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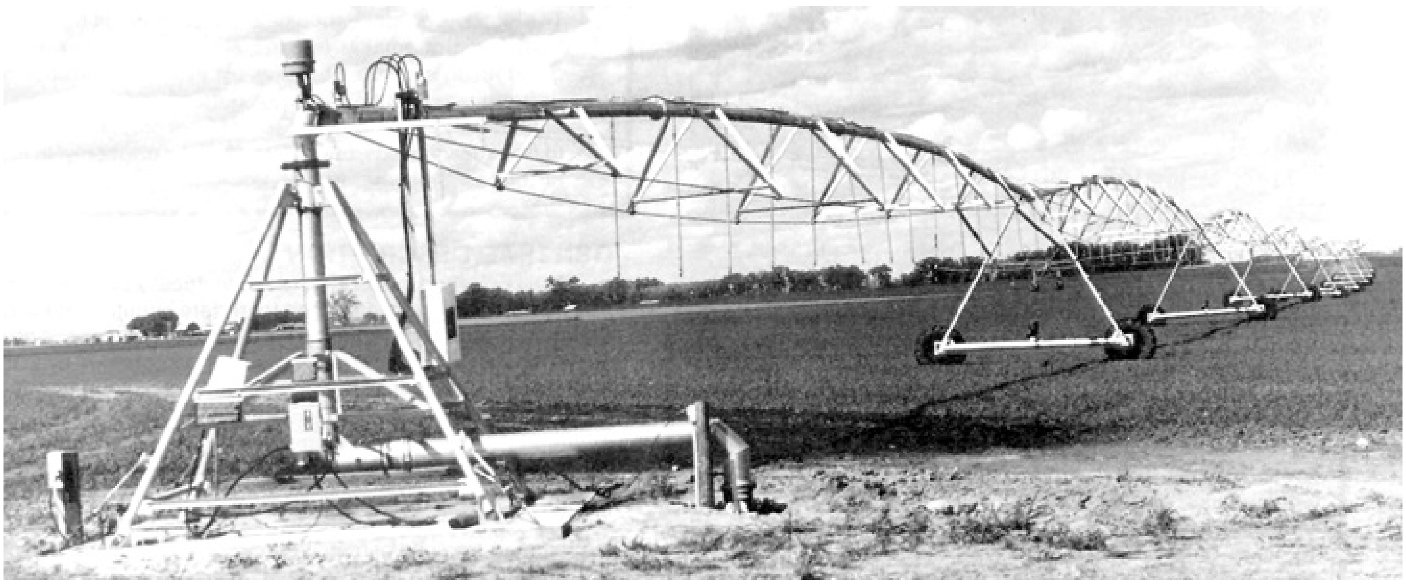

LOCKWOOD MODEL 2265 CENTRE PIVOT IRRIGATION SYSTEM WITH FLEXSPAN CORNER SYSTEM ATTACHMENT

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

LOCKWOOD MODEL 2265 CENTRE PIVOT IRRIGATION SYSTEM WITH FLEXSPAN CORNER SYSTEM ATTACHMENT

MANUFACTURER:

Lockwood Corporation
P.O. Box 160
Gering, Nebraska 69341

DISTRIBUTOR:

Rainchief Irrigation and Equipment Limited
3603 - 8 Avenue North
Lethbridge, Alberta
T1H 5E2

RETAIL PRICE:

$56,500.00 (November, 1984, f.o.b. Lethbridge, Alberta 1298 ft (396 m) system equipped as shown in APPENDIX I).

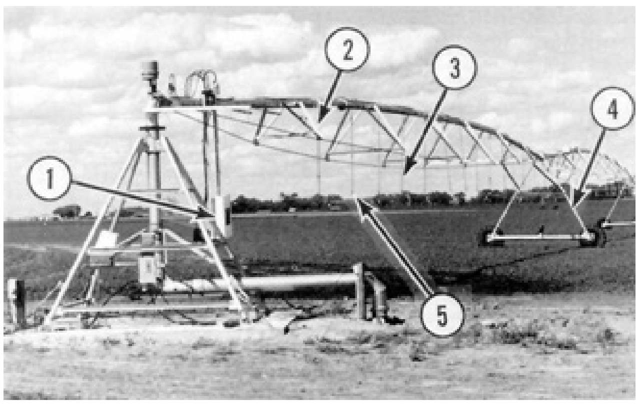

FIGURE 1. Lockwood Model 2265 Centre Pivot Irrigation System: (1) Control Panel, (2) Truss Supports, (3) Drop Tubes, (4) Support Tower, (5) Nozzles.

SUMMARY AND CONCLUSIONS

Functional Performance: Performance of the Lockwood model 2265 pivot irrigation system with Flexspan corner system attachment was very good.

Nozzle Distribution Patterns: Individual nozzle distribution patterns of the Rainbird 8X spray nozzles were pie-shaped. Very high applications occurred at the outer perimeter. Increasing nozzle pressure increased the wetted area and increased the average application rate.

System Distribution Uniformity: The coefficient of uniformity (CU)[1] under light wind conditions was 84 percent when operated with the optional end gun and the Flexspan corner system extended.

Application Rates: Nozzles were mounted on drop tubes placed on alternate sides of the lateral. The average application rate was 1.5 in/h (33 mm/h). Maximum application rate was 13.1 in/h (333 mm/h). Local ponding occurred at several positions along the lateral when operated at low timer settings.

Nozzle Calibration: Nozzle delivery varied less than one percent after 930 hours of use.

Pressure Losses: Pressure losses along the lateral were uniform and varied from 50 psi (345 kPa) at the pivot to 35 psi (240 kPa) at the system end. The system pressure gauge was accurate.

