TEO Signal Committee Meeting Minutes
Meeting Date: 05/18/2016
Water's Edge Conference Rm A
Meeting Time: 9:00am – Noon

Meeting Attendees:

Jerry Kotzenmacher	Sue Zarling	Robin Delage
Peter Skweres	Mike Schroeder	Greg Kern
Jim Deans	Mike Fairbanks	Ben Osemenam
Jeff Knofczynski	Alex Govrik	Tod Becker
John Fahrendorf	Mike Kronzer	

Mark Korwin-Kuczynski (phone)
Cindy Dittberner (phone)

Old Business-

Flashing Yellow Arrow – Hennepin County has been testing a 4 second delay prior to turning on the flashing yellow arrow in protected/permissive operation. The benefits of using this delay are allowing pedestrians to start and get in the crosswalk. The left turning vehicle on the FYA may be more likely to see the pedestrian if the pedestrian is in the crosswalk. It would also get opposing through vehicles moving before the left turns would get a flashing yellow arrow. This may prevent left turners from turning in front of opposing vehicles because left turners should see that the opposing vehicles are moving while they still have a red arrow. A potential hazard may be that if there are no opposing vehicles at the stop line, opposing thru traffic could be coming at the left turners at a higher speed when the FYA starts. OTST will look into this delay option and discuss with Hennepin County to see if this is something we may want to pursue statewide.

Another potential FYA delay type operation is the Leading Pedestrian Interval. This would delay the start of the FYA from a cycle when a pedestrian button has been pushed. Another option would be to completely prevent the FYA during a cycle if the pedestrian push button was actuated.

Cabinet/Controller Committee – There was no committee meeting since the last Signal Committee meeting. Metro gave an update on the new Intelight Central Traffic Signal Control Software they will be getting. The system will have 2500 licenses. The intent is to allow other districts onto the system if they desire. Other cities and counties will also be allowed on the system. Ethernet or cell modem connections will be required to connect to this system.

Pedestrian Station – The pedestrian station detail was modified.. Contractors at the Signals and Lighting Re-Certification Class informed the class instructors that the ADA Office inspectors were not requiring the concrete forming tube. The ADA Office was told by concrete flat workers and MnDOT concrete experts that the sudden change from the 6 inch sidewalk to the 12 inch deep foundation could create enough stress at that transition point and potentially crack the PAR ramp. Therefore a change was made to remove the concrete forming tube from the detail and replace it with a more gradual transition from sidewalk to foundation by requiring a 1V:2H slope of compacted aggregate bedding. An 18 inch X 6 inch concrete forming tube may be used when conditions do not allow for the hole to stand open as stated in the NOTES section of the detail. The new detail has been placed on the OTST web site. Use it on all new signal plans.

Sue mentioned that everyone should be designing and constructing to the approved details. Please contact OTST if anyone believes a change in the approved details or project documents is needed.

Back Ground Shields - ESS brought in an example of a background shield with folded edges. In the last meeting, OTST was asked to check into whether all suppliers have a folded edge background shield. Peter reported that all manufactures have this option. The cost of the folded edge background shield was around 50% more than the regular flat edge. The committee believed that the costs will be offset by reduced replacement costs that the flat background shields created. Maintenance reported that the flat background shields need frequent replacements out in the field

- The committee approved the use of the folded background shield as the new standard for all new signals.

Peter will develop a specification for the product and place approved products on the APL

Painting of Cabinets – MnDOT created an “Art on Trunk Highway Right of Way” policy that can be found here: http://www.dot.state.mn.us/policy/operations/op007.html The policy covers many things on the highway right of way, but does not get into specific needs for items such as traffic signal cabinets or lighting cabinets. Sue will be setting up a meeting with the policy creators to discuss specific needs to consider for our cabinets. There should be no cost to MnDOT when artistic work is placed on highway components.

New Business

Advanced Detection – John Fahrendorf did a report on advanced detection. This detection would be farther out than our normal dilemma zone detection shown in the MnDOT Signal Design Manual. This detection would be most beneficial to free operating signals and his reports done in Synchro and Vissim showed many overall improvements. He referenced a Texas DOT study that showed the following:

- Reduced vehicles exposed in dilemma zone by 73%
- Reduced delay by 14 percent

- Reduced stop frequency by 9 percent
- Reduced red-light violations by 58 percent
- Reduced heavy-vehicle red-light violations by 80 percent
- Reduced severe-crash frequency by 39 percent
- Combined with longer max green, max-out occurrences reduced by 57% (75-s to 95-s cycle)

