Mead & Hunt | EXPERIENCE EXCEPTIONAL

NRITS National Rural Intelligent Transportation Systems Conference + Exhibit

ite Portland 23 Annual Meeting and Exhibition August 13-16, 2023

Joint Annual Inspections Save Lives: Case Studies from the Midwest

August 15, 2023

October 25, 1995 – Fox River Grove, IL

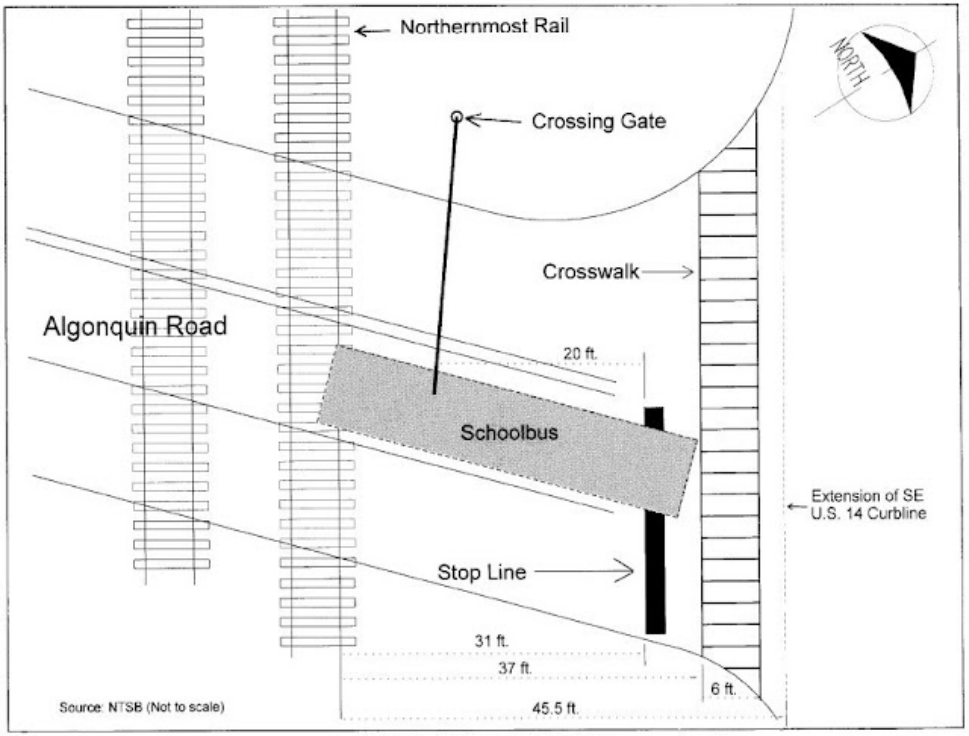
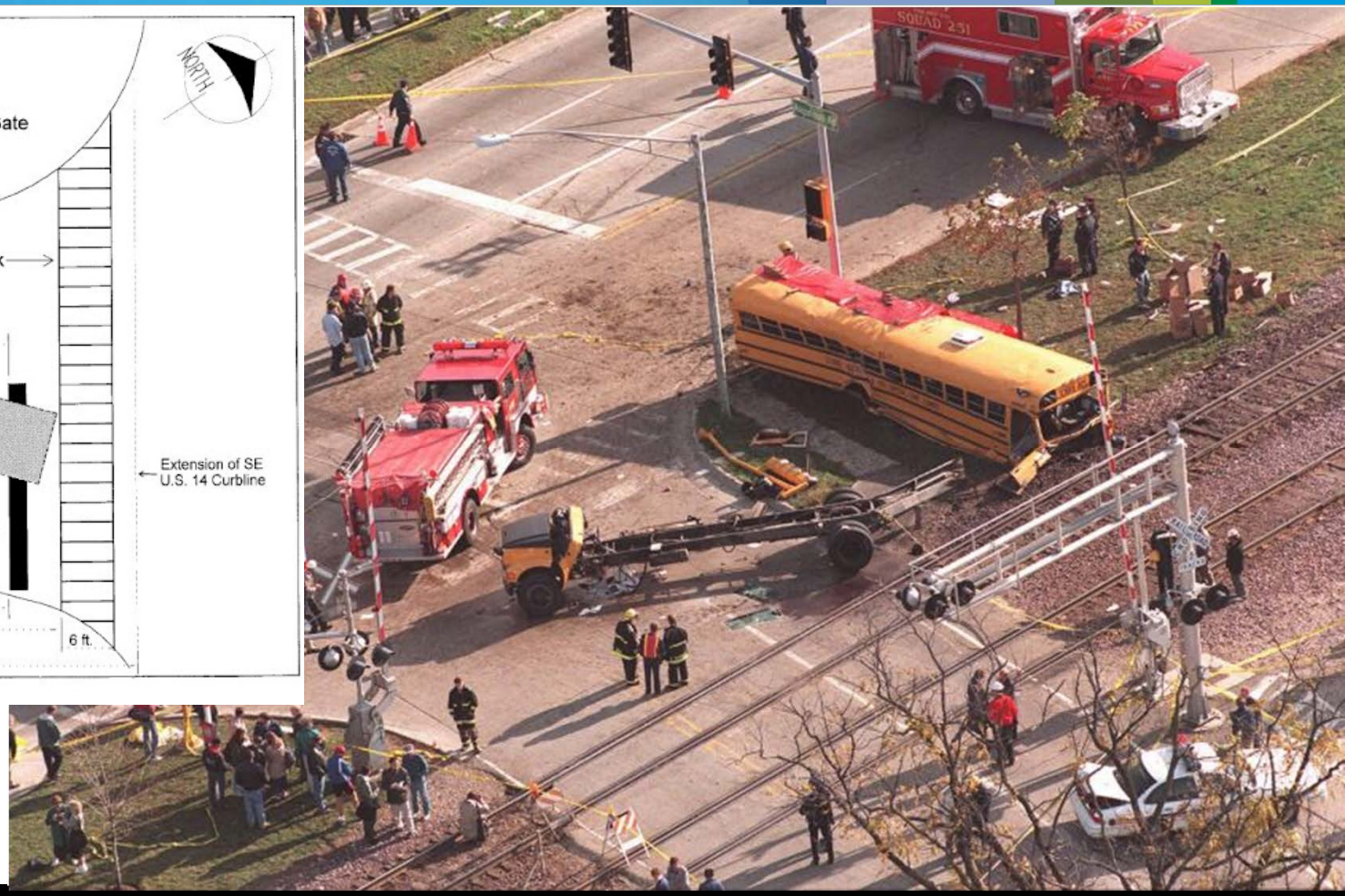


