AIR CURTAIN MACHINES FOR FOOD SERVICE FACILITIES

by

Dominic Eng

Approved for public release; distribution unlimited.
The objectives of this study were to ascertain the effectiveness of air curtain machines in excluding small insects from food service and commissary facilities, and to provide design guidance and installation information for such machines.

A limited field survey of Army and Air Force installations indicated that most of the air curtain machines have been ineffective in excluding small flying insects, due to product deficiency and insufficient technical maintenance guidance. These problems
Block 20 continued.

have sometimes been compounded by improper equipment installation and maintenance.

Manufacturers' catalog information, which was carefully studied and analyzed, is summarized, as is an isothermal jet computer analysis used to model the centerline velocity of the air curtain for varying air thicknesses and throws.

Recommended corrections to air curtain machine deficiencies and engineering criteria, and changes to existing publications that will result in reasonably effective air curtain performances are presented. These can provide more effective insect exclusion.
FOREWORD

This study was conducted for the Directorate of Military Construction, Office of the Chief of Engineers (OCE), under AOA 08-9644. The OCE Technical Monitor was Mr. William B. Holmes, DAEN-MCE-A.

This work was performed by the U.S. Army Construction Engineering Research Laboratory (CERL), Energy and Power Division (EP), Electrical-Mechanical Branch (EPM), Champaign, IL. The CERL Principal Investigator was Mr. D. Eng.

Appreciation is extended to COL T. L. Everhart (U.S. Army Troop Support Agency), MAJ J. O. May (U.S. Air Force Surgeon General/Veterinarian), Mssrs. S. Hiratsuka (DAEN-MCE-U), F. DiMarco (U.S. Air Force Food Service System’s Office), M. J. Pollock (Chief, CERL-EPM), and B. Sharrava, J. Hall, and G. Tietz (CERL) for their help and guidance in conducting this study. The help of manufacturers’ representatives in providing technical information is greatly appreciated.

COL J. E. Hays is Commander and Director of CERL and Dr. L. R. Shaffer is Technical Director. Mr. R. G. Donaghy is Chief of EP.
# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD FORM 1473</td>
<td>1</td>
</tr>
<tr>
<td>FOREWORD</td>
<td>3</td>
</tr>
<tr>
<td>1 INTRODUCTION</td>
<td>5</td>
</tr>
<tr>
<td>Background</td>
<td></td>
</tr>
<tr>
<td>Objectives</td>
<td></td>
</tr>
<tr>
<td>Approach</td>
<td></td>
</tr>
<tr>
<td>Organization of Report</td>
<td></td>
</tr>
<tr>
<td>2 AIR CURTAIN MACHINES</td>
<td>6</td>
</tr>
<tr>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>Operational Terminology</td>
<td></td>
</tr>
<tr>
<td>Operation</td>
<td></td>
</tr>
<tr>
<td>Results of Literature Review</td>
<td></td>
</tr>
<tr>
<td>Theoretical Modeling of an Air Curtain</td>
<td></td>
</tr>
<tr>
<td>3 FIELD SURVEY</td>
<td>9</td>
</tr>
<tr>
<td>4 CONCLUSIONS AND RECOMMENDATIONS</td>
<td>13</td>
</tr>
<tr>
<td>Conclusions</td>
<td></td>
</tr>
<tr>
<td>Recommendations</td>
<td></td>
</tr>
<tr>
<td>REFERENCES</td>
<td>13</td>
</tr>
<tr>
<td>APPENDIX A: Summary of Manufacturers' Data</td>
<td>15</td>
</tr>
<tr>
<td>APPENDIX B: Recommended Design Guidance and Changes to Existing Specifications</td>
<td>19</td>
</tr>
<tr>
<td>APPENDIX C: Federal Specification 00-B-1620</td>
<td>21</td>
</tr>
<tr>
<td>DISTRIBUTION</td>
<td></td>
</tr>
</tbody>
</table>
AIR CURTAIN MACHINES
FOR FOOD SERVICE FACILITIES

1 INTRODUCTION

Background

Using wire or fabric screening on doors to exclude small flying insects is not always possible, particularly where traffic through the door is heavy, the insect population in the immediate area surrounding the doorway is dense, and little if any insect entry can be tolerated. The use of air curtains to exclude small flying insects, mainly flies, from food service and commissary facilities has been a common practice on military installations. In addition to their insect exclusion application, air curtains have been used over doorways subject to heavy traffic to prevent excessive loss of conditioned air from buildings.

Although previous Air Force research had indicated that properly designed and installed air curtains are about 80 percent effective (which is more effective than screen doors), an extensive air curtain survey at various installations indicated that air curtains provided “substandard performance” for exclusion of flying insects from food service and commissary facilities. The Air Force also reported that while the use of air curtains for insect exclusion is widespread in planned and existing military facilities, little design guidance on equipment installation and maintenance is available to Army Corps of Engineers District Offices, facilities engineers, and Air Force Civil Engineers. A literature search revealed that Air Force Manual (AFM) 163-8 has some guidance on air curtains, but is of little help because of its lack of specifications.

Although Office of the Chief of Engineers (OCE) and Navy Facilities Engineering Command (NAV-FAC) personnel have indicated that neither the Army or Navy has its own design guidance on air curtains, Federal Specification 00-B-1620 has been approved for use by all Federal agencies. The existence of this specification may be the reason the Army and Navy have not developed their own design guidance. Although the specification provides more guidance than AFM 163-8, it does not provide adequate guidance for properly specifying an air curtain machine. As a result, in July 1975, OCE asked the U.S. Army Construction Engineering Research Laboratory (CERL) to evaluate and ascertain the capacities and limitations of air curtains for insect exclusion, and to develop design guidance for the proper design, specification, and installation of air curtains to be used by Corps of Engineers District Offices and facilities engineers.

Objectives

The objectives of this study were to:

1. Investigate the adequacy and effectiveness of commercially available air curtain machines in preventing insects from entering food service and commissary facilities.

2. Provide design guidance and installation information for air curtain machines in planned and existing facilities. The guidance was to be designed for use by architect-engineers under contract to Corps of Engineers District Offices and facilities engineers.

Approach

The following steps were used to accomplish the goals of this study:

1. A literature search was conducted, and pertinent reference material, including catalogs and data provided by air curtain manufacturers, was reviewed.

2. A computerized simulation of the air stream centerline velocity profile was conducted.

3. Preselected Army and Air Force installations were surveyed to observe and evaluate on-site problems of air curtain machines.

*Blower, Air Barrier. Federal Specification 00-B-1620 (General Services Administration, 26 September 1973).
4. Based on the information gained in the first three steps, design criteria were developed.

**Organization of Report**

Chapter 2 describes the air curtain machine and summarizes the results of the literature survey and computer simulation. Chapter 3 summarizes the field survey of Army and Air Force installations, including problems found in the field that contribute to ineffective performance and deficient design of available air curtain machines. Chapter 4 presents the conclusions and recommendations. Appendix A summarizes the manufacturers’ catalog data, and Appendix B presents the design guidance and recommended changes to applicable existing specifications.

**2 AIR CURTAIN MACHINES**

**Description**

An air curtain machine has two purposes:

1. To repel flying insects by providing a sufficient outward air vector from a doorway.

2. To discourage flies from gathering around the area surrounding a doorway by taking advantage of the fact that insects avoid a suddenly changing environment.

Names such as air curtain fan, air barrier, air screen, fly fan, fly chaser fan, and fly screen have been used interchangeably throughout the air curtain industry. Although no formal definition of an air curtain exists, the scope of Federal Specification 00-B-1620 describes it as “... a nonpositive displacement mechanical device having an axial or centrifugal fan impeller inclosed within a housing with an exhaust nozzle and baffles. It is designed to move air across an open entrance to provide an air barrier to ... repel flying insects.”

