FOG DETECTORS FOR CONTROLLING CHANGEABLE-MESSAGE SIGNS

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By their nature, changeable-message signs require an input. In most existing installations, the input is manual; i.e., at a central location remote from the sign a button or switch is operated, which through a hard wire or radio link changes the sign legend. Again, in most existing installations, the timing of the message is known or can be predicted. For situations such as construction, accident, traffic volume, or lane-turn restrictions, manual control is generally adequate. Fog, however, creates conditions wherein manual control leaves much to be desired. Areas where fog is a problem are usually well known from previous accidents. But the onset and duration of fog cannot be predicted with any accuracy, and any delay between the onset of fog and warning to the motorist can have serious consequence.

There have recently been made available in the United States 3 instruments that will continuously and automatically measure visibility or detect fog or do both. The instruments (manufactured by Impulsphysik, GmbH, Hamburg, West Germany) are the forward-scatter Fumosens, the back-scatter Videograph, and the transmissometer Skopograph. The Videograph and Skopograph were designed for operation at airports to measure RVR and are in operation in Europe, South America, and Canada. They are currently being evaluated by the Federal Aviation Administration for airport use in the United States. The U. S. Coast Guard recently completed an evaluation of the Videograph for use in unmanned aids to navigation (foghorns) (1).

Installations of the equipment are shown in Figures 1, 2, 3, and 4; characteristics are given in Table 1. The Videograph operates by measuring the light from an intense, pulsed-light source backscattered into a calibrated receiver housed with the source. The receiver is designed to reject all signals except those resulting from the very short (1 μsec) pulses and is, therefore, insensitive to ambient light (daylight, signs, or headlights). In addition to the current output proportional to visibility, the Videograph has an alarm circuit that may be set to operate at any level of visibility. Calibration is by means of an internal light guide that, through a solenoid-operated diaphragm, allows a known intensity of light to reach the photodiode of the receiver. The instrument may also be calibrated by using the Vivical. This unit, which is fixed to the receiver sun shield, transmits through a combination of mirrors and an adjustable, calibrated diaphragm the projected light pulse to the receiver.

Figure 1. Fumosens is in operation at Kentucky River Bridge on I-64 south of Frankfort.

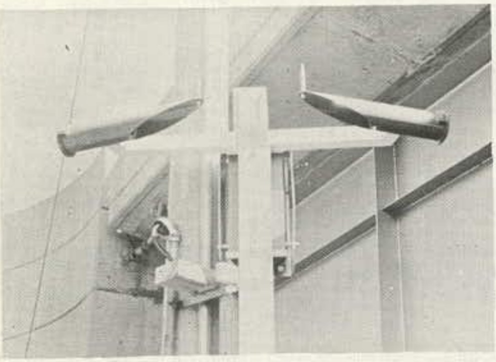

Figure 2. Videograph at Murder Creek interchange on I-5 north of Albany, Oregon, is being evaluated by Oregon State Highway Division for controlling changeable-message sign.

Figure 3. Videograph on Pennsylvania Turnpike, east of Carlisle, controls strobe lights in experimental lighting program.

Figure 4. Skopograph projector and receiver monitors visibility at Commonwealth Edison's Dresden Power Station at Morris, Illinois.

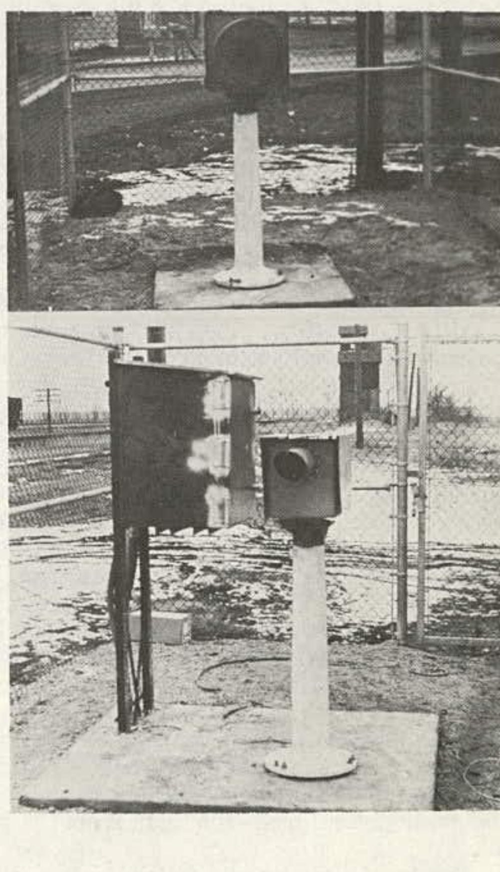

Figure 5. Changeable-message sign on I-5 in Oregon will be controlled by Videograph.

