Implementing Portable Traffic Signals in the Problem Work Zone

By Lyle Stout, B.A., ISU

Just like last year, the traffic control specifications for temporary signals in Work Zones are more problematic than ever. Short term work zones (24 hours or less in duration) cry out for solutions to reduce labor and protect workers. Seemingly simple single lane road closures now often require emergency vehicle preemption equipment. Or there are frequently single lane closures that include an intersection at one end of the work zone, or that have one or more intervening roadways or driveways entering the work zone well within the single lane closure. If it is a specification for temporary signals at an existing intersection to allow replacement of the permanent signals, there is almost always a sophisticated traffic phase sequence requiring a complex vehicle detection plan as well – frequently requiring video detection. Coordination with other intersections is occasionally called for, as is volume density control. And pedestrian movements are cropping up with more frequency as well – including temporary mid-block crossings for public events. Because these are all temporary situations, Portable Traffic Signal Systems can be a ready solution, if the equipment is chosen wisely and utilized with skill and creativity.

The critical elements that a Portable Traffic Signal System (PTSS) must possess for this type of work are capability, flexibility, and adequate monitoring. It must have the capability to handle all the traffic and pedestrian movements required and the detection necessary for them; it must be flexible enough to add and subtract such movements as needed; and the monitor must be able to monitor the results of all of these frequent changes accurately and safely. Accomplishing all of these tasks can be daunting for manufacturers – especially if one wishes to maintain wireless connectivity and solar power. It takes very good engineering to do the job. So it behooves the specifying jurisdiction to do their homework to ensure that what they specify can do the job and withstand any potential tort claims.

Short term Work Zones – Road Maintenance

To begin, most PTSS units are used in the simplest type of work zone – the simple two phase single lane closure. Our Pop-Up WZ™ with the MicroForce DCTM controller is a good example of the kind of unit that excels at this kind of work. With our electric over hydraulic lift (used throughout our line), we can deploy or retract the signal mast and arm in about 15 seconds. This type of PTSS can replace flagmen even in the short term work zone – freeing up the labor of 2 or 3 workers to actually do the work of repairing the roadway, culvert, or whatever. And these PTSS units are easy to use. For example, we

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have a special interface on the MicroForce DC™ that makes this kind of job especially easy – just tell it how long the work zone is, what is the speed limit, what is the traffic density and if the unit is to be vehicle actuated or not. It figures out the rest. We have had a lot of interest in this product from road maintenance people, who have to move their work zone daily – or even more frequently. At their request, we have also developed custom racking on the Pop-Up WZ™ to accommodate the other types of traffic control equipment that they need – road cones & barrels, signage, etc. This allows them to get “double duty” out of our trailers, and reduces the number of vehicles and trailers it takes to set up their work zone each day. All of that results in faster installation and removal and protects the signage, etc. from the damage that results from rolling around in the back of a pickup. All of this – faster install, less labor, less damage - means savings. This kind of collaboration between end user and manufacturer is the application of skill and creativity at its best.

Short Term Work Zones – Public Events

When an occasional event comes to town, like the state fair or a huge conference or concert, existing pedestrian crossing facilities can become overwhelmed. Some jurisdictions compensate by using police to direct traffic and pedestrians – consuming an expensive and precious resource. A better solution is to install a pair of PTSS units with pedestrian signals and push buttons as a mid-block pedestrian crossing to ease the pedestrian congestion at the permanent intersections. In this temporary mid-block category we offer either our Pop-Up LD™ w/ pedestrian signals or Pop-Up HD™ as a pedestrian hybrid beacon (also known in some quarters as a HAWK). And, since our entire system is low powered DC (a great safety feature, by the way), we have developed DC powered count-down pedestrian signals for this application, adding this level of safety and convenience to our PTSS.
Portable Mast Arm Trailer at each end of the lane closure (Units 1 & 5). These units control the traffic on the roadway with standard RYG signals, allowing opposing movements to alternately share a single lane. If you were to use our equipment, we would recommend our Pop-Up LD™, with a fixed arm length of 9’. You will also note Units 2, 3 & 4, one at each driveway. Each of these units consists of a wheeled battery cabinet and an 8’ vertical mast which carries a single signal face. We would recommend our Pop-Up Jr™ unit for this. Each signal face has 2 indications—both a green left and a green right arrow. These signals are not compliant with the MUTCD, which is sometimes allowed by the jurisdiction because they do not control a public right-of-way. At the bottom of the diagram you will note the traffic sequencing diagram, with Unit 1 assigned Phase 2, Unit 5 assigned Phase 4, and all left arrows on Units 2-4 assigned Phase 1, while all right arrows are assigned Phase 3. This phasing is chosen so that anyone turning left (Phase 1) from the driveway will be followed by Phase 2. This eliminates the need for Phase 1 timings to include the long red clearance needed to clear a lane closure, as that clearance is provided by the following movement—Phase 2. This pattern is repeated with Phases 3 and 4. This phasing helps traffic move more efficiently through the work zone.

