4-7-1 Sequence of Operations — April 2025

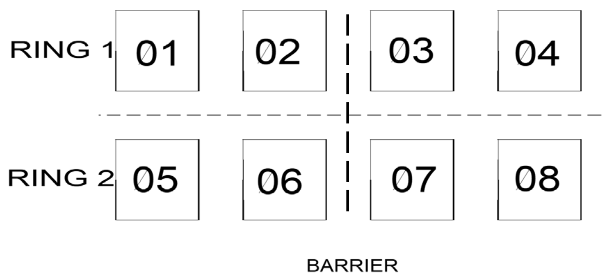
NEMA PHASING

The traffic signal maintaining authority **shall** be contacted for purposes of determining the type of NEMA phasing.

For all new state-owned signals, actuated controllers **shall** be used. Legacy equipment *may* remain for the remainder of the life of the equipment or until a construction project comes through; whichever comes first.

Traffic signal phasing **shall** be in accordance with NEMA standards for actuated signal controllers unless directed otherwise by a WisDOT Region Traffic Signal Engineer. Under NEMA phase designations, there can be a total of eight phases, which are grouped in two rings as illustrated in Figure 1.1.

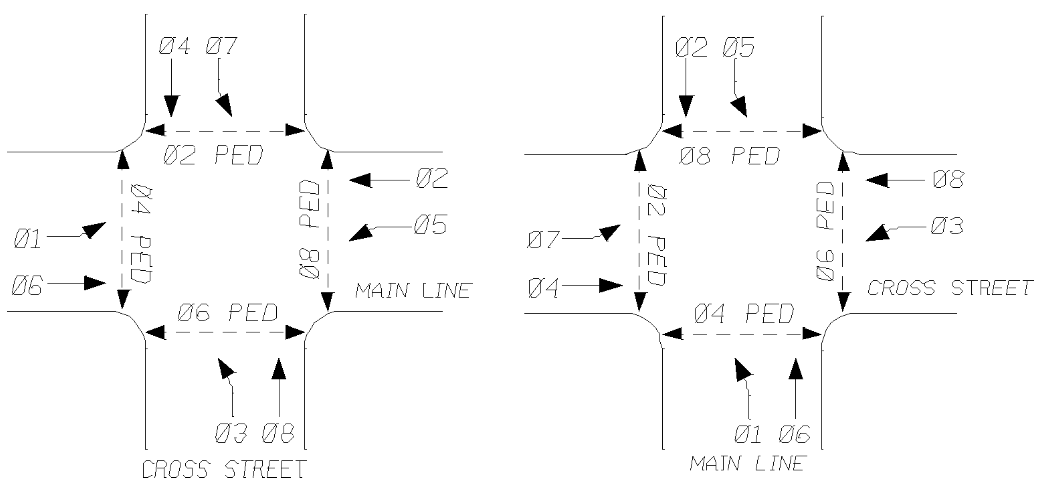
Figure 1.1. Ring Barrier Diagram



The phases are separated by what is referred to as a barrier, which prohibits the servicing of conflicting phases that are in separate rings simultaneously.

For standard traffic signal phasing the vehicular movements **shall** be referenced to the associated NEMA phase numbers as designated in Figure 1.2. The NEMA phase designation diagram represents an eight-phase signal operation with protected/permissive or protected-only left turns on all approaches. Pedestrian phasing, where applicable, *should* be designated by the complementary through movement phase associated with the specific pedestrian movement.

Figure 1.2. NEMA Phase Diagram



Phase 6 *should* normally be oriented in the mainline northbound or eastbound through direction for plan preparation purposes, with the remaining phases oriented according to the relationship illustrated in Figure 1.2.

For signals on a state trunk highway, NEMA phase designation **shall** be used. For example, mainline east-west through movements *should* be called out as Ø6 and Ø2, not just Ø2 (or just Ø6), and cross street through movements *should* be called out as Ø8 and Ø4, not just Ø8 or Ø4. In addition, left turn phasing *may* be added in the future. Due to this, eight-phase dual-ring controllers **shall** be used at state-owned signals.

STANDARD & SPECIAL OVERLAPS

Another factor related to phasing and head displays is the use of overlaps. There are two types of overlaps: standard overlaps and special overlaps. A Standard Overlap is defined as a right-of-way indication that allows traffic to turn when the right-of-way is assigned to two or more traffic phases. A Special Overlap is a non-standard overlap used to run a flashing yellow arrow which is tied to an opposing phase.

Standard Overlaps

Under this type of operation, for example, a right turn movement moves in conjunction with the complementary left turn movement from the crossing street. Typically, this type of operation is best utilized when there are exclusive lanes for each movement. This type of operation allows for efficient use of the green time for both streets by maximizing vehicle throughput. Standard Overlaps are also commonly used at interchanges, typically tying multiple complementary movements together across the interchange.

