Printed: March 1984
Tested at: Humboldt
ISSN 0383-3445
Group 1b

Evaluation Report 352

Drymor Redbird Grain Dryer

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

DRYMOR REDBIRD GRAIN DRYER

MANUFACTURER:
Geneva Manufacturing Inc.
Box 1087
Alexandria, MN 56308
U.S.A

DISTRIBUTOR:
Glenmore Grain Systems Ltd.
Box 1654
Prince Albert, Saskatchewan
S6V 5T2

Reitenbach Sales Ltd.
Box 460
Langenburg, Saskatchewan
S0A 2A0

RETAIL PRICE:
$35,700.00 (March, 1984, f.o.b. Humboldt, complete with optional canvas roof).

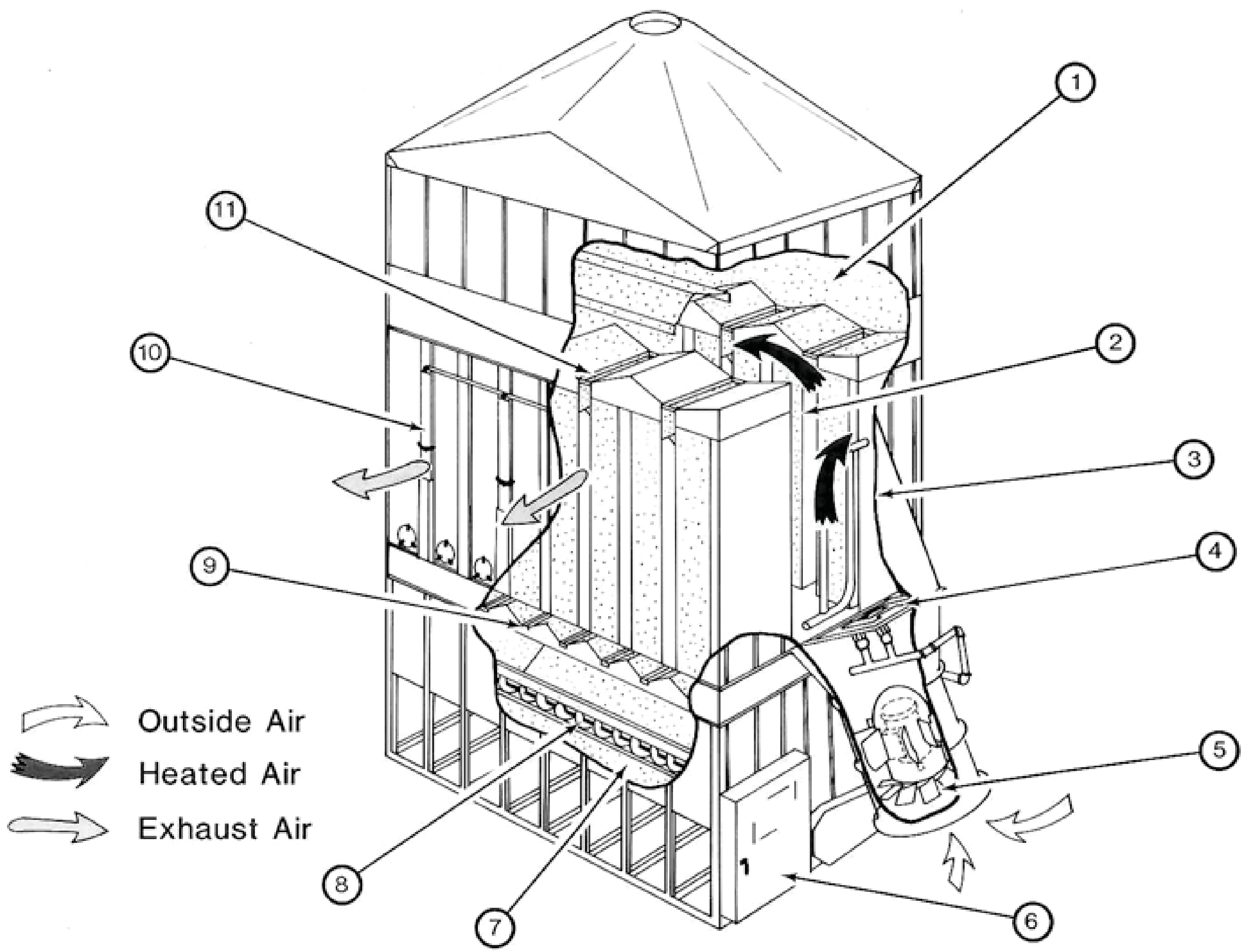

FIGURE 1. Drymor Redbird Grain Dryer: (1) Wet Grain Holding Chamber, (2) Grain Drying Chambers, (3) Air Plenum, (4) Burner, (5) Fan, (6) Control Panel, (7) Dry Grain Holding Chamber, (8) Discharge Auger, (9) Unload Gates, (10) Exhaust Air Dampers, (11) Load Gates.

SUMMARY AND CONCLUSIONS

Drying Capacity: The rated drying capacity of the Drymor Redbird was 137 bu/h (3.7 t/h) in wheat, 153 bu/h (3.3 t/h) in barley, 101 bu/h (2.3 t/h) in rapeseed and 104 bu/h (2.6 t/h) in Hybrid 3996 corn.

Fuel Consumption: At rated drying capacity, the specific fuel consumption or the amount of propane required to dry a quantity of grain was 7.4 gal/100 bu (12.4 L/t) in wheat, 5.8 gal/100 bu (12.1 L/t) in barley, 6.3 gal/100 bu (12.6 L/t) in rapeseed and 13.0 gal/100 bu (23.3 L/t) in corn. This corresponds to a fuel consumption of 10.1 gal/h (46 L/h) in wheat, 8.8 gal/h (40 L/h) in barley, 6.4 gal/h (29 L/h) in rapeseed and 13.7 gal/h (62 L/h) in corn.

