R-379

OFFICE MEMORANDUM

MICHIGAN
STATE HIGHWAY DEPARTMENT
JOHN C. MACKIE, COMMISSIONER

April 10, 1962

To: E. A. Finney, Director
Research Laboratory Division

From: M. H. Janson

Subject: Propane-Fueled Warning Lights. Research Project 61 NM-60.
Report No. 379.

By letter to the Committee for the Investigation of New Materials on October 30, 1961, W. C. Sneed of the Protane Corp. of Cleveland requested approval of his company's highway construction warning light. A sample was received by the Research Laboratory Division on December 14, 1961, and given Sample No. 61 MR-201.

Photometric testing and field observations were planned for evaluation of the warning light, to be conducted by G. M. Smith. On January 23, 1962, after many of the photometric tests had been completed, Mr. Sneed demonstrated the manufacturer's technique of obtaining desired flame characteristics at the Laboratory, and consequently some photometric testing was repeated. On February 21, the field evaluation was conducted. It was then learned that the Fire Marshal Division of the Michigan State Police had neither approved nor evaluated the warning light, and thus on March 16 Lt. G. E. Tanner examined it for that agency. A copy of his letter of March 19 to Mr. Sneed is attached.

On the basis of the photometric tests, the field observations, and the special precautions required in using the light, it is recommended that the propane-fueled warning light not be permitted for use by the Department.

The warning light consists of a bi-directional optical unit mounted over a standard 20-lb capacity propane cylinder (Fig. 1). The optical unit (Fig. 2) is constructed of 20-gage aluminized sheet metal, and separated from the propane cylinder and gas regulator assembly by a 16-gage aluminized sheet metal plate. Fig. 3 shows the regulator assembly. The steel plate surrounding this assembly is coated with 3M "Codit," a white, bead-reflectorized paint.

The flame burns at the end of a shielded copper tube crimped to produce the desired flame characteristics (Fig. 4). A natural draft venting system causes the yellow-colored flame to rise and fall rapidly by recurrent oxygen starvation. Frequency of the flame fluctuation is approximately 12 cps and varies little at different flame heights. This frequency is in the range of the Brucke phenomena (8 to 12 flashes per second), characterized by doubling of the apparent intensity of the flash, as described recently by Howard*.

* Howard, J. "Visual Characteristics of Flashing Roadway Hazard Warning Devices." HRB Bull. No. 255 (1960), pp. 146-57.

Laboratory Observations

Candlepower values were recorded in a horizontal plane at the flame height recommended by the manufacturer, and calculated on the basis of average recorded flame cycle maxima. These values may be compared with Michigan specification requirements for battery-operated flashers in Table 1. Values of 1 to 2 cp were found to be typical at the flame cycle minima.

TABLE 1
TESTED AND SPECIFIED CANDLEPOWER VALUES

Candlepower Value	Angle from Lens Center				
	10^{o} left	5^{o} left	0^{o}	5^{o} right	10^{o} right
Specification (battery flasher)	2.5	5.0	5.0	5.0	2.5
Test (propane flasher)	0.7	2.3	5.4	1.7	0.7

Replacing the lens of the propane flasher with a Stimsonite No. 781H lens resulted in more uniform candlepower distribution, but all values were reduced to less than 1 cp. The Stimsonite lens is used on many battery-operated flashers which meet Michigan candlepower distribution requirements.

Candlepower and fuel consumption values are compared with flame height in Fig. 5. It may be noted that a 2.5-cm increase above the manufacturer's recommended flame height would double the candlepower values. But even these doubled values would not be enough to meet specification requirements, and the actual effect would be only temporary since the higher flame would cause soot to form on the interior of the flasher optical unit. Daily fuel consumption at the manufacturer's recommended flame height is 0.57 lb, and at this rate a cylinder of propane would last 35 days.