Right turn overlaps can be considered for use at locations where there is an exclusive right turn lane and a complementary left turn lane with a protected left turn phase on the crossing street. In areas where pedestrian demands are high, particularly in central business districts (CBDs), school crossings, or locations associated with special events, the use of right turn overlaps *should* be carefully evaluated with respect to pedestrian safety. In most cases, right-turn overlaps for these types of areas *should* be avoided.

Figure 1.3 illustrates the chart used for Standard Overlaps. This chart is located on the Sequence of Operations Sheet. The overlap *should* only be shown if it overlaps two (2) or more phases. The chart *should* indicate which phases the overlap times concurrently.

Figure 1.3. Standard Overlap Chart

O.L. "A" =
O.L. "B" =
O.L. "C" =
O.L. "D" =

Special Overlaps

Special Overlaps are non-standard overlaps used to control flashing yellow arrows for left or right turns tied to an opposing through phase.

The WMUTCD has instituted a requirement that green circular indications **shall not** be used in front of left turn lanes. Flashing yellow arrows (FYA) *should* be utilized by WisDOT for state owned signals to meet this requirement yet still provide either permissive only OR protected/permissive left turn and/or right turn movements. For right turn FYAs, the Region's Traffic Signal Engineer **shall** be contacted on how to setup the right turn FYA.

The operation of the FYA signal heads is straight forward; however, it does require some additional wiring and programming in the cabinet. The following information details how to complete a Sequence of Operations Sheet for a traffic signal with a flashing yellow arrow.

Flashing yellow arrows are handled in the controller via the use of a SPECIAL overlap. To simplify and standardize the cabinet wiring, each overlap has been assigned to a specific phase as follows depending on what type of cabinet is used (TS1 or TS2):

Table 1.1 Overlap Assignments – TS2 Cabinet, Mode G

Overlap	Left Turn Phase	Opposing Thru Phase
"E"	1	2
"F"	3	4
"G"	5	6
"H"	7	8

For additional modes (e.g., Mode B) and TS1 cabinet overlaps, see signal controller & cabinet manufacturer documentation.

If your design only has one or two FYA operations, you do not simply assign Overlaps E & F, but rather the overlap that is associated with that left turn phase and/or opposing through phase as listed in Table 1.1.

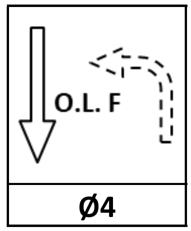
<u>Ring/Barrier Diagram:</u>

Permissive Only:

If your FYA is being operated in permissive mode only, your signal plan will show 3-section signal heads in the following configuration from top to bottom; red arrow, yellow arrow, flashing yellow arrow. The head numbers affiliated with these 3-section signal heads will be listed in the row for the associated overlap, only.

The overlap will graphically be shown in the same box as the arrow for the opposing through movement. It is recommended that this arrow either have a dotted/dashed pattern, or that it be hollow (with all other non-FYA arrows being filled in) to show that this is a flashing arrow, and not a green arrow (as shown in Figure 1.4).

Figure 1.4. Permissive Only FYA

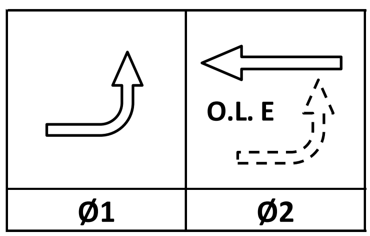


Protected / Permissive:

If your FYA is being operated in protected / permissive mode, your signal plan will show 4-section signal heads in the following configuration from top to bottom; red arrow, yellow arrow, flashing yellow arrow, green arrow. The head numbers affiliated with these 4-section signal heads will be listed in the row for the associated left turn movement **and** in the row for the associated overlap.

The overlap will graphically be shown in the same box as the arrow for the opposing through movement. It is recommended that this arrow either have a dotted/dashed pattern, or that it be hollow (with all other non-FYA arrows being filled in) to show that this is a flashing arrow, and not a green arrow (as shown in Figure 1.5).

Figure 1.5. Protected / Permissive FYA



OTHER TABLES

The Sequence of Operations Sheet contains several tables and charts. A complete description of the Detector Logic Chart and Controller Logic Chart is covered in TEOpS 4-8-2 and the Sequence of Operation Chart is discussed in TEOpS 4-7-1. Five tables have been created for special purposes; these are shown in Figure 1.6 below.