Costs of the signal would increase. These additional advanced detectors could be in the $5k to $10K range considering additional loops, hand holes and conduit. For isolated intersections with an AWF this may be able to replace the AWF. OTST will handout the report for discussion at the upcoming Signal Design Class. If any districts are interested in this new detection design for a signal, contact OTST. It would be good to get a test location to monitor prior to deployment. (See attached report)

Rural Intersection Conflict Warning System (RICWS) – Mike Kronzer, RICWS Project Manager, gave an update on the transfer from private contractor maintenance to MnDOT maintenance. There are currently 50 RICWS Systems operating throughout the state that will transfer maintenance on December 1st, 2016. 5 additional sites are already MnDOT's responsibility to maintain. The Signal TEO Committee was asked to comment on recommendation of classifying these systems as a "Priority C" traffic signal. This priority allows up to 3 days to repair or correct any malfunction with the system.

- The signal committee agreed the RICWS should be classified as a "Priority C" system.

The committee was also asked what should happen if one of the approach signs was knocked down or malfunctioned. In this case, the system would still give information to the other 3 approaches which would be better than a bag cover for all remaining approaches and/or turning the entire system off.

- Although there can be many scenarios for a malfunction, the committee agreed that the system should continue to operate the 3 approaches if one approach should fail or the sign gets knocked down. Engineering judgement will always play a role.

There are a couple County owned and operated RICWS that MnDOT will likely take over the operation and maintenance. Mike will work on an agreement with these counties through the Blanket Partnership Agreement. (See attached slides.)

Mike will be taking the final recommendation to the TEO Executive Committee for approval.

Tomar EVP – The new Tomar card has been added to the APL. The old card has been removed from the APL. ESS field testing of the new card on a couple signals is ongoing along with testing in the shop.

As Built Plans / Revisions – When revisions to existing signals are needed, the plan layout and wiring diagram should be completed in the most understandable and efficient way. After the signal revision work is completed, there must be a layout that shows only the final product. The layout should look like a layout for a new signal. No other information such as existing components or furnish and install components should be on the plan. This can be part of the deliverables on consultant projects or the districts can draw up and provide this final layout. When receiving MicroStation files from consultants, all required reference files must be attached and turned on.

Cost Participation – There is a new 2016 Cost Participation manual. Changes to the signal construction and maintenance sections include:

- Interconnect is now 100% MnDOT cost when operating our signals along the trunk highway. If signals along the local roads are interconnected then the local agencies will pay that cost.
- Battery backup is a 50/50 cost split for all installations. It is still required at all signals connected to rail road providing railroad preemption.
- The terms "major and minor maintenance" changed to "non-routine and routine maintenance" (name change only).

Door Latch – The SSB has no door latch but the door can be removed by lifting off hinge. The door is so large that it becomes a hazard in the wind. The signal controller cabinet took many years to come up with a latch that worked well. Some options were suggested such as a tie off that could be used to hold the door in place when open. Jim D. will look into a possible latch or other method to secure the door in windy conditions.

Plate 8112 – Central Office ADA Unit has informed OTST that contractors are often installing the pedestal foundations too high for the surrounding sidewalk therefore not meeting ADA requirements. This is also an issue for the AASHTO breakaway standards. The ADA requirement is no abrupt level changes over a ¼ inch. The AASHTO maximum 4 inch breakaway requirement specifies anchor bolts should not project more than 4 inches, measured from the top of the bolt to the sidewalk or ground line (not top of the foundation). The standard plate requires the top of the foundation to be installed flush to a maximum ¼ inch above the sidewalk or ground line. Alex will look into the installation process, however, district traffic office's personnel involved in the construction of signal systems should discuss this at pre-con meetings and include it in their inspections and ask the project engineer to have the contractor fix pedestal foundations that exceed the maximum ¼ inch above the sidewalk or ground line. As pointed out by Sue in the meeting the maximum ¼ inch specified in the plate is necessary to meet ADA and AASHTO requirements.

Round Robin –

Robin – Visors we are currently getting are specified as 3.5 degree tilt. The visor MnDOT has been getting is 3.00 degrees. OTST will look into the specification. *After the meeting the draft 2018 Standard Specifications for Construction was modified and will call for a minimum of 3 degrees of tilt.*

Tod – Can the background shield on the RICWS installations be replaced by the RICWS project to avoid District cost in replacing these as they are failing? No, the project used the APL listed visors and is not under warranty.