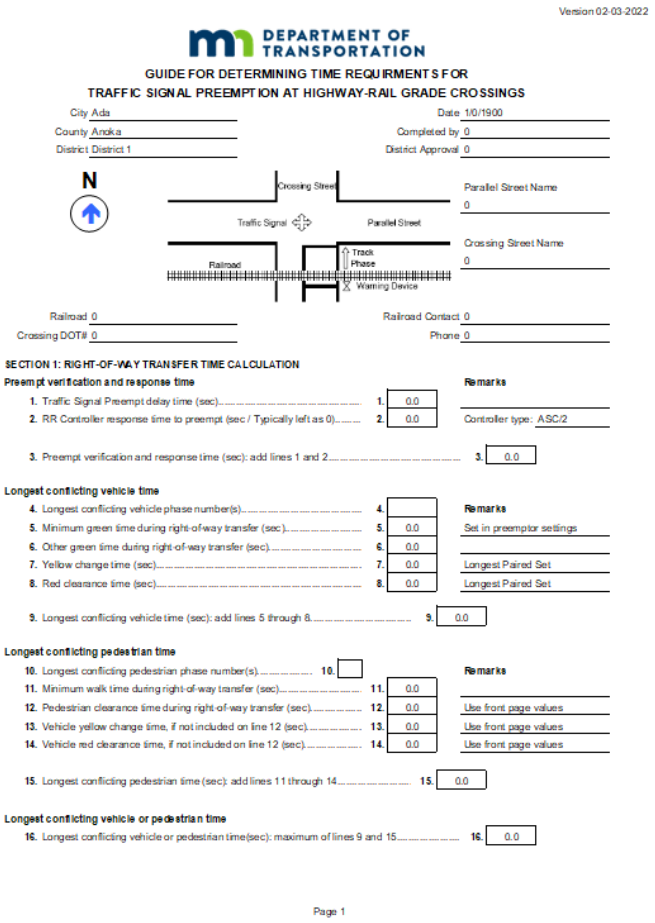
Figure 5 — Diagram of queuing area



Source (top): NTSB Report
Source (right): Sun-Times

Design and Operation of Preempted Traffic Signals

- MUTCD Parts 4 & 8
- Guidance for Determining Time Requirements for Traffic Signal Preemption at Highway-Rail Grade Crossings
- Agency policies on when to interconnect traffic signals
- Agency policies on how to operate interconnected traffic signals