Figure 1.6. Sequence of Operations – Other Tables

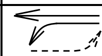
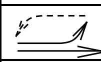
TYPE OF INTERCONNECT/COMMUNICATION	
NONE	
CLOSED LOOP	
TWISTED PAIR	
FIBER OPTIC*	
FIBER OPTIC (ETHERNET)	
RADIO	
CELL MODEM	

TYPE OF COORDINATION	
NONE	
TBC	
TRAFFIC RESPONSIVE	
ADAPTIVE	
*LOCATION OF MASTER CONTROLLER NO:	S-
SIGNAL SYSTEM NO:	SS-

TYPE OF PRE-EMPT	
NONE	
RAILROAD	
EMERGENCY VEHICLE	
GTT	
TOMAR	
HARDWIRE	
OTHER	
LIFT BRIDGE	
QUEUE DETECTION	

TYPE OF LIGHTING	
BY OTHER AGENCY	
IN TRAFFIC CABINET	
IN SEPARATE DOT LIGHTING CABINET	

EMERGENCY VEHICLE PREEMPTION SEQUENCE

EMERGENCY VEHICLE PREEMPTOR	A	B	C	D
MOVEMENT				
PHASE	2+5	6+1	4+8	8+3

The main purpose of these tables is to indicate what additional equipment *may* be installed at the intersection. These tables *should* always be filled in.

TYPE OF COORDINATION AND TYPE OF COMMUNICATION TABLES

Coordinating traffic signals requires several additional coordination settings to be made in the controller. The type of coordination *should* be indicated with an "X." If the type of coordination is other than TBC, then the master signal controller location **shall** be identified by the signal number.

Designate, with an “X”, the type of communication at the intersection in the Type of Communication Table.

TYPE OF PREEMPT AND EVP SEQUENCE TABLES

Use of a preempt device at some locations provides additional safety for both the motorist and preempt authority (i.e. railroad, emergency vehicle). The type of preempt *should* be indicated with an "X."

If railroad preemption is installed at the intersection, in addition to filling out the Type of Preempt Device Table, one *should* include a general note on the Sequence of Operations Sheet. The note *should* describe the preempt sequence beginning at the track clearance green through the preempt cycle. The note *should* describe the phases and sequence used at the intersection when the signal is preempted. A sample railroad preemption note is shown below:

> *IN THE EVENT OF A RAILROAD PREEMPTION CALL, PHASE 8 SHALL RECEIVE A GREEN INDICATION TO CLEAR THE SOUTH APPROACH. FOLLOWING THE TRACK CLEARANCE INTERVAL, THE CONTROLLER SHALL ADVANCE TO PHASES 2 & 6 GREEN AND HOLD FOR THE DURATION OF THE PREEMPTION. AT THE END OF THE PREEMPTION, THE CONTROLLER SHALL RETURN TO PHASES 4 & 8 GREEN.*

For Emergency Vehicle Preemption (EVP), emergency vehicle in the Type of Preempt Table and the brand of EVP equipment *should* be checked and the EVP Sequence Table *should* be filled in.

Additional discussion on the preemption of State signals; including eligibility, request procedure, review/approval, installation, and cost is covered in TEOpS 4-2-3.

TYPE OF LIGHTING TABLE

Designate with an "X" the type of lighting service installed at the intersection. It is important to indicate whether lighting is wired into the traffic signal cabinet or to a separate lighting cabinet. If state and local lighting exist at same intersection, multiple boxes **shall** be checked to reflect maintaining authority for all lighting.

FLASHING YELLOW ARROW

For information about flashing yellow arrows, see TEOpS 4-7-1 Standard & Special Overlaps, Special Overlaps topic.

4-7-2 Left Turn Phasing April 2025

Adding phases leads to an increase in cycle length and delay and decreases intersection efficiency, especially at pre-timed signals. In addition, adding non-warranted left turn phases *may* impact driver perception and lead to requests for left turn phases at other non-warranted locations. Left turn phasing *should* be determined early in the design process, prior to completing the capacity analysis and starting geometric design.

Left turn phases *should* be considered on approaches when:

- Visibility is limited. Queue spillback occurs into adjacent through lane
- Left turn queue does not consistently clear during permissive green.
- There exists a left turn delay of 2.0 vehicle hours or more in a peak hour on a critical approach.
- The left turn crash experience meets or exceeds: for one approach, four left turn crashes in one year or six in two years; or for opposing approaches, six left turn crashes in one year or ten in two years. Analysis **shall** include review of past 5 years of crash records. This will allow the engineer to determine if crash patterns exist, and what circumstances *may* be involved.
- The product of a left turning volume and its opposing through, and right-turn volume meet or exceed the minimum requirements given in the table below during the peak hour. All opposing through traffic including right turns *should* be considered unless the right turns are well removed from the intersection.

