ORIGINATOR Director, Bureau of Traffic Operations	4-2-34
CHAPTER 4	Signals
SECTION 2	Traffic Control Signals
SUBJECT 34	Signal Sequencing During Railroad Preemption

A. General

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

Modern signal controllers are capable of providing alternate phasing/timing plans based on train operations. Once it has been determined that a highway-rail grade crossing flashing light signal system will be interconnected with adjacent traffic signals, the traffic signal controller *should* be programmed to run an alternate sequence during railroad preemption.

Highway-rail grade crossings can be occupied by trains for extended periods of time depending on a number of operating conditions including: reduced train speeds, train length, and/or switching movements. During the time a train is located within the approach circuit and the traffic signals remain under preempted control, any non-conflicting vehicular traffic *should* be served using specialized phasing (a.k.a. railroad preemption sequencing or railroad hold sequencing) to reduce vehicular delay.

B. Policy

Even if trains are not expected to occupy crossings for long periods, signal controllers *should* be programmed to run two preemption sequences. The first preemption sequence **shall** initiate a phase to clear the tracks before the train reaches the crossing. This advanced preemption places a call in the traffic signal controller to transfer right-of-way from the current phase to the track clearance phase(s) or hold if already in those phases, prior to activating the railroad warning devices.

The second preemption sequence *should* begin once the controller receives the gate down call from the railroad bungalow, a set time after the gate down notification, or after the track clearance green interval plus the additional time to prevent turning the signal red prior to gate down. At the onset of the second preemption or if the crossing enters fail-safe mode, a constant call **shall** be placed in the signal controller causing the signal to remain preempted. At that time, the signal controller *should* be programmed to operate a sub-routine to serve traffic that does not move toward the tracks. Either blank-out signs or a red signal indication *should* prohibit vehicles from moving toward the tracks.

According to MUTCD 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 *may* be shortened to display the track clearance phase as early as possible. Minimum vehicular green times at actuated signals *should* be at least 5-seconds to allow drivers to react to the change in right-of-way and enter into the intersection.

According to MUTCD 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 is not preferred since drivers might yield to crossing pedestrians thereby preventing subsequent vehicles from clearing the tracks.

Shortened or omitted pedestrian clearance intervals are typically found in legacy systems where providing the full pedestrian change interval required a substantial increase in cost for the railroad track circuit.

For new signal designs, pedestrian clearance intervals *should not* be shortened or omitted unless all other methods to reduce the length of advance preemption time have been considered. Calculated pedestrian clearance time *may* include the yellow change interval and the red clearance interval to help satisfy the advance preemption requirements.

It is important to recognize the preemption capabilities of different signal controllers and firmware because they vary from one model or manufacturer to another. Some controllers allow minimum green times and pedestrian clearance times to be shortened during railroad preemption sequencing and others do not.

When a train no longer occupies the highway-rail grade crossing, the signal *should* serve the preempted approach immediately following preempted control before serving the mainline left-turn movements or mainline through movements if there are no left-turn phases. Additionally, the controller *should* be programmed to place calls on all initiated NEMA phases upon exiting preemption.

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

Eliminating the Left Turn Trap

When a protected/permitted phasing sequence is used for the track clearance phase, special consideration *should* be taken to eliminate the possibility of the left turn trap at the onset of railroad preemption.

For example, if the preempted approach is already green when the preemption call is received (best case scenario), the signal *should* finish servicing the minimum green time and yellow change interval before going into an all red sequence. After the all red sequence, the track clearance phase(s) *should* display a left turn green arrow and a green ball indication. This will allow the track clearance phase to serve a protected left turn movement and eliminate a left turn trap condition.

Inspection of Signal Sequencing During Railroad Preemption

State-maintained 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 inspection **shall** be forwarded to the Grade Crossing Safety Engineer at the WisDOT Railroads & Harbors Section (RHS) in the Bureau of Transit & Local Roads (BTLR). The annual Highway-Railroad Preemption Inspection Form is provided in Figure 1.

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.

The point at which preemption is released from the railroad active warning devices to the traffic control signals is critical to the proper operation of preemption re-service. In order for the traffic signal controller to recognize the second train, the preempt call for first train must be released. The railroad active warning devices must release the preempt call just as the gates begin to raise, otherwise traffic *may* drive under the ascending gates and this traffic must be cleared in the event of a second train.

