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EVALUATION REPORT 366

Dickey-john SC1000 Liquid Sprayer Control System

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

DICKEY-JOHN SC1000 LIQUID SPRAYER CONTROL SYSTEM

MANUFACTURER

DICKEY-john Corporation
P.O. Box 10
Auburn, Illinois 62615

DISTRIBUTOR

DICKEY-john Canada Inc.
700 Campbell Street
Cornwall, Ontario
K6H 6C9

RETAIL PRICE:

$3,157.00 (April, 1984, f.o.b. Lethbridge, Alberta).

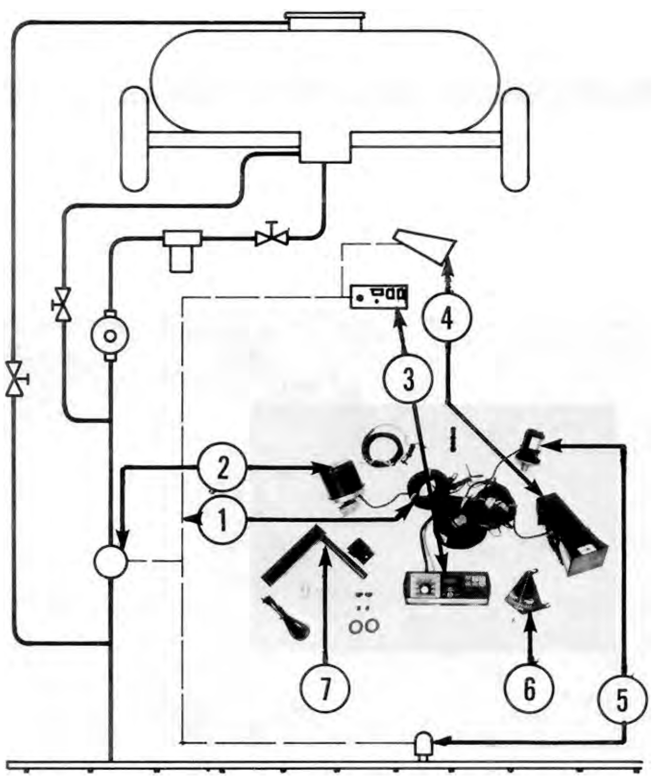

FIGURE 1. Dickey-john SC1000 Liquid Sprayer Control System: (1) Cables with Screw-on Polarity Connectors, (2) Motorized Control Valve, (3) Control Console, (4) Ground Speed Sensor, (5) Pressure Sensor, (6) Radar Angle Indicator, (7) Mounting Hardware.

SUMMARY AND CONCLUSIONS

Functional Performance: Performance of the Dickey-john SC1000 sprayer control system was very good. Performance was highlighted by the principle the system operated on, the accuracy of the pressure and speed sensors, the fast response of the motorized control valve, ease of operation and obtaining calibration numbers and ability to do stationary system checks.

Control Console: The control console was easy to use when following the instructions in the operator's manual. The control console was available for r ead-out in either metric (SI) or Imperial units.

Calibration Numbers: The system required ten calibration numbers to be entered into memory. These numbers were easily obtained from charts provided, physical characteristics of the sprayer and measurements such as weight of liquid solution, nozzle flowrate and forward speed calibration. These measurements were critical to the accuracy of the Dickey-john system.

Pressure Sensor: The pressure sensor was accurate, reliable and repeatable. Installing the sensor near a nozzle, in order to indicate true nozzle pressure, was critical to obtain accurate application rates. The sensor inlet was large and difficult to install near nozzles commonly used on the prairies.

Speed Sensor: The speed sensor was accurate and speed readings did not fluctuate. The speed sensor had to be calibrated before spraying. Calibration was easy, and the calibration number could be used in various field conditions.

Motorized Control Valve: The motorized control valve responded quickly to changes in speed. This allowed for constant application rates in hilly fields. In addition, the motorized control valve adjusted the flow to the booms in less than two seconds from its closed position. This allowed spraying immediately after cornering or turning.

Installation: The Dickey-john system took about 6 hours to install. Installation was easy and convenient. Most components were equipped with support brackets. All wires were conveniently packaged and labelled for convenient hook-up to the tractor. Screw-on connectors made hook-up quick and easy.

