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Evaluation Report 275

B.E.E. Model 7603 Sprayer Monitor

A Co-operative Program Between
ALBERTA FARM MACHINERY RESEARCH CENTRE
PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

BEE MODEL 7603 SPRAYER MONITOR

MANUFACTURER AND DISTRIBUTOR:

Baker Engineering Enterprises Limited
9620 - 27 Avenue
Edmonton, Alberta
T6N 1B2

RETAIL PRICE: $450.00 (October, 1982, f.o.b. Lethbridge)

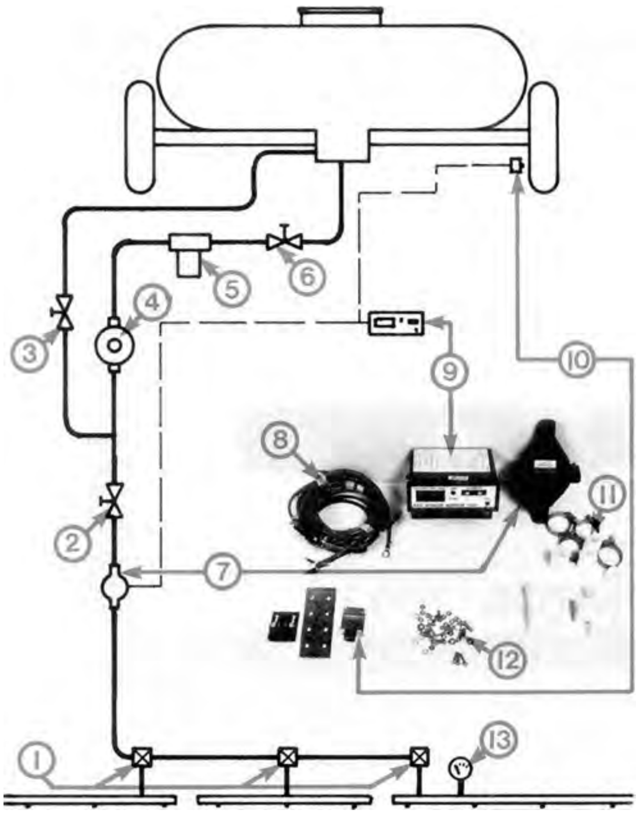

FIGURE 1. BEE Model 7603 Sprayer Monitor: (1) Boom Control Valves, (2) Throttling Valve, (3) Agitator Valve, (4) Pump, (5) Filter, (6) Shut-off Valve, (7) Flow Transducer, (8) Cable, (9) Meter, (10) Speed Transducer, (11) Plumbing Material, (12) Mounting Hardware. (13) Pressure Gauge.

SUMMARY AND CONCLUSIONS

Overall functional performance of the BEE sprayer monitor was good.

The flow transducer, when new, was accurate over the normal range of flow rates used for spraying in the prairies. After 52 hours of field operation, the flow meter indicated from 3 to 8% low.

The speed transducer was accurate over the normal range of spraying speeds used throughout the test.

The system took from 2 to 4 hours to install, depending on the sprayer plumbing system. The flow transducer was light and could be quickly inserted and secured to the main line. The speed transducer was easy to install but usually required additional material for alignment of the magnet and switch assembly. Pull-apart connectors facilitated unhooking of the tractor from the sprayer. The complete wiring harness came attached together which made it easy to fasten to the sprayer and made the sprayer took tidy. Connecting the wiring harness to the flow and speed transducers was convenient and easy since the polarity of the connections did not affect system operation.

The meter was clearly visible to the operator providing the meter display screen was not in direct sunlight. The meter was weathertight and could be operated on tractors without cabs.

The calibration number was generally easily obtained and conveniently entered into the meter.

No excessive electrical demands were made on a normal 12 V tractor battery and charging system.

The operator's manual clearly outlined installation, operation and adjustment of the system.

No mechanical failures occurred during the test.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Supplying longer electrical cables so the meter can be hooked directly to the tractor battery.
2. Providing more and longer cable ties.

Senior Engineer: E. H. Wiens

Project Technologist: B. Storozynsky

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Power cables for direct connection to the battery are available as an option.
2. Mounting hardware is changed slightly on new models.

MANUFACTURER'S ADDITIONAL COMMENTS

The model 7603 is being replaced with a model 3150-M30 with a magnetic flowmeter for the spring of 1983.

NOTE: This report has been prepared in SI units of measurement. A conversion table is given in APPENDIX III.

