Series V Layout Guidelines

VT0, VT1, VF1, VF0, VC1 & VCA

Open circuit cooling towers, closed circuit cooling towers, and evaporative condensers all depend upon an adequate supply of fresh, ambient air to provide design capacity. Other important considerations such as the proximity to building air intakes or discharges also must be taken into account when selecting and designing the equipment site. Included are the design layout guidelines for evaporative cooling products in several situations typically encountered by designers. These guidelines represent minimum spacing requirements; more open spacing should be utilized whenever possible.

As the size of an installation increases, the total amount of heat being rejected to the atmosphere and the volume of discharge air increase -- to the point where the units can virtually create their own environment. As a result, it becomes increasingly difficult to apply a set of general guidelines for each case. Such installations, and particularly those in wells or enclosures, will recirculate and the problem becomes one of controlling the amount of recirculation and/or adjusting the design wet-bulb temperature to allow for it. Consequently, any job that involves four or more cells should be referred to your local BAC Representative for review.

Axial fan equipment units are not generally suited for indoor or ducted applications. In such situations, a Series V centrifugal fan unit is recommended.

General Considerations:

When selecting the site for a cooling tower, closed circuit cooling tower, or an evaporative condenser, consider the following factors:

1. Locate the unit to prevent the warm discharge air from being introduced into the fresh air intakes of the building(s) served by the unit, intakes of neighboring buildings, or from being carried over any populated area such as a building entrance.

2. Consider the potential for plume formation and its effect on the surroundings, such as large windowed areas, and pedestrian or vehicular traffic arteries, particularly if the unit(s) will be operated during low ambient temperatures.

3. Provide sufficient unobstructed space around the unit(s) to ensure an adequate supply of fresh, ambient air to the air intake. Avoid situations that promote recirculation of unit discharge air, such as units located:
   a. Adjacent to walls or structures that might deflect some of the discharge airstream back into the air intake.
   b. Where high downward air velocities in the vicinity of the air intake exist.
   c. Where building air intakes or exhausts, such as boiler stacks in the vicinity of the unit, might raise the inlet wet-bulb temperature or starve the unit of air.

4. Provide adequate space around the unit for piping and proper servicing and maintenance, as shown in Figure 1.

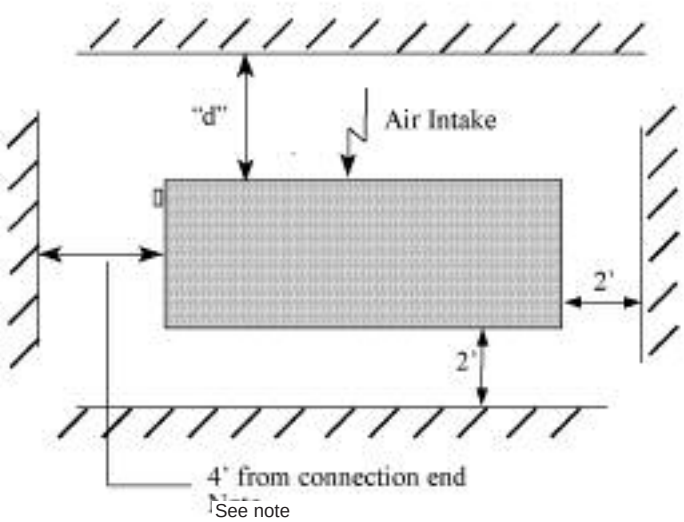

Figure 1: Plan view of recommended unit servicing and maintenance spacing for single air inlet unit Series V Cooling Towers, Closed Circuit Cooling Towers and Evaporative Condensers

Note: On Models VT0-12 through 176, VC1-10 through 205, VF1-009, 018, 027, 036, and VF1-048 clearance equal to the length of the unit should be provided on one end to facilitate fan shaft removal.

5. The top of the fan discharge cylinder, velocity recovery stack, or discharge sound attenuation must be at least level with, and preferably higher than any adjacent walls or buildings.

6. When possible, orient the unit so the prevailing summer wind blows the discharge air away from the air intakes of the unit(s).

7. When the unit is installed with intake sound attenuation, the distances given in the tables below should be measured from the face of the intake sound attenuation.

8. On larger unit installations, the problem of ensuring an adequate supply of fresh, ambient air to the tower intakes becomes increasingly difficult.

