4.0	Typical Value
44. Maximum preemption time for Queue Clearance (seconds).....	44.	26.2	L41 + L42 + L43

SECTION 5: SUFFICIENT WARNING TIME CHECK

			Remarks
45. Required minimum time, MT (seconds): per regulations	45.	30	Default Value
46. Clearance time, CT (seconds)	46.	0	(L2-35)/10 (rounded up to nearest second)
47. Total minimum warning time, MWT, needed (seconds)	47.	30.0	L45 + L46 (excludes BT and ERT)
48. Required advance preemption time (APT) from railroad (seconds)	48.	0	L44 - L47 (rounded up to nearest full secor
49. APT currently provided by railroad (seconds)	49.		Enter "0" if new crossing or signal

If the required advance preemption time (line 48) is greater than the amount of advance preemption time currently provided by the railroad (line 49), additional warning time must be requested from the railroad. Alternatively, the maximum preemption time (line 48) may be decreased after performing an engineering study to investigate the possibility of reducing the values on lines 13, 16, 17, 21, 22 and 43.

Remarks:

SECTION 6: TRACK CLEARANCE GREEN TIME CALCULATION (IF NO GATE DOWN CIRCUIT PROVIDED) (NOT TYPICALLY USED)

Preempt Trap Check

			Remarks
50. Warning Time Variability (Select One)	50.	Consistent Warning Times	
51. APT required or provided (seconds)	51.	0	See Instructions for details (max of 48/49)
52. Multiplier for maximum APT due to train handling	52.	1.00	
53. Maximum APT (seconds)	53.	0	multiply L51 and L52
54. Minimum duration for the track clearance green interval (seconds)	54.	15	Default Value
55. Track Clearance Green Time to avoid Preempt Trap (seconds)	55.	15.0	L53 + L54

Clearing of Clear Storage Distance

56. Time waiting on left-turn truck (seconds)	56.	0.0	Line 33
57. Time required for design vehicle to start moving (seconds)	57.	3.3	Line 35
58. Design vehicle clearance distance (DVCD, feet)	58.	65	Line 36

59. If CSD < DVL, you must clear the design vehicle through the entire CSD during the traffic clearance phase; however, if CSD > DVL, you should consider providing enough time to clear the design vehicle from the crossing.

a. Is the clear storage distance (CSD) less than or equal to the design vehicle length (DVL)?
YES. The design vehicle MUST clear through the entire CSD. (CSD will be entered in Line 59).

b. Do you want to clear the design vehicle through the entire CSD? (Select Yes/No)
<Select One>

Portion of CSD to clear during track clearance phase (feet)	59.	0	
60. Design vehicle relocation distance (DVRD, feet)	60.	65	L58 +L59
61. Time required to accelerate design vehicle through DVRD (seconds)	61.	12.1	Find value using Figure 3, given L60 & L8
62. Factor to account for slower acceleration on uphill grade	62.	1.284	interpolation
63. Time required to accelerate design vehicle through DVRD (seconds)	63.	15.5	Adjusted for Grade - multiply L61 & L62
64. Time to clear portion of clear storage distance (seconds)	64.	18.8	L56 + L57 + L63
65. Track clearance green interval (seconds)	65.	19.0	max of L55 and L64 (rounded up)

Maximum Duration of Track Clearance Green after gates are down (in absence of a gate down circuit

66. Total time to complete track clearance green (seconds)	66.	26	L27 + L65
67. Total time before gates are down (seconds)	67.	21.2	L44 - 5 seconds (per AREMA Manual)
68. Maximum Duration of Track Clearance Green after gates are down	68.	4.8	(seconds): L66 - L67

ECTION 7: SUMMARY OF CONTROLLER PREEMPTION SETTINGS

reempt Trap Check			Remarks
69. Duration Time (seconds).....	69.	0	Default Value
70. Preempt Delay Time (seconds).....	70.	0	Line 13

Right of Way Transfer Phase			Remarks
71. Minimum Green Interval (seconds).....	71.	7	Line 16
72. Pedestrian Walk Interval (seconds).....	72.	0	Line 21
73. Pedestrian Clearance Interval (Flashing "DON'T WALK", seconds).....	73.	0	Line 22
74. Yellow Change Interval (seconds).....	74.	-	Not typically overriden for preemption
75. All Red Vehicle Clearance (seconds).....	75.	-	Not typically overriden for preemption

Track Clearance Phase			Remarks
76. Green Interval (seconds) (in the absence of gate down circuit).....	71.	26	
77. Green Interval (seconds) with gate down circuit.....	72.	16	Line 40
78. Yellow Change Interval (seconds).....	73.	-	Not typically overridden for preemption
79. All Red Vehicle Clearance (seconds).....	74.	-	Not typically overridden for preemption

Exit Phase			Remarks
80. Dwell/Cycle Minimum Green Time (seconds).....	71.	0	Default Value
81. Yellow Change Interval (seconds).....	72.	-	Not typically overridden for preemption
82. All Red Vehicle Clearance (seconds).....	73.	-	Not typically overridden for preemption

Remarks:

