Alberta Farm Machinery Research Centre

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Evaluation Report 736

Spra-Coupe Model 3630 High Clearance Field Sprayer

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

MANUFACTURER AND DISTRIBUTOR:

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RETAIL PRICE: $ 76,900.00 December 1996 (f.o.b. Lethbridge, AB)

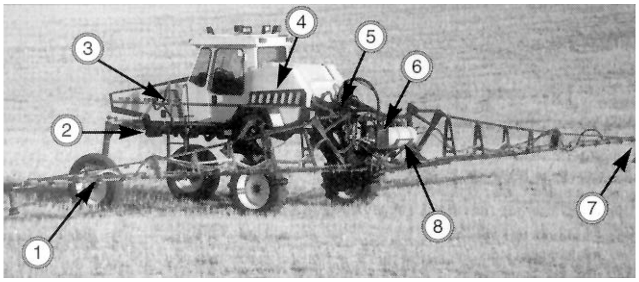

Figure 1. Spra-Coupe Model 3630 High Clearance Field Sprayer: (1) Speed Sensor, (2) Reload Line and Pump, (3) Engine, (4) Spray Tank, (5) Agitation and Tank Shut-off Valves, (6) Flow Sensor and Electric Boom Shut-off Valves, (7) Foam Discharge Tubes and (8) Richway Foam Marker System.

SUMMARY AND CONCLUSIONS

RATE OF WORK

Operating the sprayer between 4.3 and 20 mph (7 and 32 km/h) resulted in instantaneous work rates between 32 and 145 ac/h (13 and 59 ha/h). At application rates of 5 and 10 gpa (55 and 110 L/ha), 50 and 25 ac (20 and 10 ha) was sprayed with a full tank, respectively.

QUALITY OF WORK

Application rates were accurate within 1% of actual when the Spra-controller speed and flow sensors were calibrated. Calibrating the magnetic speed sensor required the sprayer be driven in a straight line for 10 wheel revolutions. The speed calibration number was 168 in most of the field conditions encountered during testing. Calibrating the flow sensor was done by measuring the flow from several nozzles. The average delivery of the nozzles measured multiplied by the number of nozzles on the sprayer was the total sprayer flow rate. The Spra-controller stabilized the application rate within 4 seconds when spraying speed changed. The Spra-controller kept application rates constant from 8 to 20 mph (13 to 32 km/h) resulting in spraying pressures from 10 to 80 psi (70 to 550 kPa). Nozzle pressures were kept above 15 psi (100 kPa) and spraying speeds above 9 mph (14 km/h) to ensure adequate spray coverage.

Delivery from Spraying Systems Turbo TeeJet (TT) 110º plastic nozzles were within 5% of Spraying Systems rated output. Variability (CV) among individual nozzle deliveries was less than 2%, indicating the deliveries from each nozzle tip tested was similar. Acceptable spray patterns occurred (CV's below 15%) at nozzle heights above 10 in (250 mm) and nozzle pressures above 15 psi (100 kPa). After some use, the spray patterns from the TT11002 nozzles looked streaky. The nozzles could be used for 300 to 400 hours before the spray pattern uniformity (CV's) measured above 15%. At 400 hours, the turbo TeeJet nozzles should be replaced.

In 12 mph (20 km/h) crosswinds, airborne spray drift was 15, 8 and 8% from the Extended Range TeeJet XR11002, drift guard TeeJet DG11002 and wide angled Turbo TeeJet TT11002 nozzles, respectively. The nozzles were operated at 40 psi (275 kPa) and a height of 24 in (600 mm) above the target. Forward speed was 20 mph (30 km/h) giving an application rate of 2.5 gpa (28 L/ha). For comparison, airborne spray drift from a conventional sprayer using the DG11002 nozzles applying 10 gpa (110 L/ha) at 5 mph (8 km/h) was only 2.1% in 12 mph (20 km/h) crosswinds. Operating sprayers at a high speed and high spray boom heights resulted in more spray drift.

Pressure losses across the boom were less than 1 psi (7 kPa). The mechanical pressure gauge and its pressure source indicated the actual nozzle pressure to within 3 psi (20 kPa) when operating the sprayer pressure and flow rate below 60 psi (400 kPa) and 20 gpm (90 L/min), respectively. With 36 nozzles on 60 ft (18 m) of a wet boom, spraying flow rates were normally less than 20 gpm (90 L/min) when applying 5 and 10 gpa (55 and 110 L/ha) at 14.4 mph (23 km/h).

Strainers prevented nozzles from plugging. Using Turbo TeeJet nozzles also prevented nozzle plugging since the nozzle orifices were larger. The agitator jet nozzles plugged frequently since the boom inlet line strainer was located after the agitator lines.

A suspension system on the sprayer wheels and boom truss reduced boom bounce and horizontal boom movement in rough fields. The horizontal boom suspension system weakened making the booms move rearwards at high spraying speeds. The spring on the horizontal suspension system was replaced preventing adverse horizontal boom movement.

Crop damage spraying post emergent cereals was insignificant.

EASE OF OPERATION AND ADJUSTMENT

Operator comfort was very good. The cab was quiet and had plenty of room for most operators. The cab air and charcoal filters effectively filtered dust and chemical fumes. The cab pressurization system helped reduce dust leak. The heating and air-conditioning system provided adequate cab temperatures in all operating conditions. The seat and steering column were adjustable to suit most operators. The operator had a clear view forward and to the sides when spraying. Boom and nozzle visibility during spraying was good. Visibility of the wheels was limited. In transport position, visibility to the sides and rear was mainly between the boom structural members. The rear view mirror was inside the cab and did not improve rear visibility.

Instrumentation was good. All instruments were useful, easy to see, read and conveniently located. The instrument panel included gauges for engine oil pressure, coolant temperature, engine hours, engine speed and fuel level, and warning lights for the parking brake, alternator, glow plugs and transmission temperature. The nozzle pressure gauge was outside the cab.

All Spra-Coupe controls were easy to reach from the operator's seat and rated as good. The boom, pump, marker and spray controls used mostly during spraying were conveniently contained together on the side console and easy to use. The boom ends lifted quickly to avoid obstacles. Although clearly marked, the boom folding controls were hard to identify at a glance and occasionally the wrong boom control was started. The spray tank shut-off valve and agitator valves were not controlled from the cab. To completely empty the spray tank during spraying, the agitator valves needed to be shut. The operator had to stop spraying and get off the sprayer to adjust the agitator valves. Gear shifting was easy and smooth even at full throttle. The engine speed was controlled with the hand throttle a majority of the time.

Ease of operating Raven's spray monitor (Spra-controller) was good after the operator's manual was studied and some practice exercised. The Spra-controller was built into the sprayer's dash. The left display showed the application rate only. The right display showed one function or calibration data at a time. The rate switch allowed a quick choice between two application rates or manual mode. Manual mode was useful to keep pressure from falling below acceptable levels. Entering the type of speed sensor or system of units (Imperial, Metric or US) used was inconvenient. The monitor memory had to be cleared by disconnecting the power to the console. Any time the controller memory was cleared the eight calibration numbers needed to be re-entered. During the test the monitor memory cleared unexpectedly several times. Why this occurred was never solved.

Sprayer lighting for transport was very good; however, for night spraying lighting was fair, even with the optional flood lights. The flood lights were adequate to illuminate the spray booms and the foam mark. The flood lights were not adequate for long range front lighting necessary for night spraying at speeds above 10 mph (16 km/h).

Ease of adjusting application rates was fair. Standard nozzles and single nozzle body assemblies were supplied with the Spra-Coupe. Changing application rates involved removing one set of nozzles and putting on another. Spraying Systems triple nozzle assemblies were installed to change application rates quicker. Ease of adjusting application rates was very good using Turbo TeeJet nozzles and triple nozzle body assemblies. Changing rates was quicker using triple nozzle body assemblies. The Spra-controller allowed changing to another application rate that was within 20% of the first using the same nozzle size. The Turbo TeeJet nozzles allowed the two rates to be greater than 20% different. Applying the correct application rate still depended on calculating or selecting the proper size of nozzle, pressure and speed.

Ease of wheel adjustments was fair. Adjusting the wheel tread on both axles took two people about four hours. A hoist and high jack stands were needed to raise the wheels off the ground safely. The rear wheel tread was easily adjusted by relocating a pin on the rear axle adjustment bracket. Adjusting the front wheel tread took more time. The front wheel toe-in was adjusted each time the front wheel tread was changed.

Ease of sprayer handling was fair. When coming over the top of a hill, out of a gully or rough ground, the steering response appeared slow. The sprayer was stable in the field and road with an empty or full spray tank at all speeds. The widest wheel tread provided more stability when spraying on hillsides. The sprayer travelled well at all speeds. The maximum speeds in the various gears were appropriate for spraying, with most spraying done in fourth gear. The sprayer towed well and was stable at tow speeds up to 50 mph (80 km/h). The manufacturer recommends highway tires for towing at higher speeds. The brakes were effective.

Ease of boom positioning was good allowing reloading from a central location. The sprayer booms were folded into partial transport position in less than 10 seconds and usually done while driving forward. In partial transport, the boom ends were not folded and extended about 11.5 ft (3.5 m) in front of the sprayer. Folding the sprayer booms from field to full transport position for longer transport required alternating tasks inside and outside the cab. Although getting in and out of the cab was inconvenient, it took less than three minutes. With the left boom positioned on the transport cradle, the cab door opened about one-third of the way, making it difficult to get in or out of the cab.

Ease of adjusting nozzle height and angle was good. Nozzle height was adjusted from inside the cab using the boom height control switches. Still the operator had to exit the cab to measure and confirm boom height. Getting out of the cab several times to measure the boom height was tedious. Nozzle height was adjustable from 21 to 76 in (530 to 1930 mm) at the low setting. The low setting was used during the entire test. Returning the nozzles to the original spraying height after raising the booms to avoid obstacles was difficult since there was no preset boom stops. Note that returning exactly to the original spray height was not important when using wide angle extended range or turbo nozzle tips. Ease of adjusting nozzle angle was poor. Nozzle angles were not meant to be adjustable from the factory position of 0°, although it was possible. A nozzle angle remained constant at all boom heights.

Ease of filling the spray tank with water and chemical was good. A transfer pump was required on the nurse tank. The sprayer reloading line was used throughout the test because less foaming and splashing occurred. Time required to fill the spray tank was less than seven minutes. The 250 gal (1140 L) spray tank was refilled every 15 to 60 minutes, depending on the application rate. Water volumes from 2.5 to 5 gpa (28 to 55 L/ha) were used to reduce the number of refills. Because the spray tank was small, the number of chemical containers lifted per refill was almost unnoticeable. Tank refill time varied from 10 to 30 minutes, depending on the chemical used.

Rinsing the chemical containers consumed the most time. Chemical handling, transfer, mixing and rinsing systems were available and made chemical inducting more convenient on the Spra-Coupe 3630.

Ease of cleaning the nozzle tips and strainers was good. The booms were set at a height convenient for removing and cleaning the nozzle caps to minimize chemical dripping down one's arms. Some strainers stuck in the nozzle body and required a piece of straw or tool to remove. Ease of cleaning the pump inlet strainer and line strainer was good. The main line that arched above the line strainer completely emptied when the strainer bowl was removed. Care was taken to prevent the spilled spray solution from running down the operator's arm.

Ease of draining the spray tank was fair. Nearly all the spray tank rinse water was first sprayed on the field and then drained through the reload line. The spray tank had a sump in the bottom but the solution did not drain well into the sump and could not be sprayed out completely. The agitators were closed to empty the spray solution or rinsate out of the spray tank better. The pump cavity was drained by installing a drain valve at the base of the pump. Draining the hoses was done by loosening the ring clamps and removing the hose ends. Rinsate in the spray booms was drained by opening the inner nozzle lines and raising the boom ends. An air pressure pump and tank were installed on the right platform and used to drain the boom spray lines and nozzle assemblies for autumn spraying and winter storage.

Ease of lubricating the sprayer was good. The Spra-Coupe sprayer had 55 grease fittings of which 37 required greasing daily. Most grease fittings were easy to get to with a grease gun. The booms were folded forward to access the inner boom hinge grease fittings. The grease fittings on the boom parallel linkage assembly were greased either by lowering the booms to field position or climbing on top of the assembly. Fifteen minutes was required to lubricate all grease fittings. Checking and adding oil was difficult. The system was modified by the manufacturer to make checking and adding engine oil more convenient.

Engine and Fuel Consumption: The engine started quickly, ran well and had sufficient power for the field conditions encountered when run above 3000 rpm. Fuel consumption averaged about 2.2 gal/hr (10 L/hr). Engine oil consumption was insignificant. When spraying on side hills, the fuel shifted, sometimes starving the engine when the tank was half full.