GENERAL DESCRIPTION

The BEE model 7603 sprayer monitor consists of a meter, speed transducer and flow transducer. The BEE model 7603 sprayer monitor measures and indicates sprayer application rate in either metric (SI) or Imperial units. The operator manually adjusts forward speed and nozzle pressure to obtain the desired spraying application rate.

The meter mounts near the operator's station. The meter consists of a three-digit LED display screen, a power switch, two calibration thumbwheel switches and a low flow indicator light. The flow transducer is mounted in the sprayer plumbing circuit to measure the amount of fluid going to the booms. The speed transducer, to monitor ground speed, consists of a magnet that mounts on a non-driven tractor wheel or a sprayer wheel and a detector switch that mounts on a bracket near the magnet. The meter uses the electrical signals from the flow and speed transducers to calculate and indicate application rate on the display screen.

The BEE 7603 is powered by the tractor electrical system and will operate on either positive or negative ground circuits.

Detailed specifications are given in APPENDIX I while FIGURE 1 shows major components and a schematic of their location in a typical sprayer plumbing system.

SCOPE OF TEST

The BEE model 7603 sprayer monitor was used for 52 hours while spraying about 570 ha (1408 ac). The system was evaluated for ease of installation, ease of operation and adjustment, quality of work and suitablity of the operator's manual.

RESULTS AND DISCUSSION

EASE OF INSTALLATION

Installation Time: Installation of the BEE sprayer monitor on a conventional field sprayer was simple and easy. It took from two to four hours to install depending on the sprayer plumbing system and ease with which the speed transducer could be mounted. With some older sprayers using hoses and plumbing fittings smaller than 25 mm (1 in), some replumbing was required. Installation on sprayers already equipped with 25 mm (1 in) plumbing, required considerably less time and fewer additional plumbing fittings and material.

Installation instructions were clear and adequate.

Meter: Mounting hardware and cables were provided to mount the meter on the tractor near the operators station and connect it to the tractor electrical system. The cables to connect the meter to the tractor electrical system were too short to be hooked to the tractor battery. Hooking to the tractor electrical system at some place other than the battery was inconvenient on most tractors encountered during the test. It is recommended that the electrical cables for meter to tractor hook-up be lengthened so the meter can be connected directly to the tractor battery.

The meter box was rain and dustproof and therefore could be mounted on tractors without cabs. The manufacturer warned that the meter should not be mounted where it would be exposed to excessive spray chemicals.

Speed Transducer: Installing the speed transducer magnet in the inside rim of a wheel usually required a couple of holes be drilled in the wheel hub to secure the magnet with bolts. The speed transducer detector switch was more difficult to install and required additional material not provided. Usually a bracket had to be fabricated to position the detector switch assembly directly in line with the magnet. The detector switch assembly had to be adjusted so there was a 3 to 6 mm (1/8 to 1/4 in) gap between the magnet and switch (FIGURE 2). Two slots provided in the switch assembly made adjusting easy and simple.

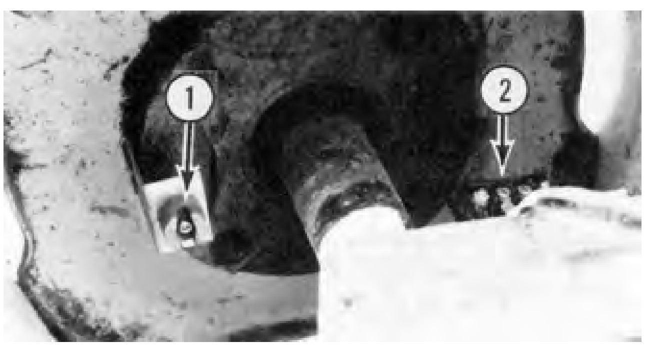

FIGURE 2. Wheel Transducer: (1) Magnet, (2) Detector Switch.

Flow Transducer: Installation of a flow transducer was easy on sprayers equipped with 25 mm (1 in) plumbing. It had to be installed so the full flow going to the booms passed through the transducer. The main line simply had to be cut and the flow meter inserted and clamped. Securing the transducer to the sprayer frame was recommended to eliminate excessive flow transducer vibration. Information and illustrations for flow transducer installation in plumbing arrangements other than the main line were provided in the operator's manual.

Wiring Harness: The BEE sprayer monitor came with two wiring harnesses which were easily connected to the meter, flow and speed transducers by screw type terminal strips. Connecting the wiring harness to the flow and speed transducers was convenient and easy since the polarity of the connections did not affect system operation. Pull-apart connectors were provided to permit convenient unhitching from the sprayer. Ties were provided to secure the cables to the sprayer. There was a shortage of cable ties and they were usually not long enough. It is recommended that the manufacturer provide more and longer cable ties.

