



Series 3000 Layout Guidelines

- Included are the design layout guidelines for Series 3000 Cooling Towers in several situations typically encountered by designers. These guidelines represent minimum spacing requirements. If available, greater spacing should be utilized whenever possible.

Overview

Operational efficiency of evaporative cooling equipment depends 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.

As the size of an installation increases, the total amount of heat being rejected into the atmosphere and the volume of discharge air increases — 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 to each case. In such installations, particularly those in wells or enclosures, some air will recirculate. The recirculation should be minimized or design wet-bulb temperature must be adjusted to allow for the recirculation. 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.



DID YOU KNOW?

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General Considerations

When selecting the site consider the following factors:

1. Locate the unit to prevent the warm discharge air from being introduced into the fresh air intakes of the unit's building(s), 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 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**.
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. See the "Multi-cell Installations" Section of this article for specific considerations.

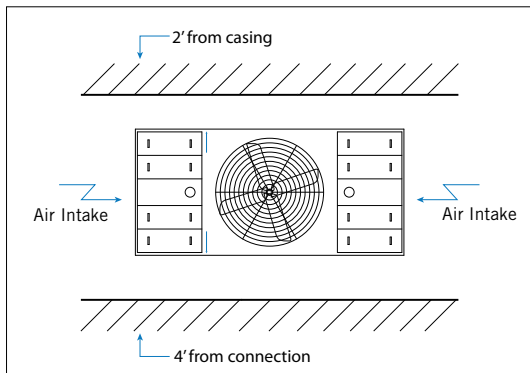


Figure 1: Plan View of the Recommended Unit Servicing and Maintenance Spacing for a Dual Air Intake Unit

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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.

Installations Adjacent to a Building or Wall(s)

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**.

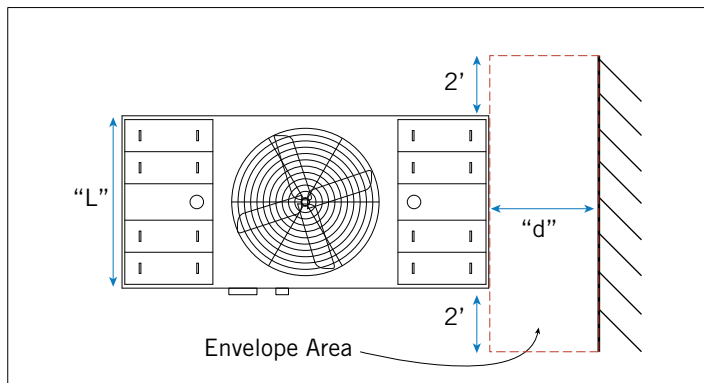


Figure 2a. Plan View of a Unit Adjacent to Wall

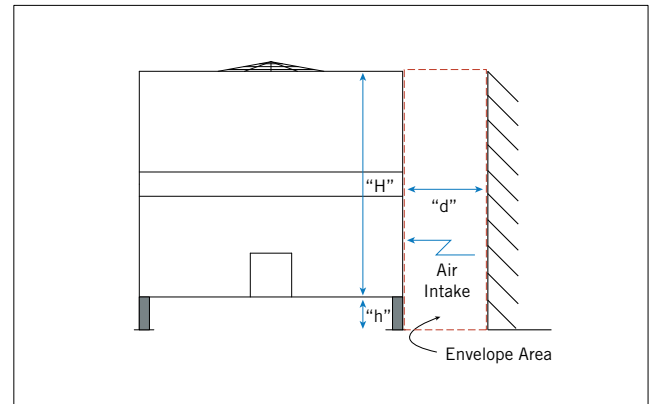


Figure 2b. Section View of a Unit Adjacent to Wall



Series 3000 Layout Guidelines

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 is 300 FPM, as illustrated in the following equation:

$$\text{Envelope Velocity} = \text{Airflow} / \text{Envelope Area} < 300 \text{ FPM}$$

The envelope area as illustrated on **Figures 2a** and **2b** on **Page 3** is $[(L + 2 + 2) * d] + 2(H+h) * d$], 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 four feet.
- “L” – length of the air intake in feet
- “d” – minimum acceptable distance between the wall and the air intake face in feet

$$\text{Therefore, } d = \frac{\text{Unit Airflow} * 0.70}{\text{Velocity} [L + 2 (H+h) + 4]}$$

The minimum acceptable dimension “d” for the products is tabulated in **Tables 1** and **2** on **Page 5**. The distance “d” was calculated using the largest horsepower model in the box size.