Pump Performance: Hypro Model 9202C centrifugal pump speed and pressure output was sufficient and rated as very good. The pump operated at 5500 rpm at an engine speed of 3500 rpm. With 36 nozzles on 60 ft (18 m) of spray booms and two jet agitators, the Hypro pump delivered pressures above 120 psi (800 kPa) to the nozzles. With the two agitator valves fully opened, the Melroe sprayer could apply 10 gpa (110 L/ha) at 7.2 and 14.4 mph (12 and 23 km/h) using the 03 and 06 nozzle tips, respectively. Agitating rates were very good. Average agitator output was 24 gpm (109 L/min) during field spraying, which exceeded recommended agitating rates for emulsifiable concentrates.

Foam Marker Performance: Richway Industries Model SC-3013 foam marker system was included with the test machine. Mark visibility was good in young cereal crops, fair in chemfallow conditions and poor in preharvest spraying conditions. Aligning the sprayer to the mark made on the previous pass was good. Mark durability was fair. The foam marks disappeared after reloading and marking the headlands. The foam marks lasted two hours in cool and humid conditions. In hot, dry conditions the foam lasted less than 10 minutes depending on the foam concentrate. Using the best foam concentrate available was necessary to rely on the foam marking system. With the foam marker set on high, mark length averaged 5 in (125 mm) and mark spacing averaged 15 ft (4.5 m) at 14.4 mph (23 km/h). Operating costs for marking solution averaged about 3 cents/ac (8 cents/ha).

Operator Safety: The operator's manual emphasized operator safety. The sprayer was safe to operate if normal safety and chemical precautions were taken. The single nozzle body assemblies were replaced by triple nozzle body assemblies to reduce operator handling of nozzle tips and strainers. A storage tank for clean water made it easy to rinse gloves and hands.

Operator's Manual: The operator's manual was very good, providing complete information and illustrations on safety, sprayer operation, maintenance and adjustments.

Mechanical History: The agitator hoses, spray boom joints and flow sensor failed twice during testing. The Spra-controller lost memory several times throughout the test.

RECOMMENDATIONS

The Alberta Farm Machinery Research Centre (AFMRC) recommends the manufacturer:

1. Make modifications to make the agitation valves adjustable from inside the cab.
2. Modify the Spra-controller to prevent the memory from clearing.
3. Modify the sprayer to improve steering response.
4. Modify the hitch to make it easier to hitch to the towing vehicle.
5. Make modifications to make it easier to get in or out of the cab with the left boom secured in its transport cradle.
6. Modify the boom to enable operators to use various types of nozzle assemblies.
7. Modify the fuel system to ensure fuel is supplied to the engine when operating the sprayer on side hills.
8. Modify the foam discharge tubes to prevent them from interfering with the spray.
9. Modify the marker system to make it easier to fill and maintain.
10. Modify the Spra-controller to prevent the flow sensor from failing.
11. Modify the agitation system to prevent the agitation hose from failing.
12. Modify the foam marker to prevent the solenoid valves from staying closed.

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MANUFACTURER'S REPLIES TO RECOMMENDATONS:

The manufacturer stated with regard to recommendation:

1. Cab controlled on/off agitator valves are standard on newer models. Individual agitation adjustments is still done outside the cab.
2. The Raven controller on newer machines has a new chip which holds the calibration numbers.
3. The steering control unit on later models was changed to improve steering response.
4. A telescoping hitch was developed to assist in connecting the hitch to a tow vehicle.
5. On the newest model the boom is wider in the folded position which will give more space between the boom and the cab.
6. No change.
7. The fuel suction hose was routed different to improve the fuel supply to the engine on side hills.
8. No change.
9. The marker system is mounted on the boom so it can be lowered for filling at ground level.
10. The flowmeter has been improved on newer models.
11. The agitation hose has been replaced with a better hose on newer models.
12. The solenoid valve was changed after 1994 by the solenoid manufacturer to remove the problem of the solenoid staying closed.

ADDITIONAL MANUFACTURER'S REPLIES:

1. The Spra-Coupe Model 3630 tested was manufactured in 1994 and tested by the Alberta Farm Machinery Research Centre in 1995 and 1996. During this period, several modifications were made to the 3630.
2. The 3630 has been replaced by the 3640 which has a larger engine.
3. The 4640 has been added to the line of Spra-Coupes which has the same engine as the 3640 but has a 400 gallon tank, automatic transmission and hydraulic operated wet brakes.
4. The rear wheel of the Spra-Coupe are adjusted hydraulically on newer models.
5. A fiberglass hood was added to the newer machines for improved engine access. The fiberglass hood is also easier to open.
6. A heavy duty spring was added to the boom suspension and the rear suspension on newer models to improve the boom stability.

GENERAL DESCRIPTION

The Melroe Spra-Coupe Model 3630 is a self-propelled high clearance, boom-type field sprayer. It is powered by a Peugeot 87 hp (65 kW) diesel engine that is located in front of the cab. Traction drive is through a 5-speed transmission and differential. Rear wheel final drive is through a double reduction roller chain. Front wheel steering is controlled hydraulically and braking by mechanical disc brakes. Conventional automotive controls are used to start, steer, brake and shift.

The cab is located at the centre of the Spra-Coupe immediately in front of the 250 gal (1140 L) plastic spray tank. The cab has air conditioning and a heater. Outside air is filtered through charcoal and conventional filters before entering the cab. The spray tank is equipped with hydraulic agitation and liquid level indicator. The booms are mounted at the rear. The booms are controlled hydraulically and fold forward for transport. The spray tank has two jet agitators, a fluid level indicator, a filler opening with a strainer, a reloading hose and coupler and a clean water tank under the non-skid platform.

The Spra-Coupe sprayer has 36 Spraying System's single nozzle assemblies with diaphragm check valves spaced at 20 in (508 mm) intervals, giving a spraying width of 60 ft (18 m). Nozzle height is hydraulically controlled. The nozzles' angle is not adjustable.

The Spra-Coupe sprayer has a clean water tank, spray tank access platform, remote control, Raven's automatic rate controller and Richway marker. The controller/monitor is integrated with the dash near the pressure regulator and boom shut-off switches. The monitor console LCD displays application rate, speed, nozzle flow rate, volume and sprayed area. The Hypro 9202C centrifugal pump is belt driven from the engine and controlled with an electromagnetic clutch.

Figure 1 shows the location of the sprayer's major components while detailed specifications are given in **Appendix 1.**

SCOPE OF TEST

The Spra-Coupe Model 3630 field sprayer was used for two spraying seasons in the conditions shown in **Tables 1** and **2**. The sprayer was used for 322 hours to spray a total of 13,546 ac (5484 ha). The sprayer was used in lab conditions for an additional 100 hours. The Alberta Farm Machinery Research Centre (AFMRC) evaluated the sprayer for rate of work, quality of work, ease of operation and adjustment, marker and pump performance, operator safety and suitability of the operator's manual.

The Spra-Coupe Model 3630 boom was modified to install Kyndestoft's air sprayer, Spraying System's triple nozzle body assemblies and Spraying System's wide angled Turbo TeeJet nozzles. Spraying System's triple nozzle body assemblies were added to change application rates faster during spray deposition and drift tests. Melroe Company did not endorse the use of Spraying System's triple nozzle assemblies because the nozzle assemblies extended beyond the boom support, therefore subjecting it to damage.

Kyndestoft's air sprayer and Spraying Sytem's Turbo TeeJet nozzles were also undergoing AFMRC evaluations to see if they would benefit high clearance sprayers. Kyndestoft's air sprayer was added to increase spray deposition in bean and potato crops and to reduce spray drift. Spraying System's wide angle Turbo TeeJet nozzles were used to increase the performance of the automatic rate controller by operating at a wider range of pressures.

The sprayer evaluated by AFMRC was configured as described in the **Appendix 1**, General Description, **Figure 1** and the Specifications section of this report. The manufacturer may have built different forms of this sprayer before or after AFMRC tests. When using this report, be sure to first check the sprayer being purchased is the same as the one shown here. The manufacturer or AFMRC will help decide how your sprayer will perform compared with the one tested.

Table 1. Operating Conditions.

CHEMICAL APPLIED	FIELD	HOURS	SPEED		FIELD AREA	
			mph	km/h	ac	ha
1995 Test						
Roundup/ Green Drop	Chemfallow	6	10.8	17.4	304	123
Roundup/ Green Drop	Chemfallow	30	14.7	23.6	1927	780
Roundup	Chemfallow	10	20.0	32.2	630	255
Roundup	Chemfallow	2	14.7	23.7	86	35
Roundup	Forages	8	10.8	17.4	272	110
Roundup	Pasture	2	4.4	7.0	25	10
2,4-D/ Banvel	Cereals	28	14.6	23.5	2211	895
Benlate/ High Pros	Beans	12	7.5	12.0	198	80
Reglone	Peas	4	4.6	7.4	64	26
Reglone/ Decis	Potato	5	4.6	7.4	64	26
Reglone/ Decis	Potato	11	7.5	12.0	210	85
Reglone	Potato	12	10.6	17.0	296	120
Horizon/ Target	Chemfallow	5	14.5	23.3	200	81
Sub-Total (1995)		**135**			**6486**	**2626**
1996 Test						
Horizon/ Target	Chemfallow	55	10.0	16.1	1500	607
Triumph Plus	Cereals	120	14.5	23.3	4900	1984
Triumph Plus	Cereals	10	20.0	32.2	500	202
Horizon/ Target	Cereals	2	14.5	23.3	160	65
Sub-Total (1996)		**187**			**7060**	**2858**
TOTALS		**322**			**13546**	**5484**

Table 2. Topography.

TOPOGRAPHY	HOURS	FIELD AREA	
		ac	ha
Level	75	2730	1105
Undulating	139	6255	2532
Rolling	53	2240	907
Hilly	55	2320	939
TOTAL	**322**	**13545**	**5484**

RESULTS AND DISCUSSION

RATE OF WORK

Table 1 shows the Spra-Coupe sprayer was operated between 4 and 20 mph (7 and 30 km/h) resulting in instantaneous work rates between 32 and 145 ac/h (13 and 59 ha/h). Actual work rates were less and depended on operator skill and reloading time. The quick folding booms and automatic rate controller reduced time. The quick folding of the boom made tank reloading from a central location convenient. When applying 5 and 10 gpa (55 and 110 L/ha), a full spray tank sprayed 50 and 25 ac (20 and 10 ha), respectively.

QUALITY OF WORK

Application Rate Accuracy: Application rate accuracy was very good after calibrating the automatic rate controller. Application rate accuracy depended on the controller's flow and speed sensor calibration numbers. The controller's flow sensor number was stamped on the flow sensor. The controller's speed sensor number had to be determined by driving the Spra-Coupe a short distance.

Figure 2 shows application rates with the controller programmed to apply 5 gpa (55 L/ha) with the original flow sensor number and after calibrating the flow sensor. With the original flow sensor number, application rate remained constant over a wide range of forward speeds, but was 6% greater than the actual rate. For example, at 14.4 mph (23 km/h), the actual application rate was 5.3 gpa (59.6 L/ha), compared to 5.0 gpa (55.0 L/ha) displayed on the monitor. Calibrating the flow sensor improved accuracy to within 1% of the desired rate, **Figure 2**. For example, changing the flow sensor number to 199 from 188, the application rate displayed on the monitor matched the desired rate of 5 gpa (55 L/ha).

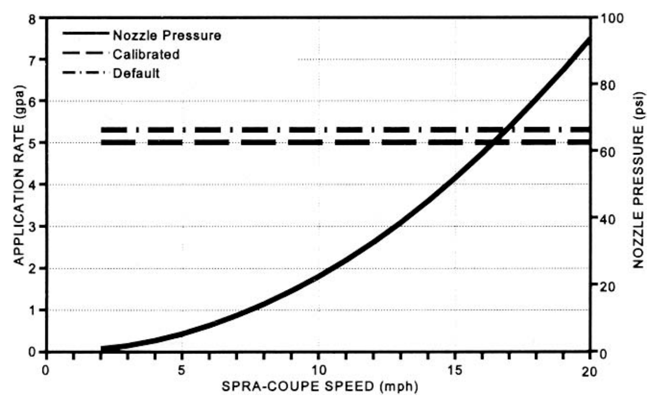

Figure 2. Application Rate and Nozzle Pressure at Various Speeds with the Spra-Controller Programmed to Apply 5 gpa (56L/ha).

Calibrating the flow sensor was done by measuring the flow from several nozzles. A graduated cylinder and stopwatch were used to determine nozzle delivery. The average delivery of the nozzles measured multiplied by the number of nozzles on the sprayer was the total sprayer flow rate.