EASE OF OPERATION AND ADJUSTMENT

Meter: The functions of the BEE meter included an "on-off" power switch, a three digit LED display screen, a low flow indicator light and two thumbwheel switches.

The display screen constantly displayed the actual application rate being applied and was easily read unless it faced directly into sunlight. The meter could be calibrated to read out in either metric (SI) or Imperial units. If calibrated to read out in metric (SI) units, terminal connections at the rear of the meter had to be altered to remove the decimal point from the readout.

One calibration number had to be obtained and dialed into the meter before actual spraying could begin. This calibration number was conveniently entered into the meter using the two thumbwheel switches. The required calibration number to be entered, depended on the sprayer wheel circumference, and spraying width of the sprayer.

Determining the wheel circumference of the sprayer wheel containing the wheel transducer was important for accurate performance of the BEE sprayer monitor. This measurement, to be accurate, had to be made in soil conditions encountered during actual spraying and with tires properly inflated. The measurement should be made with the sprayer tank half full in order to obtain an average wheel circumference. The distance travelled for at least ten wheel revolutions should be measured, rather than just one wheel revolution.

The boom width used for calibration should be the exact spraying width of the sprayer. The spraying width is the number of nozzles used times the nozzle spacing.

The calibration number to be entered into the meter, based on wheel circumference and spraying width, was obtained from a chart specifically supplied for the flow transducer being used. Calibration numbers for both metric (SI) and Imperial units were supplied. A formula was provided to calculate calibration numbers for wheel circumferences and boom widths other than those given on the chart.

Proper nozzle selection was required to apply the desired application rate at the desired forward speed and the appropriate pressure. The Machinery Institute recommends that, when using standard flat fan nozzles, minimum pressure for proper nozzle distribution patterns, not be below 200 kPa (29 psi) and that maximum pressure, to avoid spray drift, not be above 300 kPa (45 psi). Having chosen the proper nozzles, field operation was commenced by setting the nozzle pressure for optimum performance and increasing the forward speed until the desired application rate was shown on the display screen. If a higher application rate than that desired was displayed, forward speed had to be increased. If a lower application rate than desired was displayed, forward speed had to be decreased. Nozzle pressure could also be slightly adjusted manually to maintain the desired application rate.

Proper system functioning was indicated if the low flow indicator light stayed off. The low flow indicator light came on when flow through the flow transducer was too low to ensure system accuracy. The meter also monitored speed sensor operation. Proper speed sensor functioning was indicated if the display screen blinked regularly, every four wheel revolutions. This was considered a convenient feature.

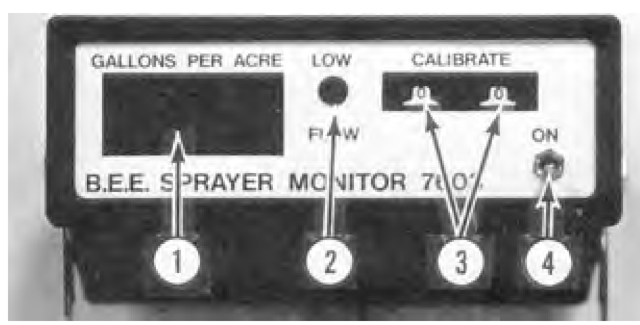

FIGURE 3. BEE Meter: (1) Application Rate Display Screen, (2) Low Flow Indicator Light, (3) Calibration Thumbwheel Switches, (4) On-Off Power Switch.

QUALITY OF WORK

Flow Transducer: When new, the BEE flow transducer was accurate between flowrates of 12 and 80 L/min (2.6 and 17.6 gal/min) at normal system pressures. After 52 hours of field use, the accuracy of the flow transducer deteriorated slightly. Flow rates with the used flow transducer were 3 to 8% low, depending on system pressure and flow. A flow rate of 12 L/min (2.6 gal/min), using an 18 m (60 ft) sprayer at 10 km/h (6.2 mph), represents an application rate of 40 L/ha (3.6 gal/ac) which is less than normally recommended application rates in the prairie provinces. Therefore, the new flow transducer was accurate for most spraying conditions encountered in the prairie provinces but was 3 to 8% low after 52 hours of use.

Flow transducer accuracy depended on system pressure. For example, the used flow transducer was about 4 and 7% low when operating at 200 and 400 kPa (29 and 58 psi), respectively. Therefore, it was important to install the flow transducer away from the higher pressure at the pump outlet line and near the lower pressure at the spray booms, since the flow transducer was more accurate at lower pressures.