NOTE: The maximum acceptable envelope air velocity is 300 FPM.

Example: Model 31132C-3 Adjacent to a Solid Wall

What is the minimum distance required between the air intake of the 31132C-3 when installed facing a wall?

Unit Airflow = 166,020 CFM x 2 cells = 332,040 CFM

H = 18' 1-1/2" (18.1'), h = 0'

L = 42' 2-3/8" (42.2')

300 FPM = maximum acceptable envelope air velocity for a unit

Envelope Velocity = (Airflow) / (Envelope Area)

Solving for “d”,

$$300 \text{ FPM} = \frac{(803,640 \text{ CFM} / 2 \text{ air intake sides})}{[(42.2+4) \times d] + 2(18.1+0) \times d}$$

$$d \times (82.4) = \frac{(401,820 \text{ CFM})}{(300 \text{ FPM})}$$

$$= \frac{[(401,820 \text{ CFM}) / (300 \text{ FPM})]}{82.4}$$

$$d = 16.25'$$

This is rounded to the next 0.5' increment. Therefore, the air intake should be located no less than 16.5' from the solid wall.





Series 3000 Layout Guidelines

Model Number	One Cell			Two Cell		
	"h"=0'	"h"=2'	"h"=4'	"h"=0'	"h"=2'	"h"=4'
3240C to 3299C	4.5	4	3.5	6.5	6	5.5
3333C to 3379C	5	4.5	4	8	7	6.5
3412C to 3436C	5.5	5	4.5	8	7.5	7
3455C to 3527C	6	5.5	5	9	8.5	8
3473C to 3501C	6	5.5	5	8.5	8	7.5
3552C to 3672C	7	6.5	6	11	10	9.5
3728C to 3828C	7	6.5	6	11.5	10.5	10
3872C to 3970C	7.5	7	6.5	12	11	10.5
3985C to 31056C	7	6.5	6.5	11.5	11	10.5
3583C to 3725C	7	6.5	6	10.5	10	9.5
31132C	8	7.5	7	13	12	11.5
31213C to 31301C	8.5	8	7.5	13.5	13	12.5

Table 1. Minimum Acceptable Air Intake Distance "d" (feet) to Solid Wall for Series 3000 Cooling Towers for One and Two Cells

Model Number	Three Cell			Four Cell		
	"h"=0'	"h"=2'	"h"=4'	"h"=0'	"h"=2'	"h"=4'
3240C to 3299C	8	7.5	7	9.5	9	8
3333C to 3379C	9.5	9	8.5	11	10.5	9.5
3412C to 3436C	10	9.5	9	10.5	11	10
3455C to 3527C	11.5	10.5	10	13	12	11.5
3473C to 3501C	10.5	10	9.5	14.5	11	10.5
3552C to 3672C	13	12.5	11.5	14.5	14	13.5
3728C to 3828C	14	13.5	13	16	15.5	15
3872C to 3970C	15	14	13.5	17	16.5	16
3985C to 31056C	15	14.5	13.5	17.5	16.5	16
3583C to 3725C	13	12	11.5	14	13.5	13
31132C	16.5	15.5	14.5	18	17.5	17
31213C to 31301C	17	16	15.5	19.5	19	18

Table 2. Minimum Acceptable Air Intake Distance "d" (feet) to Solid Wall for Series 3000 Cooling Towers for Three and Four Cells



NOTE: Refer to Figure 2b on Page 3 for location of "d" and "h".

