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Evaluation Report 528

Vicon Model LS 2340T Field Sprayer

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

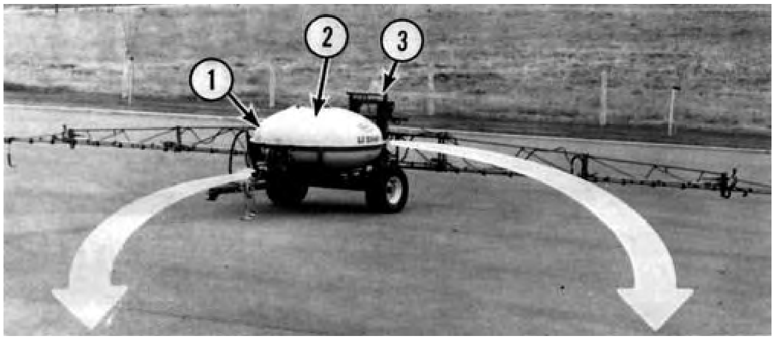
VICON MODEL LS 2340T FIELD SPRAYER

MANUFACTURER AND DISTRIBUTOR:

Vicon Wheat-Belt
6423 - 30 Street S.E.
Calgary, Alberta
T2C 1R4

RETAIL PRICE:

$9,555.00 (December, 1987 f.o.b. Lethbridge, Alberta).



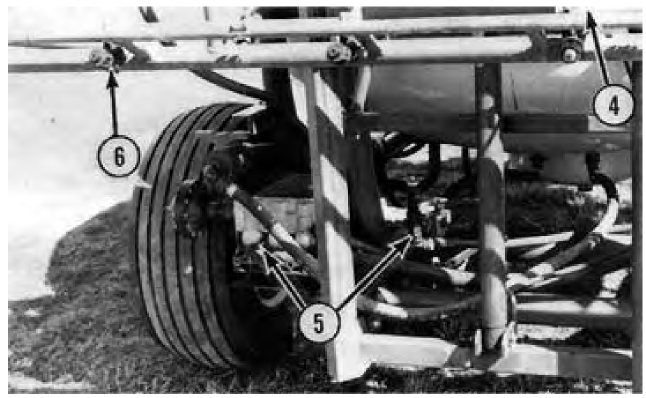


FIGURE 1. Vicon Model LS 2340T Field Sprayer: (1) Liquid Level Indicator, (2) Spray Tank, (3) Self-Stabilizing Boom System, (4) Spray Boom, (5) Main and Agitator Pumps, (6) Nozzle Body Assembly, (7) Sprayer Control System, (8) Chemical Inductor, (9) Reload System.

SUMMARY AND CONCLUSIONS

Rate of Work: Instantaneous workrates of 42 to 52 ac/hr (17 to 21 ha/h) were possible when operating the sprayer between 29 and 45 psi (200 and 310 kPa). At the application rate of 9.8 gal/ac (110 L/ha), about 51 ac (21 ha) could be sprayed with a full spray tank.

Quality of Work: The Vicon Model LS 2340T sprayer was designed to apply 4.9 and 9.8 gal/ac (55 and 110 L/ha) using Spraying Systems TeeJet 110015 and 11003 nozzles, respectively. Application rate remained constant from about 6 to 10 mph (9.7 to 16.1 km/h) but was about 2% high at the 4.9 gal/ac (55 L/ha) setting and about 2% low at the 9.8 gal/ac (110 L/ha) setting.

To ensure a constant application rate and acceptable nozzle spray distribution patterns, the sprayer had to be operated at pressures from 30 to 64 psi (205 to 440 kPa), indicated by the green zone on the pressure gauge. The operating pressure range corresponded to speeds of about 6.5 to 9.5 mph (10.5 to 15.3 km/h), respectively. This speed range was excessive in some field conditions encountered.

Spraying Systems TeeJet 11003S stainless steel nozzles produced acceptable spray distribution patterns at all pressures and nozzle heights. The TeeJet 110015S stainless steel nozzles produced acceptable spray distribution patterns only at the 17.7 in (450 mm) nozzle height. Operating the 110015S nozzles below 17.7 in (450 mm) nozzle height is not recommended.

Delivery of the TeeJet 110015S stainless steel nozzles agreed with Spraying Systems rated output. Delivery of the 11003S stainless steel nozzles was 3.7% lower than specified by the manufacturer. Variability among individual nozzle deliveries was low.

Pressure losses were insignificant since nozzle pressure was measured at the spray boom. The pressure gauge was accurate. The strainers effectively removed large foreign material. Using dugout water eventually plugged the 110015 nozzles and 100 mesh nozzle strainers.

The high capacity 11003 nozzles were less susceptible to drift because the nozzles produced coarse droplets and could be operated at low nozzle heights.

The self-stabilizing boom system reduced boom movement and kept the boom level when operating in rough field conditions. Even so, the boom ends frequently touched the ground causing large nozzle height variations along the boom. Using the high capacity TeeJet 11003 stainless steel nozzles in rough field conditions ensured acceptable spray distribution patterns since the nozzles produced acceptable spray patterns over a wide range of nozzle heights. The Vicon sprayer wheels soil contact pressure was about the same as an unloaded one-half ton truck.

Ease of Operation and Adjustment: Ease of changing application rate was very good because the sprayer was designed to apply either 4.9 or 9.8 gal/ac (55 or 110 L/ha). Therefore, application rate formulas, tractor speed calibrations and knowledge of nozzle sizes were not needed. Flow to the booms was easily controlled by the solenoid valves with the remote control system. Nozzle pressure was adjusted by adjusting tractor speed.

Ease of placing booms in transport and field position was good. The booms were light and took about two minutes to fold and unfold. The sprayer was compact and maneuverability was very good both in field and transport position. The sprayer wheel drive chain had to be removed when transporting at speeds greater than 10 mph (16 km/h).

Ease of changing the self-stabilizing boom system position was fair. Changing the boom position to accommodate the field condition was time consuming, difficult and usually didn't improve boom stability. Balancing the self-stabilizing boom was simple and easy.

Ease of adjusting nozzle height was fair. Nozzle height could be adjusted from 21 to 47 in (533 to 1194 mm) with the winch system provided or the optional hydraulic lift kit. Both systems were inconvenient to use and care had to be exercised when using them. Ease of adjusting nozzle angle was poor. The nozzles behind the tank could not be adjusted forward.

Ease of filling and inducting chemical in the spray tank was good. An auxiliary pump capable of producing about 36 psi (250 kPa) was required to induct chemical. The chemical inductor tube got very dirty during storage and interfered with the reload inlet adapter, which made reloading and inducting chemical inconvenient. The spray tank filler lid did not completely seal. The ellipsoid shaped spray tank and sump provided the pump with fluid in all topographical conditions encountered.

Ease of hitching was very good. The hitch jack provided was easy to use and safe. The hitch was adjustable.

Ease of cleaning the nozzles and strainers was fair. The quick-attach nozzle caps and strainer bowls were difficult to remove. Chemical solution splattered on the operator when cleaning the nozzles and strainers. The sprayer had to be towed to flush the plumbing system, which was inconvenient. Cleaning the chemical container was very good during reloading using the chemical inductor.

