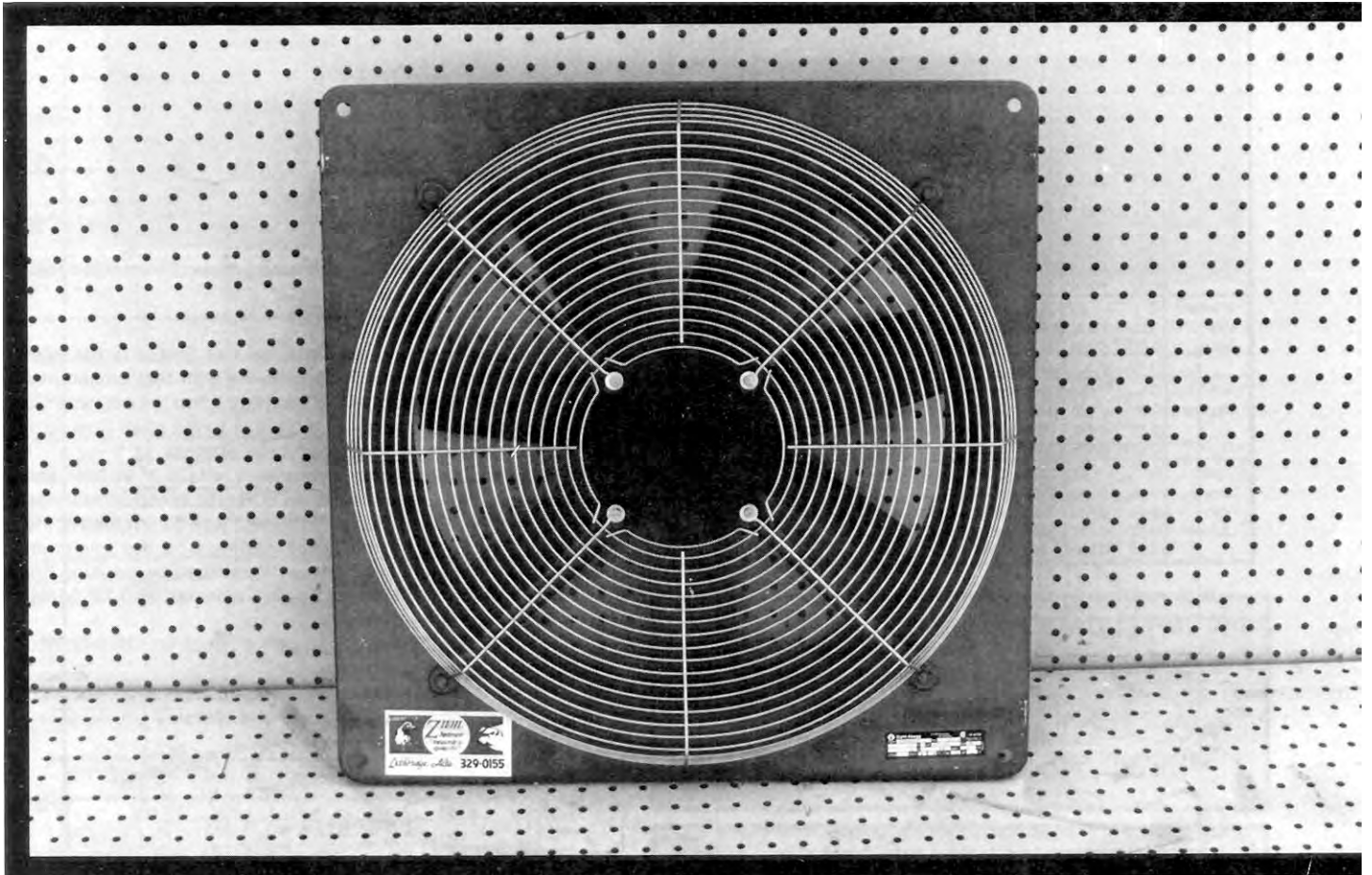


# EVALUATION REPORT

# 379



## Ziehl-Abegg Model 451-6 Ventilation Fan

A Co-operative Program Between



ALBERTA  
FARM  
MACHINERY  
RESEARCH  
CENTRE



PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

# ZIEHL-ABEGG MODEL 451-6 VENTILATION FAN

## MANUFACTURER:

Ziehl-Abegg GmbH & Co. KG  
 Postfach 1165, Zeppelinstrasse 28  
 D-7118 Kunzelsau  
 West Germany