Crop Damage: Tower wheels travelled over less than 0.8 percent of the total irrigated area.

Rate of Work: Minimum full circle rotation time for the test system was 22 hours. Application depth decreased with increased timer settings.

Ease of Operation: All controls were accessible. Servicing and cleaning were easy. Span drains occasionally plugged with silt.

Operator's Manual: The operator's manual was clearly written and contained information on operating, servicing, adjustments and safety precautions.

***Mechanical* Problems:** Several mechanical problems occurred during the 930 hours of operation. A span support tower tire deflated, the pivot coupler packing began to leak and an axle on the Flexspan corner attachment broke.

[1] Christiansen's coefficient of uniformity (CU) is commonly used as a measure of distribution uniformity. A CU above 85% indicates very uniform coverage while a CU below 70% indicates inadequate uniformity.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifications to reduce the high water application areas near the pivot.

Senior Engineer: E. H. Wiens

Project Engineer: M. V. Eliason

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. The high water application near the pivot could be reduced by the use of smaller nozzles. However, smaller nozzles could result in nozzle plugging, excessive atomization and drift or inadequate overlaps. A better solution, if the high application area is deemed to be a real problem, would be to use impact heads, in the area near the pivot only, in place of the low pressure nozzles.

GENERAL DESCRIPTION

The Lockwood model 2265 is an electrically powered centre pivot irrigation system designed to irrigate circular field areas. Water distribution is through a series of nozzles spaced along an overhead lateral pipe. The lateral pipe is supported by a bow-string truss system and is mounted on support towers. Each support tower is mounted on two wheels and supports one span of lateral pipe. Spans are connected by rigid pipe with rubber seals and knee-joint type connectors. Water is supplied to the pivot through a buried pressurized pipe line.

The Lockwood Flexspan corner system attachment extends the irrigated area and permits irrigation of irregular shaped field areas. Water distribution is through a series of electrically controlled, hydraulically operated valves and nozzles spaced along an overhead pipe. The corner system lateral pipe is supported by a bow-string truss system and is connected to the end of the centre pivot system. The corner system attachment is supported by one support tower mounted on two wheels.

The test system consisted of eight center pivot spans and one corner system span. Traction drive of each centre pivot span is powered by an electric motor through reduction gear boxes and drive shafts. The traction drive of the corner system attachment support tower is powered by two electric motors through reduction gear boxes. Power is supplied to the pivot through a buried 480 volt, three phase electrical line.

An electrical control panel, mounted near the pivot, monitors and controls system operation. Application depth is determined by system speed, with greater depths applied at slower speeds. Alignment of the centre pivot support towers is controlled through electrical micro switches and two wires stretched the length of the centre pivot system. Small centre pivot support tower alignment deviations are automatically corrected while safety switches provide system shutdown in the event of excessive alignment deviation.

Operation of the corner system attachment is controlled by electrical micro switches and a high frequency electrical signal emitted from a buried electrical line. Movement of the centre pivot end tower is sensed by electrical micro switches which results in a corresponding movement in the corner system attachment support tower. The corner system attachment support tower is guided by the buried wire and an electrical receiver located near the tower wheel. For the test system, the corner system attachment support tower followed a path as shown in FIGURE 2.

The test system was equipped with 166 Rainbird spray nozzles. System design pressure at the pivot was 50 psi (345 kPa). Nozzles were mounted on drop tubes placed on alternate sides of the lateral. Nozzle discharge height was 98 in (2500 mm) above the soil surface while nozzle spacing was 111 in (2820 mm).

The test system was equipped with the Flexspan corner system attachment, a Nelson end gun, a 2 hp (1.5 kW) booster pump and the options listed in APPENDIX I.

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

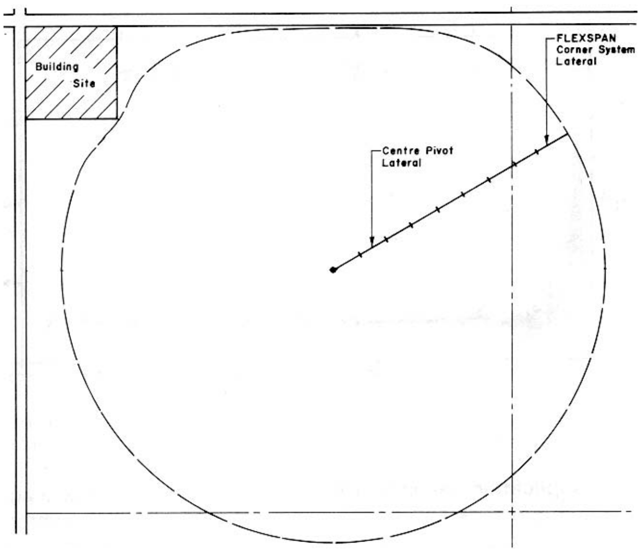

FIGURE 2. Flexspan Corner System Attachment.

SCOPE OF TEST

The Lockwood 2265 centre pivot and Flexspan corner system attachment were operated for about 930 hours while irrigating a 175 ac (71 ha) field of wheat. It was evaluated for quality of work, rate of work, ease of operation and adjustment, operator safety and suitability of the operator's manual.

RESULTS AND DISCUSSION

QUALITY OF WORK

General: The test system was equipped with 14 sizes of Rainbird model 8X spray nozzles. Sizes ranged from 8X spray-5 to 8X spray-18. The selection and arrangement of various nozzle sizes is usually unique to a particular system installation. Nozzle selection and arrangement are usually designed for the particular soil, topographic, climatic and crop conditions of each system installation. Application rates and distribution patterns of similar systems can vary significantly and may not be directly comparable.