Ease of draining was fair. The operator had to crawl under the spray tank to drain it.

Pump Performance: The piston pump capacity was very good and easily supplied fluid to the 110015 and 11003 nozzles. The roller pump supplied fluid to the agitators. Agitation capacity during spraying was low when compared to normally recommended rates, however no agitation problems were noticed while spraying the same day the tank was filled.

Operator Safety: The operator's manual did not emphasize chemical safety. The chemical inductor system reduced chemical handling.

Operator's Manual: The operator's manual was good, providing useful information.

Mechanical History: A few mechanical problems occurred during the test. The boom lock brackets and boom ends failed a couple of times.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifying the sprayer to operate at speeds below 6.5 mph (10 km/h) with acceptable nozzle spray distribution patterns.
2. Modifying the nozzle height lift assembly to make nozzle height adjusting more convenient and safer to adjust.
3. Relocating the chemical inductor tube to prevent interference with the reload inlet coupler.
4. Modifying the spray boom clamps to prevent the end spray booms from moving forward.
5. Modifying the boom ends to prevent failure when striking the ground.
6. Modifying the boom lock brackets to prevent failure.

Station Manager: R. P. Atkins

Project Technologist: L. B. Storozynsky

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. As an option Spraying Systems XRI10015 and XR11003 stainless steel tips will extend the acceptable operating zone down to 15 psi.
2. The hydraulic lift assembly has been modified to provide safe, easy and instantaneous height adjustment.
3. The chemical inductor tube is to be relocated on future production.
4. The end spray booms have been modified to provide the nozzle clamps to fit more tightly.
5. The boom ends have been modified for improved strength.
6. The boom lock brackets have been re-designed for greater strength.

GENERAL DESCRIPTION

The Vicon Model LS 2340T is a trailing, boom-type field sprayer equipped with two ground driven pumps. The sprayer is mounted on a set of single axles. The ellipsoid shaped, 503 gal (2287 L), fiberglass tank is mounted in the center of the trailer and is equipped with hydraulic agitation, fluid level indicator and large filler opening. The self-stabilizing booms mount to the trailer frame in back of the spray tank. The booms fold back for transport. The spray boom has 32 nozzle assemblies spaced at 20 in (508 mm), giving a spraying width of 53.3 ft (16.3 m). The nozzle assembly has a two-nozzle swivel chamber, a diaphragm check valve and self-aligning snap on nozzle caps. The piston and roller pumps are chain driven from the left sprayer wheel and supply fluid to the spray booms and agitators, respectively.

The Vicon is equipped with a chemical inductor, remote control and reload systems. The remote control console mounts near the tractor seat and contains two toggle switches that operate the electric boom valves. The pressure gauge mounts in front of the spray tank.

FIGURE 1 shows the location of major components while detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The Vicon sprayer was operated for 95 hours in the conditions shown in TABLES 1 and 2 while spraying about 3021 acres (1223 ha). It was evaluated for rate of work, quality of work, ease of operation and adjustment, pump performance, operator safety and suitability of the operator's manual.

The Vicon sprayer was designed to use Spraying Systems TeeJet flat fan 110015 and 11003 nozzle tips. The manufacturer supplied a batch of 110015S and 11003S stainless steel nozzle tips and a batch of 110015A and 11003A (Alumax) ceramic nozzle tips to test in the laboratory. Initial laboratory tests showed the stainless steel nozzle tips produced better spray distribution patterns than the ceramic nozzle tips. As a result, the manufacturer chose to use the stainless steel nozzle tips as standard equipment with the Vicon sprayer.

The "Alumax" 110015A and 11003A ceramic nozzle tips were used with the Vicon sprayer in the field for further testing and operated for 69 and 19 hours, respectively. Results of the ceramic nozzle tips are reported for comparison purposes only.

TABLE 1. Operating Conditions.

Chemical Applied	Crop	Hours	Speed		Field Area	
			mph	km/h	ac	ha
2, 4-D	Wheat	51.5	6.5 - 8	10.5 - 12.9	1960	794
2, 4-D/Banvel	Wheat	14	6.5 - 8	10.5 - 12.9	385	156
Water	Wheat	4.5	4 - 11	6.4 - 17.7	120	48
Mataven	Wheat	4.5	6.5 - 8	10.5 - 12.9	150	61
2, 4-D	Wheat	5	6.5 - 8	10.5 - 12.9	165	67
2, 4-D/Banvel	Wheat	3.5	6.5 - 8	10.5 - 12.9	106	43
Hoegrass/Buctril M	Wheat	1.5	6.5 - 8	10.5 - 12.9	50	20
Buctril M	Wheat	1.5	6.5 - 8	10.5 - 12.9	35	14
Water	Wheat	2	4 - 11	6.4 - 17.7	50	20
Transport		7				
Total		95			3021	1223

TABLE 2. Field Conditions.

Topography	Hours	Field Area	
		ac	ha
Level	27	948	384
Undulating	12	373	151
Rolling	49	1700	688
Total	88	3021	1223

RESULTS AND DISCUSSION

RATE OF WORK

During field testing, the sprayer was operated at nozzle pressures between 29 and 45 psi (200 and 310 kPa) which corresponded to speeds of 6.5 and 8 mph (10 and 13 km/h). This resulted in instantaneous workrates ranging from 42 to 52 ac/h (17 to 21 ha/h). Actual workrates were less depending on operator skill and reloading time. In some field conditions encountered 6.5 mph (10 km/h) was too fast causing the sprayer to bounce vigorously.

With a full spray tank about 103 and 51 ac (42 and 21 ha) could be sprayed at the 4.9 and 9.8 gal/ac (55 and 110 L/ha) settings, respectively, before refilling.

QUALITY OF WORK

Application Rate: The Vicon Model LS 2340T sprayer was designed to apply 4.9 and 9.8 gal/ac (55 and 110 L/ha) at speeds from 6 to 10 mph (10 to 16 km/h), using Spraying Systems TeeJet 110015 and 11003 nozzle tips, respectively. FIGURE 2 shows average application rates measured in actual field conditions at various ground speeds. Both application rates remained constant over the manufacturer's recommended range of forward speeds, but were about 2% high at the 4.9 gal/ac (55 L/ha) setting and about 2% low at the 9.8 gal/ac (110 L/ha) setting.

Actual application rates could vary 3% from the averages shown in FIGURE 2 since the sprayer pump was ground driven. Pump output and therefore application rate was directly proportional to the speed of the sprayer wheel. Sprayer wheel speed varied depending on the volume of fluid in the spray tank. For example, the application rate was about 9.6 gal/ac (108 L/ha) spraying with the tank full and about 9.3 gal/ac (104.4 L/ha) spraying with the tank nearly empty using the 11003 nozzles. Variations in field conditions did not significantly affect application rate when the sprayer tires were properly inflated.