## DISTRIBUTOR:

Aston Industries Inc.  
 P.O. Box 220  
 St. Leonard d'Aston, Quebec  
 J0C 1M0

## RETAIL PRICE:

\$306.00 (June, 1984, f.o.b. Lethbridge, Alberta complete with optional louvres).

## SUMMARY OF RESULTS

TABLE 1. Ziehl-Abegg Model 451-6 Fan Performance at Typical Levels of Operation.

SETTING	STATIC PRESSURE		AIR FLOW RATE		INPUT POWER		TOTAL EFFICIENCY %	FAN SPEED rpm
	in wg	(Pa)	cfm	(L/s)	hp	(W)		
Single Speed	0	(0)	2580	(1220)	0.30	(222)	15	948
	0.05	(12.5)	2380	(1120)	0.30	(226)	18	926
	0.10	(24.9)	2140	(1010)	0.31	(228)	19	902
	0.125	(31.1)	1970	(931)	0.30	(227)	19	891
	0.25	(62.3)	867	(409)	0.31	(229)	8	933
Variable Maximum	0	(0)	2570	(1210)	0.30	(226)	16	947
	0.05	(12.5)	2360	(1110)	0.30	(226)	18	922
	0.10	(24.9)	2100	(990)	0.31	(229)	18	898
	0.125	(31.1)	1930	(911)	0.31	(228)	18	888
	0.25	(62.3)	803	(379)	0.31	(228)	9	926
Variable Mid Range	0	(0)	2340	(1100)	0.25	(184)	11	816
	0.05	(12.5)	1950	(921)	0.24	(183)	14	773
	0.10	(24.9)	1600	(749)	0.25	(184)	14	751
	0.125	(31.1)	1460	(688)	0.25	(184)	14	756
Variable Minimum	0	(0)	1690	(795)	0.17	(130)	8	624
	0.05	(12.5)	1400	(663)	0.17	(129)	10	597
	0.10	(24.9)	836	(395)	0.17	(129)	8	625
	0.125	(31.1)	478	(226)	0.17	(130)	5	613
Single Speed With Louvres	0	(0)	2320	(1100)	0.30	(221)	12	904
	0.05	(12.5)	2050	(969)	0.30	(224)	13	892
	0.10	(24.9)	1720	(812)	0.30	(225)	14	880
	0.125	(31.1)	1470	(696)	0.30	(221)	12	927
	0.25	(62.3)	708	(334)	0.30	(225)	9	908

## RECOMMENDATIONS

It is recommended that the manufacturer consider:

- Updating the operator's manual to include the model 451-6 as well as including information on fan maintenance and trouble shooting.

Senior Engineer: E. H. Wiens

Project Engineer: R. P. Atkins

## THE MANUFACTURER STATES THAT

With regard to recommendation number:

- Due to the compactness and high quality of the motor fabrication, this piece of equipment is maintenance free in all mounting positions. Because of the in-stream, air-cooled design, our motor has long life at very low noise levels. The only care or attention to be given our fan is to keep the grating free of any foreign matter at all times. The same attention should also be given to the venturi casing and cradle mounting. In case of motor stoppage, contact the company's maintenance official or send it back to the supplier for replacement or capacitor replacement procedures.

## GENERAL DESCRIPTION

The Ziehl-Abegg model 451-6 ventilation fan is a 17.6 in (448 mm) diameter variable speed, direct drive, propeller type axial flow fan. It is primarily used in livestock and poultry barns as

an exhaust fan located in the wall or ceiling.

