Louver & Ducting Application Guidelines for Air-Cooled VertiCool & C-Series Units

Carefully choosing the right condensing section intake/exhaust louver(s) and determining the best location for them are critical components to a successful indoor VertiCool or C-Series installation. This article offers guidelines for selecting and installing the condenser intake and discharge ductwork and louvers. It is not intended to make recommendations for the evaporator air intake for outside air applications. Refer to the OmegaAir System installation instructions for intake guidelines in a 100% outside air application.

Basic Guidelines

1. Select a louver design that will safely separate the discharge from the intake air stream to ensure that air recirculation will not occur.
2. The intake louver should be designed to minimize and virtually eliminate water penetration at a reasonable face area velocity (fpm).
3. The discharge duct must be as short and straight as possible but of sufficient length to guarantee uniform airflow distribution though the louver for maximum velocity.
4. In most cases, the cross-sectional "free area" of

the louver must be equal to or larger than the cross-sectional areas of the intake and/or discharge unit openings to allow for optimum velocity and reasonable pressure drop across the louver.

5. Ducts should be insulated if the unit is installed and operating in cold climates.
6. Adequate access to both the evaporator and condenser coils as well as the louver must be available for cleaning purposes.
7. All louver manufacturer instructions, local codes, and industry accepted guidelines must be followed for all installations.

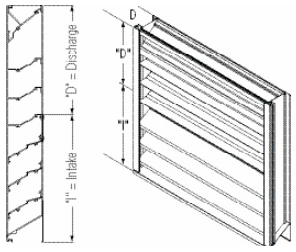
When installed according to these basic guidelines, the VertiCool and C-Series units will achieve optimum performance and maximum operating life. Please read on for further details.

Basic Louver Considerations

Since louvers vary from manufacturer to manufacturer regarding blade size, shape, angle, spacing and finish, United CoolAir does not make any specific manufacturer recommendations.

There are many manufacturers that adhere to these guidelines. The intake and discharge louver can be in separate frames or, for a VertiCool application, combined in one frame. The combination intake/discharge louver design offers an advantage over separate louvers because it requires only one wall opening which decreases installation costs. However, the blades cannot be of uniform configuration (i.e. the same blade design and angle). The discharge louver blades should be angled to direct the airflow straight out horizontally from the unit and the intake blades should be angled down at approximately 45°.

Combination Intake/Discharge



Regardless if it is a vertical or horizontal unit, it is critical that the two air streams be directed in different directions so that no recirculation of discharge air is allowed to enter the inlet air stream. In some cases it may be necessary to provide a deflector vane or separator between the two air streams. We recommend a field fabricated air deflector for the C-Series similar to the one included with our Outdoor Modification kit in the figure below. If recirculation of the discharge air does occur, the unit will likely trip on high head pressure and continue to trip until the louver design is corrected.

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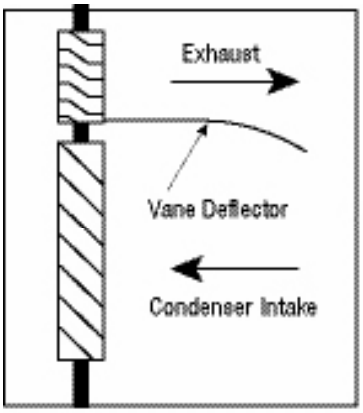
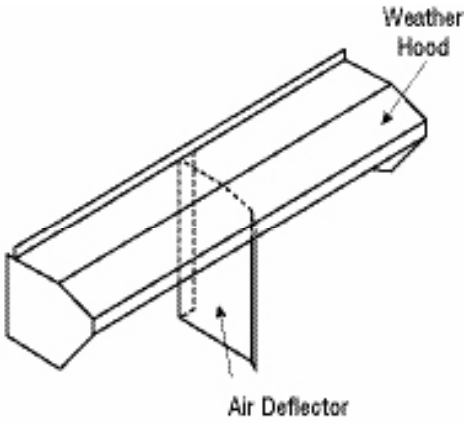
Vertical Deflector Detail



Horizontal Deflector



Louvers may be manufactured of aluminum (14 gauge) or steel (18 gauge). Louver widths of 30 inches or more should have additional bracing midway along the blades to maintain proper blade separation. If the louvers are to be installed in a coastal application or any location with environmental concerns, then the louvers should be treated. To virtually eliminate the possibility of water carry over into the ductwork and/or unit, the intake louver should have a high Water Penetration Rating (free area velocity, fpm - see explanation below). It is also beneficial to angle the bottom of the intake ductwork up from the louver toward the unit opening to minimize the possibility of water carryover reaching the unit and allow for proper drainage. Keep in mind that no louver is 100% rainproof; however, there are louvers designed specifically for areas that experience severe wind and rain, such as hurricanes.