Nozzle Distribution Patterns: Rainbird spray nozzles (FIGURE 3) delivered spray outwards and slightly downwards from the nozzle outlet resulting in a pie-shaped distribution pattern. FIGURE 4 shows a typical distribution pattern of a single stationary 8X spray-15 nozzle operating at 44 psi (300 kPa) and a 98 in (2500 mm) discharge height. Low applications occurred directly below the nozzle. Higher applications occurred at the perimeter of the pattern with very high applications in two regions of the outer perimeter. These very high application regions were characteristic of all nozzles tested and occurred in a similar relative position. TABLE 2 shows the average[2] and maximum application rates of various sizes of Rainbird spray nozzles while operating at a 98 in (2500 mm) discharge height and 44 psi (300 kPa). High application rates can cause local ponding and runoff under certain conditions. Care has to be exercised during system design to ensure application rates do not exceed soil infiltration capacity.

[2] Average application rate is the delivery rate of the nozzles divided by the wetted area.

TABLE 2. Average and Maximum Application Rates of Various Rainbird Spray Nozzles.

NOZZLE SIZE	AVERAGE APPLICATION RATE in/h	(mm/h)	MAXIMUM APPLICATION RATE in/h	(mm/h)
8X SPRAY-5	0.57	(15)	2.15	(55)
8X SPRAY-6	0.65	(16)	2.15	(55)
8X SPRAY-7	0.73	(18)	2.15	(55)
8X SPRAY-8	0.79	(20)	2.52	(64)
8X SPRAY-9	0.87	(22)	2.94	(75)
8X SPRAY-10	0.91	(23)	2.67	(68)
8X SPRAY-11	1.06	(27)	3.70	(94)
8X SPRAY-12	1.13	(29)	4.00	(102)
8X SPRAY-13	1.24	(32)	3.89	(99)
8X SPRAY-14	1.32	(34)	6.73	(171)
8X SPRAY-15	1.43	(36)	7.17	(182)
8X SPRAY-16	1.57	(40)	6.18	(157)
8X SPRAY-17	1.66	(42)	7.19	(183)
8X SPRAY-18	1.81	(46)	6.92	(176)

Single nozzle distribution patterns were not seriously affected by small pressure variations. Large pressure variations, however, altered both the wetted area and the average application rate. FIGURE 5 shows the average application rates for various nozzles while operating over a range of pressures and a 98 in (2500 mm) discharge height. Increasing nozzle pressure increased the wetted area and increased the average application rate. For example, increasing the nozzle pressure for nozzle 8X spray-13 from 15 psi (100 kPa) to 58 psi (400 kPa) increased the average application from 1.10 to 1.34 in/h (28 to 34 mm/h)

FIGURE 3. Rainbird Spray Nozzle.

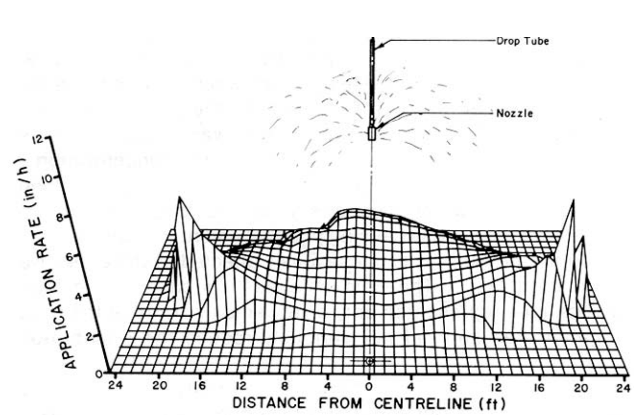

FIGURE 4. Distribution Pattern of a Rainbird 8X Spray-15 Nozzle at a 98 in (2500 mm) Discharge Height and a Pressure of 44 psi (300 kPa).

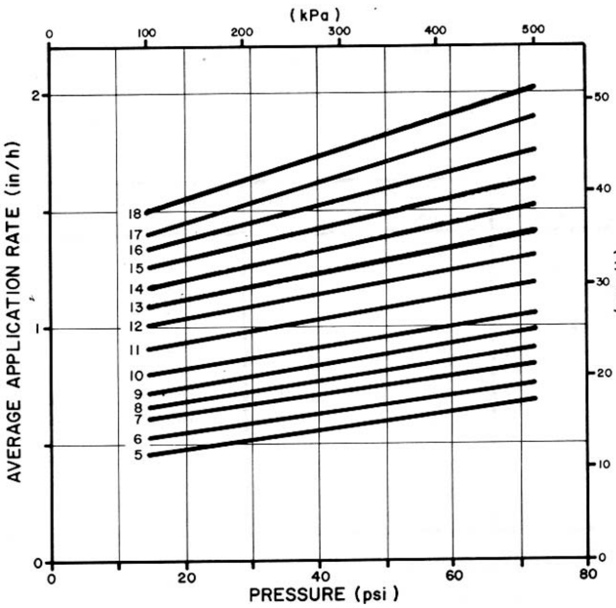

FIGURE 5. Average Application Rate of Various Rainbird Spray Nozzles While Operating at Various Pressures and a 98 in (2500 mm) Discharge Height.

Distribution Uniformity: To obtain a more uniform water application than that obtained from individual nozzles, nozzle distributions are overlapped. The amount of overlap depends on the nozzle size, lateral pressure, nozzle height and nozzle spacing. Nozzle sizes and spacing arrangments are usually designed to match the application requirements of individual system installations. For the test system, nozzle spacings were 111 in (2820 mm) along the lateral while nozzle discharge heights were about 98 in (2500 mm).

