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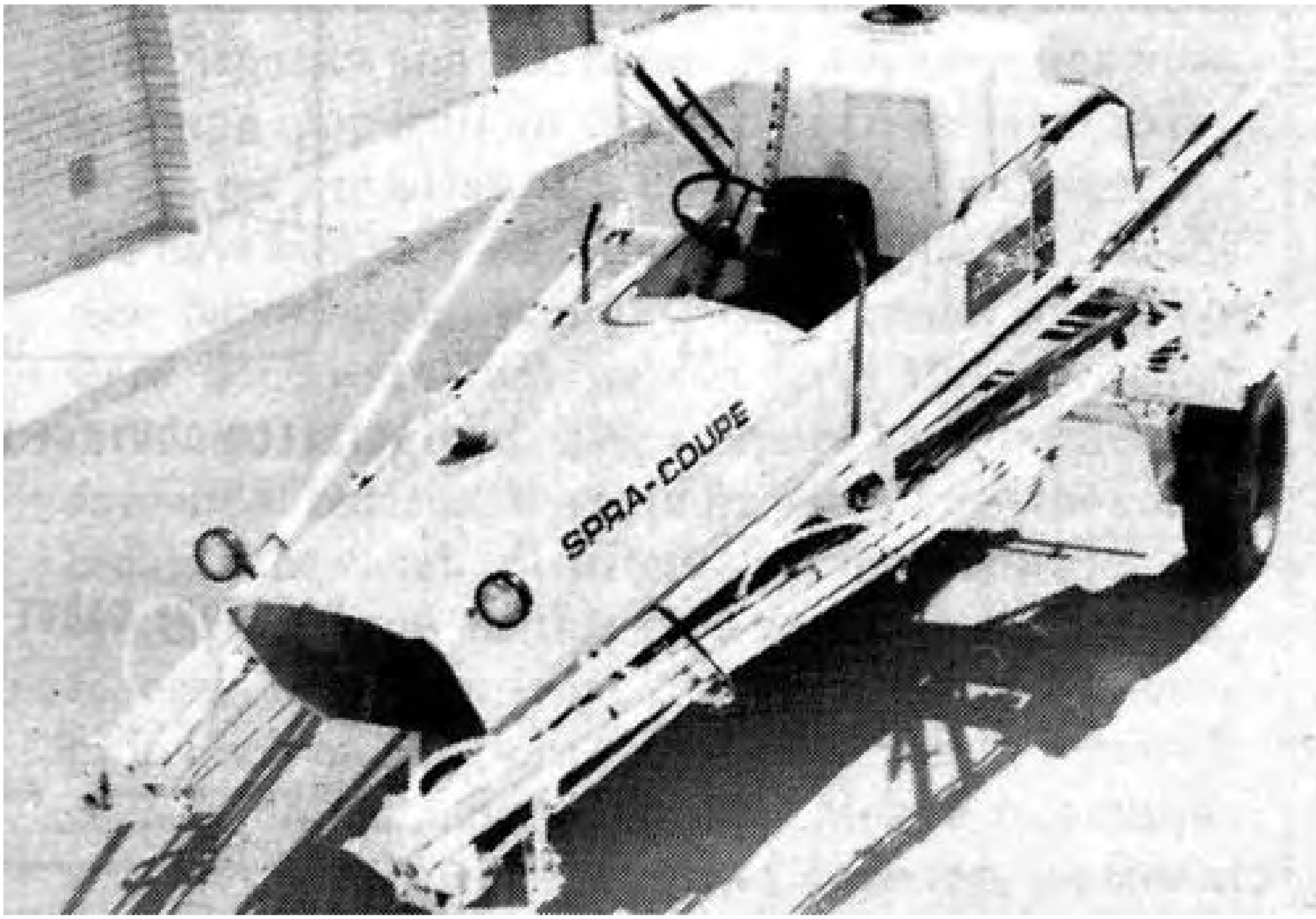
Evaluation Report 38



Melroe Model 103 Spra-Coupe

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

Melroe Model 103 Spra-Coupe

Manufacturer and Distributor:
Clark Equipment Company
Melroe Division, Ag Products
403 Airport Road
Bismarck, North Dakota 58501

Retail Price:
$6,206.72 (April, 1977, f.o.b. Bismarck, North Dakota)

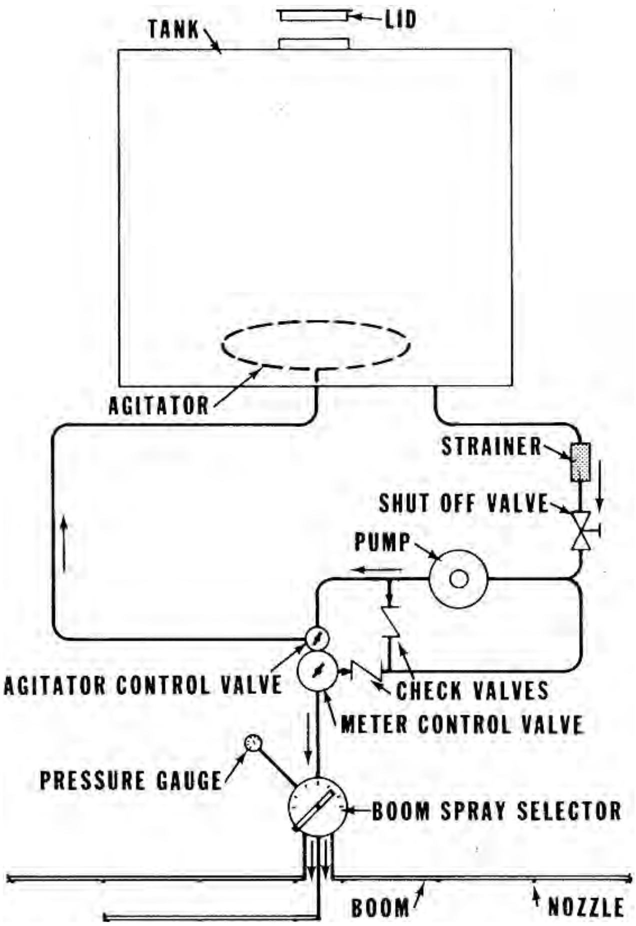


Figure 1. Flow Diagram for Melroe Spra-Coupe Model 103.

Summary and Conclusions

Functional performance of the Melroe model 103 Spra-Coupe was fair. Functional performance was reduced by poor spray patterns, excessive spray drift and a small spray tank. An extended durability test was not conducted. Durability of the Spra-Coupe during functional evaluation was very good.

The Spra-Coupe operated satisfactorily in third gear at 23 km/h (14 mph) on smooth fields, resulting in a field capacity of 36 ha/h (89 ac/h). The Spra-Coupe was difficult to control on rough fields in third gear. Operation in second gear at 13 km/h (8 mph) was satisfactory for all field conditions giving a field capacity of 21 ha/h (51 ac/h).