C. Support

According to MUTCD Section 4D.27, “Traffic control signals operating under preemption control or under priority control *should* be operated in a manner designed to keep traffic moving.”

WisDOT RAILROAD PREEMPTION INSPECTION FORM

1. REVIEW TEAM

TRAFFIC SIGNAL INSPECTION COMPLETED BY:	(include name & email)	INSPECTION DATE:	
RAILROAD INSPECTION COMPLETED BY:		DATE OF LAST INSPECTION:	

2. LOCATION DATA

HIGHWAY INTERSECTION:

TRAFFIC SIGNAL OPERATING AGENCY:	WisDOT SIGNAL NO: (ex. S1056)	MUNICIPALITY:	COUNTY:
RAILROAD OPERATING COMPANY:	RR CROSSING ID: (ex. 391768X)	RR CONTACT:	RR CONTACT PHONE:

3. RAILROAD DATA

ACTIVE WARNING DEVICES:
☐ 4-Quadrant Gates ☐ 2-Quadrant Gates ☐ Flashers

TYPE OF TRAIN DETECTION:	GATE-DOWN LOGIC: ☐ Yes ☐ No ☐ Not to exceed timer
MAXIMUM TRAIN SPEED (MPH):	SPEED RANGE OVER XING (MPH):
NUMBER OF TRAINS PER DAY:	NUMBER OF TRACKS:

NUMBER OF BROKEN GATES SINCE PREVIOUS INSPECTION? (explain)

DATE OF MOST CURRENT RAILROAD PLANS (in bungalow):

4. TRAFFIC SIGNAL DATA

CABINET TYPE: ☐ TS1 ☐ TS2	CONTROLLER MAKE & MODEL:
TYPE OF SIGNAL PREEMPTION: ☐ Advanced ☐ Simultaneous	TYPE OF SIGNAL OPERATION: ☐ Pretimed ☐ Actuated ☐ Coordinated System
OTHER TYPES OF PREEMPTION: ☐ Emergency Vehicle ☐ Bus/Transit	DOES RR PREEMPT HAVE PRIORITY? ☐ Yes ☐ No
GATE DOWN LOGIC INSTALLED? ☐ Yes ☐ No	

ROADWAY OR SIGNAL MODIFICATIONS SINCE PREVIOUS INSPECTION:

BATTERY BACKUP PRESENT? ☐ Yes ☐ No	BATTERY AGE (in service reports):
TYPE OF COMMUNICATIONS DURING BATTERY BACKUP:	

5. RAILROAD PREEMPTION PHASING SEQUENCE

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

6. RAILROAD EQUIPMENT PROGRAMMED TIMINGS

Preempt Verification and Controller Response Time:	0 sec.
Advance Preemption Time:	0 sec.
Minimum Warning Time:	0 sec.
Additional Clearance Time: (overspeed tolerance, wide/angled crossings)	0 sec.
Buffer Time:	0 sec.
Total Warning Time (Minimum Warning Time + Clearance Time + Buffer Time):	0 sec.

7. NOTES

8. FIELD TESTING AND INSPECTION

BLANKOUT SIGNS PRESENT AND WORKING PROPERLY?	☐ YES ☐ NO	IF INSTALLED, BATTERY BACKUP WORKING PROPERLY?	☐ YES ☐ NO				
DOES PREEMPT RESERVICE ACTIVATE? (see instructions)	☐ YES ☐ NO	PROTECTED ARROW FOR TRACK CLEARANCE?	☐ YES ☐ NO				
Test #		Example	1	2	3		
Train's Direction of Travel		EB					
Signal Phase Active During Preempt Call		2 / 6					
		CUMULATIVE TIME (sec)					
Preempt call received (blank out signs turn on) at		0	0	0	0		
Begin track clearance green at		0					
Railroad flashers activated at		35					
Gate descent started at		38					
Gate descent completed at		50					
End of track clearance green (start of track clearance yellow) at		50					
Train arrived at		56					
Railroad flashers deactivated at		240					
Measured Total Warning Time:		56 - 0 = **56**					
Preempt call released from signal controller at begin of gate ascent:		☑ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO		
Railroad equipment and lamps functioned:		☑ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO		
Track clearance and preempt dwell phases operated as expected:		☑ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO		