Figure 2. WisDOT Railroad Preemption Inspection Form

WisDOT RAILROAD PREEMPTION INSPECTION FORM

1. REVIEW TEAM

TRAFFIC SIGNAL INSPECTION COMPLETED BY:		INSPECTION DATE:	
RAILROAD INSPECTION COMPLETED BY:		DATE OF LAST INSPECTION:	

2. LOCATION DATA

HIGHWAY INTERSECTION:		MUNICIPALITY:	COUNTY:
TRAFFIC SIGNAL OPERATING AGENCY:	SIGNAL ID: (ex. S1056)	SIGNAL CONTACT:	SIGNAL CONTACT PHONE:
RAILROAD OPERATING COMPANY:	RR CROSSING ID: (ex. 391768X)	RR CONTACT:	RR CONTACT PHONE:
TRAFFIC SIGNAL EMERGENCY CONTACT NUMBER:		RAILROAD EMERGENCY CONTACT NUMBER:	

3. RAILROAD DATA

ACTIVE WARNING DEVICES: ☐ 3 or 4-Quadrant Gates ☐ 2-Quadrant Gates ☐ Flashers	
MAXIMUM TRAIN SPEED (MPH):	SPEED RANGE OVER XING (MPH):
NUMBER OF TRAINS PER DAY:	NUMBER OF TRACKS:
AVAILABLE CIRCUITS: ☐ APPT ☐ APT ☐ GD ☐ HC ☐ Sup ☐ XR	
USED CIRCUITS: ☐ APPT ☐ APT ☐ GD ☐ HC ☐ Sup ☐ XR	
CIRCUIT NOTES: APPT = Advanced Pedestrian Preemption APT = Advance Preemption GD = Gate Down HC = Health Circuit Sup = Supervisor	XR = Island Circuit

4. TRAFFIC SIGNAL DATA

CABINET TYPE: ☐ TS1 ☐ TS2	CONTROLLER MAKE & MODEL:
TYPE OF SIGNAL PREEMPTION: ☐ Advanced ☐ Simultaneous	BLANKOUT SIGNS PRESENT? ☐ Yes ☐ No
OTHER TYPES OF PREEMPTION: ☐ Emergency Vehicle ☐ Bus/Transit	DOES RR PREEMPT HAVE PRIORITY? ☐ Yes ☐ No
BATTERY BACKUP PRESENT? ☐ Yes ☐ No	BATTERY BACKUP COMMUNICATION? ☐ Yes ☐ No
AVAILABLE CIRCUITS: ☐ APPT ☐ APT ☐ GD ☐ HC ☐ Sup ☐ XR	
USED CIRCUITS: ☐ APPT ☐ APT ☐ GD ☐ HC ☐ Sup ☐ XR	
VEHICULAR PHASES PRESENT: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8	
PEDESTRIAN PHASES PRESENT: ☐ 2 ☐ 4 ☐ 6 ☐ 8	OTHER PHASES PRESENT:

5. RAILROAD EQUIPMENT TIMERS

RAILROAD SETTINGS	DESIGNED	MEASURED	NOTES
Equipment Reaction Time (ERT):	sec.		
Advanced Pedestrian Preemption Time (APPT):	sec.	sec.	
Advanced Preemption Time (APT):	sec.	sec.	
Minimum Warning Time (MWT):	sec.		
Additional Clearance Time (CT): (overspeed tolerance, wide/angled crossings)	sec.		
Buffer Time (BT):	sec.		
Total Warning Time (MWT + CT + BT):	sec.		

6. DESIGN RAILROAD PREEMPTION PHASING SEQUENCE

WORST CASE CONFLICTING PHASES				TRACK CLEARANCE PHASE(S)	PREEMPT DWELL PHASES	PREEMPT CYCLE PHASES
Vehicle:		Pedestrian:				

Page 1 of 2

7. TRAFFIC SIGNAL TIMINGS						
CONTROLLER SETTINGS	DESIGNED		PROGRAMMED		MEASURED	NOTES
Preempt Delay:		sec.		sec.		
Entrance Min Green:		sec.		sec.		sec.
Entrance Walk + Ped Clear:		sec.		sec.		sec.
Entrance Yellow + Entrance Red:		sec.		sec.		sec.
Maximum RWTT (Delay + Min G + Y + R or Delay + Walk + Ped Clear + Y + R):		sec.		sec.		
Track Clear Min Green:		sec.		sec.		sec.
Track Clear Ext Green:		sec.		sec.		sec.
Track Clear Max Green:				sec.		
Min Dwell:				sec.		sec.
Dwell Preemption Ext:				sec.		sec.

8. FIELD TESTING AND INSPECTION		
		NOTES
DO THE RAILROAD FLASHERS OPERATE AS EXPECTED?	☐ Yes ☐ No	
DO THE RAILROAD GATES OPERATE AS EXPECTED?	☐ Yes ☐ No	
ARE THE BLANK OUT SIGNS WORKING PROPERLY?	☐ Yes ☐ No ☐ NA	
DOES A PREEMPT CALL TRIGGER RIGHT OF WAY TRANSFER?	☐ Yes ☐ No	
DOES A PROTECTED ARROW COME UP FOR TRACK CLEARANCE?	☐ Yes ☐ No	
DOES GATE DOWN RELEASE TRACK CLEAR PHASE?	☐ Yes ☐ No ☐ NA	
PROPER DWELL/CYCLE PHASES OPERATE?	☐ Yes ☐ No ☐ NA	
IS THE PREEMPT CALL RELEASED AT BEGINNING OF GATE ASCENT?	☐ Yes ☐ No	
DOES THE SIGNAL EXIT TO THE PROPER PHASE UPON RELEASE OF PREEMPT?	☐ Yes ☐ No	
DOES PREEMPT RESERVICE ACTIVATE?	☐ Yes ☐ No	
ARE EXEMPT SIGNS POSTED AT THE CROSSING?	☐ Yes ☐ No	
ARE EMERGENCY CONTACT STICKERS IN SIGNAL CABINET AND BUNGALOW?	☐ Yes ☐ No	