The number of phases at signalized intersections *should* be kept to a minimum.

Minimum Vehicular Volumes for Left Turn Analysis

Number of left turn lanes	Number of opposing through lanes	Product of peak hour left turning vehicles and opposing plus right-turn vehicles
1	1	50,000
1	2	100,000
1	3 or more	Engineering Judgement

In any case, left turn phasing **shall** be approved by the Regional Traffic Engineer.

Typically, separate opposing or positively offset left turn lanes *should* be provided on all approaches to allow for simultaneous leading left turn phases now and in the future. If the geometrics cannot be improved to allow simultaneous leading left turn phases, then alternative phasing could be considered (Such as “Split” or a “Lead-Lag Protected-Only Left”) to avoid the conflict. These phasing alternatives are not desired, therefore **shall** only be considered as last resort in extreme cases. These alternatives are inefficient, especially if there are pedestrian phases on both approaches of a street. Geometric improvements **shall** always be explored first.

In most cases, protected/permissive left turn phasing *should* be tried prior to installing protected only phasing. Installing protected/permissive phasing rather than protected only phasing typically results in increased intersection capacity and decreased intersection delay and driver frustration.

Protected only by time-of-day *may* also be an option when opposing through traffic is high at consistent, predicted times.

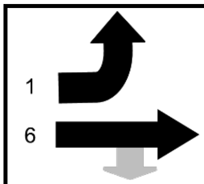
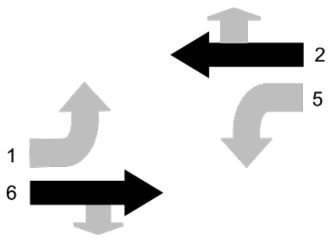
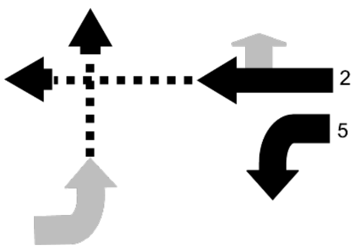
Protected only phasing *should* be used to control to control dual left turn lanes and **shall** be used to control triple left turn lanes. In addition, protected only phasing *should* be considered in cases where visibility of opposing thru traffic to left turning vehicles is not sufficient to allow for a safe movement and improving the geometrics is not feasible. This typically occurs with wide medians where left turn lanes are not opposing or positively offset. When protected only phasing is installed on one approach the opposing approach **shall** have protected only phasing **or** a flashing yellow arrow due to driver perception and safety.

Protected only left turn phasing *should* also be considered at locations with higher operating speeds (greater than 45 mph), when left-turn movements need to cross more than two opposing through lanes and when crash trends dictate.

Typically, left-turn phases are leading.

Lagging protected/permissive left turn phasing **shall not** be utilized as it creates a dangerous situation often referred to as a “left turn trap” or “yellow trap”. Figure 2.1 shows the phase intervals for this situation. Three exceptions are as follows; at T-intersections, at interchange ramp terminals where no opposing left turn movements exist, and when flashing yellow arrows are utilized for the protected/permissive left turn.

Figure 2.1. Left turn trap diagram

	**Interval 1**: Phase 1 eastbound shows protected left turn arrow while phase 6 eastbound through shows a green ball.
	**Interval 2**: Phase 1 eastbound and phase 5 westbound show permissive left turn (flashing yellow arrow or green ball) while phase 2 and phase 6 through shows green ball. At the end of interval 2, phase 1 displays a yellow indication. Since the eastbound left sees the yellow on all facing displays, they *may* incorrectly presume that westbound left and through is likewise receiving a yellow ball and about to stop.
	**Interval 3**: Phase 5 westbound shows protected left westbound turn arrow while phase 2 westbound through shows green ball. Eastbound left *may* have assumed the westbound through was stopping creating a crash situation.

Lead-lag left turn phasing *may* be utilized only when there is protected only phasing on both approaches of a street. This phasing sequence can be advantageous when used on a coordinated street as it has the potential to maximize two-way progression. An example of this sequence is: NB leading protected left phase and NB through phase followed by the NB and SB through phases, followed by the SB lagging left phase and SB through phase.

4-7-4 Flashing Operations April 2025

Reference is made to the WMUTCD, Section 4G, and Wisconsin State Statute 346.37 and 346.39.

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 an 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.

4-7-5 Vehicle Clearance Intervals — April 2025

Reference is made to the WMUTCD 4F.17.

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 WMUTCD, 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.