Since the outer boom ends were unsupported, a large variation in boom height, with resultant irregular spray patterns, occurred on rolling fields. Nozzle distribution patterns were unacceptable at pressures below 345 kPa (50 psi) and above 460 kPa (67 psi). The most acceptable distribution patterns were obtained at 415 kPa (60 psi), however, it was not possible to obtain very uniform distribution patterns. As a result of the high nozzle pressure, spray drift was excessive. The nozzle tips were too small to apply the recommended water for commonly used herbicides. The 491 L (108 gal) supply tank was too small, requiring frequent filling when using larger nozzle tips. Nozzle wear during 73 hours of operation increased output by less than 2%. The nozzle check valves effectively prevented nozzle drip when the spray booms were shut off.

Pump capacity was adequate. Filtering was adequate and strainer plugging was infrequent. The pressure drop through the plumbing system to the booms was high, indicating flow restrictions. There was no pressure drop along the booms, indicating that boom size was adequate.

Controls were conveniently located but pressure adjustment was sensitive. Calibration was easily done by matching ground speed (gear) and nozzle pressure. Nozzle angle was easily adjusted but the boom height could not be changed. The boom lifting levers were convenient in avoiding obstacles. Transporting was convenient. Filling the supply tank was inconvenient and the tank lid leaked, spilling chemical near the operator. The operator's manual was well written and clearly outlined operation, maintenance service and calibration.

The Spra-Coupe did not turn readily in soft fields and when starting, the front wheel lifted off the ground. The Spra-Coupe was rough to ride with a partially full spray tank.

The engine had sufficient power for all field conditions encountered. Fuel consumption varied from 9 L/h (2 gal/h) in average fields to 18 L/h (4 gal/h) in soft fields. Noise at the operator's ear level was about 89 decibels (A scale).

Only minor mechanical problems occurred during the test: the original spray pump had been run dry and required replacement while pump drive belts broke twice.

Recommendations

It is recommended that the manufacturer consider:

1. Modifications to improve spray distribution.
2. Modifications to reduce spray drift.
3. Supplying higher capacity nozzles as standard equipment.
4. Modifications to allow the use of different types of nozzles.
5. Modifications to indicate actual nozzle pressure.
6. Modifications to decrease the sensitivity of the pressure adjustment.
7. Supplying a high capacity 100 mesh strainer at the tank filler opening.
8. Supplying a larger spray tank.
9. Modifications to improve handling, ride and stability.
10. Supplying a roll-bar and seat belts as standard equipment.
11. Supplying amber flashing transport lights.
12. Providing a parking brake.
13. Providing a safety interlock to prevent starting the engine with the transmission in gear.
14. Modifications to the tank lid to prevent chemical splashing near the operator.
15. Preparing the operator's manual in both SI and English units.
16. Modifications to increase spray pump drive belt life.

Chief Engineer: E.O. Nyborg
Senior Engineer: E.H. Wiens
Project Engineer: K.W. Drever

The Manufacturer States That:

With regard to recommendation number:

1. Melroe Engineering has run several tests on the Spra-Coupe and determined that our distribution pattern is very good. The only thing that we can determine from your report is that you have checked the spray pattern at 36 inches from the boom rather than at the recommended 28 to 30 inches. We set this spray boom at 36 inches because it is designed to spray crops in the range of six inches to nine inches from the ground.
   PAMI Note: Boom height was not adjustable and most Western Canadian crops are sprayed before they grow to a six or nine inch height.
2. Our tests have determined that at the reduced pressure of 40 psi and the correct distance from the spray nozzles we do have relatively good coverage. We also offer several different nozzles so that a proper gallonage per acre can be obtained at the lower pressure.
3. Melroe will not have a standard nozzle for the Spra-Coupe, but offer about five different nozzle sizes in different capacity

ranges. Therefore, the customer can order the nozzle to fit his needs.

4. The Melroe boom is not adjustable up and down any more than we can rotate the nozzle from the top of the boom to the bottom of the boom, but we do offer several different 730 nozzles for different gallonage per acre.
5. We are in the process of recalibrating our present Spra-Coupe and will compensate in our chart for the pressure drops across the valves and through the nozzle.
6. Along with the recalibration program we are looking at a different type of valve arrangement that will eliminate this problem.
7. Several companies do make strainers of this type. The request had not been made before this time, but it can be readily obtained.
8. Melroe has increased the size of the spray tank from 108 gallons to 126 gallons. We feel that the extra tank capacity and the pump are sufficient for most spraying applications and to increase it further would require a considerable amount of redesign.
9. We have had very good reports from the field on the ride, handling and stability of our present coupe. We were not aware that we did have this particular problem. It would also require a considerable amount of redesign to get more stability to the coupe because the weight distribution is very critical.
10. We do not know at this time of any requirements, federal or state, that do require a roll-over protection on the Spra-Coupe. This would require a considerable, amount of redesign. Melroe does supply a seat belt for the Spra-Coupe as optional equipment.
11. If this does become a requirement in Canada, we could supply a set of amber lights as optional equipment.
12. It would be very difficult to install a parking brake on our present Spra-Coupe, but future redesign will definitely incorporate a parking brake on the Spra-Coupe.
13. Melroe is not aware that this has been a problem and do not know of any governmental regulation that requires this.
14. We have recently released a new type of lid for the tank that seals much tighter than the old one and eliminates splashing through the cover.
15. We are aware that Canada has this requirement and we do have a program started to convert all of our decals, owner's manuals, etc. to SI units.
16. We have recently redesigned the shield that holds the belt on the pulley so that it does eliminate a considerable amount of the wear problem.

General Description

The Melroe model 103 Spra-Coupe is a self propelled, boom type sprayer. It is powered by a Volkswagen industrial engine through a four speed transmission. The Spra-Coupe is supported on three wheels. The rear wheels provide ground drive and the front wheel is used for steering. Conventional automotive controls are used.

The operator is located at the centre of the Spra-Coupe immediately in front of the 451 L (108 gal) polyethylene spray tank. The tank is equipped with hydraulic agitation and a liquid level indicator. The engine and booms are mounted at the rear. The Spra-Coupe has 21 nozzles spaced at 762 mm (30 in) resulting in a spraying width of 16,000 mm (52.5 ft). Nozzles are equipped with check valves to prevent boom drip when the boom control is shut off. The booms fold forward for transport. Spray controls are located on the right side of the instrument panel. The nylon roller pump is belt driven from the engine.

Figure 1 shows the flow diagram for the Spra-Coupe while complete specifications are found in Appendix I.

Scope of Test

The Melroe model 103 Spra-Coupe was operated for 73 hours in the conditions shown in Table 1 while spraying about 1629 ha (4027 ac). It was evaluated for quality of work, distribution patterns, nozzle wear, pump capacity, ease of operation, operator safety and suitability of the operator's manual.