Application Rate Accuracy: The application rate was accurate since both the pressure and speed sensors were accurate. Special functions such as the speed sensor check, fine tune and conversion factor allowed the operator to make the system as accurate as desired. The system check functions required extra work that were time consuming; however, they were easily performed.

Automatic Control: The automatic control feature allowed the application rate to be held constant when operating in hilly conditions and be obtained quickly after turning, shut-off or cornering. Larger changes in forward speed resulted in large and rapid changes in pressure.

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

Operators Manual: The operator's manual provided complete information on installation, operation, adjustment, calibration and maintenance.

Mechanical Problems: No failures were encountered during the evaluation.

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GENERAL DESCRIPTION

The Dickey-john model SC1000 sprayer control system monitors sprayer application rate, nozzle pressure, ground speed, operating speed range, area sprayed, automatically controls application rate when changes in forward speed and flow occur and controls flow to the booms. The Dickey-john SC1000 consists of a control console, ground speed sensor, pressure sensor and motorized control valve (FIGURE 1).

The control console mounts at the operator's station. The console consists of a selection dial with 16 functions, a four-digit LCD display screen, a spray control switch, a digit switch to enter numbers and reset accumulated area, a control switch to operate the monitor in the automatic or manual mode and a system switch to display calibration or operating functions. The radar speed sensor, to indicate ground speed, mounts under the tractor. The motorized control valve is inserted in the main boom hose and automatically opens or closes to maintain the preset application rate. The pressure sensor is mounted in the sprayer plumbing near a nozzle to indicate actual nozzle pressure.

The Dickey-john control system is powered by the tractor electrical system and will operate on either a positive or negative ground.

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 Dickey-john SC1000 automatic sprayer control system, calibrated for readout in metric (SI) units, was used for 67 hours while spraying about 2150 ac (870 ha). It was evaluated for ease of installation, ease of operation and adjustment, quality of work and suitability of the operator's manual.

RESULTS AND DISCUSSION

EASE OF INSTALLATION

Installation Time: It took about 6 hours to install the Dickey-john sprayer control system on a Melroe Model 116-78 Spra-Coupe. Installation instructions were clear and adequate.

Control Console: Mounting hardware and enough cables were provided to mount the control console near the operator station and connect it to the tractor electrical system. The control console, if exposed to the weather, should be covered when not in use.

Pressure Sensor: The pressure sensor was mounted in the sprayer plumbing system near a nozzle (FIGURE 2) where it measured actual nozzle pressure. If the sprayer nozzle system contained a check or diaphragm valve it was important to install the sensor between the valve and nozzle. The large 3/4 in (19 mm) thread on the sensor inlet made it difficult to install near commonly used nozzles on the prairies. Additional plumbing components were required to reduce from the large inlet when installing the sensor between a small nozzle and check valve.

FIGURE 2. Pressure Sensor Mounted Near a Nozzle.

Motorized Control Valve: The motorized control valve (FIGURE 3) was installed in the main boom supply line. Installing the valve in the main boom supply line was easy and simply involved cutting the hose and inserting the valve. A bracket was provided to support the weight of the motorized control valve.

If flow to the booms was relatively low, it was important to install the motorized control valve before the by-pass line (or add a by-pass line after the motorized control valve if the sprayer did not have one) to ensure proper monitor operation.

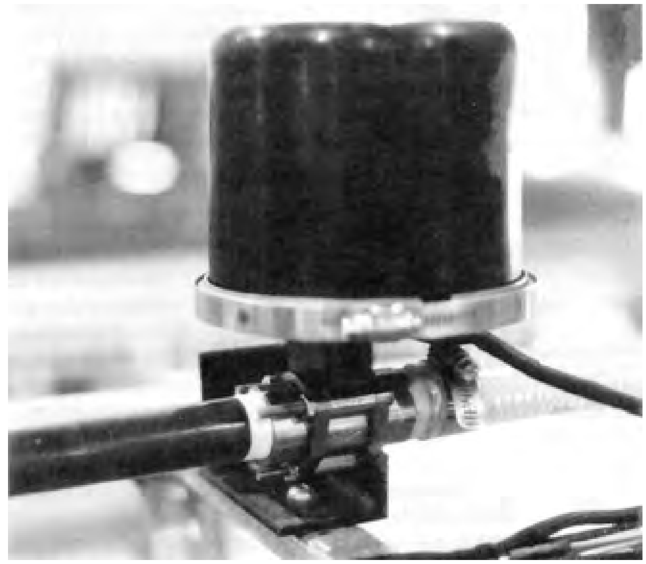

FIGURE 3. Motorized Control Valve.