FIGURE 6 shows a typical distribution along the Lockwood centre pivot with the Flexspan corner system attachment extended and the end gun operating. High applications occurred near the pivot while low applications occurred near the outer end of the system. The high applications near the pivot were a result of relatively large nozzle sizes and long application times. The low applications near the system end occurred below the end gun and were a result of improper end gun travel rotation adjustment. End gun travel rotation could be adjusted to improve application below the end gun.

The coefficient of uniformity (CU) can be used as a measure of system distribution uniformity. The average coefficient of uniformity for the test system was 84 percent when operated with the optional end gun and the Flexspan corner system attachment extended and 87 percent with the end gun shut off and the corner attachment folded. These values represent average values based on seven field distribution can tests obtained under light wind conditions. Distribution uniformity will vary depending on climatic conditions.

With the aid of a computer, individual nozzle distribution patterns can be overlapped to determine the theoretical spray distribution along the lateral. FIGURE 7 shows the theoretical spray distribution along the test system when operated with the corner system attachment extended and the end gun shut off. The theoretical CU for the test system was 92 percent. This represents very uniform coverage. High spray concentrations, however, occurred near the pivot. The large nozzle sizes and long application times of locations near the pivot resulted in excessive applications causing ponding and runoff. Distribution uniformity, however, was not seriously affected by the excessive application areas. The field area associated with the high applications represented only a very small portion of the total irrigated area and did not seriously reduce the distribution uniformity.

The theoretical coefficient of uniformity represents the spray distribution obtained for a continuously moving system under ideal environmental conditions. Actual uniformity will vary depending on environmental conditions and system speed.

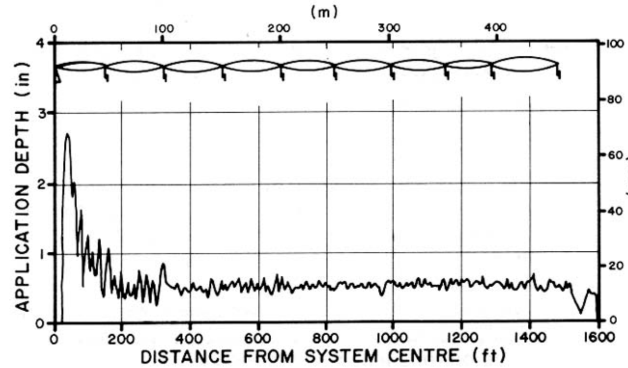

FIGURE 6. Typical Distribution along the Lockwood Centre Pivot when Operated with the Optional End Gun and the Flexspan Corner Attachment Extended.

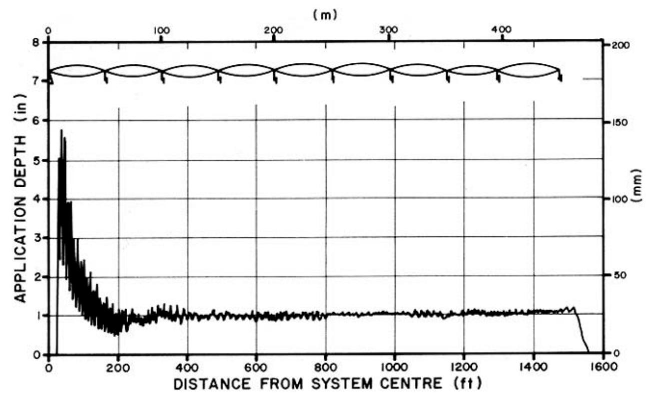

FIGURE 7. Theoretical Distribution Along the Lockwood Centre Pivot Lateral When Operated with the Flexspan Corner Attachment Extended and the End Gun Shut Off.

Application Rates: FIGURE 8 shows the theoretical average application rates for various positions along the test system when operated with the corner system attachment extended and the end gun shut off. Application rates increased as distance from the pivot increased. Higher average application rates occurred at the tower locations. For the test system, pivot travel direction was clockwise about the pivot. At the tower locations, the nozzle spray directions were altered to apply water behind the lateral. This improved traction of the tower drives and reduced the possibility of shutdown due to alignment deviation. Altering nozzle spray patterns at the tower locations decreased the area over which water was applied and increased the average application rate. Local ponding occurred at several tower locations when operated at lower timer settings.

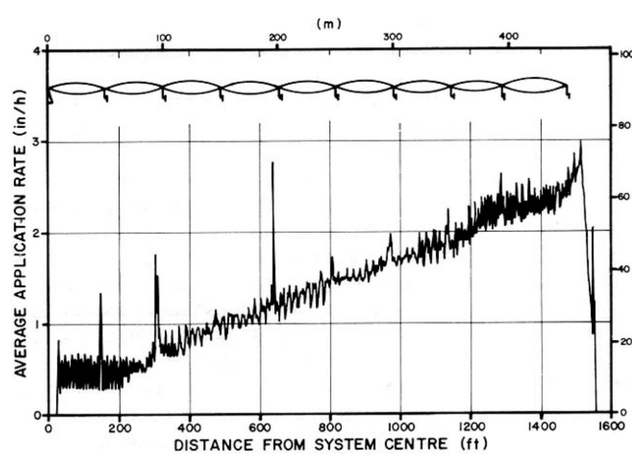

FIGURE 8. Theoretical Average Application Rates for Various Positions Along the Lockwood Centre Pivot Lateral.

FIGURE 9 shows the theoretical average application rates of the test system for various positions about the lateral when operated with the corner attachment extended and the end gun shut off. Low average application r'ates occurred below the lateral while high average application rates occurred at about 98 in (2500 mm) on either side of the lateral. The high application areas were a result of the overlapping and superimposing of individual nozzle patterns. The low application areas below the lateral were a result of the nozzle outlet diverting flow away from the lateral. Slightly higher application rates occurred on one side of the lateral and were the result of the altered nozzle patterns at the tower locations.