Version 02-03-2022

DEPARTMENT OF TRANSPORTATION

GUIDE FOR DETERMINING TIME REQUIRMENTS FOR
TRAFFIC SIGNAL PREEMPTION AT HIGHWAY-RAIL GRADE CROSSINGS

City Ada — Date 1/0/1900
County Anoka — Completed by 0
District District 1 — District Approval 0

N

Crossing Street — Parallel Street Name 0
Traffic Signal — Parallel Street
Railroad — Track Phase — Warning Device — Crossing Street Name 0

Railroad 0 — Railroad Contact 0
Crossing DOT# 0 — Phone 0

SECTION 1: RIGHT-OF-WAY TRANSFER TIME CALCULATION

Preempt verification and response time — **Remarks**

1. Traffic Signal Preempt delay time (sec)	1.	0.0	
2. RR Controller response time to preempt (sec / Typically left as 0)	2.	0.0	Controller type: ASC/2
3. Preempt verification and response time (sec): add lines 1 and 2	3.	0.0	

Longest conflicting vehicle time

4. Longest conflicting vehicle phase number(s)	4.		Remarks
5. Minimum green time during right-of-way transfer (sec)	5.	0.0	Set in preemptor settings
6. Other green time during right-of-way transfer (sec)	6.	0.0	
7. Yellow change time (sec)	7.	0.0	Longest Paired Set
8. Red clearance time (sec)	8.	0.0	Longest Paired Set
9. Longest conflicting vehicle time (sec): add lines 5 through 8	9.	0.0	

Longest conflicting pedestrian time

10. Longest conflicting pedestrian phase number(s)	10.		Remarks
11. Minimum walk time during right-of-way transfer (sec)	11.	0.0	
12. Pedestrian clearance time during right-of-way transfer (sec)	12.	0.0	Use front page values
13. Vehicle yellow change time, if not included on line 12 (sec)	13.	0.0	Use front page values
14. Vehicle red clearance time, if not included on line 12 (sec)	14.	0.0	Use front page values
15. Longest conflicting pedestrian time (sec): add lines 11 through 14	15.	0.0	

Longest conflicting vehicle or pedestrian time

16. Longest conflicting vehicle or pedestrian time(sec): maximum of lines 9 and 15	16.	0.0

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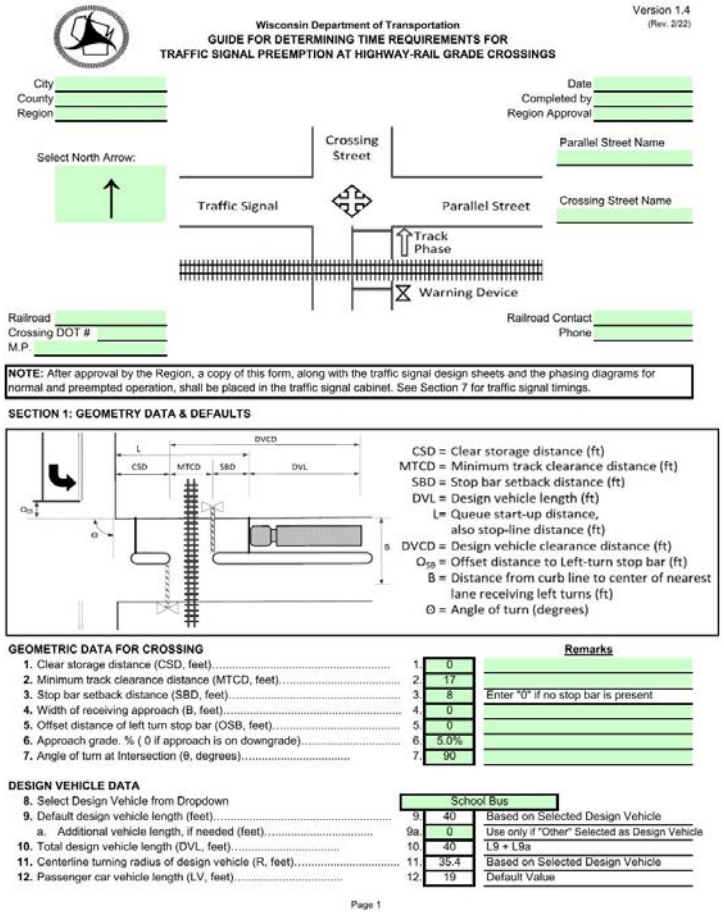

Version 1.4
(Rev. 2/22)

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

City — Date
County — Completed by
Region — Region Approval

Select North Arrow:

Crossing Street — Parallel Street Name
Traffic Signal — Parallel Street — Crossing Street Name
Track Phase
Warning Device

Railroad — Railroad Contact
Crossing DOT # — Phone
M.P.