Louvers should be inspected and cleaned on a regular basis. A bird screen is required to deter animals and debris from entering the duct system.

General Ductwork Recommendations

All ductwork must be designed in accordance with industry accepted practices. Consult ASHRAE, AMCA or SMACNA guidelines or standards for details. Ducts should be insulated in accordance with ASHRAE Standard 90.1 or per local codes, particularly if the unit will be operated during cold weather. We recommend utilizing a suitable flexible duct connector to minimize or isolate any vibration transmission to the structure. The condensing unit intake duct should include a provision to access the inlet side of the coil for periodic cleaning. It is also best to design for sufficient clearances for servicing the blower motors, expansion valves, filters, and any options installed.

Length of Ductwork for Discharge Air

The VertiCool and C-Series units should be located a minimum distance from the louvered wall to maximize efficiency of the blower. Certain conditions and obstructions at the fan inlet and outlet adversely affect fan performance (i.e. elbows, guards, dampers, etc.). "System Effect" is a term used by the industry to describe these adverse conditions. It is best to design the inlet and discharge ductwork to provide minimum sufficient straight length of duct to reduce system effect and allow for uniform air discharge.

Figure 1 illustrates the discharge air velocity profile at various distances from the centrifugal blower. It is important to determine the 100% Effective Duct Length to ensure uniform air discharge.

Based on formulas in ASHRAE Fundamentals – Duct Design, Chapter 34, the following minimum intake and discharge 100% Effective Duct Lengths (EDL) are recommended for:

VertiCool units

- 3 thru 5 tons = 3.5 feet
- 8 & 10 tons = 5 feet
- 12 thru 20 tons = 6 feet
- 25 tons = 7.75 feet

C-Series units

- 1 & 1.5 tons = 3 feet
- 2 – 5 ton single = 3.75 feet
- 4 – 8 ton dual = 4.5 feet
- 10 – 15 tons = 6.75 feet

The VertiCool units are supplied with a standard motor and drive package which provides approximately 0.25" ESP. Upgrades are available that can raise this capability to 1" ESP. The drive packages have some ability to be adjusted in the field. You must know the overall duct design in order to determine what drive package will be required. Normal startup procedures should be followed including balancing the system following the completed unit installation.

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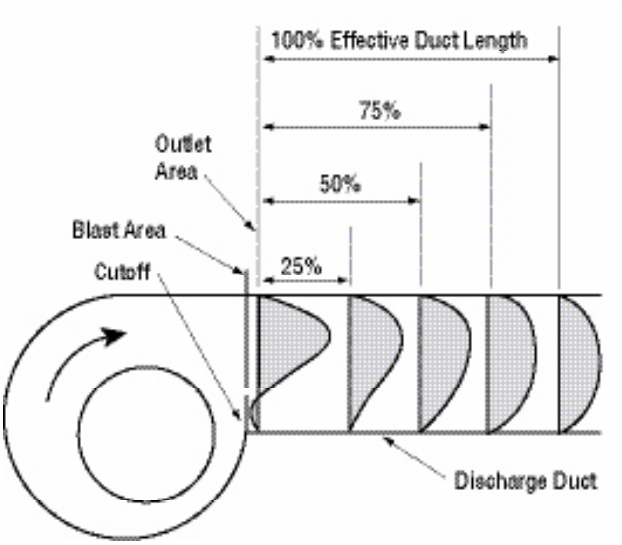
Figure 1 – Discharge Air Velocity Profile



Location, Location, Location

A strategically placed intake louver will prevent recirculation of discharge or "contaminated" air into the intake air stream. In some areas, louver location is governed by codes. Distances of intake louvers from any exhaust outlet and distances from other contaminants, people, property lines, idling vehicles, etc. must be factored into the location site. The bottom of the intake louver should be raised a minimum of 12" from a horizontal surface (roof, sidewalk, etc.) to prevent blockage from debris. If snow accumulations are expected to be greater than 12", raise the bottom of the louver above the average snowfall depth.

If more than one VertiCool or C-Series unit will be installed in the same area, then the minimum separation of one unit adjacent to another should be 6 feet. A 10-foot separation distance should be maintained where two units are installed one above the other. It is best to direct discharge air up and away from pedestrian walkways as well.