Series 3000 Layout Guidelines

Well Layout

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

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

$$\text{Downward Air Velocity} = \text{Airflow} / \text{Usable Well Area} < 400 \text{ fpm}$$

The usable well area at each air intake face is defined as illustrated in **Figure 3**.

$$\text{Usable Well Area} = 2 * [(d)(L+4'+4')] + [(4' * 1') + (4' * 1')], \text{ where}$$

“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

Therefore,

$$d = \left[\frac{(\text{Unit Airflow} * 0.50) - 8}{400} * \frac{1}{(L+8)} \right]$$

The minimum acceptable distance “d” for well installations is tabulated in **Table 2** on **Page 5**.



NOTE: The maximum allowable downward air velocity for a well installation is 400 fpm.

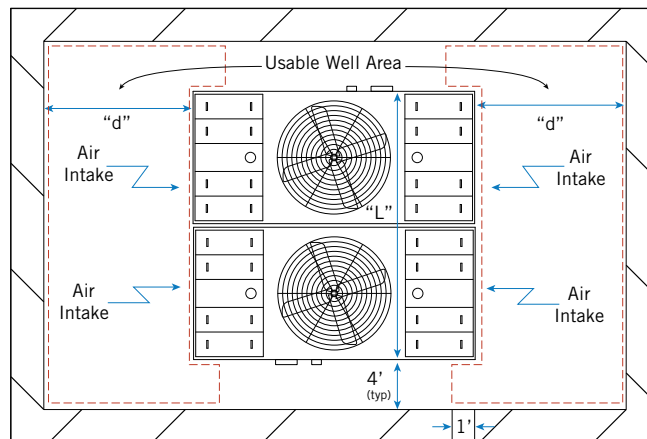


Figure 3. Plan View of Dual Air Intake Unit in a Well Enclosure



Series 3000 Layout Guidelines

Example: Model 3672C-2 in a Well

Unit Airflow = 166,020 CFM x 2 cells = 332,040 CFM

L = 23'-10" (23.8')

400 FPM = maximum allowable air downward velocity for a unit

$$\text{Downward Air Velocity} = \frac{(\text{Airflow})}{(\text{Usable Well Area})}$$

Solving for "d",

$$400 \text{ FPM} = \frac{(332,040 \text{ CFM} / 2 \text{ air intake sides})}{[(d)(23.8+4+4)]+(4+4)}$$

$$[(d)(31.8)]+(8) = \frac{(166,020) \text{ CFM}}{400 \text{ FPM}}$$

$$d = \frac{[(166,020 \text{ CFM}) / (400 \text{ FPM})] - 8}{31.8}$$

$$d = 12.8'$$

This is rounded up to the next 0.5' increment. Therefore the air intake should be no less than 13.0' from the enclosure walls.

Model Number	One Cell	Two Cell	Three Cell	Four Cell
3240C to 3299C	6	8	9	9.5
3333C to 3379C	7.5	9.5	11	11.5
3412C to 3436C	7.5	10	11	12
3455C to 3527C	9	12	13	14
3473C to 3501C	8	10	11	11.5
3552C to 3672C	10.5	13	14.5	15
3728C to 3828C	13	16	17.5	18.5
3872C to 3970C	14.5	18.5	20	21
3985C to 31056C	15.5	20	21.5	22.5
3583C to 3725C	10	12	12.5	13
31132C	17.5	21	23	24
31213C to 31301C	17.5	21	23	24

Table 3. Minimum Acceptable Air Intake Distance "d" (feet) for Series 3000 in a Well Enclosure

Series 3000 Layout Guidelines

Louvered or Slotted Wall Installations

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:

1. Air intake requirements:

- a. Units should be arranged within the enclosure such that the air intake directly faces the louver or slot locations as shown in **Figure 4**, with a minimum distance of three feet.
- b. If the available space does not permit the unit to 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 5** on **Page 9**. 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 unit.