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

L, DVCD, CSD, MTCD, SBD, DVL, O_{SB}, B, Θ

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

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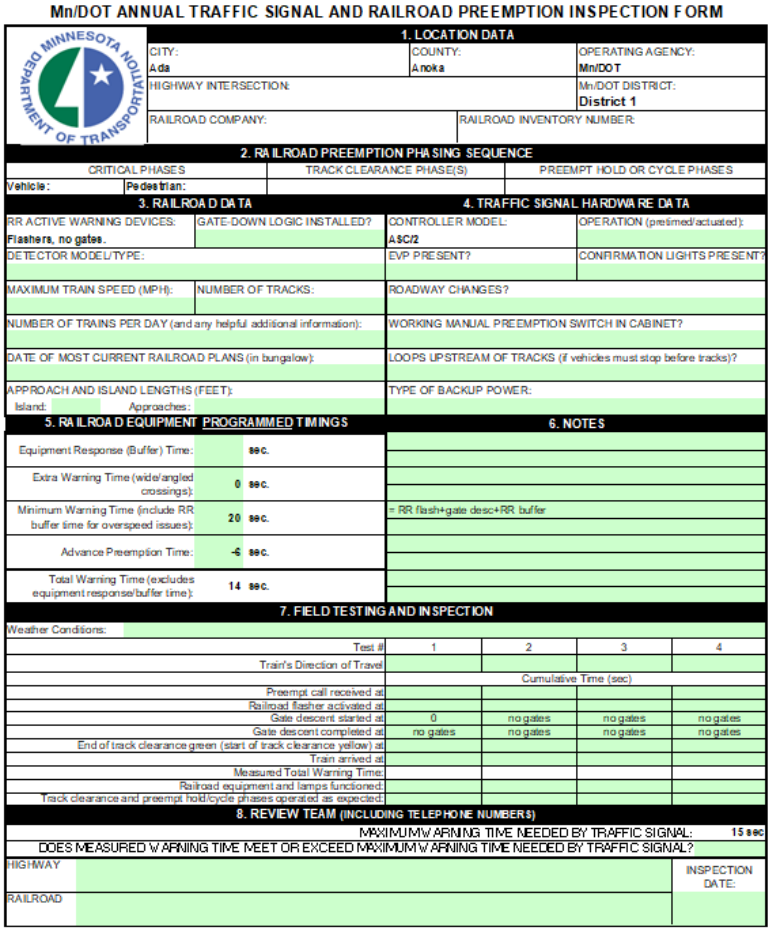
Joint Testing of Preempted Traffic Signals

- Agency policies regarding the joint inspection of preempted crossings
- Standard practice involves timing of train movement (when possible), otherwise train movements are simulated



Mn/DOT ANNUAL TRAFFIC SIGNAL AND RAILROAD PREEMPTION INSPECTION FORM

1. LOCATION DATA

CITY:	COUNTY:	OPERATING AGENCY:
Ada	Anoka	Mn/DOT
HIGHWAY INTERSECTION:		Mn/DOT DISTRICT: District 1
RAILROAD COMPANY:	RAILROAD INVENTORY NUMBER:	

2. RAILROAD PREEMPTION PHASING SEQUENCE

CRITICAL PHASES	TRACK CLEARANCE PHASE(S)	PREEMPT HOLD OR CYCLE PHASES
Vehicle: Pedestrian:		

3. RAILROAD DATA

RR ACTIVE WARNING DEVICES:	GATE-DOWN LOGIC INSTALLED?
Flashers, no gates.	
DETECTOR MODEL/TYPE:	
MAXIMUM TRAIN SPEED (MPH):	NUMBER OF TRACKS:
NUMBER OF TRAINS PER DAY (and any helpful additional information):	
DATE OF MOST CURRENT RAILROAD PLANS (in bungalow):	
APPROACH AND ISLAND LENGTHS (FEET): Island: Approaches:	

4. TRAFFIC SIGNAL HARDWARE DATA

CONTROLLER MODEL:	OPERATION (prelimed/actuated):
ASC/2	
EVP PRESENT?	CONFIRMATION LIGHTS PRESENT?
ROADWAY CHANGES?	
WORKING MANUAL PREEMPTION SWITCH IN CABINET?	
LOOPS UPSTREAM OF TRACKS (if vehicles must stop before tracks)?	
TYPE OF BACKUP POWER:	

5. RAILROAD EQUIPMENT PROGRAMMED TIMINGS

Equipment Response (Buffer) Time:		sec.
Extra Warning Time (wide/angled crossings):	0	sec.
Minimum Warning Time (include RR buffer time for overspeed issues):	20	sec.
Advance Preemption Time:	-6	sec.
Total Warning Time (excludes equipment response/buffer time):	14	sec.

