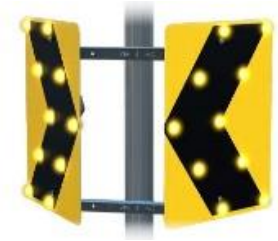
Sequential Dynamic Lighting Curve Warning Systems – Lessons Learned

Overview

A Sequential Dynamic Lighting Curve Warning System utilizes LED-enhanced solar or electric powered signs and wireless controllers with ultra-low power radar. The system flashes a series of chevron-shaped signs in sequential order to warn and guide drivers through the upcoming horizontal curve, similar to airplane approach lighting patterns. The network connecting the signs is constantly communicating and providing a synchronization pulse through the connection to ensure the signs are flashing in proper order through the curve.



Transportation Challenges Addressed

A large percentage of crashes each year are single vehicle, run-off-the-road crashes. This countermeasure can be particularly useful in helping motorists navigate sharp curves in various weather conditions, including fog, rain, and snow, as well as driving at night and through work zones. By improving advisory speed adherence through curves, Sequential Dynamic Lighting Curve Warning Systems decrease roadway departure crashes and reduce crash severity.

Where has it been used in PA? (Project highlight/case study)

As of March 2023, the innovation has been piloted at six locations in three PennDOT Districts:

District 1-0:

- Interstate 86, sharp curves at the highway's western terminus/junction with Interstate 90 in Erie County

The series of 7 solar-powered sequential chevron signs are installed on wooden posts behind guiderail where WB I-86 merges into WB I-90.

District 10-0:

- Interstate 80 eastbound, near Brookville, Jefferson County approaching North Fork Creek crossing

- SR 119, rural Indiana County near Crooked Creek crossing

Both installations in District 10 are solar powered. The I-80 installation is single-sided since it is for eastbound traffic only, while the SR 119 installation is double-sided.

District 11-0:

- Interstate 79, S-Bends near the Ohio River crossing

- Interstate 579, Ramps to and from SR 28 on Pittsburgh's North Shore

- SR 28, sharp curve in northeast Allegheny County near Freeport (Armstrong County)

The I-79 and I-579 installations are both electrically powered, while the SR 28 installation is solar powered. The I-79 and SR 28 installations utilize ground-installed wooden poles, while the I-579 installations use structure-mounted metal poles.

Lessons Learned and Best Practices

Solar vs. Electric

Both solar-powered and hard-wired installations offer benefits and drawbacks. The initial decision may be dependent on the availability of power at the chosen location.

While free from the need for a hard-wired power supply, solar-powered installations do require adequate sunlight to obtain enough power to charge and function reliably. District 11 suggested that a solar study may be required. If a proprietary installation is being used, supplier coordination is also necessary to ensure the solar system can adequately power the signs for required usage. District 10 found that its unconnected solar-powered units were simple to install; depending on the availability of power, they are generally less expensive as well.

For electrically powered installations, project costs need to consider more than the signs themselves—conduit, wire, junction boxes, for example. Consideration should be given to junction boxes at each sign location to allow for easier field repairs and installation. Proper coordination for with railroads for any new wired electrical power is also necessary.

Material Selection

Although designed to reduce run-off-the-road crashes, the chevrons are nonetheless more likely to get hit than an average sign due to their placement on horizontal curves. Rather than wood poles, which are prone to warping and can be more cumbersome to replace, District 11's construction staff advocates for use of a cast base traffic signal support similar to that shown in TC 8803, Sheet 1 of 4 (CAST BASE). If not protected by guiderail or barrier, any alternative post would need to be a breakaway design.

District 10's I-80 installation utilized a ruggedized sign design reinforced with two additional layers of material to combat against heavy winds typical for the region, as well as plowed snow.

For both electrically and solar powered chevron installations, materials chosen for the project may ultimately depend on lead times for procurement.

All of District 11's ground installations currently utilize wooden poles set in concrete as shown. In the future, staff will consider metal cast bases instead to simplify replacement.

Installation Considerations

District 11 indicated that if it were to do the projects over again, they would specify over-sized chevrons for Interstate highway installations; the signs used met the minimum size criteria but a larger size is an option.

The District believes larger signs that otherwise use the same technology would have an enhanced positive effect on safety.

The District 1 installation, located at the junction of two major high-speed Interstate highways, has experienced several guiderail intrusions resulting in damage to the units. As a result, the District believes chevrons alone may not be enough to adequately influence speed at this location and is planning additional advance warning signage in a future project.

District 10 believes it can enhance the effectiveness of its SR 119 installation by increasing the spacing between chevrons, as well as adding two additional sets of chevrons to further delineate the curve. The District has received positive and negative feedback from road users on the signs, with users believing that the lights help with getting the driver's attention and help guide drivers' paths, while others feel that the chevrons are too bright.

Cost/Benefit Information

Funded using Highway Safety Implementation Program (HSIP) dollars, District 11's two electrically powered installations were installed at a cost of $682,090 while its one solar powered installation cost $66,395. With over 150 documented run-off-the-road crashes at the three locations, each location showed a positive benefit-cost ratio.

District 1's solar-powered installations were relatively inexpensive at $5,300 per unit for a total of $37,100. District 10's two installation locations, both solar, totaled $52,000, plus installation costs incurred by county maintenance forces. With the low costs incurred, similarly positive benefit-cost ratios could be expected for these sites as well.

Applicability beyond PennDOT

Using its own experience, PennDOT could lead and educate local governments on the use of these devices on locally-owned roadways as appropriate. Although the devices can be expected to see wider use on busier, state-owned limited access highways (District 1-0 has no plans to install the signs on roads other than its Interstate system) the signs can realistically be deployed on roads of any type to improve safety. As stated by the District 10-0 traffic staff, *"we would definitely suggest this [to municipalities] in the future if we saw an opportunity for their installation."*

Likewise, more local government and public awareness of the innovation and its potential benefits (through training, marketing, and field observation) would allow outside entities to help advise PennDOT on candidate locations along the state-owned roadway network.

Next Steps

As of March 2023, PennDOT is developing a statewide approval process for sign installations. Publication 408 (Specifications), Section 1103.03(k), *LED Border Lit Signs,* has been updated to include flash rates,

acceptable colors, dimming, optional traffic detection, and flashing sequence. These requirements are used as the basis for vendor approval requests in Bulletin 15 (Qualified Products List for Construction). PennDOT also plans to update Publication 638 (Highway Safety Program Guide) use cases once sufficient data from the pilot projects around the state has been obtained.

The three pilot Districts continue to explore opportunities for future installations of Sequential Dynamic Lighting Curve Warning Systems. None of the Districts consider the devices to be a universally applicable solution; rather, it has become a “tool in the toolbox” as PennDOT continues its efforts to reduce run-off-the-road crashes and improve roadway safety.