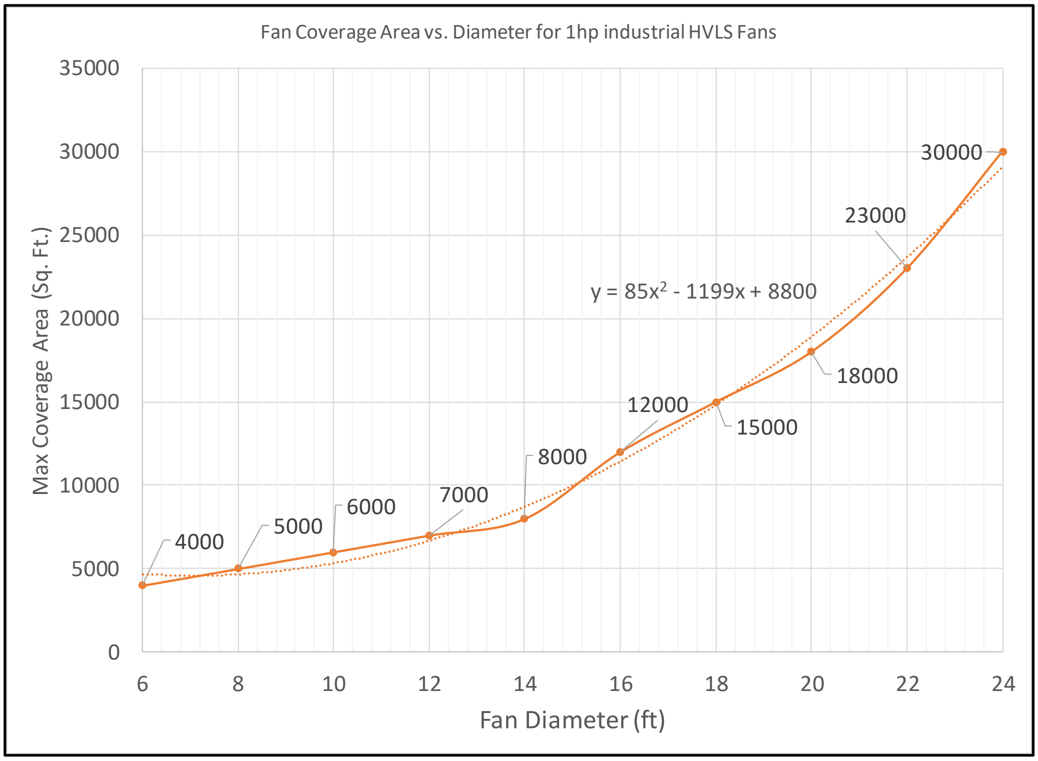

Figure 4: Max Coverage Area vs. Fan Diameter can be approximated with a quadratic equation

Max Coverage Area:

As fan diameter is increased, max coverage area is increased as shown in Figure 2 above. However, what does that really mean? It simply means that air flow can go to farther distance, however, at a slower speed. Going from a 16-ft fan to 24-ft fan increases the coverage area but at the expense of reduced air flow speed at the boundaries when the power of the fan is kept constant. We can not generate more air flow speed out of nothing. Simple change of blades simply helps to spread the air particles farther.

> Note: Coverage area increases with increase in fan diameter but at reduced air flow speed at the boundaries if power consumption is kept the same.