6. NOTES

= RR flash+gate desc+RR buffer

7. FIELD TESTING AND INSPECTION

Weather Conditions:

Test #	1	2	3	4
Train's Direction of Travel				
	Cumulative Time (sec)			
Preempt call received at:				
Railroad flasher activated at:				
Gate descent started at:	0	no gates	no gates	no gates
Gate descent completed at:	no gates	no gates	no gates	no gates
End of track clearance green (start of track clearance yellow) at:				
Train arrived at:				
Measured Total Warning Time:				
Railroad equipment and lamps functioned:				
Track clearance and preempt hold/cycle phases operated as expected:				

8. REVIEW TEAM (INCLUDING TELEPHONE NUMBERS)

MAXIMUM WARNING TIME NEEDED BY TRAFFIC SIGNAL: 15 sec

DOES MEASURED WARNING TIME MEET OR EXCEED MAXIMUM WARNING TIME NEEDED BY TRAFFIC SIGNAL?

HIGHWAY	INSPECTION DATE:
RAILROAD	

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

Questions to be Answered in the Field

- Do pre-signals (if used) operate as expected during normal operation?
- Does the traffic signal behave as expected when the preemption call comes in?
  - Exit existing phase in the manner designed by serving only minimum values (Walk, Green, and Flashing Don't Walk)
- Do blank out signs activate (if used) to prevent movements toward the crossing as expected?
- Does the traffic signal provide the minimum track clearance green?
  - If there is a gate down circuit, does it rest in track clearance green until the gate down circuit is received?
  - If the gate down circuit is activated early, does the signal wait until the minimum track clearance green is served before exiting?
- Does the traffic signal serve only the phases not in conflict with the crossing after exiting track clearance green phase?