9. OTHER INFORMATION / NOTES

Page 2 of 2

- Railroad Preemption Inspection form
- WisDOT Railroad Preemption Inspection form

4-4-3 Applications/Warrants August 2011

GENERAL

Reference is made to the MUTCD, Sections 4C.05, 4C.06, 4D.03, and 4E.

The design and operation of traffic control signals **shall** take into consideration the needs of pedestrian as well as vehicular traffic. The decision to signalize pedestrian movements *should* be a collaborative decision between the regional signal engineer and the regional bicycle/pedestrian safety coordinator and *should* be based upon the warrants and other criteria provided hereafter.

POLICY

Sidewalk and curb ramps **shall** be provided at locations where pedestrian signal heads are to be installed.

Per MUTCD Section 4E.03:

"Pedestrian signal heads **shall** be used in conjunction with vehicular traffic control signals under any of the following conditions:

A. If a traffic control signal is justified by an engineering study and meets either Warrant 4, Pedestrian Volume or Warrant 5, School Crossing (see MUTCD, Sections 4C.05 and 4C.06);

B. If an exclusive signal phase is provided or made available for pedestrian movements in one or more directions, with all conflicting vehicular movements being stopped;

C. At an established school crossing at any signalized location; or

D. Where engineering judgment determines that multi-phase signal indications (as with split-phase timing) would tend to confuse or cause conflicts with pedestrians using a crosswalk guided only by vehicular signal indications."

"Pedestrian signal heads *should* be used in conjunction with vehicular traffic control signals under any of the following conditions:

A. If it is necessary to assist pedestrians in deciding when to begin crossing the roadway in the chosen direction or if engineering judgment determines that pedestrian signal heads are justified to minimize vehicle-pedestrian conflicts;

B. If pedestrians are permitted to cross a portion of a street, such as to or from a median of sufficient width for pedestrians to wait, during a particular interval but are not permitted to cross the remainder of the street during any part of the same interval; and/or

C. If no vehicular signal indications are visible to pedestrians, or if the vehicular signal indications that are visible to pedestrians starting a crossing provide insufficient guidance for them to decide when to begin crossing the roadway in the chosen direction, such as on one-way streets, at T-intersections, or at multi-phase signal operations."

In addition to the guidance provided above, there are a few other items to consider when deciding whether or not to install pedestrian signal indications:

1. Is a blind pedestrian requesting the accommodation? (It is WisDOT's policy to accommodate blind pedestrians by installing pedestrian heads and APS devices, so long as the blind are the ones requesting it).
2. What is the land use adjacent to the intersection? Does the intersection serve as a connection between businesses? To a school? To a parking lot? To a transit/bus stop?

At locations where pedestrian heads and push buttons are not initially installed, the designer *should* locate all signal poles with future pedestrian accommodations in mind. This way the intersection can be easily retrofitted with pedestrian heads and push buttons once the sidewalk and curb ramps have been installed.

SUPPORT

In Wisconsin, pedestrians can legally cross a roadway at a traffic signal even if that traffic signal does not have

pedestrian signal heads.

Wisconsin State Statute 346.37 (1)(a)2: “Pedestrians, and persons who are riding bicycles or electric personal assistive mobility devices in a manner which is consistent with the safe use of the crosswalk by pedestrians, facing the (green) signal *may* proceed across the roadway within any marked or unmarked crosswalk.”

Wisconsin State Statute 346.37 (1)(c)2: “No pedestrian, bicyclist, or rider of an electric personal assistive mobility device facing such signal (red) **shall** enter the roadway unless he or she can do so safely and without interfering with any vehicular traffic.

Also, Wisconsin State Statute 346.23 addresses motorists’ responsibility at intersections relative to pedestrians:

(1) At an intersection or crosswalk where traffic is controlled by traffic control signals or by a traffic officer, the operator of a vehicle **shall** yield the right-of-way to a pedestrian, or to a person who is riding a bicycle or electric personal assistive mobility device in a manner which is consistent with the safe use of the crosswalk by pedestrians, who has started to cross the highway on a green or “Walk” signal and in all other cases pedestrians, bicyclists, and riders of electric personal assistive mobility devices **shall** yield the right-of-way to vehicles lawfully proceeding directly ahead on a green signal. No operator of a vehicle proceeding ahead on a green signal *may* begin a turn at a controlled intersection or crosswalk when a pedestrian, bicyclist, or rider of an electric personal assistive mobility device crossing in the crosswalk on a green or “Walk” signal would be endangered or interfered with in any way. The rules stated in this subsection are modified t intersections or crosswalks on divided highways or highways provided with safety zones in the manner and to the extent stated in sub. (2).

