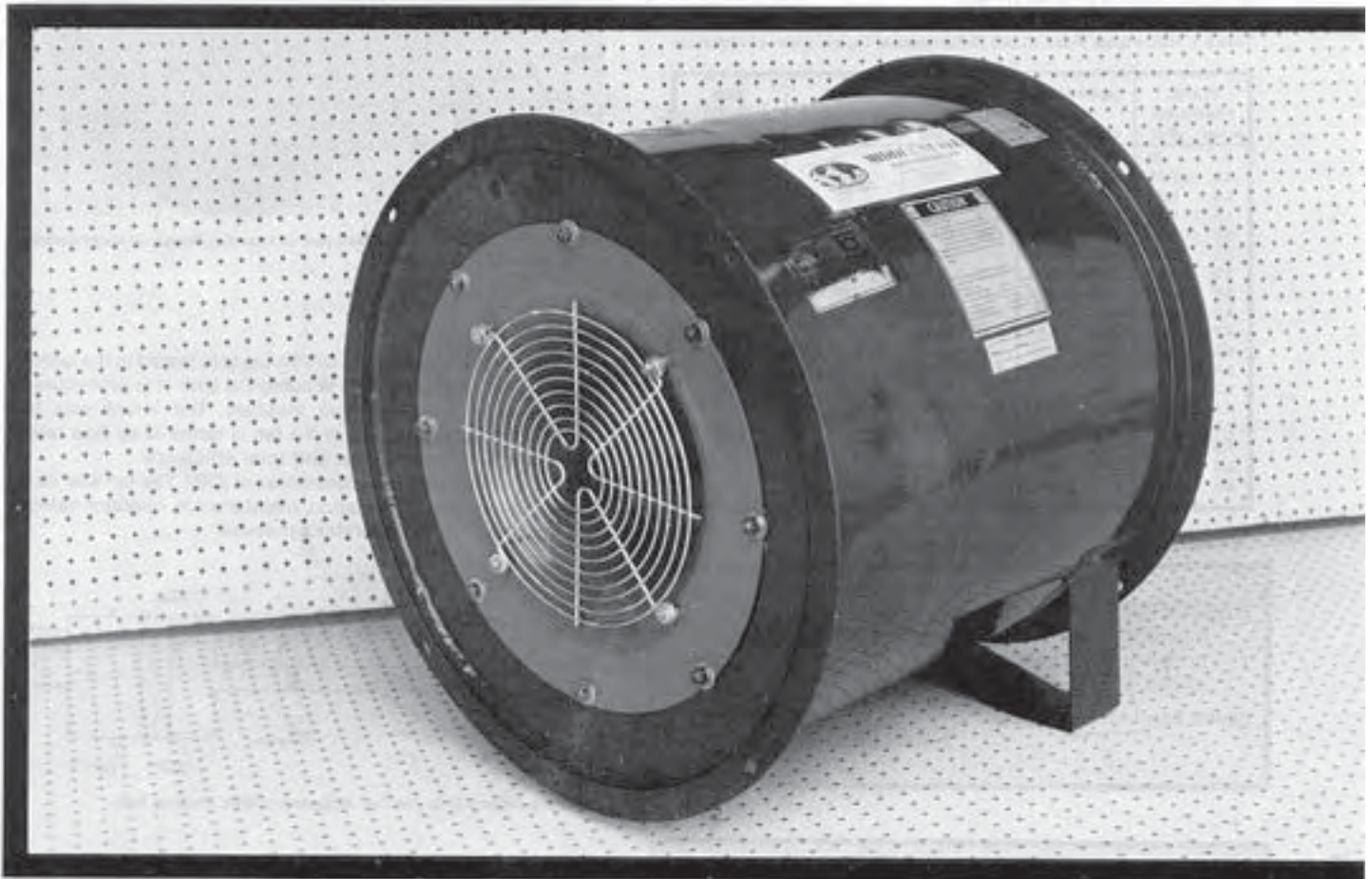


# Evaluation Report

# 375



## Middle State Model IC-24-5 5 hp In-Line Centrifugal Fan

A Co-operative Program Between



# MIDDLE STATE MODEL IC-24-5 5 HP IN-LINE CENTRIFUGAL FAN

## MANUFACTURER:

Middle State Manufacturing Inc.  
Box 788  
Columbus, Nebraska  
68601

## DISTRIBUTOR:

Westland Metals  
Box 3041  
Saskatoon, Sask.  
S7K 3S9

## RETAIL PRICE:

\$1350.00 (September, 1984, f.o.b. Lethbridge, Alberta complete with motor control).

