VENTILATION GUIDELINES CALCULATIONS

These guidelines were developed for people trained or skilled in ventilation management to apply these concepts.

1. VENTILATION GOALS REFERENCE

Table 1

Inlet Ventilation	Units	Weaned Pigs	50-65lb	275-285lb
a) Minimum ventilation	CFM/pig	2.0	3.0-4.5	13.0-14.0
b) Air speed at ceiling inlet	FPM	400-800	600-800	600-800
c) Air speed at wall inlet	FPM	600-800	700-900	--
d) Inlet capacity	CFM/pig	35-50		

Table 2

Maximum Ventilation	Units	Tunnel
a) Tunnel air speed	FPM	350-450
b) Air exchange rate	seconds	30-35
c) Air Speed at curtain in tunnel	FPM	650-800
d) Air Speed at cooling pad	FPM	350-400

Table 3

Fan Power (w/cone)	Reference of CFM*
18 inches	3,600-4,000
24 inches	6,000-7,000
36 inches	10,000-11,000
50 inches	20,000-22,000
52 inches	24,000-25,000

*Ventilation companies have an accurate fan capacity (use 0.05-0.1 SP)

Table 4

Controller Setting in Variable Fans (VF)	Reference of % real Extraction*
100%	100%
85%	85%
75%	75%
70%	68%
65%	61%
60%	54%
55%	45%
50%	35%

*New VF technologies is increasing the extraction efficiency with low speed mode

Table 5

Humidity Level	<65%

2. MINIMUM VENTILATION (MinV.)

2.1 Key Points
- Minimum air volume that should be exchanged to control humidity and gases
- It is important that systems be set-up to never drop below these air exchange rates
- MinV. operates anytime room temperatures are below the set point, therefore operating in cold weather
- MinV. is measured in CFM/pig which increases as pig weights increase.

2.2 Minimum Ventilation Calculations

Number of pigs/barn x CFM/pig (Table 1) = Total CFM needs of Minimum Ventilation per Barn

Example:	Weaned Pigs (12lb)	1,000 pigs/barn x 2 CFM/pig = 2,000 CFM/Barn
	Market Pigs (295lb)	1,000 pigs/barn x 14 CFM/pig= 14,000 CFM/Barn

2.3 Using Minimum Ventilation Calculations
MinV. rate will be achieved when the exhaust fan power is paired with the minimum ventilation calculations.

2.4 Fan Power Calculations for MinV.

Step 1: Define *how many exhaust fans* will be used for MinV. They must be able to properly ventilate entire barn area therefore, to ensure a correct ventilation rate, *an anemometer must be used to verify the selected fans are capable of extracting desired air from the furthest inlet*. Example:

Step 2: Determine Fan Power = CFM per Fan. A fan power reference guide is shown in Table 3.

Step 3: Calculation of percentage of speed in variable fans or time on/off in fans working by timer

% of Fan Speed = (Total CFM needs of MinV./Barn, reference point 2.2) / (Total CFM Fan Power)

Example (continuing example, reference point 2.2)
Step 1: Minimum ventilation needs to use 4 – 24" fans to cover the entire barn

Step 2: 24" fans have 6,000 CFM/fan (w/cone)

Step 3: 14,000 CFM per Barn / (4 fans x 6,000 CFM/fan) = 58% of Speed (for Market Pigs at 295lb)

"% of Fan" Interpretation:
- Variable Fan: Results are based on Table 4

% of Fan Speed= 58% required, then in the controller VF will be set to 63-65%

- Timer: Results should be multiplied by the seconds used as cycle to get the time ON

Time On/Off of Fan = 58% x 300 seconds*/cycle = 180 seconds ON and 120 seconds OFF**

*When operated by timer, a cycle of 300 seconds is a good standard. It can be more or less depending on the humidity and room size. **Increments of 15 seconds are standard.

Key consideration for exhaust fan power
- It isn't recommended to use less than 50% of speed setting in the controller for VF
- At controller, settings below 75% extraction power of variable fans is less than the setting %. See Table 4

2.5 Air Speed at Inlet
- Table 1 shows desired air speed at inlet – measure at inlet air outlet
- Independent of ventilation stage by inlet, the air speed at inlet should be kept constant

3. MAXIMUM VENTILATION IN TUNNEL MODE (MaxV.)

3.1 Key Points
- Maximum Ventilation is the highest practical rate for hot weather conditions.
- Once the outdoor temperature exceeds the target indoor temperature, the best that the ventilation system can do is to move enough air to maintain indoor conditions only a few degrees warmer than the outside conditions. In the case of tunnel, the air speed plays an important role as "Wind Chill Effect".
- Pigs have maximum ventilation needs; however, when operated by tunnel mode the air exchange rate and the average of air speed are considered for all calculations. (Refer to Table 2)

3.2 Important Air Speed Measures
- Air speed at curtain and panel can provide a good daily reference on proper maximum ventilation
- Air speed goal definition is a key decision (Refer to Table 2)
- Use *an anemometer to verify if the maximum ventilation is working properly*

4. INLET OPENING

4.1 Key Points
- Inlet opening defines fresh air mixing into barn and the static pressure level
- Inlet opening is determined by the air speed goal

4.2 Inlet Opening Calculations (these calculations are used only for inlet calibration or ventilation system design)

Step 1: Determine CFM/fan. Reference is shown in Table 3.
Step 2: Determine CFM/ventilation stage.
Step 3: Define the air speed goal. Reference shown in Table 1.
Step 4: Calculate total inlet opening area needed:

$$\textit{Total inlet opening area needed= (Total CFM/stage) / (Air speed goal, FPM)}$$