The average theoretical application rate for the test system was 1.5 in/h (38 mm/h). Maximum application rate for the test machine was 13.1 in/h (333 mm/h). High application rates can cause local ponding and runoff on certain soils. Few soils can accept such high applications for more than a few minutes. For the test machine, local ponding occurred at several positions along the lateral when operated at slow speeds.

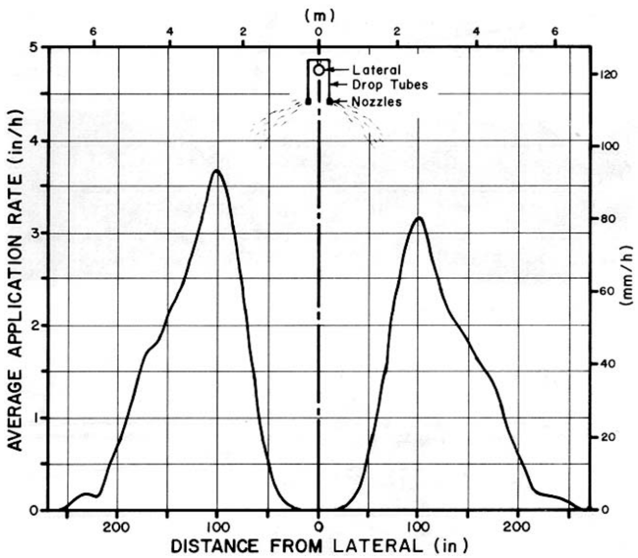

FIGURE 9. Theoretical Average Application Rates for Various Positions About the Lateral.

Spray Drift: The Rainbird 8X spray nozzles directed spray outwards and slightly downwards from the nozzle outlet. The nozzles were mounted on drop tubes which reduced exposure to wind. Excessive losses, however, occurred when wind velocities were high. The Rainbird nozzles produced fine droplets which were very susceptible to wind drift.

Nozzle Calibration: FIGURE 10 shows the average delivery of various sizes of Rainbird nozzles over a range of operating pressures. Delivery rate increased less than 1.0% after 930 hours of field use. Nozzle wear would depend on water cleanliness and type, if any, of chemicals used.

Use of Optional Nozzles: A wide range of nozzles and sprinklers are adaptable to the Lockwood centre pivot. However, to ensure even distribution and suitable application rates, various nozzles and sprinklers must suit the particular system, crop, soil and topographic conditions.

Lateral Pressure Losses: Lateral pressures were measured at the pivot and various positions along the system. Pressure at the pivot was 50 psi (345 kPa). Pressure losses along the lateral were uniform with lowest pressures occurring at the system end. Pressure at the system end was 35 psi (240 kPa).

Pressure variations when operating on flat fields did not seriously affect nozzle output. For operation in hilly fields, however, pressure variations can cause significant variations in nozzle delivery. For operation in hilly fields pressure regulators may be required.

Pressure Gauge: The pressure gauge supplied with the Lockwood centre pivot was mounted on the lateral near the pivot. A pressure switch mounted near the gauge served as a safety switch for low pressure shutdown. The pressure gauge was accurate.

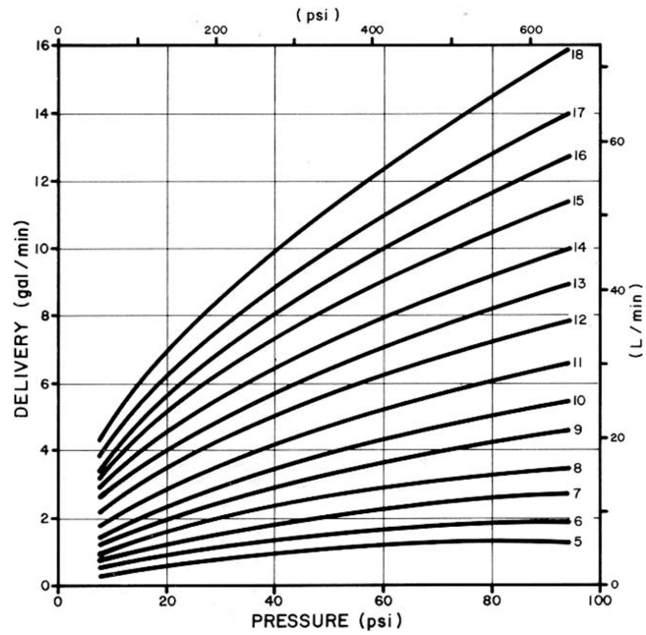

FIGURE 10. Delivery Rates for Various Sizes of Rainbird 8X Spray Nozzles over a Range of Pressures.

Strainers: No line strainers were provided on the Lockwood centre pivot system lateral. The nozzles plugged occasionally during testing, however, nozzle plugging depends on water cleanliness.

Crop Damage: The tower wheels travelled over less than 0.8 percent of the total area irrigated. This area represented a crop loss as repeated irrigations prevented crop growth.

RATE OF WORK

Field Speeds: Most electric irrigation systems travel in an on-off fashion. Travel speed during the on cycle is constant and depends on tire size, electric motor speed and the gear reduction ratios of the traction drives. Average travel speed is adjusted by the duration of the on portion of the travel cycle. Speed was controlled by adjusting the per cent timer which determines the duration of the current signal supplied to the electric motors.

Average field speeds for the Lockwood centre pivot system depended on system length, shape of the irrigated field area and equipment options.

For the test system, minimum full circle rotation time was 22 hours when equipped with 11 x 22.5 tires. FIGURE 11 shows the average depth applied for various timer settings for the test system. Average application decreased with an increase in timer settings. Average application depths for similar systems will vary.

