II Cobb Middle East Technical Meeting August 2006

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Understanding Ventilation Principals

For Better Environmental Control, Bird Health and Performance, Lower Utility Costs, and Production Efficiencies

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IN THIS PRESENTATION MANY OF THE FORMULAS CANNOT BE COMPLETELY CONVERTED INTO METRIC NUMBERS

IN MANY CASES IF THE NUMBERS WERE CONVERTED, THE RESULTS WOULD NOT BE THE SAME, SO THEY MUST REMAIN IN STANDARD NUMBERS AND/OR DISTANCES

Negative Pressure Conversions

INCHES OF WATER	PASCALS	M.BAR
.01	2.5	.025
.02	5.0	.050
.03	7.5	.075
.04	10.0	.100
.05	12.5	.125
.06	15.0	.150
.10	24.9	.249
.20	49.8	.498

General Comments

- I didn’t have to do this in the past to get good results.
- As the genetics of the birds improve the environmental requirements must improve to lower the possibilities of ascites and achieve good performance.
- Consider your priorities when making improvements. (NEVER LEAVE OUT MINIMUM VENTILATION)
- Critical periods in a birds life to satisfy cardiovascular, respiratory, and immune system development needs.
- Actual (Dry Bulb) and Effective Temperature. Why they are important.
- Understanding and controlling relative humidity.
- All the pressure drops we must understand and work with.
- Two air speeds we must deal with in all chicken houses.
- Preventive maintenance on all equipment.

The Mystery of Ventilation

- 4 things we have to deal with all day and every day:
  - 1. OXYGEN
  - 2. AIR SPEED AND VOLUME
  - 3. TEMPERATURE
  - 4. RELATIVE HUMIDITY
- They all have one thing in common:
  - What is it?

WE CANNOT SEE THEM!

Therefore we need to measure them.

FACTORS ALL GROWERS, FARM MANAGERS, SERVICEMEN, AND SALESMEN SHOULD KNOW

- 1. Total cubic volume of air to be handled inside house to be handled by the ventilation system. (length X width X average height = cubic volume)
- 2. Total available rated fan capacity at actual working pressure.
- 3. Cooling pad area should always match rated fan capacity.
- 4. All summer fans in operation before pumps run.
- 5. CFM/Watt energy factor on summer fans.
    - Pressures to use for rating fans
- Tunnel ventilated houses with foggers use .05 pressure
- Evaporative cooled houses with 6 inch pads use .10 pressure
- Blackout rearing houses with light traps use .150 pressure

REQUIREMENTS FOR GENETIC POTENTIAL

- GOOD CHICK QUALITY FROM HATCHERY (ventilation)
- PROPER AIR VOLUME AND QUALITY FROM DAY ONE (ventilation)
- SUFFIENT LITTER TEMPERATURE CONTROL
- ADEQUATE TOTAL ENVIRONMENTAL CONTROL (ventilation)
- LOW LEVELS OF ASCITES (ventilation to meet oxygen demand)
- ADEQUATE VACCINATION AND HEALTH PROGRAM
- DRY FLOORS AND ADEQUATE LITTER DEBTH
- SUFFIENT STOCKING DENSITY (ventilation)
- ADEQIATE SUPPLY OF FRESH COOL WATER
- PROPER FEED REQUIREMENTS
- OVERALL GOOD POULTRY MANAGEMENT (ventilation)

Critical Periods In High Yielding Birds Life

- 12 days of incubation to hatch in hatchery.
- 1 to 10 days in brood house.
- Transport ride from hatchery to brood house.
- 11 to 28 days in production house.
- Prevention of heat prostration from 16 to 21 weeks of age during rearing of replacement breeders.
- 7 day weight gain.
- 28 day weight gain.
- **** The performance is determined for the most part the first 28 days for meat or egg production.**
- Uniformity and sexual maturity before light stimulation for breeders.

TO FIGURE CUBIC VOLUME OF AIR IN ANY HOUSE

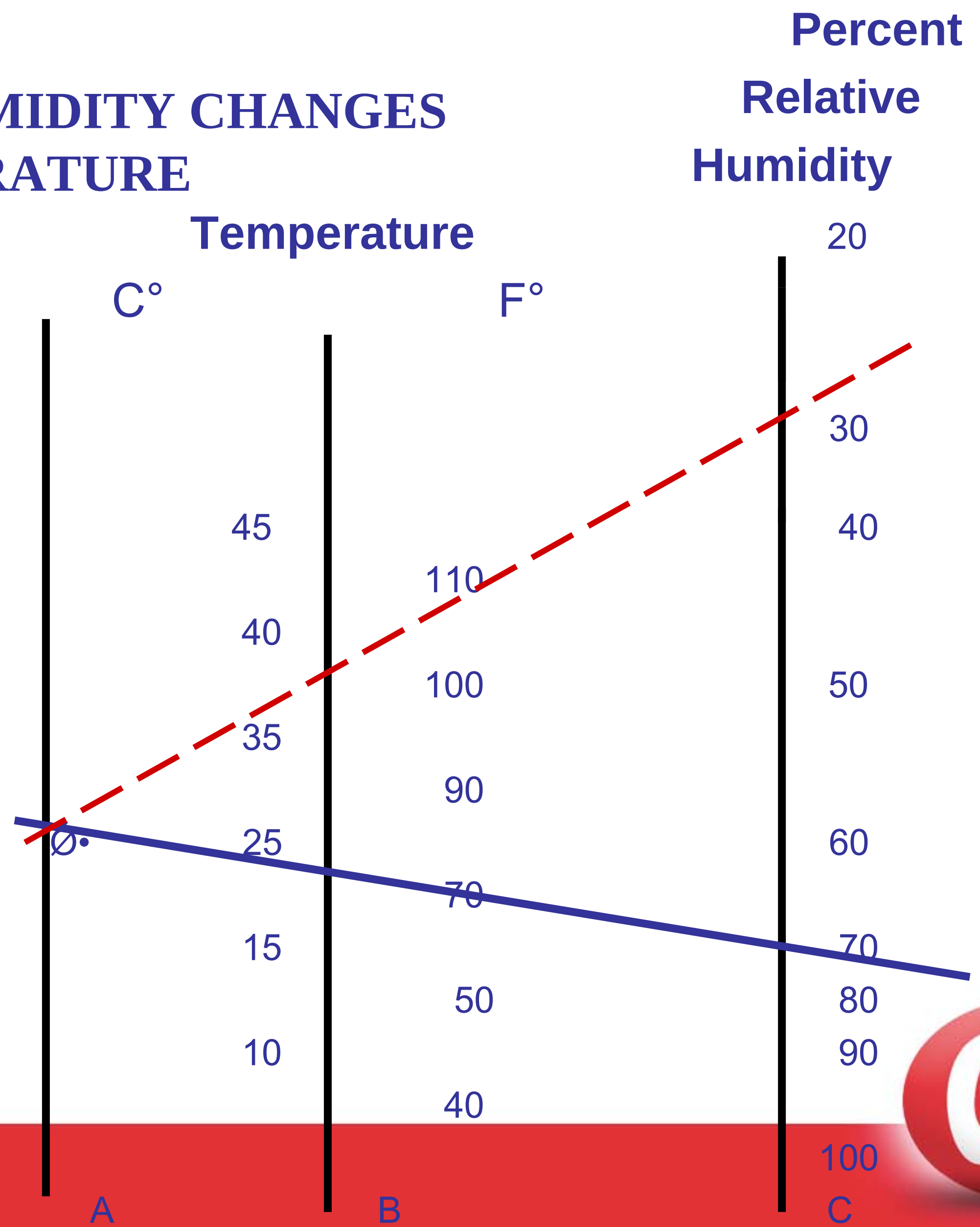
- FIRST TAKE THE SIDEWALL HEIGHT AND THE PEAK HEIGHT. ADD THEM TOGETHER THEN DIVIDE BY TWO TO GET AVERAGE HEIGHT
- SECOND MULTIPLY THE LENGTH X WIDTH X HEIGHT AND YOU WILL HAVE THE ACTUAL CUBIC VOLUME OF AIR IN THE HOUSE
- THE CROSS SECTION OF THE HOUSE WILL BE THE WIDTH
- X HEIGHT
- Length 400 Feet   Width 40 Feet   Sidewall 8 Feet   Peak 12 Feet
- 8 + 12 = 20 divided by 2 = 10 feet average high
- 400 X 40 X 10 = 160,000 cubic feet of air
- The cross section will be 400 square feet

Understanding Relative Humidity

- I. Definition of Relative Humidity is the moisture (water vapor) holding capacity of the air, relative to the dry bulb temperature.
- II. Anytime the temperature in the house and the relative humidity gets too close together and the dew point is reached condensation will form. Floors will get wet and moisture will form on all the equipment in the house.
- III. When a given amount of air is heated it expands, and its capacity to hold moisture is increased. Thus, when air temperatures increase, relative humidity decrease. The opposite occurs when air temperatures are reduced.

Ability of Air to Hold Water Vapor

RELATIVE HUMIDITY CHANGES WITH TEMPERATURE



Ventilation Control

- What is the best controller on the market?

–" "The Grower

Environmental Chambers

OSU

ENERGY BALANCE PER CALORIE CONSUMED

ENVIRONMENTAL EXCHANGE

EVAPORATIVE HEAT LOSS **NONEVAPORATIVE**

FEED INTAKE ($100\% ME_N$)

HEAT PRODUCTION (~ 34%)

EXCRETA (~29%)

RETAINED (~ 37%)

PROTEIN, LIPID, MINERAL, CHO

Definition of Good Air Quality

- Oxygen >19.6%
- Carbon dioxide < 0.3%/3000 ppm
- Carbon monoxide <10 ppm
- Ammonia <10 ppm
- Inspirable Dust <3.4mg/m3
- *Minimum ventilation must be increased if these parameters are not being met.
- Relative humidity >< 45 –65 %
- Air speed across birds after 28 days >< 350- 500 FPM

- **Air velocities over 500 FPM is not economically feasible and results are unproven for performance advantages.

Why Use Total House Volume And Not Metabolic Demand To Ventilate Chicken Houses

- Oxygen, carbon dioxide, carbon monoxide, and ammonia are all measured in % or ppm by volume in the air. When these parameters are higher than desired it affects the **total** volume of air inside the house. To correct the problem the air exchange must be based on the **total** volume of air affected. We cannot have micro climates inside the house just where the chickens are grown.
- If we grew chickens in a small box then we could use the metabolic demand and still meet the volume requirements of the entire space. The larger the house volume is, the more important it becomes to increase the air volume needed in the entire house to control the air quality to meet the birds demand.
- Metabolic demands are accurate, but we must get the necessary volume of air to the bird on the floor to meet that demand. This air comes from the total volume of air in the house, requiring us to manage all the air with air exchange.

EFFECTS OF AIR QUALITY WHEN MINIMUM VENTILATION FANS GO OFF

This is the effect of air quality once minimum ventilation fans go off. Oxygen levels should be >19.6 % at all times. The minimum run time on the cycle timer to accomplish this is >20% of the time, with the total cycle not to exceed 10 minutes.

- During this test oxygen was not measured on a routine basis.

AIR QUALITY

	Fan on	5 minutes	10 minutes	15 minutes
Ammonia	15 PPM	35 PPM	50 PPM	80 PPM
Carbon Dioxide	800 PPM	1500 PPM	2600 PPM	3500 PPM
Humidity	68 %	78 %	86 %	97 %
Temperature	68°-20°	75°-24°	82°-28°	88°-31°

The longer the fans are allowed not to run the worse the air quality and the more the chickens respiratory and immune system will be impaired from optimum development.