The Ziehl-Abegg 451-6 is a flush mounted unit equipped with an inlet guard grill, an inlet bell and optional shutters. A two speed control, a variable speed control and a thermostat are available as options, but were not supplied with the fan. The seven blade propeller, hub and motor mounts are made of cast aluminum. The external rotor of the motor forms the hub of the fan. A 0.33 hp (250 W), single phase, 120 V external rotor motor is used. The fan housing is constructed of galvanized sheet metal with a heavy enamel coating for corrosion protection.

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

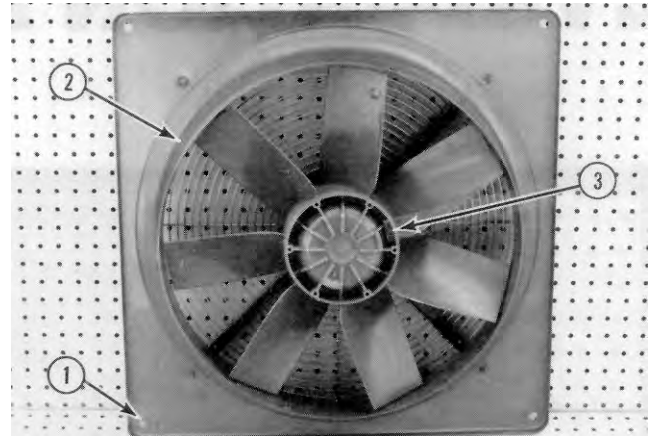


FIGURE 1. Ziehl-Abegg Model 451-6 Fan: (1) Mounting Flange, (2) Inlet Bell, (3) External Rotor & Hub Assembly.

## SCOPE OF TEST

The Ziehl-Abegg model 451-6 fan was tested in the inlet chamber setup (Figure 2) in accordance with test procedures developed by the Machinery Institute. The intent was to determine the performance of the fan in terms of air flow rate, static pressure, input power and total efficiency.

Fan performance was determined at 120 V in both the variable and single speed mode. An SCR type speed control was used to vary fan speed. Fan performance was determined at the maximum setting, the mid-range setting and the minimum setting. The minimum setting was established by reducing the fan speed to the point where a static pressure of 0.125 in wg (31.1 Pa) could still be obtained.

The effect of louvres on fan performance was determined in the single speed mode only.

The fan was also evaluated for ease of operation, operator safety and suitability of the operator's manual.

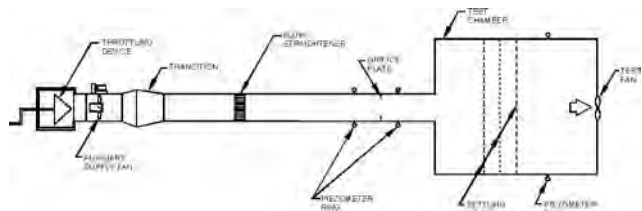


FIGURE 2. Schematic of Fan Test Apparatus - Inlet Chamber Setup.

## RESULTS AND DISCUSSION

### FAN PERFORMANCE

All fan performance results in this report are given at standard air<sup>1</sup> conditions so that direct comparisons can be made with other fan test reports. Fan performance under actual operating conditions could differ from these results by up to 10%, depending on such things as temperature, barometric pressure, humidity and elevation above sea level.

**Air Flow Rate:** Fan output in both the single speed mode and at the maximum setting on the variable speed control were similar (FIGURE 3). Reducing the fan speed, greatly reduced the

<sup>1</sup> Standard air is air with a density of 0.075 lbm/ft<sup>3</sup> (1.2 kg/m<sup>3</sup>) which occurs at 68°F (20°C), 50% relative humidity and a barometric pressure of 29.92 in Hg (101.325 kPa).

air flow rate for a given static pressure<sup>2</sup>. For example, at a static pressure of 0.125 in wg (31.1 Pa), reducing the speed from maximum to mid range to minimum setting, reduced the air flow rate from 1930 cfm (911 L/s) to 1460 cfm (688 L/s) to 478 cfm (226 L/s) respectively. At higher static pressures even larger reductions could be expected.