Energy Consumption: At rated drying capacity, the specific energy consumption or the total energy required to remove a quantity of water from the grain, was 2100 Btu/lb (4900 kJ/kg) in wheat, 2300 Btu/lb (5400 kJ/kg) in barley, 2000 Btu/lb (4700 kJ/kg) in rapeseed and 1800 Btu/lb (4200 kJ/kg) in corn.

Quality of Work: No grade loss occurred when drying commercial rapeseed or feed barley and corn. A grade loss did occur in commercial red spring wheat when operating at the manufacturer's recommended drying air temperature setting. At a drying air temperature that did not reduce the grade of commercial red spring wheat, the rated drying capacity would decrease 40 to 50%, while specific fuel and energy consumption would increase by 10 to 20%.

The drying air temperature was uniform and adequate for all drying conditions encountered, but was slightly lower than the gauge reading.

Ease of Operation and Adjustment: Ease of assembly and installation was very good. The Drymor Redbird was not equipped for transporting. The automatic controls made the ease of filling, drying, cooling and discharge very good. Supervision was only required on the first run each time grain conditions changed to determine the new control settings. The drying air temperature was easy to set. Ease of cleaning the Drymor was fair and it

required weekly cleanup. Lubrication points were accessible and daily servicing took 2 minutes, making the ease of servicing very good.

Power Requirements: The Drymor Redbird required 13.7 hp (10.2 kW) when operated on 230 V AC electrical power.

Safety: The Drymor Redbird was safe to operate as long as the manufacturer's safety instructions were followed. The dryer was quiet to work around. The operator's station was located near the fan resulting in a sound level of 90 dBa.

Operator Manual: The operator manual was well illustrated, clearly written and contained much useful information.

Mechanical History: One minor mechanical problem occurred during the test.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Reducing the recommended drying air temperature setting to prevent grade loss when drying commercial red spring wheat.
2. Modifications to prevent the mercury paddle switches settings from slipping during operation.
3. Accurately calibrating the drying air temperature high limit switch to prevent needless safety shutdowns.
4. Providing standard equipment to prevent unnecessary burner safety shutdowns when drying rapeseed.
5. Modifications to permit automatic operation when drying high moisture content grain at hot outside temperatures.
6. Modifications to the discharge auger to simplify cleaning.
7. Revisions to the operator manual to include all locations for the moisture and cool control temperature probes.

Senior Engineer: G.E. Frehlich
Project Engineer: J.D. Wassermann
Project Technologist: W.F. Stock

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Although grain damage occurred during the tests, the damage was not visible since it was due to a reduction in milling quality. Our customers have not experienced any grade loss due to grain damage. However, if milling quality is a major concern, we recommend operating the dryer at reduced temperatures when drying commercial red spring wheat.
2. The paddle switches have a good locking system on them. It is possible that they were not tightened enough at the start of the tests.
3. During normal operations, we have not experienced unnecessary shut downs.
4. We are considering this as standard equipment.
5. According to the report, this occurred only once and to the best of our knowledge, has not occurred under regular operating conditions.
6. We will look into this.
7. This will be included in all future manuals.

Manufacturer's Additional Comments

1. Redbird owners indicate that they have experienced higher drying capacities and lower fuel consumptions than shown in this report. Drying capacity in red spring wheat would increase significantly if the drying temperature was slightly higher and the present 24 minute cooling time was reduced to 15 minutes per batch. This would also reduce the specific fuel consumption.
2. A higher drying temperature in barley will be recommended in future operating instructions. This will increase drying capacity substantially and reduce specific fuel consumption.

GENERAL DESCRIPTION

The Drymor Redbird is an automatic batch, cross-flow grain dryer with an axial fan, propane burner, wet and dry grain holding chambers, and 16 grain drying chambers enclosing an air plenum. Grain fills the wet grain holding chamber at the top of the dryer and preheats while the previous batch is being dried. The preheated grain is then dropped through load gates into the grain drying chambers. Outside air is forced by the fan past the burner into the air plenum through the grain drying chambers on one side of the dryer to dry or cool the grain. Every 15 seconds, exhaust air dampers stop the flow of air through the chambers on one side and at the same time direct the air through the grain drying chambers on the opposite side. After drying and cooling, the grain is dropped through unload gates into the dry grain holding chamber where it is discharged by an auger while the next batch is being dried.

The Drymor Redbird automatically fills, drys, cools and discharges grain until the wet grain supply is exhausted. Four mercury paddle switches control grain flow through the dryer. Drying air temperature is controlled by a modulating valve and monitored on a nearby gauge. The drying and cooling cycles are controlled respectively by moisture and cool control settings. Automatic operation can by manually overridden.

The fan is driven by a 7.5 hp (5.6 kW), 230 V AC, single phase electric motor and the discharge auger is driven by a 2 hp (1.5 kW) electric motor. The exhaust air dampers, and load and unload gates are operated by air cylinders charged from an air compressor driven with a 3.4 hp (0.6 kW) electric motor.

A safety control circuit shuts down the dryer if the burner flame is extinguished, the fan shuts down, or if the drying air or exhaust air temperature high limit settings are exceeded. Controls also provide protection if air pressure is low, wet grain supply is exhausted, or if motors or circuits overload.

Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The Drymor Redbird was operated with artificially and naturally wet grain under the conditions shown in TABLE 1 for 111 hours while drying about 13,350 bu (325 t) of grain. It was evaluated[1] for rate of work, fuel and energy consumption, quality of work, ease of operation and adjustment, power requirements, operator safety and suitability of the operator manual.

TABLE 1. Operating Conditions

Grain	Grade	Dockage	Moisture Content	Hours	Grain Dried	
		%	%		bu	t
Wheat	2CW RS	1	15.8 to 23.9	21	3000	82
Barley	1 Feed	2	16.4 to 24.4	28	3240	71
Rapeseed	2CW	4	12.9 to 19.3	34	3080	70
Corn (Hybrid 3996)	2CW	3	17.7 to 29.4	28	4030	102
Total				111	13350	325

RESULTS AND DISCUSSION

RATE OF WORK

Standard Conditions: To provide a meaningful comparison of grain dryer performance, the drying capacity, and fuel and energy consumption of the dryers should be determined for identical drying conditions. Because it is impossible to obtain the same air and grain conditions in the field when testing each machine, the dryer capacities and fuel and energy consumption included in this report have been mathematically adjusted to standard drying conditions[2]. These adjusted results can be compared to the adjusted results of other dryers, even though they were tested under different conditions or in different years.

Drying Capacity: The drying capacity[3] of a dryer is the rate at which grain can be dried to the dry moisture content specified by the Canadian Grain Commission, while operating the dryer at standard conditions and the settings recommended by the manufacturer. The drying capacity is based on the time to fill, dry, cool and discharge the grain from the grain drying chambers. Drying capacity varies with the grain type and the amount of moisture removed. FIGURES 2 to 5 present capacity curves for the Drymor Redbird while drying wheat, barley, rapeseed and Hybrid 3996 corn.

Grade loss occurred when drying red spring wheat at the manufacturer's recommended drying air temperature. The drying

[1]Tests were conducted as outlined in the Machinery Institute Detailed Test Procedures for Grain Dryers.
[2]The standard drying conditions used by the Machinery Institute for the presentation of grain dryer results are given in APPENDIX II.
[3]The Machinery Institute determines the drying capacity using the weight of the dried grain discharged from the dryer. Some manufacturers state their drying capacity using the weight of the wet grain entering the dryer. See APPENDIX VI for the wet grain to dry grain conversion.

capacities shown for wheat would be 40 to 50% less if the dryer was operated at a lower drying air temperature that would not cause a grade loss.

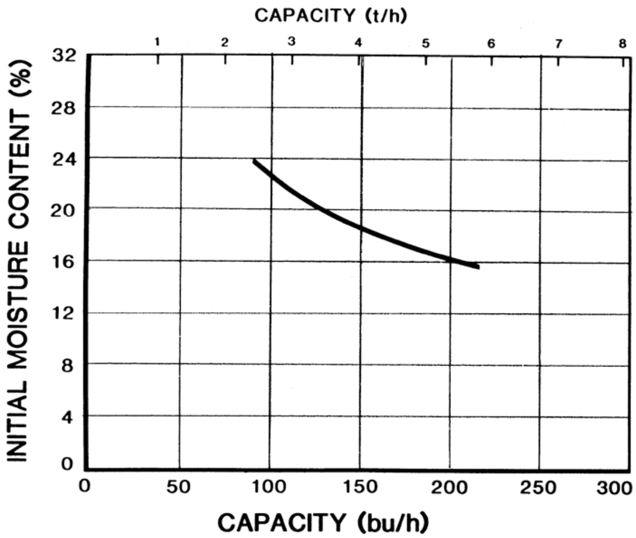

FIGURE 2. Drying Capacity in Wheat.

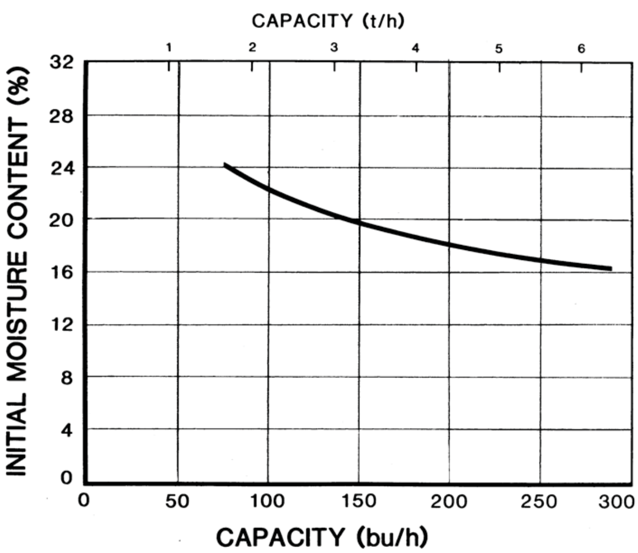

FIGURE 3. Drying Capacity in Barley.

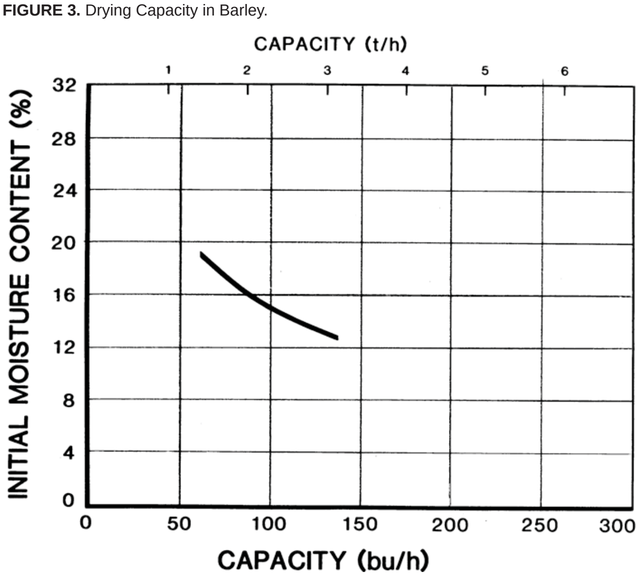

FIGURE 4. Drying Capacity in Rapeseed.