Table 1. Operating Conditions

Chemical Applied	Hours	Speed		Spraying Rate		Field Area	
		km/h	mph	ha/h	ac/h	ha	ac
2, 4-D	49	13	8	21	51	1011	2499
Banvel/2, 4-D Mixture	168	13	8	21	51	330	816
2, 4-D		23	14	36	89	288	712
TOTAL	73					1629	4027

Results and Discussion

QUALITY OF WORK

Distribution Patterns: Distribution patterns using the LF 77-730 Delavan nozzles supplied with the sprayer were unacceptable unless extremely high pressures were used. Figures 2 and 3 show the spray distribution patterns along the length of the boom when operated at 140 and 415 kPa (20 and 60 psi) respectively. The coefficient of variation[1] at 140 kPa (20 psi) was 35% and application rates along the boom varied from 8 to 36 L/ha (0.7 to 3.2 gal/ac) at a forward speed of 8 km/h (5 mph). High application occurred below each nozzle with low application occurring between nozzles due to insufficient spray overlap. At 415 kPa (60 psi) the spray distribution improved due to improved spray overlap (Figure 3). The coefficient of variation was 12% and application rates varied from 24 to 41 L/ha (2.1 to 3.6 gal/ac). However at this pressure the spray drift hazard was high.

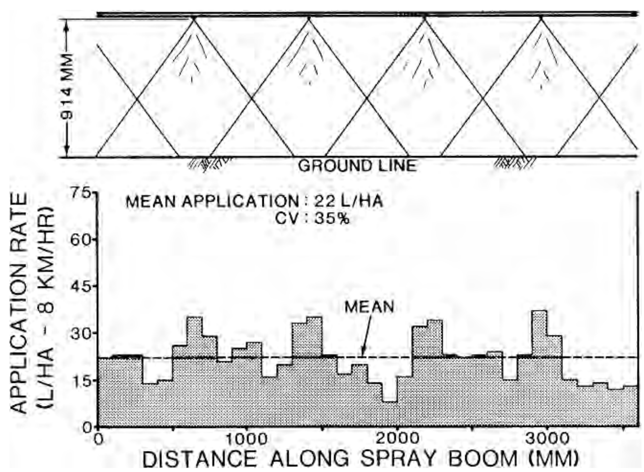


Figure 2. Distribution Pattern or a Section of Spray Boom at 140 kPa (20 psi) Pressure using LF 77-73° Nozzles, 914 mm (36 in) above the Ground.

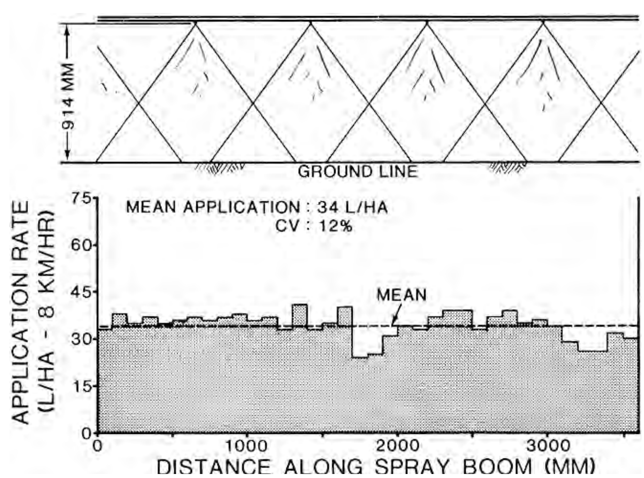


Figure 3. Distribution Pattern or a Section of Spray Boom at 415 kPa (60 psi) Pressure using LF 77-73° Nozzles, 914 mm (36 in) above the Ground.

[1]*The coefficient of variation (CV) is a measure of distribution pattern uniformity. The lower the CV, the more uniform is the spray coverage. Some researchers claim that a CV below 10% indicates very uniform coverage while a CV above 15% indicates inadequate uniformity of coverage for chemicals having a narrow range of application rates. The CV 's shown in this report were determined in stationary laboratory trials. Field trials have shown that the CV in actual .eld conditions may be up to 10% higher than that obtained in stationary tests due to boom vibration and wind effects. Manufacturer recommendations for different chemicals vary as to the acceptable range of application rates. For example, 2,4-D solutions have a fairly wide range of acceptable rates (±14%) while chemicals such as Buctril M have a very narrow acceptable range.*

Figure 4 shows the spray pattern uniformity at various pressures. Spray patterns were unacceptable at pressures below 345 kPa (50 psi) or greater than 460 kPa (67 psi). The best distribution pattern was obtained at 415 kPa (60 psi) but a very uniform distribution could not be obtained with the Spra-Coupe. Modifications are required to improve spray distribution.

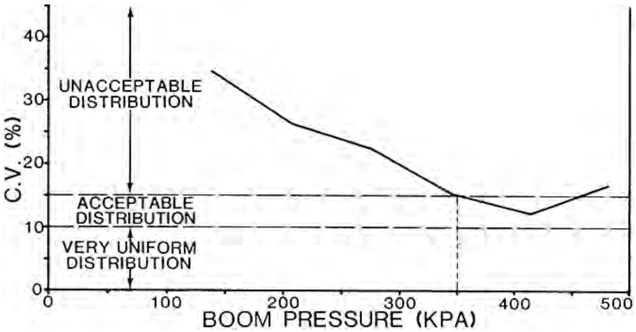


Figure 4. Spray Pattern Uniformity at Various Nozzle Pressures.

Spray Drift: Work by the Saskatchewan Research Council[2] indicates that drift from the Spra-Coupe was 5% of the material sprayed or greater, depending on wind conditions, at 280 kPa (41 psi) pressure. To obtain an acceptable spray distribution with the Spra-Coupe, a pressure of 345 kPa (50 psi) or higher was required (Figure 4). At this pressure, smaller droplets would be produced, resulting in expected spray drift greater than 5%. The Spra-Coupe boom height was higher than most conventional trailed sprayers, which would also contribute to increased spray drift.

Nozzle Calibration and Wear: Figure 5 compares the delivery rates of the Delavan LF 77-730 brass nozzles when new and after 73 hours of operation. Nozzle deliveries when new were similar to the manufacturer's rated capacity. Nozzle wear during the field operation caused the output of the nozzles to increase by 1.6%. Some researchers indicate that a nozzle needs replacement once delivery has increased by more than 10%. Nozzle wear depends on the type of chemicals sprayed and water cleanliness.