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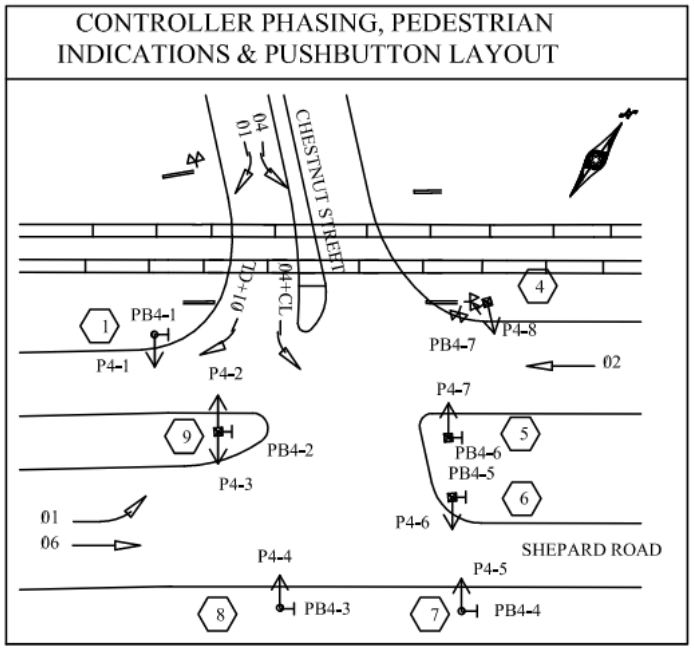
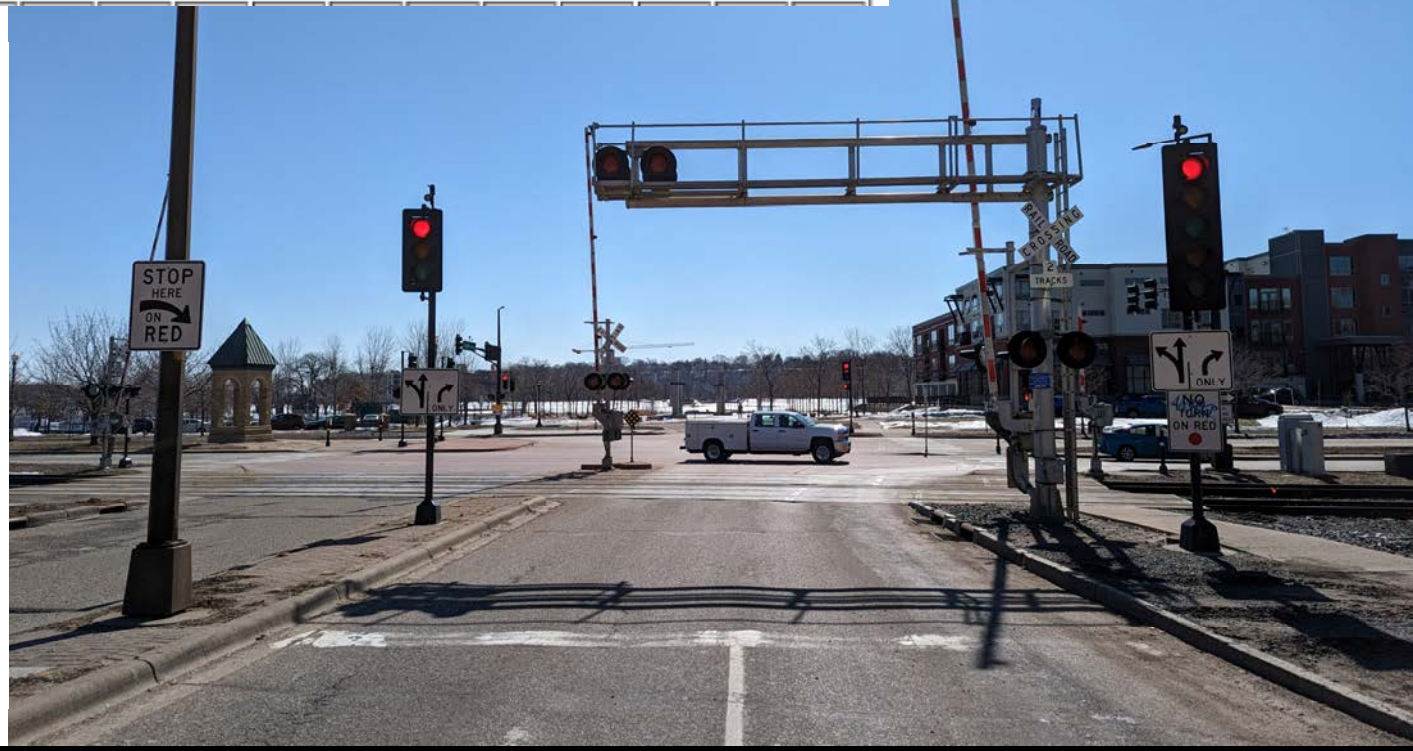
FINDINGS

Case Study: Shepard Road

Phase	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Overlap	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Track Clear Vehicle							X									
Track Clear Overlap																

