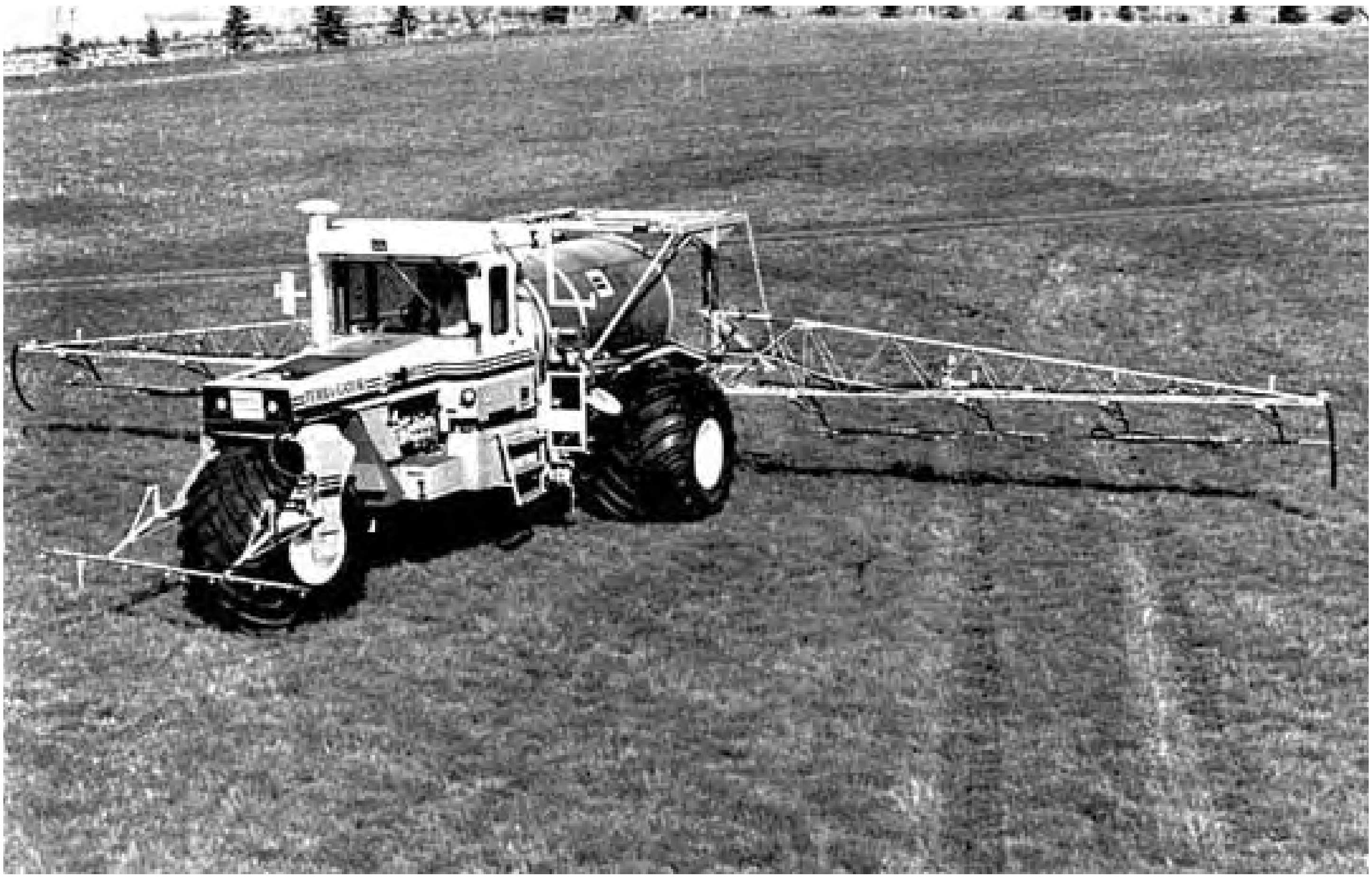
Evaluation Report No. E1880
Printed: June, 1981
Tested at: Lethbridge
ISSN 0383-3445

Evaluation Report 233



AG-CHEM EQUIPMENT CO., INC.
TERRA-GATOR MODEL 1603 FLOATATION APPLICATOR

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

TERRA-GATOR 1630 FLOATATION APPLICATOR

MANUFACTURER AND DISTRIBUTOR

Ag-Chem Equipment Co. Inc.
4900 Viking Drive
Minneapolis, Minnesota
U.S.A.

RETAIL PRICE:

$69,336.00 U.S. June, 1981, f.o.b. Minneapolis, Minnesota, with liquid system including stainless steel spray tank, 157 kW (210 hp) Caterpillar V-8 diesel engine, 10-speed Fuller transmission, drop boom assembly, pedestal 4" x 3" centrifugal pump, cab with air conditioning, stainless steel chemical inductor and foam marker assembly.

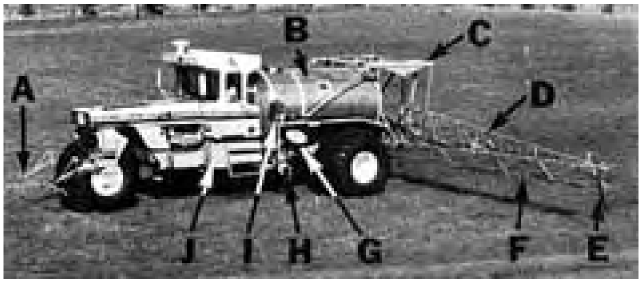


FIGURE 1. Terra-gator 1603 with Liquid System: (A) Front Drop Boom, (B) Spray Tank, (C) Boom Support Members, (D) Main Boom, (E) Foam Marker Drop Hose, (F) Rear Drop Boom, (G) Inductor System, (H) Pump Reload Hose, (I) Flow Meter*, (J) Fuel Tank.

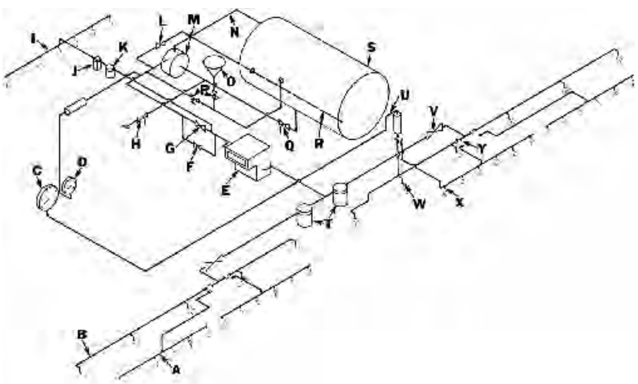


FIGURE 2. Liquid System Schematic: (A) Drop Boom, (B) Main Boom, (C) Boom Pressure Gauge, (D) Pump Pressure Gauge, (E) Flow Meter*, (F) Low Pressure Throttling Valve, (G) High Pressure Throttling Valve, (H) Reload Valve, (I) Front Boom, (J) Solenoid Valve, (K) Front Drop Boom Line Strainer, (L) Agitator Control Valve, (M) Pump, (N) By-pass Line, (O) Inductor Funnel, (P) Inductor Control Valves, (Q) Shut off Valve, (R) Agitator, (S) Spray Tank, (T) Line Strainers, (U) Boom Pressure Line, (V) Air Actuated Boom Control Valve, (W) Main Boom Nozzle Outlet, (X) Drop Boom Nozzle Outlet, (Y) Quick Couplers.

**Additional equipment installed for test purposes that was not supplied with machine.*

SUMMARY AND CONCLUSIONS

Functional performance of the Terra-gator 1603 floatation applicator when equipped with the liquid system and regular high clearance booms was very good. The special order drop boom was of no beneficial value in normal herbicide application and was deemed unnecessary for prairie crop conditions. Functional performance was reduced by difficulty in adjusting and maintaining boom pressures with special order drop booms, slow responding boom lift, exhaust irritating operators during reloading and inducting chemicals, front drop boom supply hose interfering with the front tire and a leaky hydraulic boom control assembly.

The steering and braking systems were very good. Instruments and controls were conveniently positioned. Most controls were responsive. The cab was adequately pressurized and relatively dust free. The optional air conditioning system performed well. Sound level at the operator station was about 83 dbA.

The engine had ample power for all field and road conditions encountered. Fuel consumption averaged about 18.6 L/h (4.1 gal/h). Engine oil consumption was insignificant.

Boom end visibility was good in the daytime, and poor at night. Rear visibility was restricted by the spray tank. Rear view mirror visibility was somewhat restricted by the boom structural members. Liquid level visibility was fair.

Ease of servicing was good. Care had to be exercised when walking on the machine during servicing.

The Terra-gator 1603 performed well at field speeds up to 30 km/h (18.7 mph) resulting in an average work rate of 35.9 ha/h (88.7 ac/h). Maximum transport speed was 50 km/h (31.1 mph). The Terra-gator was reasonably stable with a full tank if normal care was used when turning corners on hillsides.

The high and low pressure throttling valves and agitator valve were convenient to operate when using the regular high clearance boom. However, the pressure on the special order drop booms was difficult to adjust and maintain with the throttling valves. Regular high clearance boom height was not adjustable but nozzle height and angle could be adjusted on the drop booms. Adjusting nozzle height on the drop booms was inconvenient. The hydraulically activated booms were convenient in avoiding obstacles. However, the slow lift and drop rate made it inconvenient to quickly return the booms to their proper height after avoiding an obstacle. The Terra-gator was quickly and easily folded into transport position or placed into field position. Quick couplers and adapters made switching over to the drop booms convenient. Utilization of the inboard pump made filling and adding chemical into the spray tank easy and convenient. The spray tank was easily drained through the reload line and the tank sump allowed for complete liquid removal.

Nozzle distribution patterns were acceptable at pressures above 110 kPa (16 psi) for both the 1/4K-SS15 and TK-SS10 flood jet nozzles used on the regular high clearance boom. Nozzle distribution patterns for the 110 degree, LP Flat Fan TeeJet 11003 and 11006 nozzles used on the special drop boom assembly were very uniform at pressures above 80 kPa (12 psi). Comparative weed kill trials show that weed kill was equally as good with the regular high clearance boom and floodjet nozzles as with the special drop boom and LP flat fan nozzles. Weed kill behind the front drop boom was very poor due to the front tire absorbing and knocking the chemical off the leaves.

Nozzle distribution patterns were acceptable over a wide range of boom heights. Maximum boom movement in the field did not exceed this acceptable range and overall distribution patterns were not adversely affected by boom movement in the field.

Nozzle deliveries for the floodjet nozzles were from 2 to 4% lower than the manufacturer's rating and the LP TeeJet nozzle delivery was similar to the manufacturer's rating. With the 110 degree, LP TeeJet brass nozzles, delivery increased about 2% after field use. The nozzle assemblies accepted a wide range of standard nozzle tips.

The foam marker was a useful aid in reducing overlap or misses and was convenient to use. Marks were readily visible in crops less than 250 mm (10 in) tall. Foam mark quality depended on the amount of soap solution added and on water temperature and softness. Cost of marking solution was about 9 cents/ha (4 cents/ac).