Table 1. Instrument characteristics.

Characteristic	Fumosens	Videograph	Skopograph Projector	Skopograph Receiver
Visibility range, m	50 to 1,000	100 to 10,000 and 30 to 3,000	—[a]	—[a]
Output signal	3 DPDT relay contacts set independently	0 to 1 madc current and panel meter	N. A.	0 to 1 madc current and panel meter
Power at 110/220 V and 60 Hz, W	65	90	90	295
Operating temperature, deg F	0 to 120	-13 to 105	-15 to 120	-15 to 120
Operating humidity, percent RH	100	100	100	100
Weight, lb	46	122	122	111
Base	3 holes on 7⅞-in. diameter	3 holes on $14^{11}/_{64}$-in. diameter	3 holes on 7⅞-in. diameter	3 holes on 7⅞-in. diameter
Calibration	Mark I eyeball	Light guide and Vivical	N. A.	57 and 37 percent neutral-density filters

[a]A function of base line between projector and receiver: maximum of 10 km with 500-m base line and minimum of 20 m with 30-m base line.

In the Oregon installation, the Videograph visibility output is recorded for subsequent correlation with other traffic data and is also fed to an 8-alarm unit that ultimately will control the changeable-message sign (Fig. 5). (Currently, control for the 6 signs is from a panel in the Albany office of the state police. A return telemetry link provides confirmation from the sign to the control panel that the function initiated at the panel is working at the sign. The sign legends may also be controlled from a panel in the equipment cabinet at the base of the sign and read SLOW, FOG, SPEED, 10, 20, 30, 40, 50, and WRECK.)

The Fumosens operates in the ultraviolet portion of the spectrum. It consists essentially of a lamp and a phototube between which is placed a baffle so that no light scattered through an angle of less than 20 deg can reach the phototube from the lamp. However, when visibility is poor, some is scattered toward the phototube by the fog particles. The resulting phototube current activates 3 identical but independent circuits whose output may be used to control external devices or equipment.

The operating threshold of each circuit may be adjusted between minimum and maximum visibility values of 50 to 1,000 m. In order that the Fumosens will not be influenced by daylight or other extraneous lights, the phototube optics include a UV filter operating at the 2,537-nm mercury emission line. Calibration is by means of on-site observation of visibility and manual setting of the 3 threshold circuits.

The Skopograph is a double-ended instrument consisting of a projector and receiver mounted on a base line of 30 to 500 m (depending on the range of visibility to be measured). As in the Videograph, the projector light source is a xenon flash tube pulsed by a solid-state power supply. The light output is constant for a long period (2 years minimum in continuous operation) and is focused into a narrow 4.5-deg beam by a parabolic mirror. The light pulses from the projector are detected by a photodector in the receiver, averaged for a 15-sec period, and converted to an output current proportional to visibility. Using 2 neutral density filters, the Skopograph can be calibrated at 3 values of transmission, corresponding to visibilities of 2.5, 4, and 7 times the base line. The upper limit of the working range is determined by the accuracy with which the very small attenuation along the base line in good visibility can be measured. The lower limit depends on the minimum usable signal/noise ratio of the receiver. For the Skopograph, those limits are 20 and ⅔ times the base line respectively. In those instances where a wider range of visibility must be measured, 2 receivers on the same optical base-line path from the projector but at different distances may be used.

Fog has long been recognized as a problem on highways. The increasing speeds and traffic on Interstate highways have not lessened this problem. The instruments described in this paper, in conjunction with changeable-message signs, can provide a solution to the problem of giving the motorist a real-time warning of fog.

REFERENCES

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