Relationship Between Altitude and Partial Pressure of Available Oxygen in Air

Altitude	Reduction	Available
Sea Level	0	20.5 - 21 %
1,500 F 457 M	3.5 %	19.8 - 20.3 %
2,000 F 610 M	5.1%	19.5 - 19.9 %
2,500 F 762 M	8.1 %	18.9 - 19.3 %
4,000 F 1219 M	11.2%	18.2 - 18.6 %
6,000 F 1829 M	16.6%	17.1 - 17.5 %

- *ABOVE 2,500 FEET (762 METERS) IT IS NOT POSSIBLE TO OBTAIN THE 19.6 % USABLE OXYGNE IN THE AIR.

ASCITES
ONE OF THE HIGHIEST COST TO OUR INDUSTRY TODAY WORLDWIDE

- **COLD (FLOOR) BROODING TEMPERATURES**
- **HIGH ALTITUDE HATCHERIES** LOW PARTIAL PRESSURE OF OXYGEN IN THE AIR
- **INADEQUATE VENTILATION IN HATCHERY** LOW OXYGEN LEVELS BECAUSE OF LOW AIR VOLUME OR PRESSURE
- **INADEQUATE VENTILATION IN BROOD HOUSE FIRST 10 DAYS** AIR VOLUME, AIR DISTIBUTION, AND DRAFTY HOUSES
- **DRAFTY HOUSES WITH COOL AIR DRAFTS ON FLOOR**
- **INADEQUATE VENTILATION IN CHICK DELIVERY TRUCK** AIR VOLUME, CONTROL OF RELATIVE HUMISITY AND TEMPERATURE

- **RAPID GROWTH RATE** GENETICS OF HIGH YEILDING BIRDS
- **HIGH ENERGY FEED RATIONS**
- **HIGH LIGHT INTENSITY AND EXTENDED HOURS**

RECOMMENDED TEMPERATURES

- BROODING TO SLAUGHTER (DEATH) FOR COBB 500
- 1 DAY TO 7 DAYS 85 - 90°F (29.4 - 32.2°C) Still Air
- Directly Under The Brooder 110°F (43.3° C) Still Air
- 7 DAYS TO 14 DAYS 85°F (29.4° C) Still Air
- 15 DAYS TO 21 DAYS 80°F (26.7° C) Effective Temperature
- 22 DAYS TO 28 DAYS 75°F (23.9°C) Effective Temperature
- 29 DAYS TO 35 DAYS 70°F (21.1°C) Effective Temperature
- 36 DAYS TO DEATH 65°F (18.3°C) Effective Temperature

- Still Air Temperature Is With No Air Velocity Across The Birds To Create A Wind Chill Effect
- You Should Always Consider Effective Temperature After 14 Days
- Effective Temperature Includes Temperature, Relative Humidity, and Wind Chill

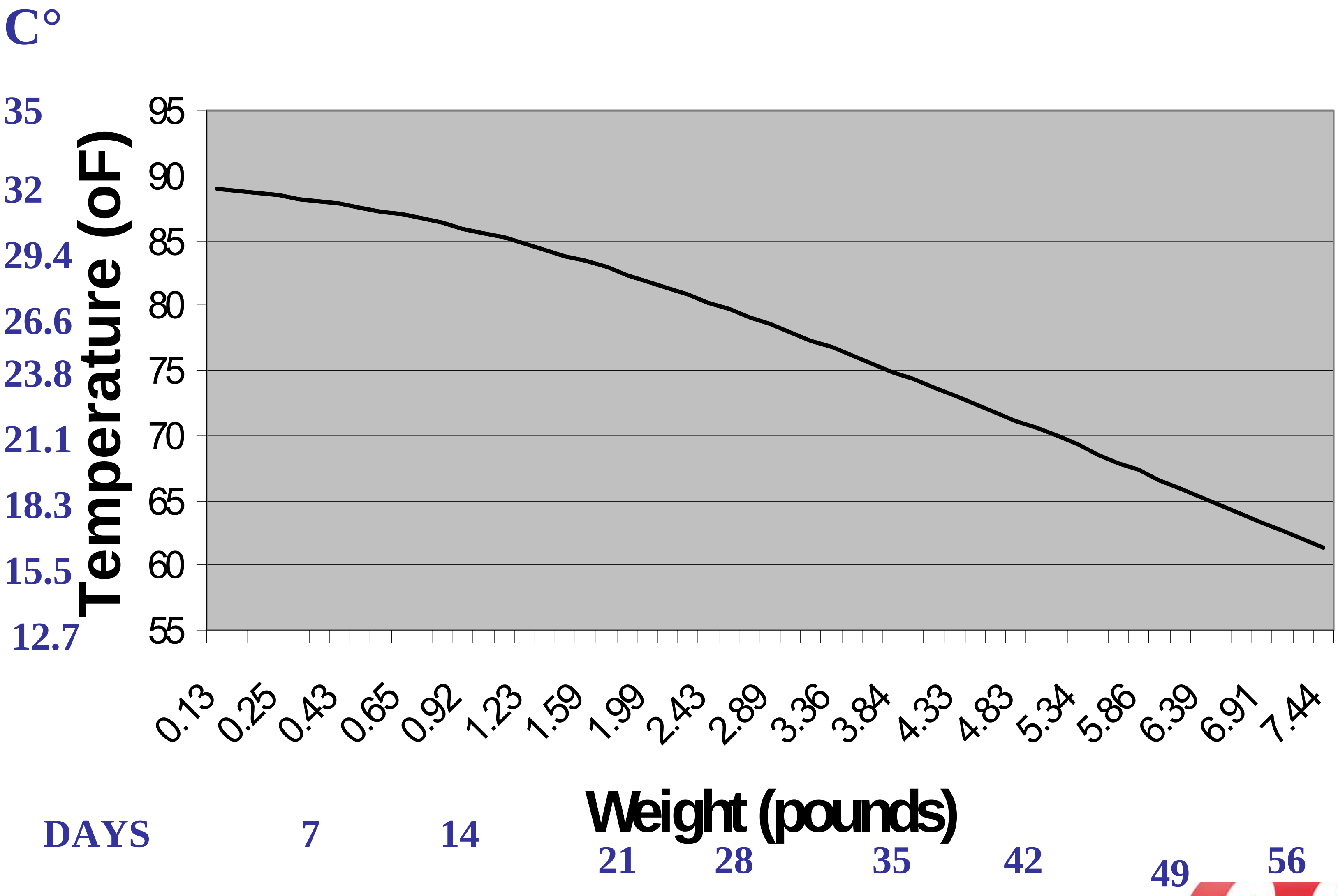
Temperature effects on oxygen demand

- The oxygen demand is at its lowest anytime the house environment allows the chickens to be in their thermal neutral zone. Ideal effective temperature.

- When the temperature goes down the oxygen demand goes up because the energy of the feed is going to heat production and the birds metabolic demand is greater. This is why we can never sacrifice air volume to accomplish temperature control.

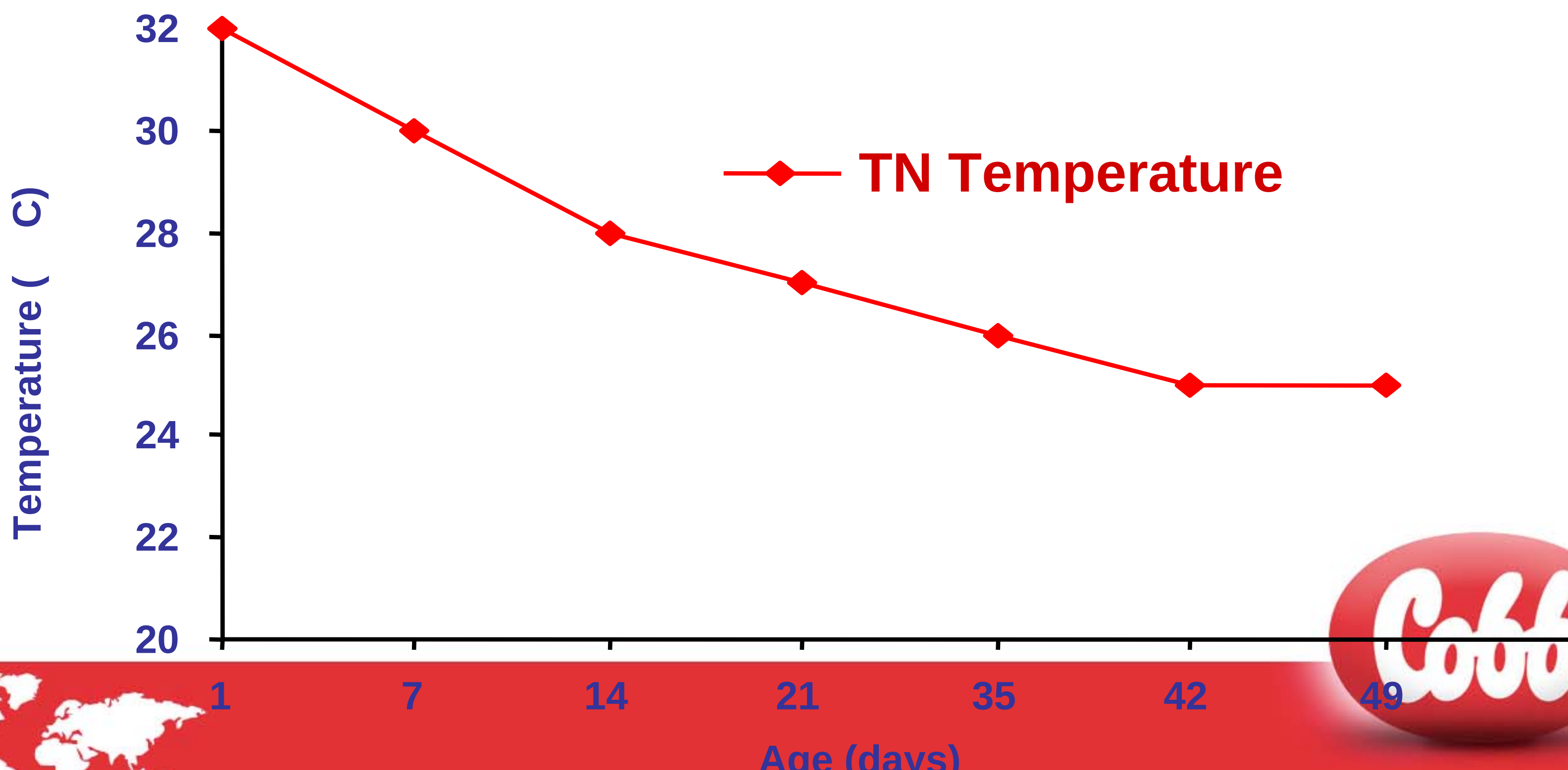
- When the temperature goes up to the point that the birds must pant to try and dispel energy from the body, the oxygen demand goes up.

Chickens Thermal Neutral Zone



Thermo-neutral Zone
TNZ = 31.896- (4.625 x Kg BW)

THE PROJECTED AGE THERMONEUTRAL ZONE RELATIONSHIP



We Must Restrict The Use Of Tunnel Ventilation Before 28 Days Of Age.

The birds are never fully feathered until 28 days of age.