<u>Kinematic Method</u>

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:

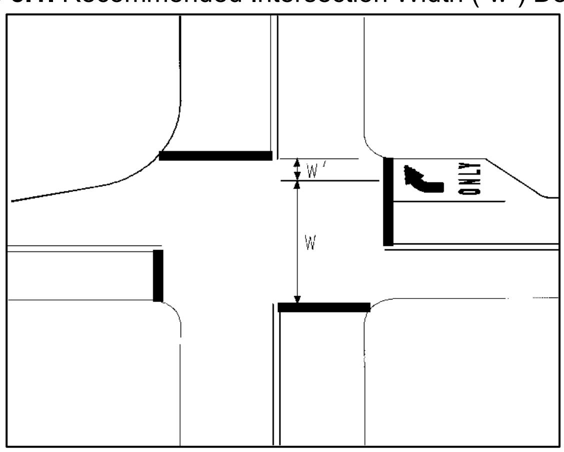
$$CT = prt + \frac{v}{2a+2Gg} + \frac{L+w}{v}$$

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

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 5.1. 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 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 5.1. 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 5.2. Yellow Clearance Intervals at Deceleration Rate of 15 fps^2

Approach	Approach Grade								
Speed (mph)	+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 5.3. All-Red Clearance Intervals

Approach	Intersection Width (ft)								
Speed (mph)	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 near 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 near 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 using 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.

4-7-6 Traffic Signal Coordination and Communication — April 2025

"Signal systems…are proven to reduce stops, reduce delays and decrease accidents; increase average travel speeds; and decrease emissions." (ITE Traffic Control Devices Handbook, pg. 336, © 2001 Institute of Transportation Engineers). There are several parameters that affect coordinated signal system efficiency: spacing, vehicle travel time, cycle length, offset, splits, and phasing. The primary factors to consider for coordination of signals are spacing of signalized intersections, traffic characteristics, and signal operations.

When signalized intersections are spaced closer than a half-mile coordination **shall** be considered. This will usually include arterial segments and interchanges. Signalized intersections spaced less than a quarter mile can be coordinated but it *may* be difficult to maintain ideal two-way progression when closely spaced. Signals that are spaced greater than a half mile *should* also be considered for coordination if traffic progression can be maintained.

Traffic characteristics will also influence the decision to coordinate adjacent signals. Random arrival patterns and/or relatively light approach demand *may* indicate the need to coordinate signals only during certain times. Alternatively, heavy volumes with repetitive patterns such as commuter routes, *may* have variable timing plans throughout a day.

Regardless of existing volumes and turning movements, plans *should* include provisions for future coordination at closely spaced intersections. Such provisions will depend on the type of coordination but will commonly include a conduit run between controller cabinets to accommodate future interconnect cable.

There are multiple ways to provide coordinated systems; however, most state-owned systems will consist of Time-Based Coordination (TBC), traffic-responsive coordination, or adaptive coordination.

TBC uses the functionality of the internal controller clocks without a physical connection between control cabinets. Clocks need to be synchronized for TBC to be effective. This type of coordination utilizes minimal infrastructure yet *may* require a more significant effort from operations staff to maintain proper coordination.

Traffic-responsive and adaptive coordination requires communications between controllers. This can be achieved by radio, phone line (tone), twisted pair, fiber optic, or cellular modem. Fiber optic is the most common in urbanized areas where connection to the fiber backbone is possible. This type of connection requires a conduit run between each control cabinet with pull boxes and/or communication vaults spaced along the run. Cellular modem is most common in rural areas. Closed Loop systems have the added functionality of being remotely accessed for program changes and timing plan verification.

There are several methods for providing specialty equipment used for signal coordinated signal systems:

- Intersections where signals will be in the future. At such locations, underground facilities *should* be installed with an improvement project or permit project (TIA process). The underground facilities generally consist of conduit runs across the intersection approaches, some pull boxes, and *may* include some loop installations. These intersection locations will usually be cited based on an engineering study where warrants are close to being met, or at locations where adjacent properties are developing.

  At such locations, conduit *may* be installed between future controller cabinet locations (typically on the side of the highway segment). Common practice is to base the need for this equipment based on spacing between adjacent intersections that *may* become signalized. It is worth remembering that these electrical facilities will need to be included in the Regional database for purposes of marking them in the field during any construction activities.

- Intersections where signals are proposed. If an engineering study determines that a signal will benefit intersections operations, yet it will need to be interconnected with an adjacent signal installation, common practice is to fund and implement any interconnection provisions with that signal.

  If the installation cannot be provided for by an improvement project or is not the result of changes to the adjacent land use, The Regional operations budget *may* be used to fund candidate locations. Highway Safety Improvement Program (HSIP) or Signals and ITS Standalone Program (SISP) funds *may* also be applied for on a case-by-case basis.