The speed sensor calibration number depended on sprayer tire circumference. Tire circumference varied depending on tire pressure, spray tank fluid volume and field soil conditions. For greater accuracy, the speed senor was calibrated in actual field conditions with the spray tank half full of fluid and sprayer tires properly inflated. The procedure required the operator drive the sprayer in a straight line for 10 wheel revolutions. The distance the sprayer travelled in 10 wheel revolutions was the speed sensor calibration number. The speed calibration number was 168 in most the field conditions encountered during testing. The small variations in tire pressure throughout the spraying day had negligible effects on the accuracy of the speed sensor. The speed calibration number did not change significantly as the sprayer tank volume changed. **Figure 2** also shows resulting nozzle pressures at various forward speeds. Nozzle pressure increased as forward speed increased. The Spra-controller was programmed to apply 5 gpa (55L/ha) at 14.4 mph (23 km/h) and 40 psi (275 kPa). With the wide angle Turbo TeeJet nozzles, speeds from 8 to 20 mph (13 to 32 km/h) were possible. Nozzle pressures from 10 to 80 psi (70 to 550 kPa) resulted from operating at 8 to 20 mph (13 to 30 km/h). This pressure range was only acceptable using the wide angled Turbo

TeeJet (TT) nozzles. Forward speed depended on field conditions, the work rate required and nozzle pressure needed to ensure an adequate spray coverage and minimum amount of spray drift. Speeds below 8 mph (13 km/h) produced pressures below 10 psi (70 kPa) which resulted in poor spray patterns with some nozzle types. In essence, nozzle spray deposition at low pressures dictated the slowest speed the sprayer could be run.

Controller Response and Stability: The Spra-controller's response to a change in speed and application rate stability were very good. Response time depended on the control valve number, application rate (nozzle size) and sensor's time sample code number. **Figure 3** shows the average response times to speed changes of 2.5 and 3.7 mph (4 and 6 km/h). The control valve default number was 2323 and the flow and speed sensor's default time code number was 202. At the default numbers the Spra-controller provided, reached and stabilized the application rate with five seconds. The size of nozzles used or higher application rates effected response times more than the valve and sample code numbers. For example, the response time was 2.8 seconds using the TT11005 tips to apply 10 gpa (110 L/ha). The response time increase to 4.8 seconds using the TT110015 tips to apply 2.5 gpa (28 L/ha). With large nozzles like the TT11005 tips, the regulator valve operated more open to supply the required amount of spray solution to the nozzles. With small nozzles like the TT110015 tips, the regulator valve operated near the closed position. Response time included the time to change speed and the time application rate stabilized within 2% of the desired application rate. It took one to two seconds to reach the maximum speed gearing up or down in the first 4 transmission gears. It took up to five seconds to accelerate to 20 mph (32 km/h) gearing up from 4th to 5th gear.

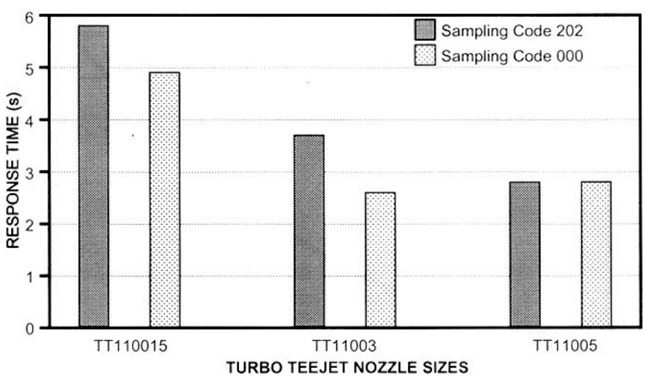

Figure 3. Automatic Rate Controller's Average Response Time 2.5 to 3.7 mph (4 to 6 km/h) Speed Change.

When using the small TT110015 and TT11003 nozzles (low application rates), changing the speed and flow sample code improved the response time by two seconds. For example, using the TT11003 nozzles, response was 3.6 seconds and reduced to 2.6 seconds with the speed and flow code changed from 202 to 000.

A fast response time ensured a constant application rate. Application stability was affected when the default numbers were changed too much. Application rate stability depended on the control valve number. Each digit in the control valve four digit number represented a function to stabilize the application rate or improve response times. Small adjustments were made, but in field conditions the performance of the controller could not be noticed. Nozzle pressure oscillated when the valve speed was set to fast. The default settings that came with the Spra-controller provided adequate response times and stable application rates.

Nozzle Calibration: Table 3 shows the average delivery from 10 randomly selected wide angle Turbo TeeJet (TT) nozzle tips of different sizes. The five sizes tested included TT11001, TT110015, TT11002, TT11003 and TT11004. The TT11005 were not available at the time of testing. Delivery from the TT11001, TT110015 and TT11002 nozzle tips was within 1.5% of Spraying Systems' rated output. The TT11003 and TT11004 nozzle tips deliveries were about 5% lower than the nozzle manufacturer's rate. The TT11002 and TT11003 nozzle tips were used in the field for 300 and 100 hours, respectively. Nozzle delivery remained the same, indicating nozzle wear was negligible. A set of nozzles should be replaced when delivery of any nozzle tip exceeds the manufacturer's rating by more than 10%.

Table 3 also shows the coefficient of variation (CV)[1] for all the wide angle Turbo TeeJet nozzles tested. Variability among individual nozzle deliveries for the Turbo TeeJet nozzles was less than 2%. This indicates the deliveries from each nozzle tip tested was similar.

Table 3. Turbo TeeJet Nozzle Deliveries and Variation.

Nozzle Tip	Nozzle Capacity @ 40 psi (gal/min)	Nozzle Capacity @ 275 kPa (mL/min)	Percent of Manufacturers Rated Output (%)	Coefficient of Variation (CV) (%)
TT11001	0.085	384	101.5	0.9
TT110015	0.126	572	100.4	2.1
TT11002	0.167	757	99.9	1.2
TT11003	0.237	1076	94.6	2.0
TT11004	0.319	1451	95.7	0.3

Distribution Patterns: Spray distribution patterns from Spraying Systems' wide angle Turbo TeeJet (TT) 110° nozzle tips were **very good**. **Figure 4** shows a typical spray distribution pattern along the boom from a batch of new TT11003 nozzles. For comparison purposes, **Figure 5** shows a typical spray distribution pattern along the boom from a batch of new standard Lurmark 03-F110 110° nozzles. Both sets of nozzles were operated at a pressure of 40 psi (275 kPa) and a height of 18 in (460 mm) above the target.

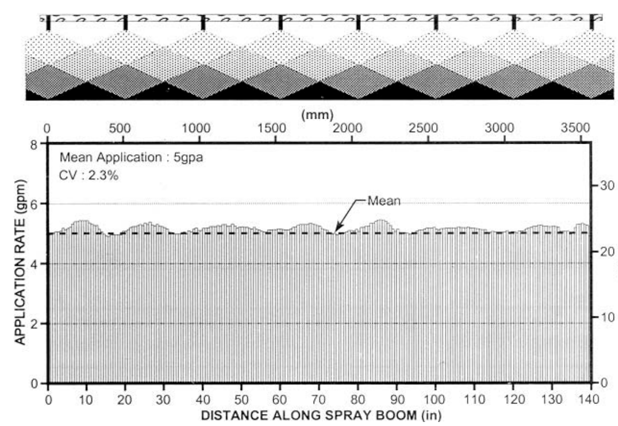

Figure 4. Spray Distribution Pattern Along the Boom at 40 psi (275 kPa) with Spraying Systems' Wide Angle Turbo TT11003 Plastic Nozzle Tips Operated at 18 in (460mm) Height and 14.4 mph (23 km/h).

Application rates along the boom varied from 4.7 to 5.3 gpa (53 to 59 L/ha) at 14.4 mph (23 km/h) with the TT11003 tips. The spray distribution pattern coefficient of variation (CV)[2] was 2.3%. Application rates along the boom varied from 4.1 to 6.6 gpa (47 to 74 L/ha) at 15 mph (24 km/h) with standard 03-F110 tips. The spray distribution pattern coefficient of variation (CV) was 12.4 %. Patterns from both nozzle types were acceptable; however, the Turbo TeeJet

1 The coefficient of variation (CV) is the standard deviation of delivery rates from 10 nozzles expressed as a percent of the mean delivery rate. A CV below 3% indicates similar delivery rates for all nozzles.

2 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 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.

nozzles eliminated the high concentration of spray below each nozzle tip that are typical of standard flat fan nozzles.

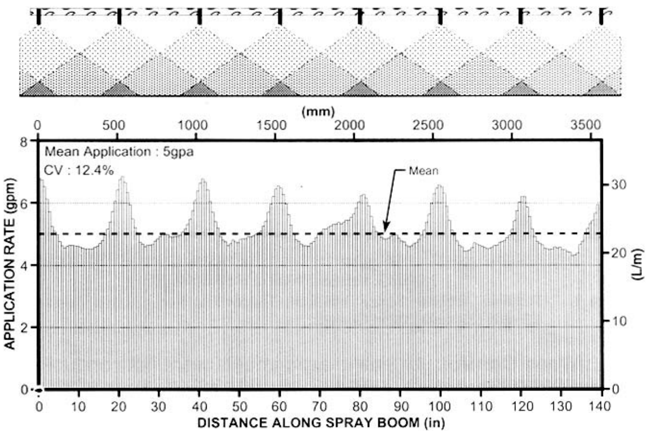

Figure 5. Spray Distribution Along the Boom at 40 psi (275 kPa) with Lurmark's Standard 03-F110 Plastic Nozzle Tips Operated at 18 in (460mm) Height and 15 mph (24 km/h).

Figures 6 and 7 show how nozzle height and pressure affected spray pattern uniformity for the turbo flat fan nozzles. The CV results are compared to previously tested flat fan nozzle tips. The previously tested flat fan nozzles included standard, extended range and low drift nozzles. As nozzle height and pressure increased, spray patterns improved with all the flat fan nozzles. The low drift nozzles had similar spray pattern characteristics as standard 80° nozzles. That is, the nozzles produced acceptable spray patterns (CV less than 15%) when operated above 16 in (400 mm) and 35 psi (250 kPa). Like the extended range nozzle, the Turbo TeeJet nozzle tips produced acceptable spray patterns at all nozzle heights and pressures tested. Both types of nozzles could be operated at pressures as low as 15 psi (100 kPa) and heights as low as 9 in (225 mm). As shown in **Figure 2**, low pressures frequently occurred operating the automatic rate controller at reduced spraying speeds.

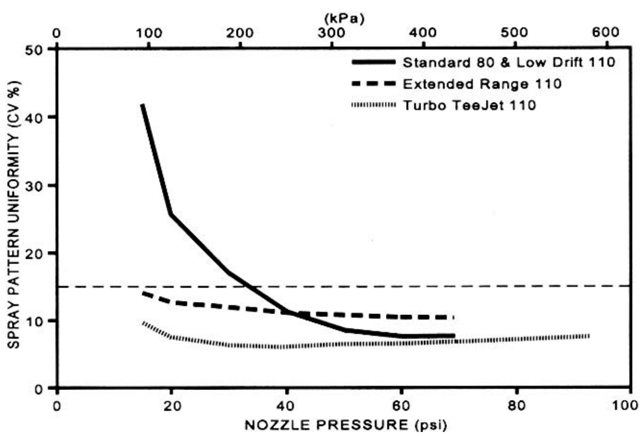

Figure 6. Spray Pattern Uniformity for Spraying Systems' Turbo TeeJet (TT) and Extended Range (XR) Nozzles and Lurmark's Standard and Low Drift (SD) Nozzles Operating at Various Pressures.

To reduce spray drift in windy conditions, nozzles should be operated at pressures and heights as low as possible without sacrificing coverage.

Figures 6 and 7 show the average variability (CV) from six size classes of each nozzle type. The sizes included 01, 015, 02, 03, 04, 05 and 06. The largest size Turbo TeeJet nozzle manufactured was the 05, which was not tested. Usually, smaller sized nozzles have higher CV's than indicated by the average. Larger sized nozzles have lower CV's. For more information on spray pattern uniformity for each type and size of nozzle, contact AFMRC.

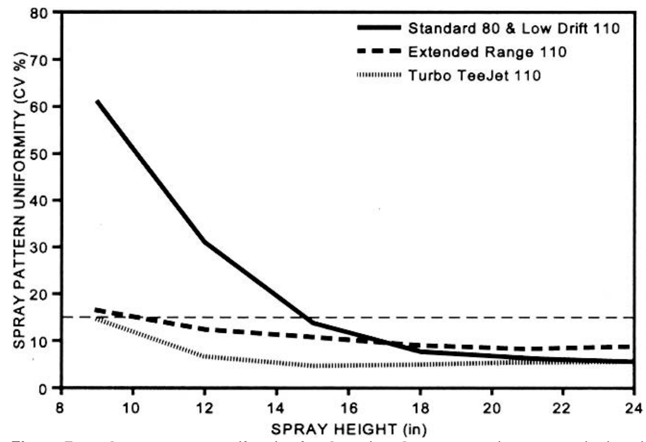

Figure 7. Spray Pattern Uniformity for Spraying Systems' Turbo TeeJet (TT) and Extended Range (XR) Nozzles and Lurmark's Standard and Low Drift (SD) Nozzles Operating at Various Heights.

Spray Drift: Table 4 shows airborne spray drift results from the Spra-Coupe sprayer using extended range (XR), wide angle turbo (TT) and drift guard (DG) 11002 nozzles. The American Society of Agriculture Engineers (ASAE) Standard S387 "Test Procedure Used for Measuring Deposits and Airborne Spray from Ground Swath Sprayers" was used to measure airborne spray drift. Spray drift test methodology developed by Agriculture and Agri-Food Canada at the Regina Research Station was also incorporated.