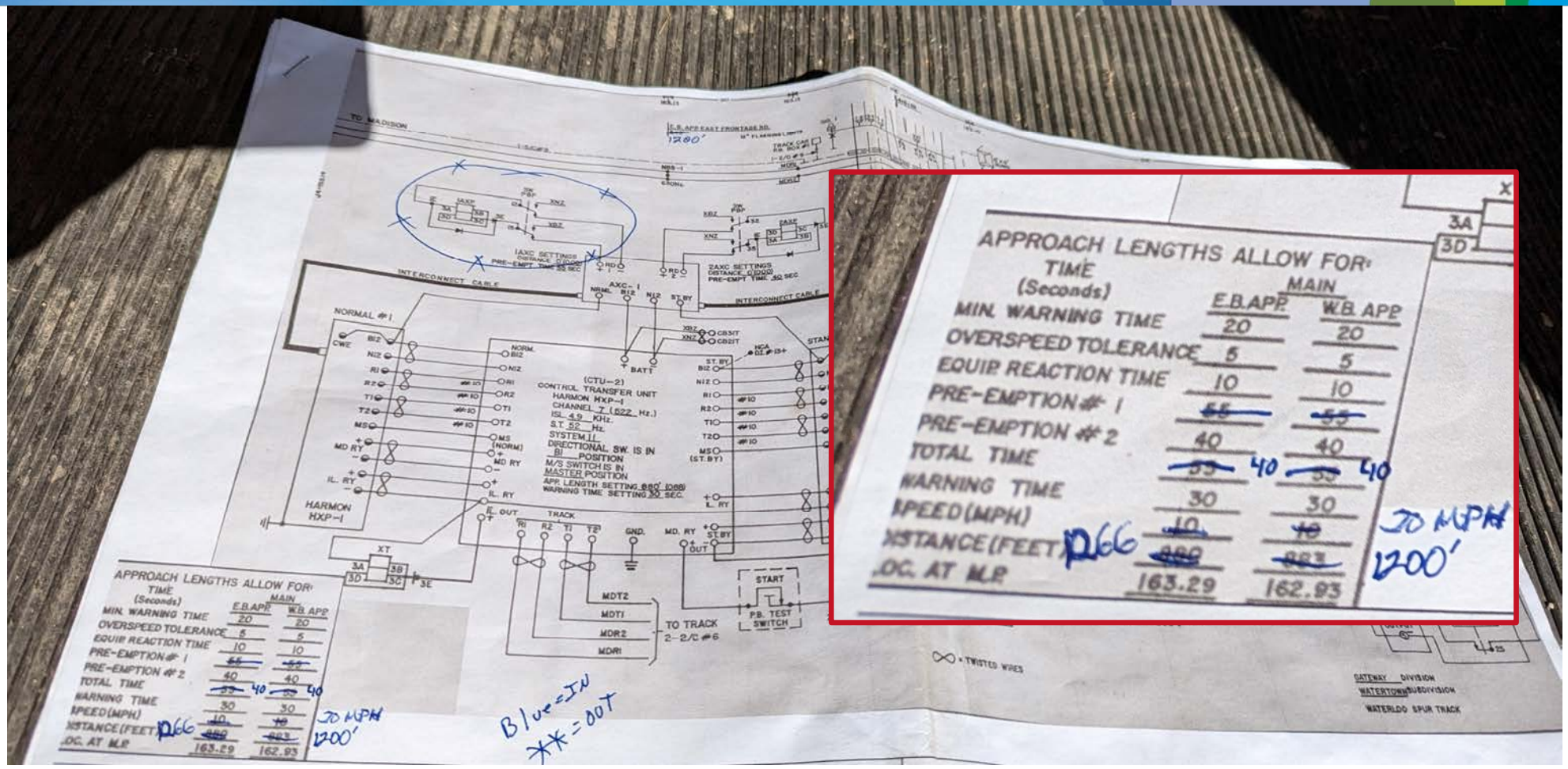




Case Study: Shepard Road

- Right turn overlap was not designed for pre-signal operation
- Original cabinet was uniquely hardwired for non-NEMA operation while new cabinet was standard NEMA
- New controller programmed to exactly match original programming

Case Study: Lexington Avenue



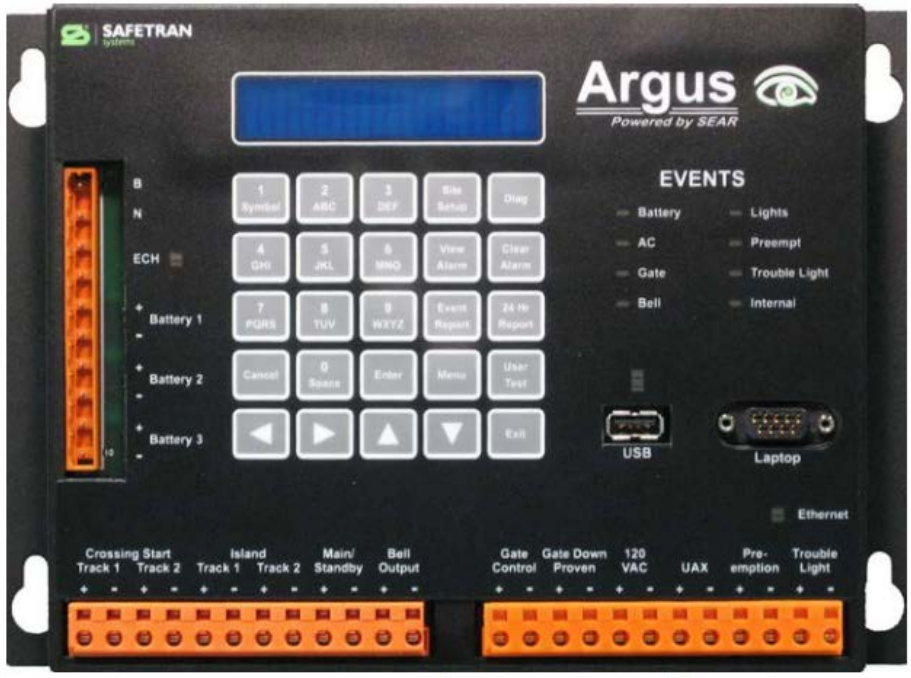
Case Study: State Street

- Preemption design included advance preemption and gate down circuit
- Controller programmed assuming standard preemption panel use
- New cabinet utilized original preemption panel which did not release advance preemption call when gate down circuit activated

Railroad Operation Certainty?