9. If the installation does not meet the recommended guidelines, the units will have a greater tendency to recirculate and the design conditions should be altered to include an allowance for the recirculation. For instance, if the design conditions are 95°F/85°F/78°F and it was estimated that the allowance for recirculation rate was 1°F, then the new design conditions would be 95°F/85°F/79°F and the units should be reselected based on the new design conditions.

The "Layout Guidelines" describe several typical site layouts for BAC's cooling towers, closed circuit cooling towers, and evaporative condensers. If these guidelines do not cover a particular situation or if the layout criteria cannot be met, please refer the application to your BAC Representative for review. Please indicate prevailing wind direction, geographic orientation of the unit(s), and other factors such as large buildings and other obstructions that may influence layout decisions.

Layout Guidelines:

1. Unit Orientation

When a unit is located near a building wall, the preferred arrangement is to have the unit situated with the cased end or blank-off side (unlouvered side) facing the adjacent wall or building.

2. Air Inlet Requirements:

Should it be necessary to install a unit with the air intake facing a wall, provide at least distance “d” between the air intake and the wall, as illustrated in Figures 2a and 2b.

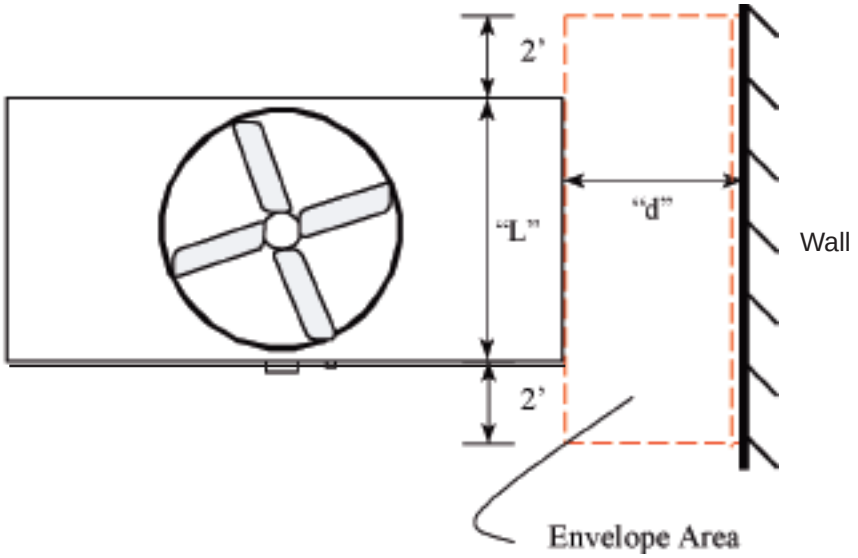

Figure 2a: Plan view of unit adjacent to a wall

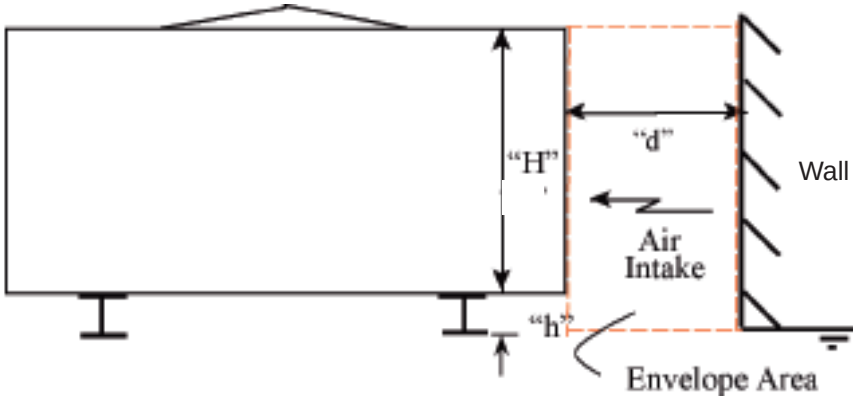

Figure 2b: Section view of unit adjacent to a wall

Below is the method for determining the minimum acceptable dimension "d" for a unit located with the air intake facing a solid wall:

The maximum acceptable envelope air velocity for all products except Series V with tapered hood is 300 FPM, as illustrated in the following equation:

$$\text{Envelope Velocity} = \frac{\text{Unit Airflow}}{\text{Envelope area}} < 300 \text{ FPM}$$

For Series V units with a tapered hood the maximum acceptable air velocity increases to 400 FPM as illustrated in the following equation:

$$\text{Envelope Velocity} = \frac{\text{Unit Airflow}}{\text{Envelope area}} < 400 \text{ FPM}$$