Speed Sensor: Three different types of speed sensors are available for use with the Dickey-john; radar velocity sensor, speedometer drive speed sensor and wheel drive sensor. The radar velocity sensor was evaluated in this test.

The radar sensor (FIGURE 4) mounted underneath the tractor, facing the rear of the vehicle. It had to be mounted a minimum of 24 in (600 mm) but not more than 8 ft. (2.4 m) above the ground, clear of any heat sources or obstructions in front of its face and in an area where a minimum amount of vibration occurred. The radar unit was easy to install since it came with its own mounting bracket. The rubberized mounting reduced shock and vibration.

The radar unit had to be positioned at a certain angle from the ground for proper monitor operation. Therefore, it was important to install the unit with the tractor on level ground. The radar unit came with a special template (FIGURE 4) that made positioning the unit at the required angle simple and easy.

FIGURE 4. Speed Sensor: (1) Radar Unit, (2) Radar Angle Template.

Wiring Harness: The component cables in the control console were conveniently combined into one cable, making it tidy and easy to fasten to the tractor and route to the sprayer hitch. The console cable then separated to individual component cables. The cables included screw-on polarity connectors and were individually labelled at the connectors, making connections at the hitch to the various monitor components quick and easy. The wiring harness package included plastic hold-down ties for securing cables to the tractor and sprayer. There was a shortage of plastic ties, requiring the use of tape to properly secure the cable.

All cables were protected with a plastic covering and the connectors contained rubber sealing rings and dust covers which were convenient in eliminating chemicals and moisture from getting on the connector contacts.

EASE OF OPERATION AND ADJUSTMENT

Control Console: The Dickey-john control console was very easy to understand and operate when following the instructions in the operator's manual. The console was equipped with a four-digit LCD display screen, a 16 function selection dial, a spray control switch, an auto-man control switch, a system switch and a digit switch (FIGURE 5).

The digit switch was used to enter numbers into the console memory and to clear the accumulated area. Selecting and entering numbers was simple and easy. Positioning the digit switch in the up position selected the digit position on the four-digit display screen (indicated by a flashing number) and holding the digit switch down caused the flashing digit to increment by one. Releasing the digit switch stopped the incrementation, thus setting the desired number at the desired position.

The numbers displayed on the screen were easily read. An internal light behind the screen permitted night operation. Readout was possible in either metric (SI) or Imperial units by adjusting a switch inside the control console. This required removal of the back cover of the console which was not explained in the operator's manual. Therefore, when purchasing the Dickey-john system, a preference for readout in either metric (SI) or Imperial units should be specified.

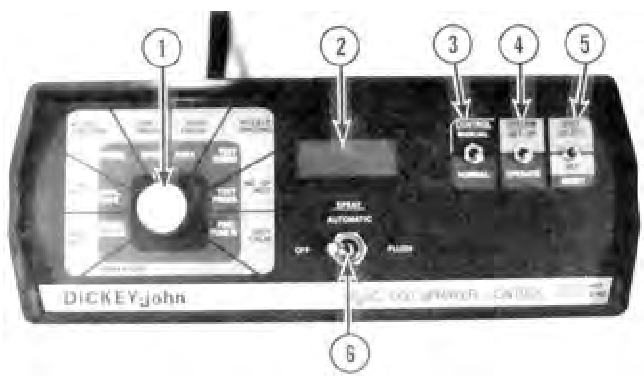

FIGURE 5. Control Console: (1) Function Selection Dial, (2) 4-Digit Display Screen, (3) Auto-Man Control Switch, (4) System Switch, (5) Digit Switch, (6) Spray Control Switch.