Although there were significant system pressure losses when using high capacity floodjet nozzles on the regular high clearance boom, they were of no consequence to the operator, since operating pressures were measured at the boom ends. Nozzle pressures varied slightly from the pressure read on the cab pressure gauge due to pressure loss from the boom end to the nozzles and a pressure loss from the boom end to the cab pressure gauge. Both the pump and boom pressure gauges were in error up to 15 kPa (2.2 psi) at the end of the test. Pressures in the special order drop boom were difficult to adjust and took longer than normal to stabilize upon opening the boom valves.

Filtering was adequate and nozzle plugging was infrequent. Nozzle strainers were added to the drop boom nozzle assemblies.

Soil contact pressure beneath the wheels was about 60% that of an unloaded pickup truck and half that of conventional field sprayer wheels. Crops up to 250 mm (10 in) high could be sprayed with no crop damage or tire marks visible after about three weeks.

Output of the Terra-gator centrifugal pump closely matched the manufacturer's rating and was more than adequate to apply and agitate all chemicals and liquid fertilizers used during the test.

No serious safety hazards were encountered when operated according to the manufacturer's recommended procedures and in accordance with good chemical practice. Exhaust fumes were irritating to the operator while positioning the valves during tank filling and inducting. Caution was required when opening the pressurized foam marker tank. The narrow cab steps made leaving the cab difficult.

The operator's manual adequately outlined sprayer operation, calibration, servicing, maintenance and parts. However, the manual was confusing and unclear since it applied to a number of Terra-gator models as well as the 1603.

Only minor mechanical problems occurred during the test: the drop boom assembly springs and snap pins bent, the tank lid bushing loosened and got jammed in the pump, and some drop boom hoses were too short.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Increasing the boom lift and drop rates to make it easier to control the booms in rough and hilly fields.
2. Modifications to improve boom end lighting for night operation.
3. Providing lubrication intervals for all grease fittings.
4. Modifications to prevent operator contact with exhaust during reloading and inducting.
5. Modifications to provide safer and more convenient filling of optional foam marker tank.
6. Modifications to the cab steps to improve safety of cab when dismounting.
7. Revising the operator's manual to improve clarity.
8. Expanding the operator's manual by providing calibration charts in metric (SI) units.
9. Supplying metric or dual calibration pressure gauges or a suitable conversion chart to facilitate sprayer operation in the metric (SI) system.
10. Modifications to prevent the hydraulic boom control assembly from leaking.
11. Modifications to reduce the possibility of bending the tire valve stems.
12. Modifications to prevent the tank lid bushing from loosening and falling into the pump.
13. Functional testing indicated that the special order drop boom assembly served no beneficial purpose in prairie grain crops and should be discontinued. If, however, some future need for the drop boom assembly is shown and it is to be manufactured, then the following changes are recommended to the drop boom assembly:
    a. Modifications to reduce pressure adjusting sensitivity.
    b. Modifications to reduce the pressure lag when the boom control valve is opened.
    c. Relocating the front boom assembly behind the wheels to improve weed kill by the central drop boom.
    d. Eliminating hose interference with various components.
    e. Modifications to eliminate support spring stretch and snap pin deformation.

Chief Engineer: E. O. Nyborg
Senior Engineer: E. H. Wiens
Project Technologist: L. B. Storozynsky

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. The boom lift and drop rates have been increased by removal of the fixed restrictor in the hydraulic line at the rod-end port of the boom lift cylinder.
2. Boom-end lighting is not offered as a standard option. Customers that do operate at night usually mount a flood type lamp on the boom support structure.
3. An illustrated lubrication chart decal is being developed for a more concise and clear maintenance guide.
4. The exhaust on the 1982 model Terra-Gator 1603 has been changed to a vertical outlet, exhausting on the right hand side, just above the cab roof.
5. The foam marker tank is placed as low as possible and yet maintain adequate ground clearance. Ag-Chem was the first manufacturer to provide a ball valve at the filler. Opening may be made slowly and even if opened inadvertently under pressure, does not result in blowing off a loose piece, such as a quick-disconnect cap.
6. The cab steps have been modified on the 1982 models by:
    a. Raising the entire assembly upward so that the top most step is flush with the top of the fuel tank to form a landing just out of the cab.
    b. Addition of another step on the bottom, which is adjustable.
    c. All stair treads are of open grate, self-cleaning and self-sharpening non-skid design.
    d. The hand grip has been moved closer to the rear edge of the door opening and another grip added to the inside of the door.
7. The operator's manual consists of separate sections on chassis, liquid systems, dry spreader system, engine, transmission, etc. Each section has various optional equipment and some interchange ability with other Ag-Chem chassis models for standardization and maximum value. The liquid system section of the operator's manual has been rewritten for clarification with added illustrations and photos. The chassis section is currently being modified for clarification and incorporation of the 1982 model changes.
8. Nozzle delivery charts in metric units are available for Spraying Systems flooding type nozzles for 150 and 300 cm nozzle spacing. These will be included in future shipments to Canada.
9. Conversion charts from U.S. customary units to metric (SI) units will be included in future shipments to Canada.
10. The hydraulic boom control valve has been changed to a different make to eliminate the external leakage.
11. The bent tire valve stem probably occurred from tie down interference in shipping. This has never been previously reported. We consider it an isolated incident and no changes are planned.
12. The tank lid gasket is retained with a large square head threaded retainer and has never previously caused a problem. These are now being checked for tightness.
13. The special order drop boom has only been made in very limited quantities and has been discontinued.

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

GENERAL DESCRIPTION

The Terra-gator 1603 is a self-propelled floatation applicator. It is available with interchangeable liquid or dry spreading application systems. The liquid system is designed for application of a wide range of liquids such as liquid fertilizer, liquid lime and herbicides. The dry system, which uses two spinning disks, is designed for spreading granular fertilizer and lime.

The basic power unit is supported by three floatation tires and is equipped with a pressurized operator cab, hydraulic front wheel steering and pneumatic brakes. Traction drive is through a ten-speed transmission and differential with planetary reduction system. Two engine options are available.

The test machine was equipped with a 157 kW (210 hp) Caterpillar V-8 diesel engine and a liquid application system complete with option accessories as listed on page 1. In addition to the normal high-clearance spray booms, designed for flood-jet nozzles with 1525 mm (60 in) nozzle spacing, the test machine was supplied with a special order low clearance drop boom attachment. The drop booms were designed for flat fan pressure nozzles at 508 mm (20 in) spacing as is commonly used for herbicide application in prairie grain crops.

The liquid system has a 6000 L (1320 gal) stainless steel tank equipped with a sparger tank agitator and a chemical inductor. The centrifugal pump is belt driven from the engine crankshaft and controlled with an electromagnetic clutch. The two, rear-mounted, hydraulically controlled, high-clearance booms, which pivot forward for transport, have a spraying width of 16.8 m (55 ft). The special order low clearance drop booms attached beneath the normal boom, on each side, while a centre section mounted on the front wheel.

FIGURES 1 and 2 identify sprayer and liquid system components while detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The Terra-gator 1603 was operated for 155 hours in the conditions shown in TABLES 1 and 2 while spraying about 3300 ha (8150 ac). It was evaluated for quality of work, rate of work, pump performance, marker performance, ease of operation and adjustment, operator safety and suitability of the operator's manual. Comparisons were also made between the suitability of the high clearance boom with floodjet nozzles and the special order low clearance boom with flat fan low pressure nozzles in application of liquid herbicides.

TABLE 1. Operating Conditions

Material Applied	Field	Nozzles	Speed km/h	Field Area ha	Hours
–	Road Transport	–	50	–	4
(a) With High Clearance Regular Boom and Floodjet Nozzles					
28-0-0/10-34-0	Cultivated Stubble	1/4K-SS15	24	141	9.6
10-34-0	Cultivated Stubble	1/4K-SS15	30	93	3.8
28-0-0/2, 4-D	Winter Wheat	1/4K-SS10	24	144	6.5
Treflan	Summerfallow	1/4K-SS15	24	90	5.3
	Cultivated Stubble	1/4K-SS10	18.8	20	2.4
2, 4-D	Wheat	TK-SS10	18.8	58	2.3
2, 4-D/WEX mix	Wheat and Barley	TK-SS10	18.8	185	7.5
Buctril M	Wheat	TK-SS10	18.8	34	1.6
Tordon 202-C	Wheat	TK-SS10	24	37	1.2
	Wheat	TK-SS10	18.8	48	2.0
(b) With Low Clearance Drop Boom and Flat Fan Low Pressure Nozzles					
2, 4-D	Wheat and Barley	11003 LP	14.5	91	7.0
		11003 LP	18.8	664	29.0
2, 4-D/Avenge	Wheat and Barley	11006 LP	24	220	8.3
Buctril M	Wheat	11003 LP	18.8	84	3.8
		11006 LP	24	219	8.9
Embutox E	Wheat and Alfalfa	11006 LP	14.5	129	9.5
Tordon 202-C	Wheat and Barley	11006 LP	24	959	36.2
		11003 LP	18.8	84	8.1
TOTAL				3300	155

TABLE 2. Field Conditions

Topography	Hours	Field Area (ha)
Level	24	493
Undulating	96	2030
Rolling	24	493
Hilly	11	284
TOTAL	155	3300

RESULTS AND DISCUSSION

QUALITY OF WORK - PERFORMANCE WITH REGULAR HIGH CLEARANCE BOOM

General: The regular boom assembly is designed for use with floodjet nozzles at 1525 mm (60 in) spacing. The boom height is fixed at 1270 mm (50 in) above ground level. The pump and system capacity make the Terra-gator suitable for high application rates. Application rates up to 842 L/ha (75.8 gal/ac) at a forward speed of 25 km/h (15 mph) and a nozzle pressure of 205 kPa (30 psi) are possible with 1/2K-80 floodjet nozzles.

Due to the low application rates normally used in the prairies, the Terra-gator was used with Spraying Systems 1/4K-SS15 floodjet nozzles for liquid fertilizer and with Spraying Systems TK-SS10 floodjet nozzles for herbicide application (FIGURE 3).

Distribution Patterns: The floodjet nozzles were designed for use over a pressure range from 70 to 270 kPa (10 to 40 psi). FIGURES 4 and 5 show typical spray distribution patterns along the boom with the TK-SS10 floodjet nozzles at 70 and 205 kPa (10 and 30 psi), at a nozzle height of 1140 mm (45 in), representing the normal boom height above a 130 mm (5 in) high crop. The coefficient of variation (CV)[1] at 70 kPa (10 psi) was 21.6%, with application rates along the boom varying from 50 to 107 L/ha (4.5 to 9.6 gal/ac) at 25 km/h (15 mph). High spray concentration occurred below each nozzle with inadequate coverage between nozzles. At 205 kPa (30 psi) the distribution pattern improved considerably, reducing the CV to 8.6%. Application rates along the boom varied from 88 to 122 L/ha (7.9 to 11 gal/ac) at 25 km/h (15 mph). Higher pressures increased the capacity of the nozzles and improved distribution by increasing the overlap among nozzles. Higher pressure, however usually causes more spray drift.