1. The first 14 days the air speed across the birds should be as low as possible < 40 fpm/.20 mps. **Should consider still air temperature.**
2. From 15 days of age to 21 days of age the air speed should be limited to no more than 100 fpm/.51 mps. Use of transition ventilation system. **Should consider effective temperature.**
3. From 22 days of age to 28 days of age the air speed should be limited to no more than 200 fpm/1.02 mps. Use of transition ventilation system. **Should consider effective temperature.**
4. After 29 days of age the air speed does not have to be restricted and it is now acceptable to use evaporative cooling. **Should consider effective temperature and relative humidity.**
5. You should always consider effective temperature (after 14 days of age) and not the actual temperature for the best performance of the birds. **You can never ventilate chicken houses for people.**

Metric Air Speed Across Birds Compared To Fan Volume And The Cross Section Of The House

House Size 450 feet long X 40 feet wide X 9.5 feet average high = 171,000 cubic feet of air to be handled by ventilation system.

36 inch fan 10,500 cfms & 50-52 inch fan 24,500 cfms @ .10 pressure drop

AE Air exchange in minutes: (Examples Only)

Fan Capacity	Cross Section	Air Speed			
		Across	Transition	Tunnel	AE
21,000 cfms (2)	4,275 sq. ft.	025 mps			8.1
31,500 cfms (3)	4,275 sq. ft.	.037 mps			5.4
24,500 cfms (1)	380 sq. ft.	(.029)mps	.082 mps	.328 mps	7.0
49,500 cfms (2)	380 sq. ft.	(.059)mps	.165 mps	.662 mps	3.5
73,500 cfms (3)	380 sq. ft.		.246 mps	.982 mps	2.3
98,000 cfms (4)	380 sq. ft.		.327 mps	1.31 mps	1.7
122,500 cfms (5)	380 sq. ft.			1.64 mps	1.4
147,000 cfms (6)	380 sq. ft.			1.96 mps	1.2
171,500 cfms (7)	380 sq. ft.			2.29 mps	1.0
196,000 cfms (8)	380 sq. ft.	(.233)mps		2.62 mps	.87

2 36-inch fans or 1 50/52-inch fan to run on cycle timer and temperature override

196,000 cfms divided by 400 = 490 square feet of 6 inch pads needed

Air Speed Too Fast For Young Chicks
15 Days Old Air Speed 450 fpm/2.3 mps

Four Sources Of Heat In A Chicken House.

I. Radiant heat on top of the house created by the sun.

II. BTU's Generated From The Energy Of The Birds

1 day old - 1 BTU

28 days-16 weeks old 6 BTU's per pound of body weight

16 weeks-65 weeks old 8 BTU's per pound of body weight

III. Radiant Brooders

Should be used for brooding only to obtain desired floor (litter) temperature during early age. A radiant brooder will only increase the house temperature by convection.

They are specifically designed to heat a solid surface by radiation.

When radiant heaters are used to obtain house temperature or to try and dry litter the relative humidity will actually increase. This will only partially work if the minimum ventilation fans were running all the time.

IV. Space Heaters (Supplemental Heat)

Should be used at all times to accomplish desired house (air) temperature. Can also be used to control relative humidity.

Poultry House Ventilation Systems

1. **NATURAL VENTILAITON** There is no air exchange in the house unless the wind is blowing and the curtains are properly adjusted. To be used only when total mechanical ventilation is not available, however it should include minimum ventilation fans and inlets for early age.

2. **MINIMUM VENTILATION SYSTEM** This system should be across the house for best results. To be used for cool weather and during brooding. Low air velocity (< 40 fpm/.20 mps) over the birds and long air exchange rate. This system is for air quality and a slight amount of temperature control. Sidewall inlets must direct the incoming into the peak of the house. **(Highest return on investment of any of the systems.)**

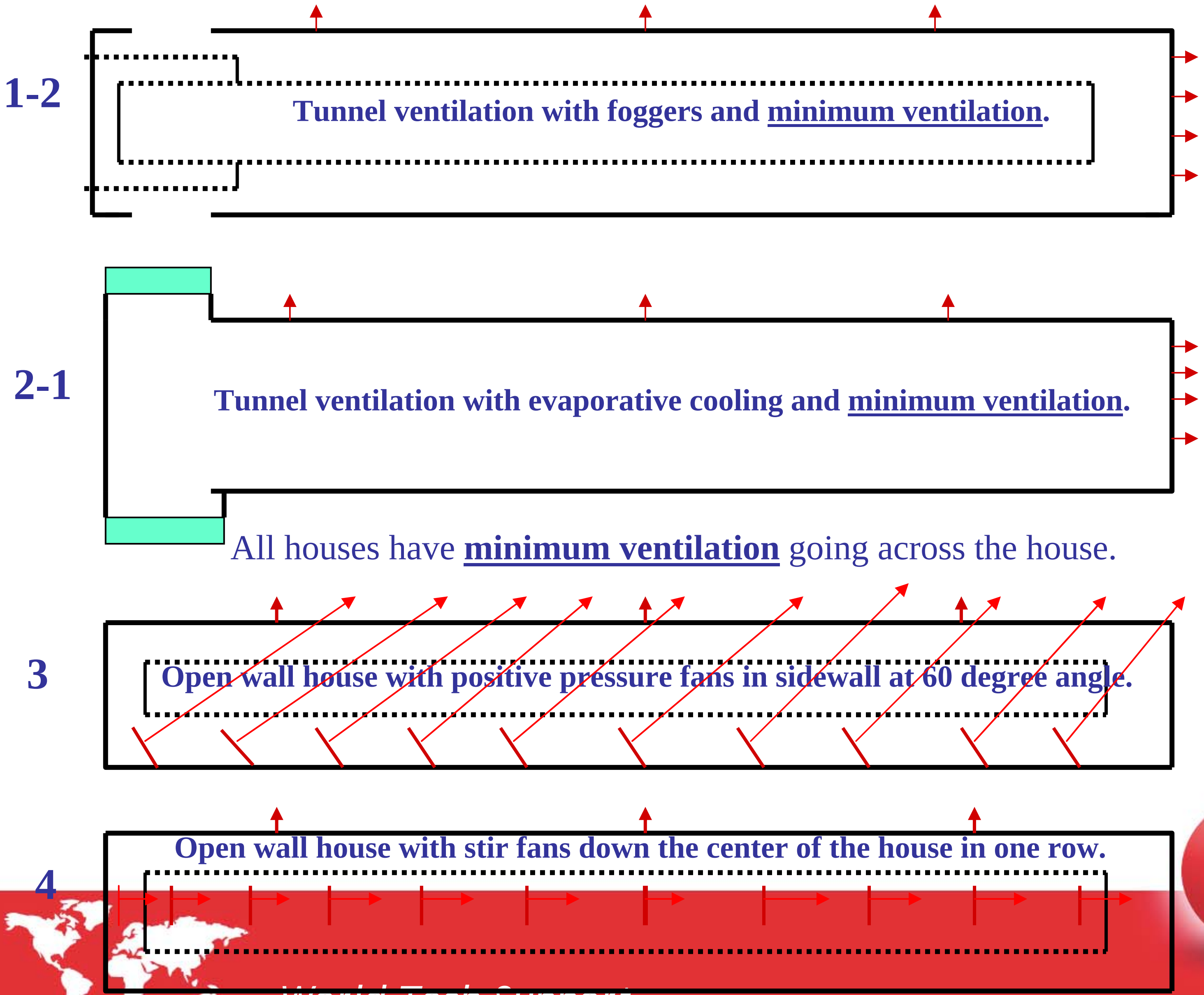
3. **TRANSITION VENTILATION SYSTEM** To be used to allow for a much better air exchange rate inside the house, without high air velocity across the birds, until the birds are more than 28 days of age. Sidewall inlets must direct the incoming air into the peak of the house.

4. **SUMMER VENTILATION SYSTEM** To be used for temperature control and create a high air speed (velocity) across the birds based on bird age and temperature. To lower the effective temperature and reduce heat prostration. Proper inlet pressure should still be used.

Functions Of Any Ventilation System

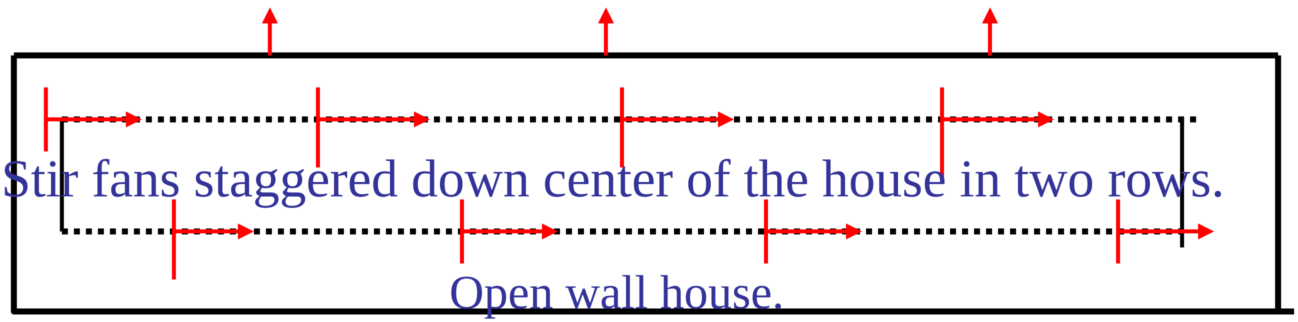
1. Create an air exchange in the house based on cubic volume.
2. Provide Oxygen (air volume) to meet the demand for the birds.
3. Allow for control of relative humidity.
4. Insure good air quality at all times.
5. Keep floors dry.
6. Remove negative gasses from the environment.
7. Obtain necessary pressure drop across inlets in the house.
8. Accomplish an acceptable effective temperature.
9. Manage the environment for best results.
10. Improve overall production efficiencies.

Order of Best Ventilation Efficiencies of Chicken Houses



Ventilation efficiencies continue.

5



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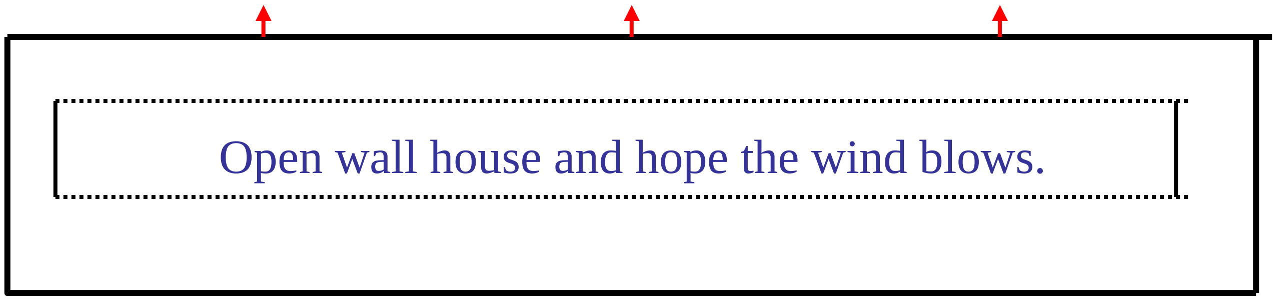


New houses being built today.

- **Broiler houses all solid sidewall with minimum, transition and tunnel ventilation (with evaporative cooling).**
- **Breeder Production houses 60% solid sidewall with transition and tunnel ventilation (with evaporative cooling).**
- **Blackout rearing all solid sidewall with minimum, transition and tunnel ventilation systems. (evaporative cooling optional)**

Natural Ventilation System

- This system should always include sidewall fans and inlets for minimum ventilation at least for the first 14 days.
- This system should only be used when the outside environment is ideal and/or there is no mechanical ventilation system available.
- When this system is used the sidewall curtains should be properly managed to prevent the prevailing wind from seeking the path of least resistance.
- This system will only be successful for good performance when the climate dictates no need for good temperature control, relative humidity control, or wind chill effect.