- Intersection where signals exist. Funding opportunities are the same as bullet above.

4-7-7 Preemption of Traffic Signals near Railroad Grade Crossings April 2025

GENERAL

Reference is made to WMUTCD Section 4D.27 and Section 8D.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 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.

Preemption Timing

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).

For additional guidance, refer to ITE's Recommended Practice on Preemption of Traffic Signals Near Railroad Grade Crossings.

Right-of-way Transfer Time and Pedestrian Clearance Intervals

Right-of-way transfer time is the maximum amount of time needed by the traffic signal system to safely exit any vehicular or pedestrian phase. According to WMUTCD 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. Minimum vehicular green times at actuated signals *should* be at least five seconds to allow drivers to react to the change in right-of-way and enter into the intersection. Additionally, according to WMUTCD Section 4D.27, pedestrian WALK and/or pedestrian change intervals *may* be shortened or omitted in order to begin the track clearance interval earlier. This practice, however, is not preferred since pedestrians may have begun crossing prior to preemption and be located in the driver's lane forcing them to yield to the crossing pedestrians. If a vehicle is unable to move while the pedestrian completes their crossing, this increases the amount of time it will take to clear a design vehicle off the tracks WisDOT standard practice is to set WALK time to zero (0) and reduce the FLASHING DON'T WALK time by calculating the necessary crossing time from gutter to gutter using the walking speed of 4 feet per second and subtracting off the yellow and all red time.

Eliminating the Left Turn Trap

When protected/permitted left turn phasing is used during the track clearance phase, special consideration *should* be taken to eliminate the possibility of the left-turn trap at the onset of railroad preemption. This possibility exists when the traffic signal is serving the track clearance phase and opposing through phase, and the opposing left turn is in a permissive operation. WisDOT standard practice is to exit all phases (ensuring min green as well as full yellow and all red clearance are displayed) before initiating the track clearance phase. Most modern controllers have a setting that will force the all-red prior to serving a track clearance phase.

Joint Annual Inspection of Signalized Intersections with Railroad Preemption

WMUTCD 8D.09 states, "Regular joint inspections by the highway agency or authority with jurisdiction, the regulatory agency with statutory authority, if applicable, and the railroad company or transit agency are a best practice and typically include verification of the preemption operation, the amount of warning time and/or preemption time being provided by the grade crossing warning system, and the timing of the highway traffic signals interconnected and/or coordinated with the flashing-light signals."

Furthermore, the Office of the Commissioner of Railroads (OCR), Wisconsin's regulatory agency with statutory authority, instituted a requirement in 2023 that all traffic signals with railroad preemption be inspected annually.

At a minimum, the joint annual preemption inspection team **shall** consist of an individual representing the traffic signal operating agency and an individual representing the railroad authority. The purpose of the inspection is to verify that the preemption system still operates as designed. Therefore, it is imperative that each party involved in the inspection thoroughly understands how their component of the preemption system is designed and expected to operate.

Observation of a live train movement, while beneficial, is not required as part of a joint annual inspection. The railroad operating agency can simulate a train movement in a variety of ways. The inspection team should discuss the options and select a methodology that best meets the goals of the inspection.

The traffic signal operating agency and the railroad operating company each have a form they **shall** complete and sign. The majority of the information on the forms should be completed in advance of the field work. This allows each party to refamiliarize themselves with the intended design and operation of their system. As a result, time spent in the field can be focused on verifying these operations.

The traffic signal operating agency **shall** submit their form (Form 1a) to the railroad. The railroad **shall** combine their form (Form 1b) with Form 1a in a single PDF and submit this final document to OCR via their E-Services Portal. Figures 2 & 3 provide a visual of these forms and fillable forms can be found online (Figure 2 Inspection 1a form, Figure 3 Inspection 1b form). Instructions on how to complete the form are also provided.

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

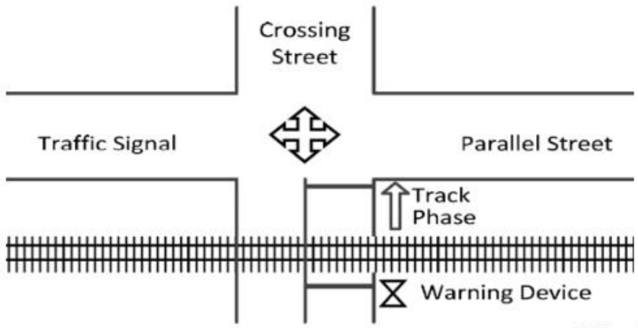
Version 1.4
(Rev. 2/22)