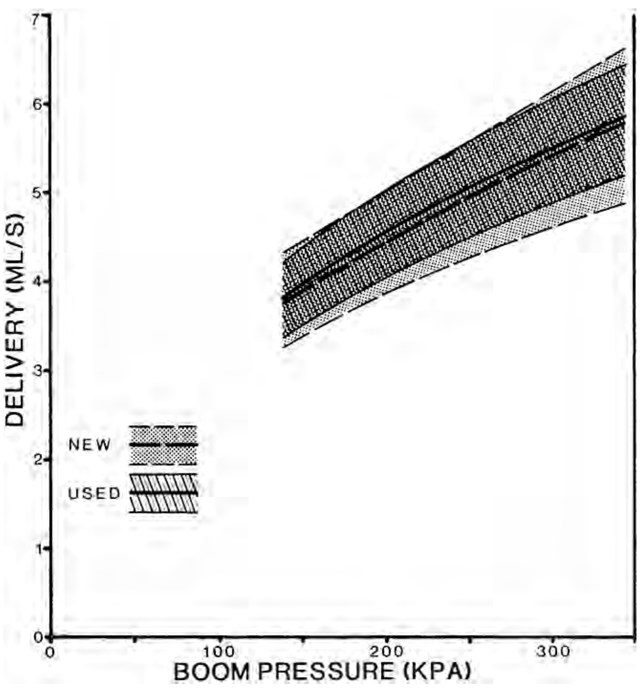


Figure 5. Delivery Rates of Delavan LF 77-73° Nozzles New and Used 73 Hours.

Figure 5 shows the variability among individual nozzles. The shaded areas represent the range over which the deliveries from 10 nozzles varied when new and after field tests. A narrow range indicates that nozzle discharges are very similar while a wider range indicates more variability among individual nozzle deliveries. Variability among individual nozzle deliveries on the Spray-Coupe was high. The coefficient of variation of the nozzle deliveries was 7.1% when new but decreased to 5.3% after field tests.

Application Rates: Figure 6 shows the range of application rates that were possible using the Delavan LF 77 730 nozzles, supplied with the Spra-Coupe, over a pressure range from 138 to 414 kPa (20 to 60 psi). It also shows the normally recommended range of water application rates for commonly used herbicides on the prairies. Delivery from the nozzles was too low to apply sufficient water in all cases. The maximum application rate was 37 L/ha (3.3 gal/ac) in first gear with lower rates at higher operating speeds. The range of application rates recommended for most herbicides used on the prairies is 45 to 170 L/ha (4 to 15 gal/ac). It is recommended that the manufacturer supply higher capacity nozzles as standard equipment so that application rates are within the recommended range. The higher capacity nozzles would have the added advantage of less spray drift since droplet size would be larger.

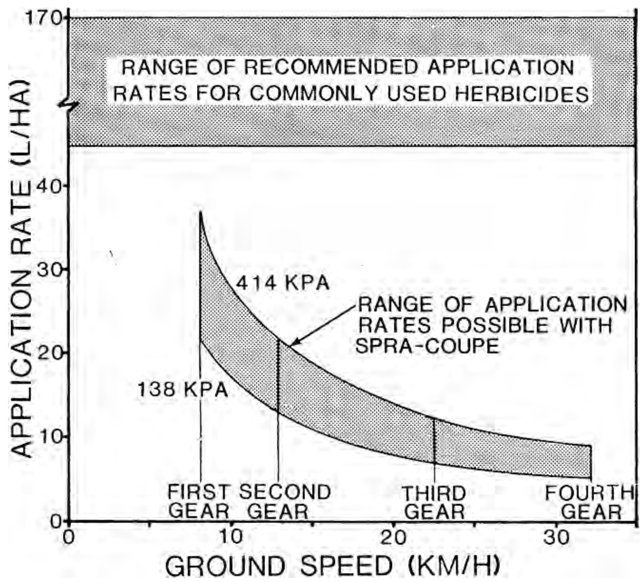


Figure 6. Application Rates for the Spra-Coupe using Delavan LF 77- 73° Nozzles.

Use of Optional Nozzles: The nozzle assemblies (Figure 7) accepted a wide range of nozzle tips. Nozzle angle was adjustable from 900 ahead to 900 back so nozzle spray could be directed at any desired angle. Nozzle height was not adjustable. Only a limited selection of nozzle types was possible due to improper spray overlap that would occur with nozzles different than 73° flat fan nozzles.

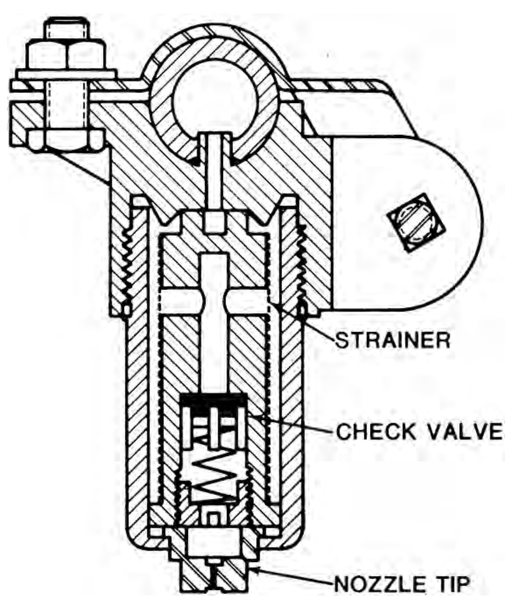


Figure 7. Cross Section of Nozzle.

[2]*Maybank, J, Yoshida, K., Shewchuk, 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 number P76-1, January, 1976, p.20.*

Booms: The Spra-Coupe was driven over a series of standard obstacles to determine boom stability. The obstacles were semi circular in cross section with lifts of 40, 65 and 105 mm (1.6, 2.6 and 4.1 in). The Spra-Coupe was driven over the obstacles at full throttle in first, second and third gear, at speeds of 8, 13 and 23 km/h (5, 8 and 14 mph). Horizontal boom movement in the direction of travel and vertical boom movement were measured at the boom end and at the centre of the sprayer.

Figure 8 shows vertical boom movement (bounce) at the end of the boom when the Spra-Coupe was driven over the obstacles at 13 km/h (8 mph). The maximum movement at the end of the boom was a lift of 140 mm (5.5 in) and a drop of 110 mm (4.3 in). This resulted in a variation in boom height above the ground from 1054 mm (41.5 in) to 804 mm (31.7 in) compared to the correct boom height of 914 mm (36 in). Figure 9 compares the nozzle overlap at these three boom heights.

The lift and drop at the centre of the boom were about half that at the boom end when travelling over the small and medium sized obstacles. When going over the large obstacles, boom movement was about the same as at the end. Operation in first gear caused vertical boom movements similar to those in second gear. Driving over the obstacles in third gear resulted in boom movements about half as large.