The function selection dial was convenient to operate. It allowed selecting 16 functions for display on the LCD digital display screen. The functions were indicated around the dial; eight on the tan (outer) ring and eight on the brown (inner) ring. The tan and brown rings indicated calibration and operating functions, respectively. This distinction was convenient. The selection dial operated in conjunction with the system switch. The system switch had to be positioned in the set-up mode for the dial to display functions indicated on the tan ring and in the operate mode to display functions indicated on the brown ring. Ten of the sixteen functions were used to enter numbers into memory to operate the system automatically. A number had to be entered into nine of these functions or a fail message appeared on the display screen. Once the numbers were entered, the procedure did not have to be repeated unless the console was disconnected from the battery. The power-off function did not affect the console memory. The 10 numbers were entered under the following functions:

1. Application Rate - used to store the desired application rate. This was the number the automatic control system maintained by adjusting the motorized control valve when changes in ground speed or flow occurred. The desired application rate number depended on the size of the nozzles used and desired tractor speed.
2. Conversion Factor - used to store a number to compensate for the density of the spray solution being sprayed. The number could be calculated from a formula provided in the operator's manual or obtained from the data chart provided. In both cases the operator was required to measure the weight of a litre or gallon of spray solution.
3. Nozzle Constant - is the flow rate of water through the nozzle being used in gal/min at 40 psi (L/min at 300 kPa). This number was obtained from the data chart provided. The data chart contained the flow rates of several of the more commonly used nozzles. This number was very important since it was the basis of the Dickey-john system. It eliminated the need for a flow meter and used pressure as the key to spraying, a term the farmer is more familiar with.
4. Low press - the minimum desired nozzle operating pressure.
5. High press - the maximum desired nozzle operating pressure. The low and high pressure numbers signalled an alarm to sound when the system operated below the low pressure setting or above the high pressure setting. The low and high pressure values were left to the operator to decide. For proper nozzle spray patterns when using standard flat fan nozzles, the Machinery Institute recommends the low pressure not be set below 30 psi (207 kPa), and to reduce spray drift, that the high pressure not be set above 45 psi (310 kPa).
6. Nozzle spacing - used to store the distance between nozzles on the sprayer boom.
7. Number of nozzles - used to store the number of nozzles on the sprayer boom.
8. Distance calibration - used to store the number that calibrates the speed sensor. The number was obtained from the distance calibration procedure outlined in the operator's manual. The procedure was easy. It required the operator to measure out a given course on a field and drive that distance at a slow speed. The number displayed on the console after the run, was the distance calibration number. It was important to do the test run on level ground, soil conditions similar to those encountered during spraying and with the sprayer tank half full of water. Actual field conditions should be simulated as closely as possible.
9. Test Speed - used to store the nominal operating speed. This generated an internal ground speed signal which enabled the operator to troubleshoot and check the spray system accuracy while stationary. This was very convenient.
10. Fine-Tune % - used to enter a percent number that compensated for nozzle pressure loss and worn nozzles. The percent number was obtained from a formula provided in the operator's manual and required the operator to measure the output of a few nozzles. The operator required a stopwatch and container to do this. The procedure was easy since the Dickey-john spray control system could simulate actual field spraying conditions while stationary.

The other 6 functions indicated operating conditions during spraying. The 6 operating functions were:

1. Area - displayed the cumulative area sprayed.
2. Speed - displayed actual ground speed.
3. Pressure - displayed actual nozzle pressure.
4. Application Rate - displayed actual application rate.
5. Speed Range - displayed the minimum and maximum operating speeds the operator could use during spraying. The speed range was automatically determined by the monitor and depended on the application rate, nozzle constant and low and high pressure entries. This function was convenient since it also indicated whether or not the proper application rate was

selected for the nozzles used. If the speed range did not include the desired nominal speed then the application rate had to be changed or different nozzles installed.

6. Test Press - indicated nozzle pressure (i.e. pressure at pressure sensor) during stationary system checks or troubleshooting.

The control switch was used to place the Dickey-john sprayer control system in either the manual or normal (automatic) mode. The control switch operated in conjunction with the spray control switch. The spray control switch was used during spraying and basically controlled flow to the booms by opening and closing the motorized control valve either in the manual or normal (automatic) mode. The spray control switch had three operating positions; off, automatic and flush. In the off position, the spray control switch completely shut off the flow to the booms. This was convenient during turning and cornering and eliminated the need for solenoid valves. In the automatic position the spray switch allowed the preselected application rate to be maintained by automatic adjustment of the motorized control valve when changes in forward speed or flow occurred. Holding the spray control switch in the flush position allowed for convenient flushing of the sprayer when stationary. System pressure automatically adjusted to 20 psi (138 kPa). Operating the spray control switch in the manual mode was extremely difficult and therefore hardly used. In the manual mode, the spray control switch shut off the flow to the booms in the off position, opened the motorized control valve in the flush position and stopped the motorized control valve from closing in the automatic position. Opening the motorized control valve manually to obtain a desired pressure was difficult since it took only a couple of seconds to fully open. Use of the manual mode would only be necessary if the pressure and speed sensors malfunctioned.