We do not recommend multiple installations between closely situated buildings where discharge air could collect and be directed back to the intake. Again, recirculation will cause the unit to trip on high head pressure.

Proper Louver Selection

Three basic criteria are considered when selecting a louver; Free Area, Water Penetration and Resistance to Airflow. Free Area is the total open area ($ft.^2$) between the blades and the frame of the louver. Manufacturers provide free area data for each of their louvers. To calculate % of free area, divide the free area ($ft.^2$) by the total area of the wall opening. Values typically range from 35% - 60% of free area. The larger the percent of free area, the smaller the wall opening needs to be, thereby reducing installation costs. It is recommended that the free area of the Intake or Discharge louver be at least equal to the area of the unit duct opening, therefore, in most cases the unit ductwork will transition to a larger cross-sectional louver area.

The next consideration when choosing an intake louver is the Water Penetration rating. This is the maximum free area velocity (fpm) permitted across the intake louver before the louver will begin to allow precipitation to enter. Louver Water Penetration ratings vary from 300 fpm – 1250 fpm depending on the distance between blades and their angle. Obviously, the higher the rating, the better the louver resists liquid penetration. Keep in mind that no louver is completely rainproof or stormproof. Each application will vary with regards to climate conditions and wind factors.

Resistance to Airflow or Pressure Drop across the louver is the third factor to consider when selecting the right louver for your application. Most manufacturers provide an Airflow Resistance Chart which graphs free area face velocity vs. pressure drop. At the selected face area velocity, the corresponding pressure drop value must be added to the overall ductwork design. If a bird screen is installed with the louver (required), then the pressure drop across the screen must also be factored into the design. ASHRAE recommends that the pressure drop across the louver should not exceed 0.1 in. of wg and others recommend a maximum pressure drop of 0.2 in. of wg.

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Louver Sizing Example (VertiCool Unit)

With these criteria in mind, select a louver which achieves the maximum amount of air through the louver with an acceptable pressure drop and does not exceed the water penetration rating (for intake louvers). See Figure 2.

A 5 ton VertiCool unit's duct openings are:

Discharge: 7" H x 33" W = 231 $in.^2$; 231 $in.^2/144\ in.^2/ft^2$ = 1.60 $ft.^2$ discharge area

Intake: 23" H x 38" W = 874 $in.^2$; 874 $in.^2/144\ in.^2/ft^2$ = 6.06 $ft.^2$ intake area...

...and the nominal condenser airflow is 2000 CFM.

The Greenheck model ESID-430 combination intake/ discharge louver considered for this application has a water penetration rating of 1002 fpm free area velocity.

We'll start by sizing the intake louver.

1. Select a free area velocity with an acceptable pressure drop from the manufacturer's "resistance to airflow" chart.

Remember to select an intake louver with a velocity that does not exceed the water penetration rating. A 25% safety factor may be applied to the rating to reduce the possibility of water carryover during windy conditions. At 1002 fpm, then the new maximum free area velocity is 1002 x .75 (25% safety factor) = 751 fpm. From the chart, the corresponding pressure drop is 0.08 in. of wg, which is less than the 0.10 in. of wg recommended by ASHRAE.