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

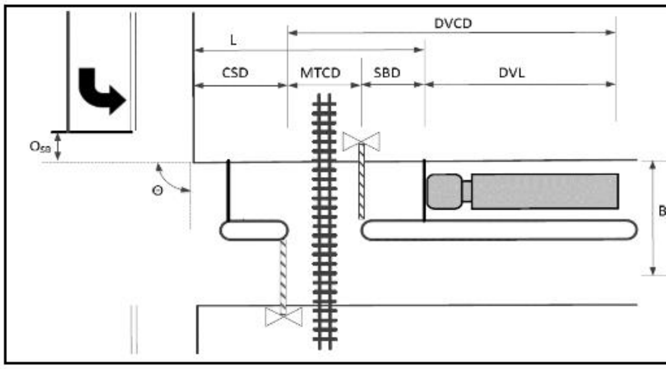
Crossing Street Name

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

Preempt 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:

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Figure 2. WisDOT Railroad Preemption Inspection Form 1a
(to be completed by the Traffic Signal Operating Agency)

WisDOT RAILROAD PREEMPTION INSPECTION FORM 1a

(to be completed by the TRAFFIC SIGNAL OPERATING AGENCY)

1. REVIEW TEAM

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

2. LOCATION DATA

HIGHWAY INTERSECTION:		MUNICIPALITY:	COUNTY:
TRAFFIC SIGNAL OPERATING AGENCY:	SIGNAL ID:	SIGNAL CONTACT:	SIGNAL CONTACT PHONE:
RAILROAD OPERATING COMPANY:	RR CROSSING ID:	RAILROAD CONTACT:	RR CONTACT PHONE:
TRAFFIC SIGNAL EMERGENCY CONTACT NUMBER:		RAILROAD EMERGENCY CONTACT NUMBER:	

3. TRAFFIC SIGNAL DATA

CABINET TYPE:	CONTROLLER MAKE & MODEL:	TYPE OF PREEMPTION:	OTHER TYPE OF PREEMPTION:
☐ TS1 ☐ TS2		☐ Advanced ☐ Simultaneous	☐ Emergency ☐ Bus/Transit

AVAILABLE CIRCUITS:	USED CIRCUITS:
☐ APP ☐ AP ☐ GD ☐ HC ☐ SIM ☐ SUP ☐ XR	☐ APP ☐ AP ☐ GD ☐ HC ☐ SIM ☐ SUP ☐ XR

VEHICULAR PHASES PRESENT:	PEDESTRIAN PHASES PRESENT:	OTHER PHASES PRESENT:
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8	☐ 2 ☐ 4 ☐ 6 ☐ 8	

DOES RR PREEMPT HAVE PRIORITY?	BLANKOUT SIGNS PRESENT?	BATTERY BACKUP PRESENT?
☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No	☐ Yes ☐ No

4. DESIGN RAILROAD PREEMPTION PHASING SEQUENCE

WORST CASE PHASES:	TRACK CLEAR PHASE(S):	PREEMPT DWELL PHASES:	PREEMPT CYCLE PHASES:
Veh: Ped:			

5. 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 + Red:	sec.	sec.	sec.	
Max Right of Way Transfer Time:	sec.	sec.		
Track Clear Min Green:	sec.	sec.	sec.	
Track Clear Ext Green:		sec.	sec.	
Track Clear Max Green:		sec.		
Min Dwell:		sec.	sec.	
Dwell Preemption Ext:		sec.	sec.	

6. FIELD TESTING AND INSPECTION

		NOTES
Are the blankout signs working properly?	☐ Yes ☐ No ☐ N/A	
Does a preempt call trigger a right-of-way transfer?	☐ Yes ☐ No	
Does a protected arrow come up for track clearance?	☐ Yes ☐ No	
Does gate down release the track clearance phase?	☐ Yes ☐ No ☐ N/A	
Do the proper cycle & dwell phases operate?	☐ Yes ☐ No ☐ N/A	
Is the preempt call released as expected?	☐ Yes ☐ No	
Does the signal exit to the proper phase(s) after preempt?	☐ Yes ☐ No	
Does preempt reservice activate?	☐ Yes ☐ No	
Is emergency contact information posted in the cabinet?	☐ Yes ☐ No	

7. OTHER INFORMATION/NOTES

Figure 3. WisDOT Railroad Preemption Inspection Form 1b
(to be completed by the Railroad Operating Company)

WisDOT RAILROAD PREEMPTION INSPECTION FORM 1b

(to be completed by the RAILROAD OPERATING COMPANY)

1. REVIEW TEAM

RAILROAD INSPECTION COMPLETED BY:		INSPECTION DATE:	
SIGNATURE:		DATE OF LAST INSPECTION:	