Rated Drying Capacity: The Machinery Institute has designated the rated drying capacity as the capacity of the dryer while removing 5% moisture in wheat, barley and rapeseed, and 10% moisture in corn. It is based on the time required to fill, dry, cool and discharge the grain under these conditions.

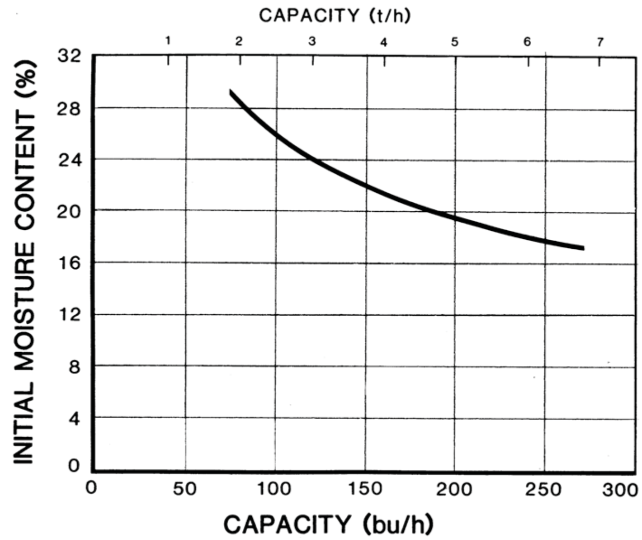

FIGURE 5. Drying Capacity in Corn (Hybrid 3996).

The total batch time (TABLE 2) for the Drymor Redbird varied from 1.1 hours in wheat and barley to 1.6 in rapeseed, while the rated drying capacity (TABLE 3) varied from 101 bu/h (2.3 t/h) in rapeseed to 153 bu/h (3.3 t/h) in barley. Operating the dryer at a lower drying air temperature to prevent grade loss in commercial red spring wheat would decrease the rated drying capacity by 40 to 50%.

TABLE 2. Batch Times

Grain	Filling	Drying	Cooling	Discharge	Total
	Hours	Hours	Hours	Hours	Hours
Wheat[4]	Fills while	0.7	0.4	Discharges	1.1
Barley	the previous	0.9	0.2	while the	1.1
Rapeseed	batch	1.3	0.3	prevous	1.6
Corn (Hybrid 3996)	dries	1.1	0.3	batch dries	1.4

TABLE 3. Rated Drying Capacities

Grain	Initial Moisture Content	Moisture Removed	Drying Air Temperature Setting		Rated Drying Capacity		Fig. No.
	%	%	°F	°C	bu/h	t/h	
Wheat[4]	19.5	5	220	104	137	3.7	2
Barley	19.8	5	160	71	153	3.3	3
Rapeseed	15.0	5	150	66	101	2.3	4
Corn (Hybrid 3996)	25.3	10	230	110	104	2.6	5

FUEL AND ENERGY CONSUMPTION

Specific Fuel Consumption: Fuel consumption of a grain dryer varies considerably with the temperature and moisture content of the grain and ambient air, the drying air temperature, airflow and burner efficiency To permit comparison of fuel used in different dryers, fuel consumption must be adjusted to standard conditions and must be related to the quantity of grain dried. Specific fuel consumption is a measure of the fuel used to dry a quantity of grain. It is expressed in gallons (gal) of propane per 100 bushels (bu) of grain dried (litres (L) of propane per tonne (t) of grain dried). A low specific fuel consumption indicated efficient fuel use.

The specific fuel consumption for the Drymor Redbird at rated drying capacity (TABLE 4) varied from 5.8 gal/100 bu (12.1 L/t) in barley to 13.0 gal/bu (23.3 L/t) in corn. Operating the dryer at a lower drying air temperature to prevent grade loss in commercial red spring wheat would increase specific fuel consumption by 10 to 20%. Fuel consumption[5] ranged from 6.4 gal/h (29 L/h) in rapeseed to 13.7 gal/h (62 L/h) in corn.

Specific Energy Consumption: Energy consumption of a dryer also varies with drying conditions and grain dryer design. To permit comparison of the energy used in different dryers, energy

[4] *Grade loss occurred.*

[5] *Fuel consumption for batch dryers is the fuel consumed during the drying cycle averaged over the total batch time.*

consumption must be adjusted to standard conditions and related to the quantity of water removed from the grain. Specific energy consumption is a measure of overall dryer efficiency. It is the total energy, including electrical, mechanical and fuel, required to remove a quantity of water. It is expressed in British thermal units (Btu) of energy per pound (lb) of water removed (kilojoules (kJ) of energy per kilogram (kg) of water removed). A low specific energy consumption indicates efficient grain drying.

The specific energy consumption for the Drymor Redbird (TABLE 4) at rated drying capacity varied from 1800 Btu/lb (4200 kJ/kg) in corn to 2300 Btu/lb (5400 kJ/kg) in barley. Operating the dryer at a lower drying air temperature to prevent grade loss in commercial red spring wheat would increase Specific energy consumption by 10 to 20%.

TABLE 4. Fuel and Energy Consumption.