APPROACH CIRCUIT DISTANCE CALCULATION TABLE	TRACK 1	TRACK 3
BASE WARNING TIME	30 SEC	30 SEC
PLUS TIME FOR CLEARANCE DISTANCE > 35'	0 SEC	0 SEC
EQUALS PLANNED WARNING TIME	30 SEC	30 SEC
PLUS TIME FOR EQUIPMENT RESPONSE	2 SEC	2 SEC
PLUS TIME FOR TRAFFIC SIGNAL PRE-EMPTION	37 SEC	37 SEC
EQUALS CIRCUIT APPROACH TIME	69 SEC	69 SEC
TIMES MAXIMUM PLANNED TRAIN SPEED	10 MPH	10 MPH
TIMES RATIO OF FEET PER SECOND TO MILES PER HOUR	1.467	1.467
EQUALS APPROACH CIRCUIT DISTANCE	**1013 FT**	**1013 FT**
ACTUAL MEASURED APPROACH CIRCUIT DISTANCE	FT	FT

ANY FRACTIONAL VALUE INCREASED TO FULL UNIT



- Are we getting the designed amount of time between advance preemption and the start of the flashing lights?
- How much time between the start of the flashing lights and gate down?
- Is the total time guaranteed?

Case Study: State Street

```
Tue 05-09-2023 14:05:01.78  DI14: Off
Tue 05-09-2023 14:05:20.58  MD/GCP1K: DOWN
Tue 05-09-2023 14:05:20.67  1SSCC: VI1 Off
Tue 05-09-2023 14:05:21.02  2BELLK: ON
Tue 05-09-2023 14:05:21.09  EN1: Lamps On
Tue 05-09-2023 14:05:21.10  EN2: Lamps On
Tue 05-09-2023 14:05:21.12  EB1: Lamps On
Tue 05-09-2023 14:05:21.14  EB2: Lamps On
Tue 05-09-2023 14:05:21.35  1SSCC: 1 L1 Flashing
Tue 05-09-2023 14:05:21.35  1SSCC: 1 L2 Flashing
Tue 05-09-2023 14:05:21.35  1SSCC: 2 L1 Flashing
Tue 05-09-2023 14:05:21.35  1SSCC: 2 L2 Flashing
Tue 05-09-2023 14:05:21.35  1SSCC: 1 Bell On
Tue 05-09-2023 14:05:21.35  1SSCC: 2 Bell On
Tue 05-09-2023 14:05:23.45  EB2: 61 FPM
Tue 05-09-2023 14:05:23.47  EB1: 60 FPM
Tue 05-09-2023 14:05:23.95  EN2: 60 FPM
Tue 05-09-2023 14:05:23.97  EN1: 60 FPM
Tue 05-09-2023 14:05:25.01  EB2: 24.9 A DC
Tue 05-09-2023 14:05:25.03  EB1: 8.0 A DC
Tue 05-09-2023 14:05:25.49  EN2: 23.8 A DC
Tue 05-09-2023 14:05:25.51  EN1: 7.3 A DC
Tue 05-09-2023 14:05:29.19  1GCK: DOWN
Tue 05-09-2023 14:05:29.20  2GCK: DOWN
Tue 05-09-2023 14:05:29.57  1SSCC: 1 GC De-energized
Tue 05-09-2023 14:05:29.57  1SSCC: 2 GC De-energized
Tue 05-09-2023 14:05:30.62  GPK: OFF
Tue 05-09-2023 14:05:30.95  1SSCC: VI8 Off
Tue 05-09-2023 14:05:37.71  2GDK: DOWN
Tue 05-09-2023 14:05:39.41  1GDK: DOWN
Tue 05-09-2023 14:06:30.26  ISL1K: DOWN
Tue 05-09-2023 14:06:30.38  (XNG)WARN TIME TK1 INFO: 70 sec
Tue 05-09-2023 14:09:42.36  ISL1K: UP
```

Only 8 of 26 events (30.8%) provide Min Track Clearance Green

Case Study: Shepard Road

- 16 of the 16 events (100%) do not provide the 26 seconds of APT as designed
- 7 of the 16 events (73.8%) do not provide the total time (56 seconds) as designed

Joint Annual Inspections Save Lives

Source: Sun-Times

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Thank you.

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