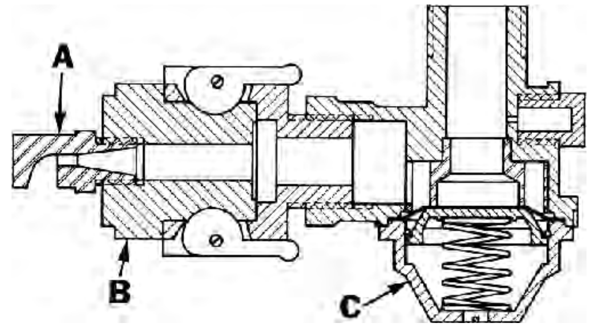


FIGURE 3. Floodjet Nozzle Used with Regular High Clearance Boom: (A) Nozzle, (B) Quick Coupler, (C) Diaphragm Check Valve.

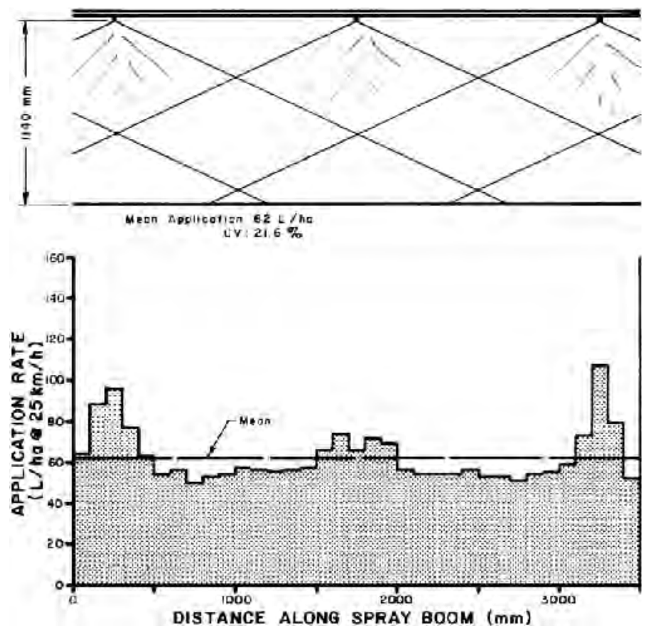


FIGURE 4. Typical Distribution Pattern at 70 kPa with Spraying Systems TK-SS10 Floodjet Nozzles, at a 1140 mm Nozzle Height.

FIGURE 6 shows how nozzle pressure, height, size and wear affected spray pattern uniformity of the floodjet nozzles. The spray pattern uniformity of new TK-SS10 floodjet tips was affected by pressure and height. At 1140 and 1270 mm (45 and 50 in) heights, which represent spraying a 130 mm (5 in) high crop or on the ground surface respectively, new TK-SS10 flood jet tips produced acceptable distribution patterns above 110 kPa (16 psi). At a height of 1140 mm (45 in) the TK-SS10 nozzles produced very uniform distribution patterns above 170 kPa (25 psi) with the best distribution at 205 kPa (30 psi). At a 1270 mm (50 in) nozzle height the TK-SS10 nozzles produced very uniform distribution patterns only between 138 and 170 kPa (20 and 25 psi) with the best distribution at 138 kPa (20 psi). Pressures above 170 kPa (25 psi) resulted in acceptable distribution patterns. There was no change in pattern uniformity after 22 hours of field use with post emergence herbicides.

[1] The coefficient of variation (CV) is the standard deviation of application rates for successive 100 mm sections along the boom expressed as a per cent of the mean application rate. The lower the CV, the more uniform is the spray coverage. A CV below 10% indicates very uniform coverage while a CV above 15% indicates inadequate uniformity for chemicals having a narrow application range. The CV's above were determined in stationary laboratory tests. In the field, CV's may be up to 10% higher 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 (±14%) while other chemicals may have a narrower range.

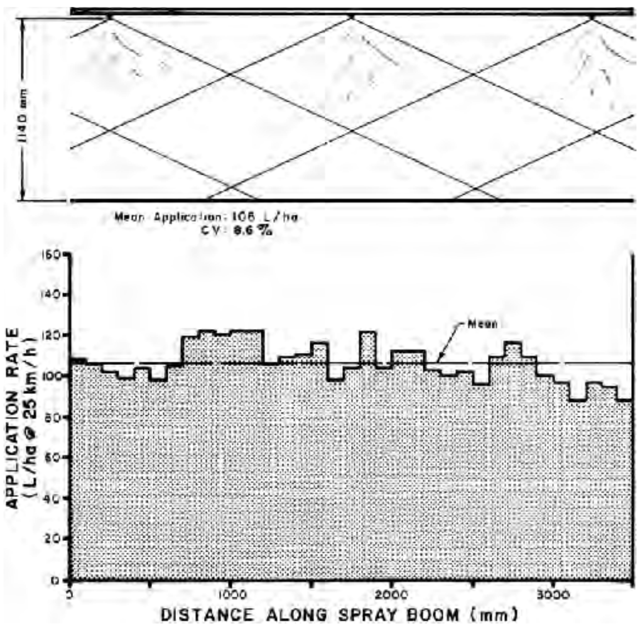


FIGURE 5. Typical Distribution Pattern at 205 kPa with Spraying Systems TK-SS10 Floodjet Nozzles, at a 1140 mm Nozzle Height.

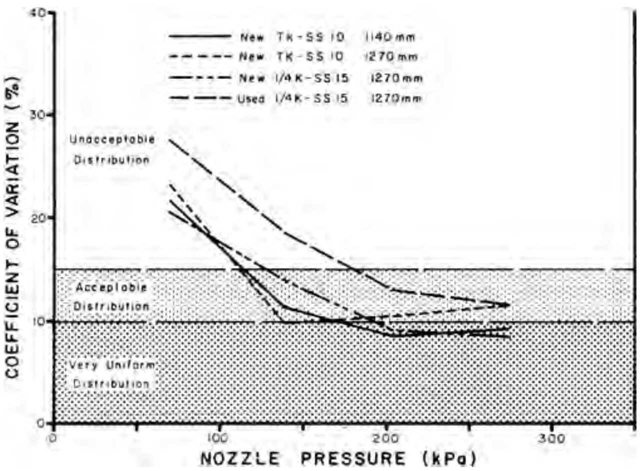


FIGURE 6. Spray Pattern Uniformity for New TK-SS10 Floodjet Nozzles, Operated at 1140 and 1270 mm Nozzle Height and for New and Used 1/4K-SS15. Floodjet Nozzles, Operated at 1270 mm Nozzle Height.

FIGURE 6 also shows the effect of pressure and wear on spray pattern uniformity for 1/4K-SS15 floodjet nozzles. The new 1/4K-SS15 nozzles produced acceptable distribution patterns at pressures above 127 kPa (18 psi) and very uniform distribution at pressures above 190 kPa (28 psi) with the best distribution at 275 kPa (40 psi). The uniformity changed appreciably after only 19 hours of use with liquid fertilizer. After 19 hours, a 180 kPa (26 psi) pressure was needed to produce an acceptable distribution pattern and the nozzles were no longer capable of producing a very uniform distribution at any pressure. The best distribution still occurred at 275 kPa (40 psi).

Nozzle Calibration: FIGURE 7 shows the average delivery of the Spraying Systems TK-SS10 and 1/4K-SS15 floodjet nozzles over the normal range of operating pressures. The delivery of new TKSS10 and 1/4K-SS15 nozzles was 2% and 4% lower, respectively, than specified by the manufacturer. The delivery rate did not change after 20 hours of field use.

Week Kill: The TK-SS10 floodjet nozzles were used to apply 2,4-D, Buctril M and Tordon 202-C in a number of crops. Nozzle heights were an average 1140 mm (45 in) above the crop surface.

Field speeds were 19 and 24 km/h (12 and 15 mph). Weed counts, conducted both behind the power unit and at the boom ends, indicated weed kill varied from good to very good on all test sites.

Although some swirl and spray pattern distortion was detected directly behind the power unit, weed kill was uniform across the full boom width. At higher field speeds, pattern distortion behind the power unit may be more noticeable.

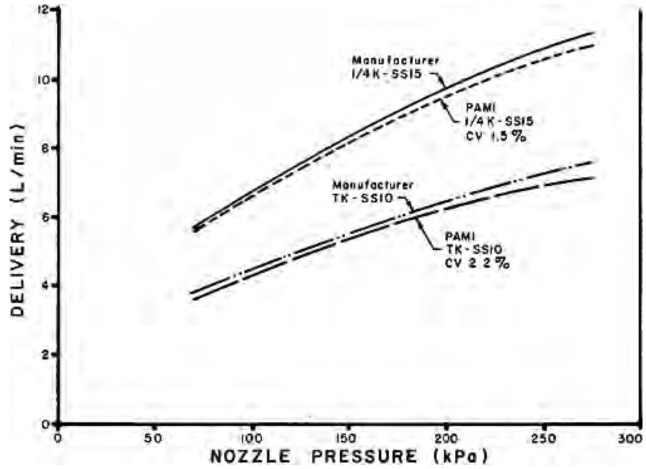


FIGURE 7. Delivery Rates for TK-SS10 and 1/4K-SS15 Floodjet Nozzles.

QUALITY OF WORK - PERFORMANCE WITH SPECIAL ORDER DROP BOOM

General: There is a general belief, among western Canadian weed researchers that floodjet nozzles are not suitable for the application of some post emergence herbicides at the rates commonly used in prairie grain crops. As a result, some floater applicator operators are using normal western Canadian spray booms as an attachment on floater applicators. A special order drop boom attachment was supplied by the manufacturer to enable comparative field tests of floodjet nozzles and flat fan spray nozzles. The drop booms had a nozzle spacing of 508 mm (20 in) and could be adjusted from 350 to 1210 mm (14 to 48 in) above ground level.

The drop booms were equipped with Spraying Systems wide angle, low pressure LP TeeJet 11003 and 11006 nozzles (FIGURE 8). The low pressure nozzles were selected because of their low drift characteristics at high operating speeds and in windy conditions.

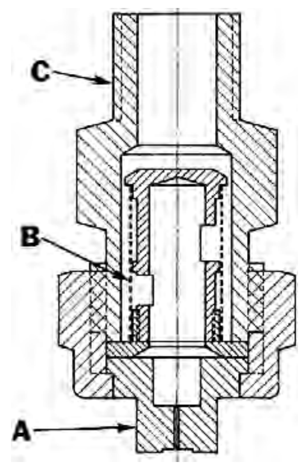


FIGURE 8. Low Pressure Flat Fan Spray Nozzles Used with Special Drop Boom: (A) Nozzle Tip, (B) Strainer, (C) Nozzle Body.

Distribution Patterns: The LP TeeJet nozzles were designed for use over a pressure range from 70 to 205 kPa (10 to 30 psi). FIGURES 9 and 10 show typical spray distribution patterns along the drop boom with LP TeeJet 11006 nozzles when operated at 380 and 1140 mm (15 and 45 in) heights at 140 kPa (20 psi). The coefficient of variation at 380 mm (15 in) was 13.2% with application rates along the boom varying from 104 to 161 L/ha (9.4 to 14.5 gal/ac) at 25 km/h (15 mph). High spray concentration occurred below each nozzle with inadequate coverage between nozzles. At 1140 mm (45 in) the distribution improved, reducing the CV to 4.7%. Application rates along the boom varied from 115 to 138 L/ha (10.4 to 12.4 gal/ac) at 25 km/h (15 mph). Higher nozzle height improved distribution by increasing the number of overlaps among nozzles. Higher nozzle heights at high speeds, however, usually causes more spray drift.