Field Observations

Visual ratings of the propane warning light in comparison with the battery-operated flasher and the kerosene bombshell torch were obtained in a snowstorm at night near the construction site of the junction of I 96 and Okemos Rd. A procedure was agreed upon in which the warning lights were displayed both as delineators and as barricade warning lights.

An observer group consisting of J. Becker, L. J. Doyle, R. F. Durfee, E. A. Finney, E. Gervais, R. L. Greenman, P. A. Nordgren, C. C. Rhodes, and J. D. Siwek, made observations in four visual test situations:

1. Three battery-operated warning flashers alongside the road as delineators and two on the barricade.

2. Five propane-fueled warning flashers at the same locations.

3. Five kerosene bombshell torches at the same locations.

4. One warning light of each type displayed together on the barricade.

Observers first drove slowly past the delineators and the barricade, and after viewing both the battery and propane flashers, marked record cards in terms of personal opinion. On the third trip, the observers drove past the kerosene torches and then compared them with the propane flashers. Finally, on the fourth trip, the observers were requested to select the most and least effective warning lights when the three types were displayed together on the barricade.

Observer reactions are tabulated in Table 2. When used as a delineator, the propane flasher was considered as effective as the battery flasher by more than half the observers, and more effective by the other observers. More than half the observers considered the propane flasher less effective than the kerosene torch, also as a delineator. As a barricade warning flasher, the propane flasher was considered less effective than the other two types by more than half the observers.

Many observers suggested that a reflex reflective ring around the flasher lens would be helpful. Placing the battery and propane flashers before barricades covered with reflectorized sheeting minimized their effectiveness, according to some observers. Both these latter comments indicate that reflective materials presently available are as bright or brighter than the flashers.

It should be noted that the observers were subjected to a difficult test procedure. The observer's eye is a fair judge of brightness when comparing lights displayed side by side, but a poor judge when required to recall the brightness of a reference sample. In this test, about half an hour elapsed between viewing the sample lights and viewings of the reference lights. Field test results indicated some observer inconsistencies which might be expected considering the procedure used.

Lt. Tanner of the Fire Marshal Division stated that certain precautions should be specified if the propane flashers are used in Michigan. Tanks must be filled at an approved charging plant, and the flashers transported in open vehicles. Flasher storage must be in accord with Michigan liquified petroleum gases regulations. The hazard from escaping gas, when a flame is accidentally extinguished, could not be evaluated.

The propane flasher does offer an unusual combination of flashing and steady-burning characteristics. Greatly increased signal intensity would certainly improve this flasher's effectiveness.

OFFICE OF TESTING AND RESEARCH

M. H. Janson

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Spectroscopy and Photometry Section
Research Laboratory Division

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TABLE 2
EFFECTIVENESS OF PROPANE LIGHT
COMPARED TO BATTERY FLASHER AND KEROSENE TORCH

Observer	More Effective as Delineator		More Effective on Barricade		Three Types Displayed Together	
	Battery vs Propane	Kerosene vs Propane	Battery vs Propane	Kerosene vs Propane	Most Effective	Least Effective
A	propane	kerosene	battery	kerosene	kerosene	propane
B	equal	propane	equal	kerosene	battery	kerosene
C	equal	kerosene	battery	kerosene	battery	propane
D	propane	kerosene	propane	kerosene	kerosene	propane
E	equal	kerosene	battery	kerosene	kerosene	propane
F	propane	propane	equal	equal	propane	kerosene
G	equal	kerosene	equal	kerosene	kerosene	battery
H	equal	propane	battery	equal	battery	kerosene
I	propane	equal	battery	equal	no opinion	