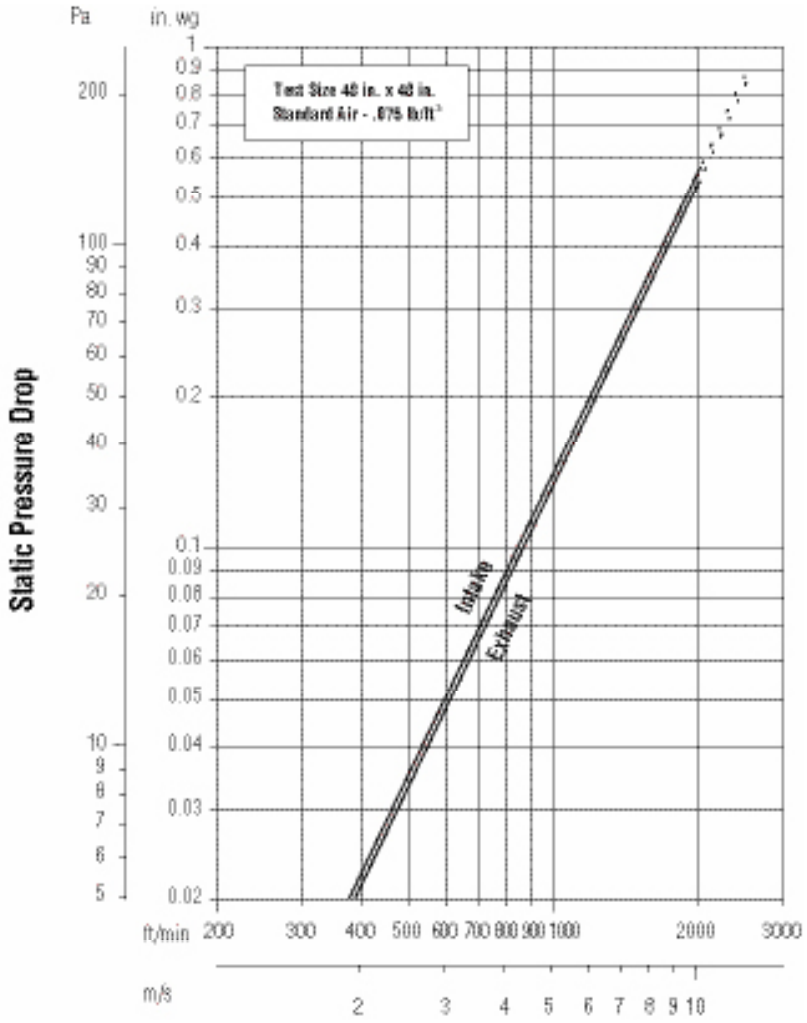
2. The nominal condenser airflow is 2000 CFM.
3. Calculate the minimum louver free area required.

- Free Area = CFM (step 2) / Velocity (step 1)
- Free Area = 2000 CFM / 751 fpm = 2.66 $ft.^2$
- However, the cross-sectional area of the intake duct opening is 6.06 $ft.^2$ so the louver free area must be at least this size. According to the intake free area chart, in order to minimize the height of the louver, a 36" H x 54" W louver with a free area of 6.03 $ft.^2$ should be acceptable.

Now let's size the discharge louver.

1. We'll choose the proper discharge louver height based on the 54" W louver determined for the intake louver.
2. The minimum discharge free area required is based on the 1.60 $ft.^2$ duct opening. At 54" W, an 18" H louver has a free area of 2.82 $ft.^2$.
3. The free area velocity through the louver would then be 2000 CFM / 2.82 $ft.^2$ = 709 fpm.
4. The pressure drop across the louver, from the chart is 0.068 in wg which is within ASHRAE guidelines.

Figure 2 – Airflow Resistance Chart (Standard Air - .075 lb./ft^2)



Reference Source: Greenheck ESID-430 Performance Data.

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Free Area Chart (Square Feet)

Intake

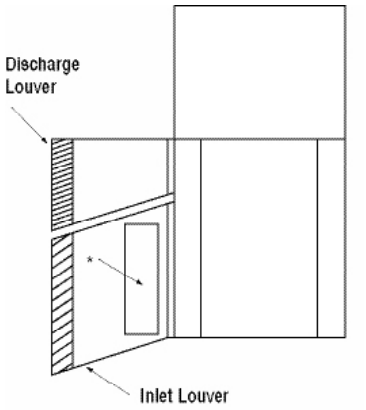
Intake Height in Inches — Louver Width in Inches

	12	18	24	30	36	42	48	54	60
12	0.18	0.29	0.41	0.52	0.64	0.73	0.84	0.96	1.07
18	0.42	0.69	0.96	1.23	1.50	1.70	1.97	2.24	2.51
24	0.65	1.07	1.50	1.92	2.34	2.66	3.08	3.50	3.93
30	0.89	1.46	2.04	2.62	3.19	3.62	4.20	4.78	5.35
36	1.12	1.85	2.76	3.30	4.03	4.58	5.30	6.03	6.76
42	1.37	2.26	3.15	4.04	4.93	5.59	6.48	7.37	8.26
48	1.62	2.67	3.72	4.77	5.82	6.61	7.66	8.71	9.76
54	1.87	3.08	4.29	5.50	6.72	7.63	8.84	10.05	11.26
60	2.12	3.49	4.86	6.24	7.61	8.64	10.02	11.39	12.76
66	2.34	3.96	5.38	6.90	8.42	9.56	11.08	12.60	14.12
72	2.58	4.25	5.92	7.59	9.26	10.52	12.19	13.86	15.53
78	2.81	4.64	6.46	8.28	10.11	11.48	13.30	15.12	16.95
84	3.05	5.03	7.00	8.98	10.96	12.44	14.42	16.40	18.37
90	3.29	5.42	7.55	9.68	11.82	13.41	15.55	17.68	19.81
96	3.52	5.81	8.09	10.38	12.67	14.38	16.66	18.95	21.24