QUALITY OF WORK

Pressure Sensor: The pressure sensor was accurate in its normal operating range from 10 to 60 psi (70 to 417 kPa). Nozzle pressure was the key to Dickey-john systems operation and accuracy. The pressure sensor had to sense acutal nozzle pressure for the system to accurately spray the desired application rate. Since pressure losses occurred along the sprayer booms and in the nozzle bodies, it was important to locate the pressure sensor as near a nozzle as possible. This usually required the pressure sensor be positioned between the nozzle and check or diaphragm valve.

Speed Sensor: The radar ground speed sensor was accurate when properly calibrated. Calibrating the sensor was clearly outlined in the operator's manual and was easy. The angle template (FIGURE 4) provided, made calibration and installation easy. The radar speed sensor had to be mounted where there was the least amount of vibration. Excessive vibration could cause an erroneous speed reading and affect the application rate.

The same speed sensor calibration number could be used for various field conditions. For example, the calibration number obtained in a cereal crop could also be used when spraying in stubble or summerfallow. However, for greater accuracy, a distance calibration check should be done when field conditions change, especially in field conditions with top growth above 4 in (100 mm). If the calibration check number was not within specified limits, the radar speed sensor angle had to be adjusted as specified in the operator's manual.

With the speed sensor mounted at the minimum 24 in (600 mm) above the ground, the speed changed when spraying fields with uneven top growth. The speed indicated increased as the height of the growth increased. As a result, the application rate increased. These increases were usually less than 5 per cent.

The movement of high crops during a moderate wind caused slight speed fluctuations. The fluctuations were small and considered insignificant.

Automatic Control: The Dickey-john sprayer control system automatically controlled application rate over the speed range indicated on the monitor. The system could also control the application rate outside the speed range indicated, however, an alarm sounded indicating that the system was spraying outside the desired nozzle pressure range. The speed range indicated depended on the desired application rate and low and high pressures entered.

For example, with the control system programmed to use TeeJet 8002 nozzles, the desired application rate set at 10 gal/ac (111 L/ha) and the low and high pressures set at 30 and 45 psi (207 and 310 kPa), respectively, the speed range indicated was 4.4 to 5.6 mph (7 to 9 km/h). Although the application rate could be automatically controlled from 1.9 to 6.5 mph (3 to 10.5 km/h), the low pressure alarm sounded at speeds below 4.4 mph (7 km/h) and the high pressure alarm sounded at speeds above 5.6 mph (9 km/h). FIGURE 6 shows how rapidly the nozzle pressure varied throughout the range of forward speeds and the importance of the pressure alarms to keep operation within the allowable pressure range for the nozzles being used. Increasing the low and high pressure functions increased the speed range. For example, increasing the low and high pressures to 15 and 60 psi (103 and 414 kPa) respectively, increased the speed range to 3.1 to 6.2 mph (5 and 10 km/h). The low and high pressure alarm would then sound at 15 and 60 psi (103 and 414 kPa), respectively. When using flat fan nozzles, pressures above 45 psi (310 kPa) are not recommended, due to excessive spray drift, and pressures below 30 psi (207 kPa) are not recommended, due to poor nozzle spray patterns. In essence, nozzle spray characteristics controlled the speed range.