There are two general classes of air curtains: recirculative and nonrecirculative. In a recirculative air curtain, the air discharge outlet is located directly opposite the receiver (Figure 1). The receiver recovers the discharged air and recirculates it through interconnecting ducts back to the discharge outlet.

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1*Blower, Air Barrier, Federal Specification 00-B-1620 (General Services Administration, 26 September 1973).*
Velocity: The speed of the air molecules to be measured in feet per minute.

Velocity pressure: The pressure corresponding to the average velocity determined from the volume of air flow at the fan outlet areas.

Volume of flow: The number of cubic feet of air per minute expressed at fan outlet conditions.

**Operation**

The energy content of a stream of air issuing from a duct into the atmosphere is primarily a function of the exit velocity. The change in momentum from entrance to exit for isothermal air is exactly offset by the change in total pressure. The velocity pressure at the exit represents a corresponding amount of kinetic energy. Thus, when the air stream must be projected a great distance from the exit, a high exit velocity is mandatory. The fan must supply the corresponding energy content through the electric motor. In addition, the fan must supply energy to overcome the internal friction loss of the air curtain unit.

**Results of Literature Review**

In a facility and equipment fact sheet published in 1963, the U.S. Department of Agriculture (USDA) endorsed the use of air curtains in food-handling establishments. The fact sheet stipulated four basic requirements for an air curtain machine:

1. Velocity of the air stream must be at least 1600 ft./min (488 m/min) (about 18 mph [29 km/hr]) at a point 3 ft (0.9 m) above the floor for overhead mounted units, or 1600 ft./min (488 m/min) across the entire opening for side-mounted units. In either case, the air stream should be at least 2 in. (50.8 m) wide (preferably 5 in. [127.0 mm]) to assure a satisfactory barrier against persistent flying or crawling insects.

2. In both overhead or side-mounted units, the air stream must cover the entire opening. Unenclosed and ductless overhead fans are seldom effective because the air stream produced is likely to dissipate before reaching floor level, thus providing uneven protection.

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**Notes:**

*Fact Sheet MID-FE-1 (U.S. Department of Agriculture, 8 March 1963).*
3. The air stream from overhead units should be directed downward and slightly outward, while streams from side-mounted units should be directed so they converge at a midpoint just outside the opening to be protected.

4. The air-stream-producing device should be designed to produce full air movement instantly when the motor is switched on. The switch should be installed so that the motor is activated automatically and immediately when the door is opened.

USDA no longer endorses this publication, however, because several other factors, such as local wind conditions, angle of throw, and negative pressure inside the facility, affect air curtain performance.

AFM 163-8 directs that air curtain fans be used over doorways where screen doors cannot be installed or where frequent use negates their effectiveness. AFM 163-8 covers only two factors—velocity and width. It requires that the air stream be the width of the door opening and that the air velocity be maintained at 1600 ft/min (488 m/min), 3 ft (0.9 m) above the floor. It does not consider the local wind design conditions.

The minimum velocity of 1600 ft/min (488 m/min) at 3 ft (0.9 m) above floor level is apparently based on a curtain thickness of at least 5 in. (127.0 mm). The requirement that the air stream should cover the full width of the doorway appears obvious; however, the manual does not specify that the discharge outlet should be the same length as the width of the door. Thus, some manufacturers might suggest that their standard unit discharge outlet would provide complete coverage even though it is smaller than the width of the door, because the air stream will fan out after it leaves the outlet. However, for insect control, the air stream should be directed toward the outside. The consensus of the literature is that the angle should be 15 degrees from the vertical and directed toward the outside.

Federal Specification 00-B-1620, which is presented in Appendix C, was found to be the most extensively written specification on air curtain machines. It covers the four necessary parameters: velocity, thickness, width, and angle of throw of the air stream. However, improvements are necessary to assure proper air curtain machine performance under various environmental conditions. Suggested improvements are presented in Appendix B.

**Theoretical Modeling of an Air Curtain**

*Isothermal Jet Flows*

In general, an air curtain draws air from a space, accelerates the air molecules, and discharges the air back into the space at a higher velocity, but still in the subsonic region. Hence, one can assume (to a high degree of accuracy) that the temperature in the space is quite uniform and that the air curtain can be approximated by an isothermal jet.

The centerline velocity of an isothermal jet emerging from a rectangular discharge outlet will persist for the first four thicknesses of the air stream (measured at the outlet), in which the integrity of the core will remain practically unchanged. From about four times the air stream thickness to a distance approximately equal to the width, multiplied by four times the aspect ratio, the centerline velocity (for rectangular outlets of large aspect ratio) will decrease as the square root of the ratio of the air stream thickness to the throw.

From the Streamline equation for an isothermal flow, the centerline velocity \( V_x \), at a distance \( X \) (feet) from the outlet is

\[
V_x = V_0 \sqrt{\frac{KH_0}{X}} \quad \text{for} \quad \frac{X}{H_0} \geq 4.94 \quad \text{[Eq 1]}
\]

where \( V_0 \) = the initial outlet discharge centerline velocity (fpm)

\( H_0 \) = the thickness (feet) of the air stream at the discharge

\( X \) = the throw (feet) of the air stream from the discharge

\( K \) = the numerical constant used.

The numerical constant in the equation reflects a discharge grille with a small deflection angle. A computer program was written to evaluate what initial velocity and air stream thickness are required to produce a required terminal velocity. Figure 3 shows the

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Figure 3. Computer simulation results for centerline velocity of 1600 ft/min (488 m/min). SI conversion factor: 1 in. = 25.4 mm; 1 ft/min = 0.3048 m/min.

results for a terminal velocity of 1600 ft/min (488 m/min). These results were used in formulating the recommended design guidance presented in Appendix B.

The initial outlet discharge centerline velocity \( V_0 \) can be calculated from

\[
V_0 = \frac{Q}{A_0} \quad \text{[Eq 2]}
\]

where \( Q \) = the volume of flow (cfm)

\( A_0 \) = the air curtain unit outlet free area (sq ft).

Air Stream Profile\(^{11}\)

The angle of expansion is well defined near the outlet, but the boundary contours are somewhat billowy and are easily affected by external influences. The rectangular outlet will produce a jet that rapidly expands into an elliptical cross-sectional shape at a short distance from the outlet face, and then to a circular shape. The rate of expansion depends primarily on the aspect ratio and air stream thickness. Measured angles of expansion for discharge into large open spaces have usually ranged from 19 to 24 degrees with an average of 22 degrees. Jets discharging into relatively small spaces, such as vestibules, show smaller angles of expansion.

3 FIELD SURVEY

Army and Air Force installations were visited to observe and evaluate the deficiency in air curtain machine performance. Army installations visited were Fort Hood, TX, Fort Lee, VA, and Fort Benning, GA. Air Force installations visited included Chanute AFB, IL, Offutt AFB, NE, McClellan AFB, CA, and Kelly AFB, TX. The evaluations were based on installation and performance effectiveness, unit operating conditions, and environmental conditions affecting equipment effec-

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tiveness. In addition, opinions of installation personnel were obtained.

Personal opinion as to the effectiveness of the air curtains ranged from favorable to unfavorable. The only general conclusion that could be drawn was that most management personnel indicated that the air curtains were effective and that there were no fly problems on the premises. Personnel from the veterinarian offices who were asked to assess the fly-control problem indicated that flies were a problem. Personnel at two of the installations also reported favorable reactions to electronic fly control (black light) devices in use at their installations.*

Most of the air curtains surveyed were unsatisfactory in excluding insects based on air stream velocity, angle of throw, thickness, and outlet width. Conditions and factors observed to be contributing to this ineffectiveness are described below.