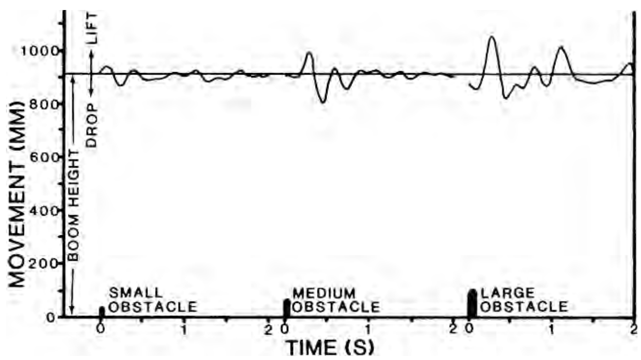


Figure 8. Vertical Boom Movement at Boom End (lift and drop) when the Spra-Coupe was Driven over Different Obstacles at a Forward Speed of 13 km/h (8 mph) (second gear).

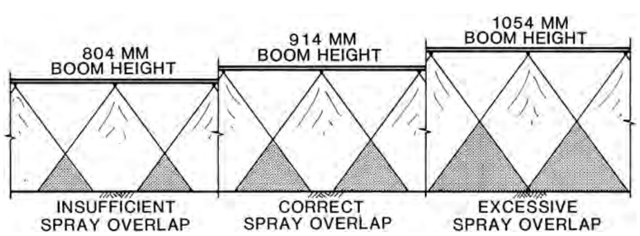


Figure 9. The Effect of Boom Lift and Drop on Spray Overlap.

Driving over an obstacle with the Spra-Coupe also caused the forward speed of the boom to vary in relation to the operating speed, since the boom initially deflects rearward and then springs forward. Figure 10 shows the forward speed of the boom end relative to the ground when the Spra-Coupe was driven over the standard obstacles. Boom forward speed is important since application rate is inversely proportional to speed (doubling the forward speed cuts the application rate in half). Assuming that the nozzle spray follows boom movement, the traces of speed illustrate the resultant variation in application rates. High application rates occur at low speeds and low application rates occur at high speeds. Extremely high variations in application rates can result for short periods of time due to horizontal boom movement. For example, driving over the 65 mm (2.5 in) obstacle at a forward speed of 13 km/h (8 mph) caused boom speed to vary from 7 to 19 km/h (4.4 to 11.8 mph). Respective application rates would vary from 34 to 2 L/ha (3 to 0.2 gal/ac). This variation occurred in only 0.16 second during which time the sprayer travelled 580 mm (23 in). Speed changes due to horizontal boom movement were very similar on the Spra-Coupe in first, second and third gear. This caused the percentage speed changes to be less at the higher operating speeds. This, combined with the smaller vertical boom movements measured in third gear leads to the conclusion that operation of the Spra-Coupe at higher speeds results in less boom movement. However, on rough ground the Spra-Coupe was difficult to control at higher speeds.

The data presented in Figure 10 are based on the assumption that the nozzle spray output follows boom movement over very short periods of time (0.16 second). The extreme variations in applications that are suggested due to boom movement indicate that more research is required on boom stability and its effect on nozzle discharge and spray distribution.

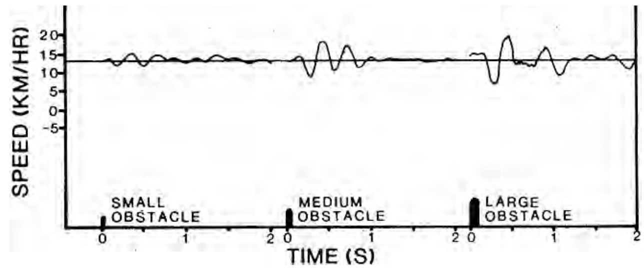


Figure 10. Variation in Boom End Speed when the Spra-Coupe is Driven over Different Obstacles at an Average Forward Speed of 13 km/h (8 mph) (second gear).

Operation of the Spra-Coupe on rolling land resulted in large variations in boom height. Operation on a side slope caused the ends of the boom to be close to the ground (Figure 11) resulting in insufficient overlap of the spray pattern.

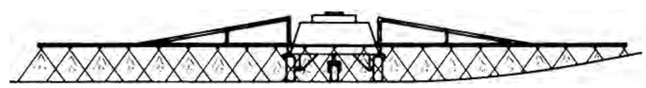


Figure 11. Variation of Boom Height on Side hills.

Pressure Losses in Plumbing System: Pressures in the plumbing system were measured at the pump outlet, boom control, boom inlet and boom end using four sets of nozzle tips capable of application rates ranging from 30 to 300 L/ha (2.7 to 26.7 gal/ ac) operating in first gear at 8 km/h (5 mph). The same nozzles operating in third gear at 23 km/h (14 mph) would apply chemicals over an application rate range from 11 to 107 L/ha (1 to 9.5 gal/ac).

Figure 12 shows the pressures at the various locations when applying 30 to 300 L/ha (2.7 and 26.7 gal/ac) at 8 km/h (5 mph) at a boom control valve pressure of 275 kPa (40 psi). The pressure at the pump outlet was 620 kPa (90 psi). The high pressure at the pump outlet occurred at all pressure settings and with different nozzle sizes. High pump pressure was due to flow restrictions caused by the agitator and meter valves (Figure 1). This did not affect the calibration of the Spra-Coupe but it reduced pump output.

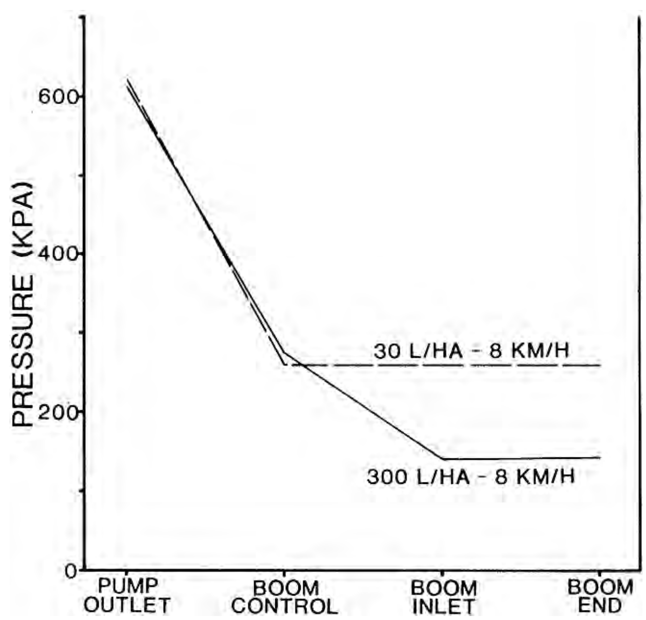


Figure 12. Pressure Losses through the Plumbing System Applying 300 and 30 L/ha (26. 7 and 2.7 gal/ac) in First Gear.

With 30 L/ha (2.7 gal/ac) low capacity nozzles, pressure losses from the boom control valve to the booms were small. With 300 L/ha (26.7 gal/ac) high capacity nozzles, pressure losses from the control valve to the boom were up to 170 kPa (25 psi), which affected calibration and nozzle distribution patterns. In addition, there was a 41 kPa (6 psi) pressure drop across the nozzle check valves.