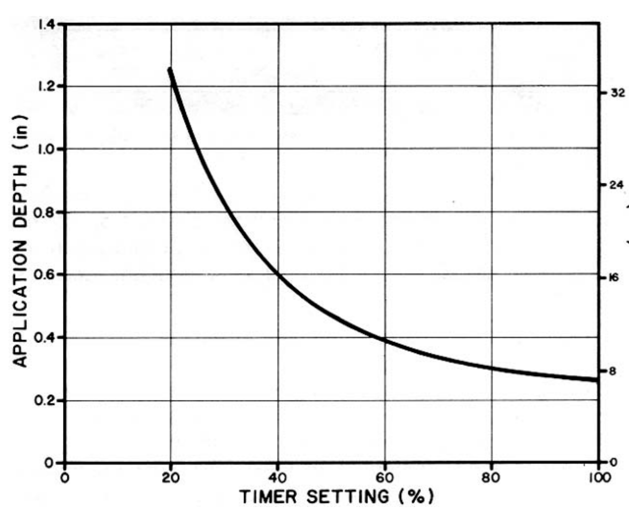

FIGURE 11. Average Applied Depth for Various Time Settings for the Test System.

EASE OF OPERATION AND ADJUSTMENTS

Controls and Gauges: The main control panel (FIGURE 12) was conveniently located for easy operation of system controls. The control panel included an hour meter, the percent timer, a main start switch, a forward and reverse selector switch, a wet or dry run switch and a pressure bypass switch. Indicator lights were provided to indicate forward or reverse operation, type of system shutdown, system power, incoming power, end tower operation and pump operation. A main power disconnect switch (FIGURE 12) was located at the pivot.

The system pressure gauge (FIGURE 12) could be observed "from the control panel location. For accurate readings, however, one had to climb the pivot braces to obtain better visibility.

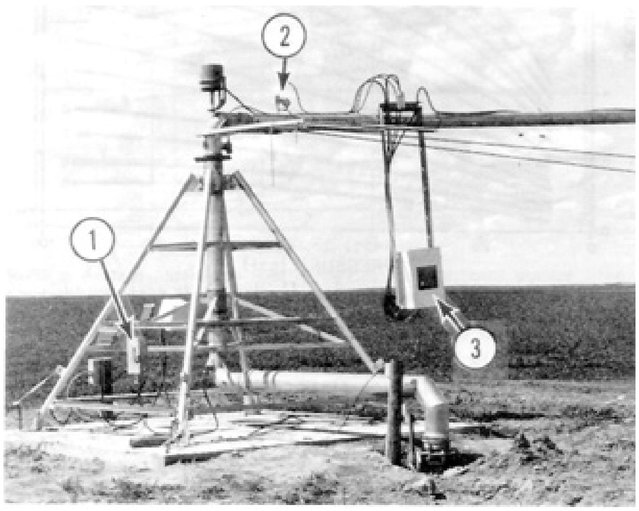

FIGURE 12. Lockwood Centre Pivot Controls: (1) Main Disconnect, (2) System Pressure Gauge, (3) Control Panel.

Access to the control panel location was inconvenient. The high applications which occurred near the pivot made travel on a pivot access road difficult (FIGURE 13). Modifications to reduce the high applications near the pivot are recommended to improve control panel access.

FIGURE 13. Inconvenient Control Panel Access due to High Applications Near the Pivot.

Towers: The support towers (FIGURE 14) provided convenient access to the tower electrical control boxes. The electrical control boxes were suitably protected from precipitation. Adjustment of the tower alignment linkages was easy but required tools.

Tower and Alignment: Alignment of the Lockwood centre pivot was automatically sensed by electrical micro switches contacting a wire stretched the length of the centre pivot system. Small angular deviations were automatically corrected while severe deviations resulted in system shutdown.

Steering and alignment of the Flexspan corner attachment was controlled through electrical micro switches and a buried electrical line. The electrical micro switches located in the end pivot tower controlled the duration of the current signal supplied to the corner attachment tower motors, while the buried electrical line controlled the corner attachment steering. A receiver (FIGURE 15) located on the corner attachment tower monitored the signal emitted from the buried line. Steering was through an electric motor, a gear reduction drive and mechanical linkages (FIGURE 16).

Operation of the corner attachment was automatic. Small corner attachment steering deviations were automatically corrected while severe deviations resulted in system shutdown.

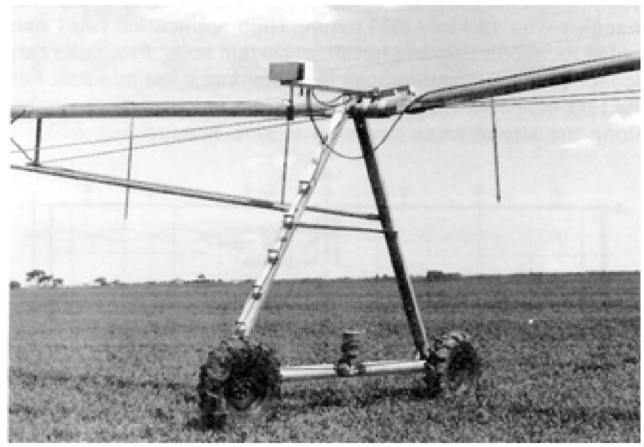

FIGURE 14. Lockwood Centre Pivot Support Tower.