1. Damaged or inoperable units. Some of the air curtains surveyed had been partially damaged or were inoperable, but had not been serviced. In a few instances, air curtains were operating ineffectively or were unsafe because of damage sustained from improper maintenance or lack of maintenance.

2. Negative pressure. Mechanical exhaust and ventilation in most of the facilities visited created a mechanical negative pressure condition in the interior of the building that drastically decreased the effectiveness of the air curtain machines. Negative pressure in the building tends to induce a horizontal flow into the building.

3. Installation. It was observed that air curtains installed inside doorways brought in dust, debris, and small insects at floor level because of short circuiting of the air current and improper directional damper settings (Figures 4 through 6). Some of the units were installed too high above the top of the door frame, making the air stream too weak to effectively expel small flying insects from the doorway (Figure 7a). Some of the units did not provide full-width coverage at the top of door (Figures 7b and c).

4. Maintenance. Most air curtain manufacturers claim that their products are maintenance-free. It was observed, however, that the inlets, outlets, and motors of all units installed in kitchen areas were thickly coated with grease, which contributed to decreased fan efficiency and, in certain cases, resulted in motor burn-up due to motor overheating. In one location, a bird's nest was found in the discharge outlet.

5. Wind conditions. Some air curtain machines observed were unable to stop the wind, a prerequisite for preventing insects from entering a building. No guidance exists on accommodating local wind conditions when selecting an air curtain machine for fly control.

6. Accessibility of air curtain machine's ON/OFF switch. Air curtains' ON/OFF switches were found to be accessible to unauthorized personnel who could turn the units off when they should have been in operation.

7. Improperly sized air curtain machines. Most installed units have discharge outlets shorter than the widths of the door openings, as observed in previous Air Force studies. In addition, most of these units do not have a directional adjustment for the angle of throw. They do, however, have directional adjustments to divert the air stream sideways, thus providing full "air stream" coverage above the door opening.

8. Weak spots in the air stream. Some of the units surveyed had weak spots in the air stream at the discharge outlet which had inadequate air stream velocity.

9. Air curtain machines for patron doorways. No separate air curtain velocity requirements exist in Federal Specifications for patron entrances and exits. With the present velocity requirements, the air curtains are very annoying to patrons. National Sanitation Foundation (NSF) Standard No. 37 recommends a separate air stream requirement for patron entrances and exits.

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*Electronic fly control devices may be used in Air Force facilities away from food preparation and serving areas, per Letter, Chief, USAF Veterinary Services Division, Subject: Electronic Fly Control Devices (2 October 1975).
Figure 4. Proper installation of air curtain machine outside the premise for insect exclusion.

Figure 5. Improper installation of air curtain machine in vestibule for insect exclusion.

Figure 6. Proper installation of air curtain machine in vestibule for insect exclusion.
a. Air curtain machine installed 13 ft (3.96 m) above door and does not have an angle of throw of 15 degrees outward.

b. Air curtain machine does not provide continuous full-width coverage at top of door.

c. Same problem as b. Note damage to unit on right.

Figure 7. Improper installation of air curtain machines.
4 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The field survey revealed that most of the air curtain machines in Army and Air Force installations have been ineffective in excluding small flying insects because of product deficiency and insufficient technical guidance. These problems have sometimes been compounded by improper equipment installation and maintenance. Proper design, installation, and maintenance of air curtain units can provide more effective insect exclusion. The following conclusions regarding design, installation, and maintenance were drawn based on this study:

1. Units must have proper discharge outlet length, exit velocity, and directional adjustment for angle of throw.

2. Local wind characteristics must be considered, and wind breakers should be used to alleviate local wind problems.

3. Building pressure balance must be designed to maintain proper (neutral) pressure in the building.

4. A thicker air jet at lower velocity is more effective than a thinner jet at higher velocity.

5. Units must be installed near the top of the door frame and outside the space the air curtain is to protect.

6. Air curtain units must receive regular preventive maintenance and be checked for proper adjustment to exclude flying insects on a continuing basis.

Recommendations

The following recommendations are based on the results of this study:

1. Properly designed and installed air curtain machines should be used at doorways in food service facilities, commissaries, and subsistence warehouses where personnel traffic is high and installation of screen doors is not possible.

2. The design guidance presented in Appendix B should be implemented.

3. Federal Specification 00-B-1620, with the changes recommended in Appendix B, should be used for Army and Air Force air curtain machine procurement.

4. A study should be conducted to determine the effectiveness of electronic fly control devices as supplements to air curtain machines for fly exclusion.

CITED REFERENCES


Blower, Air Barrier, Federal Specification 00-B-1620 (General Services Administration. 26 September 1973).


Engineering Instructions, Commissary Store Construction Program, FY 76 MCA and Surcharge Programs (Office of the Chief of Engineers, 20 May 1974).

Fact Sheet MID- FE-1 (U.S. Department of Agriculture, 8 March 1963).


Food Service Sanitation, AFM 163-8 (Department of the Air Force, 23 February 1972).


Letter, HQ, SAC, Subject: Unsatisfactory Performance of AFSO Recommended Air Curtain (20 August 1975).


UNCITED REFERENCES


Engineering Instructions. Enlisted Personnel Dining Facilities. FY 77 MCA Program (Office of the Chief of Engineers, 28 February 1975).

Enlisted Personnel Dining Facility Sketch Design Drawings and Equipment Lists (Department of the Army). Drawing number SK 36-05-137, sheets 1 through 36 (23 September 1974), Drawing number SK 36-05-139, sheets 1 through 16 (31 December 1974), and Drawing number SK 36-05-140, sheets 1 through 16 (31 December 1974).


APPENDIX A:

SUMMARY OF MANUFACTURERS’ DATA

Table A1 summarizes product data provided by air curtain machine manufacturers. The products are described briefly below.

Air Economy Corporation*

Air Economy Corporation’s L0-Dor machine, which is used for buildings such as post exchanges, commissaries, hospitals, schools, etc., is available in high and low velocity models. For the high velocity unit, it is important to specify the use of a 4 to 5 in. (101.6 to 127.0 mm) wide nozzle with a velocity of 1600 ft/min (487.7 m/min) at 3 ft (0.9 m) above the floor. For the low velocity unit, a nozzle width of 8 to 10 in. (203.2 to 254.0 mm) with a velocity of 600 ft/min (182.9 m/min) at 3 ft (0.9 m) above the floor should be specified.

Chase Industries, Inc.

The Chase fly screen units are made of 18-gage paintlock metal, doubly protected with gray mist preventive coating. Each motor has a double extended shaft operating two squirrel cage blower wheels and fan housings. The unit has no belts or pulleys to be maintained or wear out.

Directional controls in the 3 in. (76.2 mm) wide nozzle help control and direct air flow. The fly screen requires a minimum space of 14 1/2 in. (0.37 m) in height and projects 11 1/4 in. (0.29 m) from the wall. Installation is simple; adjustable brackets require only four screws or other fastening devices to attach the unit to the wall.

Dynaforce Corporation

Dynaforce manufactures several air curtains for different applications. The standard unit covers the entire width of the doorway. The F I unit, which is designed for insect control, is of the nonrecirculating type. This unit should be installed on the inside of the doorway. The unit can be hung from the ceiling with four 1/2-in. (12.7 mm) diameter steel rods. Ceiling suspension is recommended to prevent the machine from falling if a fork-lift truck strikes the wall.

King Company of Owatonna

King recommends that their air curtains used for insect control be installed on the outside of the doorway. A clear surface above the door is required to mount the unit. For maximum results, it is recommended that the bottom of the air curtain unit be positioned just above the top of the door frame. The unit’s discharge outlet should be designed to cover the entire width of the doorway.