`FIGURE 11 shows the effect of nozzle pressure and height on spray pattern uniformity for TeeJet 11003 and 11006 low pressure nozzles. At 460 mm (18 in) the lower capacity LP TeeJet 11003 brass nozzles produced very uniform distribution patterns at pressures above 80 kPa (12 psi), while the LP 11006 nozzles produced very uniform distribution patterns above 120 kPa (17 psi). Both nozzles produced very uniform distribution patterns at heights greater than 460 mm (18 in) at all pressures. Both nozzles produced acceptable distribution patterns through a range of heights from 350 to 1210 mm (14 to 48 in) at all the recommended pressures. The LP 11003 nozzles produced slightly better spray patterns at 1015 mm (40 in) than the LP 11006 nozzles. The LP 11003 nozzles would however have greater spray drift.

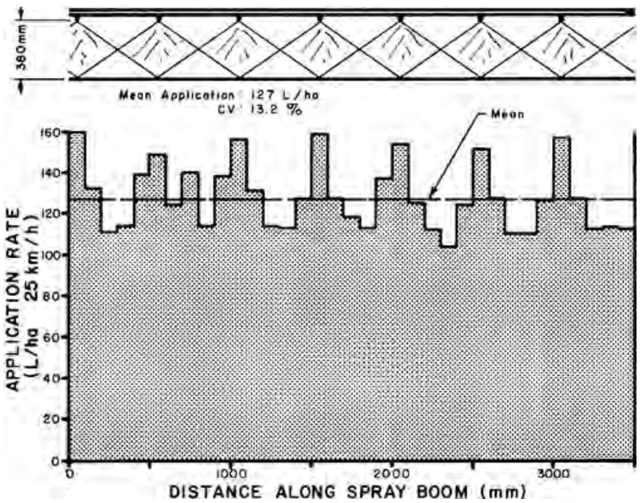


FIGURE 9. Typical Distribution Pattern at 140 kPa with LP TeeJet 11006 Brass Nozzles, at a 380 mm Nozzle Height.

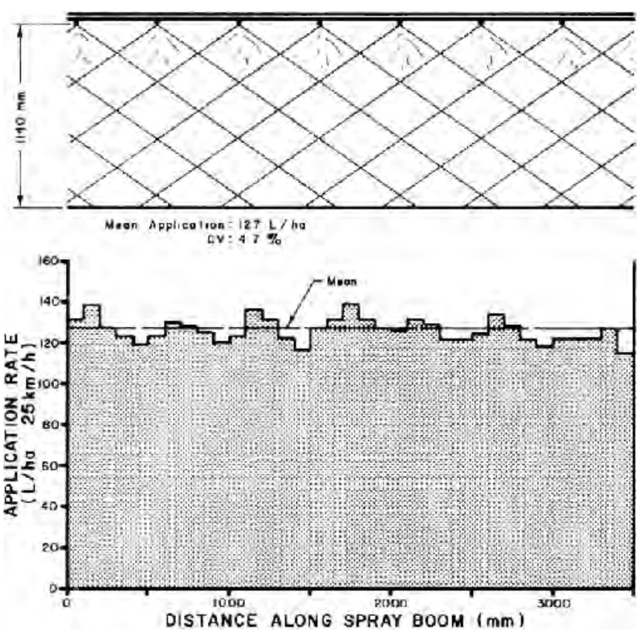


FIGURE 10. Typical Distribution Pattern at 140 kPa with LP Tee Jet 11006 Brass Nozzles, at a 1140 mm Nozzle Height.

FIGURE 12 shows how nozzle wear affected spray pattern uniformity for the 110 degree low pressure TeeJet nozzles. At a nozzle height of 460 mm (18 in) new LP 11006 brass nozzles produced very uniform distribution patterns at pressures above 120 kPa (17 psi), while after 63 hours of field use, a pressure of 145 kPa (21 psi) was needed to produce a very uniform distribution. At a 1140 mm (45 in) nozzle height, the used LP 11006 nozzle produced slightly poorer spray distribution patterns than the new LP 11006 nozzles. However, the worn nozzles were still capable of producing very uniform distribution at any pressure. Similar results were obtained with worn LP 11003 brass nozzles.

Nozzle Calibration: FIGURE 13 shows the average delivery of Spraying Systems LP TeeJet 11003 and 11006 brass nozzles over the normal range of operating pressures. Measured delivery agreed with the manufacturer's rated output.

The delivery rate of LP Tee Jet 11003 and 11006 nozzles increased an average of 2.4 and 1.3%, respectively, after about 50 hours of field use. Some researchers indicate that a nozzle needs replacement once delivery has increased by more than 10%.

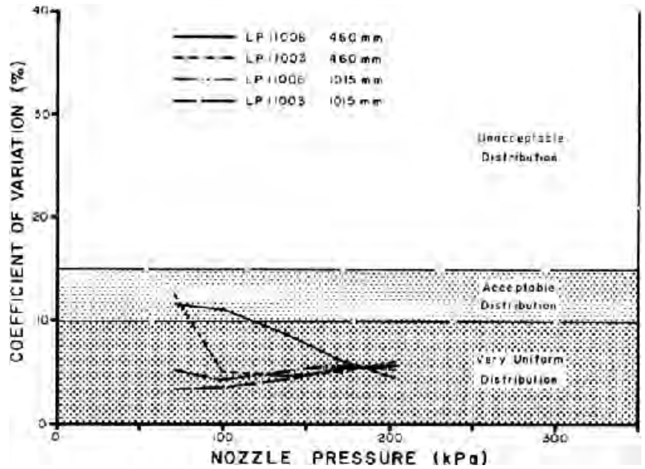


FIGURE 11. Spray Pattern Uniformity for New LP Tee Jet 11003 and 11006 Brass Nozzles, Operated at Heights of 460 and 1015 mm.

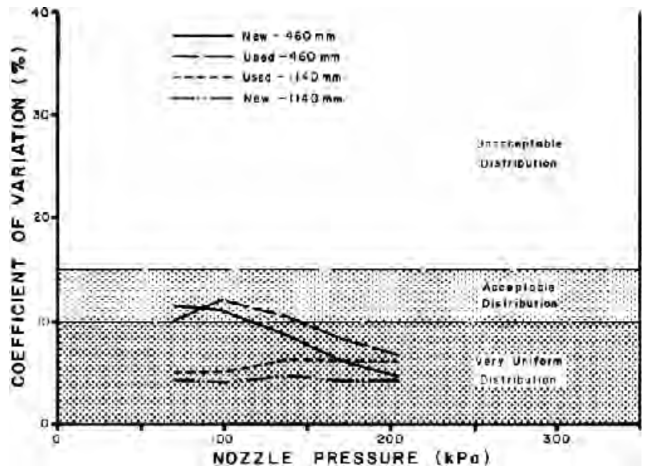


FIGURE 12. Spray Pattern Uniformity for New and Used LP TeeJet 11006 Brass Nozzles, Operated at Heights of 460 and 1140 mm.

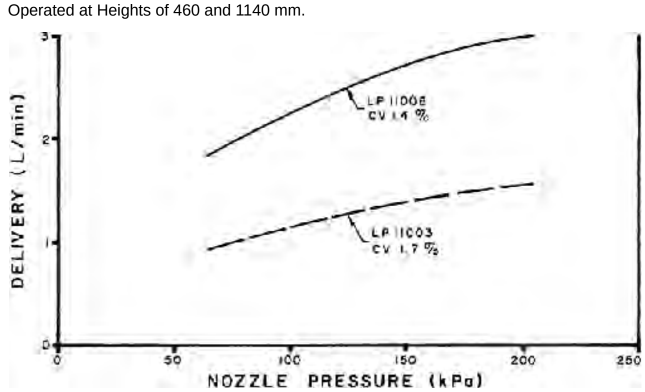


FIGURE 13. Delivery Rates for LP 11003 and LP 11006 Nozzles.

Weed Kill: The LP 11003 and LP 11006 flat fan spray nozzles were used to apply 2,4-D, Buctril M, Embutox E and Tordon 202C in a number of crops with the drop boom attachment. Nozzle heights were an average 460 mm (18 in) above the crop surface. Field speeds were 19 and 24 km/h (12 and 15 mph). Weed counts were conducted both behind the power unit and at the boom ends. Weed kill varied from good to very good on all test sites on crops sprayed with the side drop booms. In most cases, weed kill was unacceptable on portions of crop sprayed with the front drop booms. The poor kill behind the front drop boom (FIGURE 14) was probably due to the floatation tires passing over the crop as soon as it was sprayed. Apparently, the floatation tires disturbed the chemical on the weeds, either by absorbing the chemical or knocking the droplets off the leaves, or a combination of both. If the drop booms are to be considered for future applications, it is recommended that the front boom assembly be relocated behind the wheels to improve weed kill by the central drop boom.

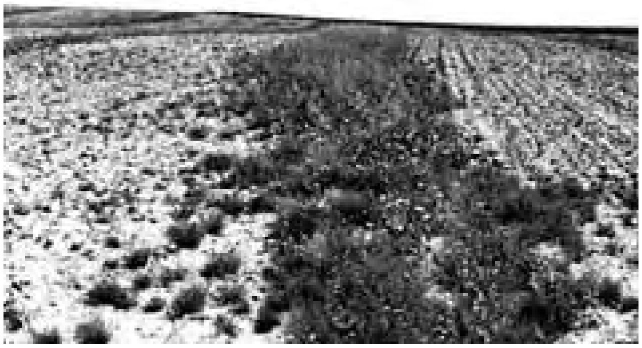


FIGURE 14. Typical Poor Weed Kill Occurring Behind the Front Drop Boom.

QUALITY OF WORK - COMPARISON OF HIGH CLEARANCE BOOM AND SPECIAL DROP BOOM

Comparative weed kill trials, using the regular high clearance boom with floodjet nozzles and using the special order drop boom with low pressure flat fan spray nozzles showed that the drop boom was of no beneficial value in normal herbicide applications using 2,4-D Buctril M and Tordon 202-C. In all cases, weed kill was equally as good with the high clearance booms with floodjet nozzles. In addition, unsatisfactory weed kill behind the front drop boom, made the drop boom assembly unacceptable. In all field conditions the regular high clearance booms with floodjet nozzles produced acceptable results indicating that the addition of a special order drop boom assembly for prairie crop conditions is unnecessary.

Perhaps there are certain chemicals, with very narrow tolerance ranges, where the drop boom assembly with flat fan spray nozzles is more acceptable. If a situation should arise to make the drop boom assembly necessary, then it is recommended that the manufacturer relocate the centre drop boom behind the power unit to enable spraying behind the wheel tracks to improve weed kill. Another option would be to use 110 degree, wide angle, low pressure flat spray nozzles, at 508 mm (20 in) spacings directly on the regular high clearance boom, thereby eliminating the need for a drop boom.

FIGURE 15 compares TeeJet LP 11006 flat spray nozzles, at 508 mm (20 in) spacing with TK-SS10 Floodjet nozzles, at 1525 mm (60 in) spacing, over a range of nozzle heights. As can be seen, the LP 11006 flat spray nozzles produce a very uniform distribution at the normal 1140 mm (45 in) height of the regular high clearance boom above the crop surface.