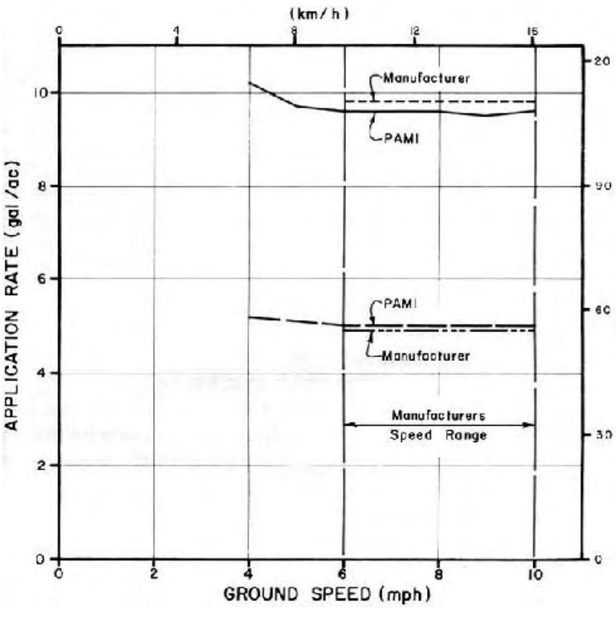


FIGURE 2. Average Application Rates In Actual Field Conditions at Various Forward Speeds.

Nozzle Pressure and Distribution Patterns: FIGURE 3 shows the resulting nozzle pressures at various ground speeds with the spray tank full, half and nearly empty of fluid. Nozzle pressure decreased as the spray tank fluid volume decreased. This is common for ground driven sprayers and accounts for the corresponding decrease in application rate as tank fluid volume decreases.

Nozzle pressure increased as ground speed increased. The manufacturer's recommended operating nozzle pressure range from 30 to 64 psi (205 to 440 kPa), indicated by the green zone on the pressure gauge, corresponded to a speed range of about 6.5 to 9.5 mph (10 to 15 km/h), respectively. Operating in the green pressure zone ensured a constant application rate (FIGURE 2) and acceptable spray distribution patterns. FIGURE 4 shows a typical spray distribution pattern along the boom operating the TeeJet 110015S nozzles in the green pressure zone. The coefficient of variation (CV)[1] was about 10% with application rates along the boom varying from 3.8 to 6.3 gal/ac (42 to 70 L/ha). This was considered acceptable.

Operating the sprayer in the green pressure zone was not always possible because the corresponding speed range of 6.5 to 9.5 mph (10 to 15 km/h) was excessive in some field conditions encountered. FIGURE 5 shows a typical spray distribution pattern when operating the TeeJet 110015S nozzles below the green pressure zone in rough fields. The nozzle pressure and corresponding speed was about 14.5 psi (100 kPa) and 4.5 mph (7 km/h), respectively. High spray concentrations occurred below each nozzle with inadequate coverage between nozzles. The coefficient of variation (CV) was about 18%, with application rates along the boom varying from 3.4 to 7.1 gal/ac (38 to 80 L/ha). It is recommended that the manufacturer consider modifying the sprayer to operate at speeds below 6.5 mph (10 km/h) with acceptable nozzle spray distribution patterns.

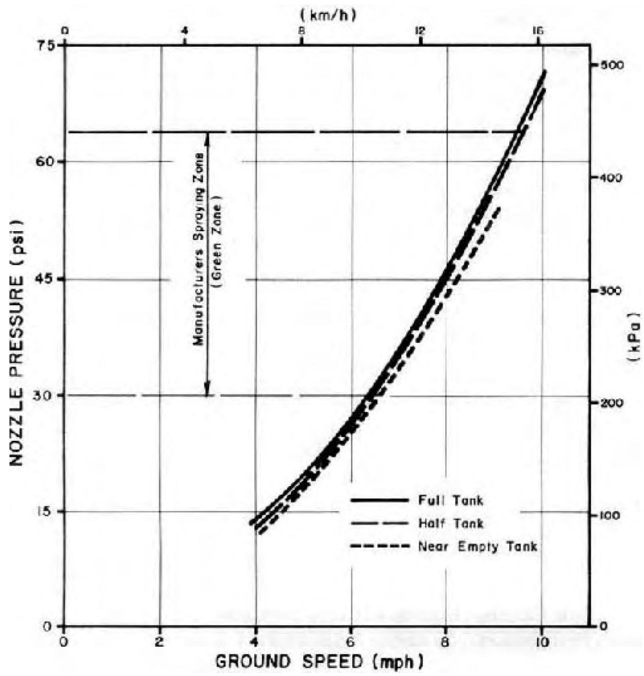


FIGURE 3. Nozzle Pressures Over a Range of Forward Speeds and Spray Tank Volumes.

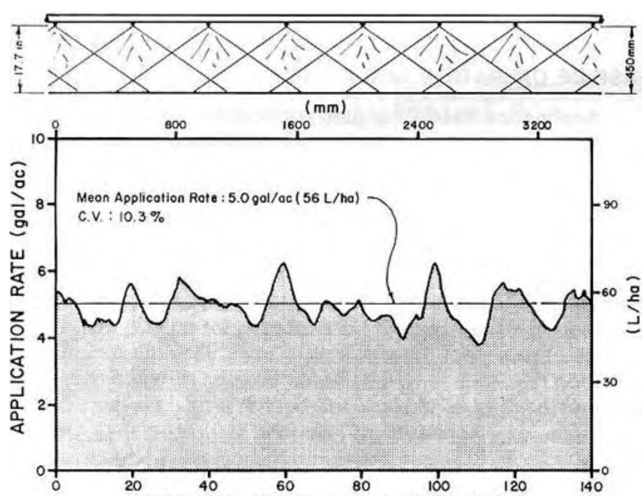


FIGURE 4. Typical Spray Distribution Pattern Along the Boom with the Tee Jet 110015S Nozzles Operating in the Green Pressure Range.

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[1]The coefficient of variation (CV) is the standard deviation of application rates for successive 0.63 in (16 mm) sections along the boom expressed as a percent of the mean application rate. The lower the CV, the more uniform is the spray coverage. A CV below 10% indicates very uniform coverage while a CV above 15% indicates inadequate uniformity. The CV's above were determined in stationary laboratory tests. In the field, CV's may differ due to boom vibration and wind. Different chemicals vary as to the acceptable range of application rates. For example, 2,4-D solutions have a fairly wide acceptable range while other chemicals may have a narrow range.

Distribution Pattern Uniformity: At 20 in (508 mm) nozzle body spacings Spraying Systems Tee Jet flat fan nozzle catalogues indicate the 110 degree nozzles could be operated at nozzle heights as low as 11 in (280 mm). Therefore, spray distribution patterns with the 110 degree stainless steel and ceramic nozzle tips were measured at the minimum and conventional nozzle heights of 11 and 17.7 in (280 and 450 mm), respectively. The results of the "Alumax" ceramic nozzle tips are reported for comparison purposes.

FIGURE 6 shows how nozzle pressure and height affected spray pattern uniformity for the TeeJet flat fan 110015S and 11003S stainless steel nozzles. The coefficient of variation (CV) was used to express spray distribution pattern uniformity. The high capacity 11003S stainless steel nozzles produced acceptable spray distribution patterns at all pressures and nozzle heights. The lower capacity 110015S nozzles produced acceptable spray distribution patterns above 20 psi (138 kPa), but only at the 17.7 in (450 mm) nozzle height.