Mars Air Doors*

The Mars Air Curtain needs only to be bolted to the wall with three fasteners and connected to an electrical power source. Adjustable volumetric damper controls are provided to regulate the rate of air flow.

Mars’ CH models are recommended for normal insect control conditions which exist at receiving doors in commissaries, post exchanges, restaurants, hospitals, etc.

Nieco Division, NPI Corporation

Nieco manufactures three series of air curtains:

1. The LTV Series of air curtain units is designed for industrial applications (8 to 10 ft [2.4 to 3.0 m] high doors) where insect or wind protection is important. The units are built for outdoor installation, with practically no maintenance required according to the manufacturer.

2. The MTV Series is designed for the same purpose as the LTV series, but has different discharge velocities.

3. The HTV Series gives three types of Nieco air screens. No information on installation of the equipment is available for this series of units.

*Information on these manufacturers’ products was inadequate to permit inclusion in Table A1.
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<th>Company</th>
<th>Model No. or Series</th>
<th>Volumetric Control</th>
<th>Directional Control</th>
<th>Width, in. (m)</th>
<th>Discharge Velocity at Outlet, ft/min (m/min)</th>
<th>Thickness of Air Stream at Outlet, in. (mm)</th>
<th>Motor hp (W) at Rated rpm</th>
<th>No. of Motor</th>
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<td>EHV-38</td>
<td>NA</td>
<td>NA</td>
<td>38 (0.9)</td>
<td>4500 (1372)</td>
<td>~ 2½ (63.5)</td>
<td>1½ (1118)</td>
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<td>EHV models for fly-insect and dust control. For doors 8 to 11 ft (2.4 to 3.4 m) high.</td>
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<td>5200 (1585)</td>
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<td>1½ (1118)</td>
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<td>Chase*</td>
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<td>NA</td>
<td>NA</td>
<td>38 (0.9)</td>
<td>6000 (1829)</td>
<td>~ 2½ (66.7)</td>
<td>3 (2237)</td>
<td>1</td>
<td>EHH models for fly-insect and dust control or where excessive draft conditions (over 15 mph [24 km/hr]) exist. For doors 11 to 16 ft (2.4 to 4.9 m) high.</td>
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<td>84 (2.0)</td>
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<td>Yes</td>
<td>Single Deflection</td>
<td>36 (0.9)</td>
<td>1500 to 3000 (457 to 914)</td>
<td>2½ (57.2)</td>
<td>¾ (559)</td>
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<td>R series used for light-duty control of insects.</td>
</tr>
<tr>
<td></td>
<td>F/I Series</td>
<td>No</td>
<td>Single Deflection</td>
<td>48 (1.2)</td>
<td>1500 to 3000 (457 to 914)</td>
<td>2½ (57.2)</td>
<td>¾ (559)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R&amp;E Series</td>
<td>No</td>
<td>Single Deflection</td>
<td>36 (0.9)</td>
<td>4000 (1219)</td>
<td>4½ (114.3)</td>
<td>2 (1491)</td>
<td>1</td>
<td>F/I series is designed for insect control at loading docks. Has a higher sound level than the R series.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>48 (1.2)</td>
<td>4000 (1219)</td>
<td>4½ (114.3)</td>
<td>2 (1491)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60 (1.5)</td>
<td>4000 (1219)</td>
<td>4½ (114.3)</td>
<td>2 (1491)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>72 (1.8)</td>
<td>4000 (1219)</td>
<td>4½ (114.3)</td>
<td>2 (1491)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>96 (2.4)</td>
<td>4000 (1219)</td>
<td>4½ (114.3)</td>
<td>2 (1491)</td>
<td>1</td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>108 (2.7)</td>
<td>4000 (1219)</td>
<td>4½ (114.3)</td>
<td>2 (1491)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>120 (3.0)</td>
<td>4000 (1219)</td>
<td>4½ (114.3)</td>
<td>2 (1491)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>144 (3.7)</td>
<td>4000 (1219)</td>
<td>4½ (114.3)</td>
<td>2 (1491)</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

* Thickness, $H_o$, determined by: Area = $H_o \cdot L$. Where, $H_o = \frac{Q}{L \cdot V_o}$. 