## SUMMARY OF RESULTS

TABLE 1. Middle State Model IC-24-5 Performance at Typical Levels of Operation

Static Pressure		Airflow Rate		Input Power		Total Efficiency	Fan Speed
in wg	(a)	cfm	(L/s)	hp	(W)	%	rpm
0	(0)	3770	(1780)	4.05	(3020)	2	3560
0.5	(125)	3690	(1740)	4.28	(3190)	7	3555
1.0	(249)	3620	(1710)	4.49	(3350)	12	3550
1.5	(374)	3520	(1660)	4.78	(3570)	18	3545
2.0	(497)	3450	(1630)	4.96	(3700)	21	3542
2.5	(823)	3390	(1600)	5.11	(3810)	24	3538
3.0	(747)	3320	(1570)	5.28	(3940)	26	3537
3.5	(872)	3230	(1520)	5.47	(4080)	29	3534
4.0	(996)	3120	(1470)	5.66	(4220)	31	3531
4.5	(1120)	3010	(1420)	5.83	(4350)	33	3529
5.0	(1240)	2890	(1360)	5.96	(4440)	35	3527
5.5	(1370)	2770	(1310)	6.04	(4500)	36	3526
6.0	(1490)	2660	(1260)	6.08	(4530)	37	3525
6.5	(1620)	2540	(1200)	6.07	(4530)	38	3525
7.0	(1740)	2390	(1130)	6.00	(4780)	39	3526
7.5	(1870)	2180	(1030)	5.82	(4340)	39	3527
8.0	(1990)	1860	(878)	5.43	(4050)	40	3530
8.5	(2120)	1360	(643)	5.02	(3740)	31	3541

## RECOMMENDATIONS

It is recommended that the manufacturer consider:

- Updating the operator's manual to include the model IC-24-5.

Senior Engineer: E. H. Wiens

Project Engineer: R. P. Atkins

## THE MANUFACTURER STATES THAT

With regard to recommendation number:

- An operator's manual is now available for in-line centrifugal fans.

## GENERAL DESCRIPTION

The Middle State model IC-24-5 fan is a 15.25 in (387 mm) diameter, single speed, direct drive, in-line centrifugal flow fan. It is primarily used for grain aeration or grain drying systems.

The Middle State model IC-24-5 is equipped with a chromed guard grill, an inlet bell, a duct mounting flange, straightening vanes, and an optional motor control. The welded steel impeller consists of a hub-backplate, 9 backward inclined blades and a flange. The impeller is directly mounted on the 5 hp (3730 W), single phase, 208/230 V electric motor. The fan housing, motor mounts, straightening vanes, inlet bell, flanges and mounting legs are of steel construction with an enamel coating for corrosion protection.

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

## SCOPE OF TEST

The Middle State model IC-24-5 fan was tested in the outlet 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 230V. The fan was also evaluated for ease of operation, maintenance, operator safety and suitability of the operator's manual.

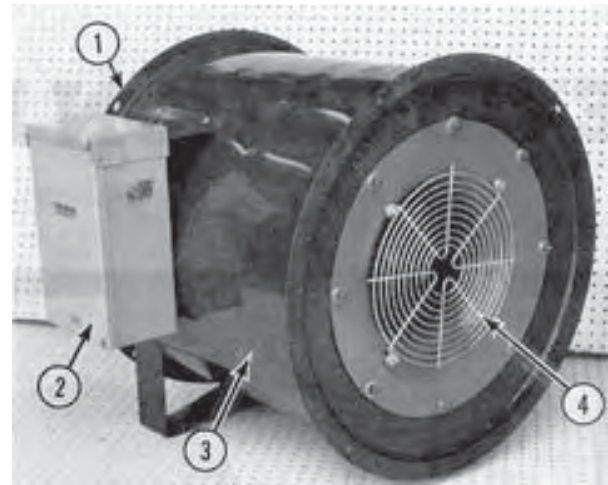


FIGURE 1. Middle State Model IC-24-5 Fan: (1) Mounting Flange, (2) Motor Control, (3) Fan Housing, (4) Guard Grill.