(2) At intersections or crosswalks on divided highways or highways provided with safety zones where traffic is controlled by traffic control signals or by a traffic officer, the operator of a vehicle **shall** yield the right-of-way to a pedestrian, bicyclist, or rider of an electric personal assistive mobility device who has started to cross the roadway either from the near curb or shoulder or from the center dividing strip or a safety zone with the green or “Walk” signal in the favor of the pedestrian, bicyclist, or rider of an electric personal assistive mobility device.

4-4-7 Animated Eyes Symbol — December 2004

GENERAL

Reference is made to the MUTCD Section 4E.04.

The animated eyes symbol is a dynamic display that supplements standard pedestrian signal indications within the same section. This symbol consists of illuminated eyes that scan from side to side and is meant to prompt pedestrians to be aware of approaching vehicles.

POLICY

Pedestrian signal heads **shall** not incorporate the animated eyes symbol at state-owned signal installations.

SUPPORT

WisDOT supports the use of technologies that address a distinct need related to highway safety & traffic operations. Animated eyes are expected to have a limited effect on improving intersection safety but would require an increase in capital, operations, and maintenance costs. Benefits are not expected to outweigh additional resource expenditures.

4-5-1 General Provisions — July 2018

GENERAL

Reference is made to the WisMUTCD Chapter 4L.

Flashing beacons (a.k.a. flashers, warning flashers, beacons) are a special type of signal indication used to supplement standard regulatory and warning signs. According to the WisMUTCD, flashing beacons have the following applications:

1. Intersection control beacon
2. Stop beacon
3. Speed limit sign beacon
4. Warning beacon (includes Rectangular Rapid Flashing Beacons)

Warning beacon includes Rectangular Rapid Flashing Beacons (RRFB). Flashing beacons are part of a sign, as it pertains to the provisions for allowing the installation of the beacons on highway right-of-way. Statutes 84.02 (4)(c) and 86.19 (3) convey exclusive authority for signs and warning devices on the state trunk system to the department.

This policy contains provisions for proper application, design, and permitting of flashing beacons on the STH system.

POLICY

General

The following general criteria apply to all flashing beacon installations on the STH system:

1. There are two types of flashing beacons:
   a. Red—only to be used with STOP signs
   b. Yellow—to be used with any yellow warning (W-series) signs, speed limit, speed limit reduction, pedestrian warning and school speed limit signs

   Flashing beacons **shall** only be associated with the sign installations referred to above.
2. Flashing beacons are supplementary to signs. When used, they **shall** be mounted on the same support as the sign which the beacon supplements in accordance with WisMUTCD 4L.03.
3. Activated flashing beacons **shall not** be approved on the STH system for use in conjunction with train crossings.
4. Emergency vehicle entrances *may* have activated flashing beacons, which will cancel after a pre-timed period of flash.
5. State-owned and permitted installations
   a. The department *may* determine that flashing beacons are needed and *may* install and maintain them at specific sites. In this case, the regional traffic engineer **shall** make a final determination regarding the use of these devices on behalf of the department.
   b. At locations where local authorities determine that the use of flashing beacons is desirable, a permit *may* be issued for the installation and maintenance of flashing beacons. Permitted installations are subject to the approval of the department and the conditions of this policy. Additionally, permits are revocable at the discretion of the department.

Application of Flashing Beacons

The following sections highlight policy items for flashing beacons that *may* be different from those represented in WisMUTCD Chapter 4L.

Intersection Control Beacon: Used at intersections where traffic or physical conditions do not justify conventional traffic control signals but crash rates indicate the possibility of a special need, generally located over the center of an intersection. Refer to WisMUTCD Section 4L.02.

Stop Beacon: Refer to WisMUTCD Section 4L.05.

Speed Limit Sign Beacon: Refer to WisMUTCD Section 4L.04. The department rarely, if ever, would install and maintain flashing beacons with speed limit signs or school speed limit signs. Local authorities **shall** follow the permit requirements stated below.

Warning Beacon: Refer to WisMUTCD Section 4L.03.

Flashing Beacon Design & Installation

The following provisions pertain to the installation, operation, and maintenance of flashing beacons other than rectangular rapid flashing beacons (RRFBs) on the state trunk highway system.