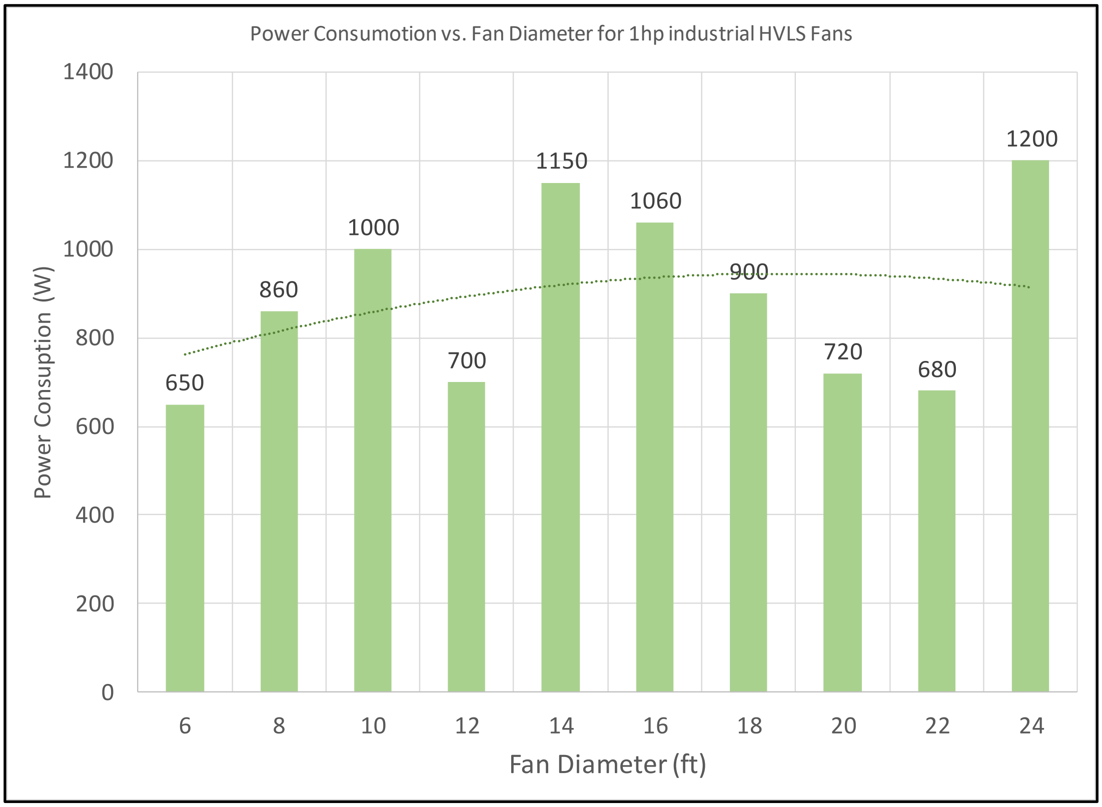

Figure 5: Power Consumption vs. Fan diameter of Industrial HVLS fans

POWER CONSUMPTION:

Power consumption is a critical indicator of air flow. It can be easily measured by anyone and used to compare different fans. Manufacturers do not list the real power consumption on their data sheet. Hence an actual measurement is required. If you see figure 3 above, 24-ft fan produces twice as much air flow as the 12-ft fan (1200W vs. 650W).

Note: Real input power consumption is a critical indicator of air flow.