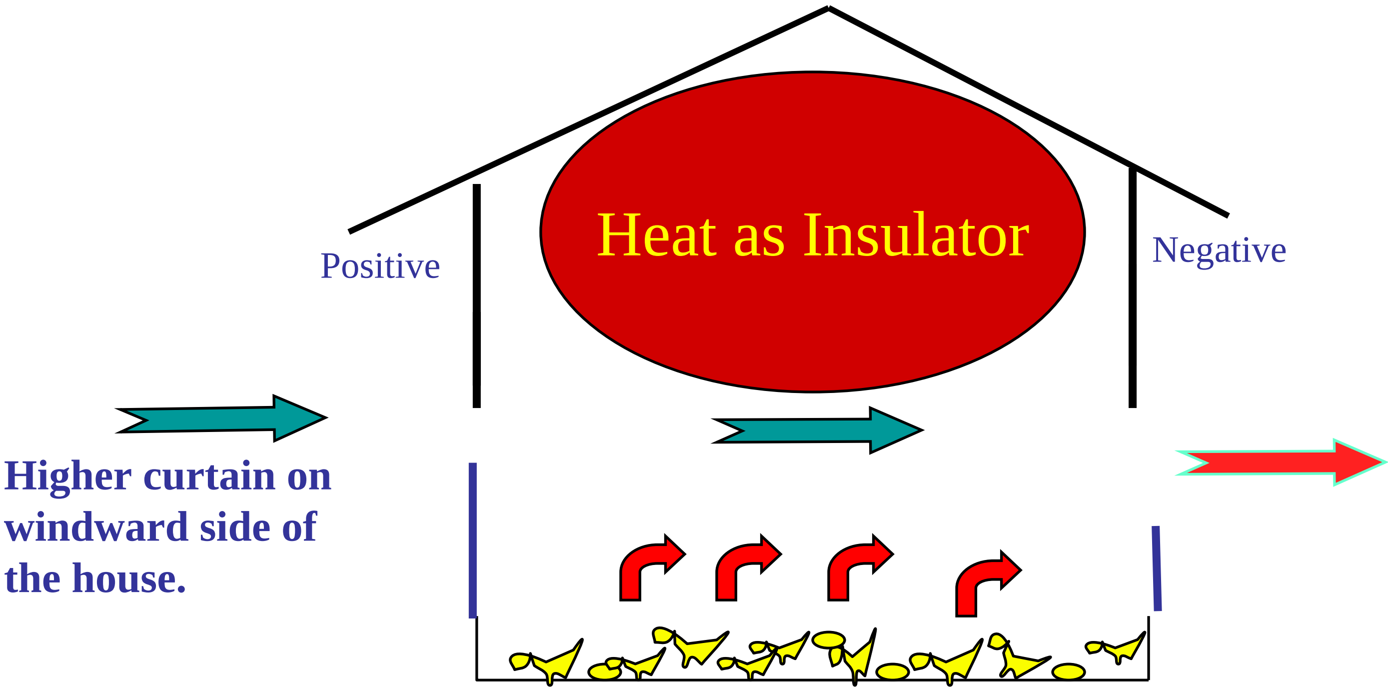

Mini Curtain
Minimum Ventilation Fan
With Natural Ventilated House
Curtain Open


Minimum Ventilation Fan With House Closed

How To Manage Sidewall Curtains In Naturally Ventilated Chicken Houses For Better Performance

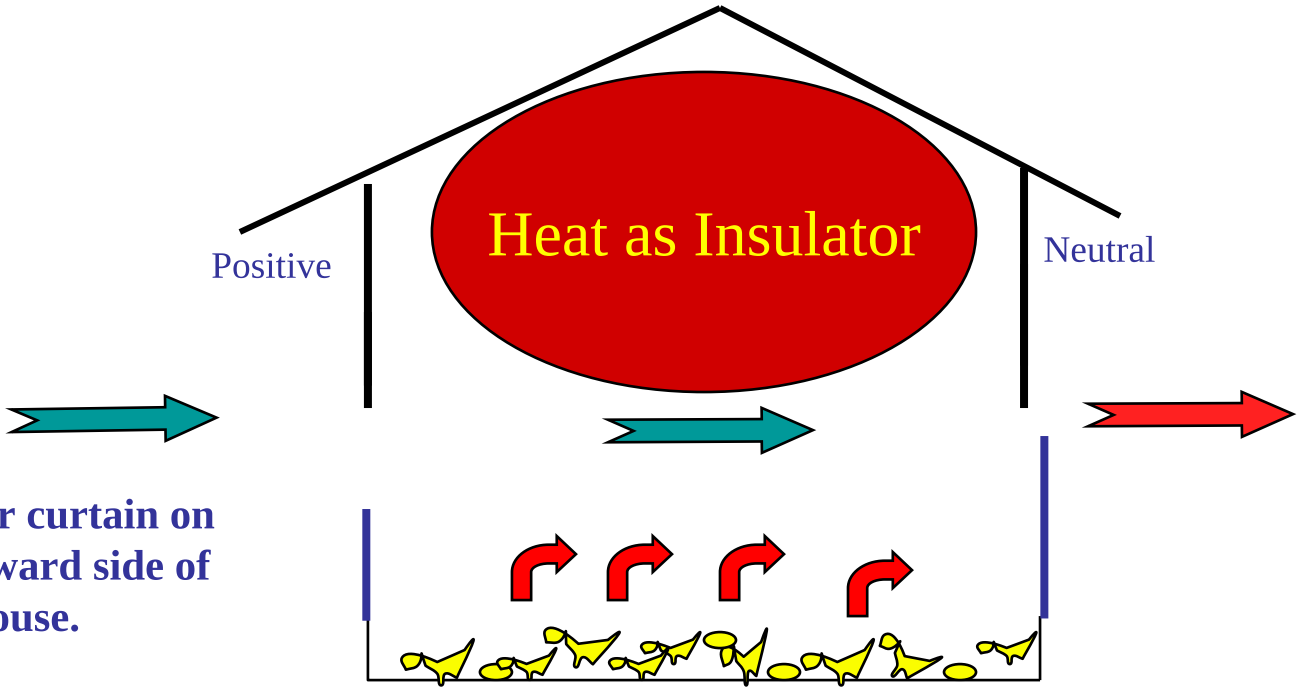
- **To improve air exchange in the house and speed the air velocity up entering the house you need to adjust the windward curtain higher than on the off side of the house. The inlet ratio should be 1 to 4 opening area.**
- **To lower the air exchange in the house and slow the air velocity down entering the house you need to adjust the windward curtain lower than on the off side of the house. The inlet ratio should be 1 to 4 opening area.**
- **To obtain the same air speed entering the house as the prevailing wind each curtain should be adjusted the same. If the sidewall opening is too high the fresh air will get into the thermal up draft and prevent the air from moving across the birds on the floor. This is done when you want to obtain as much wind chill on the birds as possible when the opening is not too high from the ground.**
- **The reason these factors are obtained is the fact that wind blows with gravity or terrain level.**

Improved House Design With Drop Curtain Sidewalls At Top Of Opening For Natural Ventilation



To increase air exchange in the house without high air velocity across birds.

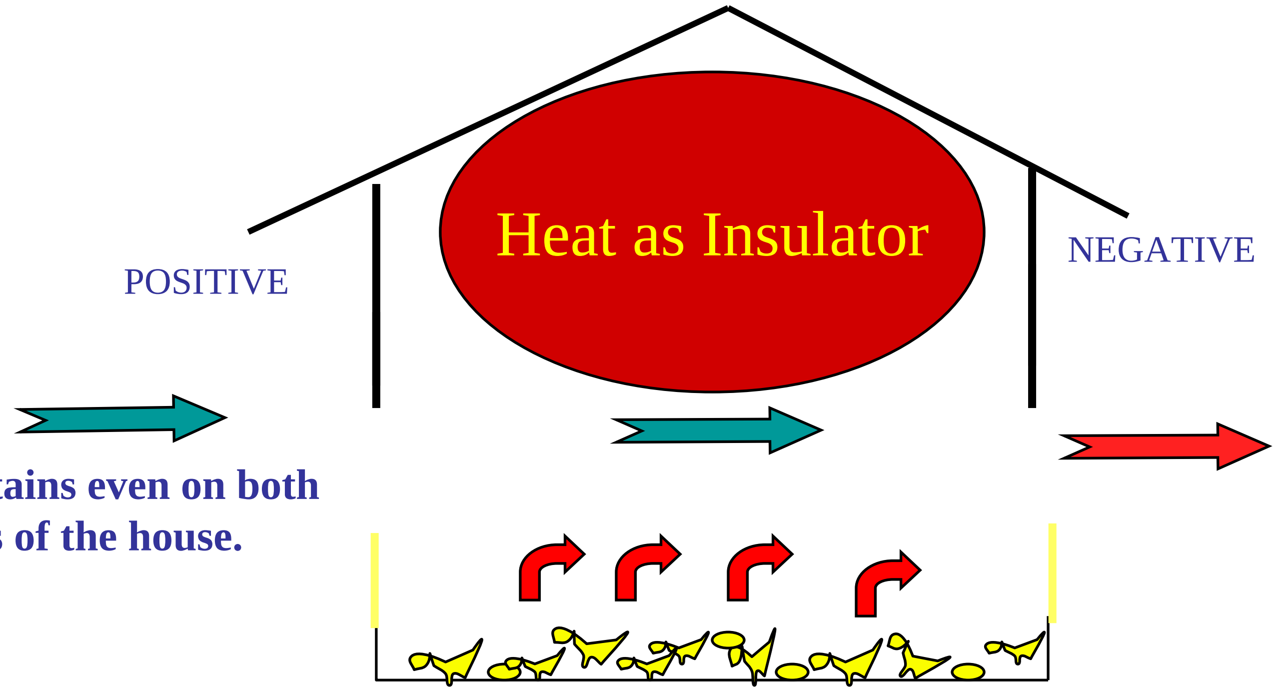
Improved House Design With Drop Curtain Sidewalls At Top Of Opening For Natural Ventilation



Lower curtain on windward side of the house.

To decrease air exchange in the house without high air velocity across birds.

Improved House Design With Drop Curtain Sidewalls At Top Of Opening For Natural Ventilation



Curtains even on both sides of the house.

To increase air exchange in the house and higher air velocity across birds.

MINIMUM VENTILATION PRIORITIES

1. STOP AIR LEAKS (HOUSE AIR TIGHT AS POSSIBLE)
2. AIR EXCHANGE RATE BASED ON CUBIC VOLUME OF THE HOUSE (AIR VOLUME)
3. PRESSURE DROP ACROSS THE INLETS (AIR SPEED ENTERING HOUSE)
4. DIRECTION OF AIR ACROSS INLETS ENTERING THE HOUSE (INTO PEAK OF HOUSE)
5. SETTINGS ON CYCLE TIMER (MINIMUM RUN TIME TO MEET OXYGEN DEMAND OF >19.6%)
6. CONTROL OF RELATIVE HUMIDITY (45 TO 65 %)
7. TYPE OF HEATING (SPACE AND RADIANT)
8. TEMPERATURE CONTROL (BASED ON AGE OF BIRDS)
9. SEQUENCE OF CONTROL OPERATION (SETTINGS OF CONTROLS)

Factors For Minimum Ventilation To Work Properly And Keep Floors Dry

- I The house must be air tight enough to achieve the necessary negative pressure with the minimum number of fans.
- II. Fans must have the capability to work against the necessary negative pressure and achieve the required air exchange rate.
- III. Inlets must have the capability to react to the fan volume and control the house pressure (pressure drop across the inlets) consistently based on the width of the house being ventilated. (Properly weighted or suspension kept adjusted.)
- IV. Inlets must direct the air into the peak of the house to prevent drafts on the floor and utilize the energy accumulated up in the peak.
- V. Temperature must be adequate to allow for expansion of the outside air (> 55°F/13°C) to increase the moisture holding capacity of the air and reduce the relative humidity.
- VI. The cycle timer must be adjustable and run time increased as air quality begins to deteriorate or birds get older.