Table 4. Airborne Spray Drift Results.

Sprayer Operation	Nozzles	Spray Height	Spray Rate	Spraying Speed	Wind Speed mph (km/)h		
		in (mm)	gpa (L/ha)	mph (km/h)	6 (10)	12 (20)	20 (30)
Low Speed Application	DG11002	18 (450)	10 (110)	5 (8)	n/a	2.1	n/a
	8002	18 (450)	10 (110)	5 (8)	1.9	2.7	3.4
High Speed Application	DG11002	24 (600)	2.5 (28)	20 (32)	2.2	7.5	13
	TT11002	24 (600)	2.5 (28)	20 (32)	2.9	7.7	12
	XR11002	24 (600)	2.5 (28)	20 (32)	6.3	15	23
Air Assist System	XR11002	24 (600)	2.5 (28)	20 (32)	9.9	20	29

The sprayer was tested in field conditions with the wind perpendicular (crosswind) to the sprayed swath. The nozzles were operated at 40 psi (275 kPa) and a height of 24 in (600 mm) above the target. Forward speed was 20 mph (32 km/h) giving an application rate of 2.5 gpa (28 L/ha). The cereal crop was 6 in (150 mm) tall. The sprayer operating conditions, high spraying height and high speed were used to represent a worst case scenario. From a worst case scenario, applicators can select spraying speeds, nozzles and nozzle operating conditions to keep spray drift at acceptable levels.

Table 4 shows the amount of airborne spray drift as a percent of the chemical sprayed. In 20 km/h crosswinds, airborne spray drift was 15, 8 and 8% from the XR11002, DG11002 and TT11002 nozzles, respectively. Spray drift from the Extended Range XR11002 nozzles was highest. This was expected since XR nozzles produce a higher percentage of spray droplets below 100F than DG or TT nozzles at 40 psi (275 kPa) spraying pressure. Drift was similar for DG11002 and TT11002 nozzles. The TT nozzles, like the XR nozzles, have very good coverage at low pressures, rates and spray heights, **Figure 6 and 7**. Therefore, the TT nozzles would work best in windy spraying conditions for the applicators using automatic rate controllers and sprayers with unsupported booms that frequently strike the ground. With the introduction of Turbo TeeJet nozzles, spray with course droplets is again a means of managing spray drift.

An air-assist system, **Figure 8**, was installed on the Spra-Couple 3630 to decide the air system's potential as a drift reduction system when spraying at high speeds and spray heights. As shown in **Table 4**, the air system increased spray drift by 5%. Spray drift increased from 15 to 20% in a 20 km/h crosswind. Applicators using air-assist systems strictly for controlling spray drift are cautioned. The air system will be retested at a different set-up to increase its potential as a spray drift reduction device.

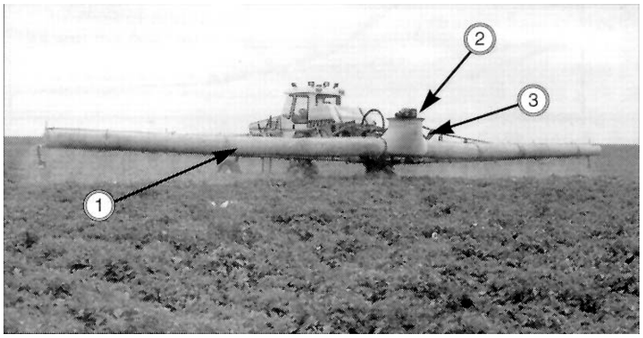

Figure 8. Kyndestoft Airbag: (1) Airbag, (2) Fan Motor and (3) Fan Housing.

Airborne spray drift from a low speed application conventional sprayer is shown for comparison. Drift from standard 8002 nozzles applying 10 gpa (110 L/ha) at 5 mph (8 km/h) was only 3% in 12 mph (20 km/h) crosswinds. Spraying at 10 gpa (110 L/ha) was introduced in Canadian prairies 30 years ago as a way to improve coverage and reduce drift. From the results, operating sprayers at a high speed and spray height results in more spray drift. For example, spray drift from the DG11002 nozzles was 2.1% when used the conventional way and 7.5% when used on the high clearance sprayer. However, several things can be done with high clearance sprayers to manage spray drift to acceptable levels. When the wind comes up, operators using extended range nozzles, especially 110^o nozzles, are encouraged to reduce spraying speed. When equipped with automatic rate controllers, speed should be reduced until nozzle pressure falls below 20 psi (140 kPa).

Figure 9 shows spray drift reduced to acceptable levels at low nozzle pressures and heights. Tests were conducted in AFMRC's wind tunnel at a speed of 20 mph (32 km/h). The boom was static and perpendicular to the wind. At 40 psi (275 kPa) and 18 in (460 mm) spray drift from the 110^o Extended Range XR11002 nozzles was 3 times higher than standard 80^o 8002 nozzles. Studies show 110^o Extended Range nozzles produce a higher percentage of droplets less than 150F than 80^o nozzles of the same size. Spray droplets less than 150F are more susceptible to drift. A lower percentage of susceptible droplets were produced operating the XR11002 nozzles at 20 psi (140 kPa). Operating the XR11002 nozzles at 20 psi (140 kPa) and 12 in (305 mm) reduced spray drift to acceptable levels. As shown in **Figures 5 and 6**, XR11002 nozzles were operated at low nozzle pressures and heights without adverse effects on spray patterns. Operating the 110^o Turbo TeeJet nozzles at low heights and pressures to reduce spray drift was also possible.

Appendix 3 shows actual spray drift trial results. Results include off-swath ground drift, swath deposits, airborne drift and swath deposit variability (CV). Swath deposit variability was determined by calculating the coefficient of variation (CV) of the spray deposits measured in the sprayed swath. The CV'S averaged 25%. This showed the 20 mph (32 km/h) spraying speed did not adversely affect spray deposition. Off-swath ground drift was low and usually occurred within the first two metres.

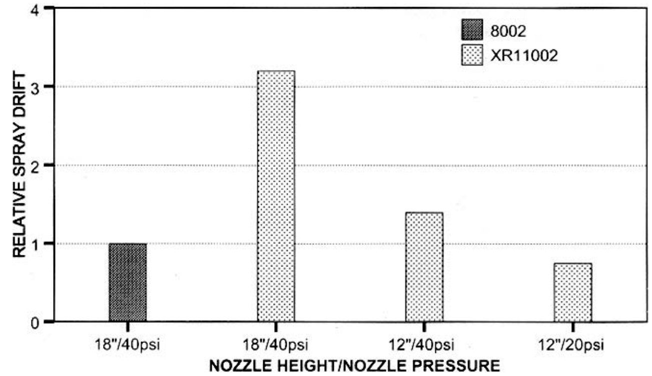

Figure 9. Relative Airborne Spray Drift from TeeJet Flat Fan Nozzles Operated in 20 mph (32 km/h) Wind Speeds.

Weed Control: Scientific experiments were not conducted to determine whether high spraying speeds affected weed control. General observations showed weed control was typical on the crops sprayed with chemicals applied at label rates, **Table 1** .

Pressure Losses: Sprayer plumbing pressure losses were low and rated as **good**. Pressures in the plumbing system were measured at the mechanical pressure gauge, pressure tap, boom inlets, spray booms and nozzles. The mechanical pressure gauge line was tapped into a tee just before the right boom shut-off valve as the source for indicating nozzle pressure. Therefore, the mechanical gauge did not indicate actual nozzle pressure. However, as shown in **Figure 10,** the pressure at the right boom inlet tee was within 2 psi (15 kPa) of the actual nozzle pressure at spraying flow rates up to 20 gpm (90 L/min). As flow to the nozzles increased, the pressure loss from the pressure tap and nozzles increased. With 36 nozzles on a 60 ft (18 m) wet boom, spraying flow rates were less than 20 gpm (90 L/min) when applying 5 and 10 gpa (55 and 110 L/ha) at 14.4 mph (23 km/h). Pressure loss across the 60 ft (18 m) boom was less than 1 psi (7 kPa).

Pressure in the middle boom nozzles was higher than the left and right boom nozzle pressures. This pressure difference depended on spraying flow rate as shown in **Figure 10**. At spraying flow rates less than 20 gpm (90 L/min), the nozzle pressures at the middle boom were within 3 psi (20 kPa) of the left and right boom nozzle pressures.

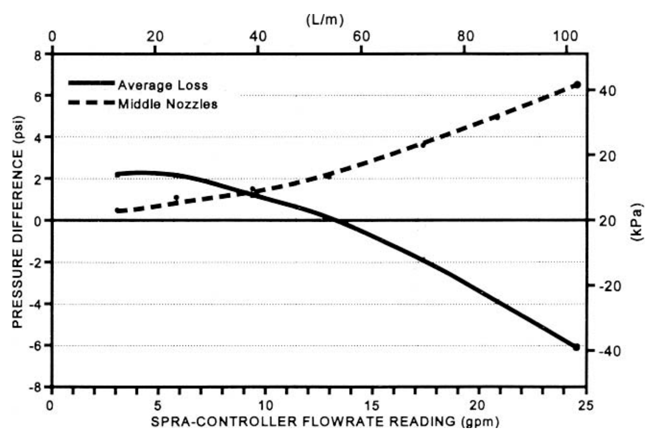

Figure 10. Pressure Difference from Pressure Source and Middle Nozzles.

The mechanical pressure gauge was accurate within 2 psi (15 kPa) between 10 and 60 psi (70 and 400 kPa), spraying pressures normally used in the prairies. **Figure 11** shows the actual nozzle pressure at various sprayer operating pressures and flow rates. The actual nozzle pressure was within 3 psi (20 kPa) of the gauge pressure reading when operating the gauge and flow rate below 60 psi (400 kPa) and 20 gpm (90 L/min), respectively.

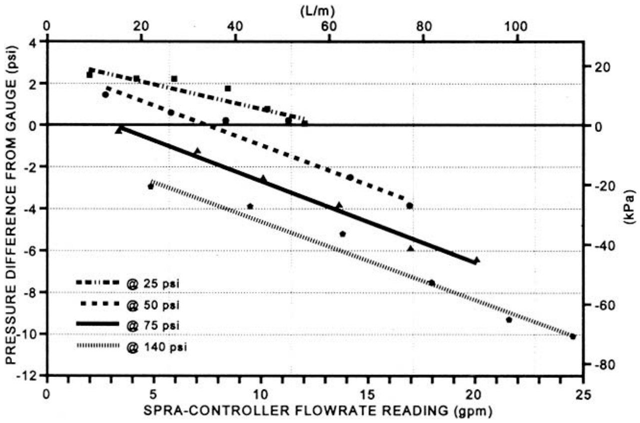

Figure 11. Pressure Difference Between Nozzles and Gauge Operating the Sprayer at Various Pressures and Flow rates.

The pressure losses and differences did not affect application rate. Application rates depended on the Spra-Coupe's flow and speed sensors. However, some confusion resulted when referencing nozzle application rate charts and catalogues. Nozzle charts and catalogues were referenced to quickly check the Spra-controller's accuracy. At a specific spraying speed the flow indicated on the monitor and the pressure indicated on the pressure gauge should be similar to the flow and pressure indicated on the nozzle chart. For example, when using a TT11002 nozzles, at 14.4 mph (23 km/h) the monitor and pressure gauge should read 12 gpm (55 L/min) and 40 psi (275 kPa), respectively.

System Strainers: The Spray-Coupe Model 3630 was equipped with a 40 mesh reloading line strainer, a 40 mesh pump outlet strainer, a 40 mesh pump outlet strainer and 50 mesh nozzle strainers. The strainers effectively prevented the Turbo TeeJet nozzles from plugging and were rated as **good.** The spray tank jet agitators plugged frequently because the 40 mesh boom inlet hose was located after the agitator lines. Later during the test strainers were installed in each agitator line to prevent the jet agitators from plugging. **It is recommended the manufacturer modify the straining system to prevent the agitators from plugging with foreign material.**

Use of Optional Nozzles: Spraying Systems' nozzle body assembly accepted flat fan nozzle tips, **Figure 12**. The sprayer was delivered with single nozzle body assemblies, that came with standard 8002 nozzles. Melroe Company does not supply multiple nozzle body assemblies or nozzles as optional accessories for the Spra-Coupe model 3630. The decision on nozzle assemblies and tip selection are left to the end user to make.

Boom Stability: Spra-Coupe boom stability was **good**. The booms remained stable in the field conditions encountered, **Table 2**. The boom truss and suspension system reduced boom bounce and horizontal boom movement in rough fields. The boom suspension system that allowed some horizontal boom movement weakened, making the boom ends move rearwards at high spraying speeds. The spring on the horizontal suspension system was replaced preventing adverse horizontal boom movement. Boom stability was limited by the suspension and height of the machine. The sprayer leaned outward on the suspension when turning at high field speeds, causing the boom ends to hit the ground if the boom ends were not lifted quickly. Turning sharply at 10.6 mph (17 km/h), the outside boom would drop about 30 in (760 mm) from the machine leaning.