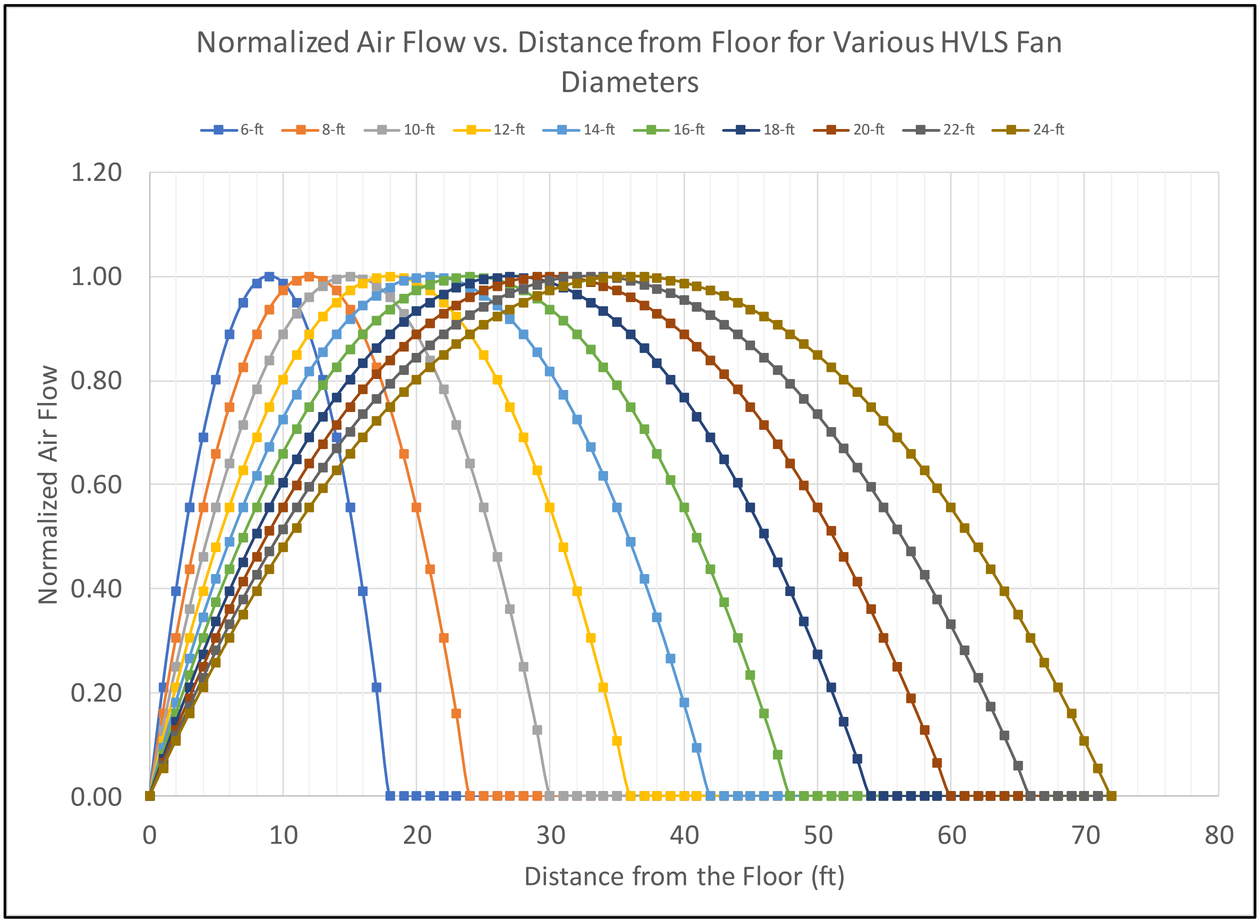

Figure 6:Normalized air flow vs. fan distance from the floor. 6-ft fan has the shortest distance and airflow coverage.

DISTANCE BETWEEN FROM THE FLOOR:

Note: Air flow is most optimum at 1.5 times the fan diameter.

This is one of the critical factors to examine before specifying HVLS fans. If you specify a fan and the appropriate distance does not exist, the air flow will not materialize. Why is that? At shorter distances, air particles will collide with each other causing loss of laminar flow and hence lack of air flow. At larger distances, air particles will not reach the floor with required air velocity again causing loss of air flow. The phenomenon can be understood in the figure 4 shown above and figure 5 below. For example, 6-ft fan diameter will produce optimum air flow at 9 ft from the floor. Air flow is 0 at 18-ft and reduced proportionally when distance is decreased or increased from 9 ft. Similarly, for 24-ft fan diameter, optimum air flow occurs at 36-ft and proportionally reduces when increased beyond 36-ft or reduced below 36-ft.