The flow transducer could be installed in a 19 or 25 mm 3/4 or 1 in) hose and still retain the same accuracy. Density and viscosity of the chemical mixture being sprayed could affect flow transducer accuracy.

Repeatability is a measure of how consistently the flow transducer gives the same reading repeatedly, using the same calibration number, pressure and flow rate. Some repeatability problems were encountered but were not significant.

The pressure loss created by installing the flow transducer in the sprayer plumbing system was negligible at application rates commonly used in the prairie provinces.

Speed Transducer: The speed transducer was accurate over the normal range of prairie spraying speeds encountered during the test. As already discussed, accurate measurement of the wheel circumference upon which the speed transducer was mounted, was important for proper monitor performance.

Meter: The meter combined the electrical signals from the flow and speed transducer to accurately display the application rate. As already discussed, flow transducer readings, after 52 hours of field use, were from 3 to 8% low. Similar errors in application rate could be expected.

Effect of Plugged Nozzles: Each plugged nozzle resulted in an increased pressure. The BEE monitor system was not equipped with a pressure gauge and therefore pluggled nozzles were difficult to detect. However, if forward speed and engine speed were kept constant, decreases in application rate usually indicated that one or more nozzles were plugged.

Effect of Boom Width: Shutting off part of the boom during spot spraying resulted in a decrease in application rate and a large increase in nozzle pressure. The application rate indicated on the meter was incorrect since it indicated the application rate for the total width of the sprayer and not the reduced width. It was important to decrease the nozzle pressure to the nominal spraying pressure and maintain a constant speed to ensure proper nozzle distribution, reduce spray drift and ensure proper application rate for that part of the boom being used.

Environmental Effects: The BEE sprayer monitor system was both rain and dust proof.

Effect of Voltage: The BEE sprayer monitor functioned well between 5 and 17 volts, which was well beyond the voltages encountered in a normal 12-volt electrical system.

OPERATOR'S MANUAL

The operator's manual provided adequate information on operation, installation, adjustment, calibration, trouble shooting and maintenance.

POWER REQUIREMENTS

The BEE sprayer monitor drew a maximum current of 0.3 A when attached to a 12~volt electrical system.

MECHANICAL PROBLEMS

The BEE sprayer monitor was operated in the field for 52 hours. The intent of the test was functional performance and an extended durability evaluation was not conducted. No mechanical problems occurred during field use.

APPENDIX I

SPECIFICATIONS

MAKE:	BEE Sprayer Monitor System
MODEL:	7603 A
SERIAL NO.:	1818 SPM
METER:	
- size	145 x 117 x 51 mm
- controls	power on-off switch and calibration thumbwheel switches
- alarm	low flow warning light and wheel turn monitored by display blink
- display	3 digit LED display screen, application rate
CONNECTORS:	
- meter	screw type connectors
- battery	screw type connectors
- flow and wheel transducer	screw type connectors
- tractor and sprayer hitch	pull-apart connector
FLOW TRANSDUCER:	
- serial number	3242 FTR
- type	multi-jet turbine
- size	
- inlet and outlet	25 mm O.D. barbed connection 18 mm I.D.
- body	180 x 120 x 70 mm
SPEED TRANSDUCER:	
- type	magnetic switch
- detector switch	56.5 x 44 mm
- magnet	28 x 52 mm
WEIGHTS:	
meter	0.410 kg
flow transducer	0.320 kg
wheel transducer	0.075 kg
wiring harness	0.465 kg
mounting hardware	0.238 kg
plumbing material	0.238 kg
Total	1.746 kg

APPENDIX II

MACHINE RATINGS

The following rating scale is used in Machinery Institute Evaluation Reports:

(a) excellent	(d) fair
(b) very good	(e) poor
(c) good	(f) unsatisfactory

APPENDIX III

CONVERSION TABLE

1 kilometre/hour (km/h)	= 0.6 miles/hour (mph)
1 hectare (ha)	= 2.5 acres (ac)
1 litre per hectare (L/ha)	= 0.09 Imperial gallons per acre (gal/ac)
1 kilopascal (kPa)	= 0.15 pounds per square inch (psi)
1 kilogram (kg)	= 2.2 pounds mass (lb)
1 litre per second (L/s)	= 13.2 Imperial gallons per minute (gal/min)
1 litre (L)	= 0.22 Imperial gallons (gal)
1 meter (m)	= 3.3 feet (ft)
1 millimetre (mm)	= 0.04 inches (in)
1 kilowatt (kW)	= 1.3 horsepower (hp)

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