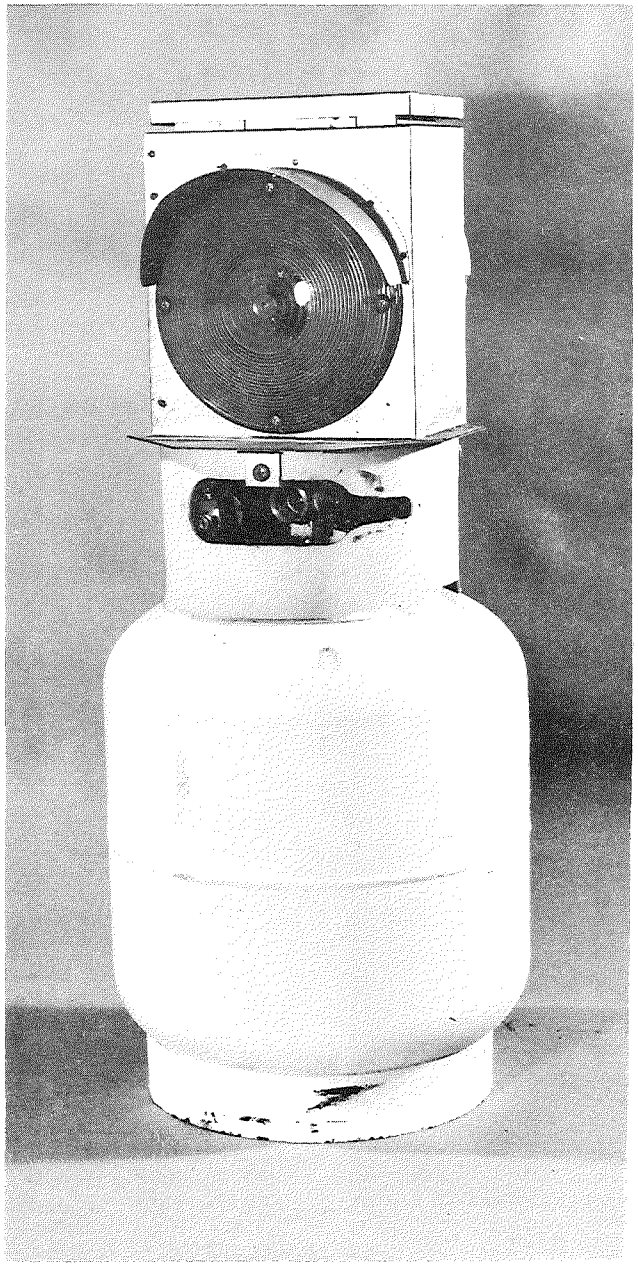

Figure 1. Propane-fueled warning light.

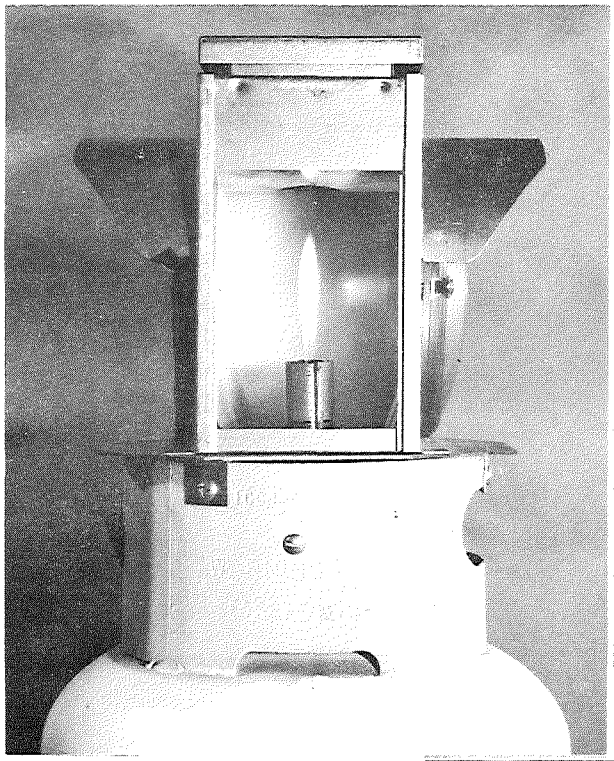

Figure 2. Bi-directional optical assembly.