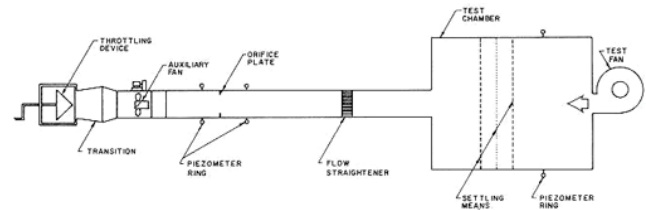


FIGURE 2. Schematic of Fan Test Apparatus - Outlet Chamber Setup.

## 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 at typical levels of operation (i.e. static pressure<sup>2</sup>) are given in TABLE 1. The air flow rate ranged from 1360 cfm (643 L/s) at 8.5 in wg (2120 Pa) to 3770 cfm (1780 L/s) at 0 in wg (0 Pa). FIGURE 3 illustrates the fan performance curves for the Middle State model IC-24-5 fan and a comparison to the manufacturer's rated performance. The manufacturer's literature provided fan performance information over a range of static pressures from 3 to 8 in wg (747 to 1990 Pa) in increments of 1 in wg (249 Pa). The difference in output between the manufacturer's and PAMI's results varied depending upon the level of operation. At static pressures greater than 7 in wg (1740 Pa) the air flow rates were similar. Below 7 in wg (1740 Pa) the PAMI results were lower than the manufacturer's results. For example, at 4 in wg (996 Pa), PAMI's measured air flow rate was 3120 cfm (1470 L/s). This was 12% lower than the manufacturer's rated output of 3530 cfm (1670 L/s) at the same static pressure.

**Power Requirements:** The power required to run the fan depended upon the point of operation of the fan. The minimum input power of 3.0 hp (2240 W) occurred at maximum static pressure and minimum air flow rate. The peak power input of 6.08 hp (4530 W) occurred at 6 in wg (1490 Pa) static pressure and an air flow rate of 2660 cfm (1260 L/s). The maximum amperage drawn by the motor was 22.2 amps which was well below the rated motor amperage of 24 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 2 to 40%. The maximum total efficiency of 40% occurred at 2025 cfm (956 L/s) at a static pressure of 7.85 in wg (1950 Pa).

FIGURE 3. Middle State Model IC-24-5 Fan Performance Curves.

<sup>1</sup>Standard air has 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).

<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).

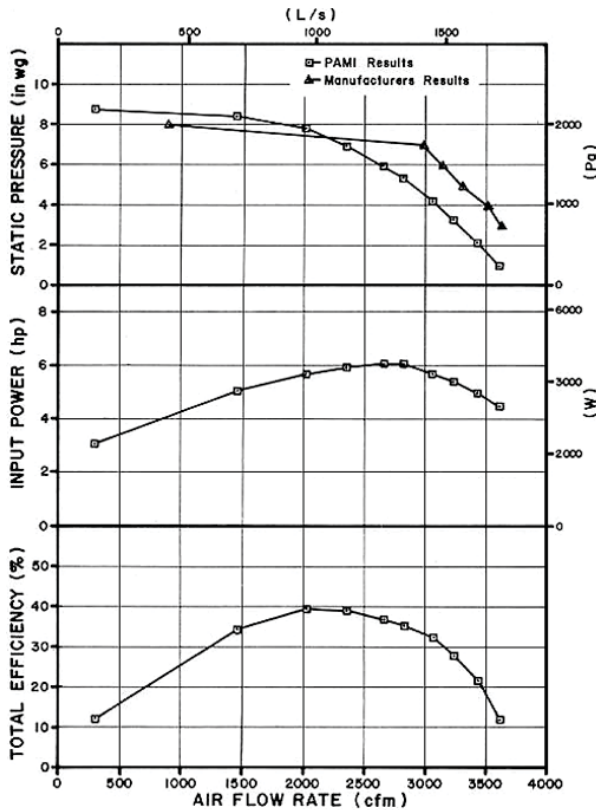


FIGURE 3. Middle State Model IC-24-5 Fan Performance Curves.