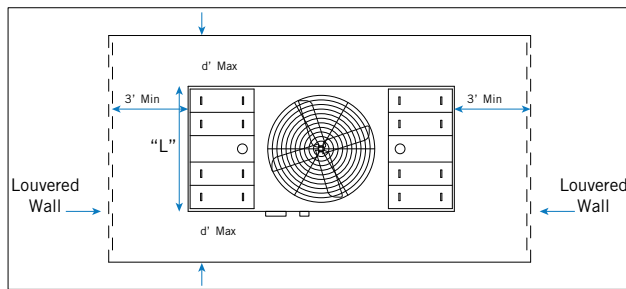


Figure 4. Plan View of Dual Air Intake Unit in Enclosure with Louvered Walls

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 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 two feet if needed to achieve the minimum gross louver area. To calculate air velocity through the louver, the usable louvered or slot area may extend beyond the ends of the unit, by two feet maximum on either side.



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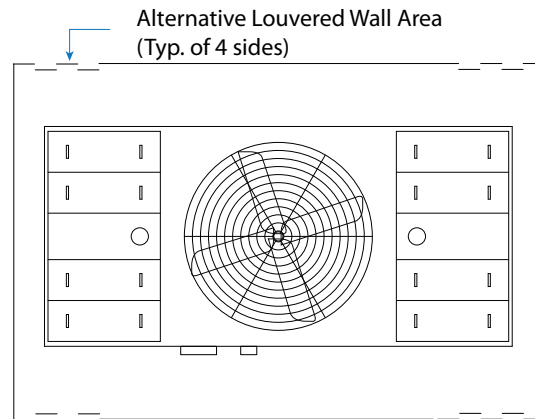


Figure 5. Plan View of Dual Air Intake Unit with Alternate Louver Arrangement

Calculate the louver velocity as follows:

$$\text{Louver Velocity} = \frac{\text{Airflow (CFM)}}{\% \text{ Louver Free Area} * \text{Usable Louver Area (sq ft)}} < 600 \text{ fpm}$$

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.



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Example: 3473C-2 in a Louvered Enclosure

The enclosure is 27.5' long x 38' wide x 10' tall. The enclosure walls are equal in elevation to the unit discharge height. The louvers are 70% free area and 3' 0" from the air inlet of the tower. The louvers extend the full width of the enclosure (38') on both air intake ends and they extend 9' vertically of the 10' enclosure height.

Unit Airflow = 118,870 CFM x 2 cells = 237,740 CFM

Unit "L" Dimension = 11' 9-3/4" per cell x 2 cells = 23' 10" (23.83')

"d" max. = 4 feet per side

Usable Louver Length = 23.83' + 4' + 4' = 31.83 ft. (of total 38' louver length)

600 FPM = Maximum Allowable Louver Velocity

$$\begin{aligned}
 \text{Louver Vel.} &= \text{Louver Face Airflow (CFM)} / [(\% \text{ Louver Free Area}) \times (\text{Use. Louver Area})] \\
 &= \frac{(237,740 \text{ CFM} / 2 \text{ intake sides})}{[(70\%) \times [(23.83' + 4' + 4') \times (9')]} \\
 &= \frac{(118,870 \text{ CFM})}{(200 \text{ sq ft})} \\
 &= 594 \text{ fpm}
 \end{aligned}$$

Therefore, louver sizing is sufficient because 594 FPM < 600 fpm maximum allowable.

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Multi-Cell Installation

Multiple cells create a “wall” of moist discharge air which could easily be swept into the air intakes due to prevailing wind. To minimize the potential of recirculation of the discharge air, the units should be situated with adequate spacing between air intakes.