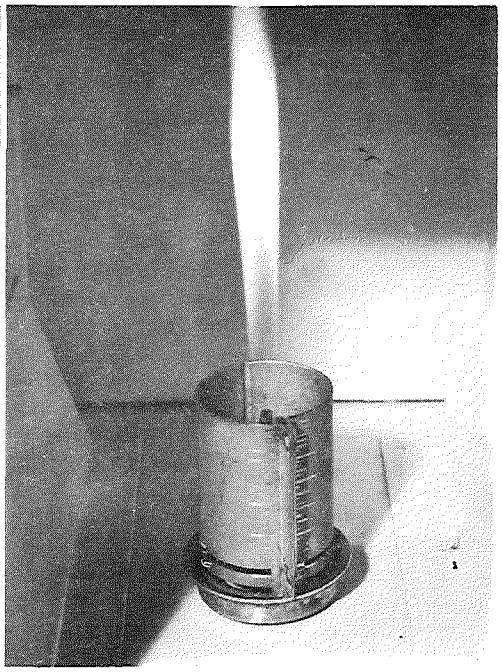

Figure 4. Light source.

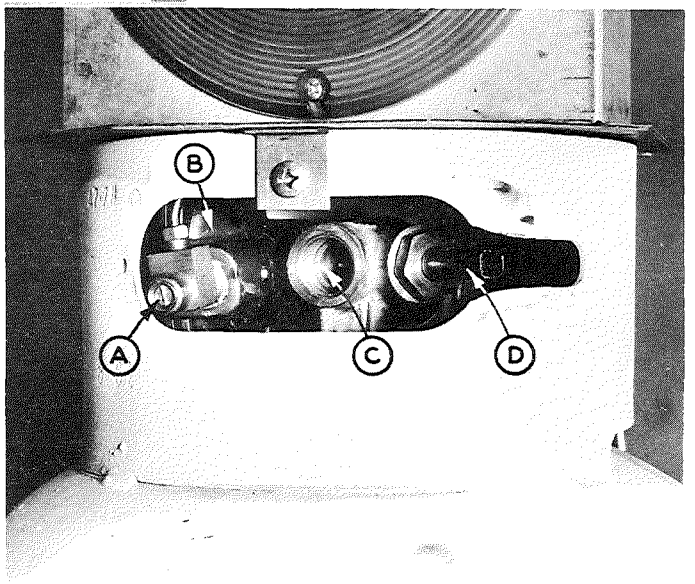

Figure 3. Regulator assembly, showing needle valve (A), pressure reducer (B), filling port (C), and shutoff valve control (D).