Factors For Minimum Ventilation To Work Properly Continues

- VII. There must be a temperature override to either speed up a variable speed fan or override the cycle timer on fixed volume fans.
- VIII.The shutters on the summer fans must be air tight or all but two covered during severe cold weather.
- IX. When the house is more than 250 feet/76 meters long the minimum ventilation should be across the house. If mechanical operated (baffle) inlets are used, when sidewall fans are being used only the inlets on the opposite side of the house should be used.
- X. Minimum ventilation fans should always be used on the windy side of the house (North or East) in cold weather to allow for proper control of the house pressure. (No minimum inlet have the capability to work against wind speed on the outside of the house without excellent wind protection.)

Minimum Ventilation System

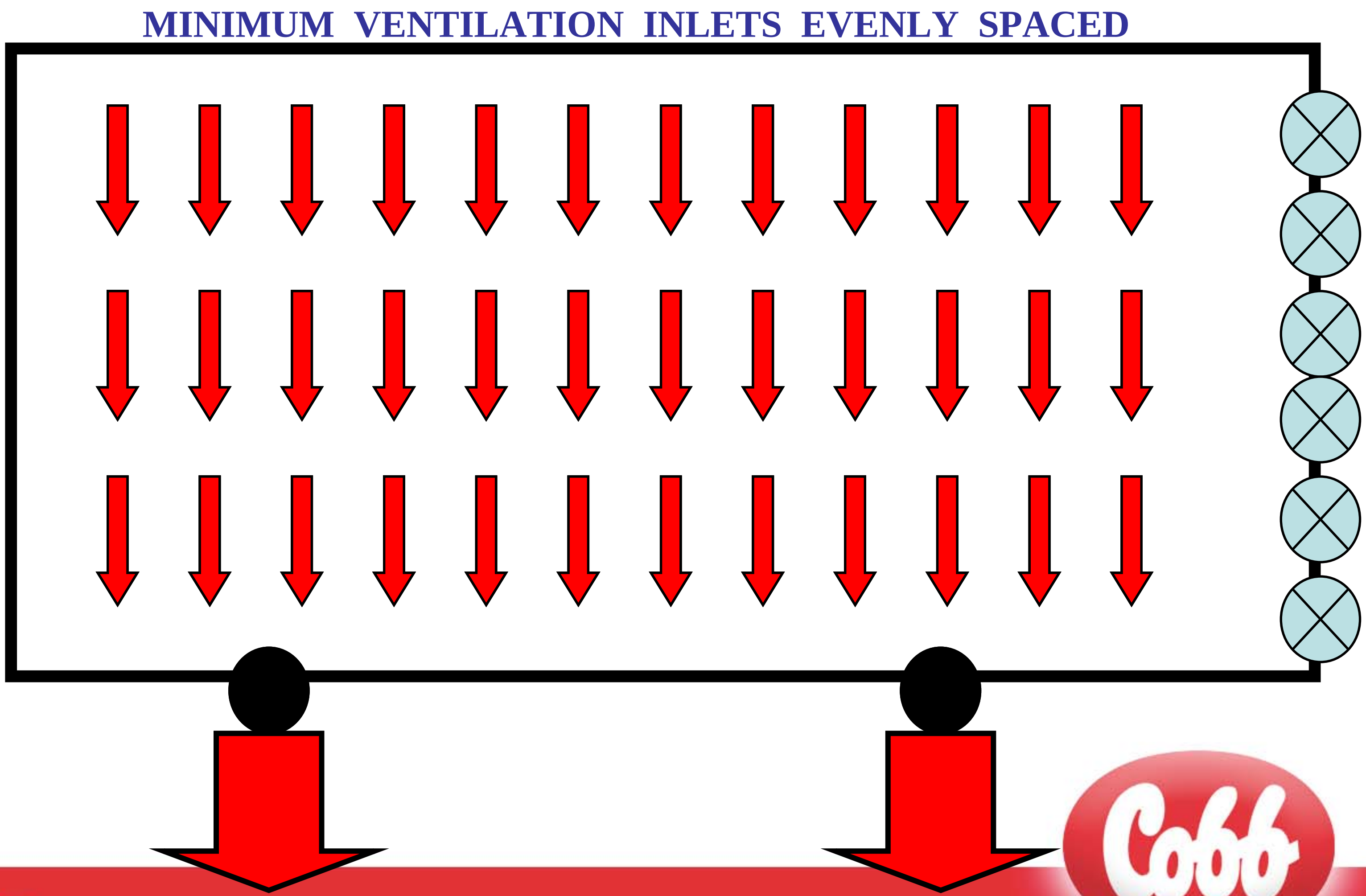
- Air exchange must equal fan volume that ranges from 1 air exchange every 8 minutes to one air exchange every 5 minutes for total house cubic volume. The air velocity across the birds should be very low.

- First stage (minimum) must be fan volume equal to 1 air exchange every 8 minutes and run a minimum of 20 % of the time. This stage should operate on a cycle timer and temperature override. Inlets should direct air into peak of house.

- Second stage (maximum) must be fan volume equal to 1 air exchange every 5 minutes and run 100 % of the time.

- All stages must have the ability to get the necessary pressure drop across the inlets of the house based on width of the house.

Cross-flow for Cold Weather Ventilation



Formula For Figuring Minimum Ventilation Inlets Using Air Cannons and TJP2100 Inlets

1. First take length of house and divided it by 10 and add 8 for number of air cannons needed. Air cannons should be installed at the same angle as the pitch of the roof. The air cannons should not be more than 30 inches (76 cm) long. Air cannons are for air distribution and direction and not volume.

(450 feet divided 10 (1 every 10 feet opposite fans) + 8 (2 in each corner of the house) = 53 2.5 inch air cannons needed)

2. Second take the total minimum ventilation fan volume at .010 pressure drop subtract estimated house leaks and air cannon air volume then divide by 2,000 cfms = number of TJPs inlets needed. TJPs are for air volume and control of house pressure drop across inlets.

Example

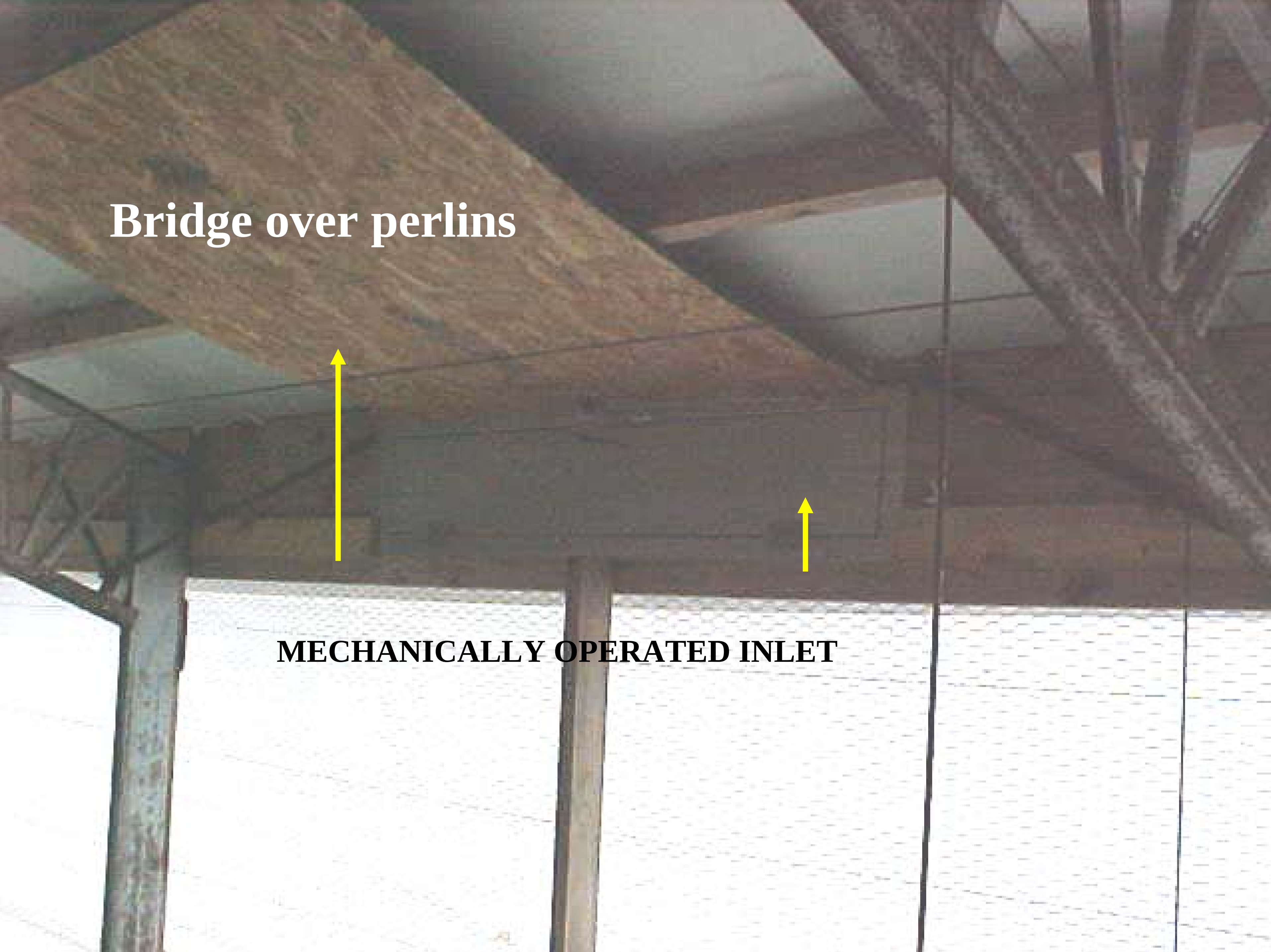
3 36-inch fans at 10,200 cfms = 30.600 cfms – 6,000 cfms for leaks – 2,400 cfms for air cannons = 22,200 cfms divided by 1,800 cfms per TJP = 13 TJPs needed weighted to .055 pressure drop.


