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Solar Powered Barricade Warning Lights

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Supplemental Notes

Abstract

SOLAR-POWERED BARRICADE WARNING LIGHTS

Introduction

Warning lights are commonly mounted on barricades and barrels at work zones and are used in either flashing or steady-burn mode (*1*). Type A flashing warning lights are used to warn motorists of upcoming work zones or road hazards. Type C steady-burn lights are used to delineate the travel lane through and around a construction area.

Battery-powered warning lights are powered using two six-volt batteries. Warning lights using light-emitting diodes (LED) consume less energy than incandescent lights. The cost for LED and incandescent lights with no batteries is about $21.00 and $12.50, respectively. An average price for a six-volt battery is about $2.50.

Interplex Solar, Inc. has recently introduced new solar-powered warning lights which recharge completely using solar energy. The solar-powered LED lights are completely weatherproof and recharge even on cloudy days. A solar-powered light weighs about 1.5 pounds, which is more than 2.5 times lighter than a battery-powered light with two batteries. Each solar-powered warning light costs $26.50.

As a part of the Midwest States Smart Work Zone Deployment Initiative (MwSWZDI), Types A and C solar-powered LED lights were compared with two brands of battery-powered lights (one with incandescent lights and one with LED lights) currently used by the Iowa Department of Transportation (Iowa DOT). The purpose of the study was to examine whether solar-powered lights provide consistent illumination over an extended period of time (e.g., 14 weeks, which is as long or longer than most long-term work zone projects). The study also examined the life cycle of the solar-powered lights to determine if they could eliminate the costs associated with the maintenance of battery-powered lights.

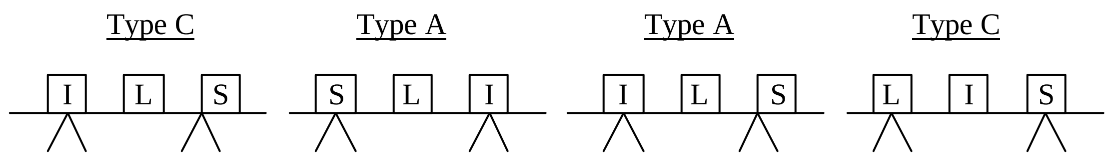
Test Setup

Six Type A and six Type C (including two of each of the three brands – battery-powered LED, battery-powered incandescent, and solar-powered LED) warning lights were mounted side-by-side on four sawhorses. The four sawhorses were placed on the roof of one of the Iowa DOT's buildings on October 16, 1999. Figure 2-1 shows the four arrays of three lights at the testing site. A close-up picture of one of the arrays, shown in Figure 2-2, shows the three brands of warning lights.

FIGURE 2-1 Four arrays of warning lights at the testing site.

FIGURE 2-2 Array of lights at the testing site. From left to right: battery-powered incandescent, battery-powered LED, and solar-powered LED lights.

Each array contains one light of each brand. The positions of the lights in each array were assigned at random. Figure 2-3 shows a schematic of the lights' arrangement in the four arrays. The two end and the two middle arrays contain the Type C flashing and Type A steady-burn lights, respectively.



I – Battery-powered incandescent
L – Battery-powered LED
S – Solar-powered LED

FIGURE 2-3 Warning lights' arrangement.

Test Operation

An observer viewed and ranked the warning lights from two positions at a distance of 1,000 feet from the arrays once per week during darkness. One position was a straight-on view and the other position was at a 30-degree viewing angle. The lights' positions were not known to the observer.

The intensity of the warning lights viewed at the 30-degree angle was low, with all light providing very similar levels of illumination. Their illumination levels, however, were different at the straight-on view. Table 2-1 shows the recorded warning lights' weekly performance when viewed straight-on.

TABLE 2-1 Performance of warning lights viewed from a straight-on position.