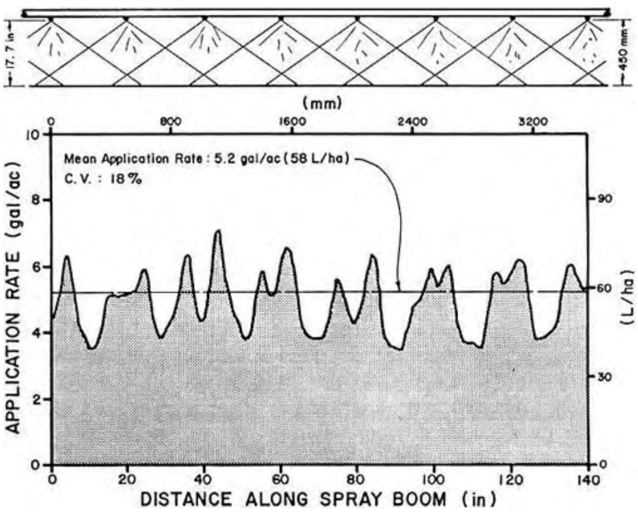

FIGURE 5. Typical Spray Distribution Pattern Along the Boom with the Tee Jet 110015S Nozzles Operating Below the Green Pressure Range.

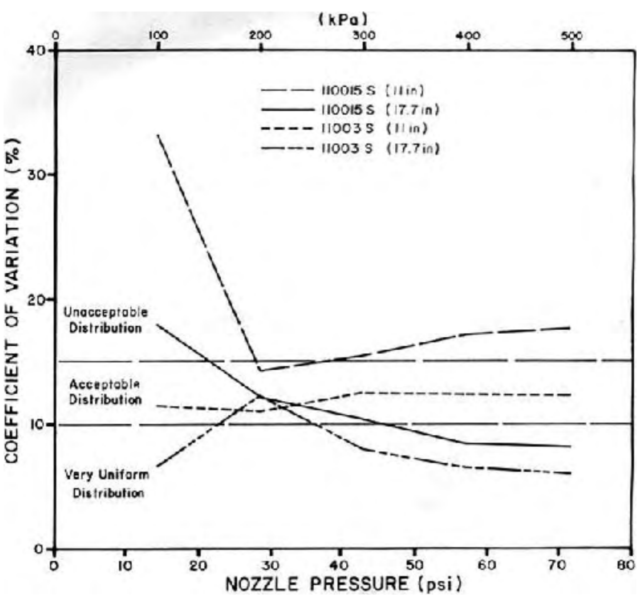

FIGURE 6. Spray Pattern Uniformity for Spraying Systems Tee Jet 110015S and 11003S Stainless Steel Nozzles Operated at 11 and 17.7 in (280 and 450 mm) Nozzle Heights.

FIGURE 7 shows how nozzle pressure and height affected spray pattern uniformity for the Tee Jet flat fan 110015A and 11003A ceramic nozzles. At the minimum recommended height of 11 in (280 mm) the TeeJet 110 degree ceramic nozzles produced unacceptable spray distribution patterns at all pressures tested. At the higher nozzle height of 17.7 in (450 mm), the 110 degree ceramic nozzles produced acceptable spray distribution patterns but only above a nozzle pressure of 37.7 psi (260 kPa). To obtain a nozzle pressure of 37.7 psi (260 kPa) the Vicon sprayer had to be towed at 7.3 mph (12 km/h), which was excessive in some field conditions.

FIGURES 6 and 7 show that the TeeJet 110 degree stainless steel nozzles produced better spray distribution patterns than the Tee Jet 110 degree ceramic nozzles at both the 11 and 17.7 in (280 and 450 mm) nozzle heights and at all nozzle pressures. Therefore, the manufacturer chose to supply the 110015S and 11003S TeeJet stainless steel nozzles with the Vicon sprayer as standard equipment.

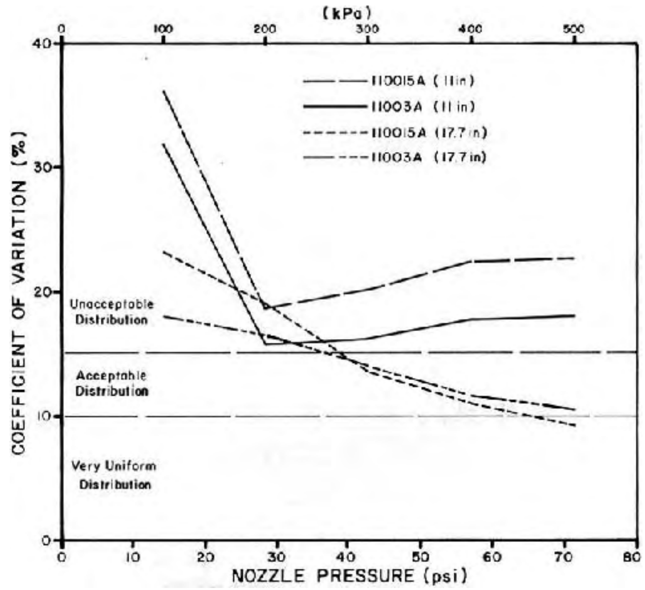

FIGURE 7. Spray Pattern Uniformity for Spraying Systems Tee Jet 110015A and 11003A Ceramic Nozzles Operated at 11 and 17.7 in (280 and 450 mm) Nozzle Heights.

Nozzle Calibration: FIGURE 8 shows the average delivery of Spraying Systems TeeJet 110015 and 11003 nozzles at various pressures. Measured delivery of the new 110015 stainless steel and ceramic nozzles agreed with Spraying Systems rated output. At 43.5 psi (300 kPa) the delivery of the new 11003 stainless steel and ceramic nozzles was 3.7% lower than specified by the manufacturer.

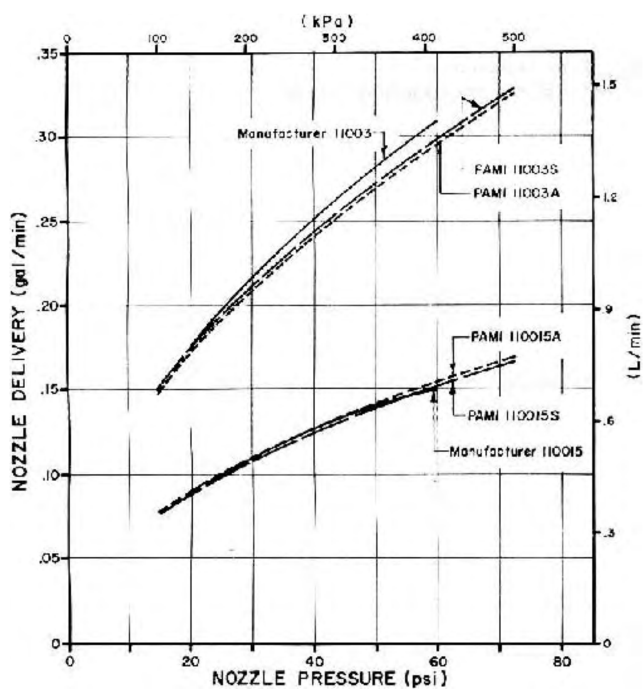

FIGURE 8. Average Delivery Rates for Spraying Systems Tee Jet 110015 and 11003 Nozzles.