Grain	Moisture Removed	Fuel Consumption		Specific Fuel Consumption		Specific Energy Consumption	
	%	gal/h	L/h	gal/100 bu	L/t	Btu/lb	kJ/kg
Wheat[4]	5	10.1	46	7.4	12.4	2100	4900
Barley	5	8.8	40	5.8	12.1	2300	5400
Rapeseed	5	6.4	29	6.3	12.6	2000	4700
Corn (Hybrid 3996)	10	13.7	62	13.0	23.3	1800	4200

QUALITY OF WORK

Grain Quality: Grain can be damaged in the dryer, if it is dried too long at excessively high temperatures. The grain damage that can occur before there is a loss in the grade and corresponding reduction in the grain price depends on whether the grain is seed, commercial or feed. Feed grain is permitted the greatest damage and seed grain the least damage before a grade loss occurs. It is very important for the operator to occasionally have the grain tested for damage especially when drying unfamiliar grains or operating at new dryer settings.

No grade loss[4] occurred when drying commercial rapeseed or feed barley and corn. A grade loss did occur when drying commercial red spring wheat at the recommended drying air temperature setting. However, reducing the drying air temperature to 150°F (66°C), as recommended in Canada Agriculture's Heated Air Grain Dryer publication, would prevent grade loss when drying commercial wheat. It is recommended that the manufacturer consider reducing the recommended drying air temperature setting for drying commercial red spring wheat.

Drying Air Temperature: A uniform drying air temperature minimizes grain damage and provides uniform and efficient grain drying. The drying air temperature for the Drymor Redbird was uniform. The average drying air temperature was slightly lower than the gauge reading. See APPENDIX IV for further details.

EASE OF OPERATION AND ADJUSTMENT

Transporting: The test machine was not equipped for transporting. A transport kit is available as an option.

Assembly: The Drymor Redbird required some assembly. The top air plenum shroud, ladder, wet grain holding chamber and cover were assembled by two men in 1 hour. Assembly instructions were clear.

Installation: The Drymor Redbird was installed by two men in about 2 hours. The dryer was easily located and connected to electrical and propane supplies. The manufacturer's recommended installation height provided adequate clearance for an auxiliary unloading auger.

Grain Filling: The Drymor Redbird could be filled (FIGURE 6) by a grain conveyor with a discharge height of 19 ft (5.8 m). A paddle switch was very useful to control the conveyor to maintain the grain level in the wet grain holding chamber. The Drymor Redbird had an electrical panel to also power auxiliary filling and discharge conveyors. Occasionally, the mercury bulb on the wet holding chamber paddle switch had to be readjusted because it's setting had slipped. Other paddle switches also required occasional adjustment. It is recommended that the manufacturer consider modifications to prevent the paddle switch setting from slipping during operation.

The dryer was automatically shut clown if the wet grain supply was exhausted.

The holding capacity[6] of the wet grain holding chamber was about 280 bu (10.2 m³). The holding capacity of the grain drying chambers was about 158 bu (5.8 m³). The load gates remained open throughout the drying cycle keeping the grain drying chambers completely filled. Batches smaller than the holding capacity could not be dried.

[6]*The holding capacity is determined with wheat at 19.5% moisture content.*

FIGURE 6. Grain Filling.

Grain Drying: The fan (FIGURE 7) and burner were started automatically when the paddle switch sensed the grain drying chambers were full. The drying air temperature was set by adjusting a dial on the modulating valve. Drying air temperature and fuel pressure were monitored on nearby gauges. Adequate drying air temperatures were easily achieved under all conditions. The maximum drying air temperature and maximum exhaust air temperature were set on the limit switches at the control panel (FIGURE 8). If either setting was exceeded, the dryer was shut down. The drying air temperature high limit switch was not properly calibrated causing unnecessary safety shutdowns. A setting higher than the setting recommended by the manufacturer was required especially when drying high moisture content grain. It is recommended that the manufacturer accurately calibrate the drying air temperature high limit switch.

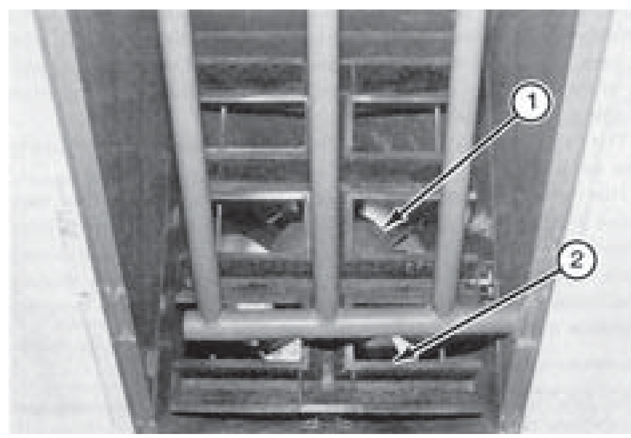

FIGURE 7. Fan Housing: (1) Fan, (2) Burner.

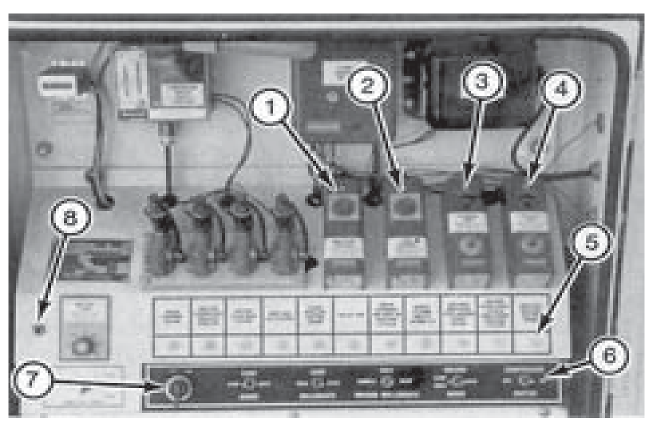

FIGURE 8. Control Panel: (1) Moisture Control, (2) Cool Control, (3) Drying Air Temperature High Limit Switch, (4) Exhaust Air Temperature High Limit Switch, (5) Indicator Lights, (6) Auger and Roller Gate Controls, (7) Main Switch, (8) Damper Override Switch.

