# Evaluation of a Field Testing Device for Flashing Barricade Warning Lights

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Past studies have shown that up to 30 percent of the type A flashing lights in field use fail to meet Pennsylvania Department of Transportation specifications. A device, shown in Figure 1, was constructed to measure the effective intensity (candelas), flash time (milliseconds), and period (seconds) of flashing lights in the field. It weighs 14.6 kg (32.3 lb), its dimensions are 0.72 by 0.23 by 0.28 m (28.5 by 9.25 by 11.0 in), and it contains all optical, electronic, and power components. A front-mounted gimbal allows measurement angles of ±9 deg horizontal and ±5 deg vertical.

To obtain the three primary specification parameters, the electronic circuitry performs the following calculation in successive integrations, displaying a maximum effective intensity Ie on a meter.

$$I_e = \frac{\int_{t_1}^{t_2} I\,dt}{0.2 + (t_2 - t_1)} = \frac{\int_{t_1}^{t_2} I\,dt}{0.2 + \int_{t_1}^{t_2} dt} \quad (1)$$

where

$I$ = instantaneous intensity,
$t_1$ and $t_2$ = flash duration limits, and
$I_e$ = a maximum value.

A second meter shows the flash time of the light, and a third meter shows the period. Thus,

$$\text{Percentage of on time} = (0.1 \times \text{flash time})/\text{period} \quad (2)$$

$$\text{Flash rate (f/m)} = 60/\text{period} \quad (3)$$

Without the device, only the flash rate can be determined in the field.

Evaluation of the device consisted of a direct correlation between values obtained for the aforementioned parameters by means of the device and the department's optical tunnel facilities. Variables under investigation were different light manufacturers, variable light power levels, and different viewing angles. Individual lights were tested initially, and results showed a one standard deviation ($\sigma$) for Ie as high as ±1.77 cd at 12-V power but only ±0.4 cd at 8 V. It was apparent that the device was more accurate when reading a light with a low intensity. The device was calibrated to read a light emitting 4.0 cd exactly (specification passing value). Thus it appeared that a light with an effective intensity of about 4.0 cd could be read within ±10 percent with a good degree of confidence.

Further work with additional lights showed definitely that optical centering of the light was important for good correlation. Following this procedure, correlation was within ±0.4 cd at 68 percent confidence with lights operated at or near the pass-fail region of 4.0 cd. Statistical evaluation of data also showed the device could determine the percentage of on time of a type A light to within ±5 percent of the value obtained at 68 percent confidence by using standard lab procedures.

## CONCLUSIONS

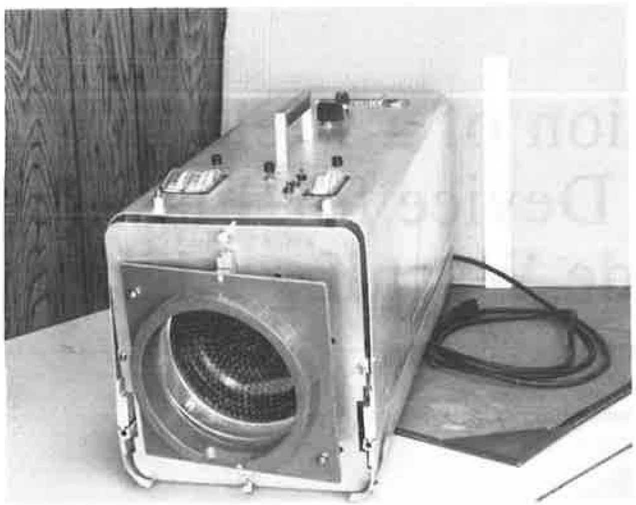
The device is too heavy and bulky for easy field use. The gimbal used to set viewing angles is not accurate enough or repeatable. The battery power system limits operation to about 1 h after full charge.

After careful optical alignment to a type A light powered with a voltage to cause a failing light (< 4.0 cd at ±9 deg horizontal, ±5 deg vertical), the test device will read within ±10 percent ($1\sigma$ = ±0.4 cd) of the value currently obtainable with the optical tunnel instruments. Of the ±0.4-cd deviation, about one-third or ±0.12 cd can be statistically attributed to the use of regression analysis techniques; the remaining two-thirds (±0.28 cd) is due to measurement error, reading error, or other experimental errors.

The apparent success of the device in determining quickly the percentage of on time and F-factor (a value currently used in the standard optical tunnel test tech-

Publication of this paper sponsored by Committee on Maintenance Operations.

Figure 1. Measuring device.



nique) may justify its use as a laboratory testing instrument.

Serious consideration should be given to developing a second-generation device, perhaps of two-piece design and having a lightweight optical head with accurate angular settings obtainable. An electrical cord could connect the head to a digital readout console containing computer and power elements.

ACKNOWLEDGMENT

This paper is an abridgment of a final report for Pennsylvania Department of Transportation Research Project 74-7, which was carried out in cooperation with the Federal Highway Administration under the direction of Leo D. Sandvig and Wade Gramling of the Bureau of Materials, Testing and Research, Pennsylvania Department of Transportation. The opinions, findings, and conclusions expressed in this report are mine and not those of the Pennsylvania Department of Transportation or the Federal Highway Administration.