Variability among individual nozzle deliveries for both the 110015 and 11003 nozzles was low. A low CV indicates similar delivery rates for all nozzles while a high CV indicates larger variability among individual nozzle deliveries. The CV of nozzle deliveries of the 110015 and 11003 nozzles was 2.5 and 1.5%, respectively, when new.

Spray Drift: Work by the Saskatchewan Research Council[2] indicates that off-swath drift from the 8002 TeeJet nozzle operated at 30 psi (207 kPa) and 18 in (457 mm) height was generally below 1% of the emitted material in 13 mph (21 km/h) winds. The low drift was attributed to the nozzles high capacity, coarse droplets and low nozzle height operation. The high capacity 110 degree 11003 TeeJet nozzles used on the Vicon sprayer produced more coarse spray droplets and could be operated at lower heights than the 80 degree 8002 Tee Jet nozzles. It is recommended the operator use the 11003 nozzles when spraying in light wind conditions.

Pressure Losses in Plumbing Systems: Nozzle pressure was measured at the boom, rather than at the pump. Pressure losses across the boom width were negligible. The pressure gauge was accurate throughout the test.

Strainers: The reload, main hose and nozzle strainers effectively removed the larger foreign material. Using dugout or lake water eventually plugged the 110015 nozzles and 100 mesh nozzle strainers.

Boom Stability: The self-stabilizing boom system reduced boom end movement when operating in rough field conditions and kept the boom level with the trailer wheels in hilly field conditions. Even so, the boom ends frequently touched ground causing large variations in nozzle heights along the boom. In rough and hilly field conditions it is recommended the operator use the 11003S stainless steel nozzles because moderate variations in nozzle heights did not significantly deteriorate spray distribution patterns. For example, at 43.5 psi (300 kPa), the 11003S stainless steel nozzles produced acceptable spray distribution patterns at both the 11 and 17.7 in (280 and 450 mm) nozzle heights (FIGURE 6).

Soil Compaction and Crop Damage: The Vicon sprayer wheels travelled over about 3.5% of the total field area sprayed. The average soil contact pressure and tire track width was 31 psi (214 kPa) and 11.25 in (286 mm), respectively. For comparative purposes, an unloaded one-half ton truck has a soil contact pressure of about 30 psi (207 kPa).

EASE OF OPERATION AND ADJUSTMENT

Application Rate: Changing application rate was easy and convenient because the sprayer was designed to apply either 4.9 or 9.8 gal/ac (55 or 110 L/ha). Therefore, application rate formulas, tractor speed calibrations and knowledge of nozzle sizes were not needed. The application rate control valve (FIGURE 9) simply had to be positioned at either the 4.9 or 9.8 gal/ac (55 or 110 L/ha) setting and the dual nozzle body assembly (FIGURE 10) switched to the corresponding nozzle tip. The control valve application rate decal and nozzle tips were color coded to ensure the proper sized nozzles were used with the desired application rate. Mismatching the application rate and nozzle tip resulted in either excessively low or high nozzle pressures. Nozzle pressures above 100 psi (690 kPa) damaged the pressure gauge.

Controls: Flow to the booms was controlled from the tractor seat by an electronic remote system. Tractor speed had to be adjusted until the pressure was operating within the green zone (FIGURE 9). The pressure gauge was located in the front of the spray tank and was easy to see from the tractor seat.

Maneuverability: The Vicon sprayer was very compact and maneuverability was very good both in field and transport position.

Boom Positioning: The Vicon sprayer booms were light and were easily folded into transport (FIGURE 11) or placed into field position in about two minutes. To prevent one side of the boom from tipping, it was important to have the transport pins in place during folding and unfolding of the booms. During spraying the transport pins had to be removed for the self-stabilizing booms to function properly.

The self-stabilizing boom system could be adjusted to operate in either of two positions depending whether field conditions were hilly or rough. Changing the boom position to accommodate the field condition was time consuming and difficult and usually didn't make much difference in boom stability in the field conditions encountered. During the test the sprayer booms were operated mainly in the hilly setting.

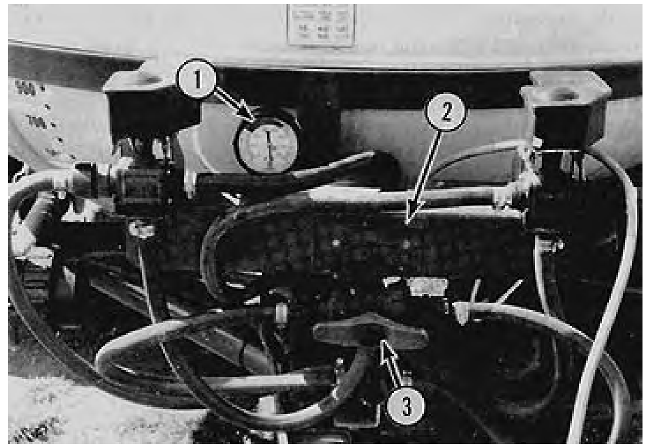

FIGURE 9. Application Rate Control System: (1) Pressure Gauge Green Zone, (2) Application Rate Decal, (3) Control Valve.

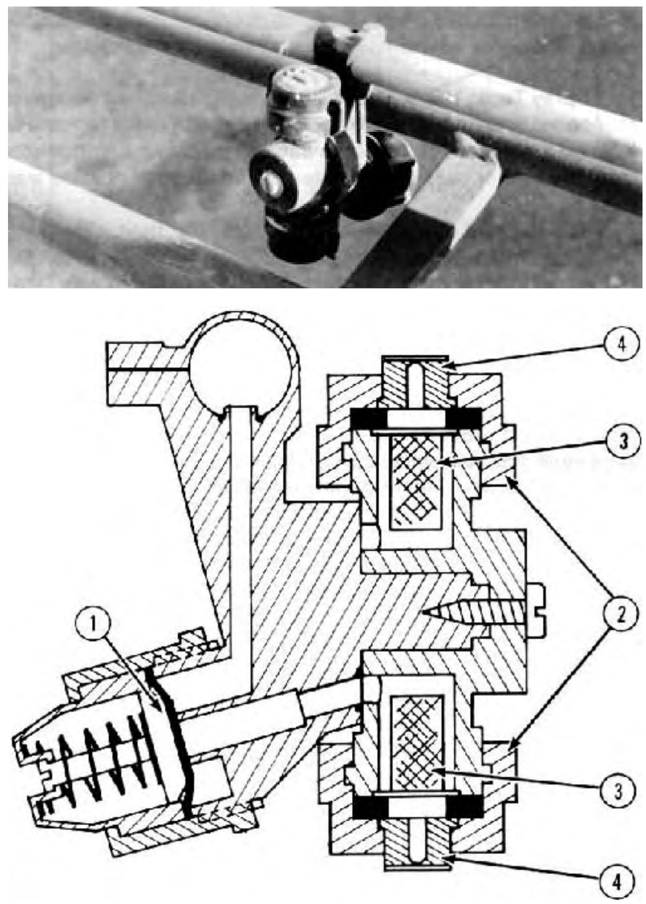

FIGURE 10. Nozzle Body Assembly: (1) Diaphragm Check Valve, (2) Nozzle Caps, (3) Strainers, (4) Nozzle Tips.