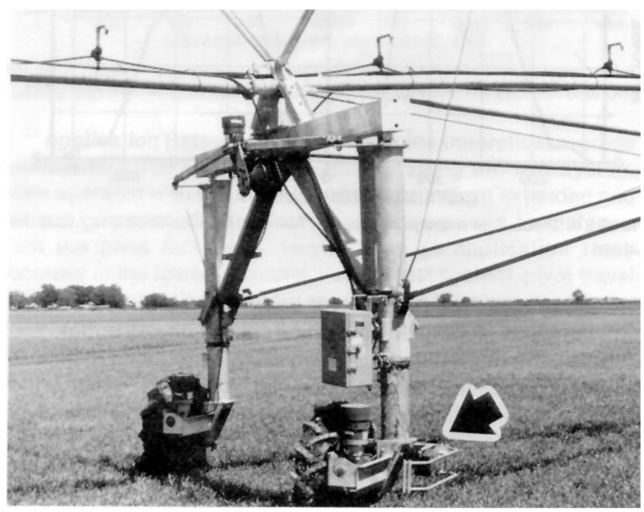

FIGURE 15. Flexspan Corner System Attachment Receiver.

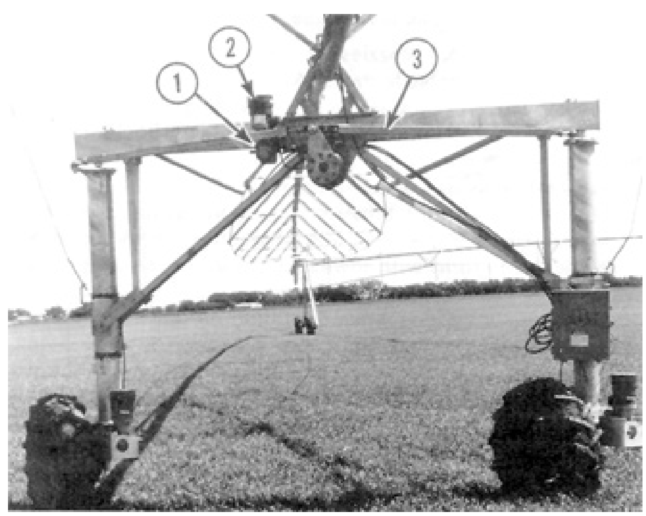

FIGURE 6. Flexspan Corner System Steering Mechanism: (1) Gear Reduction Drive, (2) Electric Motor, (3) Mechanical Linkages.

Safety Devices: The Lockwood centre pivot and Flexspan corner attachment were equipped with automatic safety devices to provide system shut-off in the event of mechanical or electrical failures. Safety switches were provided for low pressure shutdown, low temperature shutdown, overwater shutdown and power interruption shutdown. Safety switches located in the support towers prevented excessive tower alignment deviation.

The Lockwood centre pivot could be automatically stopped at a preselected position by a switch located on the pivot. An automatic reversing switch was also available.

When using an internal combustion engine to supply pump power, a safety switch was available to stop the engine when the centre pivot system shut down.

End Gun and Booster Pump: An optional end gun and booster pump system could be mounted on the system end to increase the irrigated area. Operation of the end gun was automatic and could be controlled to operate at any preselected position. For the test system, a model PC 100 Nelson end gun and a 2 hp (1.5 kW) booster pump (FIGURE 17) were mounted on the Flexspan corner system attachment end. For the test system, the end gun increased the irrigated area by about 20 ac (8 ha).

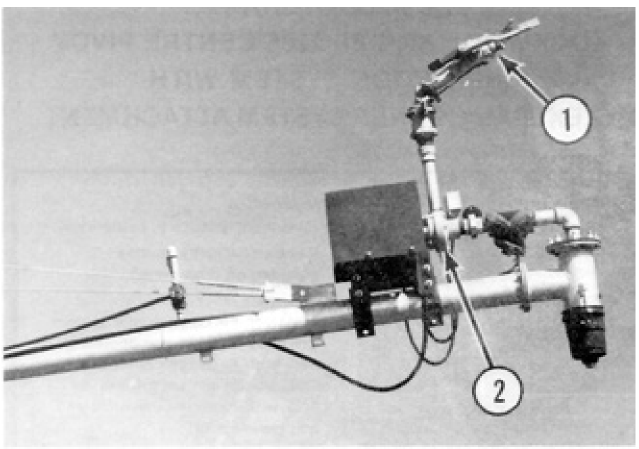

FIGURE 17. End Gun (1) and Booster Pump (2).

Running Light: An optional running light mounted on the end tower provided a convenient means of monitoring system operation. A light was also mounted near the control panel.

Servicing and Cleaning: The Lockwood centre pivot and Flexspan corner system attachment required seasonal checks and lubrication of the pivot, tower drive shaft universal joints, tower motors, gear motors and gear boxes.

Periodic flushing of the system was required to remove accumulated debris or sand. Flushing required removal of the end caps. A ladder was required to remove the end caps.

Occasionally, the span water drains (FIGURE 18) plugged. Cleaning was easy but occasionally required periodic system flushing.

OPERATOR SAFETY

The Lockwood centre pivot and Flexspan corner attachment were safe to operate if manufacturer's recommendations were closely followed. Extreme care must be exercised when handling electric irrigation machines. To reduce the possibility of electrical shock, all electrical connections should be inspected by a qualified electrician during system assembly.

OPERATOR'S MANUAL

The operator's manual was clearly written and contained much useful information on operating, servicing, adjustments and safety precautions.

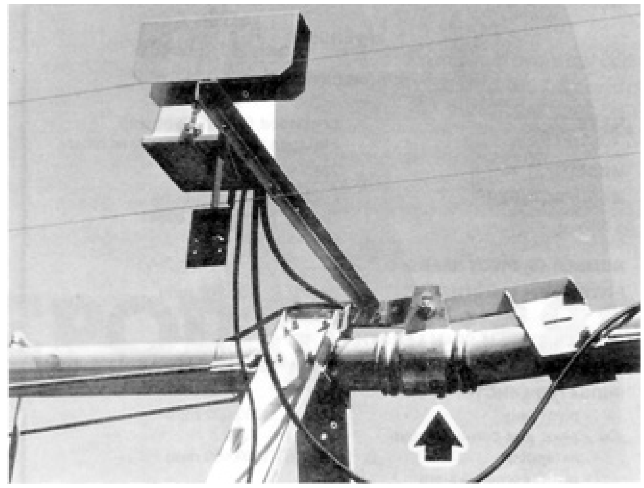

FIGURE 18. Span Water Drains.