Discharge

Louver Height in Inches — Louver Width in Inches

	12	18	24	30	36	42	48	54	60
12	0.22	0.36	0.51	0.65	0.80	0.90	1.05	1.19	1.33
18	0.52	0.85	1.20	1.55	1.89	2.14	2.48	2.82	3.15
24	0.84	1.38	1.92	2.45	3.00	3.41	3.95	4.49	5.03
30	1.15	1.90	2.55	3.40	4.15	4.71	5.46	6.20	6.95
36	1.47	2.43	3.38	4.34	5.29	6.01	6.95	7.91	8.86
42	1.77	2.92	4.07	5.22	6.37	7.23	8.38	9.53	10.68
48	2.08	3.42	4.76	6.11	7.46	8.46	9.81	11.16	12.50
54	2.38	3.92	5.45	7.00	8.54	9.70	11.24	12.78	14.33
60	2.58	4.42	6.15	7.89	9.63	10.93	12.57	14.41	16.15
66	2.98	4.91	6.85	8.78	10.72	12.16	14.10	15.03	17.96
72	3.28	5.41	7.54	9.57	11.80	13.40	15.53	17.56	19.79
78	3.59	5.91	8.24	10.55	12.89	14.53	16.96	19.28	21.51
84	3.89	6.41	8.93	11.45	13.97	15.86	18.39	20.91	23.43
90	4.19	6.91	9.53	12.34	15.05	17.10	19.82	22.53	25.25
96	4.49	7.41	10.33	13.24	16.16	18.34	21.26	24.17	27.09
102	4.81	7.93	11.05	14.17	17.30	19.54	22.76	25.58	29.00
108	5.13	8.46	11.78	15.11	18.44	20.93	24.26	27.59	30.91
114	5.44	8.96	12.50	15.02	19.55	22.20	25.72	29.25	32.78
120	5.74	9.46	13.19	15.91	20.54	23.43	27.15	30.88	34.50



* Access panel for condenser coil cleaning

Typical Vertical Installation

The combined height of the louvers selected is now 36" intake + 18" discharge = 54". Since the overall height of the VertiCool condensing section is 34.5", the unit will need to be mounted on a field fabricated unit stand so that the discharge duct can be directed horizontally as straight as possible out from the unit and accommodate the larger dimension. The stand design must be able to support the unit and not allow any vibration or movement from side to side. The bottom of the intake duct should slope upward toward the unit. Any precipitation that might carry over through the louver will drain away from the unit. The bottom of the discharge duct may also slope upward from the louver toward the discharge duct flange, however the top of the duct should remain horizontal.

If height restrictions do not allow the unit to be installed on a support stand, louvers that are wider but achieve a similar velocity, pressure drop and free area may be selected. Louver selections for a C-Series unit would follow the same procedure as listed above.

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Conclusion

It is extremely important to select a louver that separates the direction of the discharge air stream from the intake air stream to avoid short-circuiting of the air and promote optimum unit performance. Free area, water penetration rating, and pressure drop are all criteria used to select intake and discharge louvers for VertiCool and C-Series applications. Intake louvers should be sized so that water penetration is virtually eliminated and located an appropriate distance away from discharge and contaminated air. Discharge ducts should provide sufficient straight length of duct to ensure maximum velocity through the louver with minimum obstructions.

As with all installations, we recommend documenting unit performance at start-up.

References

ASHRAE Systems and Equipment Handbook - Building Air Distribution, Chapter 2

ASHRAE HVAC Applications Handbook - Building Air Intake and Exhaust Design, Chapter 44

ASHRAE Standard 62.1-2004 "Ventilation for Acceptable Indoor Air Quality"

Architectural Louvers www.archlouvers.com/How_Louvers_Work.htm

Greenheck Dampers & Louvers, "Application and Design" - ESID-430 Specialty Intake/Discharge Louver

Greenheck Dampers & Louvers, "Understanding Fan System Effects"

http://www.epa.gov/iaq/schooldesign/hvac.html
"Heating, Ventilation and Air-Conditioning (HVAC) Systems"

http://www.efisystemsgroup.com/system.htm
"System Effects, How Do They Impact The Performance Of A Fan?"

http://greenbuildings.santa-monica.org/hvac/hvacairpollutants.html
"Separate Outdoor Air Intakes from Air Pollutant Sources"

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