Table A1: Tabulation of Manufacturers' Product Data
<table>
<thead>
<tr>
<th>Company</th>
<th>Model No. or Series</th>
<th>Volumetric Control</th>
<th>Directional Control</th>
<th>Width, in. (m)</th>
<th>Discharge Velocity at Outlet, ft/min (m/min)</th>
<th>Thickness of Air Stream at Outlet, in. (mm)</th>
<th>Motor hp (W) at Rated rpm</th>
<th>No. of Motor</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynaforce</td>
<td>H Series</td>
<td>Yes</td>
<td>Double</td>
<td>60 (1.5)</td>
<td>3000 to 6000 (914 to 1829)</td>
<td>4 3/4 (114.3)</td>
<td>S(NOM) (3728)</td>
<td>1</td>
<td>This series used for doors over 20 ft (6.1 m). At 14 ft (4.3 m), door can stop wind of 18.5 mph (29.6 km/hr) at 12 ft (3.7 m), door can stop wind of 33.0 mph (53.1 km/hr) at 10 ft (3.0 m), door can stop wind of 40.0 mph (64.4 km/hr) at 8 ft (2.4 m).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Deflection</td>
<td>96 (2.4)</td>
<td>3000 to 6000 (914 to 1829)</td>
<td>4 3/4 (114.3)</td>
<td>S(NOM) (3728)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>108 (2.7)</td>
<td>3000 to 6000 (914 to 1829)</td>
<td>4 3/4 (114.3)</td>
<td>S(NOM) (3728)</td>
<td>2</td>
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</tr>
<tr>
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<td></td>
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<td></td>
<td>120 (3.0)</td>
<td>3000 to 6000 (914 to 1829)</td>
<td>4 3/4 (114.3)</td>
<td>S(NOM) (3728)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>144 (3.7)</td>
<td>3000 to 6000 (914 to 1829)</td>
<td>4 3/4 (114.3)</td>
<td>S(NOM) (3728)</td>
<td>2</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>164 (4.2)</td>
<td>3000 to 6000 (914 to 1829)</td>
<td>4 3/4 (114.3)</td>
<td>S(NOM) (3728)</td>
<td>2</td>
<td></td>
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<tr>
<td>Dynaforce</td>
<td>I Series</td>
<td>Yes</td>
<td>Double</td>
<td>48 (1.2)</td>
<td>2000 to 4000 (610 to 1219)</td>
<td>4 3/4 (114.3)</td>
<td>2(NOM) (1491)</td>
<td>1</td>
<td>I series is used at loading dock applications. At 10 ft (3.0 m), door can stop wind of 15.0 mph (24.0 km/hr) at 8 ft (2.4 m), door can stop wind of 18.0 mph (28.8 km/hr) at 6 ft (1.8 m), door can stop wind of 22.0 mph (35.2 km/hr)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Deflection</td>
<td>60 (1.5)</td>
<td>2000 to 4000 (610 to 1219)</td>
<td>4 3/4 (114.3)</td>
<td>2(NOM) (1491)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td>72 (1.8)</td>
<td>2000 to 4000 (610 to 1219)</td>
<td>4 3/4 (114.3)</td>
<td>2(NOM) (1491)</td>
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<td>96 (2.4)</td>
<td>2000 to 4000 (610 to 1219)</td>
<td>4 3/4 (114.3)</td>
<td>2(NOM) (1491)</td>
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<td>108 (2.7)</td>
<td>2000 to 4000 (610 to 1219)</td>
<td>4 3/4 (114.3)</td>
<td>2(NOM) (1491)</td>
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<td>120 (3.0)</td>
<td>2000 to 4000 (610 to 1219)</td>
<td>4 3/4 (114.3)</td>
<td>2(NOM) (1491)</td>
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<td></td>
<td>144 (3.7)</td>
<td>2000 to 4000 (610 to 1219)</td>
<td>4 3/4 (114.3)</td>
<td>2(NOM) (1491)</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>164 (4.2)</td>
<td>2000 to 4000 (610 to 1219)</td>
<td>4 3/4 (114.3)</td>
<td>2(NOM) (1491)</td>
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<tr>
<td>King Air Curtains</td>
<td>Standard</td>
<td>Yes</td>
<td>Double</td>
<td>24 (0.6)</td>
<td>100 to 3700 (305 to 1125)</td>
<td>7 3/4 (190.5)</td>
<td>3/4 (1750)</td>
<td>1/4</td>
<td>The standard series is used for thermal or insect barriers for doors of 8 ft (2.4 m). No definite thickness at outlet could be found.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Deflection</td>
<td>36 (0.9)</td>
<td>100 to 3700 (305 to 1125)</td>
<td>7 3/4 (190.5)</td>
<td>3/4 (1750)</td>
<td>1/4</td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>48 (1.2)</td>
<td>100 to 3700 (305 to 1125)</td>
<td>7 3/4 (190.5)</td>
<td>3/4 (1750)</td>
<td>1/4</td>
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<td></td>
<td></td>
<td></td>
<td>60 (1.5)</td>
<td>100 to 3700 (305 to 1125)</td>
<td>7 3/4 (190.5)</td>
<td>3/4 (1750)</td>
<td>1/4</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>72 (1.8)</td>
<td>100 to 3700 (305 to 1125)</td>
<td>7 3/4 (190.5)</td>
<td>3/4 (1750)</td>
<td>1/4</td>
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<tr>
<td>King Air Curtains</td>
<td>Super</td>
<td>Yes</td>
<td>Double</td>
<td>48 (1.2)</td>
<td>NA*</td>
<td>NA</td>
<td>2 (1491)</td>
<td>1/4</td>
<td>For use on doors up to 12 ft (3.6 m) high.</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>Deflection</td>
<td>60 (1.5)</td>
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<td>NA</td>
<td>3 (2237)</td>
<td>1/4</td>
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<td></td>
<td>72 (1.8)</td>
<td>NA</td>
<td>NA</td>
<td>3 (2237)</td>
<td>1/4</td>
<td></td>
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*NA: Information not available.
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<tr>
<th>Company</th>
<th>Model No. or Series</th>
<th>Volumetric Control</th>
<th>Directional Control</th>
<th>Width, in (m)</th>
<th>Discharge Velocity at Outlet, ft/min (m/min)</th>
<th>Thickness of Air Stream at Outlet, in. (mm)</th>
<th>Motor hp (W) at Rated rpm</th>
<th>No. of Motor</th>
<th>Comments</th>
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<td>Super XIX</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Industrial air curtains for doors up to 20 ft (6 m).</td>
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<td>XH-6-500</td>
<td>Yes</td>
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<td>72 (1.8)</td>
<td>NA</td>
<td>NA</td>
<td>5 (3728)</td>
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<td>XH-8-600</td>
<td>Yes</td>
<td>20' Range</td>
<td>96 (2.4)</td>
<td>NA</td>
<td>NA</td>
<td>7½ (5593)</td>
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<tr>
<td>NIECO</td>
<td>LTV-40</td>
<td>NA</td>
<td>Yes</td>
<td>40 (1.0)</td>
<td>NA</td>
<td>NA</td>
<td>½ (249)</td>
<td>2</td>
<td>For use on doors 10 ft (3 m) high. Industrial applications for insect and wind protection.</td>
</tr>
<tr>
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<td>LTV-60</td>
<td>NA</td>
<td>Yes</td>
<td>60 (1.5)</td>
<td>NA</td>
<td>NA</td>
<td>½ (249)</td>
<td>3</td>
<td></td>
</tr>
<tr>
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<td>NA</td>
<td>Yes</td>
<td>48 (1.2)</td>
<td>NA</td>
<td>NA</td>
<td>½ (249)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LTV-72</td>
<td>NA</td>
<td>Yes</td>
<td>72 (1.8)</td>
<td>NA</td>
<td>NA</td>
<td>½ (249)</td>
<td>3</td>
<td>For use on doors 8 ft high (2.4 m). Industrial applications for insect and wind protection.</td>
</tr>
<tr>
<td>NIECO</td>
<td>HTV-40</td>
<td>NA</td>
<td>Yes</td>
<td>40 (1.0)</td>
<td>NA</td>
<td>NA</td>
<td>1 (746)</td>
<td>2</td>
<td>For use on door up to 18 ft (5.4 m) high. All NIECO Air Screens have two vent design.</td>
</tr>
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<td>HTV-60</td>
<td>NA</td>
<td>Yes</td>
<td>60 (1.5)</td>
<td>NA</td>
<td>NA</td>
<td>1 (746)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HTV-80</td>
<td>NA</td>
<td>Yes</td>
<td>80 (2.1)</td>
<td>NA</td>
<td>NA</td>
<td>1 (746)</td>
<td>4</td>
<td>HTV series have two – 3½ in. (77.5 mm) outlet streams.</td>
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<td>HTV-100</td>
<td>NA</td>
<td>Yes</td>
<td>100 (2.5)</td>
<td>NA</td>
<td>NA</td>
<td>1 (746)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>NIECO</td>
<td>MTV-40</td>
<td>NA</td>
<td>Yes</td>
<td>40 (1.0)</td>
<td>NA</td>
<td>NA</td>
<td>½ (249)</td>
<td>2</td>
<td>For use on doors up to 14 ft (4.3 m) high. Twin vent design.</td>
</tr>
<tr>
<td></td>
<td>MTV-60</td>
<td>NA</td>
<td>Yes</td>
<td>60 (1.5)</td>
<td>NA</td>
<td>NA</td>
<td>½ (249)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MTV-80</td>
<td>NA</td>
<td>Yes</td>
<td>80 (2.0)</td>
<td>NA</td>
<td>NA</td>
<td>½ (249)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MTV-100</td>
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<td>100 (2.5)</td>
<td>NA</td>
<td>NA</td>
<td>½ (249)</td>
<td>5</td>
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</tbody>
</table>
APPENDIX B:

RECOMMENDED DESIGN GUIDANCE
AND CHANGES TO EXISTING
SPECIFICATIONS

Design Guidance

1. All air curtain machines for fly control should be installed on the outside of doors opening to spaces where fly control is intended.

2. Air curtain machines should have a directional adjustment for the angle of throw that will permit the air barrier to be directed at angles of 15 to 20 degrees off the vertical center and toward the outside of the opening. Proper markings for the angle setting should be indicated on the machine’s casing. A failsafe device should be built into the machine to return the angle of throw to 15 degrees.

3. Turning vanes should be used in air curtain machines whenever abrupt changes in air flow direction are involved.

4. A pressurizing box should be used in air curtain machines to produce a uniform outlet velocity.

5. For dining facility and commissary patron entrance doors up to 8 ft (2.4 m) high, air curtain units should be installed, preferably in vestibules, on the outside of the doors. The air stream at the discharge outlet must be at least 8 in. (203.2 mm) thick and able to maintain a minimum uniform outlet velocity of 1200 ft/min (366 m/min).