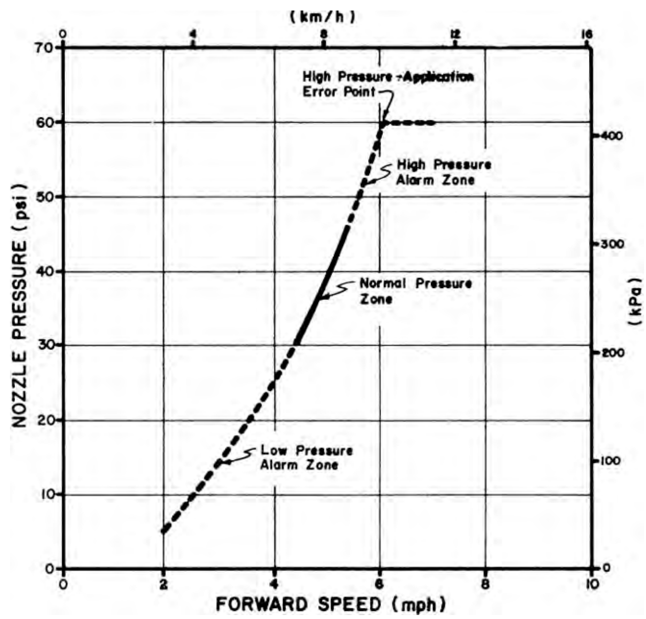

FIGURE 8. Nozzle Pressures at Various Forward Speeds.

Application Rate Accuracy: The Dickey-john system application rate accuracy was almost entirely dependent on the operator's desire to check system accuracy. Special functions such as the speed sensor check, fine tune and conversion factor allowed the operator to make the system very accurate.

Due to such things as worn nozzles, pressure losses through nozzle bodies and varying flow rates among the same nozzles, the desired application rate indicated on the monitor and the actual application rate could be different. The fine tune function could be used to compensate for this. Before the fine tune function could be used, the operator had to measure the output of several nozzles. For greatest accuracy, the output of several nozzles along the entire width of the boom should be measured. Using the formula provided, the operator then could set the fine tune function accordingly, to obtain an accurate application rate.

Motorized Control Valve: The Dickey-john motorized control valve adjusted pressure to the booms and shut off flow to the booms. The shut-off feature was convenient since it eliminated the need for boom shut-off valves and allowed very low flow rates to the boom.

It took the valve less than 2 seconds to fully open from the closed position or vice versa. This was convenient in the automatic mode and less convenient in the manual mode. In the manual mode it was nearly impossible to adjust to a desired nozzle pressure, since small adjustments of the spray control switch resulted in large pressure changes. The valve could also be adjusted manually, by removing the motorized control valve cover and rotating the manual override coupling. This was easier, but had to be done in the stationary position and usually required an additional person to signal when the desired pressure was reached. Also, access to the motorized control valve could be inconvenient.

In the automatic mode, the valve adjusted the pressure quickly. FIGURE 7 shows a typical response curve for a 0.6 mph (1 km/h) change in forward speed. Due to the valves quick response, momentary changes in tractor speed, and consequently pump speed, in hilly fields resulted in the application rate remaining constant. This was convenient.

FIGURE 7 also shows a typical response curve when the spray control switch was set from off to automatic. This was a normal operation after turning or cornering. The desired pressure was reached and stabilized quickly, ensuring proper spray patterns shortly after a turn.

At times the motorized control valve oscillated (FIGURE 8), when it operated near its closed position. This occurred at very low boom flow rates. If oscillating occurred, it was necessary to install a by-pass line between the motorized control valve and the booms. The extra flow to the by-pass line eliminated the oscillation since the valve could then be operated in a more open position.

Adding a by-pass line required additional plumbing material and required the operator to adjust the flow to the by-pass line, to ensure an adequate supply of flow to the booms. This procedure was inconvenient.

The Dickey-john system displayed an application error (APEr) when the motorized control valve was at its maximum open position. This was convenient since it informed the operator of one of the following: excessive ground speed, empty sprayer tank, excessive agitation or by-pass flow or inadequate pump output.

Boom Width: Sections of the sprayer boom could be shut off and the application rate and nozzle pressure displayed were still valid. This was convenient. However, it was important not to shut off the section of boom where the pressure sensor was installed. The motorized control valve would then open and the pressure and application rate displayed would not be correct. Also, with a section of boom shut off, the area function would not be correct, unless the operator re-entered a new number under number of nozzles.

Plugged Nozzles: Plugged nozzles could not be detected with the monitor. Visual inspection was necessary during stationary tests.

Environmental Effects: The dust common to normal spraying operations did not affect the monitor's performance. The motorized control valve, pressure sensor, speed sensor, and wiring connections were all sealed. The control console could be operated exposed to the weather; however, it should be covered when not in use.

Electrical Power Requirements: No excessive demands were made on the tractor battery or electrical charging system. The control console drew up to 0.02A with the power switch off and up to 0.9A with the power switch on and systems operating, when attached to a 12-volt electrical system.