Air flow rates at typical levels of operation (i.e. static pressure) are given in TABLE 1. Ventilation fans are often rated on their output at a static pressure of 0.125 in wg (31.1 Pa). The manufacturer's rated air flow rate at 0.125 in wg (31.1 Pa), in the single speed mode, was 2400 cfm (1130 L/s). PAMI's measured flow rate at the same conditions was 1970 cfm (931 L/s) or 18% lower than the manufacturer's rating.

The manufacturer provided fan performance information at other levels of operation in the form of a performance curve. The graph provided was not easily interpreted and there was difficulty in accurately determining air flow rates for various static pressures. The manufacturer is encouraged to modify their sales literature such that the fan performance information given can be used to its full advantage.

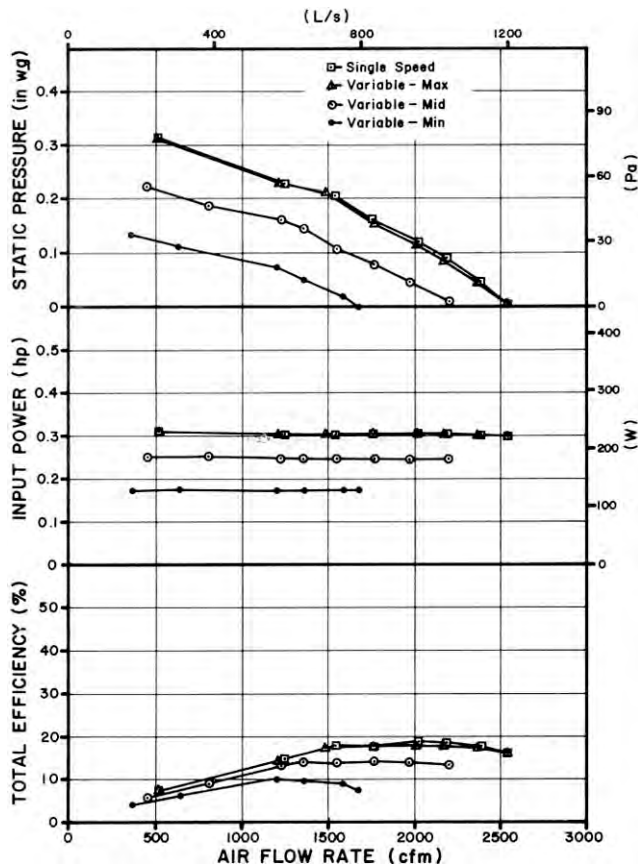


FIGURE 3. Ziehl-Abegg 451-6 Fan Performance Curves in the Single Speed Mode and at Three Speed Settings in the Variable Speed Mode.

**Power Requirements:** The power required to run the fan depended on fan speed. For typical levels of static pressure (TABLE 1), the input power was fairly constant at 0.31 hp (227 W) at maximum speed, at 0.25 hp (184 W) at mid range and 0.17 hp (130 W) at minimum speed. The maximum amperage drawn by the motor was 1.7 amps, which was well below the rated motor amperage of 2.4 amps.

**Total Efficiency:** Total efficiency is the ratio of air horsepower over the input power. Air horsepower is dependent upon the air flow rate and corresponding total pressure. For typical levels of operation, the total efficiency (TABLE 1) ranged from 9 to 18% at maximum speed, 11 to 14% at mid range and 5 to 10% at minimum speed. The total efficiency at maximum fan speed and a static pressure of 0.125 in wg (31.1 Pa) was 18%.

<sup>2</sup>Static pressure is a measure of the pressure difference between the pressure inside the building and the pressure on the outside of the building. Static pressure is usually expressed in inches of water gauge (in wg) or Pascals (Pa).

**Effect of Louvres:** The optional louvres were installed on the outlet side of the fan (FIGURE 4) to determine their effect on fan output. The fan was tested under these conditions in the single speed mode only. Using the louvres reduced the air flow rate by 10 to 25% (FIGURE 5) over the typical range of operation. For example, at a static pressure of 0.125 in wg (31.1 Pa), the louvres reduced the air flow rate by 25%, from 1970 cfm (931 L/s) to 1470 cfm (696 L/s) (TABLE 1). The efficiency was in turn reduced from 19 to 12%. The use of other control devices such as shutters, dampers, screens, and hoods would also reduce air flow rates by varying amounts. The use of such control devices have to be taken into consideration when designing a ventilation system.