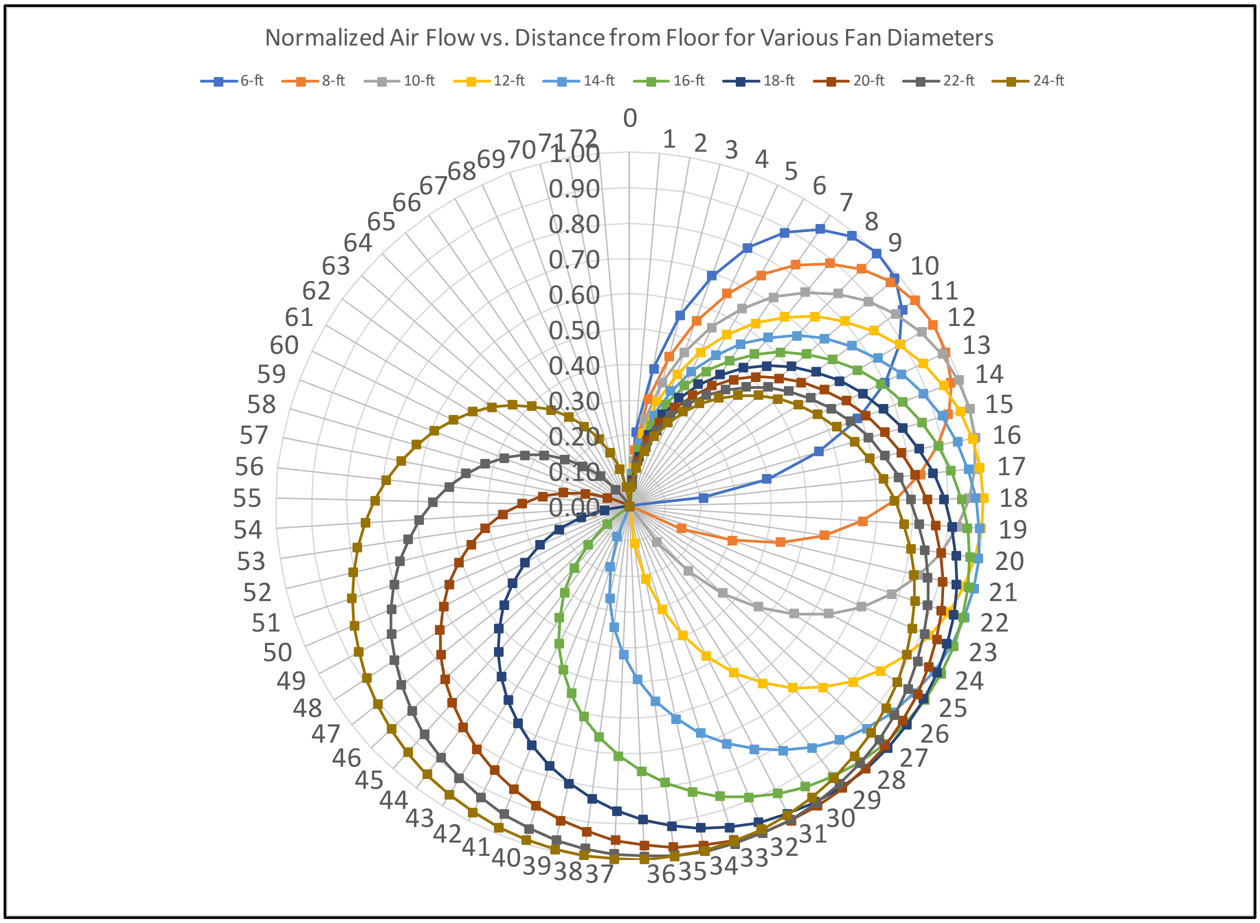

Figure 7: Normalized air flow vs. fan distance from the floor (radar graph)

APPLICATION OF THE RULES:

Following are some of the quick thumb rules which can be used to specify an HVLS fan.

Step 1: Measure the distance between the ceiling and the floor.

Step 2: Measure wall to wall distance on all sides**.**

Step 3: Subtract the distance X from table 1 for all fan values. You will get 10 new values.

Step 4: Divide numbers obtained in step 2 by 2 and then by 1.5. Take a minimum of these numbers. Let us say d1.

Step 5: Divide numbers obtained in step 3 by 1.5. Subtract these numbers from the fan diameter. Take a minimum of these numbers. Let us say e. Select the fan diameter for which e is the lowest. Let us say d2.