VF 48 INLET
AIR CANNON
MINI CURTAIN

TJP2100 OR TJP2600


TJP2100--TJP2600
CLOSED

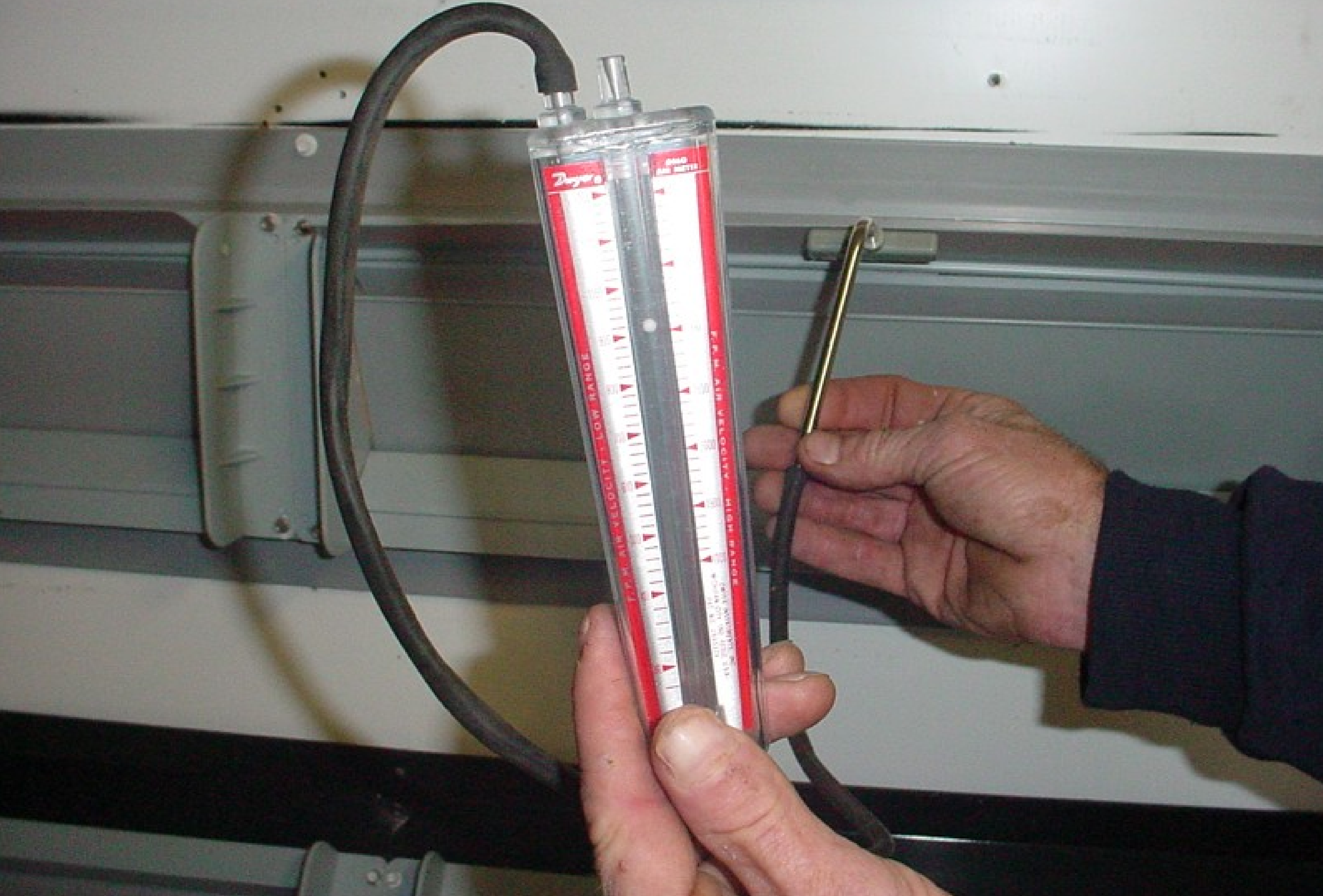

OPEN BY HOUSE PRESSURE


Bridge over perlins
MECHANICALLY OPERATED INLET


AIR DISTRIBUTION COMES FROM AIR CANNONS
AIR CANNON
MINI CURTAIN


VOLUME COMES FROM VF48,
TJP2100, OR MECHANICAL INLETS
VF 48
MINI CURTAIN

CHECK PRESSURE DROP ACROSS INLETS TO SET CONTROLS




1099
ON
MODE

CORRECT PRESSURE DROP ACROSS INLETS


UNIFORM AIR DISTRIBUTION

Understanding Minimum Ventilation Inlets

I. Air Cannons.

Intended only for air distribution to introduce cold outside air into the peak of the house. Never intended for air volume. Air cannons should never exceed 30 inches long.

II. VF48 inlets.

Intended for air volume and to control the pressure drop across the inlets. Must be properly weighted to accomplish proper air speed through air cannons and control house pressure based on house width. Will react completely to fan volume.

III. TJP2155 -2655 inlets.

Same as VF48 but comes from factory counter weighted to desired house width.

IV. Mechanically operated sidewall inlets.

Must have drive motor, suspension system, additional control module, high maintenance. Must either open before fans begin to run or remain open after fans go off thus loosing far too much energy creating high utility costs.

Pressure Drops (Negative Pressure)

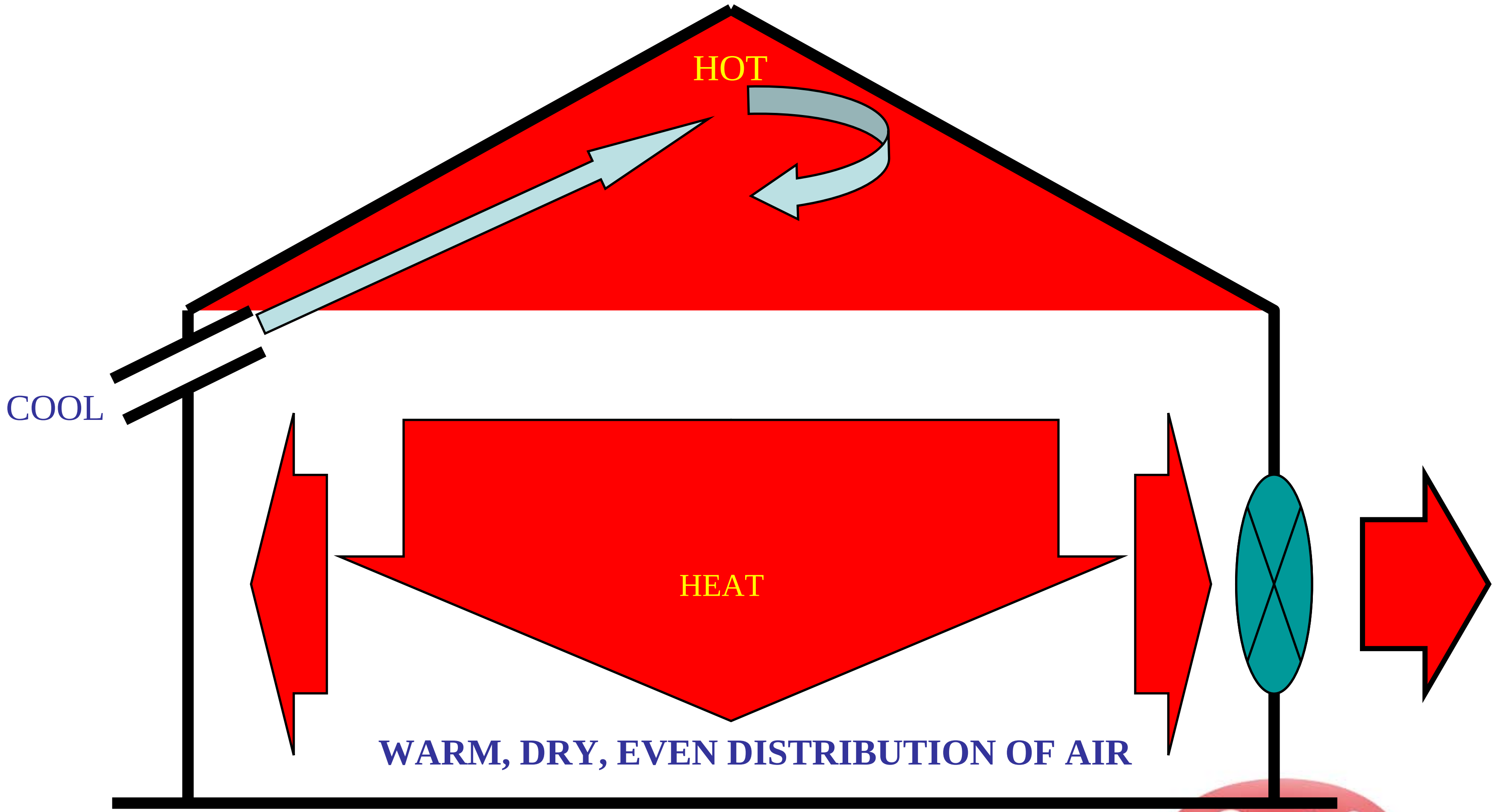
- I Actual Negative Pressure (pressure drop) from inside the house to atmosphere.
- *This is created only by the fan volume compared to the inlet area openings, including unwanted leaks.

- II. Pressure drop across inlets (air speed) entering the house. This is the important one to the chicken business for air distribution.
- *This is created by the negative pressure with the resistance of the inlets taken into consideration. The more the resistance the higher the negative pressure will be above the pressure drop across the inlets.
- In a normal curtain wall chicken house the difference in the actual negative pressure and pressure drop across the inlet is approximately .02 inches of water. The more the house leaks the more difference there will be in the two pressures.

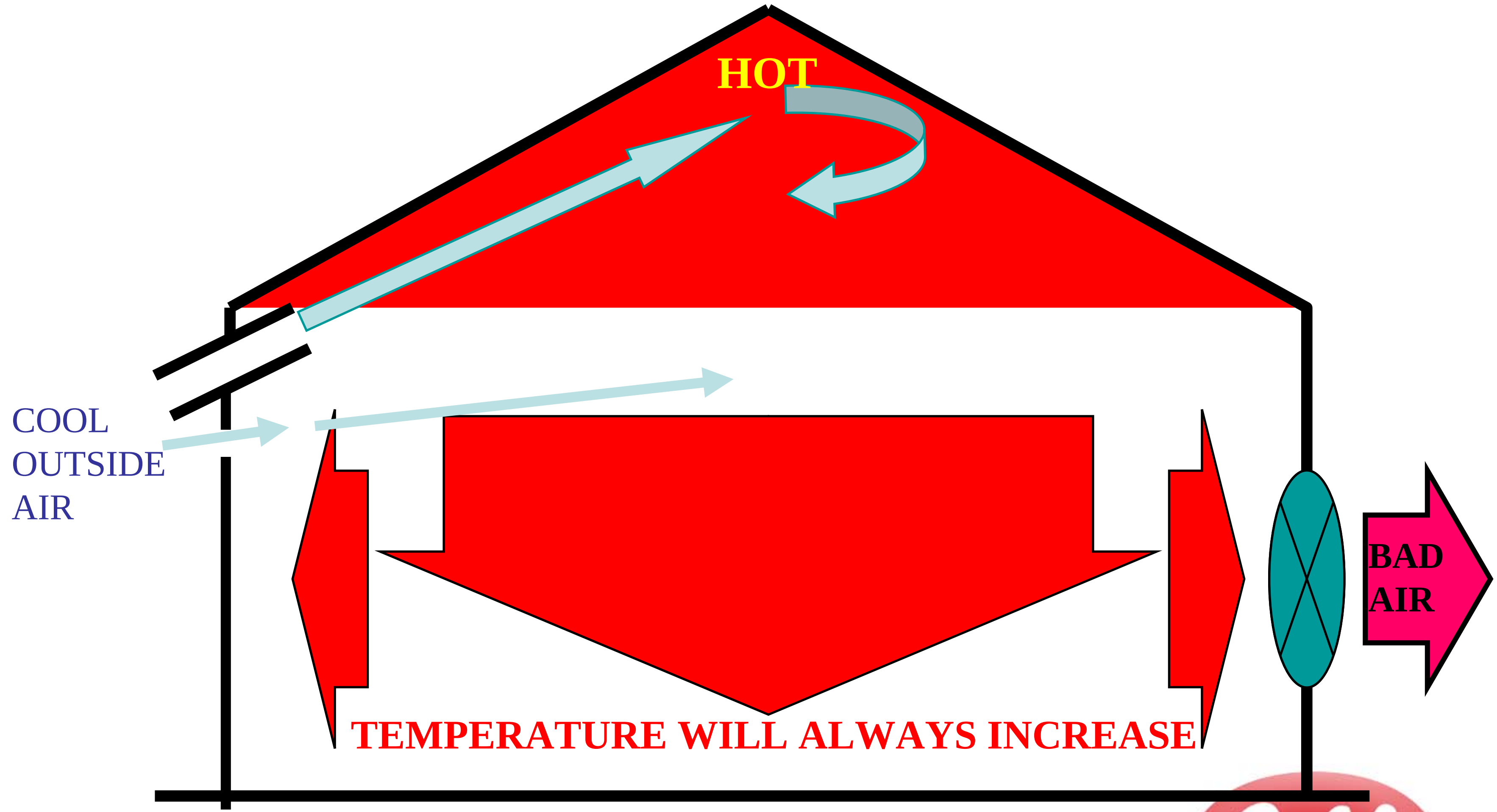
FORMULA FOR FIGURING INLET AREA BASED ON HOUSE PRESSURE AND/OR WIDTH OF THE HOUSE