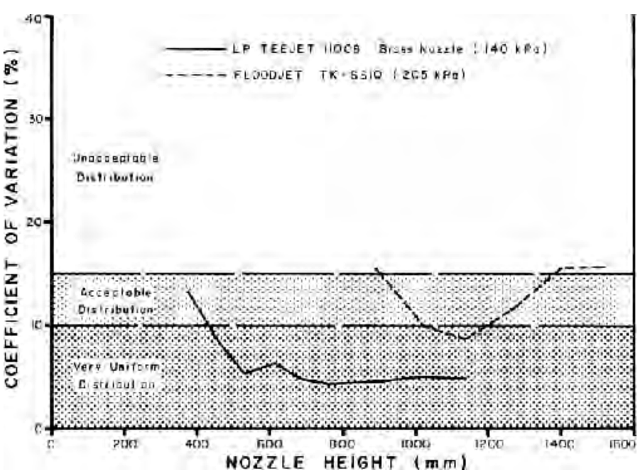


FIGURE 15. Comparison of LP 11006 Flat Spray Nozzles at 508 mm (20 in) Spacing, with TK-SS10 Floodjet Nozzles at 1525 mm (60 in) Spacing.

QUALITY OF WORK - OTHER ITEMS

Boom Stability: The Terra-gator 1603 was driven over a series of standard obstacles[2] representing field bumps, to assess boom stability. At speeds between 15 and 30 km/h (9 and 19 mph) the maximum boom end movement was a 270 mm (10.6 in) lift and a 75 mm (3 in) drop. This resulted in a boom height variation from 1065 to 1410 mm (42 to 56 in), compared to the normal 1140 mm (45 in) height. FIGURE 15 shows that this height variation did not appreciably affect spray distribution uniformity when equipped with TK-SS10 floodjet nozzles. For example, at 205 kPa (30 psi), the TK-SS10 produced acceptable spray distribution at nozzle heights ranging from 900 to 1390 mm (35 to 55 in).

System Pressure: FIGURE 16 shows the maximum pressures available along the flow path when the regular high clearance boom is equipped with Spraying Systems TK-SS10, 3/8K-SS30 and 1/2K-80 floodjet nozzles. These nozzles are capable of application rates of 122, 370 and 981 L/ha (11, 33.3 and 88.3 gal/ac), respectively, when operated at 275 kPa (40 psi) and 25 km/h (15 mph). For these runs, the pump was equipped with its normal 143 mm (5.63 in) impeller and was run at 4165 rpm corresponding to rated engine speed. In addition, the agitator control valve was fully open to give maximum tank agitation. Considerably higher pressures were available with the agitator valve closed.

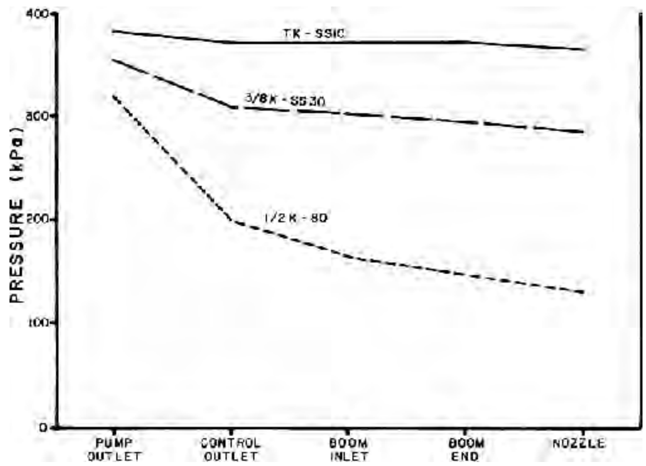


FIGURE 16. Maximum Pressure at Various Locations along the Main Boom when Using Various Floodjet Nozzles.

Pressure at the pump outlet depended on the agitator valve setting and nozzle size. The throttling control valves changed pump pressure only slightly when adjusted. Pressure loss from the pump outlet to the boom control valve outlet was the greatest due to flow restrictions caused by the throttling valves, flow meter and hoses. With the low capacity TK-SS10 floodjet tips, pressure losses from the control outlet to the nozzles were small. With the high capacity 1/2K-80 floodjet nozzles, pressure losses from the control outlet to the nozzles were up to 70 kPa (10 psi). The pressure loss that occurred from the pump to the boom end was unimportant to the operator since the pressure shown at the cab nozzle gauge was measured at the boom end.

Pressure losses from the boom end to the nozzles affected calibration slightly, especially with high capacity nozzles. For example, the pressure lost from the boom end to the nozzles was up to 17 kPa (2.5 psi) with the 1/2K-SS80 nozzles. In addition, there was up to a 27 kPa (4 psi) pressure drop from the boom end to the cab nozzle pressure gauge. For accurate calibration and proper distribution patterns at high flow rates, nozzle pressures should be set about 30 kPa (5 psi) higher than indicated on the cab pressure gauge.

Pressure losses from the control outlet to the drop boom system were negligible when using Spraying Systems TeeJet LP 11003 and 11006 low pressure nozzles, due to the low flow rates.

Closing the agitator valve substantially increased nozzle pressures. The amount of nozzle pressure increase depended both on agitator valve setting and nozzle size. Agitator valve setting was important when high capacity nozzles were used. For example, 128 kPa (19 psi) was the maximum nozzle pressure obtained with the agitator valve fully open when using high capacity 1/2K-80 floodjet nozzles. This pressure was inadequate since liquid fertilizers are normally sprayed at pressures between 140 and 275 kPa (20 and 40 psi). Completely closing the agitator valve brought the nozzle pressure up to 205 kPa (30 psi). Liquid fertilizer usually needs no tank agitation during application.

[2]*PAMI T764-R78, Detailed Test Procedures for Field Sprayers.*

Pressure Gauges: The pump pressure gauge read 5 kPa (0.7 psi) high at the beginning of the test and 13 kPa (1.9 psi) high at the end of the test. The boom pressure gauge was accurate in the normal operating range at the beginning of the test but at the end of the test it read 15 kPa (2.2 psi) high.

The pressure gauges were calibrated only in psi. It is recommended that metric or dual calibration gauges or a suitable conversion chart be supplied to facilitate sprayer operations in the metric (SI) system.

Line Strainers: Two strainer bowls equipped with 10 mesh strainers, were located at the main boom inlet line. A combination 16180 mesh line strainer was also provided in the supply line for the special front drop boom. Although no protection was provided for the pump, centrifugal pumps are much less susceptible to damage from foreign material than roller pumps.

Nozzle Strainers: The Terra-gator 1603 was not equipped with nozzle strainers. The high capacity floodjet nozzles used on the regular high clearance boom did not need any strainers. The 10 mesh inlet strainer effectively removed large foreign material to eliminate floodjet nozzle plugging. The 10 mesh line strainer was not effective in preventing plugging of the rear special drop boom nozzles. Fifty-mesh nozzle strainers were therefore installed for field testing of the special drop booms.

Tank Strainer: No strainer was provided at the tank filler opening since the majority of the refilling was done with the reload system. The operator should strain lake or ditch water before storing it in nurse trucks.

Soil Compaction and Crop Damage: The Terra-gator wheels travelled over about 15% of the total field area sprayed. The low soil contact pressure of only 124 kPa (18 psi) permitted spraying post emergence crops up to 203 mm (8 in) high without any damage. Crops up to 300 mm (12 in) high were sprayed with very little or no crop damage. Crops over 254 mm (10 in) high took longer to recover to the same height as the rest of the field.

Soil contact pressure beneath the wheels was about 60% that of an unloaded pickup truck and half that of conventional field sprayer wheels. The average soil contact pressures under the Terra-gator wheels with a full tank are given in TABLE 3.

TABLE 3. Soil Compaction by Floater Wheels

	Average Soil Contact Pressure* With Tank Full	Tire Track Width
	kPa	mm
Front Wheel	124	743
Rear Wheels	124	845

**For comparative purposes, an unloaded one half ton truck has a soil contact pressure of about 200 kPa (30 psi).*

RATE OF WORK

Field Speeds: The Terra-gator 1603 had ten forward speeds ranging from 6 to 50 km/h (3.7 to 31 mph). All test work was conducted in gears 5, 6, 7 and 8, which gave loaded field speeds of 14.5, 18.8, 24 and 30.1 km/h (9, 11.7, 15 and 18.7 mph), respectively.

Excessive bouncing usually occurred in ninth gear. Suitable field speed depended on the nozzles used, field conditions and material applied. Liquid fertilizers were applied on summerfallow with floodjets at speeds up to 30.1 km/h (18.7 mph) and on post emergence crops at 24 km/h (15 mph). Preplant herbicide application with floodjets was done at speeds up to 30.1 km/h (18.7 mph). Post emergence herbicide applications were done at speeds between 14.5 and 24 km/h (9 and 15 mph) using both floodjet and low pressure (LP) TeeJet nozzles. When cornering and making sharp turns, engine speed had to be reduced considerably to avoid crop damage and boom contact with the ground. Forward speeds had to be reduced to 11 km/h (7 mph) on most corners. Spraying during a turn is not recommended due to poor distribution patterns that occur at low pressures and erratic application rates that result along the boom due to different ground speeds of the boom.

Application rate changed very little when the Terra-gator was operated at engine speeds between 2000 and 2980 rpm.

This permitted herbicide spraying in rough and hilly terrain where engine speed was usually reduced. Boom valves would be switched on before maximum engine speed was reached, thus permitting spraying shortly after a turn.

Average Work Rates: TABLE 4 presents the average work rates obtained for the Terra-gator 1603 during the test. Average work rates varied from 17.6 to 35.9 ha/h (43.5 to 88.7 ac/h). Considerable variation can be expected due to field size, shape and topography.

TABLE 4. Average Work rates

Gear	Field Condition	Boom	Maximum Speed (km/h)	Average Workrate (ha/h)
5	Wheat/Wheat & Alfalfa	Drop	14.5	17.5
6	Wheat/Barley	Drop	18.8	23.6
		Regular	18.8	24.4
7	Summerfallow/Stubble	Regular	24	29.2
	Wheat/Barley	Regular	24	27.4
	Wheat/Barley	Drop	24	27.4
8	Summerfallow	Regular	30	35.9

PUMP PERFORMANCE

Priming: The 4” x 3” centrifugal pump supplied with the Terra-gator was not self-priming. Since the pump was mounted at the bottom of the spray tank, the positive inlet pressure needed for pump priming was automatically provided. The manufacturer cautioned that the pump not be run dry to avoid damaging the pump seals. The tapered sump in the tank bottom provided the pump with liquid in all topographic conditions.

Output: FIGURE 17 gives the pump performance curve for the 4” x 3” centrifugal pump, equipped with the standard 143 mm (5.63 in) impeller, when operated at 4000 rpm. Pump output was similar to the manufacturer’s curve. Pump wear was negligible after 155 hours of field operation.

Agitation Capability: Normally recommended agitation rates for emulsifiable concentrates such as 2,4-D are 0.03 L/s per 100 L of tank capacity (1.5 gal/min per 100 gal of tank capacity). For wettable powder such as Atrazine and Sevin, recommended agitation rates are 0.05 L/s per 100 L of tank capacity (3.0 gal/min per 100 gal of tank capacity). No field agitation is usually needed for liquid fertilizers.