Low airflow when drying rapeseed caused the airflow safety switch to trip intermittently and cut out the burner. A dealer installed switch in the control panel, which held all exhaust air dampers open continuously, eliminated this problem. It is recommended that the manufacturer consider providing standard equipment to prevent unnecessary burner safety shutdowns when drying rapeseed.

The dryer was equipped with a moisture control that measured grain temperature and would automatically shut off the burner when the set temperature was reached. The initial drying cycle required supervision to determine the moisture control setting corresponding to dry grain. This could easily be determined using the appropriate drying time guidelines in the operator manual and then sampling discharge moisture content to fine tune the drying time. Another more laborious procedure required sampling grain moisture content from the grain drying chambers throughout the drying cycle. The moisture control setting had to be readjusted when the grain type, moisture content or temperature changed. The moisture control temperature probe was placed in one of three locations across the width of the grain drying chamber depending on the initial grain moisture content.

Relocation from the normal central location was only required when removing more than 10% moisture content and took one man only 2 minutes.

The drying chambers quickly gravity dumped and refilled for drying in approximately 1 minute.

The Drymor Redbird required supervision on the first run after changing grain conditions, but operated automatically once the control settings for the new conditions were determined.

Grain Cooling: Grain cooling occurred after the moisture controller automatically shut off the burner. The cooling cycle was set by adjusting the cool control temperature setting to the desired discharge grain temperature.

The manufacturer recommended that the cool control temperature probe be positioned directly below the moisture control temperature probe in one of the three locations. For the majority of operations, the probe was in the centre hole and the discharge grain temperature closely corresponded to the cool control setting. However, with the probe located for high moisture grain, the discharge grain cooled to about 8°F (4°C) below the setting.

Overcooling grain is not a serious problem, but it does reduce dryer capacity. Also, once when drying high moisture grain at hot outside temperatures, the cool control could not be set high enough to automatically initiate the cooling cycle. This was inconvenient as manual operation was required. It is recommended that the manufacturer consider modifications to allow automatic operation when drying high moisture content grain at hot outside temperatures.

Grain Discharge: After cooling, the grain automatically dropped into the dry grain holding chamber at the bottom of the dryer. It was then discharged by an auger at the rear (FIGURE 9) that was controlled by a paddle switch. A shield on top of the discharge auger could be adjusted to maximize the output of the auger. However, caution was required to prevent motor overload.

FIGURE 9. Grain Discharge.

Cleaning: Ease of cleaning the Drymor Redbird was fair. The screens never plugged during the tests, however, several locations on the dryer required regular cleanup. Wet grain that built up in the wet grain holding chamber and on the exhaust side of the grain drying chambers had to be cleaned weekly and when switching grains. The 5 bu (0.2 m³) of grain that remained in the dry grain holding chamber (FIGURE 10) required cleanup after a rain and when switching grains. Rapeseed and its fines that collected on the ground and in the air plenum had to be cleaned up weekly.

Grain that built up under the discharge auger was very difficult to remove. It is recommended that the manufacturer modify the discharge auger to simplify cleaning. It took one man about 1-1/2 hours to completely clean the dryer.

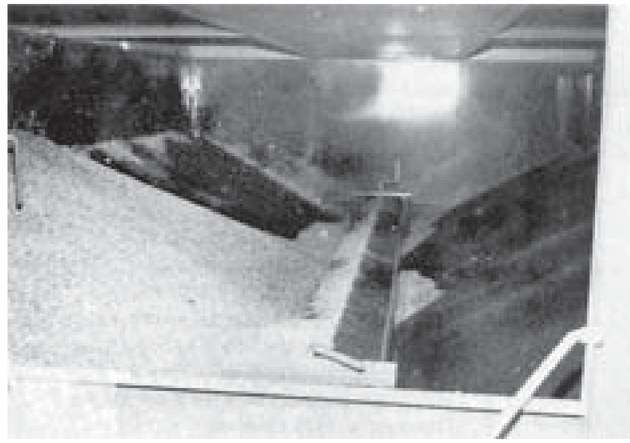

FIGURE 10. Buildup of Grain in the Dry Grain Holding Chamber.

Servicing: It took about 2 minutes to service the compressor and drain the propane drip sump each day. Two pressure grease fittings on the discharge auger and the dampers required lubrication weekly. The oil in the compressor pump had to be changed each season. To gain access to a pressure grease fitting on the discharge auger, the safety shield had to be unbolted.

POWER REQUIREMENTS

The Drymor Redbird was equipped with a 200 ampere main panel. It drew a current of 51 amperes when operating on 230 V AC single phase power. The dryer was capable of powering auxiliary filling and discharge conveyors. Power requirement with the fan, compressor and discharge auger running was 13.7 hp (10.2 kW). Optional 230 or 460 V AC three phase electrical systems were available.

OPERATOR SAFETY

The Drymor Redbird operator manual emphasized safety, and warning decals adequately indicated dangerous areas. Drives were well shielded and machine adjustments were easily made.