Jim – contractor requests for cabinet pickups continue to not meet the 30 day requirement. Committee recommended that a contractor request for cabinet pickup date be recorded by Jim, placing the date in the system when they call. Jim Deans will start to log and record when contractors call for cabinets and equipment.

Next meeting: Thursday, October 6th, 2016

Waters Edge **Conference Room 176**

9:00am – 12:00noon

Send agenda items to Jerry K

Attachments to Signal TEO Committee Meeting:

- Advance Detection Report by John Farhendorf
- RICWS by Mike Kronzer

A case for advance detection further from the intersection

The current locations for advance detection generally address vehicle exposure to the dilemma zone, but the design is not always efficient. At 45 mph for example, MnDOT standards place the advance detector 300 feet from the stop bar. When the signal gaps out and a vehicle is just prior to the detector, this will typically allow 234 feet to stop after a one second perception/reaction time. It would be more efficient to have a detector further out so vehicles getting a yellow short of the detector can coast for a short period and brake more gradually.

When vehicles approach a known stop condition such as a stop sign, drivers typically take their foot off the gas and coast for a brief period before gradually braking to a stop. In a 45 mph zone, few drivers approaching a known stop condition would maintain 45 mph up to 234 feet short of the stop bar and then quickly brake only to stop and idle as this increases fuel consumption, brake wear, and pollution. Braking is even more abrupt when vehicle speeds are over the posted limit or when drivers have longer perception/reaction times. A Popular Mechanics article suggests the #1 tactic to save gas is to coast for a time before stopping. Below are the braking distances and the braking deceleration rates for each speed limit for ideal and less than ideal driving behaviors. For reference, the MnDOT Road Design Manual sets uses 11.2 ft/sec^2 as the emergency braking rate that 90% of drivers are capable of when designing for stopping sight distances.

Vehicle braking rates when vehicle is at detector when signal turns yellow Assuming vehicle speed equals speed limit, 1.0 second perception/reaction time								
Speed Limit (mph)	30	35	40	45	50	55	60	65
Detector distance from stop bar (feet)	120	180	250	300	400	475	550	625
Remaining distance to stop bar after percept/react time	76	129	191	234	327	394	462	530
Required Deceleration rate (feet/sec^2)	12.7	10.2	9.0	9.3	8.2	8.3	8.4	8.6

Vehicle braking rates when vehicle is at detector when signal turns yellow Assuming vehicle is speeding 5 mph over limit, 1.5 second perception/reaction time								
Speed Limit (mph)	30	35	40	45	50	55	60	65
Detector location from stop bar (feet)	120	180	250	300	400	475	550	625
Remaining distance to stop bar after percept/react time	43	92	151	190	279	343	407	471
Required braking deleration rate (feet/sec^2)	30.6	18.7	14.4	14.2	11.7	11.3	11.2	11.2

A case can be made for enhancing safety when increasing detector distances from the stop bar. In the 45 mph example, if a vehicle gets yellow just prior to the detector (300 feet), at 66 fps the vehicle will make it to the stop bar in 4.5 seconds. The standard 45-mph yellow time is also 4.5 seconds which may encourage some to speed up to reach the stop bar before the signal turns red. By definition this makes this area a dilemma zone as some drivers may speed up or keep going their steady speed while most will likely brake.

A Texas DOT study of advanced dilemma zone detection installed modified detection systems at eight isolated intersections. (1) One objective of the study was to better protect vehicles from the dilemma zone. Their findings revealed that to minimize vehicles exposure to a dilemma, the vehicle needs to be 7 or more seconds from the stop bar in travel time at the onset of yellow. See figures below.

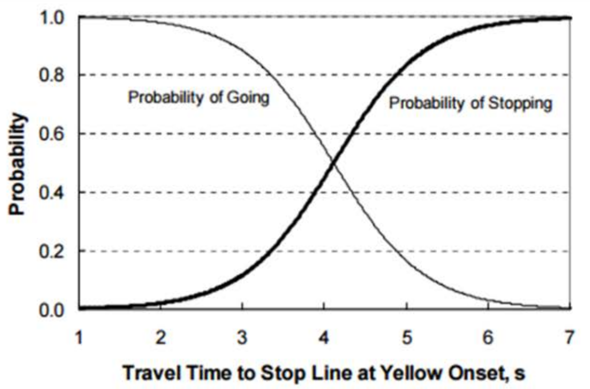


Figure 3-1. Probability of Stopping or Going at Yellow Onset.