6. For a service door up to 8 ft (2.4 m) high, the air stream should be adjusted for local wind conditions* as follows:

   a. Light local wind conditions: minimum outlet air velocity and thickness should be 2800 ft/min (853 m/min) and 4½ in. (114.3 mm); minimum uniform velocity 3 ft (0.9 m) above the floor should be 1600 ft/min (488 m/min).

   b. Moderate local wind conditions: minimum outlet air velocity and thickness should be 3000 ft/min (914 m/min) and 4½ in. (114.3 mm); minimum uniform velocity 3 ft (0.9 m) above the floor should be 1800 ft/min (549 m/min).

   c. High local wind conditions: minimum outlet air velocity and thickness should be 3000 ft/min (814 m/min) and 6 in. (152.4 mm); minimum uniform velocity 3 ft (0.9 m) above the floor should be 2000 ft/min (610 m/min).

7. For 10- to 12-ft (3.0 to 3.7 m) high door openings to subsistence warehouses exposed to the outside, the air stream should be adjusted for various local wind conditions as follows:

   a. Light local wind conditions: minimum outlet air velocity and air thickness should be 3200 ft/min (975 m/min) and 6 in. (152.4 mm); uniform velocity at 3 ft (0.9 m) above the floor should be 1600 ft/min (488 m/min).

   b. Moderate local wind conditions: minimum outlet air velocity and air thickness should be 3500 ft/min (1067 m/min) and 6 in. (152.4 mm); uniform velocity at 3 ft (0.9 m) above the floor should be 1800 ft/min (549 m/min).

   c. High local wind conditions: minimum outlet air velocity and thickness should be 4000 ft/min (1213 m/min) and 6 in. (152.4 mm); minimum uniform velocity at 3 ft (0.9 m) above the floor should be 2000 ft/min (610 m/min).

8. Key-operated air curtain machine switches should be installed to prevent unauthorized personnel from turning off air curtain units.

9. Devices should be installed to activate/deactivate the air curtain units for overhead doors before/after the doors have been raised/closed.

10. If a negative pressure exists in the building, modifications must be provided to allow make-up air to enter the building.

11. Where possible, a 3 to 6 in. (76.2 to 152.4 mm) overlap on each side of the door should be provided.

Changes to Existing Specification

The following sections of Federal Specification 00-B-1620 should be modified:

1. Section 3.5.2 should be modified to specify that for insect control, the angle of throw is to be directed toward the outside of the area to be protected.

*Wind conditions defined in the 1972 ASHRAE Handbook of Fundamentals, Table 1, Chapter 33.
2. Section 3.5.5 should be modified to specify that no directional adjustment vanes should be provided for any directional adjustment other than the angle of throw in all air curtain machines for insect exclusion.

In addition, this section should specify that the discharge nozzle of the air curtain unit or a multiple installation should be at least as wide as the entryway and should provide continuous uniform air stream coverage at the top of the entryway to be protected.

3. In Section 3.8, the words “and the air stream shall be at least 2 inches wide” should be deleted. In addition, a requirement for patron entryway should be included.

4. In Section 4.3.3, the words “four feet wide and seven feet high” should be deleted.

5. Section 4.3.6 should indicate that the thickness of the air stream is to be measured at the air curtain unit discharge outlet. Paragraphs 2, 3, and 4 of this section should be modified as follows:

a. Paragraph 2 should be modified to specify that measurements are to be taken at 6-in. (152.4 mm) intervals with the first and last measurements to be taken at each side of the door opening. In addition, a sweeping velocity measurement at the outlet of the air curtain machine should be taken to assure a continuous uniform air stream at the outlet.

b. Paragraph 3 should be modified to include a minimum outlet velocity requirement for air curtain unit for patron entryways.

c. Paragraph 4 should be modified to include hot-wire anemometer.

6. In Section 4.3.6, the sentence “The air barriers specifically covered by this specification are intended for an opening four feet wide by seven feet high but the options provide for specifying other size openings” should be deleted.
APPENDIX C:

FEDERAL SPECIFICATION 00-B-1620

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers a nonpositive displacement mechanical device having an axial or centrifugal fan impeller enclosed within a housing with an exhaust nozzle and baffles. It is designed to move air across an open entrance to provide an air barrier to minimize heat loss or gain and repel flying insects.

1.2 Classification. Blower air barriers covered by this specification shall be of the following types (see 6.2):

Type I - Insect control.
Type II - Thermal control.

2. APPLICABLE DOCUMENTS

2.1 The following documents, or the issues in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

Federal Specifications:

FED-B-501 - Boxes, Shipping, Fiberboard, Wood-Cleated.
FED-B-601 - Boxes, Wood, Cleated-Flywood.
FED-B-440 - Boxes, Fiberboard, Corrugated, Triple-Wall.

Federal Standards:

Fed. Std. No. 123 - Marking for Domestic Shipment (Civil Agencies).

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402.

(Single copies of this specification and other Federal Specifications required by activities outside the Federal Government for bidding purposes are available without charge from Business Service Centers at the General Services Administration Region Offices in Boston, New York, Washington, D.C., Atlanta, Chicago, Kansas City, Mo., Fort Worth, Denver, San Francisco, Los Angeles, and Seattle, Wa.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

Military Specifications:

MIL-F-116 - Preservation, Methods of.

Military Standards:

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking for Shipment and Storage.
(Copies of Military Specifications and Standards required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents from a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on date of invitation for bids or request for proposal shall apply.

**Underwriters' Laboratories (UL) Inc. Standards:**

No. 507 - Electric Fans.

(Application for copies should be addressed to the Underwriters' Laboratories, Inc., Wall Whitman Bldg., Beltsville, L.I., N.Y. 1149; 353 Pringsten Road, Box 247, Northbrook, Ill. 60062; 16th Scott Blvd., Santa Clara, CA. 95050; 2602 Tampa East Blvd., Tampa, FL 33619; or 207 East Ohio St., Chicago, Ill. 60611.)

**National Electrical Manufacturers Association (NEMA) Publications:**

No. NC1 - Motors and Generators.

(Application for copies should be addressed to the National Electrical Manufacturers Association, 155 East 44th Street, New York, N.Y. 10017.)

**National Motor Freight Traffic Association, Inc., Agents:**

National Motor Freight Classification.

(Application for copies should be addressed to the American Trucking Association, Inc., Tariff Order Section, 316 F Street, N.W., Washington, D.C. 20036.)

**Uniform Classification Committee, Agents:**

Uniform Freight Classification.

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, Ill. 60606.)

**American National Standards Institute, Inc. (ANSI) Standards:**

S1.4 - 1961 - General Purpose Sound Level Meters.

(Application for copies should be addressed to the American National Standards Institute, Inc., 1450 Broadway, New York, N.Y. 10018.)

3. REQUIREMENTS

3.1 Bid and preproduction samples.

3.1.1 Bid sample. A bid sample shall be submitted for inspection as specified in the Invitation for Bids to determine compliance with subject requirements not covered by a specific test in Section 4.5 or referenced specifications.

3.1.2 Preproduction sample. Unless otherwise specified (see 6.7), before production is commenced, a complete sample, if required by this specification shall be submitted or made available to the contracting officer or his authorized representative for approval in accordance with 4.5.1. Approval of the preproduction sample authorizes the commencement of production but does not relieve the supplier of responsibility for compliance with all applicable provisions of this specification. The preproduction sample shall be manufactured in the same facilities to be used for the manufacture of the production item.
3.1.2.1 Waiver of preproduction sample tests. Preproduction-sample tests may be waived provided the contracting officer finds that the model offered by the contractor is equal to or superior in quality and performance and meets all the requirements of this specification. This determination may be made by visual examination or by comparison of component parts, bills of materials, or drawings of a model previously found acceptable on a government contract, provided the contractor furnishes copies of certified test data covering previous tests of this model to the contracting officer. The test data must indicate compliance with the specified test conditions and must have been obtained as a result of tests conducted within the past 4 years on an identical type blower air barrier furnished on a government contract. In addition to test data, a certified statement to the effect that the blower air barriers being furnished are identical with those previously tested will be required.