Vehicle Detection and the Work Zone

However, if efficient traffic movement is one of the goals, then you must add the complexity of vehicle actuation. This is especially critical for the driveways, as the traffic flowing out of them will be infrequent and sporadic compared to that of the roadway. If they were included within a fixed cycle, there would be a great deal of the cycle time in which little traffic would be moving, but in which a great deal of traffic would be impeded. Vehicle actuation would allow these two phases (1 & 3) to drop out of the cycle when there was no traffic. If the traffic patterns are also unpredictable for the roadway, it would be wise to add vehicle actuation to those movements (2 & 4) as well. Once you add vehicle actuation and the variability it adds to the traffic sequence, monitoring becomes much more complex. Another complexity in monitoring is the fact that not only must each individual indication be identified and monitored, but there are 2 phases present on each of units 2, 3 & 4, AND, each of those traffic phases will be on simultaneously on each of those same units (i.e. - all Phase 3 indications on simultaneously across all 3 units, etc.). Thus, one must have the flexibility to identify which green indications are NOT in conflict with one another, and which indications ARE. This demands a single, centralized monitoring unit of considerable sophistication. It must be in constant communication with all other units, and it must also be able to identify each of the other units and each indication on each unit on the fly. If this is accomplished via a wireless connection, the data is flying around pretty quickly. Our basic MicroForce DCT™ control system, which has an easy user interface and communicates wirelessly, would be our recommendation for this application.

What is Green Revert? What is it good for?

Another benefit to vehicle actuation in a single lane closure—even one of this complexity—is the possibility of implementing a feature we call “green revert.” In some standard NEMA traffic controllers, the trailing green overlap can be utilized to create this function. It is particularly useful in situations where the traffic flow is light and sporadic, such as late at night. It makes the traffic control system more responsive to traffic demand, which hopefully causes the motoring public to willfully obey the signals. This is how it works.

First you must program the system to rest in red in the absence of a vehicle call. This allows any call to get immediate service, because if all signals are in red rest, the single lane through the work zone should be unoccupied. (Motorists like immediate service!) Now, any actuated system can do this much. But the problem for a typical system is when you have sporadic demand on the same phase without demand on the opposing phase. To elaborate, suppose that you have a car enter the detection zone, actuate the signal and get an immediate green. The car then proceeds, the minimum green gaps out, and the signal changes to yellow. At this point, another car traveling in the same direction enters the detection zone and the signal changes to red. This motorist can see that another car has proceeded through the work zone just ahead of it. However, without green revert, it must wait for the entire red clearance time to elapse before it can proceed, even if there is no conflicting demand. If the motorist sees nothing approaching from the far end of the work zone, he/she may become impatient and run the red light. However, if green revert is implemented, the red clearance time is divided into a minimum red and total red clearance. If there is an un-serviced vehicle call in the detection zone during red clearance and there is no opposing demand, only the minimum red is timed, and the signal then reverts back to green. This improves traffic flow and safety, in that the motorist is likely more willing to obey a signal that is responsive. Both of our control systems (MicroForce DCT™ & ATC) provide green revert.

A Basic Intersection - to actuate or not

Now we will look at Diagram 2 on page 58. This is a simple intersection without protected left turns. We have placed four Portable Mast Arm units (Pop-Up LD™ again) at this intersection, each controlling a direction of travel. Each unit has basic RYG signals—no green arrow indications. Note that units 1 & 3 are both...
assigned Phase 1, while units 2 & 4 are assigned Phase 2. Such an installation can be fixed cycle (no actuations – it simply cycles based upon time), semi-actuated, or fully actuated. A semi-actuated installation works well if you have a high-traffic main street with a low volume side street. Obviously, the side street is the actuated phase, while the main street rests in green unless there is a vehicle call on the side street. If traffic volume is more equal between phases, full actuation can be implemented. Again, you must have communication between units to accommodate the vehicle calls and your monitoring must be sophisticated enough to allow programming of compatible phases. (The MicroForce DC™ can provide this level of control.)