2. LOCATION DATA

HIGHWAY INTERSECTION:		MUNICIPALITY:	COUNTY:
TRAFFIC SIGNAL OPERATING AGENCY:	SIGNAL ID:	SIGNAL CONTACT:	SIGNAL CONTACT PHONE:
RAILROAD OPERATING COMPANY:	RR CROSSING ID:	RAILROAD 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 ☐ Flashing Light Signals ☐ None		
MAXIMUM TRAIN SPEED (MPH):		SPEED RANGE OVER CROSSING (MPH):	
NUMBER OF TRAINS PER DAY:		NUMBER OF TRACKS:	
AVAILABLE CIRCUITS:		USED CIRCUITS:	
☐ APP ☐ AP ☐ GD ☐ HC ☐ SIM ☐ SUP ☐ XR		☐ APP ☐ AP ☐ GD ☐ HC ☐ SIM ☐ SUP ☐ XR	

4. RAILROAD EQUIPMENT TIMING

RAILROAD SETTINGS	DESIGNED		MEASURED (sec.) MIN	AVG	MAX	NOTES
Equipment Reaction Time (ERT):		sec.				
Advance Pedestrian Preemption Time (APPT):		sec.				
Advance Preemption Time (APT):		sec.				
Minimum Warning Time (MWT):		sec.				
Clearance Time (CT):		sec.				
Buffer Time (BT):		sec.				
Total Warning Time (MWT + CT):		sec.				
Total Time (APPT + APT + MWT + CT):		sec.				
TOTAL TRAIN MOVEMENTS ANALYZED:		DATE RANGE FOR TRAIN MOVEMENTS:				

5. FIELD TESTING AND INSPECTION

		NOTES
Do the flashing light signals operate as expected?	☐ Yes ☐ No ☐ N/A	
Do the railroad gates operate as expected?	☐ Yes ☐ No ☐ N/A	
Is emergency contact information posted in the bungalow?	☐ Yes ☐ No	

6. OTHER INFORMATION/NOTES

4-7-9 Emergency Vehicle Preemption and Traffic Signal Priority April 2025

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

POLICY

Statutory Provisions

Traffic control signal preemption and priority devices. (2m) An authorized emergency vehicle *may* be equipped and operated with lamps designed and used, or with any other transmitter designed and used, to activate traffic control signal preemption devices. (2r) A snow removal vehicle equipped with oscillating, rotating, or flashing lights that is actively engaged in snow removal activities *may* be equipped and operated with lamps designed and used, or with any other transmitter designed and used, to activate traffic control signal priority devices (3m) The lamps authorized for use under this section *may* be any color and *may* be flashing, oscillating, rotating or pulsating. (4) No operator of an authorized emergency vehicle *may* use a transmitter, including lamps under sub (2m), 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 and snow removal services is eligible to request an EVP or TSP 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 / TSP 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 / TSP 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 / TSP 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 / TSP 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 / TSP 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. If 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.

<u>Installation & Maintenance</u>

1. Department forces **shall** perform the installation, maintenance, modification, or removal of the EVP / TSP 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 to service the EVP / TSP system equipment located at 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 / TSP 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 / TSP system by performing a field test using an emergency vehicle equipped with an EVP emitter device and/or snow removal vehicle equipped with a TSP emitter device. The local unit is responsible for periodically checking the EVP / TSP equipment.
6. In the event of a construction project, EVP / TSP service **shall** be maintained at any intersection with permanent EVP / TSP agreements. In addition, EVP / TSP 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.

<u>Operation/Phase Timing</u>

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 / priority 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.

<u>Driver Training</u>

1. The local unit **shall** be responsible for training the emergency services and snow removal 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 or snow removal vehicle at the beginning of this policy
   b. The conditions when preemption or priority *may* be used
   c. The use of preemption / priority does not remove the responsibility of the vehicle operator from determining whether it is safe to enter the intersection
   d. The operator cannot assume that the preemption / priority 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.

<u>Cost</u>

1. The most common source of funding for a complete EVP / TSP system has been local funds or federal urban funds. However, EVP / TSP 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 <u>Program Management Manual 3-25-5</u> 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 / TSP system at the traffic signal unless nonstandard EVP / TSP 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 / TSP system on temporary signals or on a temporary route during a construction project **shall** be borne by the project.

WISCONSIN DEPARTMENT OF TRANSPORTATION

Emergency Vehicle Pre-emption (EVP) and Traffic Signal Priority (TSP) 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) and/or Traffic Signal Priority (TSP) 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 / TSP equipment shall be provided by WisDOT/Local Agency.

The Department's Policy for *Use of Emergency Vehicle Pre-emption (EVP) and Traffic Signal Priority (TSP) 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 ______________________________