3.2 Fire and casualty hazards.

3.2.1 Each supplier shall submit to the contracting agency proof that the blower air barrier he proposes to supply under this specification conforms to the requirements of the Underwriters’ Laboratories, Inc., UL Standard 507, as applicable. The UL label, or listing mark will be accepted as evidence that the blower air barrier conforms to these requirements.

3.2.2 In lieu of the label, or listing mark, the contractor may submit independent proof, satisfactory to the contracting agency, that the blower air barrier conforms to the applicable requirements of the published standard including methods of tests of the Underwriters’ Laboratories Standard 507.

3.2.3 Compliance with the above preliminary requirements in regard to fire and casualty hazards does not absolve the contractor from compliance with the other requirements of this specification in order to secure acceptance of the material or appliance.

3.3 Material. All material used in the blower, air barrier shall be new, have smooth even surfaces, and shall be free of any defects that may affect its serviceability or its appearance.

3.4 Construction. The design and fabrication of the blower air barrier shall be such as to minimize the retention of moisture and dust and to facilitate inspection, servicing, maintenance and cleaning. All blower shall be complete and assembled electric motor driven machine. The material shall be of sufficient thickness, adequately reinforced and insulated to eliminate excessive noise and vibration. All joints and areas shall be closed except that joints may be made by overlapping sheets of metal in a vertical plane in such a manner as to eliminate dirt-catching horizontal edges. Electrical wiring to the motors) shall be adequately insulated and anchored to prevent contact with the fan blade assembly. Unless otherwise specified (see 6.2), the wiring shall terminate in a junction box mounted on an outside surface of the air barrier, and shall be suitable for outdoor use.

3.5 Component parts.

3.5.1 General. The blower air barrier shall essentially consist of a housing, plenum, one or more electric motors, fan blade assembly or assemblages, discharge nozzle, and other parts not specifically mentioned but which are essential to form a complete assembled operating unit.

3.5.2 Housing. Unless a specific location is specified (see 6.2), the housing shall have air intake parts on one end, both ends, top or front. All air intake openings shall be protected by a screen having openings no greater than 1/4 inch square dimension and when the guard is lower than 7 feet from the floor, the minimum opening shall be no greater than 1/2 inch. An adjustment feature shall be included that will permit the air barrier to be directed at angles of 15 to 20 degrees off the vertical center of the opening.

3.5.3 Motors. Motors shall conform to the requirements of NEMA Standard Publication No. 22-1. Motors shall have adequate starting torque to start the fan and shall be capable of operating the fan continuously under maximum load without exceeding the maximum allowable temperature rise specified in UL Standard 507.

3.5.3.1 Bearings. Bearings shall be ball, sleeve, or spherical sleeve type. They shall be of the maintenance free permanent lubrication type.

3.5.4 Fan blade assembly. The fan blade assembly or assemblages shall be mounted directly on the motor shaft or may be belt driven. They shall be of a design and size that will adequately move the required volume of air necessary to meet the air velocity requirements (see 3.6).

3.5.4.1 Fan balance-vibrations. The rotating components of the type I and II blower air barriers shall be balanced to the extent that the total vibration in both the horizontal and vertical planes does not exceed the vibration levels of 0.02 inch (see 4.3.4).
3.5.5 Discharge nozzle. The discharge nozzle shall extend the full width of an opening (four feet wide) enabling the air stream to cover the entire opening. There shall be adjustable vanes to control the directional air flow.

3.6 Performance. Unless a different size opening is specified (see 6.7), blower air barriers furnished under this specification shall be capable of providing an air barrier at the specified velocities (see 3.0) over the entire area of an opening four feet wide by seven feet high. The air barrier shall be designed to produce full air movement instantly when the motor is switched on.

3.7 Noise level. The noise level of the blower air barrier at maximum speed shall not exceed 75 dBA (see 4.3.5).

3.8 Velocity. The velocity of the air barriers shall be measured in feet per minute (f.p.m.) when subjected to the test specified in 4.3.6 and the air stream shall be at least 2 inches wide.

3.8.1 Type I. Shall have a minimum air stream velocity of 1600 f.p.m. measured at points 3 feet above the floor.

3.8.2 Type II. Shall have a minimum air stream velocity of 600 f.p.m. measured at points 3 feet above the floor.

3.9 Instruction manual. An instruction manual shall be furnished with each blower air barrier that clearly instructs the user on the proper installation procedures, operation and maintenance.

3.10 Finish. The finish shall be of the manufacturer's standard practice.

3.11 Marking for identification.

3.11.1 Military applications. The blower air barriers shall be marked in accordance with MIL-STD-130.

3.11.2 Civil applications. The blower air barriers shall be marked with the name of the manufacturer, contract number and date.

3.12 Workmanship. The finished blower air barrier shall be clean and conform to the quality and grade of the products established by this specification. All burns, rough and sharp edges shall be removed. All exposed welds or seams shall be ground smooth. There shall be no flaking, peeling or chipping of paint or any exposure of bare metal. All bolt and rivet holes shall be accurately and cleanly punched or drilled and rivet heads neatly finished. In general, the blower air barrier shall be free from any defects that affect appearance and serviceability and any defects that may cause injury to the user.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the government. The government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to ensure that supplies and services conform to prescribed requirements.

4.2 Sampling for inspection and acceptance. Sampling for inspection and acceptance shall be made in accordance with the provisions set forth in MIL-STD-130, except where otherwise indicated herein.

4.4.1 Inspection of components and materials. In accordance with 4.1, the supplier is responsible for ensuring that components and materials used were manufactured, tested and inspected in accordance with the specified requirements of reference subsidiary specifications and standards, or if none, in accordance with this specification.

4.4.2 End product inspection. All blower air barriers of the same type offered for acceptance at one time shall be considered a lot for the purpose of inspection. The sample unit for these inspections shall be one completely fabricated blower air barrier.

4.4.2.1 Visual examination. The completely assembled end item shall be examined for defects in finish, construction, workmanship, and marking. All instances of nonconformance shall be considered as a defect and identified as affecting serviceability, or not affecting serviceability of the air barrier. Acceptable quality levels (AQI) 1.5 and 4.0 defects per hundred units respectively, shall be used to determine whether or not the number of defects warrants rejection of the entire lot.
EXAMINES

<table>
<thead>
<tr>
<th>Examine</th>
<th>Defect</th>
<th>Major</th>
<th>Minor</th>
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<tbody>
<tr>
<td>Finish</td>
<td>Not finished as required.</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Design</td>
<td>Any characteristic not in accordance with the specified requirements.</td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>Construction and Workmanship</td>
<td>Fractured, split, bowed, malformed, or otherwise impaired.</td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>general (applicable to all components and assemblies)</td>
<td>Sharp burns, splinters, or splinters that may be injurious to personnel.</td>
<td></td>
<td>I</td>
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<tr>
<td>Assembly</td>
<td>Not properly assembled or secured.</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Marking identification</td>
<td>Missing, incomplete, not legible, not as specified.</td>
<td></td>
<td>X</td>
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4.2.2.2 Sampling for test. A random sample of air barriers shall be selected from each lot offered for acceptance. The sample size shall be in accordance with level 3-2 of MIL-STD-105 with an AQL of 4.0 defects expressed in defects per hundred units.

4.2.3 Code and standards compliance. The contractor shall provide the Government representative with proof of compliance with the Underwriters' Laboratories requirements of 3.2.

4.3 Tests.

4.3.1 Preproduction sample tests. Preproduction sample tests shall consist of all tests specified or described under 4.3 of this specification.

4.3.1.2 Place of preproduction sample tests. Preproduction sample tests shall be conducted at a Government laboratory designated by the Standardization Division, Federal Supply Service, General Services Administration or upon approval by Standardization Division, Federal Supply Service, tests may be conducted at a commercial laboratory, or at the manufacturer’s plant.

