

SEQ SEQUENTIAL FLASHING WARNING LIGHT SYSTEM



AASHD Innovation Initiative

What is A.I.I.?

AASHTO Innovation Initiative (A.I.I.)

Dedicated to sharing...

- High payoff,
- Market-ready technologies

Accelerating adoption of innovation among...

• Peers in U.S. transportation agencies



Why SEQ? Why now?

Due to highway congestion, nighttime work is increasing.

So the goals for SEQ are to:

- Enhance the nighttime work zone visibility of merging tapers, especially on interstate projects.
- Increase driver awareness.
- Reduce speeds toward speed limit compliance.
- Maximize traffic flow through the merging taper.



The SEQ lights are seen from a greater distance alerting the drivers to merge earlier, which provided a much safer taper area. We had no incidents and several motorists let us know that they really liked the SEQ lights.

--John Elliott, Senior Construction Inspector, MoDOT

Presentation Agenda

- Oklahoma DOT piloted in 2010
- Missouri DOT piloted in 2010-2011
- Findings of the University of Missouri-Columbia Study
- Future Use of Sequential Flashing Warning Lights



Oklahoma DOT



Kristie Drury, P.E. Oklahoma Turnpike Authority

2009 MUTCD includes sequential flashing warning lights as an option.



Option: A series of sequential flashing warning lights may be placed on channelizing devices that form a merging taper in order to increase driver detection and recognition of the merging taper.

2009 MUTCD includes sequential flashing warning lights as an option.



Standard: If a series of sequential flashing warning lights is used, the successive flashing of the lights shall occur from the upstream end of the merging taper to the downstream end of the merging taper in order to identify the desired vehicle path.

Each flashing warning light in the sequence shall be flashed at a rate of not less than 55 or more than 75 times per minute.

Oklahoma DOT

Oklahoma's practice is to place SEQ equipment at the taper of the work zone where the workers are present.

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ODOT finds it important to specify in plans that the sequential lights move as the work zone moves.

Oklahoma DOT

Oklahoma Turnpike Authority uses 900' taper lengths. One sequential zone involves two sets of sequential lights at that length.

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Oklahoma practice has been to place sequential lights on drums. Some suppliers now want to use them on Direction Indicator Barricade (DIB). This option is being approved.



I feel they are a much better alternative than standard drums with lights. They guide the traffic through the taper even after they pass the first drum...a lot like landing strip lights guiding a plane to the runway.

--Jimmie D. Marshall, Jacobs Engineering Group Inc./Oklahoma

Missouri MoDOT



Dan Smith, P.E. Missouri Department of Transportation

Missouri DOT

MoDOT piloted the sequential lights on I-44 nighttime maintenance project. Twenty sequential lights were used on shoulder and merging taper.

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MoDOT expanded the pilot program by purchasing a set of 20 SEQ lights for every district.

MoDOT initiated a study to evaluate the effectiveness of SEQ.

Users say...



The SEQ lights immediately got the drivers' attention to move over before fully entering the work space.

--Brady Watson, Senior Construction Technician, MoDOT

MoDOT I-44 Interstate Video

http://youtu.be/oD3NtNKV9xY



The SEQ lights clearly define the merging taper for nighttime work, especially on higher speed roadways.

--Tim Ackert, Senior Construction Inspector, MoDOT

COST-BENEFIT ANALYSIS OF SEQUENTIAL WARNING LIGHTS IN NIGHTTIME WORK ZONE TAPERS

June 6, 2011

Report to the Smart Work Zone De<mark>ployment Initiative</mark>



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http://www.intrans.iastate.edu/s martwz/projects/details.cfm?proj ectID=88

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University of MO-Columbia Study

The MU Study included one urban and two rural interstate projects:

- Rural speed limit decreased from 70 to 60 mph.
- Urban speed limit remained the same.
- Video and Radar data were collected.

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University of MO-Columbia Study

Study included one urban and two rural interstate projects:

- A data collection time of three hours was used (90 minutes with & without lights).
- Data was collected from a point 730-feet upstream of the taper to the merging taper.
- The data collection area was divided into 8 zones as shown on next slide.



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ALL DELINEATORS ARE SPACED 80 FEET APART.

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Findings were reported in the following categories:

- Total vehicles
- Passenger cars
- Trucks
- Rural work zone
- Urban work zone

85 th Percentile Speed & Mean Speed										
	With Lights 85 th (mph)	Without Lights 85 th (mph)	With Lights Mean (mph)	Without Lights Mean (mph)						
Total Vehicles	62	63	55.55	57.76						
Passenger Cars	63	64	56.50	58.7						
Trucks	60	61	53.80	56.30						
Rural Work Zones	63	63	57.65	58.43						
Urban Work Zones	60	62	53.09	56.24						

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Speed Reduction with SEQ Lights

Speed Limit Compliance Rate

	With Lights (%)	Without Lights (%)	
Total Vehicles	78.1	71.4	
Passenger Cars	73.1	65.2	
Trucks	87.3	80.9	
Rural Work Zones	69.0	68.3	
Urban Work Zones	88.8	78.4	

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Increased Compliance











Overall Performance

Benefit/Cost

The following resources were used to calculate benefits:

- Missouri work zone fatal & injury data for freeways/major highways
- Nilsson Power Model (quantitative relationship between crashes and speed)

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Costs of Crashes (User Benefit Analysis for Highways, AASHTO)

Benefit/Cost

The following costs were used:

- SEQ light cost per unit (\$104/light)
- Power cost (batteries)
- Based on 1,968 nighttime work zones deployed in 2010 Number of nights per work zone (average 7.6 nights) Maximum 109 nighttime work zones

Labor costs (2 workers, 20 SEQ lights, 30 min. install, 30 min. remove) Scenario 1—install/remove SEQ lights every night Scenario 2—install remove SEQ lights at beginning/end of project

Benefit/Cost Ratio

Total Benefits: \$3.65 million Total Cost:

- Scenario 1--\$705,008
- Scenario 2--\$341,580

Benefit/Cost Ratio ranged from 5 to 10



Safety is the primary reason I like SEQ lights. The SEQ lights alert drivers about closed lanes better than an arrow board. Drivers tend to get over sooner and not wait until the last minute to merge. Also, the SEQ lights were very rarely hit by traffic, which means less maintenance.

--John Casey, Senior Construction Inspector, MoDOT

Summary of the Report

- SEQ lights appear to be an effective tool for improving driver awareness of the work zone merging taper.
- SEQ lights was shown to be most effective with trucks and rural work zones as compared to passenger cars and urban work zones.
- Most measures of performance supported this conclusion as speeds were reduced and early merging increased.

Summary of the Report

A small percentage of aggressive drivers caused an increase in speed variability and late merges.

- No operational or synchronization problems were observed in the lab or in the field.
- Benefit/Cost ratio of the SEQ lights ranged from 5 to 10, depending on labor costs.

Users say...



The cost to benefit ratio of the SEQ lights was noteworthy and their continued use is highly encouraged!

--Matt Daulton, Senior Construction Inspector MoDOT

MoDOT US 60 Video

http://youtu.be/C3LyRxlgpxY



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Future Use of Sequential Flashing Warning Lights

- MoDOT has successfully deployed sequential lighting on nighttime interstate construction and maintenance projects.
- MoDOT has developed a formal policy for the use of SEQ lights on nighttime interstate projects.
- Oklahoma's future use.

MoDOT Engineering Policy

http://epg.modot.org/index.php? title=616.6_Temporary_Traffic_C ontrol_Zone_Devices_%28MUTC D_6F%29#Fig._616.6.83_Seque ntial_Flashing_Warning_Light

Figure: 616.6.83 Sequential Flashing Warning Light

	(5)	(S)	(T1)	(T2)	LENGTH (ft.) (B)		Work Areas
0-35	200	200	70	245	250	35	50
40-45	350	500	150	540	360	40	100
50-55	500	1000	185	660	495	50	100
60-70	SA - 1000, SB - 1500, and SC - 2640		235	840	730	60	100
Shoulder ta	per length based	d on 10 ft. (stand	dard shoulder widt	h) offset 2 La	ne taper length based	on 12 ft. (standar	d lane width) offset

This Sequential Flashing Warning Light sheet provides guidance on the placement of lights within shoulder and merge taper and operational information. Review appropriate typical applications for signs, sign spacing, taper length, buffer length, channelizer spacing, TMAs, channelizers, etc.

The sequential lights should be self-contained and placed within the merging taper and still communicate with any light within the sequence. The lights should be capable to be spaced at least 60° and may have a offset capability of at least 6°.

Pay item description: The number of sequential lights used in the merge taper will be dependent on the above table oritoria based on posted speed limit. Depending on project location and intesity of lighting, the number of lights may be reduce to a minimum of 10 lights within the merge taper. Contract cost of light would be based on purchase, installing and maintaining per light.

Battery Recommendation:

6-Volt Battery: Sequential lights with one 6-volt battery were used on several projects and the lights were getting about 3 weeks of battery life. Several different types of batteries (6-volt) were used on the projects. This is based on continuous use of the light (24/7).

4 D-cell Batteries: Sequential lights with 4 D-Cell batteries with converter were used on several projects and were getting about 3 weeks of battery life. This is based on continuous use of the light (24/7).



Number of Batteries Used on Channelizers:

Due to weight and consistency, a 6-volt battery and 4 D-cell batteries with converter will be considered as equal. All sequential lights must be securely mounted to all channelizers.

If sequential lights are used on Drum-like channelizers, two batteries can be installed. If they are mounted on a Trimline, only one battery may be installed. An extra ballast ring may be necessary to keep the trimline from tipping over.

If they are mounted on a Directional Indicator Board, only one battery may be installed.



Two Batteries One Battery One Battery



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Users say...



The SEQ lights were amazing; we didn't have one incident and we received a number of positive comments from area residents.

--Kevin Schuette, Construction Inspector, MoDOT



Well in advance of the taper, motorists can see the path they need to take to get around the closure. We had <u>ZERO</u> incidents during nighttime bridge work with the SEQ lights.

--Jason Williams, P.E., Transportation Project Manager, MoDOT

Questions?

aii.transportation.org Select Sequential Flashing Warning Lights for Work Zones

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Thank you.