Crop Damage: Crop damage was considered insignificant. The sprayer tracks were not visible during harvest in the cereal crops that were sprayed when less than 8 in (200 mm) tall. No potato damage was noticed after being sprayed. The crop was damaged in the tire tracks during preharvest spraying. However, the sprayer wheels tracked a small percentage of the total field area sprayed.

EASE OF OPERATION AND ADJUSTMENT

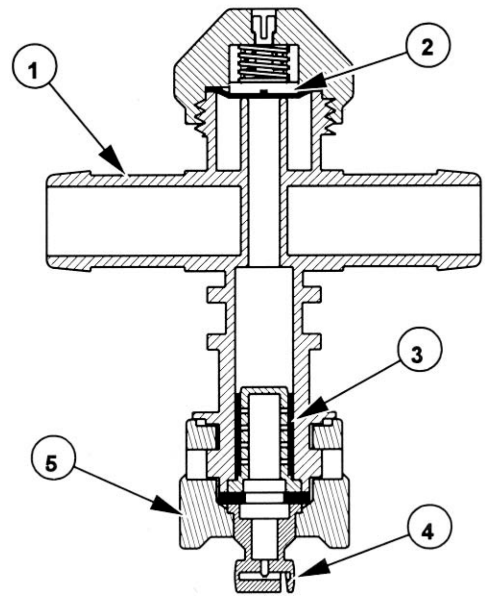

Figure 12. Spraying Systems' Single Nozzle Body Assembly: (1) Spray Boom, (2) Diaphragm Check Valve, (3) Strainer, (4) Nozzle Tip and (5) Quick-Disconnect and Self-Aligning Nozzle Cap.

Operator Comfort: Operator comfort was **very good**. The Melroe 3630 Spra-Coupe was equipped with an operator's cab centered on the applicator body between the engine hood and tank. The cab was easily accessed with the spray booms in field position. With the spray booms folded in transport position the cab was entered after lifting the left boom away from the step ladder using the manual boom control valve.

The cab was quiet and had plenty of room for the operator. The cab air and charcoal filters effectively filtered dust and chemical fumes. The cab's pressurization system helped reduce dust leaks. The heating and air-conditioning system provided adequate cab temperatures in all operating conditions.

Visibility was **good** during spraying and **fair** during transport. The operator had a clear view forward and to the sides when spraying. Boom and nozzle visibility during spraying was good, however, more nozzles were visible by leaning over toward the side of the cab. Six nozzles behind the spray tank were not visible from inside the cab. Visibility of the wheels was limited because of their proximity to the applicator body. Visibility to the rear was fair with the small rear window, requiring some caution when manoeuvring in confined areas. In transport position, visibility to the sides and rear were reduced by the booms and foam tank. The operator's view of the sides and rear was mainly between the boom structural members. The rear view mirror was inside the cab and did not improve rear visibility.

Instruments: Instruments were useful and rated as **good**. All the gauges were easy to see and read. Most instruments were to the right of the operator, **Figure 13**. The instrument panel included gauges for engine oil pressure, coolant temperature, engine hours, engine speed and fuel level, plus warning lights for parking brake, alternator, glow plugs and transmission temperature. The panel was lit by a white or red dome light. The nozzle pressure gauge was on top of the engine hood, just outside the front window, which was lit by a white light.

The air cleaner condition indicator was on the air filter assembly inside the engine housing and required the right side engine cover be raised to reach it.

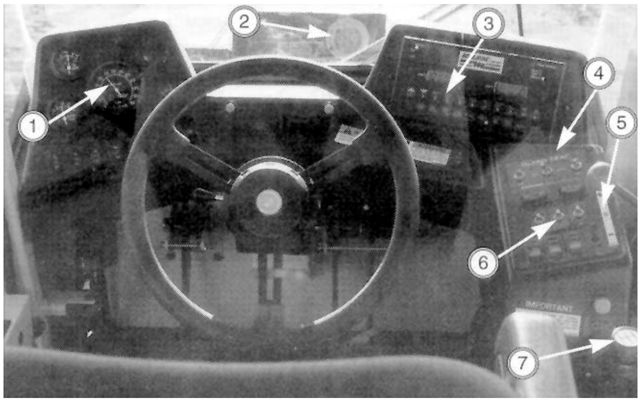

Figure 13. Spra-Coupe's Console Layout: (1) Instrumentation Console, (2) Pressure Gauge, (3) Raven Spra-controller Console, (4) Foam Marker Controls, (5) Hand Throttle Lever, (6) Boom Control Console and (7) Shift Lever.

Controls: All Spra-Coupe controls were easy to reach from the operator's seat and rated as **good**. The boom, pump, marker and spray controls used mostly during spraying were conveniently contained together on the side console, immediately ahead and to the right of the operator. All controls were easy to use and the systems started quickly. The boom ends lifted quickly to avoid obstacles. The boom solenoid valves opened and shut quickly. Although clearly marked, the boom folding controls were hard to identify at a glance and occasionally the wrong boom control was started.

The spray tank shut-off valve and agitator valves were under the rear of the spray tank. They were not controlled from the cab, but were easy to reach from the ground. The operator had to take care when adjusting these valves to prevent contact with chemical residues on the sprayer. During spraying the spray tank was completely emptied by shutting the agitator valves. The agitator valves were shut with about 25 gal (115 L) of solution remaining inside the spray tank. The operator had to stop spraying and get off the sprayer to adjust the agitator valves. This was inconvenient and reduced work rates. **AFMRC recommends modifications be made to make the agitator valves adjustable from inside the cab.**

The 5-speed, plus reverse, manual transmission was controlled by the shift lever placed right of the operator seat. Gear shifting was quick, easy and smooth even at full throttle. Standard automotive controls were used for the gas pedal, clutch, brakes, steering and turn signals. Although a gas pedal was provided, the engine speed was controlled with the hand throttle the majority of the time. The heating, air conditioning and blower controls were located away from the spraying controls which was convenient.

Spray Monitor: Ease of operating the Raven spray monitor (Spra-controller) was **good**. The operator's manual was studied and some practice exercised before the controller was used for the first time in the field. The Spra-controller was built into the sprayer's dash, eliminating external brackets and wiring. The power and rate control switches, keys and two LCD displays were contained in one console that mounted inside the front dash, just to the right of the operator. The left display showed the application rate only. The right display showed one function or calibration data at a time. Both displays were visible during day and night spraying. The console had 21 touch keys that made programming and displaying spraying functions easy to use at a glance. Ten keys displayed functions that included total area, total volume, field area, field volume, distance, speed, flow rate, work rate, volume remaining in tank and time. Nine keys were used to program the monitor. The following calibration numbers were needed before the controller functioned automatically; boom lengths, two application rates, self-test key speed, flow and the valve calibration numbers. The two other keys were used to clear and enter numbers.

The rate switch allowed a quick choice between two application rates and manual mode. Manual mode allowed the operator to adjust nozzle pressure. This was useful when the controller adjusted the pressure below acceptable levels, **Figure 2**. A warning buzzer indicated the controller was unable to adjust flow to achieve the desired rate. The speed and flow sensors were easy to calibrate following the procedure described in the operator's manual.

Entering the type of speed sensor or system of units used (Imperial, Metric or US) was inconvenient. The monitor memory had to be cleared by disconnecting the power to the console. This was done by either disconnecting the battery cables on the sprayer, removing the fuse from the rear of the console or by removing the 9-volt battery if used. Any time the controller memory was cleared, the eight calibration numbers needed to be re-entered.

During the test, the monitor memory cleared unexpectedly several times. Why this occurred was never solved. System units, speed sensor type and the eight calibration numbers were re-entered each time memory cleared. This was a nuisance and reduced work rate. **It is recommended the manufacturer modify the Spra-controller to prevent the memory from clearing.**

Lighting: Sprayer lighting for transport was **very good**. Spraying at night, however, lighting was **fair**, even with the optional flood lights. The Spra-Coupe had two front road lights and was equipped with the optional flood light kit. The kit included two front and three rear lights that all mounted on the roof of the cab. The flood lights were adequate to illuminate the spray booms and the foam marker. The flood lights were not adequate for long range front lighting necessary for night spraying at speeds above 10 mph (16 km/h).

Application Rate: Ease of adjusting application rates was **fair** using standard nozzles and the single nozzle body assemblies supplied with the Spra-Coupe. Changing application rates involved removing one set of nozzles and putting on another. The Spra-controller was programmed to apply two different rates using the same nozzles. Adjusting application rates during spraying was useful in fields with varying weed infestations. When using standard nozzles, the rates entered were usually within 15% of the desired nominal rate. Adjusting application rates more than 15% from the nominal rate required a speed change or different sized nozzle.

Ease of adjusting application rates was **very good** using Turbo TeeJet nozzles and triple nozzle body assemblies. When using Turbo TeeJet nozzles the two application rates programmed in the Spra-controller were set more than 20% apart. In addition, large changes in speed were possible using the Turbo TeeJet nozzles in conjunction with the Spra-controller. Changing rates was quicker using the triple nozzle body assemblies rather than the single nozzle body assemblies. Applying the correct application rate still depended on calculating or selecting the proper size of nozzle, pressure and speed.

Wheel Adjustments: Adjusting the front and rear wheel treads was **fair**. Front and rear wheel spacing were adjusted from 80 to 108 in (203 to 274 cm). Tread width was adjustable in 4 in (10 cm) increments. Adjusting the wheel tread on both axles took two people about four hours to do. The sprayer wheels were lifted off the ground to adjust the wheel treads. A hoist and high jack stands were needed to raise the wheels off the ground safely. The rear wheel tread was easily adjusted by relocating a pin on the rear axle adjustment bracket. A pry bar was needed to aid in moving the rear axle tubes.

Adjusting the front wheel tread took more time. Two axle and two tie-rod adjustment bolts were removed to slide each front wheel. The front wheel toe-in was properly set by spacing each front wheel the same distance from the front axle centerline. The front wheel toe-in was adjusted each time the front wheel tread was changed.

Handling: Sprayer handling was **fair**. Keeping the sprayer aligned along the swath while spraying was a struggle in some conditions. Spraying down a hill, out of a gully or rough ground, the steering response was slow. Incorrect front wheel toe-in setting also affected the steering. **AFMRC recommends the manufacturer modify the sprayer to improve steering.**

The sprayer was stable in the field and road with an empty or full spray tank at all speeds. Normal caution was needed when operating on hillsides. The sprayer travelled well at all speeds. The maximum speeds in the various gears were appropriate for spraying, with most spraying done in fourth gear. The Spra-Coupe had a 5-speed manual transmission that delivered speeds up to 22 mph (35 km/h). Gear shifting was quick, easy and smooth even at full throttle.

The sprayer towed well with the tow hitch provided. The sprayer was stable at tow speeds up to 50 mph (80 km/h). The manufacturer recommended changing to highway tires when towing at higher speeds.

The brakes were effective. The turning radius was 21 ft (6.4 m) at a wheel spacing of 108 in (274 cm) and 29.5 ft (6 m) at a wheel spacing of 80 in (203 cm).

Hitching: Ease of hitching was **good**. A tow hitch was provided for towing the sprayer long distances. The hitch option was very useful for a one-man operation when switching fields with both the Spra-Coupe and a water truck. It took about 10 minutes to disconnect the final drives and hook the hitch from the Spra-Coupe to the towing truck. The majority of time was taken connecting the hitch to the towing vehicle's hitch since alignment had to be near perfect. **AFMRC recommends the manufacturer modify the hitch to make it easier to hitch to the towing vehicle.**

Boom Positioning: Ease of boom positioning was **good**. Positioning the booms from inside the sprayer cab allowed getting in and out of fields quickly and safely. Returning to the spray tank reloading location without getting out of the cab was convenient. The sprayer booms were folded into partial transport position in less than 10 seconds and usually done while driving forward. In partial transport, the boom ends were not folded and extended about 11.5 ft (3.5 m) in front of the sprayer, **Figure 14**. The boom ends partially limited the forward view, but the benefits of partial folding out weighed the disadvantages.

Folding the sprayer booms from field to transport position for longer transport required alternating tasks inside and outside the cab. Although the process was inconvenient, it took less than three minutes to do. Preparing the sprayer for road transport required the operator to leave the sprayer cab twice. Firstly, to fold the outer sections of the boom ends. Folding the boom ends reduced transport length from 31 to 20 ft (10 m to 6 m), **Figure 14**, providing safer road transport. Secondly, to secure the safety boom stop and booms into the transport cradles. With the left boom positioned on the transport cradle, the cab door opened about one third of the way, making it difficult to get in or out of the cab. **AFMRC recommends modifications be made to make it easier to get in or out of the cab with the left boom secured in its transport cradle.**

Nozzle Adjustments: Ease of adjusting nozzle height was **good**. Nozzle height was adjusted from inside the cab using the boom control switches that operated the boom hydraulic cylinders.