When multiple cells are arranged with the air intakes facing each other, the distance between air intakes should follow the equation below:

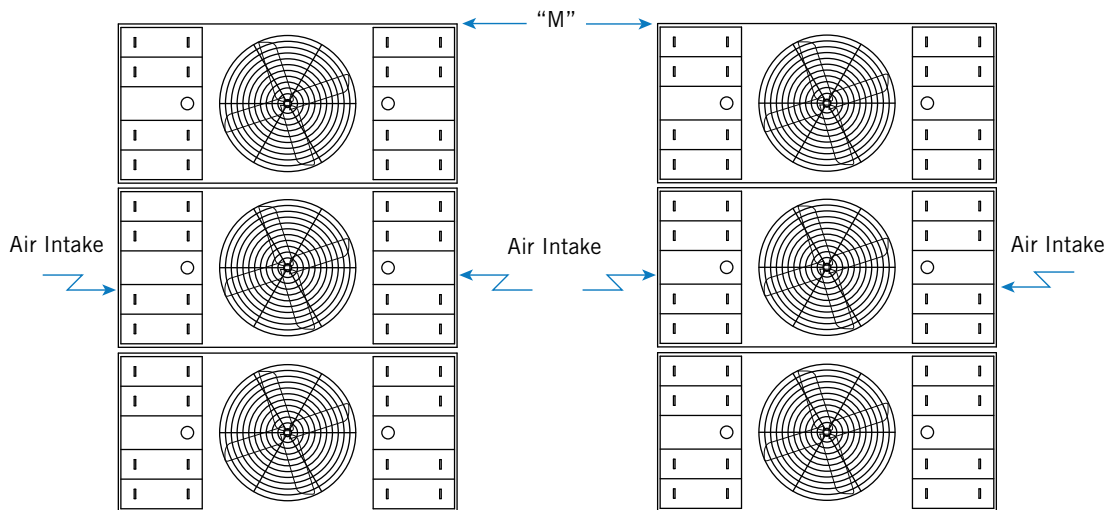


Figure 6: Plan View of Multi-cell Units with Air Intakes Facing Each Other

$M = (2 \times d) + (\text{number of cells per module})$, where “d” is obtained from the appropriate model in Wall Layout section, **Table 2** on **Page 5**.

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Example: Model 2-3985C-3

There are two modules of three cells of units on a roof. There are no enclosures surrounding the unit installation. The two banks of units have air intakes facing each other. The minimum distance “M” between rows of units is determined as follows:

From table 1, “d” = 15.5’,

$$\begin{aligned}
 M &= (2 \times d) + (\text{number of units per module}) \\
 &= (2 \times 15.5) + (3) \\
 &= 34 \text{ feet}
 \end{aligned}$$

The calculated “M” dimension of 34 feet will minimize the potential of recirculation of the discharge air.

Group the units in two cell or three cell groups, spaced at least one unit length between adjacent end walls to allow fresh air to circulate around each group, as shown in **Figure 7**.

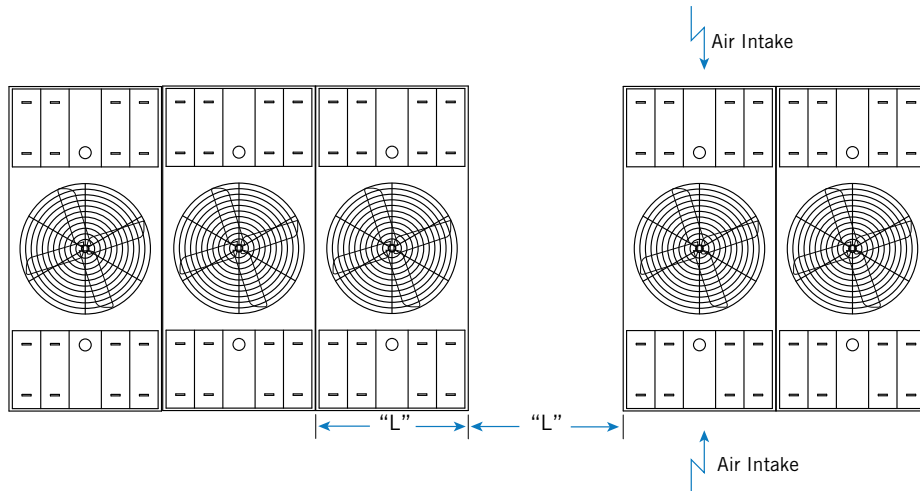


Figure 7: Plan View of Recommended Multi-cell Installation

In the extreme case, when multiple cells are arranged with the air inlets facing each other in a well, the dimensions between the cells should follow the following requirements.