The Envelope area as illustrated on Figures 2a & 2b is [(L +2 +2) x d) + 2(H+h) x d)], where:

"H" - height of the air intake face in feet
“h” - elevation of the unit from the roof/ground/pad in feet. The maximum elevation is 4 feet.
"L" - length of the air intake in feet
"d" - minimum acceptable distance between the wall and the air intake face in feet

The minimum acceptable dimension "d" for the products is tabulated in Table 1. **The distance "d" was calculated using the largest horsepower model in the box size.**

Example: VT1-415-R adjacent to a wall

What is the minimum distance required between the air inlet of the VT1-415-R when installed facing a wall?

Solution:

Unit Airflow = 90,250 CFM

H = 8'4" (8.33')

h = 0'

L+4' = 11' 7-3/4"+4' (15.65')

300 FPM = maximum acceptable envelope air velocity with no hood.

Solving for "d"

$$d = \frac{\textit{Unit Airflow}}{300 \text{ x } [2(H + h) + (L + 6)]}$$

$$d = \frac{90{,}250 \textit{ cfm}}{300 \textit{ fpm} \text{ x } [2(8.33'+0') + (15.65')]}$$

$$d = 9.5' \textit{ rounded}$$

Therefore, the air intake should be no less than 9.5 feet from the wall.

Minimum Acceptable Air Inlet Distance "d" (feet) to Solid Wall

Table 1: VT0/ VT1

	No Discharge Hood			4' Discharge Hood		
Elevation	**0'**	**2'**	**4' & Up**	**0'**	**2'**	**4' & Up**
VT0-12-E to VT0-176-O	5	6	3	3.5	3	3
VT1-N209-P to VT1-N255-P	6.5	6	5	5	4.5	4
VT1-N301-Q to VT1-N395-R	8	7.5	6.5	6	5.5	5
VT1-N418-P to VT1-N510-P	9	8.5	7.5	7	6.5	6
VT1-275-P to VT1-415-R	9.5	8.5	7.5	7	6.5	6
VT1-416-O to VT1-600-P	11.5	10.5	9.5	8.5	8	7
VT1-550-P to VT1-830-R	13.5	12.5	11.5	10	9.5	8.5
VT1-825-P to VT1-1335-S	17	16	15	13	12	11.5

Table 2: VC1/ VF1

		No Discharge Hood			4' Discharge Hood		
Unit Elevation		**0'**	**2'**	**4'**	**0'**	**2'**	**4'**
VC1-10 to 25	VF1-009-XXX	3	3	3	3	3	3
VC1-30 to 65	VF1-018-XXX	3	3	3	3	3	3
VC1-72 to 90	VF1-027-XXX	3	3	3	3	3	3
VC1-100 to 135	VF1-036-XXX	4	3.5	3	3	3	3
VC1-150 to 205	VF1-048-XXX	5	4.5	4	3.5	3	3
VC1-N208 to N230	VF1-072-XXX	6.5	5.5	5	5	4	3.5
VC1-N243 to N315	VF1-096-XXX	7	6	5.5	5	4.5	4
VC1-N338 to N470	VF1-144N-XXX	7	6.5	6	5	4.5	4
----	VF1-192-XXX	10	9	8	7	6.5	6
----	VF1-288N-XXX	9.5	8.5	8	7	6.5	6
VC1-386 to 516	VF1-144-XXX	10	9	8	7.5	6.5	6
VC1-540 to 804	VF1-216-XXX	13	11.5	10.5	9.5	8.5	8
VC1-772 to 1032	VF1-288-XXX	13.5	12.5	11.5	10	9.5	8.5
VC1-1158 to 1608	VF1-432-XXX	17.5	16	15	13	12	11.5
VC1-C216 to C320	----	7	6	5.5	5.5	4.5	4
VC1-C339 to C469	----	10	8.5	7.5	7.5	6.5	5.5

Table 3: VCA

	No Discharge Hood		
Elevation	**0'**	**2'**	**4'**
VCA-122A to 191A	4	3.5	3
VCA-174A to 259A	5.5	5	4.5
VCA-261A to 322A	6	5.5	5
VCA-323A to 446A	7	6.5	5.5
VCA-300A to 512A	7.5	7	6
VCA-460A to 779A	11.5	10	9
VCA-662A to 1024A	15	13.5	12
VCA-S700A to S884A	12.5	11.5	10
VCA-920A to 1558A	22.5	20	18
VCA-302A to 661A	9	8	7.5
VCA-526A to 1010A	13.5	12	11
VCA-S870A to S1204A	17.5	16	14.5
VCA-605A to 1321A	17.5	16	14.5
VCA-930A to 2019A	26.5	24	21.5

Well Layout

The following method is used to determine the minimum acceptable dimension "d" for units installed in a well layout.