Step 6: Measure the area to be covered. Let us say A1. Use the equation in figure 3 to obtain d3.

Step 7: Now you have 3 possible solutions, d1, d2 and d3. Evaluate each of the solutions and the final solution must meet A, X, Y and Z parameters of table 1 to proximity.

Example :

Let us say height, h from ceiling to floor is 18 ft. and three wall to wall distances were measured to be 48-ft, 24-ft and 36-ft. Area to be covered is 10,000 sq. ft. Recommend fan (s) for this area.

Let us jump to **step 3**. We get the following values after subtracting X from 18-ft (Table 1).

6-ft	**8-ft**	**10-ft**	**12-ft**	**14-ft**	**16-ft**	**18-ft**	**20-ft**	**22-ft**	**24-ft**
16	16	16	15	15	14	14	13	13	13

Step 4 yields 16, 8 and 12 as values from wall to wall distances. Hence d1 (minimum of 16, 8 and 12) is 8-ft.

Step 5 yields the following values after dividing by 1.5 for various fan diameters.

Fan d	**6-ft**	**8-ft**	**10-ft**	**12-ft**	**14-ft**	**16-ft**	**18-ft**	**20-ft**	**22-ft**	**24-ft**
Divided values	11	11	11	10	10	9	9	9	9	9
Fan d	6	8	10	12	14	16	18	20	22	24
e (absolute values)	5	3	1	2	4	7	9	11	13	15

Minimum of these values is 1. Hence d2 = 10.

Step 6 is calculated as follows:

d3 = =(-(-1199)+SQRT(((-1199)^2-4*85*(8800-10000))))/(2*85) using equation shown in figure 3.

$$d3 = \frac{(-b + \sqrt{(b\text{^}2 - 4a(c - A)})}{2a}$$

Where,

b = -1199

a = 85

c = 8800

A = 10,000 (Area to be covered)

d3 is computed to be 15.

d1, d2 and d3 are 8,10 and 15 respectively.

Therefore, all solutions ranging from 6-ft to 16-ft should be evaluated as shown below.

Let us review these solutions:

	2X6-ft (Ideal)	2X6-ft (Actual)	Comment
Y, Optimum distance from the floor	9	16	Very Good (With extension)
Z, Optimum distance from the wall	9	2	Poor (Minimum wall to wall distance is 24-ft. Installing 2 fans 10-ft apart will leave a 2-ft distance from the wall)
Coverage Area	8000	10,000	Fair

	2X8-ft (Ideal)	2X8-ft (Actual)	Comment
Y, Optimum distance from the floor	9	16	Very Good (With extension)
Z, Optimum distance from the wall	9	2	Poor (Minimum wall to wall distance is 24-ft. Installing 2 fans 10-ft apart will leave a 2-ft distance from the wall)
Coverage Area	10,000	10,000	Good

	10-ft (Ideal)	10-ft (Actual)	Comment
Y, Optimum distance from the floor	15	16	Excellent (Use 1-ft extension)
Z, Optimum distance from the wall	15	12	Good
Coverage Area	6000	10,000	Fair

	12-ft (Ideal)	12-ft (Actual)	Comment
Y, Optimum distance from the floor	18	15	Fair
Z, Optimum distance from the wall	18	12	Fair
Coverage Area	7000	10,000	Fair

	14-ft (Ideal)	14-ft (Actual)	Comment
Y, Optimum distance from the floor	21	15	Poor

Z, Optimum distance from the wall	21	12	Fair
Coverage Area	8000	10,000	Fair

	16-ft (Ideal)	16-ft (Actual)	Comment
Y, Optimum distance from the floor	24	14	Poor
Z, Optimum distance from the wall	24	12	Fair
Coverage Area	12000	10,000	Fair

Conclusion: The most optimum solution is 1 number of 10-ft fan. The second most optimum solution is 2 numbers of 8-ft fans.