1. **Enclosure:** The bottom 3 feet of the well should be louvered a minimum of 50% net free area to allow air flow under the units as shown in **Figure 9** on **Page 13**.
2. **Support:** The units should be raised off the roof deck to allow fresh air to flow under to the air inlets between the bank of cells.
3. **The distance between the cells should be determined using the following method:**
 - a. Determine the maximum airflow drawn from the louvered area using the following equation:
 CFM drawn through the louvers = Louver Velocity x % Louver Free Area x Usable Louver Area
 CFM drawn through the louvers = 800 FPM x % Louver Free Area x Usable Louver Area
 - b. Determine the CFM drawn from the top of the enclosure using the following equation:
 CFM drawn from the top of the enclosure = Downward Velocity x Usable Well Area

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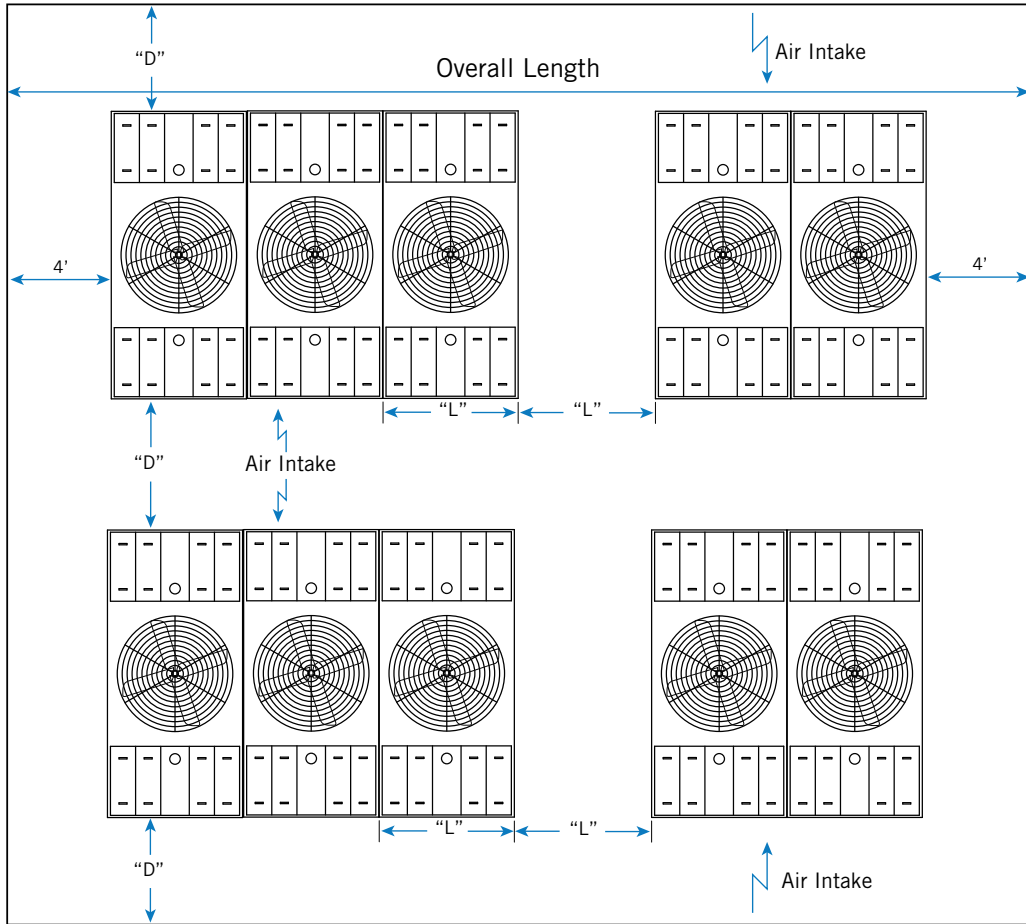