Figure 1a. WisDOT Railroad Preemption Inspection Form

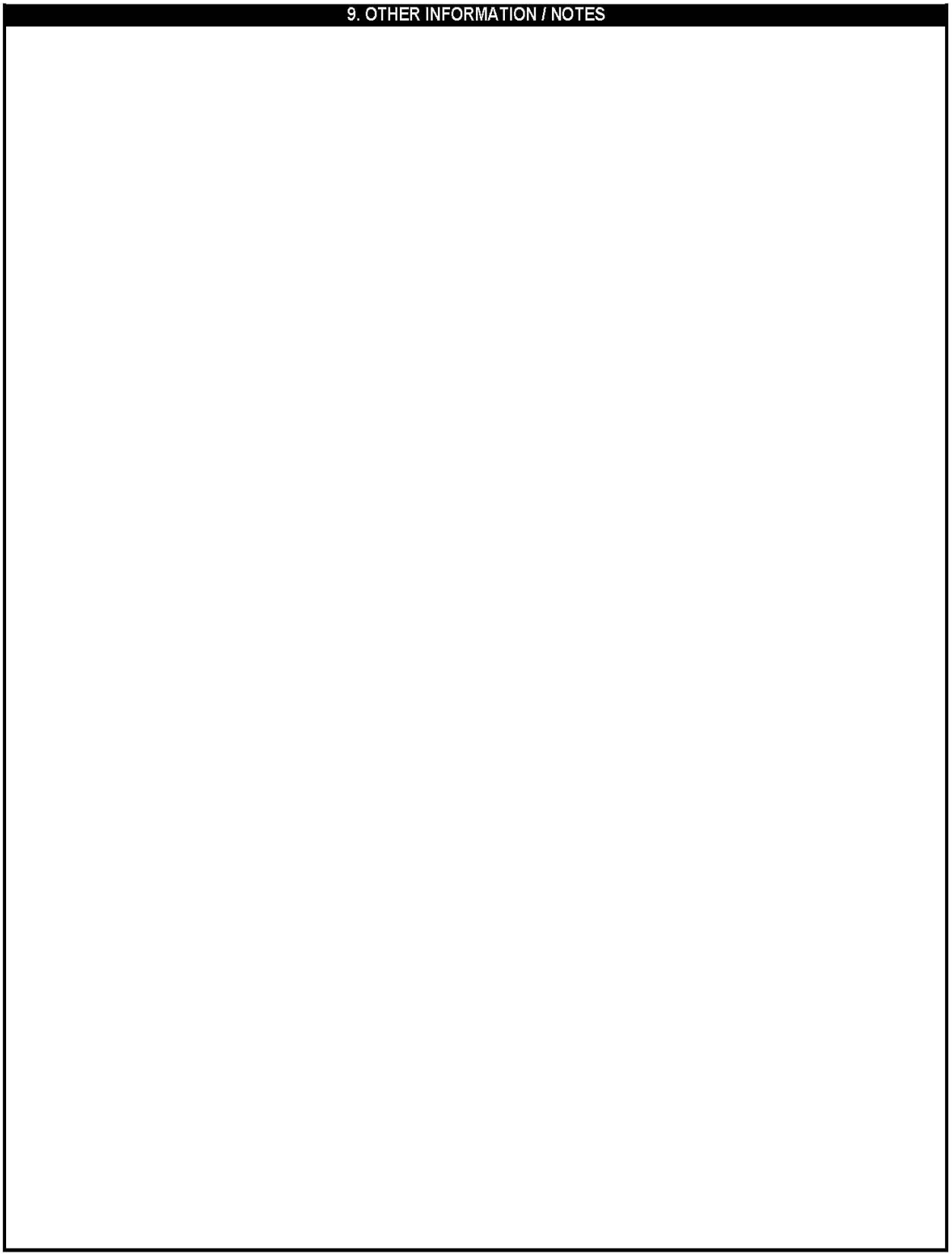

Figure 1b. WisDOT Highway-Railroad Preemption Inspection Form