The monitor had to be recalibrated if the voltage supply was disconnected from the console.

OPERATOR'S MANUAL

The operator's manual provided complete information on monitor installation, operation, calibration, adjustment and maintenance. An illustrated parts list was not included.

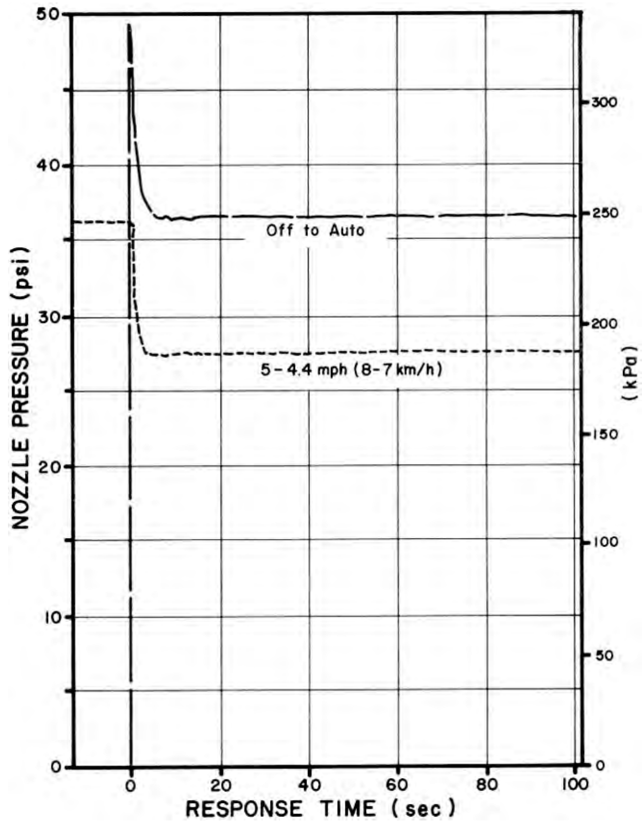

FIGURE 7. Response Curves for the Motorized Control Valve to a Change in Forward Speed and When Switched to the Automatic Mode.

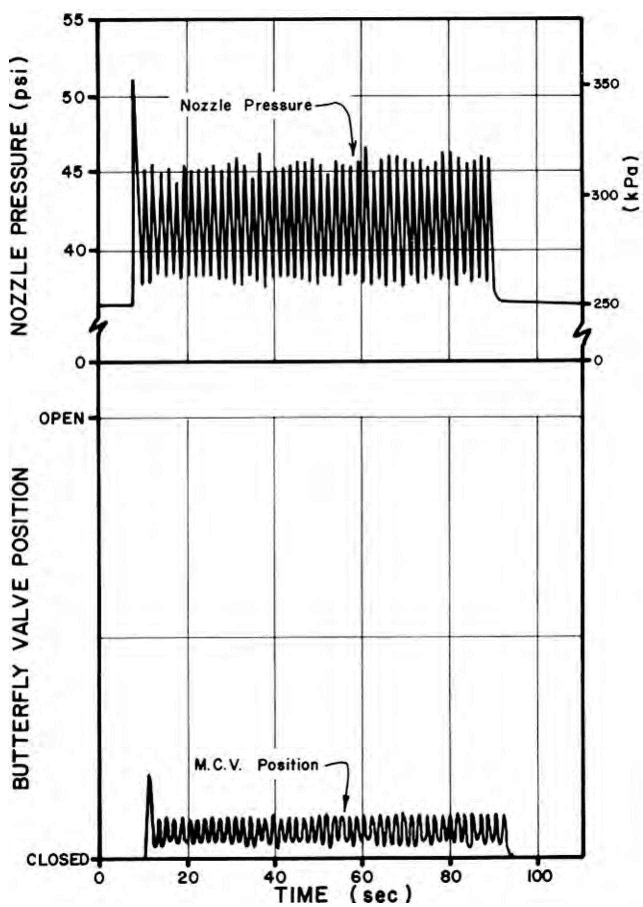

FIGURE 8. Motorized Control Valve Oscillating at Low Boom Flow Rates.

DURABILITY RESULTS

The Dickey-john sprayer control system was operated in the field for 67 hours. The intent of the test was evaluation of functional performance and an extended durability evaluation was not conducted, No mechanical problems were encountered during the test.