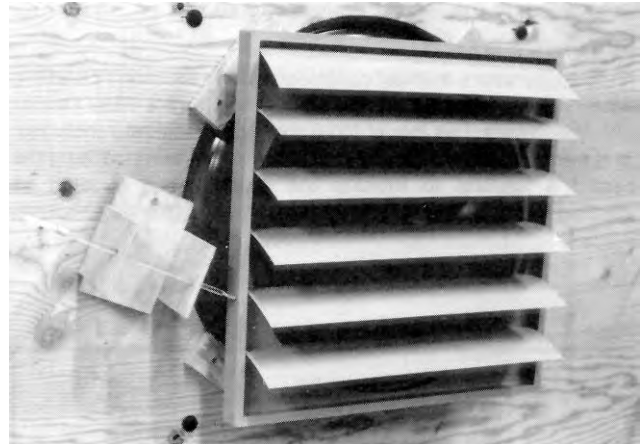


FIGURE 4. Louvres Located on Fan Discharge.

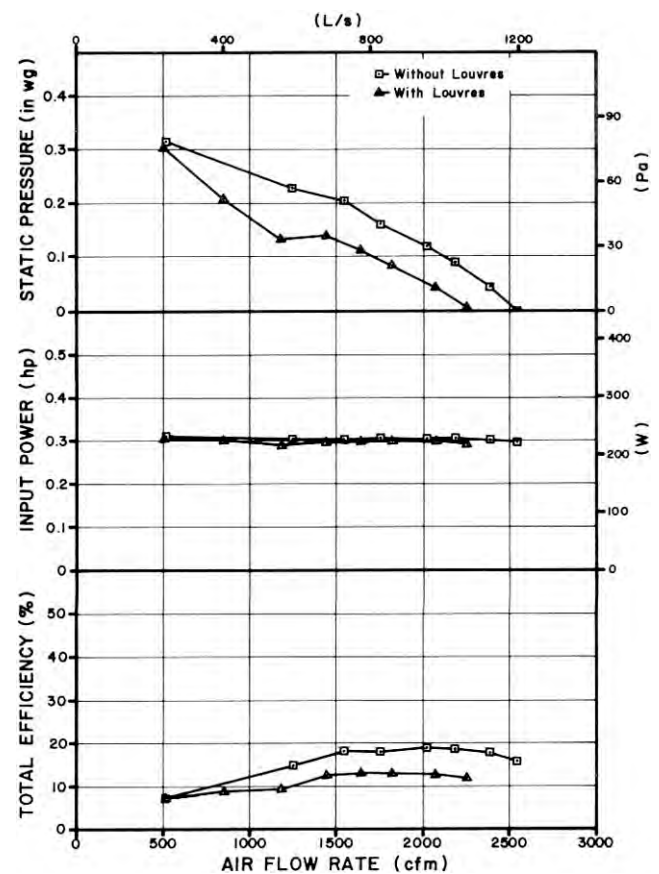


FIGURE 5. Effect of Louvres on Fan Performance.

#### EASE OF OPERATION

**Maintenance:** No maintenance instructions were supplied. The removeable inlet guard grill allowed easy access for fan cleaning. Regularly scheduled cleaning and maintenance will ensure longer motor life and optimum performance.

## OPERATOR SAFETY

The inlet guard grill provided adequate protection from the fan blades. The motor was a totally enclosed unit and presented no safety hazards. The Ziehl-Abegg 451-6 was CSA approved.

The noise level<sup>3</sup> of the Ziehl-Abegg 451-6, at a distance of 4.9 ft (1.5 m) from the centre of the fan discharge, while operating at a 0.125 in wg (31.1 Pa) static pressure, was 61 dB(A). Higher noise levels could be expected if the fan was operated in the vicinity of other buildings. The Ziehl-Abegg 451-6 falls near the bottom of range 3 of the PAMI noise level range classification (APPENDIX II). The noise level produced by this fan can be considered annoying and detrimental to operator performance under continuous exposure. Ear protection should be considered if working near the fan for prolonged periods.