- THE HOUSE WIDTH SHOULD DETERMINE THE PRESSURE DROP YOU USE FOR BEST RESULTS AND TO FIGURE INLET SPACE FOR BEST DISTRIBUTION OF AIR THOUGH THE HOUSE
    - EXAMPLES OF PRESSURE DROPS USED
- PRESSURE -INLET SPACE -WIDTH OF HOUSE--AIR SPEED
- .03 1 SQ.IN. 4.0 CFMS 10.4 M 34 F 700 FPM 3.55 MPS
- .04 1 SQ.IN. 4.5 CFMS 10.9 M 36 F 800 FPM 4.06 MPS
- .05 1 SQ.IN. 5.0 CFMS 12.2 M 40 F 900 FPM 4.57 MPS
- .06 1 SQ.IN. 5.5 CFMS 13.7 M 45 F 1000 FPM 5.08 MPS
- .07 1 SQ.IN. 6.0 CFMS 15.2 M 50 F 1100 FPM 5.59 MPS
- .08 1 SQ.IN. 6.5 CFMS 18.3 M 60 F 1200 FPM 6.10 MPS
- ** 144 square inches in one square foot

Cross-Flow For Minimum Ventilation

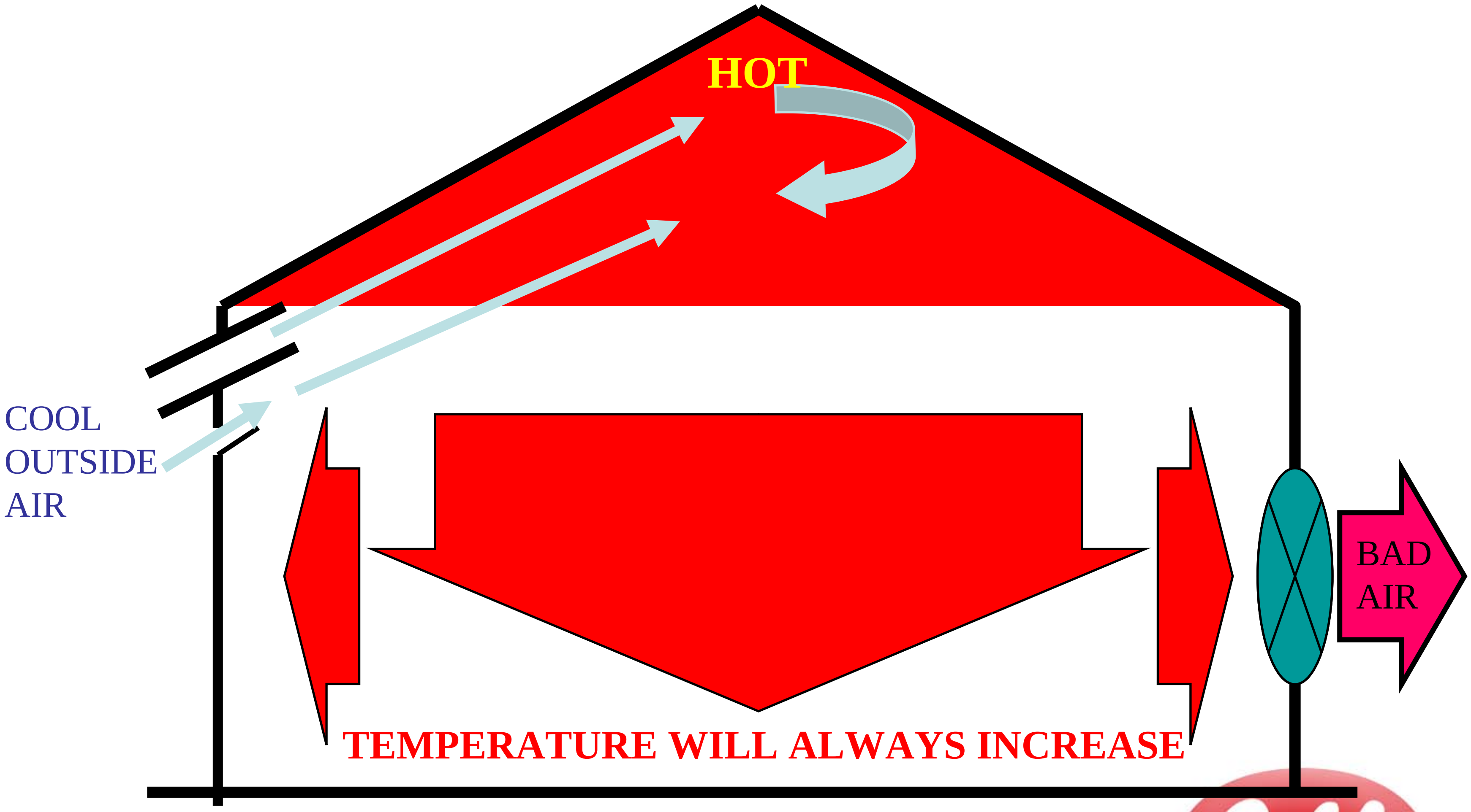


Cross-Flow Ventilation With Continuous Slot For Second Stage Air Volume



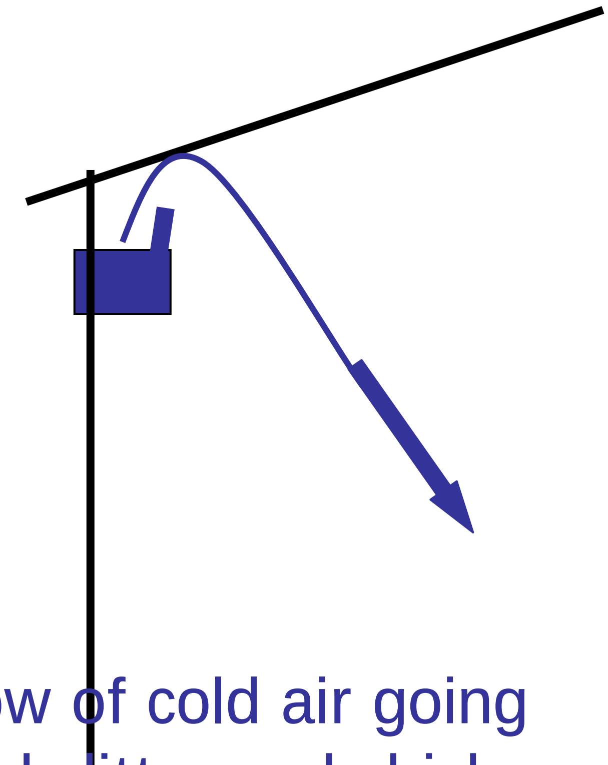