Tank agitation was always sufficient during road transport, stationary engine idle and tank filling. During road transport at maximum engine speed, 19.9 L/s (263 gal/min) was delivered through the tank agitator. During idling, a maximum of 7.4 L/s (98 gal/min) was delivered to the agitator. During induction of chemicals, the Terra-gator was usually operated at an engine speed of 2000 rpm. At this speed, 13.8 L/s (182 gal/min) was supplied to the agitator and inductor. Additional agitation also occurred through the pump by-pass hose.

During field operation, agitation flow decreased when the boom valves were opened. FIGURE 18 shows typical agitator and by-pass flows at normal nozzle operating pressures with 114K-SS15 nozzles and with the agitator valve fully open. Since pump outlet pressure varied very little through the normal nozzle operating range, agitator and by-pass flows remained relatively constant. Agitation and bypass flow averaged about 16.7 and 2.6 L/s (220 and 34 gal/min), respectively, over the normal nozzle operating pressure range.

Agitation was more than sufficient and allowed field operations with
the agitator valve nearly closed.

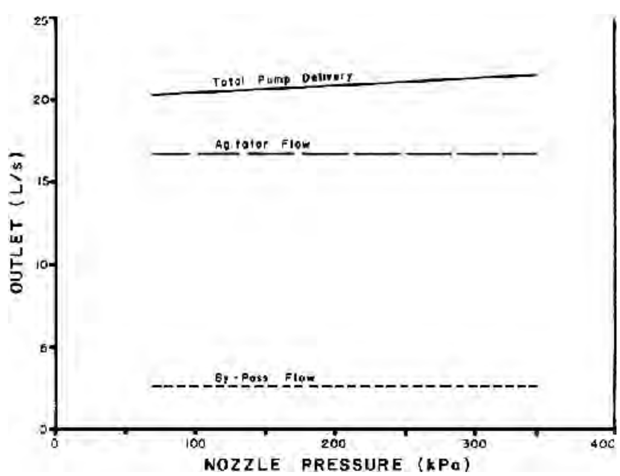


FIGURE 18. Pump Output when Equipped with Spraying Systems 1/4K-SS15 Floodjet Nozzles.

MARKER PERFORMANCE

Field Operation: The test machine was equipped with the optional foam marker assembly (FIGURE 19). The marker was useful in reducing overlaps or misses. The foam marks allowed successive passes of the applicator to be properly aligned. Marks were left at the outer edge of the previous round, so on the next pass an operator could eliminate most sprayer misses or overlaps by aligning the foam drop hose with the foam marks. Alignment required operator skill and judgement, since the boom ends were over 7.6 m (25 ft) from the cab.

Controls: The air compressor from the power unit was used to pressurize and agitate a soap and water solution in the foam tank.

All marker controls were inside the cab and convenient to operate and adjust. Solenoid valves, operated with a switch inside the cab, controlled foam to the desired boom.

Filling: Filling the 115 L (25 gal) foam tank, in most cases, required a separate nurse tank with pump. The foam tank filler opening was 2060 mm (81 in) above ground level and was only 32 mm (1-1/4 in) in diameter, which made the tank difficult to fill by gravity from a large nurse tank. Access to the tank filler lever was inconvenient as the operator had to climb onto the right wheel fender to open the valve. It is recommended that modifications be provided for safer and more convenient foam tank filling.

A fluid level indicator was provided on the foam tank. The fluid level was difficult to view as the level tube became discolored. The foam tank required frequent flushing to eliminate soap hardening in the solenoid valves and level indicator openings. A drain plug was provided on the bottom of the tank for cleaning.

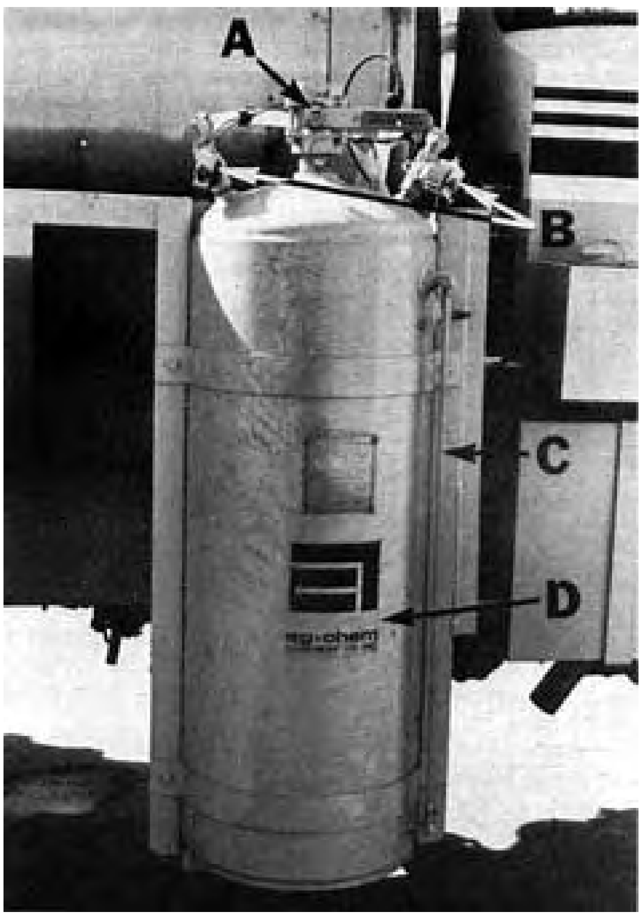


FIGURE 19. Foam Marker Assembly: (A) Refill Valve, (B) Solenoid Valves, (C) Fluid Level Indicator, (D) Foam Tank.

Mark Visibility: Mark visibility was dependent on crop height, field surface conditions and mark spacing. Mark visibility was adequate in all field conditions as long as mark spacing was adjusted to suit forward speed and field conditions. For best visibility, the foam tank pressure was set at 205 kPa (30 psi), resulting in an average mark spacing of 2100 mm (7 ft) at 24 km/h (15 mph).

Mark spacing varied considerably. For example, at 205 kPa (30 psi) mark spacing varied from 250 to 5000 mm (0.8 to 16 ft) at 24 km/h (15 mph). Average mark spacing varied from 8900 mm (29 ft) at 70 kPa (10 psi) to 1660 mm (5.5 ft) at 275 kPa (40 psi).

The foam marks were difficult to see in crops over 250 mm (10 in) tall. Adding water softener to the tank solution produced lighter, foamier marks, which were more easily seen in tall crops.

Mark length varied considerably while mark width depended on foam drop hose size. Average mark length and width were 190 and 45 mm (7.5 and 2 in), respectively. Mark length varied from 45 to 500 mm (2 to 20 in) and changed very little with pressure and forward speed.

Mark Durability: The marks remained visible from 60 to 90 minutes on cool and cloudy days and for less than 30 minutes in hot, dry and windy conditions. This was adequate when making successive passes. However, when starting a field, a pass was usually made across each end of the field. These marks left at the end of the field for making turns, would disappear by the time a 40 ha (100 ac) field was completed.

The quality of foam mark was only slightly dependent on the amount of soap solution added to the water. Usually, one can of solution per tank of water was adequate. The best foam was obtained with warm, soft water.

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.

Quantity of Fluid Used: The amount of marking fluid needed depended on desired mark spacing and varied with foam tank pressure. The amount of fluid used at each tank pressure setting varied considerably. For example, at a foam tank pressure setting of 205 kPa (30 psi) the amount of fluid used varied from 16 to 69 L/h (3.5 to 15.2 gal/h), averaging 42 L/h (9.2 gal/h). At foam tank pressure settings of 140 and 275 kPa (20 and 40 psi) an average of 23 and 57 L/h (5.1 and 12.5 gal/h) were used, respectively. More fluid was usually used in the morning than in the afternoon. This was because colder water temperature in the mornings resulted in a lower quality, watery foam, which emptied from the tank more rapidly than good quality foam. Less fluid was used if a water softener, to improve foam quality, was added to the tank.

Operating costs for marking solution averaged about 9 cents/ha (4 cents/ac).

EASE OF OPERATION AND ADJUSTMENT

Operator Location: The Terra-gator 1603 was equipped with an operator's cab as standard equipment. The cab was positioned ahead of the spray tank, centered on the applicator body, giving good visibility to the left, front and right. Visibility to the rear was obstructed, necessitating some caution when maneuvering in confined areas.

The rear view mirrors improved rear visibility for road transport. Rear visibility was obstructed by the booms when using the mirrors and required that the operator view the rear between the boom structural members. The air intake stack added to the obstruction when using the right mirror. Boom visibility was good in the daytime and poor at night. Only the top portion of the spray tank solution level could be viewed from the operator's seat.

The operator's seat was comfortable and had an adequate range of adjustment. The steering column was not adjustable. The cab was not high enough to permit standing operation. However, seat position and control location made standing unnecessary.

The cab was relatively dust-free. The cab pressurization system effectively filtered the incoming air and reduced dust leaks and chemical fumes. The heating and optional air conditioning system provided suitable cab temperatures in all operating conditions.

Operator station sound level was about 83 dbA.

Controls: The control arrangement is shown in FIGURE 20.

Although most controls were conveniently placed, easy to use and responsive, the hydraulically controlled boom lift and drop rate was too slow. The levers for lifting the booms were convenient in avoiding field obstacles. However, the slow lift and drop rate made it inconvenient to quickly return the booms to their proper height after avoiding an object. It also was difficult to tell whether the booms were level from inside the cab. The slow lift rate required that the operator exercise care when operating in rough and hilly terrain to prevent the booms from striking the ground, especially when using the special drop booms. Operation with the regular high clearance booms was much less critical. The boom structure featured a breakaway system, which prevented severe damage to the booms if it struck the ground or an object. It is recommended that the manufacturer consider increasing boom lift and drop rates to make it easier to control the booms in rough and hilly fields.

FIGURE 20. Control and Instrument Layout.

Application rate was controlled by gear and nozzle selection and adjusting nozzle pressure according to calibration charts supplied by the nozzle manufacturer. Nozzle pressure could be controlled with either the low or high pressure throttling valves or the agitator valve. These valves were convenient to set when using the regular high clearance boom with floodjet nozzles. They were inconvenient to set when using the special order drop boom since pressure adjustment was very sensitive. A small adjustment of the throttling valves resulted in a large change in drop boom pressure.

In an attempt to reduce the sensitivity of the pressure adjustment on the special order drop booms the manufacturer supplied an optional 121 mm (4.75 in) pump impeller, to reduce system pressures. The smaller pump impeller did not significantly improve drop boom pressure adjustment. It is recommended that modifications be made to make pressure adjustment less sensitive if drop booms are to be considered for future applications.

When the boom control valves were shut to turn corners and then reopened, the boom pressure returned to its desired setting immediately on reopening the valve when using the regular high clearance booms. When using the special order drop booms, it took about 20 seconds for the drop boom pressure to return to normal after the boom control valves were reopened upon turning a corner.

At 24 km/h (15 mph) this resulted in a distance of about 7 m (23 ft) receiving reduced application. Use of the optional small impeller did not improve this problem. If the drop booms are to be considered for future applications, it is recommended that the manufacturer reduce the lag time in establishing drop boom pressure, when the control valves are opened.