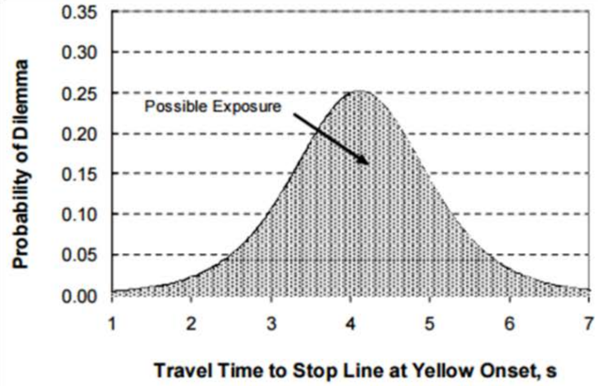


Figure 3-2. Probability of Dilemma.

As a key component of the signal modifications, detectors on the high speed approaches were placed further from the stop bar between 700 and 1,000 feet to ensure vehicles were outside the 7-second zone on yellow onset. The results from this advanced detection system include:

- *Reduced vehicles exposed in dilemma zone by 73%*
- *Reduced delay by 14 percent*
- *Reduced stop frequency by 9 percent*
- *Reduced red-light violations by 58 percent*
- *Reduced heavy-vehicle red-light violations by 80 percent*
- *Reduced severe-crash frequency by 39 percent*
- *Combined with longer max green, max-out occurrences reduced by 57% (75-s to 95-s cycle)*

So where is the ideal location for this distant detector? One criterion should be that it be located outside the 7-second travel time to the stop bar. Below are the existing and proposed detector locations and the resultant travel times to the stop bar.

Existing travel times from detector to intersection at yellow onset				Proposed travel times from detector to intersection at yellow onset			
Speed Limit (mph)	Existing Dist from Detector to stop bar (feet)	Travel time from detector to stop bar (sec)	Travel Time when Vehicle Speed is 5 mph over limit (sec)	Speed Limit (mph)	Proposed Dist from Detector to Stop Bar (feet)	Travel time from detector to stop bar (sec)	Travel Time when Vehicle Speed is 5 mph over limit (sec)
30	120	2.7	2.3	30	300	6.8	5.8
35	180	3.5	3.1	35	400	7.8	6.8
40	250	4.3	3.8	40	500	8.5	7.6
45	300	4.5	4.1	45	600	9.1	8.2
50	400	5.5	5.0	50	700	9.5	8.7
55	475	5.9	5.4	55	800	9.9	9.1
60	550	6.3	5.8	60	900	10.2	9.4
65	625	6.6	6.1	65	1000	10.5	9.7

Another criterion should address efficiency giving the driver the opportunity to coast for a short period and more gradually brake. No published average for coasting ahead of a red light could be found but, but NCHRP Report 600 found 3 seconds was the average coasting time before braking when exiting off a freeway. (2) For a conservative gradual braking rate, the 2000 Highway Capacity Manual listed the low end at 6.56 ft/sec^2. (3) The proposed detector locations allow for 3 seconds of coasting and a gradual braking deceleration. In less than ideal driving behaviors, if a vehicle speeds by 5 mph and the perception/reaction time is 1.5 seconds, coasting time is still possible but must be reduced to 1.5 seconds to maintain a gradual braking rate near 6.56 ft/sec^2. Below are the proposed detector locations and the resultant coasting and deceleration rates.

Vehicle braking rates for Proposed Detector Locations when vehicle is at detector at yellow onset Assuming vehicle traveling at posted limit; 1.0 perception reaction time								
Speed Limit (MPH)	30	35	40	45	50	55	60	65
Proposed detector distance from stop bar (feet)	300	400	500	600	700	800	900	1000
Initial Speed (ft/sec)	44.00	51.33	58.67	66.00	73.33	80.67	88.00	95.33
Dist traveled during Peception/Reaction	44	51	59	66	73	81	88	95
Coasting time (foot off gas, vehicle in gear)	3	3	3	3	3	3	3	3
Coasting distance (Assuming 2.5 ft/sec^2 deceleration)	121	165	187	209	231	253	275	297
Speed after coasting (ft/sec)	37	44	51	59	66	73	81	88
Distance remaining after percep/react & coasting	135	183	254	325	395	466	537	607
Required braking rate after coasting & percep/react time	4.93	5.24	5.15	5.27	5.48	5.74	6.04	6.35