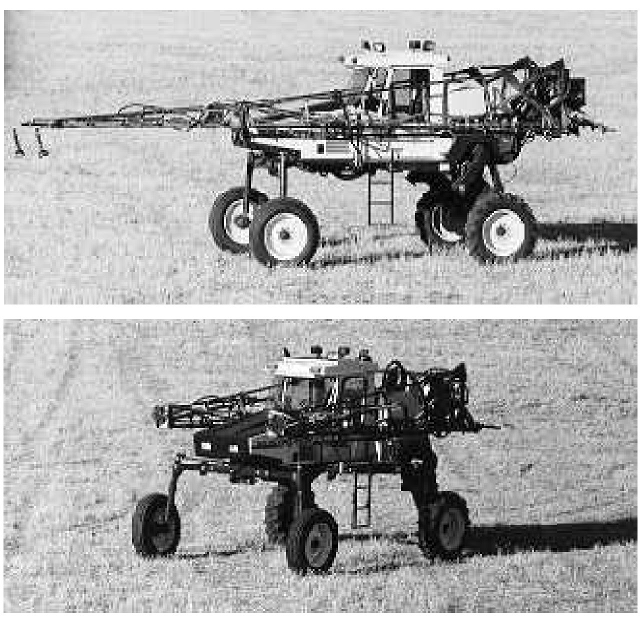

Figure 14. Spra-Coupe Sprayer in Transport Position: Top) Field Transport Bottom) Road Transport.

The operator had to exit the cab to measure boom height. Sometimes the cab was exited several times before the desired nozzle height above the spray target was correct. Nozzle height was adjustable from 21 to 76 in (530 to 1930 mm) at the low setting, and from 27 to 92 in (685 to 2340 mm) at the high setting. The low setting was used during the entire test. A wrench was needed to level the right and left booms with each other.

The entire boom or boom ends lifted quickly to avoid obstacles. After raising the boom ends they were easily placed back to the original spraying height. When the entire boom was lifted after going through gullies, returning the boom to the original spraying height was difficult since there was no return stops. Returning to exactly the original spray height was not important when using extended range or turbo nozzles, **Figure 7**. Lowering the boom or boom ends took longer than raising the booms. This feature prevented over shooting. The outer portion of the boom had a break away system to prevent damage to the boom or nozzles if the ground or other obstacles were struck.

Ease of adjusting nozzle angle was **poor**. Nozzle angle was not meant to be adjustable from the factory position of 0°. However, by using a wrench, each individual nozzle assembly clamp was loosened and adjusted to the desired angle. Nozzle angle remained constant at all boom heights.

The Spra-Coupe was factory equipped with single nozzle assemblies. The single nozzle assemblies were protected by the boom structure. However, changing nozzles to apply a different rate was tedious. Changing to a different nozzle size involved removing the entire set of nozzles that needed to be used again. Spraying Systems' triple nozzle assemblies were installed to quickly change application rates. The nozzle caps on Spraying Systems' triple nozzle assemblies protruded below the boom structure. The nozzles were no longer protected by the boom. Several triple nozzle assemblies damaged or twisted when the boom struck the ground. **AFMRC recommends the manufacturer modify the boom to enable operators to use various types of nozzle assemblies.**

Tank Filling: Ease of filling the spray tank with water was **good**. The 250 gal (1140 L) spray tank was filled through the sprayer reloading line. A nurse tank with a transfer pump was required. The spray tank could also be filled through the tank filler opening. Using the reloading line was safer because less foaming and splashing occurred. The spray tank was opaque and usually the liquid level could be seen against the tank wall. It took less than 10 minutes to fill the spray tank using a 2 in (50 mm) diameter transfer hose.

The 250 gal (1140 L) tank was small requiring frequent filling for the majority of applications encountered during testing. Applying 10 gpa (110 L/ha) at 14.4 mph (23 km/h), the tank emptied in less than 15 minutes using 0.5 gpm (2.3 L/min) nozzles. As a result many operators used low water rates to reduce the number of refills. Applying 2.5 gpa (28 L/ha) at 14.4 mph (23 km/h), the tank would last about an hour. Spraying at low water rates are not guaranteed by chemical suppliers in the Canadian prairies. In addition, custom applicators are required to spray at the rates written on chemical manufacturer's labels.

Chemical Inducting: Ease of adding chemical to the spray tank was **good**. Chemical was added manually through the spray tank filler opening. The chemical containers were lifted onto the non-skid platform first. The non-skid platform allowed easy and safe access to the spray tank filler opening. Still this was difficult, since the tank opening was about 7 ft (2 m) from the ground. Having the nurse tank deck near the same height as the sprayer platform made adding chemical easier. Because the spray tank was small, the number of chemical containers lifted per refill was small, making chemical adding almost unnoticeable. Caution was required to prevent the chemical splashing in windy conditions.

Tank refill time varied from 10 to 25 minutes, depending on the chemical used. Rinsing chemical containers and pre-mixing chemicals consumed the most time. Chemical handling, transfer, mixing and rinsing systems were available and made chemical inducting more convenient on the Spra-Coupe 3630.

Cleaning: Ease of cleaning the nozzle tips and strainers was **good**. Safety gloves were worn when removing strainers to prevent contact with the chemical draining from the lines after removing the strainers. In addition, the booms were set at a height convenient for removing and cleaning the nozzles and strainers to reduce chemical contact. Removing Spraying Systems' quick disconnect nozzle caps for cleaning was quick and easy. Some strainers stuck in the nozzle body and required a tool to remove. Nozzles were unplugged using a soft bristle toothbrush or compressed air to prevent nozzle orifice damage. Often the nozzle assemblies located behind the sprayer wheels were coated in dirt. The dirt rarely caused a nozzle orifice to plug, but required extra care when removing the nozzle cap to ensure no dirt fell into the orifice.

Ease of cleaning the pump inlet strainer and line strainer was **fair**. Both strainers were located approximately 5 ft (1.5 m) above the ground. Extra care was taken removing the line strainer bowl to prevent contact with the spray solution. The main line that arched above the line strainer completely emptied when the strainer bowl was removed.

The sprayer and booms were easy to wash. A wash hose with a nozzle was installed on the nurse tank to wash the sprayer in the field.

Draining: Ease of draining the spray tank was **fair**. Draining tank and line, rinsate solution was needed when switching chemicals to prevent freezing during late fall applications and before storing the sprayer. Nearly all the spray tank rinse water was first sprayed on the field and then drained from the tank and lines. The spray tank was drained through the reloading line by removing the reloading line cap and opening the reloading valve. The rinse water from the spray tank drained slowly. The Spra-Coupe was parked at an angle to empty the spray tank completely.

Draining the hoses was done by removing a hose end. Rinsate in the spray lines was drained by opening the inner nozzle lines and raising the boom ends. The diaphragm nozzle body assemblies were difficult to drain. The diaphragm was removed to drain the nozzle body assembly completely. An air pressure pump and tank were installed on the right non-skid platform. Compressed air was used to drain booms and nozzle assemblies for fall spraying and winter storage. The pump cavity was drained by installing a drain valve at the base of the pump.

Lubrication: Ease of lubricating the sprayer was **good**. The Spra-Coupe sprayer had 55 grease fittings. Thirty-seven grease fittings required greasing daily or every 10 hours. Twelve grease fittings required grease every 50 hours and the remaining six required grease every 500 hours. Most grease fittings were easy to get to with a grease gun. The grease fitting on the steering pivot was difficult to see and reach with a grease gun. The booms were folded forward to get to the inner boom hinge grease fittings. The grease fittings on the boom parallel linkage assembly were greased either by lowering the booms to field position or climbing on top of the assembly. Care had to be taken when climbing on the machine to reach grease fittings. Fifteen minutes was required to lubricate all grease fittings.

To get accurate oil capacity readings, the Spra-Coupe was parked on level ground before checking hydraulic or engine oil levels. Accessing the left side of the engine to check the engine oil was inconvenient. The left boom cradle was unsecured and rotated to avoid interference with the engine hood side cover.

The oil filler tube was concave on the top and collected water on the cavity. When removing the dipstick to check the oil level the water drained down the oil filler tube and into the engine. Adding oil to the engine was also difficult. A long spout or small oil container was required to avoid spillage. Before the test was over the manufacturer modified the oil fill housing to prevent water contamination and made it easier to add and check engine oil.

The transmission, rear end and final drive chain case oil levels were checked by removing check plugs located just above the full lines. The hydraulic oil reservoir had a sight glass that made it easy to check hydraulic oil capacity.

ENGINE AND FUEL CONSUMPTION

Engine: The engine had sufficient power for the field and road conditions encountered during the test. The turbo diesel engine supplied sufficient power for normal spraying conditions when operated above 3000 rpm. The engine lugged down only in very muddy conditions or climbing steep hills. The Spra-Coupe was started in any of the first 4 gears. The engine started easily when the glow plugs were used properly.

Engine oil consumption was insignificant.

Fuel Consumption: Fuel consumption averaged about 2.2 gal/hr (10 L/hr). The fuel tank straddled both sides of the sprayer and protruded behind the cab. When spraying on side hills the fuel shifted, sometimes starving the engine when the tank was half full. **It is recommended the manufacturer modify the fuel system to ensure fuel is supplied to the engine when operating the sprayer on side hills**. The fuel filler opening was located on the sprayer's left side non-skid platform. The filler opening was exposed to spillage from the spray tank solution when overfilled. The fuel tank could be filled from an average height fuel storage tank.

PUMP PERFORMANCE

Pump Output: Hypro Model 9202C centrifugal pump speed and pressure output was sufficient and rated as **very good**. The pump was belt driven from the engine. **Figure 15** shows pump speed and maximum nozzle pressure at various engine speeds using standard 8002 nozzles. In field conditions, the sprayer engine was operated above 3000 rpm for optimum performance. Maximum engine speed was 3750 rpm. The pump operated at 5500 rpm at an engine speed of 3500 rpm. With 36 nozzles on 60 ft (18 m) of spray booms and two jet agitators, the Hypro pump speed was adequate, delivering pressures above 120 psi (800 kPa) to the nozzles.

Figure 16 shows the maximum nozzle pressures available for various nozzle sizes. The maximum nozzle pressure available decreased as the nozzle size increased. For example, the maximum nozzle pressure was 155 psi (1070 kPa) for an XR8001 nozzle and 113 psi (780 kPa) for an XR8006 nozzle. The decrease was insignificant because the pressures were still above the standard spraying pressure of 40 psi (275 kPa). With the additional spraying

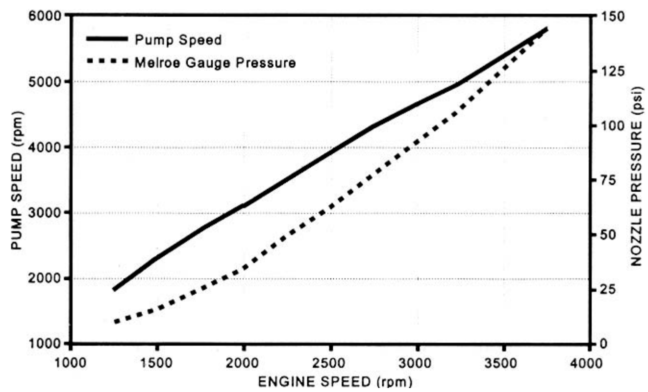

Figure 15. Pump Speed and Nozzle Pressure at Various Engine Speeds.

pressures, the automatic rate controller worked better with wide angled nozzle tips. With the wide angle 110^{o} extended range or turbo nozzles, slowing by gearing down was possible.

With the two agitator valves fully opened, the Melroe sprayer applied 10 gpa (110 L/ha) at 7.2 and 14.2 mph (12 and 23 km/h) using the 03 and 06 nozzle tips, **Table 5**. The sprayer applied 5 gpa (55 L/ha) at 7.2 and 14.2 mph (12 and 23 km/h) using the 015 and 03 nozzle tips, respectively. Shutting the agitator valves to increase nozzle pressure was unnecessary even with the large 8006 nozzles.

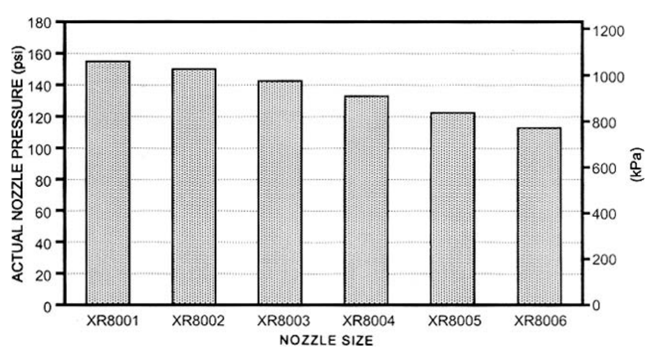

Figure 16. Maximum Nozzle Pressures at Maximum Engine Speed.

Table 5. Application Rates.