Before spraying, the self-stabilizing boom had to be balanced. Balancing the boom was easy and required adjusting the balance weight along the boom until both sides of the boom were the same height above the ground. The balance weight supplied did not level the boom and another weight was required.

The boom ends had a breakaway feature that conveniently returned to the normal position after striking the ground.

Transporting: The Vicon sprayer was very compact in transport position making it easy to transport on roadways and visibility to the rear was very good. The wheel drive chain had to be removed when transporting at speeds greater than 10 mph (16 km/h). Removing the chain was inconvenient and time consuming.

With a full tank and transporting below 10 mph (16 km/h) the

[2]Maybank, J; Yoshida, K; Skewchuk, S.R., "Comparison of Swath Deposit and Drift Characteristics of Ground Rig and Aircraft Herbicide Spray Systems" (Report of the 1975 Field Trials, Saskatchewan Research Council Report No. P76-1, January, 1976, p. 16).

pump valve should be adjusted to the bypass position for maximum agitation to occur. With the tank empty, the pumps ran nearly dry when transporting. This could reduce the life of the pumps.

FIGURE 11. Transport Position.

Nozzle Adjustment: Nozzle height could be adjusted manually using the winch provided or remotely from the tractor seat with the optional hydraulic lift kit. The winch system allowed precise increments of nozzle height adjustment but the winch handle interfered with the boom frame (FIGURE 12) making it unsafe and difficult to operate.

FIGURE 12. Winch Crank and Boom Frame Interference.

The hydraulic lift kit was easy to install. The hydraulic lift kit allowed the operator to avoid obstacles by quickly lifting the booms from the tractor seat. This is a desirable feature on cantilever type booms since the boom ends strike the ground frequently. The hydraulic ram tended to creep during the test requiring constant readjustment.

The nozzles could be adjusted from 21 to 47 in (533 to 1194 mm). Near the maximum height the hydraulic ram interfered with the boom frame (FIGURE 13) preventing the boom from coming down. The boom and hydraulic ram had to be separated manually which was unsafe. It is recommended that the manufacturer consider modifying the nozzle height lift assembly to make nozzle height more convenient and safer to adjust.

Adjusting nozzle angle was possible but time consuming and inconvenient. The rear spray boom nozzles could not be adjusted forward unless the nozzle spray boom was repositioned on the boom frame. This was inconvenient. Range of angle adjustment varied depending on the spray boom position on the main boom.

Tank Filling: Refilling utilizing the tank filler opening was possible but unsafe and inconvenient since the filler opening was high and not easily accessible. The reload system (FIGURE 14) provided a convenient way to fill the 503 gal (2287 L) tank but required an auxiliary pump and a 2 in (50 mm) supply hose. The reload valves were accessible and easy to use. It took about 12 minutes to fill the tank with a Monarch centrifugal pump. Once the tank became full, the reload valve had to be shut off first to prevent spray tank fluid from entering the water supply.

The reload inlet coupler was inconvenient to operate since the chemical inductor tube interfered with the process (FIGURE 15). It is recommended that the manufacturer consider relocating the chemical inductor tube to prevent interference with the reload inlet coupler.

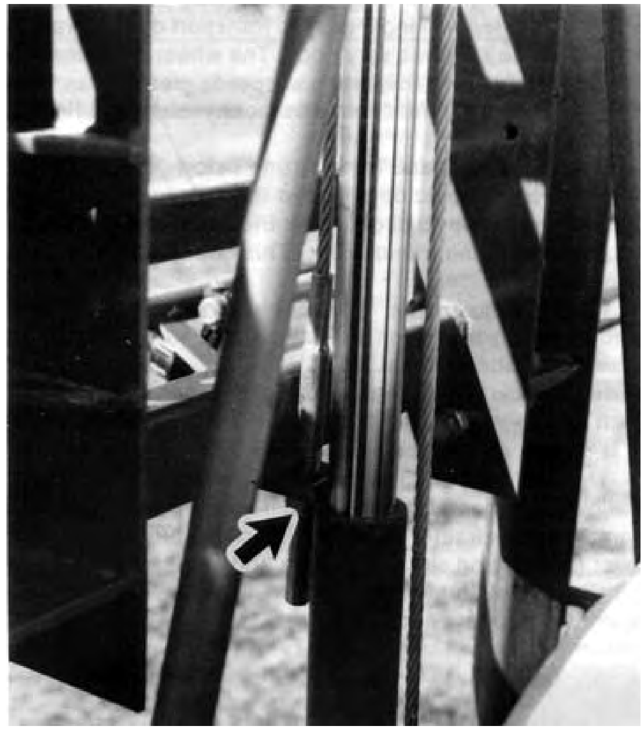

FIGURE 13. Hydraulic Ram and Boom Frame Interference.

Chemical Inducting: Chemical was easily loaded with the chemical inductor tube (FIGURE 14) during tank reloading. It took about 15 to 30 seconds to empty a 2.2 gal (10 L) chemical container depending on the volume of water in the spray tank. It took longer as the water volume in the spray tank increased. Therefore, it was important to add chemical early.

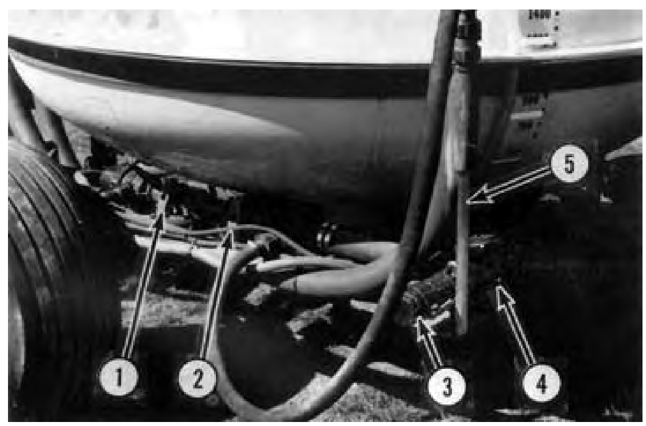

FIGURE 14. Reload System: (1) Pump Supply Hose Valve, (2) Reload Valve, (3) Reload Inlet Coupler, (4) Reload Strainer, (5) Chemical inductor Tube.

FIGURE 15. Chemical Inductor Tube and Reload Inlet Coupler Interference.