Vehicle braking rates for Proposed Detector Locations when vehicle is at detector at yellow onset Assuming vehicle traveling 5 mph over the posted limit; 1.5 perception reaction time								
Speed Limit (MPH)	30	35	40	45	50	55	60	65
Proposed detector distance from stop bar (feet)	300	400	500	600	700	800	900	1000
Initial Speed (ft/sec)	51.33	58.67	66.00	73.33	80.67	88.00	95.33	102.67
Dist traveled during Peception/Reaction	77	88	99	110	121	132	143	154
Coasting time (sec) (foot off gas, vehicle in gear)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Coasting distance (Assuming 2.5 ft/sec^2 deceleration)	74	91	102	113	124	135	146	157
Speed after coasting (ft/sec)	48	55	62	70	77	84	92	99
Distance remaining after percep/react & coasting	149	221	299	377	455	533	611	689
Required braking rate after coasting & percep/react time	7.61	6.82	6.48	6.42	6.50	6.66	6.86	7.10

Existing and proposed detector scenarios were modeled in VISSIM and Synchro/SimTraffic. See attachments for results. Generally, mainline stops and delay were reduced while overall stops and delay had mixed results. Of note, no other strategies were implemented in terms of gap reductions, soft recalls, or reduced minimum greens with density phasing which may help stop and delay performance. The only modification besides detector placement and cooresponding extend times was in the 55 mph Synchro model where the max green was extended from 79 seconds to 99 seconds. This resulted in a decrease in the percent of mainline greens maxing out. All modeling results are averages from five 1-hour simulation runs.

Other details not known concerning more advanced detector placement:

- *When should the proposed detector be the only mainline detector versus acting as a 2nd advance detector?*
- *What should the gap-out reduction parameters be to minimize max-outs*

Potential Benefits:

- *Distant detector could be used to detect large trucks or platoons*
- *With mainline on soft recall, a minor phase can extend beyond max green until a mainline vehicle arrives, and with the more advanced detection, the signal can turn back to mainline green before vehicles need to stop.*
- *Mainline minimum green time can be shortened to reduce minor movement delay as signal would know if mainline vehicles are present for a good distance out. Density function with added initial green would ensure clearing of any stopped vehicles.*
- *Fewer overall stops*
- *Reduced vehicle wear and tear*
- *Reduced fuel consumption and pollution, especially for mainline*
- *Lower noise levels*
- *Reduced driver frustration*
    - *No waiting on a minor phase for 20+ seconds as no one is passing through the intersection*
    - *No approaching a stale mainline green with no one ahead of you only to turn yellow just before the dilemma zone*
- *Safer? As fewer vehicles are exposed to the dilemma zone*

References:

1) *Texas DOT Report Summary: http://safety.fhwa.dot.gov/intersection/conventional/signalized/tech_sum/fhwasa09008/*
   Full Report: http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/0-5629-1.pdf
2) *NCHRP Report 600, chapter 12, page 13*
   http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_600Second.pdf
3) *NCBI http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3728714/*

Rural Intersection Conflict Warning System (RICWS)

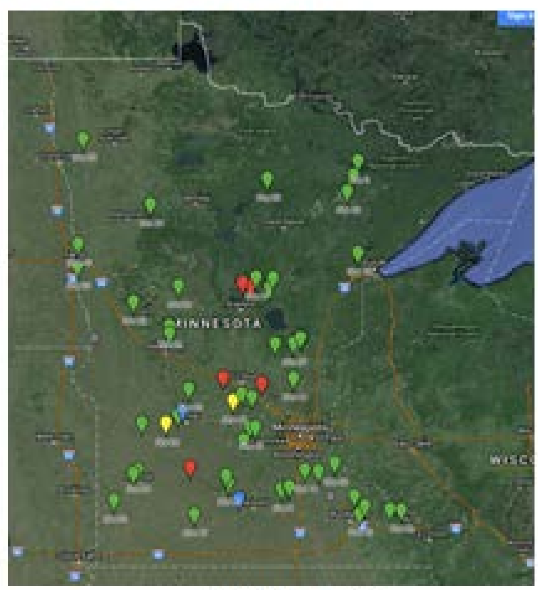
- Signing, vehicle detection and dynamic warning beacons
- Typical cost for a site is ~$150,000
- System reliability greater than 99.9% over it's design life
- Flexible configuration

RICWS Major Road Warning

RICWS Minor Road Warning

RICWS Deployment Statewide

- 55 total RICWS
  - 50 sites RICWS I (design-build)
  - 5 sites RICWS II (design-bid-build)
- Deployed at rural high crash risk locations
- Operations at District level



RICWS Sites

Safety Benefits

- Provides real-time warning of traffic conditions
- Reduce right angle crashes and severity of crashes
- Expect 25-30% reduction in total crash rate

For more information contact:
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RICWS Layout