ELF FOR ELECTRONIC LINEAR FLOW CONTROL OF VARIABLE SPEED GROUND ULV APPLICATIONS

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ABSTRACT. The Elf device delivered the appropriate ground ULV rate at variable road speeds ranging from 4 to 21 mph (6 to 32 kph), and shut off automatically at higher and lower speeds. The system is designed to be compatible with vehicles equipped with digital as well as standard speedometers and can be calibrated at any speed within its operating range. Although not used in these studies, Elf has a distance calibration feature designed to enhance the accuracy of the transducer and thus to yield greater flow precision than could be achieved with the transducer alone.

The Elf (Vectec Inc., Orlando FL 32807) is an independent electronic device for linear flow control of ground ULV applications against mosquitoes and other flying pests. The system is designed to be compatible with vehicles equipped with digital as well as standard speedometers for use at road speeds varying between 4 to 21 mph and to shut off automatically at higher and lower speeds.

To assess Elf accuracy under controlled and operational conditions, a prototype unit was wired into the ignition system of a 1987 Ford Ranger pickup truck. The truck was equipped with a Curtis-Dyna Simplex ULV generator (Model 2956) and an Engler Instruments Sangamo electronic tachograph. Power for the Elf unit and the FMI 1/8-inch (32-mm) positive displacement pump (Fluid Metering, Inc., Oyster Bay, NY 11771) came from the vehicle's starter battery, which provided 13.2–13.8 volts at operational rpm levels. The transducer was attached to the transmission with a standard adapter. The Elf distance setting, which serves to enhance transducer precision when calibrated over a measured 0.1 mi. (0.16 km) with the transducer in operation, was not used during these trials. The studies were conducted at the Indian River Mosquito Control District (IRMCD) during February and March, 1989.

The unit was calibrated with mineral oil to provide a flow rate of 6 fl oz/mi. (110 ml/km). In lieu of a separate voltage regulator, the air-conditioning and headlights were engaged, and the engine was run above idle to simulate a normal operational power load. Care was taken to select a pump with an operating range suited to the desired delivery rates. The pump was broken-in prior to calibration and run for 15 to 20 min before calibration to warm it up. Calibration was performed by use of 40 electronic steps programmed into the unit in conjunction with the less accurate external adjustment of the pump setting. To minimize bias due to minor pump nonlinearity, which causes a somewhat greater change in flow rate between settings at lower pump speeds than at higher pump speeds, the calibration was conducted in the following manner. The initial 20 mph (32.2 kph) static setting was conducted by manually positioning the pump adjustment screws and electronically adjusting the flow rate. Fluid delivery settings for speeds below 20 mph were then established electronically at 2.5-mph (4-kph) increments, confirmed by volumetric measurement of a 2 min flow, and entered into the memory of the Elf. During the 2-h calibration process an effort was made to select options that would result in underdelivery, rather than overdelivery, in order to assure subsequent operational delivery rates would not exceed label requirements. The static calibration (Table 1) resulted in a mean underdelivery error of 2.6%.

Controlled road trials were conducted by travelling as closely as possible to fixed speeds of 5, 10, 15 and 20 mph (8, 16, 24, and 32 kph) over a measured mile (1.6 km) to determine actual delivery rates at operational speeds. The mean speed was confirmed by concurrent measurement of the elapsed time for the measured distance. The road calibration (Table 1) resulted in a mean delivery error of 4.6%.

After confirming the accuracy of the delivery system in these controlled trials, the equipment was tested operationally for 7 evenings in the community. Insecticide delivery was quantified by weighing the on-board fenthion container before and after each night's run and comparing the amount used with the expected usage, based on concurrent tachometer readings. Similar observations were conducted with 4 other ULV units operated concurrently using Scamp variable flow control devices (Street 1980). The observed mean flow rate from the experimental unit was 6.4% below the target label rate (range: 2.2% over target to 8.9% below target; Table 2). This represents a mean delivery rate of 5.6 fl oz/mi. (103 ml per km), compared with the target label rate of 6 fl oz (110 ml). Among the

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Table 1. Elf calibration.

MPH	Static test (2 min)				Road test (1 mi.)		
	Target volume	Set volume	Percent off target		Target volume	Observed volume	Percent off target
	ml	ml	Observed	Mean	ml	ml	Observed
20.0	118.3	122.0	3.1				
		119.0	0.6	1.9			
5.0	29.6	27.6	−6.7		177	182	2.6
		28.2	−4.6	−5.6		192	8.2
7.5	44.4	43.5	−1.9				
		42.0	−5.3	−3.6			
10.0	59.1	53.7	−9.2		177	182	2.6
		53.8	−9.0	−9.1		179	0.9
12.5	73.9	73.9	0.0				
		71.0	−4.0	−2.0			
15.0	88.7	87.8	−1.0		177	185	4.3
		87.7	−1.1	−1.1		202	13.9
17.5	103.5	103.4	−0.1				
		103.0	−0.5	−0.3			
20.0	118.3	118.0	−0.2		177	179	0.9
		117.0	−1.1	−0.7		184	3.7
Mean				−2.6			4.6

Table 2. Elf operational runs.

Night	Percent off target				
	Controls				Elf
	1	2	3	4	Test vehicle
1	−10.5	−8.5	−7.6	4.7	−8.8
2	−4.7	−10.9	−6.8	0.9	−5.8
3	−7.6	−12.0	−8.1	−6.4	−6.4
4	−6.8	1.5		−11.8	2.2
5	−4.0	−5.4		−3.0	−8.8
6					−8.2
7					−8.9
Mean	−6.7	−7.1	−7.5	−3.1	−6.4

units with manually operated Scamp controllers, a somewhat wider range of delivery error was observed (4.7% over to 12.0% below the target label rate), whereas the mean flow rate was similar (6.1% below target). These differences were not statistically significant (Kruskal-Wallis test probability: 0.669).

Results obtained in these studies revealed that the fully automatic Elf system operated within the accuracy level currently achieved by manually activated units in use, and provided assurance that label requirements would not be exceeded. Compatibility of the Elf with both standard and digital speedometers, and the increased precision expected from use of the distance calibration feature provide useful options for the user. The automatic shut off feature relieves the operator from the responsibility of manually shutting the system down and then activating it when slowing or stopping at intersections or travelling at speeds over 21 mph (32.2 kph). Located inside the cab, the controller can be operated manually if desired. The desirability of extending the calibrated range upwards became evident during the testing process because higher operational speeds are not uncommon in actual practice. Once calibrated, a unit should not require further calibration during the year unless the delivery requirements are modified.

We would like to acknowledge the contributions of Michael Capps, Vectec Inc., for installation and technical assistance with the Elf system, Robert Lafferty (IRMCD), for operational assistance with the ULV equipment, and E. Jon Beidler (IRMCD), for support and constructive guidance throughout the conduct of this study.

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