Sound level at the control panel was 90 dBA. This apparently high sound level occurred because the control panel was directly beside the fan; however, the Drymor Redbird was very quiet to work around.

The Drymor Redbird is CSA (Canadian Standards Association) certified as meeting the requirements of Gas Fired Equipment for Drying Farm Crops. The safety controls were effective in automatically shutting off the fuel to the burner if the burner flame went out, if the drying air temperature or exhaust air temperature exceeded the set maximum, or if the fan shut down.

Although the operator manual was very detailed, the complex control circuit was difficult to understand without a good electrical knowledge. Qualified electricians should be consulted if electrical servicing is required to ensure proper operation.

A ULC approved multi-purpose fire extinguisher with a 2A 10BC rating should be kept with the dryer at all times.

OPERATOR MANUAL

The operator manual was clearly written and well illustrated. It contained useful information on safe operation, adjustments, service and maintenance. However, it did not indicate all three locations for the moisture and cool control temperature probes. It is recommended that the manufacturer revise the operator manual to include all three locations.

DURABILITY RESULTS

TABLE 5 outlines the mechanical history of the Drymor Redbird during 111 hours of operation while drying 13,350 bu (325 t) of grain. The intent of the test was to evaluate the functional performance of the machine. An extended durability test was not conducted.

TABLE 5. Mechanical History

Item	Operating Hours	Grain Dried bu	(t)
-A vaporizer connection leaked propane and was sealed at	The beginning of test		

APPENDIX I
SPECIFICATIONS

MAKE: Drymor
MODEL: Redbird
SERIAL NUMBER: DR605831 LPNG12
MANUFACTURER: Geneva Manufacturing Inc.
Box 1087
Alexandria, MN 56308
U.S.A.

GRAIN FILLING:
- -- position: top centre
- -- height: 18.3 ft (5.6 m)

WET GRAIN HOLDING CHAMBER:
- -- shape: rectangular with peaked roof
- -- length: 12.0 ft (3.7 m)
- -- width: 7.4 ft (2.3 m)
- -- height: 8.0 ft (2.4 m)
- -- volume: 280 bu (10.2 m³)

GRAIN DRYING CHAMBERS:
- -- type: vertical columns
- -- number: 16
- -- length: 28 in (711 mm)
- -- width: 12 in (305 mm)
- -- height: 57 in (1450 mm)
- -- volume: 158 bu (5.8 m³)

DRY GRAIN HOLDING CHAMBER:
- -- shape: rectangular inverted triangle
- -- length: 12.0 ft (3.7 m)
- -- width: 7.5 ft (2.3 m)
- -- height: 3.7 ft (1.1 m)
- -- volume: 177 bu (6.4 m³)

GRAIN DISCHARGE:
- -- type: auger
- -- diameter: 5 in (127 mm)
- -- length: 14.0 ft (4.3 m)
- -- drive: belt driven from electric motor -speed 445 rpm
- -- discharge rate adjustment: varying height of shield over auger
- -- discharge height: 3.0 in (76 mm) above machine base
- -- discharge position: bottom rear centre of dryer

AIR PLENUM:
- -- shape: rectangular
- -- air transfer to grain: screen
- -- screen porosity: 49 holes/in² (7.6 holes/cm²)
- -- screen holes shape: circular
- -- screen holes size: 0.04 in (0.9 mm) diameter
- -- screen area per chamber: 11.1 ft² (1.0 m²)
- -- total screen air: 178 ft² (16.6 m²)

FAN:
- -- type: vane-axial
- -- outer diameter: 30 in (762 mm)
- -- number of blades: 8
- -- speed: 1700 rpm
- -- drive: direct from motor
- -- control: automatic switch

BURNER:
- -- maximum rating: 2.5 MBtu/h (2.7 G J/h)
- -- type: 1 x 1 x 29.5 in (25 x 25 x 750 mm) main tube with eight 1 x 2 x 12.8 in (25 x 51 x 324 mm) lateral tubes
- -- fuel: propane
- -- ignition: spark-ignited pilot
- -- temperature adjustment: modulating valve

ELECTRICAL SYSTEM:
- -- main circuit: 200 amp, 230 V AC, single phase
- -- electric motors
  - -number: 3
  - -size
    - -fan: 7.5 hp (5.6 kW), 230 V AC, single phase
    - -discharge auger: 2 hp (1.5 kW), 230 V AC, single phase
    - -compressor: 3/4 hp (0.6 kW), 230 V AC, single phase

NUMBER OF CHAIN DRIVES: 0

NUMBER OF BELT DRIVES: 2

NUMBER OF PRELUBRICATED BEARINGS: 0

LUBRICATION POINTS:
- -- weekly: 20

OVERALL DIMENSIONS:
- -- field length: 22.4 ft (6.8 m)
- -- field width: 8.2 ft (2.5 m)
- -- field height: 18.3 ft (5.6 m)
- -- body metal thickness: 13 gauge (2.3 mm)

WEIGHT: (Dryer Empty) 7780 lb (3540 kg)

SOUND LEVEL: (At Operator's Station) 90 dBA

HOLDING CAPACITY:
- -- all three chambers full: 615 bu (22.4 m³)

INSTRUMENTS: batch counter; fuel pressure gauge; drying air temperature gauge; bin level, fan, burner, loading and unloading indicator lights

OPTIONS: canvas roof
230 or 460 V AC three phase electrical systems

APPENDIX II
MACHINERY INSTITUTE STANDARD DRYING CONDITIONS

The Machinery Institute has chosen to state the performance of grain dryers at the following air and grain conditions:

Ambient temperature	50°F (10°C)		
Initial grain temperature	50°F (10°C)		
Initial grain temperature	50°F (10°C)		
Barometric pressure	13.8 psia (95 kPa)		
Final grain moisture content		-wheat	14.5%
(Canadian Grain Commission)		-barley	14.8%
		-rapeseed	10.0%
		-corn	15.5%

APPENDIX III
REGRESSION EQUATIONS FOR DRYING CAPACITY RESULTS

Regression equations for the drying capacity results shown in FIGURES 2 to 5 are presented in TABLE 6. In the regressions, B = drying capacity in bu/h, C = drying capacity in t/h and M = initial grain moisture content in percent of total weight, while $\ln$ is the natural logarithm. Sample size refers to the number of tests conducted. Limits of the regression may be obtained from FIGURES 2 to 5 while the grain conditions are presented in TABLE 1.