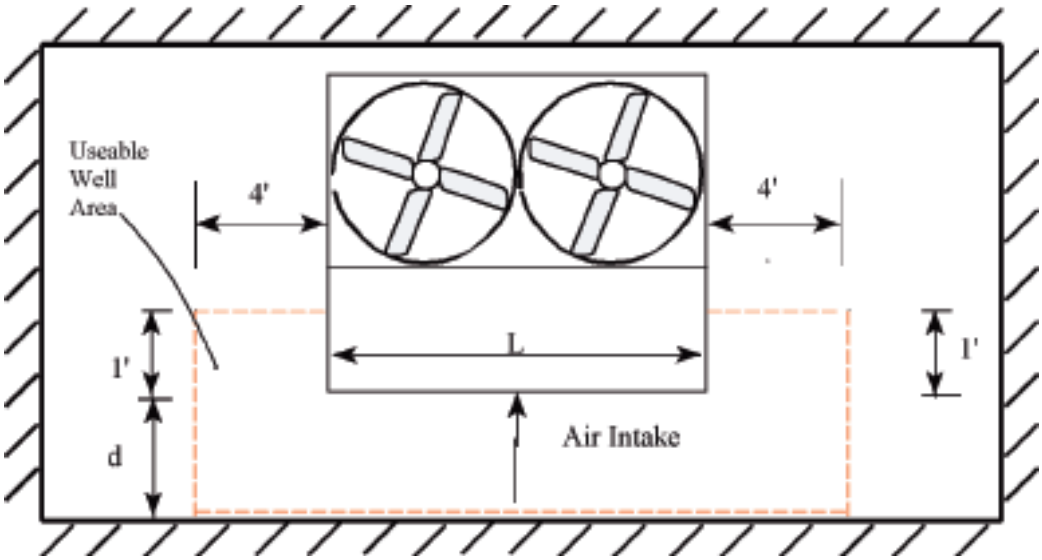

Figure 3: Plan view of single air intake units in a well enclosure

The maximum allowable downward air velocity for a well installation is 400 fpm. The downward velocity is determined using the following equation:

$$\text{Downward Air Velocity} = \frac{\text{Unit Airflow}}{\text{Useable Well Area}} < 400 \text{ fpm}$$

The usable well area at each air intake face is defined as illustrated in Figure 3.
Useable Well Area = [(d)(L+4'+4')]+[(4' x 1') + (4' x 1')], where

"d" - minimum acceptable distance between the air intake of the unit and the wall of the well in feet
"L" - length of the air intake of the unit in feet.

The minimum acceptable distance "d" for well installations is tabulated in Table 2.

Example: VF1-144-31Q

If the VF1-144-31Q has a 4' tapered discharge, what is the minimum distance between the air inlet of the VF1-144-31Q in a well?

cfm = 86,500 cfm per cell.
Length = 11'-7 3/4" (11.65')
400 fpm = maximum allowable downward velocity for a VF1 with tapered hood

400 fpm = (86,500cfm)/ [d (11.65 + 4 + 4)] + (4 + 4)
[d(19.65)] + 8 = (86,500 cfm) / (400 fpm)
d = [((86,500 cfm) / (400 fpm)) - 8] / 19.65
d = 10.59 feet

This is rounded up to the next 0.5' increment. Therefore the air intake should be no less than 11 feet from the enclosure walls.