Auxiliary pumps with pressure ratings below 30 psi (207 kPa) took longer than 30 seconds to empty a 2.2 gal (10 L) chemical container and could not induct chemical at all when the spray tank water level was above 264 gal (1200 L). Auxiliary pumps with pressure ratings above 45 psi (310 kPa) are not recommended since the reload strainer housing failed at high pressures. It was therefore important to use auxiliary pumps with pressure ratings of about 36 psi (250 kPa). After using, the chemical inductor tube was exposed to the environment and dust collected on the tube. The inductor was inconvenient to clean.

Spray Tank: The 503 gal (2287 L) spray tank was adequate for normal spraying. The compact shape of the spray tank made it easy to see most of the boom and other sprayer components from the tractor seat. Spotting leaks and plugged nozzles was easy.

The filler lid did not completely seal the fluid. Operating the sprayer with the tank nearly full caused the fluid to leak out which quickly attracted dust. The filler opening was large enough to permit access inside the tank. The ellipsoid shape of the tank and sump provided the pump fluid in all topographical conditions encountered.

The spray tank volume indicator gave only a rough indication of liquid volume. The numbers at the bottom half of the tank indicated up to 15% lower than the actual volume. The numbers were more accurate above 250 gal (1137 L) and only reliable when the sprayer was stopped on level ground.

Hitching: The Vicon sprayer when empty was easily hitched to a tractor. With the spray tank full the hitch jack provided was safe and convenient to use. The hitch was adjustable to level the sprayer. This was important for proper operation of the self-stabilizing boom. Hitching also included the hook-up of an electronic coupler and hydraulic line.

Cleaning: The quick release nozzle caps were difficult to remove and required the use of a tool to clean the nozzle tips and strainers. The line strainer bowls were large and were removed using a tool. Cleaning strainers and nozzles was messy because chemical solution usually splashed on the operator. Flushing the sprayer plumbing system with clean water is recommended before cleaning strainers. Flushing the plumbing system was inconvenient because the sprayer had to be towed a considerable distance to thoroughly flush the plumbing system.

After inducting chemical, the chemical containers were easily rinsed with the supply water using the chemical inductor tube. This was a desirable and convenient feature.

Draining: The spray tank could be completely drained through the sump at the bottom of the tank. Draining required the operator to get under the tank and remove the drain plug. This was inconvenient because fluid splashed on the operator.

The main hose couplers were easily removed which made hose draining convenient. The piston pump contained a drain plug and although the agitator pump was not easily accessible it could be removed for draining.

Lubrication: The Vicon sprayer required no greasing which was convenient.

PUMP PERFORMANCE

Output: The sprayer was equipped with two positive displacement pumps. The General model T77 piston and Hypro model 1700 roller pumps supplied fluid to the nozzles and agitators, respectively, during spraying. FIGURE 16 gives the performance curves for both pumps when operated at various ground speeds. At 6 to 10 mph (10 to 16 km/h) both pumps operated between 210 and 360 rpm. Delivery rate was proportional to pump speed. Pump wear was negligible after 95 hours of operation.

Agitation: Agitation with the Vicon sprayer occurred through the tank agitators, pump bypass hose and through the turbulence created while inducting chemical during reloading. FIGURE 16 shows the agitator output during spraying. Agitation during spraying was low when compared to normally recommended rates. Normally recommended agitation rates for emulsifiable concentrates such as 2, 4-D are 1.5 gal/min per 100 gal of tank capacity (1.5 L/min per 100 L of tank capacity). For wettable powders, recommended agitation rates are 3 gal/min per 100 gal of tank capacity (3 L/min per 100 L of tank capacity). Without doing a detailed assessment on agitation effectiveness, taking into consideration factors such as tank shape, agitator type, fluid velocity, size and location of nozzles within the tank, no conclusions can be drawn with regard to agitation effectiveness.

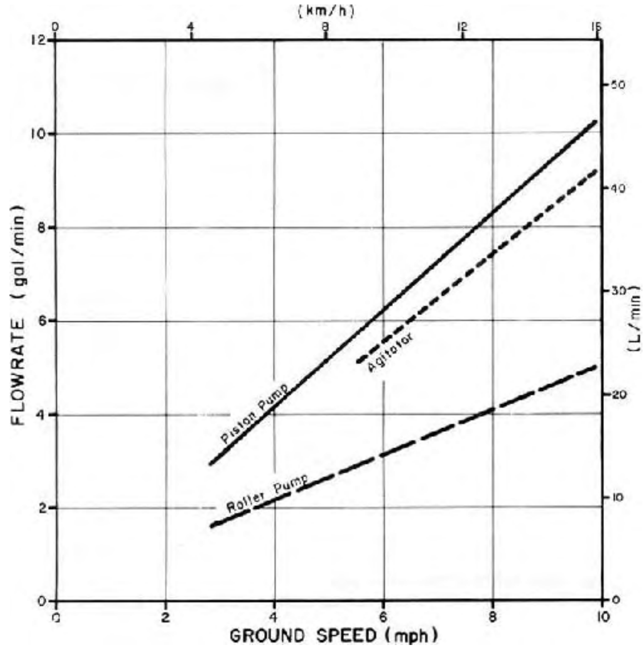

FIGURE 16. Pump Performance Curves.

No agitation problems were noticed while spraying the same day the tank was filled, using those chemicals listed in TABLE 1. However, leaving the spray solution over a period of time, due to weather conditions for example, could cause chemicals to settle or come out of suspension. The sprayer had to be driven a considerable distance to effectively agitate the entire solution using the agitator pump only. Placing the piston pump selector valve on bypass reduced the distance required to re-agitate chemicals since the total piston pump output was returned to the tank.

OPERATOR SAFETY

The sprayer was equipped with a chemical inductor system, which reduced chemical handling. This was a very good feature.

The operator's manual did not emphasize chemical safety.

Caution: Operators are cautioned to wear suitable eye protection, respirators and clothing to minimize operator contact with chemicals. Although many commonly used agricultural chemicals appear to be relatively harmless to humans, they may be deadly. In addition, little is known about the long-term effects of human exposure to many commonly used chemicals.

In some cases, the effects may be cumulative, causing harm after continued exposure over a number of years.

OPERATOR'S MANUAL

The operator's manual adequately outlined sprayer operation. It was simple and easy to understand. A complete parts list was provided.

MECHANICAL PROBLEMS

TABLE 3 outlines the mechanical history of the Vicon sprayer during 95 hours of operation while spraying about 3021 ac (1223 ha). The intent of the test was evaluation of functional performance. An extended durability evaluation was not conducted.

DISCUSSION OF MECHANICAL PROBLEMS

End Spray Booms: The end section of the spray booms moved forward (FIGURE 17) changing the desired nozzle spray angle. The spray boom clamps were tightened several times until the wing nuts broke. It is recommended that the manufacturer consider modifying the spray boom clamps to prevent the end spray booms from moving forward.

Boom Stabilizing Springs: The two boom stabilizing springs came off and were not replaced. The self-stabilizing boom performed the same without the stabilizing springs.

Boom ends: Although the self stabilizing boom reduced boom movement the boom ends still struck the ground frequently. As a result, the boom ends failed (FIGURE 18) several times during the field test. It is recommended that the manufacturer consider modifying the boom ends to prevent failure when striking the ground.