Maneuverability: Steering and maneuverability were very good. The hydrostatic steering front wheel was smooth and responsive, while the pneumatic brakes were effective. The turning radius was 6.3 m (20.7 ft). The supply hose for the special order front drop boom interfered with the front tire on turns. It is recommended that this interference be eliminated if the drop booms are to be used for future applications.

Transmission: Gear selection depended on the nozzles used, material applied and field conditions. Ten transmission gears on the Terra-gator allowed the operator a choice of eight field gears, up to 30.1 km/h (18.7 mph) and road speed up to 50.2 km/h (31.2 mph). Two reverse gears were also available. Gear shifting was quick and easy. Transport: The regular high clearance boom hydraulically folded forward into transport position in less than one minute.

Instruments: The instrument panel (FIGURE 20) included gauges for engine oil pressure, coolant temperature, engine hours, forward speed, distance, engine speed, boom and pump pressures and battery voltage.

An indicator light was provided for the parking brake and warning buzzers were provided for coolant temperature, engine oil pressure and air pressure. The air cleaner restriction monitor was visible from inside the cab.

Lights: The Terra-gator 1603 was equipped with two front lights and two working lights. Long range front lighting was good. Operating the Terra-gator at night was inconvenient since the boom ends were difficult to see. The interior panel lights, caused a reflection, which also made it difficult to see the booms through the side windows. It is recommended that modifications be made to provide sufficient lighting to the boom ends to permit easier night operation.

Engine: The engine had ample power for all field and road conditions. It was possible to start the Terra-gator in the field in any of the first eight transmission gears.

Fuel consumption averaged about 18.6 L/h (4.1 gal/h).

The engine started easily. Engine oil consumption was insignificant. The two fuel tanks, which were located on each side of the cab, were easily filled from average height gravity fuel tanks.

Stability: The centre of gravity, with a full spray tank, was about 1710 mm (67.3 in) above the ground, 1480 mm (58.3 in) ahead of the drive wheels and 12 mm (0.5 in) to the right of the Terra-gator centre line.

The Terra-gator 1603 was reasonably stable, even with a full tank. Normal care had to be used when turning corners on hillsides or driving through deep gullies. The Terra-gator had a tendency to rock from side to side after one drive wheel dipped lower than the other.

Care had to be used when operating the Terra-gator in ninth gear, at speeds between 34 and 40 km/h (21 and 25 mph), since it had a tendency to bounce excessively in that speed range. The bounce increased if the speed was kept constant for a period of time. The bouncing ceased after the maximum speed in ninth gear was reached.

Lubrication: The Terra-gator 1603 had 28 grease fittings. Twelve grease fittings needed greasing every day and eight needed greasing every 100 hours. The operator's manual did not indicate lubrication frequency of the other eight grease fittings. During field testing, the six grease fittings in the pump and hydraulic shafts were greased every 100 hours and the two grease fittings on the front axle were greased every 50 hours. It is recommended that the manufacturer indicate lubrication information on these eight grease fittings in the operator's manual.

Most grease fittings were accessible. Care had to be used when climbing up the front tire to grease the front wheel spindle.

Transmission oil level was inconvenient to check and very difficult to fill. The hydraulic system was easy to check and fill.

Spray Tank: The 6000 L (1320 gal) tank was of adequate size for all application rates used. The large reloading hose and utilization of the inboard pump made refilling from a nurse truck convenient. The 102 mm (4 in) loading hose was equipped with a quick-coupler adapter making connections to a nurse tank quick and easy. To accommodate most nurse tank hoses, a 3 in adapter was used instead of the regular 4 in adapter.

Time to fill the tank depended on engine speed, water head, nurse tank hose size and agitator valve setting. Usually it took about 7.5 minutes to fill the tank with a 76 mm (3 in) hose at an engine speed of 1500 rpm. Increased engine speed resulted in pump cavitation.

The deep sump in the tank bottom provided the pump with liquid in all topographic conditions, made it possible to completely empty the tank and made tank draining convenient. The spray tank came equipped with front and rear liquid level indicators. The rear liquid level indicator was obstructed by the boom support members and was difficult to read. The front liquid level indicator was between the cab and spray tank and only the top portion could be read through the cab window. The liquid level in the tube was only visible from the side.

Inductor: The Terra-gator was equipped with an inductor (FIGURE 21), which made it easy to add chemical to the tank by using the inboard pump. Chemical could be added during refilling water or after filling water while agitating the solution. The latter was more convenient. Care had to be used when inducting chemical during refilling to avoid pump cavitation and chemical spillage. Both could be avoided if the chemical was inducted before the tank was half filled. The chemical induction rate depended on water head, agitator valve setting and engine speed. It took about 1.5 minutes to induct 115 L (25 gal) of chemical into a filled tank.

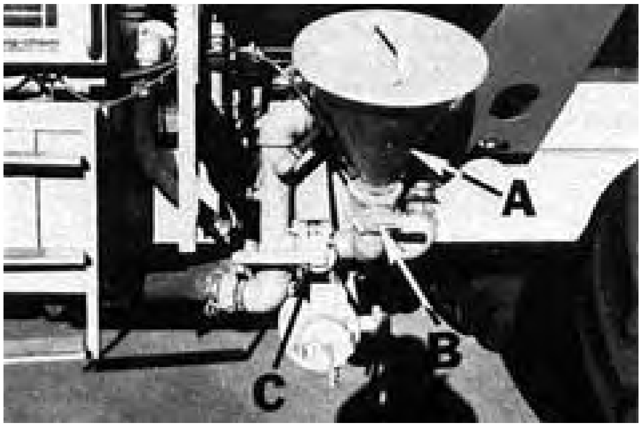


FIGURE 21. Inductor System: (A) Filling Funnel, (B) Funnel Valve, (C) Inductor Line Valve.

Nozzle Angle: Nozzle angle on the special order drop booms was easily adjusted with a wrench. Range of angle adjustment was dependent on boom height. The floodjet nozzles on the regular high clearance boom could be mounted at various angles by changing the nozzle plumbing.

Nozzle Height: Nozzle height was adjustable on the drop booms but was not adjustable on the regular high clearance booms. Drop boom nozzle height could be adjusted from 350 to 1210 mm (14 to 48 in). Nozzle height adjustment on the drop booms was inconvenient since the operator had to simultaneously hold the boom, pull the snap pin and align the chain link with the pin hole (FIGURE 22).

FIGURE 22. Drop Boom Height Adjustment.

Use of Optional Nozzles: The nozzle assemblies accepted a wide range of standard nozzle tips. The nozzles on the drop booms were easily removed and cleaned without the use of tools. The floodjet nozzles on the regular high clearance booms were attached to adapters, which were easily connected to the quick couplers on the boom. The quick couplers and diaphragm check valves used during the test were not supplied as standard equipment but there use made nozzle changing quick and easy. Care should be used in selection of quick coupler size for larger nozzles to avoid excessive pressure drop.

OPERATOR SAFETY

The Terra-gator 1603 had adequate warning decals. It was equipped with warning lights and rear view mirrors for road transport. The operator's manual contained appropriate safety instructions.

Front Drop Boom: In transport position the ends of the special order front drop boom attachment extended high to the sides and could cause eye injury to an operator if he accidentally walked into it while servicing.

Exhaust Outlets: The exhaust outlets were positioned under the Terra-gator in the vicinity of the reloading and inducting valve levers. The exhaust fumes became very irritating to the operator while positioning the valves during tank filling and inducting. Access to the valve levers required the operator to get under the Terra-gator directly behind the exhaust outlets (FIGURE 23). It is recommended that the manufacturer make modifications to prevent operator contact with exhaust during reloading and inducting.

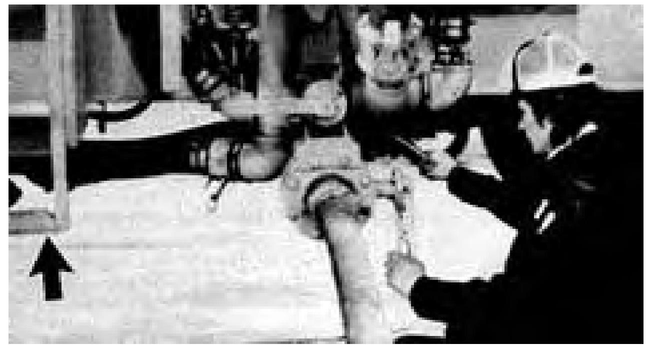


FIGURE 23. Operator Directly Behind Engine Exhaust Outlet when Filling Tank.

Foam Marker Tank: Refilling the foam marker tank could be dangerous if care was not taken to slowly open the tank valve to decompress the tank. Opening the tank valve quickly resulted in a sudden surge of air and foam solution, which could cause harm to the operator.

The foam marker refill valve was over 2060 mm (81 in) above the ground. Care had to be taken when climbing onto the fender to gain access to the valve.

Cab Steps: The cab steps were narrow and positioned close to the cab, making it easy to slip when leaving the cab. It is recommended that modifications be made to eliminate this hazard.

Chemical Inducting: Care had to be taken to avoid operator contact with chemicals during chemical induction. While inducting chemical it was important to keep the funnel filled with chemical and immediately shutting the inductor valve after the chemical was inducted to prevent air from entering the inducting line. Air entering the system resulted in foaming and foam spilling through the spray tank lid.

Stability: Reasonable care had to be exercised when operating the Terra-gator on steep and hilly terrain since it had a tendency to rock from side to side if one rear wheel suddenly dropped into a depression.

Caution: Operators are cautioned to wear suitable eye protection, respirators and clothing to minimize operator contact with chemicals. Although many commonly used agricultural chemicals appear to be relatively harmless to humans, they may be deadly. In addition, little is known about the long term effects of human exposure to many commonly used chemicals. In some cases the effects may be cumulative, causing harm after continued exposure over a number of years.

OPERATOR'S MANUAL

The operator's manual outlined sprayer operation, maintenance, servicing, calibration, parts, lubrication and safety tips. Some discussions and illustrations were not sufficiently detailed and were confusing since the same manual applied to a number of their Terra-gator models. It is recommended that the operator's manual be revised to improve clarity for each specific Terra-gator model.

The calibration charts supplied with the sprayer were prepared only in U.S. units. To accommodate the present changeover to the metric (SI) system, calibration charts should also be supplied in metric (SI) units.

MECHANICAL PROBLEMS

TABLE 5 outlines the mechanical history of the Terra-gator 1603 during 155 hours of operation while spraying about 3300 ha (8150 ac). The intent of the test was evaluation of functional performance. An extended durability evaluation was not conducted.