Minimum Acceptable Air Intake Distance "d" (feet)

Table 4: VTO/ VT1

Model Number	With or Without a Tapered Discharge Hood
VT0-12-E to VT0-176-O	3
VT1-N209-P to VT1-N255-P	6.5
VT1-N301-Q to VT1-N395-R	8
VT1-N418-P to VT1-N510-P	8.5
VT1-275-P to VT1-415-R	11
VT1-416-O to VT1-600-P	12.5
VT1-550-P to VT1-830-R	14
VT1-825-P to VT1-1335-S	16.5

Table 5: VCA

Model Number	One Cell
VCA-122A to 191A	5.5
VCA-174A to 259A	7.5
VCA-261A to 322A	8
VCA-323A to 446A	11
VCA-300A to 512A	10
VCA-460A to 779A	15
VCA-662A to 1024A	20
VCA-S700A to S884A	16.5
VCA-920A to 1558A	30
VCA-302A to 661A	11.5
VCA-526A to 1010A	17
VCA-S870A to S1204A	22.5
VCA-605A to 1321A	23
VCA-930A to 2019A	34

Table 6: VC1 / VF1

		With or Without a Tapered Discharge Hood
VC1-10 to 25	VF1-009-XXX	3
VC1-30 to 65	VF1-018-XXX	3
VC1-72 to 90	VF1-027-XXX	3
VC1-100 to 135	VF1-036-XXX	3
VC1-150 to 205	VF1-048-XXX	4.5
VC1-N208 to N230	VF1-072-XXX	6.5
VC1-N243 to N315	VF1-096-XXX	8
VC1-N338 to N470	VF1-144N-XXX	7.5
----	VF1-192-XXX	10
----	VF1-288N-XXX	9
VC1-386 to 516	VF1-144-XXX	11.5
VC1-540 to 804	VF1-216-XXX	14
VC1-772 to 1032	VF1-288-XXX	13.5
VC1-1158 to 1608	VF1-432-XXX	16.5
VC1-C216 to C320	----	8.5
VC1-C339 to C469	----	11.5

Louvered Well Installation

Check to see if the layout meets the requirements for a well installation. If the criteria for the well installation are met, the layout is satisfactory. If the layout does not satisfy the criteria for the well installation, analyze the layout as follows:

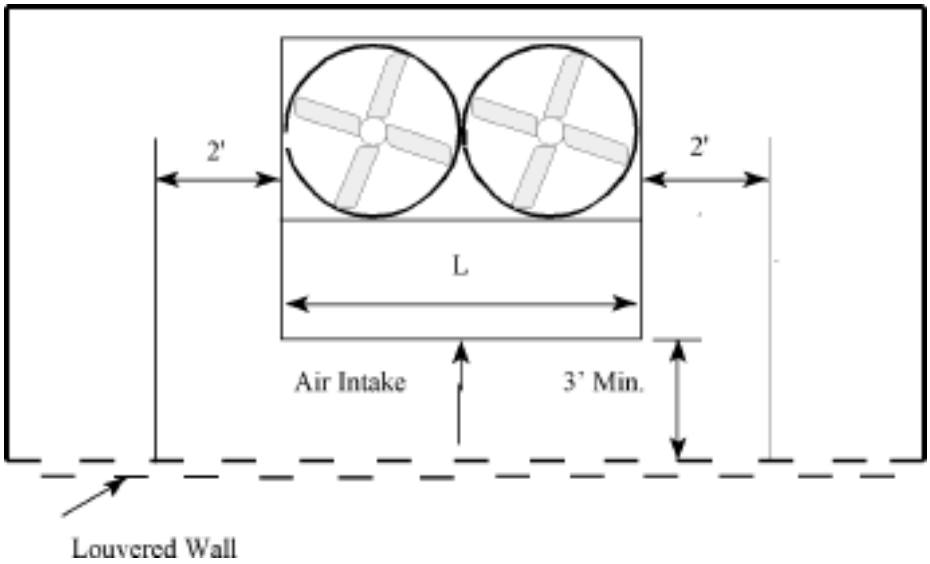

Figure 4: Plan view of a single air lintake unit in enclosure with louvered walls

1. Air intake requirements:

Units should be arranged within the enclosure such that:

a. The air intake directly faces the louver or slot locations as shown in Figure 5.

b. Maintain a distance of at least three feet (3'-0") between the unit air intake(s) and the louvered or slotted wall for uniform air distribution.

c. If the available space does not permit the unit can be arranged with the air intakes facing the louvered or slotted walls and the enclosure cannot be modified to permit such an arrangement, consider the alternative illustrated in Figure 4. This arrangement should be restricted to one-cell or two-cell installations. The effective area of the louvers is only the length extending beyond the width of the tower.