TABLE 3. Mechanical History

Item	Operating Hours	Equivalent Field Area ac	(ha)
-the left sprayer wheel came off the axle and was repaired at	1	10	(4)
-the right boom stabilizing spring came off and was refastened at	4	150	(61)
-the spray tank bolts loosened and tightened at	4	150	(61)
-both boom stabilizing springs came off at	9	330	(134)
-both end spray booms moved forward	throughout the test		
-both boom end skid bolts loosened and were tightened at	34	1175	(476)
-the end of the left boom broke and was welded at	41, 80	1460, 2680	(591, 1085)
-the right boom lock bracket broke and was welded at	47	1760	(713)
-the right skid broke off the boom and was welded at	60	2110	(854)
-the right boom pivot bracket and top lock bracket failed and were welded at	95	3021	(1223)

FIGURE 17. End Spray Booms Moved Forward.

Boom Lock Bracket: The top boom lock bracket (FIGURE 19) that secures the right boom to the rear boom frame failed twice. The failures were attributed to excessive field vibration. It is recommended that the manufacturer consider modifying the boom lock brackets to prevent failure.

FIGURE 18. Failed Boom End.

FIGURE 19. Failed Boom Lock Bracket.

APPENDIX I
SPECIFICATIONS

MAKE:	Vicon
MODEL:	LS 2340T
SERIAL NUMBER:	5002 400 008
MANUFACTURER:	Vicon Wheat-Belt 6423 - 30 Street S.E. Calgary, Alberta T2C 1R4
OVERALL DIMENSIONS:	
-wheel tread	6.44 ft (1.96 m)
-transport height	6.04 ft (1.84 m)
-transport length	15.37 ft (4.69 m)
-transport width	9.29 ft (2.83 m)
-field height	6.04 ft (1.84 m)
-field length	14.44 ft (4.40 m)
-field width	52.21 ft (15.9 m)
-clearance height	10.5 in (267 mm)
TIRES:	2, 31 x 13.50-15NHS, 6 ply, 30 psi (207 kPa)

WEIGHT: Transport Position	Empty	Loaded
-left trailer wheel	1025 lb (465 kg)	3175 lb (1440 kg)
-right trailer wheel	965 lb (438 kg)	3115 lb (1413 kg)
-hitch	15 lb (7 kg)	815 lb (370 kg)
Total	2005 lb (910 kg)	7105 lb (3223 kg)
Field Position	Empty	Loaded
-left trailer wheel	1025 lb (465 kg)	3175 lb (1440 kg)
-right trailer wheel	935 lb (424 kg)	3075 lb (1395 kg)
-hitch	45 lb (21 kg)	855 lb (388 kg)
Total	2005 lb (910 kg)	7105 lb (3223 kg)

SPRAY TANK:	
-material	fiberglass
-capacity	503 gal (2287 L)
-agitation	hydraulic
-shape	ellipsoid
FILLER OPENING:	
-shape	round
-size	
-small opening	5.5 in (140 mm)
-large opening	18.25 (464 mm)
-location	top, center
-height above ground	67 in (1702 mm)
-type of seal	plastic
CHEMICAL INDUCTOR:	
-type	hand held wand
-size	1 in (25.4 mm) pipe
STRAINERS:	
-nozzles	32, 50 and 100 mesh
-reload system	1, 30 mesh
-pump discharge	1, 50 mesh
-pump inlet	1, 50 mesh
PUMP:	
-make	General
-type	piston
-type of drive	chain, ground driven
AGITATOR PUMP:	
-make	Hypro
-type	roller
-type of drive	ground driven
CONTROLS:	remote boom flow control
SPRAY BOOMS:	
-material	stainless steel
-size	0.5 in (12.7 mm) I.D.
-suspension	nylon clamps
-height adjustment	
-type	winch or optional hydraulic
-range	21 to 47 in (533 to 1194 mm)
-nozzle assembly	
-type	dual swivel, spring loaded diaphragm
-number	32 -spacing 20 in (508 mm)
-nozzle cap	quick-attach, self aligning
-nozzle tips	Spraying Systems TeeJet 110015S and 11003S
-effective spraying width	53.3 ft (16.3 m)

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)
feet (ft) x 0.305	= metres (m)
Imperial gallons (gal) x 4.55	= litres (L)
imperial gallons per acre (gal/ac) x 11.23	= litres/hectare (L/ha)
inches (in) x 25.4	= millimeters (mm)
miles/hour (mph) x 1.61	= kilometres/hour (km/h)
pounds force per square in (psi) x 6.89	= kilopascals (kPa)
pounds mass (lb) x 0.45	= kilograms (kg)

SUMMARY CHART

VICON MODEL LS 2340T FIELD SPRAYER

RETAIL PRICE:	$9,550.00 (December, 1987 f.o.b. Lethbridge)
RATE OF WORK:	42 to 52 ac/hr (17 to 21 ha/hr) at operating pressures between 29 and 45 psi (200 and 310 kPa)
QUALITY OF WORK:	
Application Rate	4.9 and 9.8 gal/ac (55 and 110 L/ha) over a range of speeds
Nozzle Pressure	varied with speed
Nozzle Calibration	
- delivery	
- 11003S	**very good;** about 8.7% lower than manufacturer
- 110015S	**excellent;** same as manufacturer
- coefficient of variation	
- 11003S	**very good;** about 1.5%
- 110015S	**good;** about 2.5%
Spray Distribution	
- 11003S & 110015S	**very good;** at all recommended nozzle pressures
- 11003A & 110015A	**fair;** acceptable above 87.7 psi (260 kPa)
Spray Drift	**good;** using 110 degree 11003S nozzles
Pressure	
- loss	**very good;** negligible
- gauge	**very good;** accurate
Straining	**good;** dugout or lake water plugged the 10015 nozzles
Boom Stability	**good;** boom ends frequently hit the ground
EASE OF OPERATION AND ADJUSTMENT:	
Application Rate	**very good;** precalibrated, no need to calibrate tractor speed
Controls	**very good;** easy to control flow and adjust pressure
Maneuverability	**very good;** sprayer compact and easy to transport
Boom Positioning	
- for transport	**good;** manual, about 2 minutes
- for stability	**fair;** time consuming and difficult
Nozzle Adjustments	
- nozzle height	**fair;** both winch and hydraulic system were inconvenient
- nozzle angle	**poor;** time consuming and difficult
Tank Filling	**good;** about 12 minutes, interference from chemical inductor tube
Chemical Inducting	**good;** with proper auxiliary pump
Hitching	**very good;** hitch jack was safe and hitch was adjustable
Cleaning	
- strainers	**fair;** difficult to remove and messy
- plumbing system	**good;** needed to drive considerable distance
- chemical containers	**very good;** using chemical inductor
Draining	**fair;** needed to get under spray tank
PUMP PERFORMANCE:	
Piston	**very good;** adequate for the 110015 and 11008 nozzle tips
Roller	**fair;** low agitation rates
OPERATOR SAFETY:	normal precautions should be taken when handling chemical
OPERATOR'S MANUAL:	**good;** simple and easy to understand
MECHANICAL HISTORY:	boom lock brackets and ends failed

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