TABLE 5. Mechanical History

Item	Hours	Field Area ha
Plumbing Assembly		
-The right inner main boom hose was damaged and replaced at	beginning of test	
-The pump bearing seized and was replaced at	106	2131
Regular High Clearance Boom Assembly		
-The control lever actuating the left boom valve broke and was replaced at	5	54
-The left boom valve did not completely" shut off resulting in nozzle dripping. No further problems occurred after the set screws on the valve drive were tightened at	28	487
-A crack around the grease fitting of the right horizontal sliding column resulted in inadequate lubrication	throughout the test	
Drives		
-A grease nipple on the hydraulic pump drive was missing and a new nipple was installed at	beginning of test	
-The tachometer needle was fluctuating and its driveline was replaced at	beginning of test	
-Four bolts retaining the gear shifter housing to the transmission loosened and were tightened at	end of test	
Hydraulic		
-The brake line to the differential housing was kinked and replaced at	beginning of test	
-The hydraulic boom control assembly leaked despite frequent attempts to tighten the bolts	throughout the test	
Special Order Drop Boom Assembly		
-The front boom supply hose interfered with the front tire	throughout the test	
-The inner right drop boom supply hose was too short and was extended at	28	487
-The drop boom pressure line hose was too short and was extended at	28	487
-The ends of most of the springs on the right-drop booms had stretched and ware repaired at	54	948
-The chain on the right boom assembly slipped out of position and was repositioned at	83	1637
-The ends of most of the springs on the left drop booms had stretched and were repaired at	90	1822
-The end drop booms fell from their upright positions while using the main boom, resulting in spray interference. No further problems occurred after the locknuts were tightened on the drop boom pivots at	90, 106	1822, 2131
-The extreme fight drop boom snap pin was lost and was replaced with a bolt at	134	2830
-All snap pins on the drop booms were bent a	end of test	
Miscellaneous		
-The rear tire valve stems bent at	beginning of test	
-The cab roof leaked around the boom hanger bolts. The bolts were tightened at	5, 36	54, 612
-The foam marker master switch loosened and was tightened at	18, 67, 141	12,174, 2039
-The tank lid bushing loosened and fell into the pump. The pump was disassembled and the bushing was removed at	100	1951

DISCUSSION OF MECHANICAL PROBLEMS

Inner Boom Hoses: The right inner boom hose was crushed between the right boom and boom frame assembly (FIGURE 24) when the right boom was put into transport position. Rerouting the hose prevented further damage.

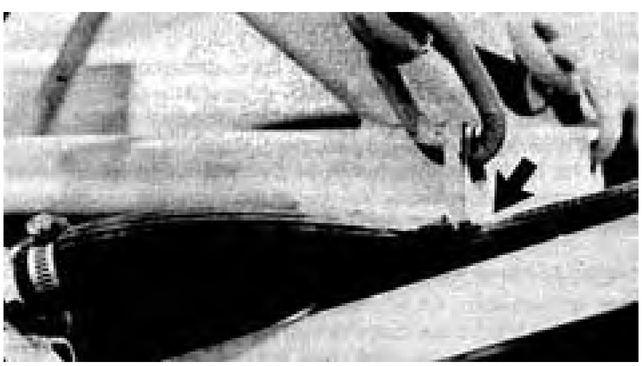


FIGURE 24. Crushed Right Boom Inner Hose.

Hydraulic Boom Controls: The hydraulic boom control assembly leaked throughout the test despite frequent efforts to tighten the bolts and locate the leak. As a result, the cab floor became very messy. It is recommended that modifications be made to prevent the hydraulic boom control assembly from leaking.

Tire Stems: The rear tire valve stems were long and bent when air was put in with a manual chuck. As a result, air leaked from the valves throughout the test. It is recommended that modifications be made to reduce the possibility of valve stem damage.

Spray Tank Bushing: The bushing that secures the rubber seal to the sprayer tank lid loosened, fell to the bottom of the tank and eventually jammed inside the pump impeller. No damage occurred to the pump. However, six hours after the bushing was removed from inside the pump, the bearing on the pump seized. It is recommended that modifications be made to prevent the bushings from loosening.

Special Order Drop Boom Assembly: Considerable durability problems occurred with the drop boom assembly. The front supply hose interfered with the front tire on turns. The right inner drop boom supply hose interfered with a structural member, causing the hose to kink and necessitating addition of a nipple. The drop boom pressure hose was too short to enable the booms to be lowered less than 500 mm (20 in). The drop boom support spring eyes stretched during operation. As well, the height adjusting snap pins all bent during field operation. Functional testing indicated that the special order drop boom assembly served no beneficial purpose and that suitable performance could be obtained in prairie crops with the regular high lift booms. For that reason it is recommended that the drop boom assembly be discontinued. If, for some special applications, the drop boom assembly is found to be beneficial, then it is recommended that the above problems be corrected before manufacture of the drop boom assembly.

APPENDIX I
SPECIFICATIONS

MAKE:	Terra-gator Floatation Applicator	
MODEL:	1603	
SERIAL NUMBER:		
-- body	1602480	
-- engine	90N46809	
MANUFACTURER:	Ag-Chem Equipment Co. Inc.	
4900 Viking Drive Minneapolis, Minnesota U.S.A.		
ENGINE:		
-- make and model	Caterpillar 3208	
-- type	4 stroke diesel	
-- number of cylinders	8	
-- displacement	636 cu. in.	
-- governed speed	2990 rpm (no load)	
-- manufacturer's rating	157 kW at 2800 rpm	
-- fuel tank capacity		
-useable	377 L	
-total	409 L	
-- engine oil capacity	12L	
-- air cleaner	pre-cleaner and safety indicator	
-- electrical system	12 volt - 208 amp-hr battery, 60 amp alternator	
-- air system	belt driven air compressor, governed, twin reservoir	
TRANSMISSION:		
-- type	Fuller Roadranger RTO-610	
-- oil capacity	6L	
-- final drive	differential with planetary reduction	
-- speed (max.)	Road (km/h)	Field (km/h)
-- 1st	6.1	5.6
-- 2nd	7.7	7.4
-- 3rd	9.8	9.2
-- 4th	12.6	11.8
-- 5th	15.5	14.5
-- 6th	20.0	18.8
-- 7th	25.7	24.0
-- 8th	32.7	30.1
-- 9th	41.2	
-- 10th	50.2	
-- Rev - LO	5.3	
-- HI	18.5	

INSTRUMENTS:
- -- voltmeter gauge
- -- engine oil pressure gauge with alarm
- -- engine water temperature gauge engine hourmeter
- -- speedometer/odometer
- -- air pressure gauge with low pressure warning signal
- -- tachometer
- -- spray and foam tank sight gauges
- -- fuel tank gauge
- -- foam tank pressure gauge
- -- nozzle pressure gauge
- -- pump pressure gauge
- -- parking brake light
- -- engine air cleaner gauge

CLUTCH:

clutch pedal operates both the 2-plate clutch (356 mm self-adjusting with ceramic lining) and clutch brake. Full pedal depression applies transmission clutch brake, slowing or stopping shaft rotation.

AXLE:

-- rear	differential with heavy duty inboard planetary reduction
-- front	89 mm diameter solid shaft

BRAKES:

-- service	self adjusting, oil cooled internal disc brakes, air over hydraulic actuated
-- parking	mechanically activated calliper disc on transmission drive line

STEERING:	dual hydraulic cylinder operated front wheel
HYDRAULIC SYSTEM:	shaft driven (from engine) tandem hydraulic pump operates steering and booms independently
TIRES:	3, 66 x 43.00-25, 8-ply

ADDITIONAL EQUIPMENT:
- liquid system with stainless steel spray tank
- V8 caterpillar engine
- 10 speed Fuller transmission
- drop boom assembly
- 4” x 3” centrifugal pump
- cab with air conditioning
- stainless steel chemical inductor
- foam marker assembly
- air actuated micro switch for acre monitor

LUBRICATION POINTS:

-- front wheel spindle	2, serviced daily
-- boom frame	10, serviced daily
-- front wheel axle	2
-- rear axle	2, 100 hours
-- clutch pivot shaft	2, 100 hours
-- drive shaft	4, 100 hours
-- hydraulic pump shaft	2
-- pump drive shaft	4
-- vertical sliding column	4, serviced daily
-- horizontal sliding column	2, serviced daily
-- boom pivot joint	2, serviced daily
-- boom frame pulleys (top)	2, serviced daily

OVERALL DIMENSIONS:

-- wheel tread	2286 mm
-- wheel base	5740 mm
-- transport height	
-drop boom	3747 mm
-main boom	3550 mm
-- transport length	9310 mm
-- transport width	
-drop boom	4343 mm
-main boom	3780 mm
-- field height	3550 mm
-- field length	
-drop boom	9715 mm
-main boom	9310 mm
-- field width	1540 mm
-- clearance height	489 mm
-- turning radius	
-left	6560 mm
-right	6080 mm

WEIGHT:

	Transport (kg)		Field (kg)	
	Empty	**Loaded**	**Empty**	**Loaded**
-- front	3559	4005	3366	3786
-- left rear	2902	5686	3018	5774
-- right rear	2984	5855	3061	5986
Total	9445	15,546	9445	15,546

SPRAY TANK:

-- material	stainless steel
-- capacity	6000 L (sump included)
-- agitation sparger	51 mm pipe
-- shape	cylindrical (domed ends)
-- saddle	rubber cushion on large sheet metal support, self centering

FILLER OPENING:

-- shape	round
-- size	254 mm with 406 mm manhole
-- location	front center top
-- type of seal	rubber

STRAINERS:

-- number and size	2, 10 mesh main boom line (16, 30, 50 and 80 mesh optional) 1 for front drop boom 31, 50 mesh nozzle strainers
-- size	1-combination 16 and 80 mesh 2-10 mesh and 2-16 mesh

PUMP:

-- make	Ag Chem Equipment
-- model	519926
-- serial number	3152 K13
-- type	4” x 3” centrifugal
-- operating speed	4160 rpm at full throttle
-- type of drive	engine driven through belt and shaft

PRESSURE GAUGES:

-- make	Marshall Town
-- type	Bourdon
-- range	0-60 psi nozzle, 0-100 psi pump

BOOM:	**Regular High Clearance Boom**	**Special Order Drop Boom**
-- size	254 mm I.D.	11.1 mm I.D. 23.8 mm O.D.
-- material	rubber	galvanized steel
-- suspension	hydraulic cushioned cylinder	combination coil spring, chain and strut
-- height adjustment range		350-1210 mm
-- angle adjustment type	positioning of plumbing	rotation of boom
-- effective spraying width	16,764 mm	15,758 mm
-- nozzle number	11	31
-- method of attachment	1” female NPT canted (canted 3°)	64 mm male nozzle body and nozzle cap
-- pressure regulator	2, throttling valves (76 and 25 4 mm)	
-- shut off valves	air actuated, from cab (51mm)	

MARKER:

-- type	pneumatic controlled foam
-- capacity	recommended 115 L total 135 L

INDUCTOR:

-- line size	762 mm
-- valve	762 mm ball valve

RELOAD SYSTEM:

-- line size	102 mm reduced to 762 mm
-- valve	102 mm butterfly

APPENDIX II
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

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

APPENDIX III
CONVERSION TABLE

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

ALBERTA FARM MACHINERY RESEARCH CENTRE
3000 College Drive South
Lethbridge, Alberta, Canada T1K 1L6
Telephone: (403) 329-1212
FAX: (403) 329-5562
http://www.agric.gov.ab.ca/navigation/engineering/afmrc/index.html

Prairie Agricultural Machinery Institute
Head Office: P.O. Box 1900, Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-2555

Test Stations:
P.O. Box 1060
Portage la Prairie, Manitoba, Canada R1N 3C5
Telephone: (204) 239-5445
Fax: (204) 239-7124

P.O. Box 1150
Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-5033
Fax: (306) 682-5080