## OPERATOR'S MANUAL

The operator's manual contained information on operation, specifications, installation and safety aspects for other similar Ziehl-Abegg fans. The model 451-6 was not specifically included. It is recommended that the manufacturer consider updating the operator's manual to include the model 451-6 as well as including information on fan maintenance and trouble shooting.

<sup>3</sup>PAMI Test Procedure for Determining Fan Noise Level.

### APPENDIX I

#### SPECIFICATIONS

<b>MAKE:</b>	Ziehl-Abegg
<b>MODEL:</b>	ECDQ 451-6 SP
<b>SERIAL NUMBER:</b>	D113335
<b>MANUFACTURER:</b>	Ziehl-Abegg GmbH & Co. KG Postfach 1165, Zeppelinstrasse 28 D-7118 Kunzelsau West Germany
<b>OVERALL DIMENSIONS:</b>	
- housing width	22.6 in (575 mm)
- housing height	22.6 in (575 mm)
- housing depth	7.1 in (181 mm)
- housing diameter	18 in (457 mm)
- guard grill diameter	21.4 in (543 mm)
- grill opening	0.09 in (2 mm) diameter spaced at 0.44 in (11 mm) in a circular pattern.
<b>PROPELLER:</b>	
- diameter	17.6 in (448 mm)
- hub diameter	5.75 in (146 mm)
- number of blades	7
- blade angle	variable - 27 degrees at tip to 43 degrees at hub
<b>WEIGHT:</b>	26 lb (12 kg)
<b>MOTOR NAMEPLATE DATA:</b>	
- make	Ziehl-Abegg
- class	B
- rpm	1050
- ambient temperature rise	40°0
- volts	120
- amps	2.4
- phase	1
- cycles	60 Hz
- horsepower	0.33 hp (250 W)

### APPENDIX II NOISE LEVEL RANGES

RANGE	SOUND LEVEL (dBA)	COMMENTS
1	up to 45	Tolerable, low level background noise.
2	45 to 60	Dominating background noise that would interfere with normal conversation.
	60 to 85	Could be annoying and be detrimental to hearing and operator performance under long-term continuous exposure. Ear protection should be considered.
	over 85	Could damage hearing, depending on level and exposure time. Ear protection is definitely recommended.

### APPENDIX III

#### CONVERSION TABLE

cubic feet/minute (cfm) x 0.472	= litres/second (L/s)
horsepower (hp) x 745.7	= watts (W)
inches (in) x 25.4	= millimetres (mm)
inches water gauge (in wg) x 249.1	= pascals (Pa)
pounds (lb) x 0.45	= kilograms (kg)

## SUMMARY CHART ZIEHL-ABEGG MODEL 451-6 VENTILATION FAN

<b>RETAIL PRICE:</b>	\$306.00 (June, 1984, f.o.b. Lethbridge)
<b>FAN DESCRIPTION:</b>	17.6 in (448 mm) propeller fan, variable speed, direct drive, 0.33 hp (250 W) external rotor electric motor
<b>FAN SPEED:</b>	
- single speed	993 to 948 rpm
- variable speed	597 to 947 rpm
<b>EFFICIENCY RANGE:</b>	
- without louvres	8 to 19%
- with louvres	9 to 14%
<b>EFFICIENCY AT 0.125 in wg (31.1 Pa):</b>	
- without louvres	19%
- with louvres	12%
<b>AIR FLOW RATE:</b>	
- range	478 to 2580 cfm (226 to 1220 L/s)
- at 0.125 in wg (31.1 Pa)	1970 cfm (931 L/s) without louvres and 1470 cfm (696 L/s) with louvres
<b>INPUT POWER:</b>	0.17 to 0.31 hp (129 to 229 W)
<b>OPERATOR SAFETY:</b>	inlet guard provided CSA approved noise level = 61 dB(A) at 4.9 ft (1.5 m) from fan discharge
<b>OPERATOR'S MANUAL:</b>	requires updating



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