What About Coordination?
It is likely that such an intersection would be coordinated with other intersections, especially if it is one of many along a high-traffic street. Now, coordination is based upon a synch pulse given as a reference point, with each intersection then calculating its coordinated green based upon its time/distance from the start point – known as the offset. This is usually accomplished either via some sort of link between all intersections (hardwire, fiber optic, RF, WAN, etc.) or via internal Time Based Coordination (TBC). TBC is based upon the 60 Hz signature of standard AC line voltage. If you are using solar powered portable equipment, you do not have this reference point. However, sophisticated controllers can interface with the GPS system and get their time signature from that. A truly sophisticated GPS application will not only provide TBC, but can also allow access to the control system via the Internet (assuming a cellular or WAN connection), and feed the location of the unit back to the agency responsible for its care. This is particularly useful on rental units, as it gives a low-cost means of technical support, and a means of verifying customer use. This feature is available as an option on our ATC controller, which is custom manufactured for us by Intelight.

PTSS in the Wide Arterial Intersection – 3 Phases
Next, look at Diagram 3, an intersection with 2 protected left turns. Per the phasing diagram at the bottom, it is a 3 phase intersection, with both left turns as Phase 1, the North/South through movement as Phase 2, and the East/West through movement as Phase 3. Units 1 & 4 must service
both the through movements and the turn movements. We would recommend our Pop-Up HD™, which has an adjustable arm out to 15 feet, and can support a 5 section signal at the end of the arm – typically a “cluster” or “doghouse left.” Units 2 & 5 have no left turns, so a standard Pop-Up LD™ with standard RYG signals will work well there. Units 3 & 6 would typically be Pop-Jr™ units with left turn arrows of all 3 colors. They would function as a re-enforcement for the turning movement (Phase 1). Traffic jurisdictions often use such non-compliant signals to reinforce the overhead signals within a very wide intersection. Again, a non-actuated, semi-actuated (Phase 1 and Phase 3) or a fully actuated detection scheme could be implemented. Our MicroForce DC™ controller could handle any of these scenarios.

PTSS in the Wide Arterial Intersection – 6 Phases

Finally, take a look at Diagram 4 on page 60. At first glance, it appears identical to Diagram 3 – the same intersection and the same PTSS units. However, note the phase diagram at the bottom and the phase assignments by each unit. We have moved into a dual ring application! Dual ring technology typically allows 4 independent through movements and 4 independent turn

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Diagram 4

movements. It is programmed to allow two compatible phases to operate simultaneously in up to 8 different combinations. In an actuated application, this provides for the greatest flexibility and the greatest ability to move traffic. However, in our equipment line, only our Intelight ATC™ controller with 2070 software, EDI CMU, and custom radio network is capable of this level of complexity. This system can also typically control 4 pedestrian movements, and is also capable of these additional advanced features: volume density traffic control, yellow flashing arrow, lead/lag left turns, and Canadian rapid flash green arrow.

So What Are You Waiting For?
While I have clearly demonstrated that PTSS are capable of safely controlling traffic in both simple and complex scenarios, the real advantages they bring are the speed and ease of installation. To be able to install a system in a matter of minutes opens up new possibilities! Plus, the PTSS can be installed where no infrastructure exists (i.e. - AC power) by workers who do not have access to large equipment, such as bucket trucks and trenchers. Add to that the elements of portability (when you are finished with the temporary application, just tow the PTSS to the next job site to use again) and green solar power, and Portable Traffic Signal Systems, such as the OMJC Signal™ Pop-Up line of equipment, are hard to beat.

LYLE STOUT, B.A., ISU, has accrued 20+ years experience with traffic equipment. He is certified for IMSA Level 2 Bench. He has been involved in the development of portable traffic signals at OMJC since its onset. He assisted in the development of many products in the Port-a-Mast line. He has been part of the mechanical and electrical component development team, including solar power and traffic control.

LYLE STOUT is a long time advocate of renewable energy. He has devoted much of his professional time to realizing its effective use in traffic control.