TABLE 6. Regression Equations

Grain	Fig. No.	Regression Equation	Simple Correlation Coefficient	Variance Ratio	Sample Size
Wheat	2	$\ln B = 11.24 - 2.13 \ln M$ $\ln C = 7.64 - 2.13 \ln M$	0.99	180[1]	8
Barley	3	$\ln B = 15.18 - 3.40 \ln M$ $\ln C = 11.36 - 3.40 \ln M$	0.99	127[1]	8
Rapeseed	4	$\ln B = 10.08 - 2.02 \ln M$ $\ln C = 6.29 - 2.02 \ln M$	0.94	636[1]	8
Corn (Hybrid 3996)	5	$\ln B = 12.68 - 2.48 \ln M$ $\ln C = 9.02 - 2.48 \ln M$	0.98	183[1]	11

[1] *Significant at $P \leq .01$*

APPENDIX IV
DRYING AIR TEMPERATURE VARIATION

The coefficient of variation[7] (CV) is used to describe the variation in the temperature within the air plenum during drying. The lower the CV, the more uniform is the drying air temperature.

TABLE 7 presents the coefficients of variation for the Drymor Redbird when drying, wheat, barley, rapeseed and corn.

TABLE 7. Drying Air Temperatures.

Grain	Gauge Setting		Average Drying Air Temperature		CV
	°F	°C	°F	°C	%
Wheat	220	104	212	100	10
Barley	160	71	158	70	7
Rapeseed	150	66	147	64	7
Corn	230	110	221	105	9

[7] *The coefficient of variation is the standard deviation of the measured drying air temperatures expressed as a percent of the average drying air temperature.*

APPENDIX V
MACHINE RATINGS

The following rating scale is used in Machinery Institute Evaluation Reports:

excellent	fair
very good	poor
good	unsatisfactory

APPENDIX VI
CONVERSION TABLE

Imperial Units	Multiply By	SI Units
British Thermal Units/Pound (Btu/lb)	2.33	Kilojoules/Kilogram (kJ/kg)
Bushels (bu) - volume	0.0364	Cubic Metres (m^3)
-weight	0.0272	Tonnes (t) wheat
	0.0218	Tonnes (t) barley
	0.0227	Tonnes (t) rapeseed
	0.0254	Tonnes (t) corn
Feet (ft)	0.305	Metres (m)
Gallons (gal)	4.55	Litres (L)
Horsepower (hp)	0.746	Kilowatts (kW)
Inches (in)	25.4	Millimetres (mm)
Pounds (lb)	0.455	Kilograms (kg)
Pounds/Square Inch (psi)	6.89	Kilopascals (kPa)

Dry Grain Weight = Wet Grain Weight x (100 - wet moisture content (%)) / (100 - dry moisture content (%))

SUMMARY CHART

DRYMOR REDBIRD GRAIN DRYER

RETAIL PRICE: $35,700.00 (March, 1984, f.o.b. Humboldt, complete with optional canvas roof)

	EVALUATION		COMMENTS
RATED DRYING CAPACITY	bu/h	(t/h)	
Wheat	137	(3.7)	-capacity would be 40 to 50% less when drying wheat at a lower temperature to prevent grain damage
Barley	153	(3.3)	
Rapeseed	101	(2.3)	
Hybrid 3996 Corn	104	(2.6)	
SPECIFIC FUEL CONSUMPTION	bu	(L/t)	
Wheat	7.4	(12.4)	-specific fuel consumption would be 10 to 20% less when drying wheat at a lower temperature to prevent grain damage
Barley	5.8	(12.1)	
Rapeseed	6.3	(12.6)	
Hybrid 3996 Corn	13.0	(23.3)	
QUALITY OF WORK			
Grain Quality			-no grade loss in commercial rapeseed or feed barley and corn -a grade loss occurred in commercial wheat
Drying Air Temperature			-uniform and adequate for all drying conditions -slightly lower than gauge reading
EASE OF OPERATION AND ADJUSTMENT			
Dryer Preparation	**very good**		-easily assembled and hooked up
Filling and Discharge	**very good**		-automatic operation convenient
Drying	**very good**		-automatic operation convenient, supervision required to determine settings -drying air temperature was easy to set
Cooling	**very good**		-automatic operation convenient
Cleaning	**fair**		-wet grain buildup in several locations required weekly cleanup
Servicing	**very good**		-daily servicing took 2 minutes
POWER REQUIREMENTS	13.7 hp (10.2 kW)		-230 V AC electric drive
OPERATOR SAFETY	**very good**		-CSA certified, well shielded, quiet fan
OPERATOR MANUAL	**very good**		-very clear and complete

CAUTION:
This summary chart is not intended to represent the final conclusions of the evaluation report. The relevance of the ratings is secondary to the information provided in the full text of the report. It is not recommended that a purchase decision be based only on the summary chart.

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