	Type C			Type A			Type A			Type C		
Date	I	L	S	S	L	I	I	L	S	L	I	S
10/16	Low	Low	Low	High	Med	Low	Low	High	High	Low	Low	Low
10/23	Dim	Low	Low	High	Med	Low	Low	High	High	Low	Dim	Low
10/30	**Out**	Low	Low	High	Med	Low	Low	High	High	Low	**Out**	Low
11/07	Low	Low	Low	High	**Out**	Low	Low	High	High	Low	Low	Low
11/12	Low	Low	Low	High	Med	Low	Low	Low	High	Low	Low	Low
11/20	Low	Low	Low	High	Med	Low	Low	**Out**	High	Low	**Out**	Low
11/27	Dim	Low	Low	High	Med	Low	Low	High	High	Low	Low	Low
12/05	**Out**	Low	Low	High	Med	Low	Low	High	High	Low	Low	Low
12/11	Low	Dim	Low	High	Med	Low	Low	High	High	Low	Low	Low
12/19	Low	Dim	Low	High	Med	Low	Low	High	High	Low	Low	Low
01/01	Low	Dim	Low	High	Med	Low	Low	High	High	Low	**Out**	Low
01/11	**Out**	**Out**	Low	High	Med	**Out**	Dim	High	High	Low	Low	Low
01/23	Low	Low	Low	High	Med	Low	**Out**	High	High	Low	Low	Low
01/31	Low	Low	Low	High	Med	Low		High	High	Low	Low	Low

I – Battery-powered incandescent
L – Battery-powered LED
S – Solar-powered LED

Results

Table 2-1 indicates that Type C steady-burn lights generally had lower illumination than Type A flashing lights. The batteries of each of the two tested Type C incandescent warning lights ran out and were replaced three times during the evaluation period. Having consumed less energy, the batteries of one of the Type C LED lights were changed only once during the last month of the testing period.

As shown in Table 2-1, the Type A flashing lights offered a better performance than the Type C steady-burn lights. The batteries of each of the four Type A incandescent and LED warning lights ran out only once during the 14-week evaluation period.

The solar-powered LED lights provided a consistent performance throughout the testing period and required no maintenance. Similar to battery-powered lights, the Type A flashing solar-powered lights were brighter than the Type C steady-burn lights.

In a separate test, one solar-powered Type A light and one solar-powered Type C light were placed inside a filing cabinet to evaluate their battery life without solar charging. The Type C light ran out of energy in about 40 hours. The Type A light, however, flashed at high intensity for five days and ran completely out of energy life after seven days.

The same procedure was repeated during a second round of indoor testing after the two lights were placed outdoors for a few hours to recharge. Similar to their first indoor performance, both steady-burn and flashing lights ran out of battery life in about 40 hours and 7 days, respectively.

To determine the lights' life-cycle costs, the accumulated costs of each of the Type A and Type C lights during the evaluation period are calculated and shown in Table 2-2. Assuming an average cost of $2.50 for each six-volt battery, the total cost, for example, for the Type C incandescent light with six battery replacements adds up to $32.50 during the14-week testing period.

The total values presented in Table 2-2 indicate the solar-powered and incandescent lights are the two least expensive ones among the evaluated Type C flashing and Type A steady-burn warning lights, repectively. In considering the time spent for changing the batteries, the Type A incandescent light may, however, become more expensive than the solar-power light which required no maintenance.

TABLE 2-2 Accumulated costs of the lights during the testing period.

	Type C			Type A		
	S	L	I	S	L	I
Initial Cost w/batteries ($)	26.50	26.00	17.50	26.50	26.00	17.50
Replacement Batteries ($)	0	2@2.50	6@2.50	0	2@2.50	2@2.50
Total ($)	26.50	31.00	32.50	26.50	31.00	22.50

Conclusion

The illumination levels and life-cycle costs of solar-powered LED barricade warning lights were examined from October 16, 1999, to January 31, 2000. The outdoor evaluation of lights indicated they provided consistent illumination throughout the testing period. Due to being tested during the fall and winter months, when there are fewer clear days, it can also be concluded that they efficiently recharge when it is overcast. Their indoor evaluation indicated that they completely recharge after being placed outside for a few hours. Requiring no maintenance, they proved to be the most cost effective when compared to the tested battery-powered lights.

Another benefit of the solar light is its weight. A solar-powered light weighs about 1.5 pounds where a battery-powered light weighs about four pounds. The higher weights of battery-powered lights with their six-volt batteries may cause secondary damage on vehicle impact. These lighter weight solar lights should eliminate the secondary damage.

Furthermore, the solar-powered lights are fully compliant with specification 6E-5 of the MUTCD and Institute of Transportation Engineers (ITE) Purchase Specification of Flashing and Steady Burn Warning Lights. Overall, the solar-powered lights provided a satisfactory performance during the evaluation period. They provide consistent illumination for several months and eliminate the need to spend valuable time and money on battery replacements.