Figure 13 shows the pressure losses from the control valve gauge to the nozzles at various application rates in each gear. For example, application at 100 L/ha (8.9 gal/ac) in third, second and first gears resulted in corresponding pressure losses of 170, 105 and 65 kPa (25, 15 and 9 psi) from the control valve to the nozzles. At lower application rates such as 50 L/ha (4.5 gal/ac) the pressure losses were 95, 54 and 45 kPa (14, 8 and 7 psi). For accurate calibration and proper distribution patterns, pressures at the boom control should be set higher by amounts indicated on Figure 12. Modifications are required so that actual pressure is known.

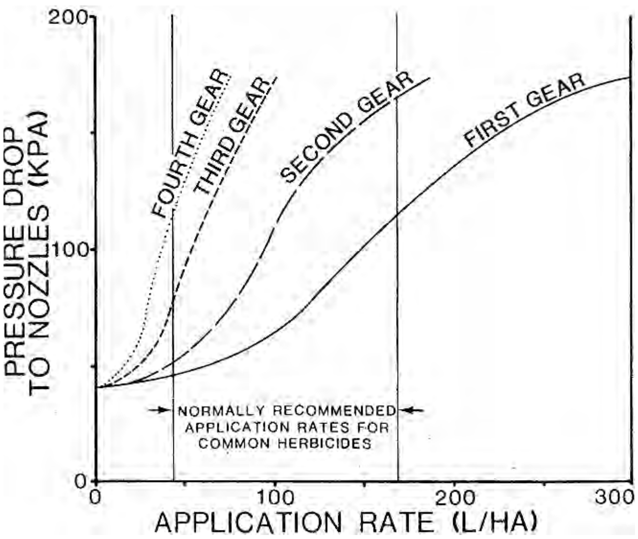


Figure 13. Pressure Losses from the Control Valve to the Nozzles at Various Application Rates and Operating Speeds.

Pressure drops from one end of the boom to the other were negligible with all sizes of nozzles (Figure 12), indicating adequate boom size.

Pressure Gauge: The pressure gauge read 14 kPa (2 psi) high throughout the test. This was insignificant compared to the pressure losses from the boom control to the nozzles.

The pressure gauge was calibrated only in psi. Due to the present changeover to the SI (metric) system, a pressure gauge calibrated in both psi and kPa or suitable conversion tables should be supplied with the sprayer.

Tank Filler Strainer: No strainer was provided at the tank opening. A fine (100 mesh) high capacity strainer would be desirable to strain out foreign particles before they enter the tank.

Line Strainer: The 80 mesh screen in the line strainer adequately removed most abrasive materials that could damage the pump. The plastic strainer bowl was conveniently removed for cleaning without tools.

Nozzle Strainers: The 80 mesh nozzle strainers prevented nozzle plugging. The check valves located in the nozzle strainers (Figure 7) stopped boom drip when the boom control valve was shut off.

Soil Compaction and Crop Damage: The sprayer wheels travelled over approximately 2.5% of the total field area sprayed. The soil contact pressure was very similar to that of an unloaded pickup truck, and would probably cause some crop damage. The average soil contact pressure under the sprayer wheels, with a full tank, are given in Table 2.

Table 2. Soil Compaction by Sprayer Wheels

	Average Soil Contact Pressure[3] With Tank Full		Tire Track Width	
	kPa	psi	mm	in
Front Wheels	172	25	102	4.0
Rear Wheels	234	34	150	5.9

[3]*For comparative purposes an unloaded pickup truck has an approximate soil pressure of 207 kPa (30 psi).*

PUMP CAPACITY

Agitation Capacity: The pump, when new, delivered 1.08 L/s (14.2 gal/min) at 1270 rpm pump speed (full engine throttle) throughout the normal operating pressure range (Figure 14).

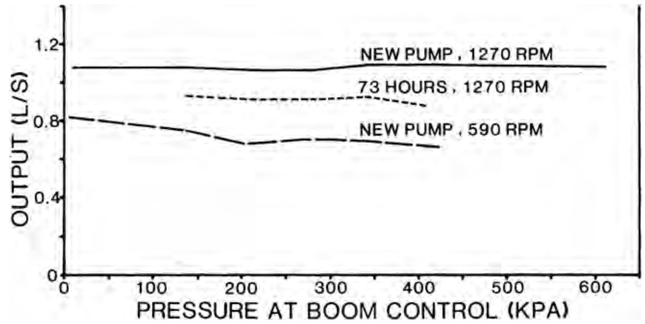


Figure 14. Pump Curves.

Table 3 shows the maximum rates of emulsifiable concentrates and wettable powders that the Spra-Coupe pump could apply and still provide sufficient agitation[4] to keep solution in the tank properly mixed. It also shows the maximum application rates if a 20% pump wear allowance is assumed.

The table shows that pump capacity was adequate for tank agitation and applications over 225 L/ha (20 gal/ac) in first gear and 56 L/ha (5 gal/ac) in fourth gear. This is a very suitable range for herbicides currently used on the prairies.

Table 3. Pump Capability - Maximum Application Rates

	Application Rate							
	Emulsifiable Concentrates				Wettable Powders			
	New Pump		20% Pump Wear		New Pump		20% Pump Wear	
Gear	L/ha	gal/ac	L/ha	gal/ac	L/ha	gal/ac	L/ha	gal/ac
First 8 km/h (5 mph)	266	23.7	217	19.3	233	20.7	182	16.2
Second 15 km/h (8 mph)	166	14.8	135	12.0	145	12.9	115	10.2
Third 23 km/h (14 mph)	95	8.5	78	6.9	83	7.4	65	5.8
Fourth 32 km/h (20 mph)	66	5.9	54	4.8	58	5.2	46	4.1

Operation at Reduced Speed: Figure 14 shows that reducing pump speed from 1270 rpm (full engine throttle) to 590 rpm (half throttle) resulted in a 36% reduction in pump capacity. Reduction in pump speed could occur when reducing speed to turn a corner or when operating at reduced engine speed to obtain a correct ground speed to suit nozzle calibration.

Pump Wear: Pump capacity decreased by 17% after the 73 hours of field operation. Pump wear depends on the type of chemicals sprayed and abrasive materials in the water.

ENGINE

Power: The engine had sufficient power for all types of normal spraying operations.

Fuel Consumption: Fuel consumption varied from 9 L/h (2 gal/h) in average fields to 18 L/h (4 gal/h) in soft fields.

EASE OF OPERATION

Calibration: The Spra-Coupe was conveniently calibrated by matching gear selection and pressure indicated on the calibration chart supplied by the manufacturer. The calibration charts were in error due to pressure losses between the control valve and the booms.