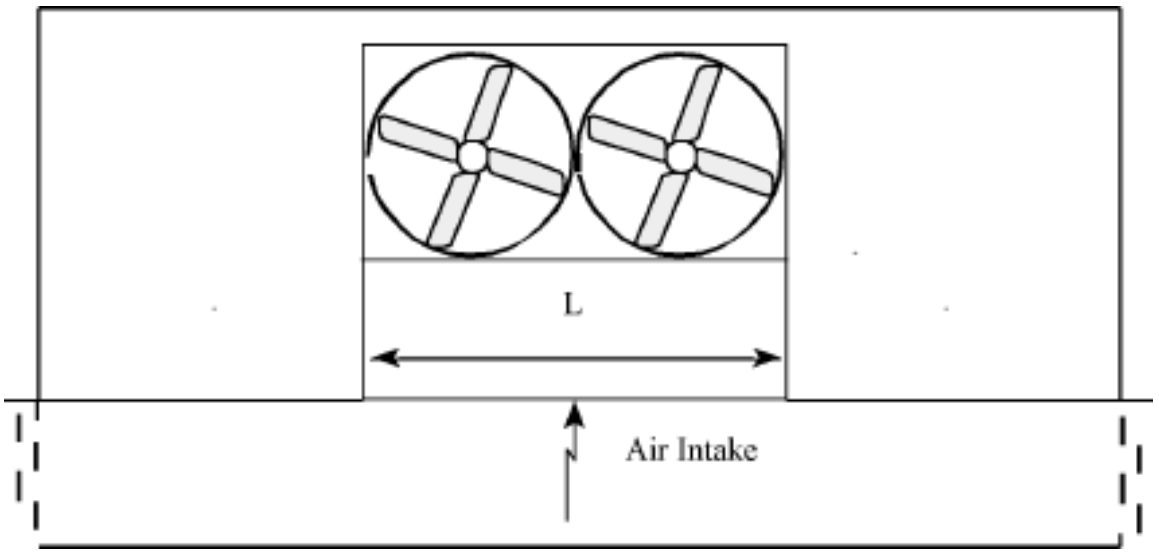

Figure 5: Plan view of single air inlet unit in enclosure with alternate louver arrangement

2. Louver Requirements:

a. Louvers must provide at least 50% net free area to ensure that the unit airflow is not reduced due to friction or dynamic losses and that sufficient air is drawn through the openings and not downward from above.

b. The required total louver or slot area is based on drawing the total unit airflow through the net free area of the louvers at a velocity of 600 FPM or less.

c. Locate the louver area in the walls of the enclosure such that air flows uniformly to the air intakes.

d. If the unit is elevated to ensure the discharge is at the same level or above the top of the enclosure, it is acceptable to extend the louvered or slot area below the base of the units up to 2 feet if needed to achieve the minimum gross louver area. To calculate air velocity through the louver, the useable lou vered or slot area may extend beyond the ends of the unit, by 4' maximum

Calculate the louver velocity as follows:

$$\text{Louver Velocity} = \frac{\text{Total Unit Airflow (CFM)}}{\text{\% Louver Free Area x Useable Louver Area (sq ft)}}$$

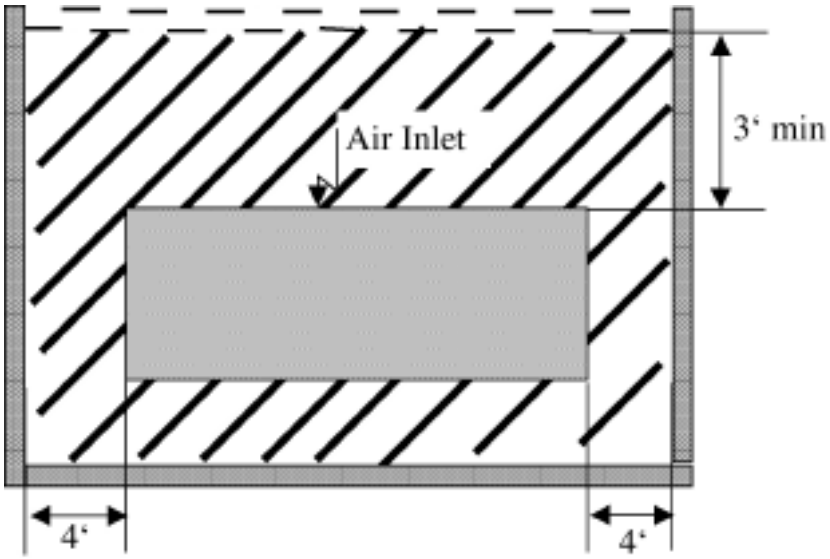

Figure 6: Plan view of unit enclosure with louvered wall & closed top installation