	Application rate gpa (L/ha) @ 40 psi (275 kPa)				
Nozzle Size	**4.3 mph (7 km/h)**	**7.2 mph (12 km/h)**	**10.8 mph (17 km/h)**	**14.4 mph (23 km/h)**	**20.0 mph (32 km/h)**
8001	5.7 (64)	3.4 (37)	2.3 (26)	1.7 (19)	1.2 (13)
80015	8.6 (96)	5.2 (56)	3.4 (39)	2.6 (28)	1.9 (21)
8002	11.5 (128)	6.9 (75)	4.6 (53)	3.4 (37)	2.5 (28)
8003	17.2 (192)	10.3 (112)	6.9 (79)	5.2 (56)	3.7 (42)
8004	23.0 (255)	13.7 (149)	9.2 (105)	6.9 (75)	4.9 (55)
8005	28.7 (319)	17.2 (186)	11.4 (131)	8.6 (93)	6.2 (70)
8006	34.5 (383)	20.6 (224)	13.7 (158)	10.3 (112)	7.4 (84)

Agitation: Agitation output was **very good**. The Spra-Coupe sprayer was equipped with two horizontally mounted hydraulic agitators. **Table 6** shows agitator input and output using the 0.19 in (4.8 mm) diameter orifice. Agitator input depended on pump speed. Size of nozzle or valve openings had little effect on agitation. Maximum agitation rates occurred with the agitator fully opened. Average agitator output was 32 gpm (145 L/min) during field spraying. This exceeded recommended agitation rates for emulsifiable concentrates and wettable powders. Normally recommended agitation rates for emulsifiable concentrates such as 2,4-D are 1.5 gpm per 100 gal (1.4 L/min per 100 L) of tank capacity. For wettable powders such as Atrazine, recommended agitation rates are 3.0 gpm per 100 gal (3.0 L/min per 100 L) of tank capacity. During reloading, agitator output was 12 gpm (55 L/min).

Table 6. Agitation.

Operating Conditions	**Engine Speed rpm**	**Agitation Input gpm (L/min)**	**Agitation Output gpm (L/min)**
Reloading	1500	6 (27)	12 (55)
Field Spraying	3500	16 (73)	32 (145)

MARKER PERFORMANCE

Sprayer Alignment: Aligning the sprayer to the mark made on the previous pass was **good**. Richway Industries Model SC-3013 foam marker system, **Figure 17**, was included with the test machine. When the foam mark was visible, the sprayer boom end was aligned to the foam using the end marker hose. The foam marks allowed successive passes of the sprayer to be properly aligned. The marker was useful in reducing overlaps or misses. Alignment required operator skill and judgement since the boom ends were more than 30 ft (9 m) from the operator.

The foam discharge tubes hit the ground frequently during spraying, moving the tubes into the spray of the end nozzles. Tightening the foam discharge tube support brackets did not help. Over tightening caused damage to the spray boom ends. **AFMRC recommends the manufacturer modify the foam discharge tubes to prevent them from interfering with the spray.**

Figure 17. Richway Industries Model SC-3013 Foam Marker. 1) Foam Discharge Tubes, 2) Foam Discharge Boots, 3) Compressor, Filter and Control Valve Housing, 4) Foam Tank, 5) Foam Carrier Hoses, 6) Foam Tank Cap and 7) Hardware.

Mark Visibility: Mark visibility was **good** in cereal and thick crop canopy conditions. Mark visibility was dependant on crop height, canopy density, field surface condition and mark spacing.

Mark visibility was adequate in most cereal crop conditions as long as mark spacing was adjusted to suit forward speed and field conditions. Foam marks were easy to see in crops less than 7 in (180 mm) tall. **Figure 18** shows a typical foam mark in a young cereal crop.

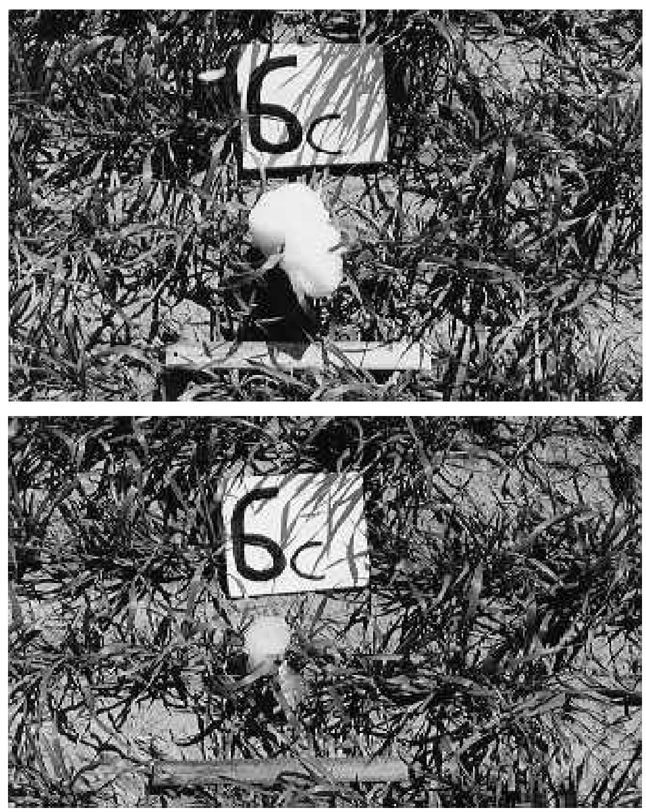

Figure 18. Typical Foam Marks in a Cereal Crop: **Top**: After Discharge and **Bottom**: 30 to 90 minutes After Discharge.

Mark visibility in chemfallow conditions was **fair**. Mark visibility in preharvest conditions was **poor**. The marks were difficult to see in tall crops and in stubble since the foam often dropped below the canopy.

Mark Adjustments: Mark length and spacing were dependent on the high/low switch setting, liquid control valve setting and boom end vibration. Foam length and spacing varied at all settings used. With the foam marker set on high, mark length varied from 3 to 11 in (75 to 280 mm) and averaged 5 in (125 mm). Mark spacing varied from 8 to 20 ft (2.5 to 6 m) with an average of 15 ft (4.5 m) at 15 mph (24 km/h). On the low foam setting, mark length and spacing depended on the liquid control valve setting. Opening the liquid control valve 5 revolutions was equivalent to having the foam marker high/low switch on high. Adjusting the valve towards the shut-off position increased mark length and spacing. Long foam marks wiped on the crop canopy or were blown off by the wind. Near shut-off, mark length averaged 6 in (150 mm) and the mark spacing averaged 40 ft (12 m). Mark width averaged 3 in (75 mm) and was dependent on the diameter of the boot on the foam discharge tubes.

Mark Durability: Mark durability was **good** using a good foam concentrate. The foam marks remained visible for approximately 90 minutes on cool and cloudy days. The foam marks were visible for less than 30 minutes in the hot and low humidity conditions typical of Southern Alberta. This was adequate when making successive passes. However, marks left on the outside round as a guide for turning often disappeared before the field was completed.

Controls: Ease of operating the foam marker controls was **very good**. The control switches were mounted in the Spra-Coupe cab console. The controls consisted of three toggle switches. The switches controlled solenoid valves located in the power unit. The high/low switch was convenient for applying extra foam on headlands and high and thin crops. The low rate was used to conserve foam solution during normal spraying conditions. The left/right switch was normally responsive. When the foam feeder hoses were full it took about 2 seconds for the foam to dispense after switching sides. When the foam feeder hoses were empty, it took about 15 seconds before foam filled the hoses and started dispensing. On several occasions the marker would not switch sides. The control console and/or solenoid valve was tapped until the switch worked. The left/right switch was replaced, but the solenoid valve still needed tapping to get it working.

The liquid control valve located in the power unit was inconvenient to use. The sprayer had to be stopped to remove the cover off the power unit and adjust the valve. Adjusting the valve took a great amount of time at the beginning before the desired foam size and spacing was achieved.

Quantity of Fluid Used: The amount of marking fluid used depended on the desired mark spacing. With the marker set on high, one tank marked about 100 ac (40 ha) at 15 mph (24 km/h). The marker was operated on high the majority of the time. When the marker was operated on low, one tank would mark about 270 ac (110 ha). Operating costs for marking solution averaged about 3 cents/ac (8 cents/ha).

Filling: Ease of filling the 11 gal (50 L) foam tank was **fair**. The boom assembly was lowered to place the foam tank filler opening at the desired height. The tank was pressurized so care was exercised when removing the cap. The fluid level was difficult to see through the sides of the foam tank. Adding water or foam concentrate to the tank caused foaming which usually resulted in overfilling the tank. A small transfer pump with a long discharge hose was needed to fill the foam marker tank since the nurse tank was parked near the spray tank filler hose during reloading.

Cleaning: Ease of cleaning the foam marker system was **fair**. Three air filters and two fluid filters required cleaning. The air filters were cleaned regularly because the power unit was mounted behind the sprayer where an abnormal amount of dust collected. The air filters were cleaned using an air compressor. The foam tank was emptied to clean the discharge fluid filter. A foam tank shut off valve was not provided. The second fluid filter was inconvenient to clean since the power unit had to be opened and the foam head taken apart to remove the filter. **AFMRC recommends that the manufacturer modify the marker system to make it easier to fill and maintain.**

Crop Damage: No crop damage resulted from the foam solution. The foam contacted less than 0.2% of the total crop area sprayed, and caused no injury to the plants.

OPERATOR SAFETY

The operator's manual emphasized operator safety. The manual discussed operating, chemical, maintenance, transport, hydraulic and tire safety. A storage tank for clean water and a charcoal air-filter in the cab increased spraying safety.

The booms were coated with dust and chemical residue after spraying. Polyurethane gloves were used when changing, cleaning or checking nozzle tips or spray patterns. The booms were rinsed in the field before repairs were done on them.

Caution: Operators are cautioned to wear suitable eye protection, respirators and clothing to reduce operator contact with chemicals. Although many commonly used agricultural chemicals may by harmless to humans, they are hazards if improperly used. In addition, knowledge is limited about the long-term effects of human exposure to many commonly used chemicals. Sometimes the effects may be cumulative, causing harm after continued exposure over several years.

OPERATOR'S MANUAL

The operator's manual was **very good**. The manual was clearly written, well illustrated and followed a practical order. Information was provided on safety, sprayer operation, maintenance, adjustments, troubleshooting, specifications and optional equipment.

MECHANICAL PROBLEMS

Table 7 outlines the mechanical history of the Spra-Coupe Model 3630 sprayer during 322 hours of operation while spraying 13546 ac (5484 ha). The intent of the test was evaluation of functional performance. An extended durability evaluation was not conducted.

Discussion of Mechanical Problems

Flow sensor: The flow sensor failed to function twice. The flow sensor failed at the beginning of the test. The sensor was replaced and failed again. The cable was faulty and replaced along with the flow sensor. **It is recommended the manufacturer modify the Spra-controller to prevent the flow sensor from failing**.

Agitator hoses: The agitator hoses supplied with the Spra-Coupe failed several times. The failures went unnoticed since the pump had enough capacity to keep the boom pressure at the desired level. The agitator hoses were replaced with hoses rated for 150 psi (1030 kPa). **It is recommended the manufacturer modify the agitation system to prevent the agitation hose from failing.**

Foam Marker Solenoid Valves: On several occasions the foam marker solenoid valves stayed closed. The valves were replaced and performed better. However, the problem occurred again, but not as frequently. **It is recommended the manufacturer modify the foam marker to prevent the solenoid valves from staying closed.**

Outer boom hinges: The outer boom hinges failed twice. The outer booms were modified during the test period.

Boom spring: The main boom breakaway spring was not strong enough to hold the booms in position. When spraying against a head wind the spring would release and the booms would fold rearwards. Melroe Company modified the spring during the test period.

Table 7. Mechanical History.