Controls: The Spra-Coupe was controlled with a steering wheel. Throttle, brake and clutch controls were the standard automotive type. The gear shift was conveniently located.

Location of spray controls was convenient. Flow of chemicals to the booms was controlled with one lever. Pressure and agitation

[4]*Normally recommended agitation rates for emulsifiable concentrates such as 2,4-D are 0.03 L/s per 100 L of tank capacity (1.5 gal/min per 100 gal of tank capacity). For wettable powders such as Atrazine and Sevin, recommended agitation rates are 0.05 L/s per 100 L of tank capacity (3.0 gal/min per 100 gal of tank capacity).*

were controlled with two variable orifice valves (Figure 1). These valves were inconvenient to set since pressure adjustment was very sensitive. A small movement of the agitator or the meter control lever resulted in a large change in pressure. It is recommended that modifications be made to make pressure adjustment less sensitive.

At the start of the evaluation, there was interference between the accelerator control rod and the pump control lever (Figure 15). New holes were drilled and the pump control lever was moved left to eliminate interference.

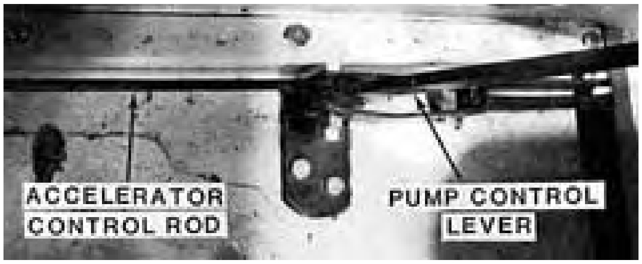


Figure 15. Interference Between Pump Lever and Throttle Rod.

Maneuverability and Handling: The Spra-Coupe was easy to handle in first, second or third gear on smooth fields. On rough fields, the front wheel bounced excessively in third gear causing steering difficulty. When turning in soft ground the front wheel skidded unless speed was reduced. Modifications are required to improve steering. Ride was rough with a partially full spray tank. Operation at higher speeds improved the ride but increased handling problems. Modifications to improve ride are desirable.

Boom Levers: The levers for lifting the booms were convenient in avoiding field obstacles. The boom end had a breakaway feature to prevent serious damage if it struck an object.

Transport: The Spra-Coupe could be folded into transport by one man in five minutes. Mounting the sprayer in transport position was awkward since the operator had to climb over the booms (Figure 16).

Figure 16. Awkward Mounting in Transport.

The Spra-Coupe transported well at its maximum speed of 32 km/h (20 mph). For transporting at higher speeds a tow hitch was provided. The rear axle chains had to be removed to tow at speeds above 32 km/h (20 mph).

Spray Tank: The 491 L (108 gal) spray tank was too small. Frequent filling of the tank was required if recommended water application rates were followed. For example, applying 112 L/ha (10 gal/ac) in second gear would require a tank refill every 13 minutes. A larger tank would be desirable to minimize frequent stops while spraying.

The 206 mm (8 in) opening was adequate for adding chemicals and water. The tank filler opening was 1820 mm (6.0 ft) above ground, which was high for filling by gravity from a nurse tank on a farm truck. This also made it awkward for adding chemicals. Modifications to make tank filling more convenient would be desirable.

Nozzle Adjustment: Nozzle angle was easily adjusted without the use of tools by rotating the nozzle assembly (Figure 7). Nozzle height was not adjustable. The boom could be levelled by adjusting the nut at the top of the spring loaded boom support.

Nozzle Cleaning: The nozzle assemblies could be removed for cleaning without the use of tools.

Servicing and Cleaning: The Spra-Coupe was convenient to service. Grease fittings were accessible except for the fitting located on the front wheel fork shaft. The tank was easy to drain by removing a plug at the back of the sprayer.

OPERATOR SAFETY

Stability: There was a tendency for the front wheel to lift off the ground when starting out in the field. More weight on the front wheel is required.

It is recommended that the manufacturer supply a roll bar and seat belt as standard equipment to minimize operator injury if the machine should upset.

On-Road Visibility: The Spra-Coupe was equipped with headlights, a taillight, a slow moving vehicle sign and rear reflectors on the fenders. It is recommended that the manufacturer consider supplying amber flashing lamps complete with turn signals to make the sprayer more visible on highways and roads.

Parking Brake: The Spra-Coupe was not equipped with a parking brake. This was a hazard when parking on a slope. A parking brake should be supplied as standard equipment.

Safety Interlock: The ignition switch was accessible from the ground and it was possible to start the engine with the transmission in gear. It is recommended that a safety switch be installed as standard equipment so that the engine cannot be started when the transmission is in gear.

Caution: Operators of all spraying equipment are cautioned to wear suitable eye protection, respirators and clothing to minimize operator contact with the chemical.

Although many commonly used agricultural chemicals appear to be relatively harmless to humans, they may be quite 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.

Location of Operator: The operator was located immediately ahead of the sprayer tank and booms. Spray drift from the rear would expose the operator to the chemical. The tank lid leaked when the tank was full, causing chemical to splash near the operator. A better tank lid seal is required.

Noise: The total noise at operator ear level was about 89 decibels (A scale) when spraying on flat fields at full engine speed. According to current operator exposure recommendations, this level is not expected to cause any permanent hearing impairment for eight hours of operation per day, or less.

OPERATOR'S MANUAL

The well illustrated operator's manual clearly outlined operation, maintenance, servicing and calibration of the Spra-Coupe. The operator's manual was prepared only in US units. It is recommended that the manual be prepared in Imperial and SI (metric) units.

Durability Results

Table 4 outlines the mechanical history of the Spra-Coupe during the 73 hours of field operation while spraying about 1629 ha (4027 ac). The intent of the test was evaluation of functional performance. The following failures represent only those, which occurred during the functional testing. An extended durability evaluation was not conducted. Consider each failure separately since some are not as serious as others.

Table 4. Mechanical History

Item	Hours	Hectares	Acres
Plumbing Assembly			
-the spray pump wore out and was replaced at	5	113	276
-the spray pump drive belt broke and was replaced at	6, 71	134, 1585	331, 3917
-the line strainer gasket expanded slightly and would not seat properly at		end of test	
-some wear on the pump hoses was evident at		end of test	
Chassis Assembly			
-the rubber dust seal on the brake cylinder had deteriorated at	51	1139	2813
-the left boom clamp was lost and replaced at	51	1139	2813
-the left cable hook was missing at		end of test	
-the right cable hook was bent at		end of test	
-the right rear motor mount bolt was missing at		end of test	

Discussion of Mechanical Problems

PLUMBING ASSEMBLY

Pump: The pump was ruined near the beginning of the test. Severe wear was evident on the rollers and pump housing (Figure 17). The wear was attributed to operation of the pump when dry. The pump was replaced and no further problems were encountered.