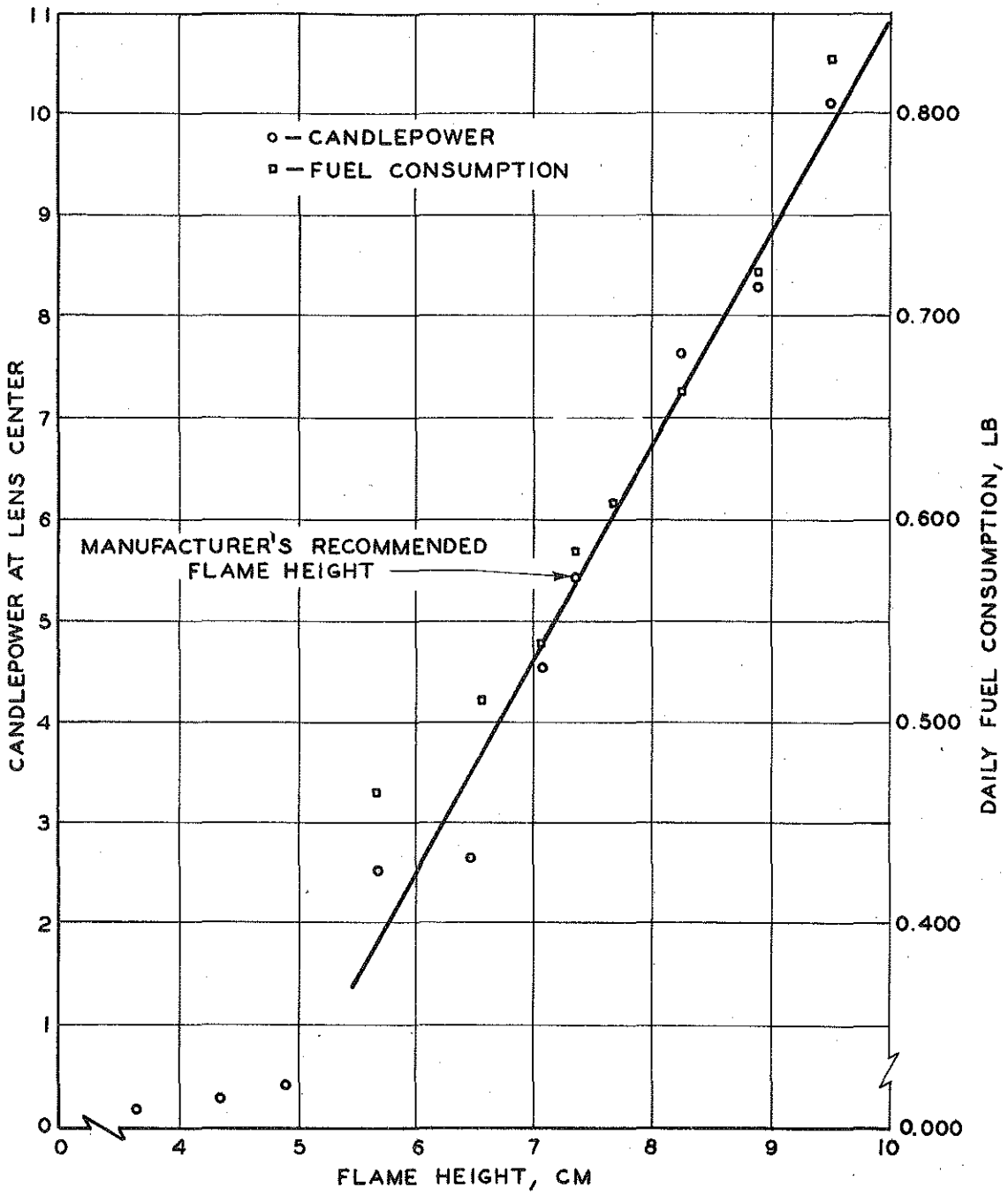

Figure 5. Candlepower and fuel consumption of propane warning light.

JOHN B. SWAINSON
GOVERNOR

JOSEPH A. CHILDS
COMMISSIONER

STATE OF MICHIGAN

MICHIGAN STATE POLICE

EAST LANSING

March 19, 1962

Mr. W. C. Snead, Manager
Protane Warning Litee
The Protane Corporation
302 East 131st Street
Cleveland 8, Ohio

Re: LPG Flame Warning Lights

Dear Mr. Snead:

This will acknowledge receipt of your letter of March 5, 1962 in regard to component parts for the above captioned warning lights.

We have viewed the light which is in the hands of the State Highway Department and will have no objection to its use provided the following are complied with:

1. The instructions for lighting which are on the removable sliding plate is very poorly done, partially illegible, and for its extreme importance should be revised so that legibility and permanence is assured.

2. The following information should also appear on the collar or light assembly, in a manner so as to be permanently legible:

   (a) For outdoor use only.
   (b) To be recharged only at approved LPG charging plants.
   (c) Not to be transported in closed vehicles.
   (d) To be stored in accordance with Michigan Liquefied Petroleum Gases Regulations.

Very truly yours,

GLENROY M. WALKER, Chief
Fire Marshal Division

Glen E. Tanner
Detective Lieutenant

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cc: Mr. Marvin Janson