1. Location
    a. Ground mount: Flashing beacons *may* be ground mounted, where they will be approximately one foot above the sign they supplement. The sign *should* be in the lateral and vertical location as specified in the WisMUTCD Part 2 (no change). Illustrations of typical ground-mount installations are in Figure 1 below.
    b. Overhead mount: A flashing beacon *may* be mounted on one or both sides of an overhead sign. It *may* be mounted above the sign if the entire assembly including the sign has a minimum clearance of 17 feet.
2. For state-maintained installations, the standard size of flashing beacons is 12 inches in diameter. At the discretion of the regional traffic engineer, permitted (not state-maintained) installations that are in areas with a posted speed less than 30mph *may* use 8-inch diameter beacons.
3. Ground-mounted supports **shall** be the same as are normally used to support the sign, and of the same cross-section as normally used. These **shall** be 4 x 4 or cross-drilled 4 x 6 posts, or in urban areas signal posts on concrete footings, or light poles or wood poles where speeds are low. Usage of any kind of pole **shall** be in conformance with the offsets specified in highway lighting permit policy, FDM 11-15-1.
4. The installation of two posts, one for the sign and the other for the flashing beacon, is not permissible within the clear zone because of the unpredictable behavior of the combination of two posts when struck.
5. Service poles must be offset to the right-of-way line or in conformance with offsets in FDM 11-15-1.
6. Service *may* drop to the top of the support, which would be extended to maintain an 18-foot minimum wire-to-ground clearance as per Wisconsin electrical code. Service *should* preferably be installed underground. In the latter case, the conduit **shall** be run up and attached to the post or pole. The control box *may* be mounted on the post or pole.
7. At the discretion of the regional traffic engineer, solar-powered flashing beacon installations *may* be allowed on the STH system provided the installation meets applicable electrical and crash standards.
8. According to TEOpS 2-1-8, flashing beacons and STOP or STOP AHEAD signs that incorporate flashing displays (e.g. blinker signs) **shall not** be used at the same intersection approach.

Warning Beacon (i.e., RRFBs) Design & Installation

Yellow flashers are to be used with any yellow warning (W-series) signs and school speed limit signs. Actuated blinker signs are supplementary to warning signs. When used, they **shall** be mounted on the same support as the sign which the beacon supplements in accordance with WisMUTCD 4L.03.

At locations where it is determined that the use of warning sign enhancements signs is desirable, a permit *may* be issued for the installation and maintenance of these blinker-type signs. Permitted installations are subject to the approval of the Department and the conditions of this policy. Additionally, permits are revocable at the discretion of the Department.

It is recognized that the use of warning sign enhancements *may* affect STH traffic operations by increasing delay and reducing mobility, especially if used near existing signalized or stop controlled intersections. The following location criteria *should* be met prior to approval:

1. The location is an uncontrolled pedestrian crossing.
2. A minimum volume of 20 or more pedestrians during a single hour (any four consecutive 15-minute periods) of an average day *should* be met. Young (<12), elderly (>85) and disabled pedestrians count 2 times toward volume thresholds. Additionally, seasonal day volumes can be used in place of average day volumes if the crossing is in a known tourist area.

3. A minimum vehicular volume of 1,500 vehicles per day.
4. Maximum of four lanes crossed, unless there is a raised median, in which case it can be six lanes.
5. There exists a minimum of 300 feet between the subject crossing and the nearest controlled pedestrian crossing or intersection traffic control device on the state trunk highway system. Consideration *should* be given to extending this distance beyond 300 feet if the proposed crosswalk location falls within an auxiliary turn lane for the nearby intersection or if the standing queue from the intersection extends over the proposed crosswalk location.
6. Adequate stopping sight distance exists based on FDM 11-10-5 or greater than 8 times the posted speed limit.
7. RRFBs **shall** use a much faster flash rate and **shall** provide 75 flashing sequences per minute (except for existing RRFBs that follow FHWA IA-11). According to IA-21, the left and right RRFB indications **shall** operate using the following sequence:

RRFB Flash Pattern												
Beacon	0.05 sec	0.05 sec	0.05 sec	0.05 sec	0.05 sec	0.05 sec	0.05 sec	0.05 sec	0.05 sec	0.05 sec	0.05 sec	0.25 sec
Left	ON	OFF	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF	OFF	OFF
Right	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF	ON	OFF	ON	OFF

The use of warning sign enhancements *may not* be appropriate at locations where there is a combination of both high traffic volumes and high pedestrian volumes. In these situations, there *may* be an increase in crashes and/or delay that make the use of the actuated blinker signs inappropriate. Instead a traffic signal or Pedestrian Hybrid Beacon (PHB) *should* be considered, if feasible.

Consideration *should* also be given to spacing between pedestrian crossings – both uncontrolled as well as those supplemented with warning sign enhancements. These blinker-type signs are highly visible and therefore can be confusing or distracting to drivers if there are too many within their field of vision at one time. Historically, 1,200 feet has been a rule of thumb for minimum spacing.

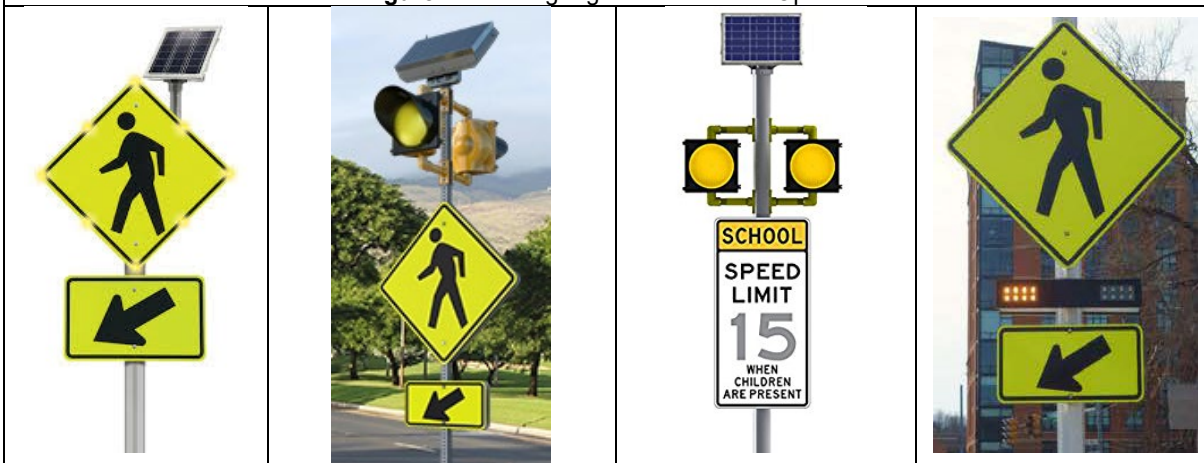
Warning beacon types

There are four options that *may* be used to enhance pedestrian and school warning signs:

1. Blinker Sign. Refer to TEOpS 2-1-8 for application criteria.
2. Standard Blinker Beacon. Refer to TEOpS 4-5-1 for application criteria.
3. Rapid Flashing Beacon (Wig-Wag).
4. Rectangular Rapid Flashing Beacon (RRFB). RRFBs can only be pedestrian actuated.

These devices can be pedestrian actuated and/or time-of-day programmed.

Figure 1. Warning Sign Enhancement Options



Blinker Sign	Standard Blinker Beacon	Rapid Flashing Beacon (Wig-Wag)	Rectangular Rapid Flashing Beacon

As of March 20, 2018, FHWA has granted interim approval (IA-21) for the optional use of the RRFB as a pedestrian-actuated conspicuity enhancement to supplement standard pedestrian crossing or school crossing signs at uncontrolled marked crosswalks to any jurisdiction that submits a written request to FHWA. WisDOT received statewide approval from FHWA to allow all jurisdictions to install an RRFB. The jurisdiction must agree to furnish a list of locations where RRFBs are installed, acknowledge that FHWA has the right to rescind the

interim approval at any time and acknowledge that the interim approval does not guarantee that the provisions will be adopted into the WisMUTCD.

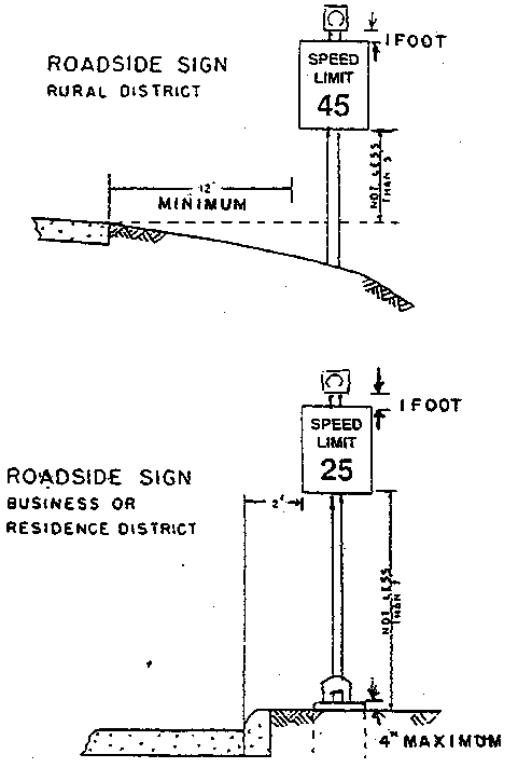
PERMITTING OF FLASHING BEACONS

Any improperly installed electrical equipment *may* pose a hazard to the public. As such, the department spells out general and specific conditions, which are part of the permit agreement. These conditions are incorporated into the permit form, DT1877, a copy of which is appended to this policy. The WisMUTCD Chapter 4L and specific conditions stated above **shall** also be followed for flashing beacons installed on all state trunk highways. Flashing beacons installed on connecting highways **shall not** require a WisDOT permit.

The following information provides conditions and processes related to the issuance of permits:

1. Permit applications **shall** be received, and permits issued, by the appropriate regional office.
2. Permits for flashing beacons *may* only be issued to municipalities, not to private individuals at agencies, or to power companies. This *should* result in working with the most responsible and objective agency associated with the safety problem being addressed.
3. The region *may* rightfully deny the issuance of the permit. Reasons for denial *may* include: lack of need, conflict with other traffic control devices, vulnerable location, lack of confidence in the maintaining ability of the subject agency, or knowledge that the request is due to reaction rather than long term need of commitment.
4. The region *may* revoke the permit for any of the reasons above, especially regarding lack of maintenance, as well as for reasons cited on the permit itself.
5. For permitted flashing beacons installed on signal standards, Standard Detail Drawings 9C2, 9C3, and 9E7 *should* be made part of the permit. SDDs 9C5 and 9D3 for control cabinet installations *may* also apply.
6. In the event of the reconstruction of the highway, reasonable notice *should* be given to the municipality to allow their removal of the equipment and arranging for disconnecting the electrical service.

Figure 1. Standard Flashing Beacon Installations for Rural & Urban Districts



4-6-1 Control for Emergency Access Vehicles May 2011

GENERAL

Reference is made to the MUTCD, Section 4G, and Wisconsin State Statute 346.455

POLICY

The following conditions describe various forms of traffic control associated with emergency vehicle access as well as general installation, design, and operational criteria.