MECHANICAL PROBLEMS

TABLE 3 outlines the mechanical history of the Lockwood centre pivot and Flexspan corner attachment during 930 hours of operation. The intent of the test was evaluation of functional performance. The following failures represent only those which occurred during functional testing. An extended durability evaluation was not conducted.

TABLE 3. Mechanical History.

ITEM	OPERATING HOURS
- A span support tower tire deflated and was repaired at	150
-The pivot coupler packing began to leak and was tightened at	580
- An axte on the Flexspan corner attachment tower broke and was repaired at	900

DISCUSSION OF MECHANICAL PROBLEMS

Corner System Tower Axle: The Flexspan corner system tower axle broke (FIGURE 19) when the support tower became stuck. The axle was replaced and no further problems were encountered.

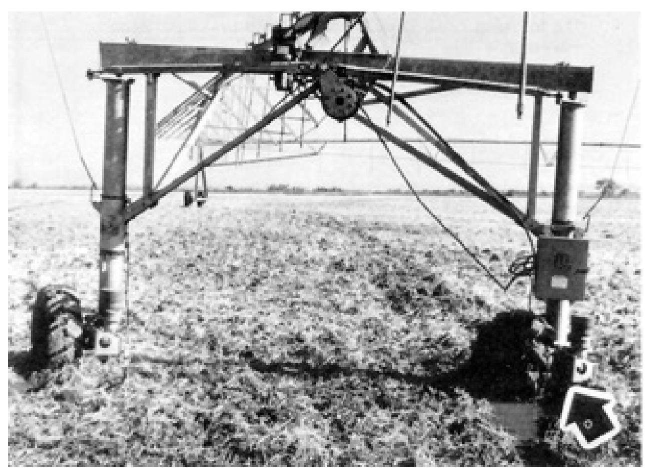

FIGURE 19. Broken Ftexspan Corner Attachment Tower Axle.

APPENDIX I

SPECIFICATIONS

MAKE:	Lockwood Centre Pivot with Flexspan Corner System Attachment
MODEL:	2265
MANUFACTURER:	Lockwood Corporations Gering, Nebraska 69341 U.S.A.
NUMBER OF PIVOT SPANS:	8
PIVOT SPAN LENGTHS:	6 - 167 ft (50,900 mm) 2-149 ft (45,415 mm)
CORNER SYSTEM SPAN LENGTH:	1 - 185 ft (56,390 mm)
OVERHANG LENGTH:	74.5 ft (22,710 mm)
IRRIGATED LENGTH:	
- pivot only	1298 ft (395,600 mm)
- pivot and corner system extended	1540 ft (469,400 mm)
- pivot, corner system extended and end gun	1650 ft (503,000 mm)
TOWER WHEEL BASE:	
- pivot tower	12.8 ft (3900 mm)
- corner system tower	12.6 ft (3900 mm)
TOWER MOTORS:	1 hp (.75 kW) 60 Hz 480 V
TIRES:	11 x 22.5 recap
CROP CLEARANCE:	9.5 ft (2900 mm)
LATERAL PIPE DIAMETER:	6.6 in (168 mm)
LATERAL PIPE FINISH:	Galvanized
LATERAL PRESSURE:	50 psi (345 kPa)
FLOW:	790 gal/min (3590 L/min)
SPRAY NOZZLE SPACING:	9.25 ft (2820 mm)
NOZZLES:	
- make	Rainbird
- model	8X spray
- sizes	5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18
END GUN:	
- make	Nelson
- model	PC-100
OPTIONS:	
- automatic end gun valve	
- automatic temperature and pressure shutdown	

APPENDIX II

MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

Excellent
Very Good
Good
Fair
Poor
Unsatisfactory

APPENDIX III

CONVERSION TABLE

acres (ac) x 0.40	= hectares (ha)
feet (ft) x 0.305	= metres (m)
horsepower (hp) x 0.75	= kilowatts (kW)
Imperial gallon (gal) x 4.55	= litres (L)
inches (in) x 25.4	= millimetres (mm)
pounds force/square inch (psi) x 6.69	= kilopascals (kPa)

SUMMARY CHART
LOCKWOOD MODEL 2265 CENTRE PIVOT IRRIGATION SYSTEM WITH FLEXSPAN CORNER SYSTEM ATTACHMENT

RETAIL PRICE:	$56,500.00 (November, 1984, f.o.b. Lethbridge)
SPRINKLER TYPE:	- Rainbird 8X spray nozzles mounted on drop tubes
DISTRIBUTION UNIFORMITY:	
- field tests	- 84% with Flexspan corner system extended and end gun operating. - 67% with Flexspan corner system folded and end gun shut off
- theoretical	- 92% with Flexspan extended and end gun shut off
APPLICATION RATES:	- 1.5 in/h (38 mm/h) average - 13.1 in/h (338 mm/h) maximum
CROP DAMAGE:	- 0.8% of total irrigated area
ROTATIONAL SPEED:	- minimum 22 h for full circle rotation
EASE OF OPERATION AND ADJUSTMENT:	- controls were conveniently located - access to control panel was inconvenient
SAFETY DEVICES:	- low pressure shutdown - low temperature shutdown - overwater shutdown - power interruption shutdown - tower misalignment shutdown
OPERATOR'S MANUAL:	- complete and informative

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