### EASE OF OPERATION

**Maintenance:** Motor bearings required lubrication seasonally or twice a year under continuous use. During the off season the fan should be operated for 30 minutes every 3 weeks to ensure even distribution of lubricant within the bearing cavity and to prevent condensation in the motor.

### OPERATOR SAFETY

The guard grill provided adequate protection from the fan blades. The motor was a totally enclosed unit and presented no safety hazards. The Middle State model IC-24-5 was CSA approved.

The noise level<sup>3</sup> of the Middle State model IC-24-5, at a distance of 4.9 ft (1.5 m) from the centre of the fan inlet, while operating at a 1 in wg (249 Pa) static pressure, was 86 dB(A). Higher noise levels could be expected if the fan was operated in the vicinity of other buildings. The Middle State model IC-24-5 falls within range 4 of the PAMI noise level range classification (APPENDIX II). The noise level produced by this fan could damage hearing depending on exposure time. Ear protection is definitely recommended.

### OPERATOR'S MANUAL

The operator's manual contained information on operation, installation, maintenance and safety for axial fans. The model IC-24-5 in-line centrifugal fan was not specifically included in the manual. It is recommended that the manufacturer consider updating the operator's manual to include the model IC-24-5 in-line centrifugal fan.

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

### APPENDIX I SPECIFICATIONS

**MAKE:** Middle State  
**MODEL:** IC-24-5  
**SERIAL NUMBER:** 167001474103001  
**MANUFACTURER:** Middle State Manufacturing Inc.  
 Box 788  
 Columbus, Nebraska 68601

#### OVERALL DIMENSIONS:

- housing width 30.5 in (775 mm)
- housing height 27.2 in (692 mm)
- housing length 23.2 in (591 mm)
- inside tube diameter 24 in (610 mm)
- inlet bell diameter 9.1 in (232 mm)
- guard grill diameter 12.1 in (308 mm)
- grill opening 0.125 in (3mm) diameter, spaced at 0.5 in (13 mm) in a circular pattern.

#### PROPELLER:

- diameter 15.25 in (387 mm)
- inside flange diameter 10.4 in (265 mm)
- number of blades 9
- blade angle 42 degrees

#### WEIGHT:

212 lb (96 kg)

#### MOTOR NAMEPLATE DATA:

- make Marathon Electric
- model MVH 184T CDP 7001 CNL
- frame 184T
- class B
- code H
- duty continuous
- rpm 3510
- service factor 1.15
- ambient temperature rise 40° C
- volts 208/230V
- amps 24A
- phase 1
- cycles 60 Hz
- horsepower 5 hp (3730 W)

### APPENDIX II NOISE LEVEL RANGES

Range	(Dba)	Comments
1	up to 45	Tolerable, low level background noise.
2	45 to 60	Dominating background noise that would interfere with normal conversation.
3	60 to 85	Could be annoying and be detrimental to hearing and operator performance under long-term continuous exposure. Ear protection should be considered.
4	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	= millimeters (mm)
inches water gauge (in wg) x 249.1	= pascals (Pa)
pounds (lb) x 0.45	= kilograms (kg)

### SUMMARY CHART

MIDDLE STATE MODEL IC-24-5 5 HP IN-LINE CENTRIFUGAL FAN	
<b>RETAIL PRICE:</b>	\$1350.00 (September, 1984, f.o.b. Lethbridge)
<b>FAN DESCRIPTION:</b>	15.25 in (387 mm) single speed, direct drive, 5 hp (3730 W) electric motor
<b>FAN SPEED:</b>	3525 to 3560 rpm
<b>MAXIMUM EFFICIENCY:</b>	40%
<b>AIR FLOW RATE:</b>	- range 1360 to 3770 cfm (643 to 1 780 L/s) - at maximum efficiency 2025 cfm (956 L/s) at a 7.85 in wg (1950 Pa) static pressure
<b>INPUT POWER:</b>	3 to 6.08 hp (2240 to 4530 W)
<b>OPERATOR SAFETY:</b>	guard grill provided CSA approved noise level = 86 dB(A) at 4.9 ft (1.5 m) from fan inlet complete for axial fans but requires updating to include in-line centrifugal fans
<b>OPERATOR'S MANUAL:</b>	



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