Condition 1: Warning Device with No Traffic Control

Prescribed practice is to use the warning sign W11-8, Fire Station Truck, with or without a flashing beacon used to supplement the sign (see TEOpS 4-5-1). Use of this type of warning is intended for use only at locations with restricted sight distances. If used with a flashing beacon, the beacon *should* be activated by a control in the firehouse for a preset period of time for the emergency vehicle to enter the highway.

An alternate method is to use a W11-8 at the emergency vehicle access with a yellow flashing beacon, and also install an advance warning sign, W54-60, Fire Trucks (Emergency Vehicles) Enter when Signal Flashes.

On the state trunk highway system, signing will be furnished, installed, and maintained by the department. The municipality *may* have an option to install a flashing beacon subject to obtaining a permit from the regional office and accepting responsibility for operating and maintaining the beacon in accordance with the permit.

Condition 2: Emergency Vehicle Hybrid Beacons and Mid-Block Access

Under this condition, the emergency vehicle access is at mid-block and controlled by a hybrid beacon.

Application

Emergency vehicle hybrid beacons **shall not** be installed mid-block on two-lane roadways. In addition to guidance provided in the MUTCD Section 4G.04, emergency vehicle hybrid beacons *may* be considered on multilane highways when the following volume criteria is met:

1. Traffic volume on the adjacent roadway exceeds 18,000 vehicles per day, or
2. Traffic volume on the adjacent roadway exceeds 1,800 vehicles during the peak hour of the day.

In addition to the volume criteria above, a specialized study **shall** be conducted by the agency requesting the beacons to demonstrate the need for control at emergency vehicle access points. Minimally, k=the study will consider adjacent roadway geometry (to include sight distance criteria), traffic volumes and characteristics, relative emergency vehicle exposure, and related vehicular conflicts (to include crash history). The study *should* also include a traffic capacity analysis to evaluate the effects of such an installation on the adjacent roadway. Such an installation *may* be denied if the study determines that a substantial, negative impact will be created by the installation of an emergency vehicle hybrid beacon.

Design and Operation

All design and operation requirements for an emergency vehicle hybrid beacon can be found in MUTCD Section 4G.04.

Maintenance and Funding

Since emergency vehicle hybrid beacons are installed to serve a defined community, it is reasonable to assign maintenance responsibilities to the community being served. However, for installations outside connecting highway limits, communities *may not* have resources available to manage such systems. As such, this function will likely need to be fulfilled by WisDOT. In that case, an agreement with the community *may* be developed that will establish a means to reimburse WisDOT for any time and materials spent maintaining these installations. This agreement *may* address costs to install traffic control hybrid beacons as well.

Other Traffic Control Methods for Emergency Vehicle Access

Devices used to control traffic on the STH system, including connecting highways, at locations of emergency vehicle access are subject to Wisconsin State Statute 346.455, the WisMUTCD, and this policy. Forms of traffic

control outside of these standards are not permitted. Examples of this include using red flashing beacons with signs indicating “WHEN FLASHING – STOP FOR FIRE TRUCKS” or similar messages.

SUPPORT

Regardless of the reason traffic control devices are installed, they need to convey a purposeful, clear, and consistent message to motorists.

In addition to providing these types of devices on the STH system to promote safety, drivers of emergency vehicles *should* be properly trained regarding the proper operation of emergency vehicle hybrid beacons, and the concept that use of emergency vehicle hybrid beacons does not remove the responsibility of the vehicle operator from determining whether or not it is safe to enter the highway.

The local municipality **shall** be responsible for such training programs.

4-12-2 At Pedestrian Crosswalks March 2011

GENERAL

Reference is made to the MUTCD Chapter 4N.

In-roadway warning lights (IRWLs) are special types of highway traffic control devices installed in the roadway pavement to warn road users that they are approaching a condition on or adjacent to the roadway that *may* not be readily apparent and might require the road users to slow down and/or yield.

IRWLs are actuated devices with flashing indications that provide real-time warning of a specific condition. In-pavement lights that supplement pavement markings by operating in a steady burn state **shall** also require WisDOT approval but are not the focus of this policy.

On the STH system in Wisconsin, IRWLs are limited to situations warning of: marked school crosswalks, marked mid-block crosswalks, marked crosswalks on uncontrolled approaches, and other roadway situations involving pedestrian crossings that are not associated with other types of traffic control.

POLICY

IRWLs, as defined herein, *may* be used on the Wisconsin STH system provided the local jurisdiction:

1. Applies for a permit
2. Agrees to fund the installation, operation, and maintenance of the device
3. Agrees to be responsible for any corresponding damage to the roadway or damage to highway maintenance equipment, and
4. Properly cites appropriate locations based on the conditions of this policy.

The municipality *should* understand that the permit may be revoked, especially in the event of safety or operational issues. In such a situation, the original costs and costs to restore the pavement are the obligation of the permit holder.

When allowed by permit, IRWLs **shall** be installed perpendicular to the direction of travel on the roadway and used to supplement crosswalk markings. IRWLs placed along the centerline of a highway, parallel to the direction of travel, **shall not** be used. IRWLs **shall not** be allowed on freeways or expressways.