Air inlet Requirements

a. Louvers must have at least 50% net free area.

b. Install the cooling tower with the limitations shown in Figure 6 for uniform air distribution.

c. Determine the total louver or slot area required based on drawing the total unit cfm through the net free area of the louvers at a velocity of 800 fpm or less.
Calculate the louver velocity as follows:

d. The louver or slot area should be located in the walls of the enclosure so that air flows uniformly to all air inlets.

e. It is acceptable to extend the louvered or slot area below the base of the unit if needed to achieve the minimum gross free area. The usable or slot area may also be extended beyond the ends of the tower by 4’.

f. As a general rule, Series V Multi-Stage Axial Fan Models cannot be located indoors.

Ductwork Requirements

a. Air velocities in the inlet duct should be kept below 800 FPM to hold static pressure losses to a minimum and ensure a uniform supply of air to all fans. In general the maximum allowable ESP on Series V centrifugal fan units is 1/2". Consult the factory for any ESP greater than 1/2".

b. Air velocities in the discharge duct(s) should not exceed 1,000 fpm to reduce friction losses in the duct, and more importantly, to ensure uniform air through the unit.

c. Turns in inlet or discharge ducts should be avoided. Where turns must be used, velocities should be minimized in the vicinity of the turn. Turns in discharge ducting should be designed in accordance with the "2/3's rule" shown in Figure 7

d. Where individual fan sections are to be cycled for capacity control, each fan section must be ducted as a separate system on both inlet and discharge to avoid recirculation within the ductwork. All ductwork systems should be symmetrical to ensure that each fan section operates against the same ESP.

e. Access doors must be provided in both the inlet and discharge ducts.

f. When multi-cell units are located indoors with the room as a plenum, the installation must be operated as a single unit to avoid pulling air through an idle cell.

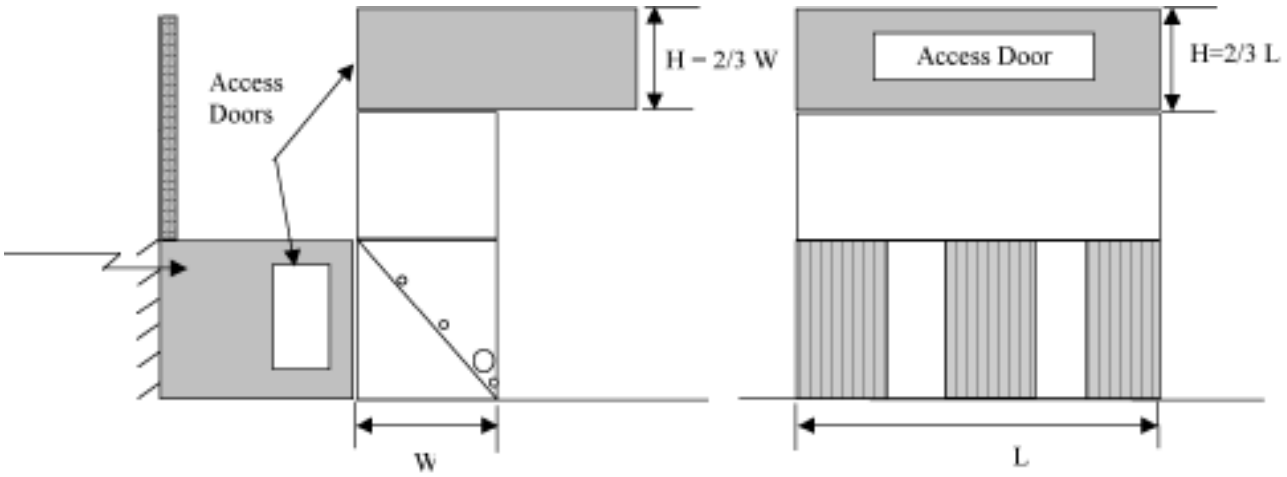

Figure 7: Section & front view of ducted unit enclosure

The "Layout Guidelines" describe several typical site situations involving evaporative cooling products. If these guidelines do not cover a particular situation or if the layout criteria cannot be met, please refer the application to the your local BAC Representative for review. Please indicate prevailing wind direction, geographic orientation of the unit(s), and other factors such as large buildings and other obstructions that may influence layout decisions.