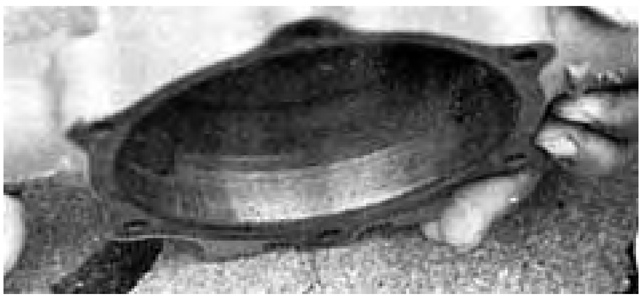


Figure 17. Worn Pump.

Pump Drive Belt: The drive belt on the pump broke twice during the test. This was caused by the belt wearing on the engine drive pulley while the pump was disengaged. Modifications are, required to eliminate belt wear when the pump is disengaged.

Hoses: The hoses were worn slightly due to rubbing against the motor shroud (Figure 18). The hoses could be re routed to eliminate this problem.

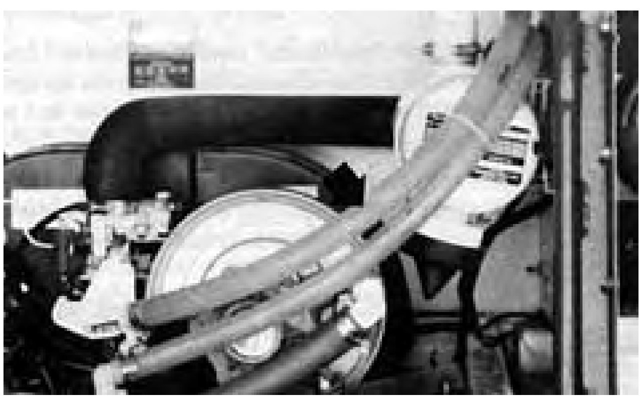


Figure 18. Worn Hoses.

CHASSIS ASSEMBLY

Cable Hooks: The cable hooks (Figure 19) were damaged because operators neglected to unhook the cable when unfolding the booms to field position.

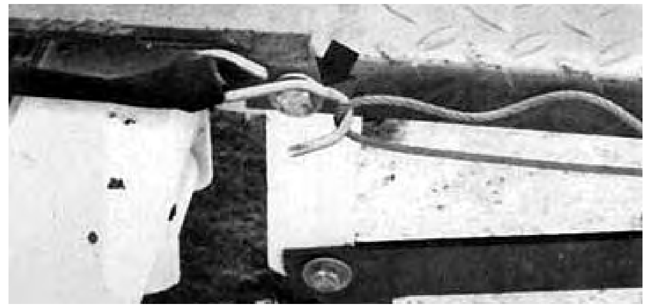


Figure 19. Cable Hooks.

APPENDIX I
SPECIFICATIONS

Model:	Melroe Spra-Coupe Model 103	
Serial Number:	M13 6774	
	Field Position	**Transport Position**
Overall Width:	15,430 mm (50.6 ft)	2455 mm (8.1 ft)
Overall Length:	4750 mm (15.6 ft)	5160 mm (16.9 ft)
Overall Height:	1820 mm (6.0 ft)	1820 mm (6.0 ft)
Wheel Base:	3048 mm (10.0 ft)	
Wheel Tread:	2185 mm (7.2 ft)	
Tire Size:	front - 1, 600 x 13, 2-ply, smooth rear - 2, GR 78 x 15, 4-ply, smooth	
Weights: (field position) including operator [95 kg (210 lb)] and full tank of fuel.		
	Tank Empty	**Tank Full**
-- front wheel	204 kg (450 lb)	240 kg (530 lb)
-- left wheel	435 kg (960 lb)	671 kg (1480 lb)
-- right rear wheel	440 kg (970 lb)	680 kg (1500 lb)
TOTAL	1079 kg (2380 lb)	1591 kg (3510 lb)
Spray System:		
-- spray tank	material - polyethylene capacity - 491 L (108 gal)	
-- strainers	line strainer - 80 mesh nozzle strainer - 80 mesh c/w check valves	
-- pump	Hypro model C7560 nylon roller (1270 rpm at full throttle)	
-- agitation	hydraulic pressure	
-- gauge	Marshalltown (0 - 160 psi)	
-- booms	1/2 inch nylon hose	
-- nozzles	Delavan LF 77-730 brass) number - 21 spacing - 762 mm (30 in)	
-- spraying width	16,002 mm (52.5 ft)	
-- boom adjustment	height - 914 mm (36 in) not adjustable nozzle angle - 1800 (horizontal ahead to horizontal rearward)	
Suspension:	coil springs and shock absorber suspension	
Engine:		
-- make	Volkswagen industrial air cooled	
-- serial number	068164	
-- type	125 A, 4 cylinders horizontal opposed	
-- bore	853 mm (3.36 in) stroke: 691 mm (2.72 in)	
-- displacement	1584 cc (96.66 in^3)	
-- compression ratio	7.5:1	
-- output	39.5 kW (53 hp) at 3 800 rpm	
-- fuel	regular gasoline, 83-90 octane	
-- fuel tank capacity	39.8 L (8.75 gal)	
-- engine oil capacity	2.4 L (2.1 qt)	
-- air cleaner	dry cartridge type with condition indicator	
-- electrical system	12 volt	
-- lubrication	force fed by gear pump	
Transmission:		
-- type	heavy duty, synchromesh, 4 speeds forward plus reverse transmission -- oil capacity 2.5 L (2.2 qt)	
-- final drive	1:3 ratio, chain sprockets and roller chain running in oil	
-- speed ranges	8.0, 12.9, 22.5 and 32.2 km/h (5, 8, 14 and 20 mph)	
Instruments:	hour meter, electric fuel gauge, key ignition switch, generator, warning light, oil pressure warning light, liquid pressure gauge, light switch.	
Lubrication Points:		
-- final drive	6	
-- tie rod	2	
-- front wheel fork shaft	1	

APPENDIX II
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

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

APPENDIX III
METRIC CONVERSIONS

In keeping with the intent of the Canadian metric conversion program, this report has been prepared in SI units. For comparative purposes, the following conversions may be used:

1 hectare (ha)	= 2.47 acre (ac)
1 litre per hectare (L/ha)	= 0.09 Imperial gallon per acre (gal/ac)
1 kilopascal (kPa)	= 0.15 pound per square inch (psi)
1 kilometre per hour (km/h)	= 0.62 mile per hour (mph)
1 kilowatt (kW)	= 1.34 horsepower (hp)
1 litre per second (L/s)	= 13.20 Imperial gallons per minute (gal/min)
1 metre (m) = 1000 millimetres (mm)	= 39.37 inches (in)
1 litre (L)	= 0.22 Imperial gallon (gal)

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