APPENDIX I

SPECIFICATIONS

MAKE:	Dickey-john Liquid Sprayer Control System	
MODEL:	SC 1000	
COMPONENTS:	four - control console, pressure sensor, speed sensor, motorized control valve	
CONTROL CONSOLE:		
- serial number	CS 4-6609	
- size	11.75 x 5.5 x 4.0 in (298 x 140 x 102 mm)	
- controls	function selection dial, spray control switch, digit switch, system switch, and control (auto-man) switch	
- display	4-digit LCD display screen	
- alarm	beeping buzzer with flashing digital display screen	
- warnings	application error	(APEr)
	low pressure	(LoPr)
	high pressure	(HiPr)
	fail	(FAIL)
	short circuit	(ShCr)
PRESSURE SENSOR:		
- serial number	CS 43461	
- type	electronic transducer	
- thread size	3/4 in NPT (19 mm)	
- body	cylindrical - 6.2 in high and 39 in diameter (157 mm x 99 mm)	
SPEED SENSOR:		
- serial number	0033-16740	
- type	radar	
- size	rectangular- 11.5 in long, 4.8 in wide and 5.75 in high (292 x 122 x 146 mm)	
MOTORIZED CONTROL VALVE:		
- serial number	CS 45405	
- line size	3/4 in (19 mm)	
- operating pressure	175 psi (1207 kPa)	
- body size	cylindrical - 5.5 in diameter and 8 in high (140 x 203 mm)	
CONNECTIONS:		
- components	screw-on polarity	
- battery	crimp.on	

WEIGHTS:		
- monitor control console	3.78 lb	(1.71 kg)
- pressure sensor	2.97 lb	(1.35 kg)
- speed sensor	4.41 lb	(2.00 kg)
- motorized control valve	4.03 lb	(1.83 kg)
- radar and motorized control valve brackets	4.80 lb	(2.18 kg)
- power cable	0.49 lb	(0.22 kg)
- mounting hardware - nylon ties, bolts, nuts, washers	0.47 lb	(0.21 kg)
Total	20.95 lb	(9.50 kg)

APPENDIX II

MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

- Excellent
- Very Good
- Good
- Fair
- Poor
- Unsatisfactory

APPENDIX III

CONVERSION TABLE

acres (ac) x 0.40	= hectares (ha)
gallons (gal) x 4.55	= litres (L)
gallons/acre (gal/ac) x 11.23	= litres/hectare (L/ha)
inches (in) x 25.4	= millimetres (mm)
miles/hour (mph) x 1.61	= kilometres/hour (km/h)
pounds (lb) x 0.45	= kilograms (kg)
pounds force per square inch (psi) x 6.89	= kilopascals (kPa)

SUMMARY CHART
DICKEY-JOHN SC1000 LIQUID SPRAYER CONTROL SYSTEM

RETAIL PRICE:	$3,157.00 (April, 1984, f.o.b. Lethbridge)
COMPONENTS:	- control console, pressure sensor, speed sensor and motorized control valve
INSTALLATION:	- easy and convenient, about 6 hours
CONTROL CONSOLE:	
- display	- sprayer application rate, nozzle pressure, ground speed, operating speed range and area sprayed
- calibration	- ten numbers have to be stored into memory. Calibration numbers are easily obtained from charts and formula's provided, physical characteristics of the sprayer and from specified measurements.
- features	- indicates spraying pressure - automatically controls desired application rate - allows stationary system checks - adequate warning systems - easy to operate - total spray control with one switch - indicates operating speed range - allows easy setting of maximum and minimum pressures - compensates for density of solution, worn nozzles and pressure losses - completely shuts off flow to booms during turns or cornering
PRESSURE SENSOR:	- accurate, reliable and repeatable
SPEED SENSOR:	- radar speed sensor was accurate, consistent and easy to calibrate and install
MOTORIZED CONTROL VALVE:	- responds in less than 2 seconds to changes to allow constant rate of application
APPLICATION RATE ACCURACY:	- the distance calibration, conversion factor and fine tune functions allowed the operator to make the displayed application rate as accurate as desired
POWER REQUIREMENTS:	- 12 volt system - draws 0.9A
OPERATOR'S MANUAL:	- complete
MECHANICAL PROBLEMS:	- none

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