Prior to the use of IRWLs, adequate trail of standard remedial measures **shall** be used to warn motorists of pedestrian crossings. IRWLs will be used only to supplement typical warning devices such as signs, markings, and crossing guards. Other strategies, such as providing a median refuge roadway lighting in advance of the crossing, or enforcement campaigns, are more universally recognizable methods of warning motorists of these conditions, and *should* also be implemented when practicable.

Location Criteria

It is recognized that the use of IRWLs *may* affect STH traffic operations by increasing delay and reducing mobility, especially if used near existing signalized or stop-controlled intersections. The following criteria **shall** be met:

1. Location is an uncontrolled pedestrian crossing.
2. Location is an established school route, accommodates a minimum pedestrian volume of 100 pedestrians/day, or location has experienced pedestrian crashes in the past 3 years.
3. Subject crossing is located in municipal (non-rural) limits.
4. There exists a minimum of 300 feet between the subject crossing and the nearest uncontrolled pedestrian crossing, or intersection traffic control device on the STH.
5. There exists a minimum of 1200 feet between the subject crossing and the nearest uncontrolled pedestrian crossing supplemented with in-roadway warning lighting, unless exceptional conditions exist.
6. Roadway has a maximum of four travel lanes with a maximum single-stage crossing distance of 50 feet.

7. Approach speed is posted at less than 50 mph.
8. Adequate stopping sight distance exists based on the following approach speeds:
    a. 15 or 25 mph = 200 ft
    b. 30 mph = 250 ft
    c. 35 mph = 300 ft
    d. 40 mph = 400 ft
    e. 45 mph = 500 ft

Design Requirements

In the interest of uniformity, reliability, and consideration for other highway users, the following minimum design requirements for IRWLs **shall** be met:

1. Number/positioning of lights:
    a. For two-lane undivided roadways: 5 IRWLs per direction
    b. For four-lane undivided roadways: 7 IRWLs per direction
    c. For four-lane divided roadways: 5 IRWLs per direction.
2. IRWLs **shall** be actuated and **shall not** flash continuously.
3. If pedestrian push buttons are used to actuate the IRWLs, a PUSH BUTTON TO TURN ON WARNING LIGHTS (R10-25) sign **shall** be mounted adjacent to or integral with each pedestrian push button.
4. For four-lane divided roadways with median widths equal to or exceeding 6 feet, pedestrian actuation in the median **shall** be provided to allow for a two-stage crossing of the roadway.
5. Lights **shall** be evenly spaced across the entire traveled way. Lights *should* be positioned outside of vehicle wheel paths and *should* also consider bicyclist routes adjacent the traveled way. Lights placed near the centerline of the roadway *should* be offset slightly to minimize interference with pavement marking operations.
6. Electrical wire **shall** be cast in a minimum of 8-inch concrete pavement. If IRWLs are being installed with an improvement project that requires a pavement section greater than 8 inches, then the pavement at the crossing *should* be made to match that of the adjacent roadway. Pavement reinforcement *may* not be required, but this decision will reside with the regional pavement design unit. Doweling to adjacent concrete pavement will also be required at the direction of the regional pavement engineer. A minimum 2 feet of clearance to the edge of the concrete **shall** be maintained. Pavement structure **shall** be installed according to WisDOT Standard Specifications. Installation in existing pavement by sawing or coring is not permissible. Minimal width of the concrete, measured longitudinally in the direction of traffic, **shall** be 12 feet.
7. Roadway profile **shall** be appropriately maintained by milling or wedging the approach to the crossing, as required.
8. IRWLs **shall** flash for the entire calculated pedestrian clearance time. Pedestrian clearance *should* be calculated based on a 3.5 ft/sec walking speed. Locations frequented by children and elderly users *may* have a pedestrian clearance based on a slower walking speed. A brief time extension of 3 to 7 seconds *may* be added to allow for vehicle/pedestrian response and separation.
9. Features meant to accommodate impaired pedestrians such as actuator buttons with locator tones, supplemental braille signing, etc., *should* be considered at individual locations on a case-by-case basis. If used, these devices **shall** be furnished and maintained by the municipality that requests the IRWLs.
10. Other design criteria **shall** conform to the manufacturer's recommendations.

SUPPORT

There are several general points of concern regarding the use of these devices:

1. IRWLs do not ensure that motorists will appropriately yield the right of way to pedestrians in the crossing.
2. A public awareness and education campaign *may* be required to educate the public prior to operating

IRWLs.

3. IRWLs *may* cause rear-end collisions similar to a signal installation.
4. Placement of IRWLs between coordinated traffic control signals *may* cause progression problems.
5. Any improperly installed electrical equipment *may* pose a hazard to the general public.
6. In Wisconsin, IRWLs *may* be susceptible to premature failure due to moisture buildup and/or snow removal operations.
7. The type of actuation used for IRWLs needs to be considered. Active detection (i.e. pushbutton) may create a false sense of security for pedestrians who are not familiar with the use of such devices or the rules of the road. Because of these factors, passive detection (i.e. infrared) is considered more appropriate for these types of applications, especially in crosswalks associated with school zones. In either case, an informational plaque should be used to briefly describe proper crossing behavior while using IRWLs. These are similar to informational plaques used at signalized pedestrian crossings (R10 series).
8. In IRWLs will be placed outside of existing connecting highway limits within a municipality, consideration *should* be given to extend those limits to include the installation location.