Item	Operating Hours	Equivalent Field Area	
		ac	ha
The Spra-controller's flow sensor failed and was replaced at	15	0	0
A bolt on the spray pump stand was missing. The bolt was replaced and the spray pump drive belt tension was adjusted at	28	54	22
The spray hose between the rear strainer and shut-off valves came off. The hose was reset and the hose clamp tightened at	62	1030	417
The left side of the centre boom bent and two nozzle assemblies broke spraying over a large pothole. The boom was repaired and nozzle assemblies replaced at	87	2095	848
The lower seal on the right front wheel shock started leaking at	89	2310	935
The agitator hose failed and replaced at	97 120	2595 3272	1050 1324
The agitator hose failed and replaced with a 150 psi (1030 kPa) hose at	124	3333	1349
The left/right foam marker solenoid valve housing cracked and was replaced at	123	3320	1344
The spray boom hinges failed and were re-welded at	134 281	4836 6637	1957 2686
The Spra-controller quit registering flow and the cable was repaired at	160	5080	2056
Oil leaked from the hub of the left rear wheel. The hub seal was replaced at	183	5080	2056
The Spra-controller quit registering flow and the flow sensor was replaced at	222	5666	2293
A switch in one of the boom shut-off valves failed and was replaced at	222	5666	2293
The spray boom ends pivoted rearwards at high spraying speeds throughout the test. The spring on the boom suspension system was replaced at	312	6637	2686

APPENDIX I
SPECIFICATIONS

MAKE:	Melroe Spra-Coupe	
MODEL:	3630	
SERIAL NUMBER:	209411354	
MANUFACTURER:	Melroe Company 521 South 22nd Street, Box 1215 Bismarck, ND 58504 (701) 222-5000	
OVERALL DIMENSIONS:*		
-wheel tread		
maximum	6.7 ft (2.0 m)	
minimum	9.0 ft (2.7 m)	
-wheel base	11.3 ft (3.4 m)	
-transport position:		
-height	10.8 ft (3.3 m)	
-length	19.6 ft (6.0 m)	
-width	7.7 ft (2.3 m)	
-field position:		
-height	10.8 ft (3.3 m)	
-length	19.8 ft (6.0 m)	
-width	58.3 ft (17.8 m)	
-clearance height	4.2 ft (1.3 m)	
-turning radius (@108 in spacing)	17.3 ft (5.3 m)	
TIRES:		
-front implement	9:00*24 SL, 6 ply	
-rear lug	12.4*24 F8, 8 ply	
WEIGHT: (with air assist on)	TRANSPORT POSITION Empty	FIELD POSITION Loaded
-front left wheel	1470 lb (670 kg)	1295 lb (590 kg)
-front right wheel	1480 lb (670 kg)	1260 lb (570 kg)
-rear left wheel	3270 lb (1485 kg)	4595 lb (2090 kg)
-rear right wheel	3025 lb (1375 kg)	4805 lb (2185 kg)
TOTAL	9245 lb (4200 kg)	11955 lb (5435kg)
SPRAY TANK:		
-material	plastic	
-capacity	250 gal (1130 L)	
-agitation	hydraulic, 2 jet agitators	
FILLER OPENING:		
-shape	round	
-size	8 in (200 mm) I.D.	
-location	top, front, left side	
-height above ground	7 ft (2.1 m)	
CHEMICAL INDUCTOR:	none	
STRAINERS:		
-reload hose	1, 40 mesh	
-spray pump outlet	1, 40 mesh-nozzle assembly 36, 50 mesh	
PUMP:		
-make	Hypro	
-model	9202C	

-type	centrifugal
-operating speed	5800 rpm at maximum engine speed
-type of drive	belt, magnetic clutch

SPRAY MONITOR:

-make	Raven (custom)
-flow sensor	turbine
-speed sensor	magnetic dial, outside cab

SHUT-OFF VALVES:

-type	ball
-size	3, 1 in (25 mm) NPT, 12 VDC

SPRAY BOOM:

-type	dry
-line size	0.75 in (19 mm)
-height adjustment	
-type	Electro-hydraulic
-range (low)	21 to 76 in (530 to 1930 mm)
-angle adjustment	none
-nozzle assembly	
-make	Spraying Systems
-type	split-eyelet diaphragm single nozzle
-number	36
-spacing	20 in (508 mm)
-cap	quick-connect, colour coded, self-aligning
-effective spraying width	60 ft (18 m)

Engine:

-make	Peugeot
-model	XUD11AT
-horsepower	87 hp (65 kW)
-governed speed	3600 rpm
-torque	154 ft-lbs (209 Nm)
-number of cylinders	4
-bore/stroke	3.35/3.62 in (85/92 mm)
-displacement	127.4 in^3 (2088 m^3)
-cooling system	liquid
-air cleaner	dual element, dry replacement cartridge
-ignition	diesel-compression

CONTROLS:*

-steering	power steering
-direction	transmission
-engine	foot pedal/hand throttle, key start and shutdown
-brake	foot pedal - mechanical disc

HYDRAULIC SYSTEM:*

-pump	engine driven gear pump
-pump capacity	priority flow - 3.5 gpm (16 L/min)
-system main relief	1500 psi (10300 kPa)
-filter	10 micron replaceable cartridge
-suction strainer	100 mesh screen
-boom	
-hydraulic cylinders	double acting
-number	4, boom lift and fold, boom end lift, power steering
-control	2, 4 and 6 section electro-hydraulic, open centre, 12 V neg. ground

ELECTRICAL:*

-alternator	105 amp, open, w/integral regulator
-battery	12 volt
-amps	420 cold crank amps at 0F (-18ºC)
-reserve	180 min reserve capacity
-starter	12 volt

DRIVE SYSTEM:*

-transmission	Borg-Warner T-5, neutral start interlock
-1st gear	4.3 mph (6.9 km/h)
-2nd gear	7.2 mph (11.6 km/h)
-3rd gear	10.8 mph (17.4 km/h)
-4th gear	14.4 mph (23.2 km/h)
-5th gear	20.0 mph (32.0 km/h)
-reverse	4.6 mph (7.4 km/h)
-rear axle	Dana Model 44-IC
-final drive	oil bath, double reduction roller chain
-upper chain	#80
-lower chain	#100
-reduction	5.35:1
-clutch	spring loaded pressure plate and disc
-disc	9.25 in (235 mm)

INSTRUMENTATION:

- -voltmeter gauge
- -engine oil pressure gauge with alarm
- -engine coolant temperature gauge
- -engine hourmeter/tachometer
- -fuel gauge
- -pressure gauge

CAPACITIES:

-cooling system	2.1 gals (9.5 L)
-fuel	21.0 gals (95.0 L)
-engine oil	1.7 gals (7.6 L)
-hydraulic oil	2.9 gals (13.0 L)
-transmission oil	0.6 gals (2.7 L)
-rear axle gear lube	0.3 gals (1.4 L)
-final drive chaincase	1.1 gals (5.2 L)
-front wheel tubes	0.4 gals (1.9 L)
-fresh water tank	12.5 gals (57.0 L)

*from Melroe's Operator's Manual - 3630 Spra-Coupe Specifications

APPENDIX II
MACHINE RATINGS

The following rating scale is used in Alberta Farm Machinery Research Centre Evaluation Reports.

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

APPENDIX III

SPRAY DRIFT TRIALS AND RESULTS

Trial Number	Wind Speed at 2m height (km/h)	Amount of 2,4-D sprayed Me (g)	On Swath Deposit Ms (g)	Off Swath Deposit Mg (g)	Airborne Drift Mass Ma (g)	On Swath Deposit (% Me)	Off Swath Deposit (% Me)	Airborne Drift D (% Me)	Total Drift Mass Mt (g)	Total Drift Dt (% Me)	Recovery (%)	Swath CV (%)
DG11002												
95-17	6.4	107.2	103.9	1.8	1.7	96.9	1.7	1.6	3.5	3.3	100.5	9.6
95-8	11.3	108.8	97.0	3.1	3.3	89.3	2.9	3.0	6.4	5.9	95.6	16.1
95-1	18.6	106.0	86.7	3.0	3.5	81.7	2.8	3.3	6.4	6.1	88.2	15.2
95-36	23.9	107.4	84.3	5.6	9.9	78.6	5.2	9.2	15.5	14.4	94.0	19.3
95-23	26.0	107.4	78.8	6.7	12.7	73.4	6.2	11.8	19.4	18.0	92.8	17.7
95-37	26.8	107.4	79.5	8.2	13.1	74.0	7.7	12.2	21.4	19.9	95.4	19.5
TT11002												
95-9	7.9	108.3	96.8	2.2	2.1	89.4	2.0	2.0	4.3	4.0	93.7	22.8
95-18	12.5	111.0	85.6	3.0	3.8	77.1	2.7	3.4	6.9	6.2	84.0	19.4
95-2	20.0	106.8	77.6	4.7	9.0	72.7	4.4	8.5	13.7	12.8	86.4	37.0
95-31	31.3	111.0	75.8	10.5	14.2	68.2	9.5	12.7	24.6	22.2	92.9	24.1
XR11002												
95-10	5.3	105.6	98.0	4.7	3.8	92.8	4.4	3.6	8.5	8.0	101.2	17.3
95-19	11.9	108.7	84.6	2.0	8.8	77.9	1.8	8.1	10.8	9.9	88.7	15.9
95-21	14.9	105.0	84.8	4.1	9.8	80.8	3.9	9.4	14.0	13.3	94.7	17.7
95-3	18.2	108.7	108.7	6.5	1.2	72.4	6.0	11.2	18.7	17.2	91.1	17.6
95-32	28.0	106.0	70.2	13.2	24.6	66.2	12.4	23.2	37.8	35.6	104.0	27.3
XR11002 Air Assist On												
95-16	6.3	106.4	76.2	6.2	6.3	71.7	5.8	6.0	12.6	11.8	84.2	22.3
95-13	10.7	107.6	83.5	7.9	12.4	77.6	7.3	11.5	20.1	18.8	97.9	14.4
95-4	16.1	109.5	69.7	6.0	14.0	63.7	5.4	12.8	20.0	18.2	83.6	17.6
95-7	17.0	105.7	75.0	6.9	20.5	71.1	6.5	19.4	27.4	25.9	98.4	18.5
95-20	21.1	108.5	67.9	4.6	22.2	62.6	4.2	20.5	26.8	24.7	89.3	25.0

SUMMARY CHART
Melroe Model 3630 Spra-Coupe Field Sprayer

RETAIL PRICE:	$76,900.00 (December, 1996, f.o.b. Lethbridge, Alberta)
RATE OF WORK:	100 ac/h (42 ha/h) at 14.4 mph (23 km/h)
QUALITY OF WORK:	
-application rate	
-accuracy	**very good**; within 1% after calibrating flow and speed sensors.
-response time	**very good**; within 5 seconds
-nozzle calibration (Turbo TeeJet Nozzles)	
-delivery	**very good**; within 5% of manufacturer's rating
-CV	**very good**; 2%
-wear	**good**; typical of polyurethane tips
-spray distribution (Turbo TeeJet Nozzles)	
-CV	**very good**; less than 10% operating above 15 psi (100 kPa) and 12 in (300 mm)
-spray drift (12 mph (20 km/h) crosswind)	
-DG11002	7.5% at 40 psi (275 kPa)
-TT11002	7.7% at 40 psi (275 kPa)
-XR11002	15.0% at 40 psi (275 kPa)
-air assist	20.0% with XR11002 nozzles
-pressure	
-loss	**very good**; less than 1 psi (7 kPa) across booms
-pressure gauge accuracy	**good;** within 2 psi (14 kPa) between 10 and 60 psi (15 and 400 kPa)
-nozzle pressure	**good**; within 3 psi (20 kPa) of gauge reading
-straining	**good**; agitators plugged
-boom stability	**good**; suspension system on booms, boom springs weakened
-crop damage	considered insignificant in young cereal crops
EASE OF OPERATION AND ADJUSTMENT:	
-operator comfort	**very good**; quiet and clean
-instruments	**good**
-controls	**good**; easy to reach
-spray monitor	**good**
-lighting	
-transport	**very good**
-night spraying	**fair**; optional flood light kit was not adequate
-application rate	**fair**; when using standard nozzles and single nozzle body assemblies **very good**; when using wide angle nozzles and multiple tip nozzle body assemblies
-wheel adjustments	**fair**; time consuming
-handling	**fair;** sprayer was stable, steering response was slow
-boom position	**good**; electric over hydraulic control
-nozzle adjustments	**good**
-tank filling	**good**; chemical was added through top of sprayer tank
-chemical inducting	**good**
-cleaning	**good**; spray line and pump inlet strainers were difficult to remove without spilling chemical on hands and arms
-draining	**fair**, draining was slow and tank drained in front of cab access ladder
-lubrication	**good**; some grease fittings were difficult to get at and 37 required greasing daily
-hitching	**good**; tow hitch was useful
ENGINE AND FUEL CONSUMPTION:	
-consumption was insignificant	
-fuel consumption	2.2 gal/hr (9.9 L/hr)
PUMP PERFORMANCE:	
-capacity	**very good**, adequate for 0.5 gpm nozzles (2.3 L/min), e.g., 8006, 11006, etc.
-agitation	**very good**; exceeded recommended rates, agitator valves needed to be shut off to completely empty tank or prevent foaming
END MARKER PERFORMANCE:	
-mark visibility	
-cereal crops	**good**; in crops less than 8 in (200 mm)
-chemfallow	**fair**; mark below canopy difficult to spot
-preharvest	**poor**; marks difficult to see
-sprayer alignment	**good**; aided by end marker tubes
-mark durability	**good**; lasted up to 90 minutes in cool conditions and less than 30 minutes in hot conditions
-controls	**very good**; problems with switch control
-area marked	100 ac (40 ha) at high setting
-filling and cleaning	**fair**
OPERATOR SAFETY:	**very good**; safety warnings and decals throughout sprayer and operator's manual, had small water tank to rinse hands
OPERATOR'S MANUAL:	**very good**; complete information on safety and operation
MECHANICAL HISTORY:	monitor crashed, foam marker did not switch, weak agitator hoses, outer boom hinges failed

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