4.3.2 Lot acceptance test. Unless otherwise specified, the contractor shall furnish all samples and shall be responsible for accomplishing the required tests. Testing if conducted at the contractor’s plant, shall be under the supervision of the Government inspector. Suppliers not having laboratory testing facilities satisfactory to the Government shall engage the services of a commercial testing laboratory acceptable to the Government. Unless otherwise indicated, lot acceptance tests shall include all tests specified or described under 4.3.

4.3.2.1 Failure of any sample on any test shall cause per rejection of the lot represented by the sample.

4.3.3 Performance tests. Tests as specified or described under 4.3.4 to 4.3.6 inclusive, shall be conducted at rated voltage and frequency of the blower air barrier. The following tests shall be conducted with the blower air barrier mounted over an opening four feet wide and seven feet high.

4.3.4 Fan balance-vibration. The fan balance is indicated by measuring the vibration level of the blower air barrier when in operation. Procedures are as follows:

1. Start the unit in operation, observe and record the readings. Any of which exceed 0.02 inch shall be cause for failure.

2. A minimum of 5 readings randomly selected by the government representative shall be taken on the exterior surface area of the blower air barrier.

3. The vibration measurements shall be made with a Bruel and Kjaer impulse precision sound level meter type 2204 with integrator type 220020 and accelerometer type 4352 or equivalent. Frequency range is between 5 and 4000 Hz.
4.3.4.1 If acceptable to the government, an alternate method for determining vibration movement may be utilized in lieu of the procedure specified in 4.3.4.

4.3.5 Noise Measurements. Noise measurements shall be made with a sound level meter conforming to ANSI Standard S1.4, with the blower operating at maximum speed. Procedures are as follows:

1. Locate the microphone on a tripod 3.5 feet above the floor and ten feet away from the front and center of the blower.
2. Connect the sound level meter to the microphone and locate it at least 3 feet back of the microphone so as not to induce any reflectance from the operator.
3. The increase in the sound pressure level with the sound source (blower) operating, compared to the ambient sound pressure level above, (without blower) shall be 10 dBA slow or more.
4. Start the blower in operation and run for a period of not less than five minutes before taking any readings.
5. A minimum of three readings shall be taken. One at the ten foot distance from the center and in front of the blower and one reading 5 foot each side of the center reading in the same plane. If the average of the three readings exceeds 75 dBA, it shall be cause for failure.

4.3.6 Velocity. Air velocity measurements are to be made with the blower air barrier operating at the desired speed. The air stream must cover the entire opening and shall be not less than 2-inches wide to assure a satisfactory barrier. Procedures are as follows:

1. Start the blower air barrier in operation and run for at least five minutes before taking any readings.
2. Five measurements are to be taken at the 3-foot level evenly distributed from one side to the other of the opening. Also readings shall be taken six inches from the upper corners of the opening to assure complete air stream coverage of the opening.
3. For the type I, unit, any reading less than 1600 FPM or the type II unit any reading less than 1800 FPM shall be cause for failure.
4. The instrumentation to be used shall be the rotating vane anemometer, Weather Measure Corporation Model #132 or equivalent.

4.3.7 Inspection of packaging for delivery. An inspection shall be made to determine that the preservation, packing, and marking comply with the requirements in section 5 of this specification. Defects shall be scored in accordance with Table 2. The sample shall be one shipping container fully prepared for delivery. The lot size shall be the number of shipping containers in the end item inspection lot. Sampling shall be in accordance with MIL-STD-105, Inspection Level S-2, and the AQL shall be 4.0 defects per hundred units.

<table>
<thead>
<tr>
<th>TABLE 1. Classification of defects</th>
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<tbody>
<tr>
<td><strong>Examine</strong></td>
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<tr>
<td>Preservation</td>
</tr>
<tr>
<td>Containers</td>
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<tr>
<td>Workmanship</td>
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<tr>
<td>Marking</td>
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5. PREPARATION FOR DELIVERY

5.1 Cleaning and preservation. Cleaning and preservation shall be level A or C, as specified (see 6.2).

5.1.1 Level A. Each fan shall be cleaned by method C-1 of MIL-I-116 and preserved by method IIA of MIL-I-116.

5.1.2 Level C. Each fan shall be cleaned and preserved to prevent corrosion and deterioration during shipment from the supplier to the first receiving activity.

5.2 Packing. Packing shall be level A, B, or C, as specified (see 6.2).

5.2.1 Level A.

5.2.1.1 Fan without cabinet. Each fan without cabinet, preserved, as specified in 5.1.1, shall be packed in a fiberboard box conforming to FFP-2-040, class weather-resistant, style 621. The preserved fan shall be secured to wood strips within the fiberboard box. The strips shall be positioned and braced to prevent the preserved fan from moving or exerting pressure against the sides, ends, and top of the box.

5.2.1.2 Fan with cabinet. Each fan, with cabinet, preserved, as specified in 5.1.1, shall be packed in a wood- cleated fiberboard, wood- cleated plywood, nailed wood, or fiberboard box conforming to FFP-2-040, class II; FFP-2-040, overseas type; FFP-2-040, class 2; or FFP-2-040, class 3, respectively. The preserved fan shall be secured to wood strips within the box. The strips shall be positioned and braced to prevent the fan from exerting pressure on the sides, ends, and top of the box.

5.2.2 Level B.

5.2.2.1 Fan without cabinet and fan with cabinet. Each fan, preserved, as specified in 5.1, shall be packed in a fiberboard box conforming to FFP-2-040, class domestic, style 621. Blocking or bracing shall be provided to prevent movement of the fan within the box.

5.2.3 Level C. Each fan, packaged, as specified in 5.2, shall be packed to assure carrier acceptance and safe delivery to destination at lowest rates, in containers complying with the Uniform Freight Classification or National Motor Freight Classification Rules, as applicable.

5.3 Markings.

5.3.1 Civil agencies. In addition to any special markings required by the contract or order, each shipping container shall be marked in accordance with Fed. Std. No. 129.

5.3.2 Military agencies. In addition to any special markings required by the contract or order each shipping container shall be in accordance with MIL-STD-179.

6. NOTES

6.1 Intended use. These air barriers are intended to be used to provide an air barrier across opening or doorway to separate inside and outside air with different temperatures, or to prevent the entry of insects through the doorway when the door is open. The air barriers specifically covered by this specification are intended for an opening four feet wide by seven feet high but the options provide for specifying other size openings. Other options provide for specifying velocities and outward angling of the air curtain to counteract wind currents or pressure differentials. Also provided, are options for specifying location of intake ports when clearance is a critical factor.
6.2 Ordering data. Purchasers should select the preferred options permitted herein, and include the following information in procurement documents:

(a) Title, number, and date of this specification.
(b) Type of fan (see 1.2).
(c) Wiring connection, if different (see 3.4).
(d) Size of opening, if different (see 3.6).
(e) When angle adjustment feature is required (see 3.5.2).
(f) Location of intake ports, when required (see 3.5.2).
(g) Minimum velocity of type I fans, when required (see 3.8.2).
(h) Minimum velocity of type II fans, when required (see 3.8.2).
(i) Level of preservation and packing required (see 5.4 and 5.2).
(j) Whether preproduction sample is required (see 3.1.2).

6.3 It is believed that this specification, adequately describes the characteristics necessary to secure the desired material, and that normally no samples will be necessary prior to award to determine compliance with this specification. If, for any particular purpose, samples with bids are necessary, they should be specifically asked for in the invitation for bids, and the particular purpose to be served by the bid sample should be definitely stated, the specification to apply in all other respects.
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Defense General Supply Center
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