Figure 8: Plan View of Multi-cell Installation

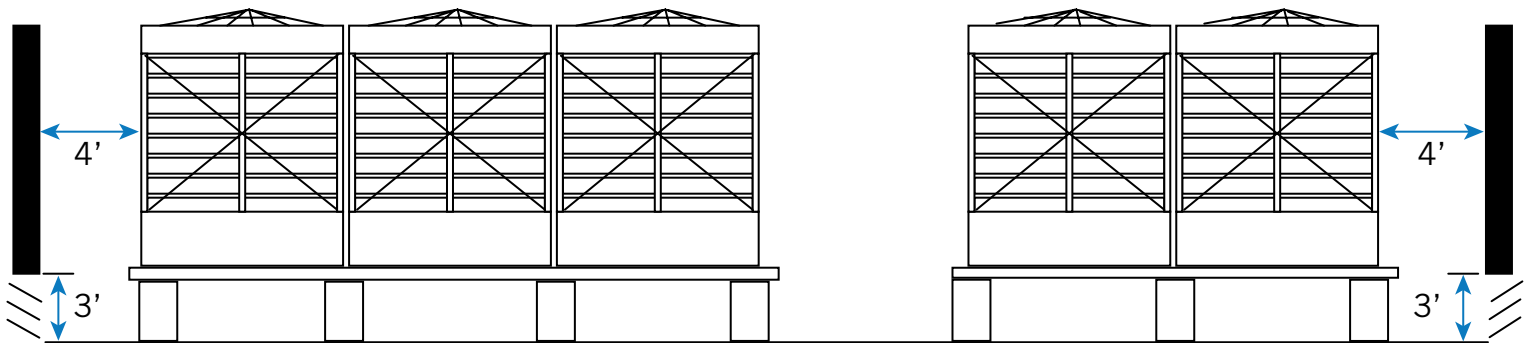


Figure 9: Elevation View of Recommended Enclosure

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Example: (10) 31056C

For example, what is the minimum distance D between the banks of cells of a (10) 31056C?

$$\text{Unit Airflow} = 246,700 \text{ CFM} \times 10 \text{ cells} = 2,467,000 \text{ CFM}$$

$$\begin{aligned} \text{Overall length of enclosure} &= \text{Number of cells} \times L + \text{Number of Openings} \times L + 4 + 4 \\ &= 5 \times 12 + 1 \times 12 + 4 + 4 \\ &= 0 \text{ feet} \end{aligned}$$

3' of 50% louvered around building with a louver velocity of 800 fpm

$$\text{CFM Drawn Through Louvers} = \text{Louver Velocity} \times \% \text{ Louver Free Area} \times \text{Usable Louver Area}$$

$$\begin{aligned} &= \text{Louver Velocity} \times \% \text{ Louver Free Area} \times \text{Perimeter of the Enclosure} \times \text{Height of Louvered Wall} \\ &= \text{Louver Velocity} \times \% \text{ Louver Free Area} \times (2 \times (\text{Overall Length} + \text{Overall Width}) \\ &\quad \times \text{Height of Louvered Wall}) \\ &= 800 \times 0.5 \times 2 \times (80 + 4D) \times 3 \\ &= 192,000 + 9600D \end{aligned}$$

$$\text{CFM Drawn from Top of the Enclosure} = \text{Downward Velocity} \times \text{Usable Area}$$

$$\begin{aligned} &= \text{Downward Velocity} \times 4D \times (\text{Overall Length}) \\ &= 400 \times 4D \times \text{Overall Length} \\ &= 400 \times 4D \times 80 \\ &= 128000D \end{aligned}$$

$$\text{CFM Drawn through louvers} + \text{CFM Drawn from Top of the Enclosure} = \text{Total CFM per Installation}$$

$$\begin{aligned} 192000 + 9600D + 128000D &= 2467000 \\ 137600D &= 2467000 - 192000 \\ 137600D &= 2275000 \\ D &= 16.533 \end{aligned}$$

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