Step 5: Calculate total inlet length:

$$\textit{Total inlet length, feet = (Number of inlets/room x inlet length, inches x sides/inlet) / 12}$$

Step 6: Calculation of inlet opening for ventilation stage:

$$\textit{Inlet opening, inches = (Total of inlets opening area needed, sqft / Total inlet's length, feet) x 12}$$

Example (continuing example, reference point 2.2)
Step 1: Using 24" fans (6,000 CFM/fan) and 36" fans (10,000 CFM/fan). Table 3
Step 2: 4 – 24" fans + 1 – 36" fan; 4 x 6,000 CFM/fan + 1 x 10,000 CFM/fan = 34,000 CFM
Step 3: 800 FPM (table 1.b)
Step 4: 34,000 CFM / 800 FPM = 42.5 sqft of inlet opening are needed
Step 5: (24 inlets x 32 inches length/side x 2 sides/inlet = 1,536 inches of total inlet length)/12 = 128 ft.
Step 6: 42.5 sqft / 128 ft x 12 = 4.0 inches
- Interpretation: At 34,000 CFM fan power, each inlet side should open by 4 inches to achieve 800 FPM of air speed at inlet

5. SOFFIT

5.1 Key Points
- The general rule states that the soffit area should be double of inlet area
- Bird netting is recommended. Soffit panel design used in houses is not recommended
- The soffit area feeds the ventilation system with fresh air and can't be restricted

6. VENTILATION THROUBLESHOOTING

Indicator	Most Frequent Reasons	Main Consequence
Air Speed > Goal	• High static pressure situation • Not enough inlet/curtain opening • Dirty cooling pad or not enough cooling pad area • Wrong inlet/curtain/panel or controller setting • Inlet/curtain calibration problems	• Air drafts • Barn integrity • Discomfort in people and pigs

Air Speed < Goal	• Low static pressure situation
	• Infiltration issues
	• Incorrect inlet/curtain opening
	• Fan power problems
	   ✓ Dirty shutters/louvers/fans
	   ✓ Soft belts
	   ✓ Voltage
	• Distance between fans and inlets
	• Soffit restriction
	• Manure levels
	• Wrong inlet/curtain/panel or controller setting
	• Inlet/curtain calibration problems
		• Air drafts
		• Incorrect air mixing
		• Incorrect humidity removal
		• Wasted electricity
		• Potential fan motor risks
		• Poor ventilation rates with both performance and pig behavior consequences

Humidity>65% High Gases Levels	• Wrong controller setting • Incorrect air exchange measured as air speed at inlet • Not enough time ON or cycle time when fans working by timer are used • Incorrect cooling pad setting • Challenges with temperature curve definition	• Poor pig performance and behavior problems • Potential health problems • Human health Risk • Animal welfare considerations • Maintenance problems

7. VENTILATION PROGRAM FORMAT

Step 1: Fan Power & CFM/pig
Example: 1,000 market pigs/barn, Minimum Ventilation Goal 14 CFM/pig

| Stage | 24" Fans – Variable | | | | 36" Fan | | | | 52" Fans | | | Total CFM/stage | CFM/pig |
	Qty	CFM/fan	% Extraction[a]	Total CFM	Qty	CFM/fan	% Extraction[a]	Total CFM	Qty	CFM/Fan	Total CFM		
1	4	6,000	58%	13,920	-	-	-	-	-	-	-	13,920	13.9
2	4	6,000	100%	24,000	-	-	-	-	-	-	-	24,000	24.0
3	4	6,000	100%	24,000	1	10,000	100%	10,000	-	-	-	34,000	34.0
4	4	6,000	100%	24,000	1	10,000	100%	10,000	1	24,000	24,000	58,000	60.0
5	4	6,000	100%	24,000	1	10,000	100%	10,000	2	24,000	48,000	82,000	82.0
6	0	6,000	100%	0	1	10,000	100%	10,000	4	24,000	96,000	106,000	106.0

Note: [a]Check Table 4

Step 2: Inlet & Curtain Opening
Example: 128 feet of inlet length and 800 FPM of air speed goal at inlets with a maximum opening of 7 inches/inlet side

Stage	CFM/Stage	SQFT Needs by Inlets (800 FPM goal)	Inlet Opening (128 ft of total inlet length
1 Inlet	13,920	13,920 CFM / 800 FPM 17.4 sqft	(17.4 sqft / 128 ft) x 12 1.6" of inlet opening
2 Inlet	24,000	24,000 CFM / 800 FPM 30.0 sqft	(30.0 sqft / 128 ft) x 12 2.8" of inlet opening
3 Inlet	34,000	34,000 CFM / 800 FPM 42.5 sqft	(42.5 sqft / 128 ft) x 12 4.0" of inlet opening
4 Inlet	58,000	58,000 CFM / 800 FPM 72.5 sqft	(72.5 sqft / 128 ft) x 12 6.8" of inlet opening (maximum opening)
Tunnel Mode		SQFT Needs by Tunnel (650 FPM goal)	Tunnel Curtain Opening (36 ft of total curtain length)
5 Tunnel	82,000	82,000 FM / 650 FPM 126 sqft	(126 sqft / 36 ft) 3.5 ft of curtain opening
6 Tunnel	106,000	106,000 CFM / 650 FPM 163 sqft	(163 sqft / 36 ft) 4.5 ft of curtain opening

Note: [a]Check Table 4