COMFORTABLE ANIMALS, WARM DRY FLOORS, EVEN DISTRIBUTION OF AIR, LOW ENERGY COST

Cross-Flow Ventilation With Counter Balanced Inlet For Second Stage Air Volume

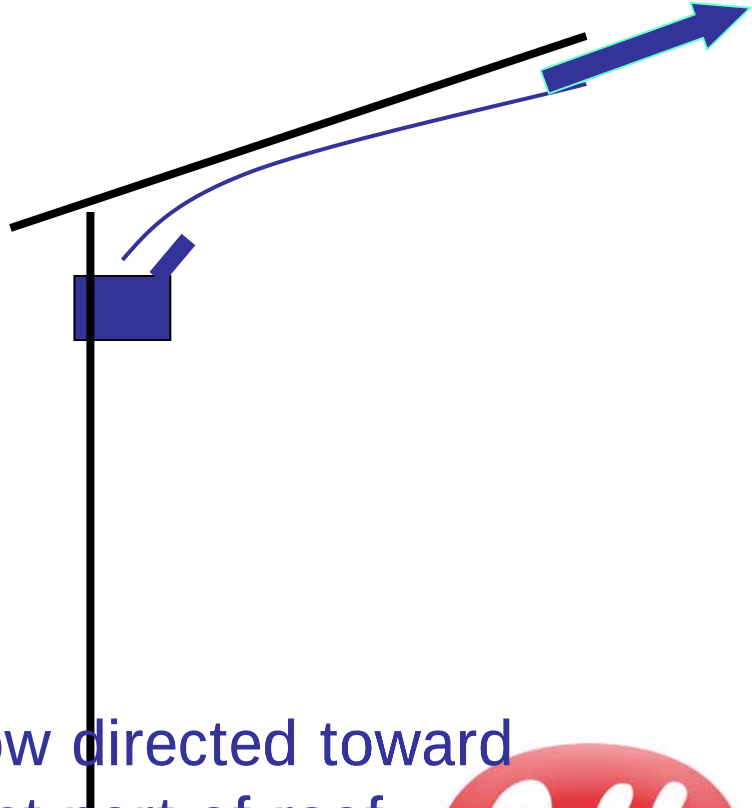


COMFORTABLE ANIMALS, WARM DRY FLOORS, EVEN DISTRIBUTION OF AIR, AND LOW UTILITY COSTS

Wrong Position Directional Flap

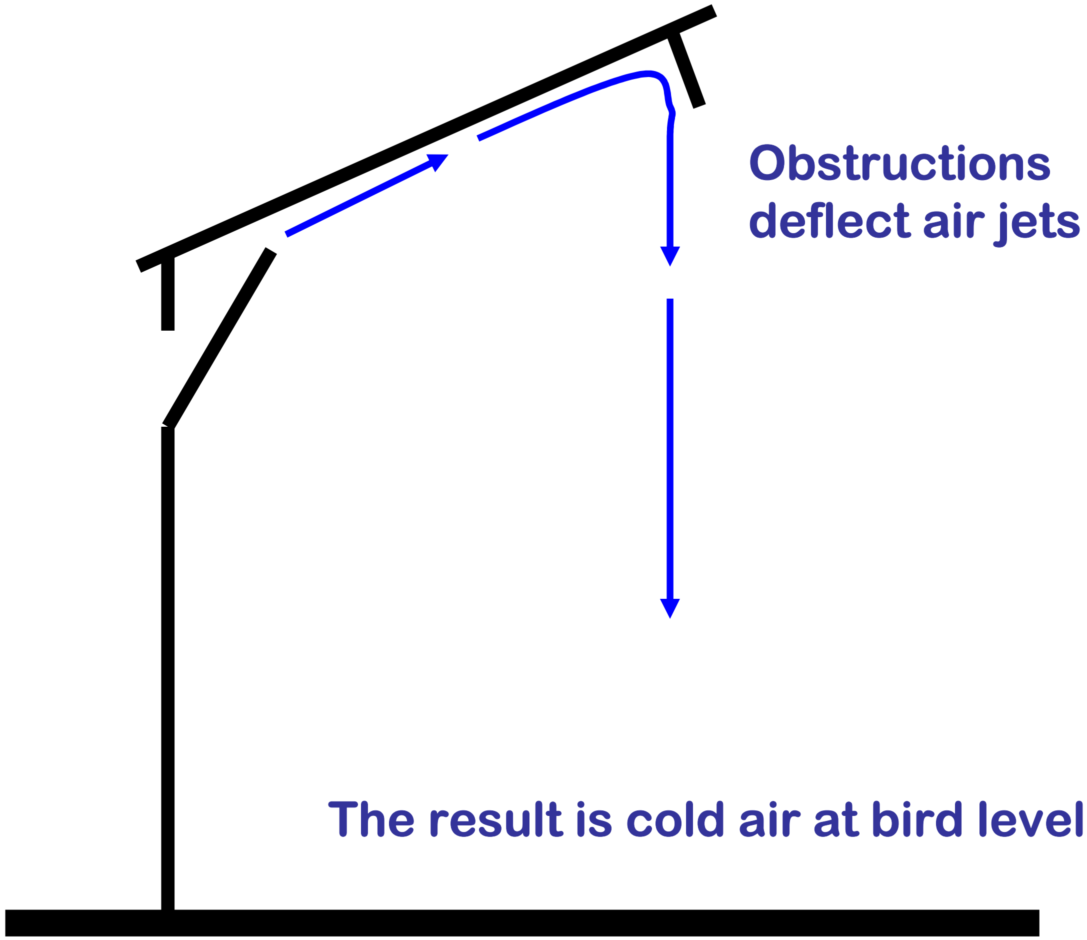


Air flow of cold air going towards litter and chicks

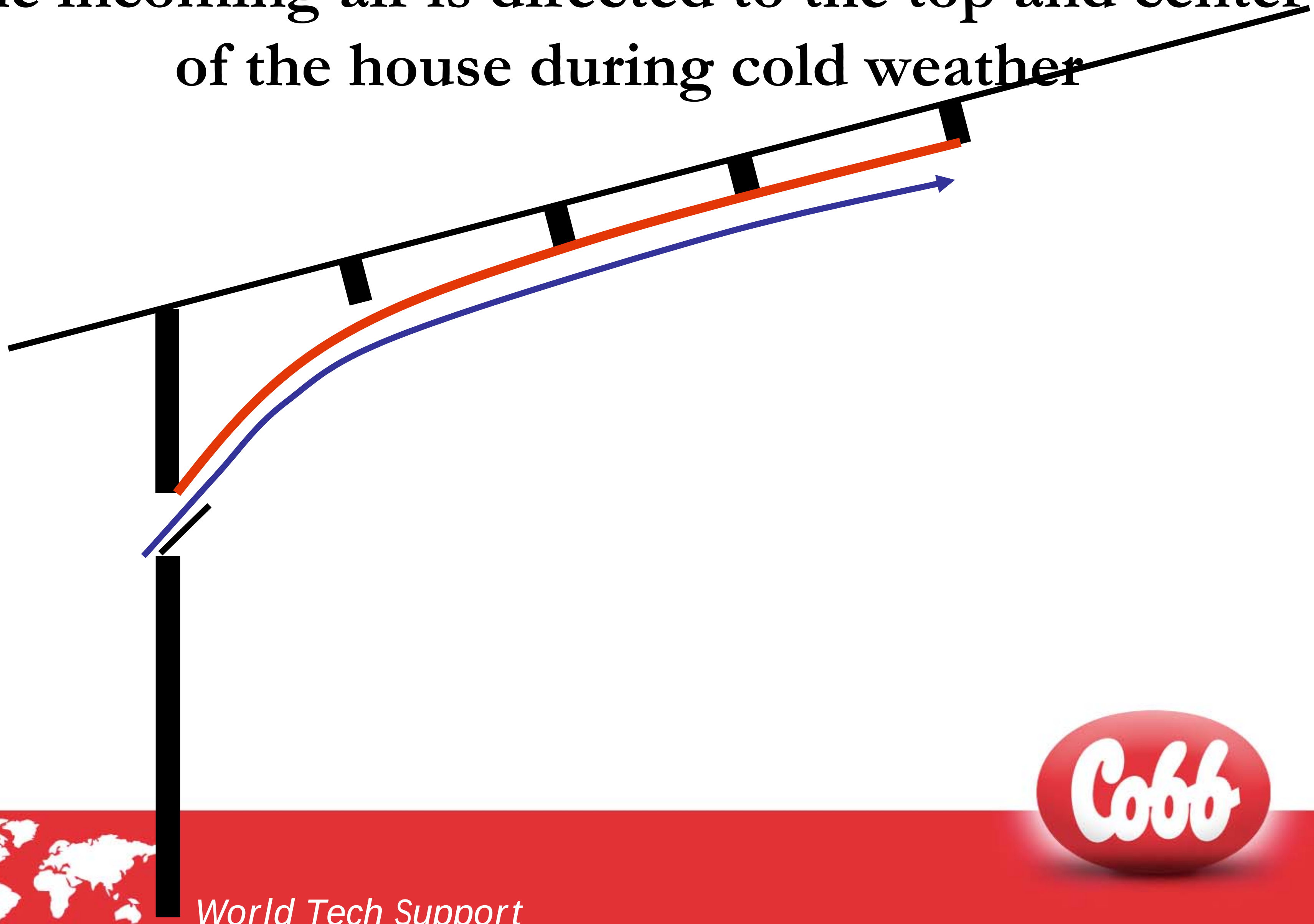


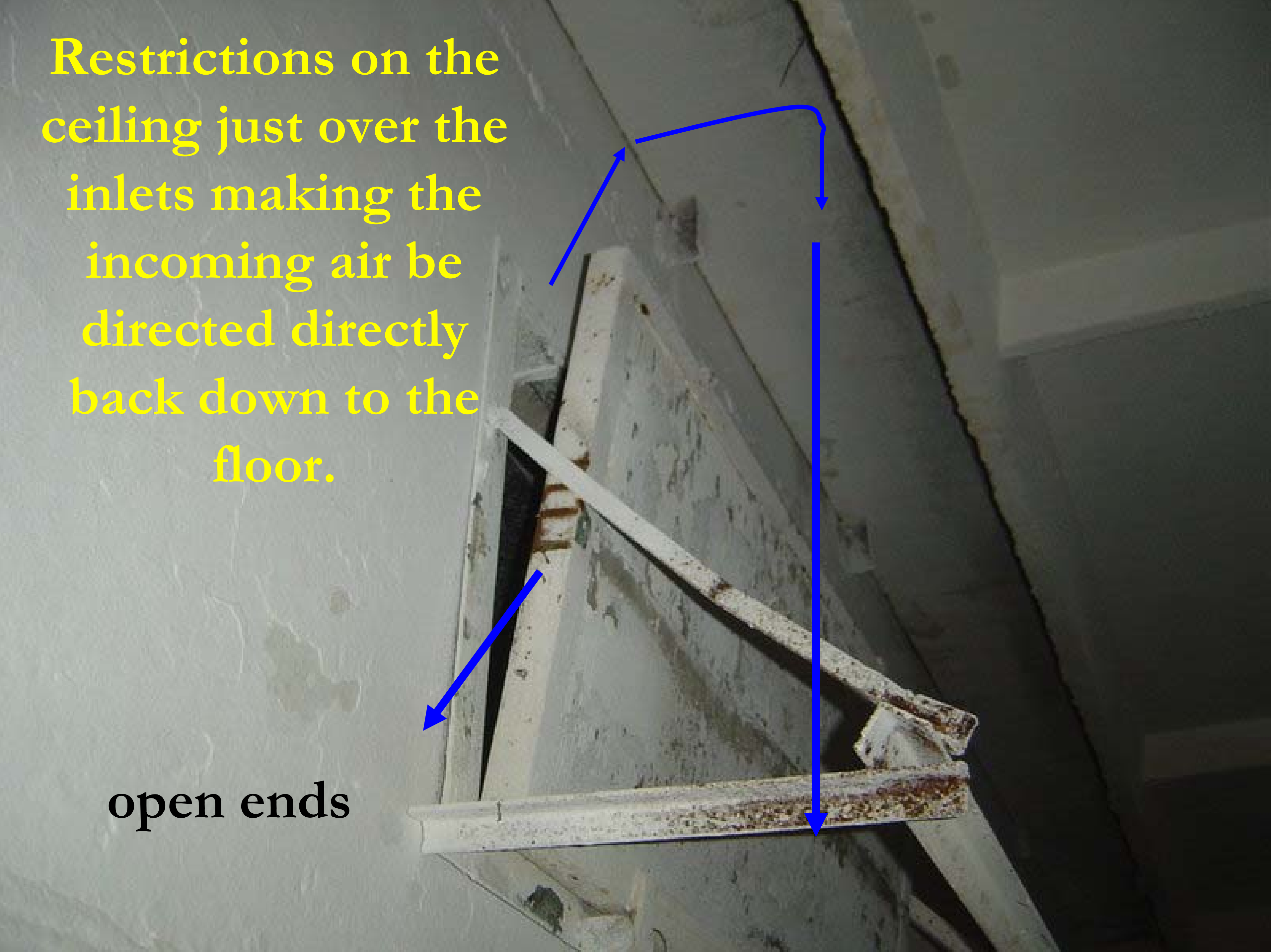
Air flow directed toward highest part of roof

Ceiling should be free of obstruction

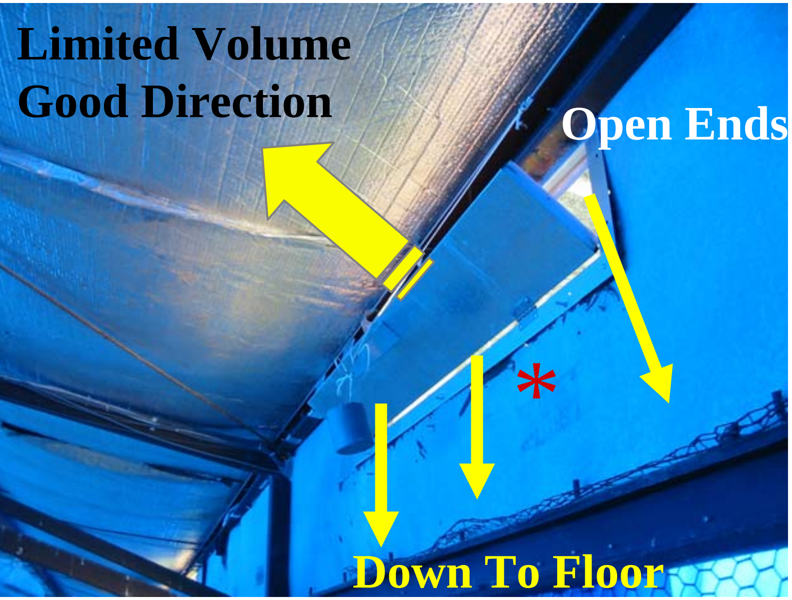


Air deflectors over the top of all inlets to insure the incoming air is directed to the top and center of the house during cold weather



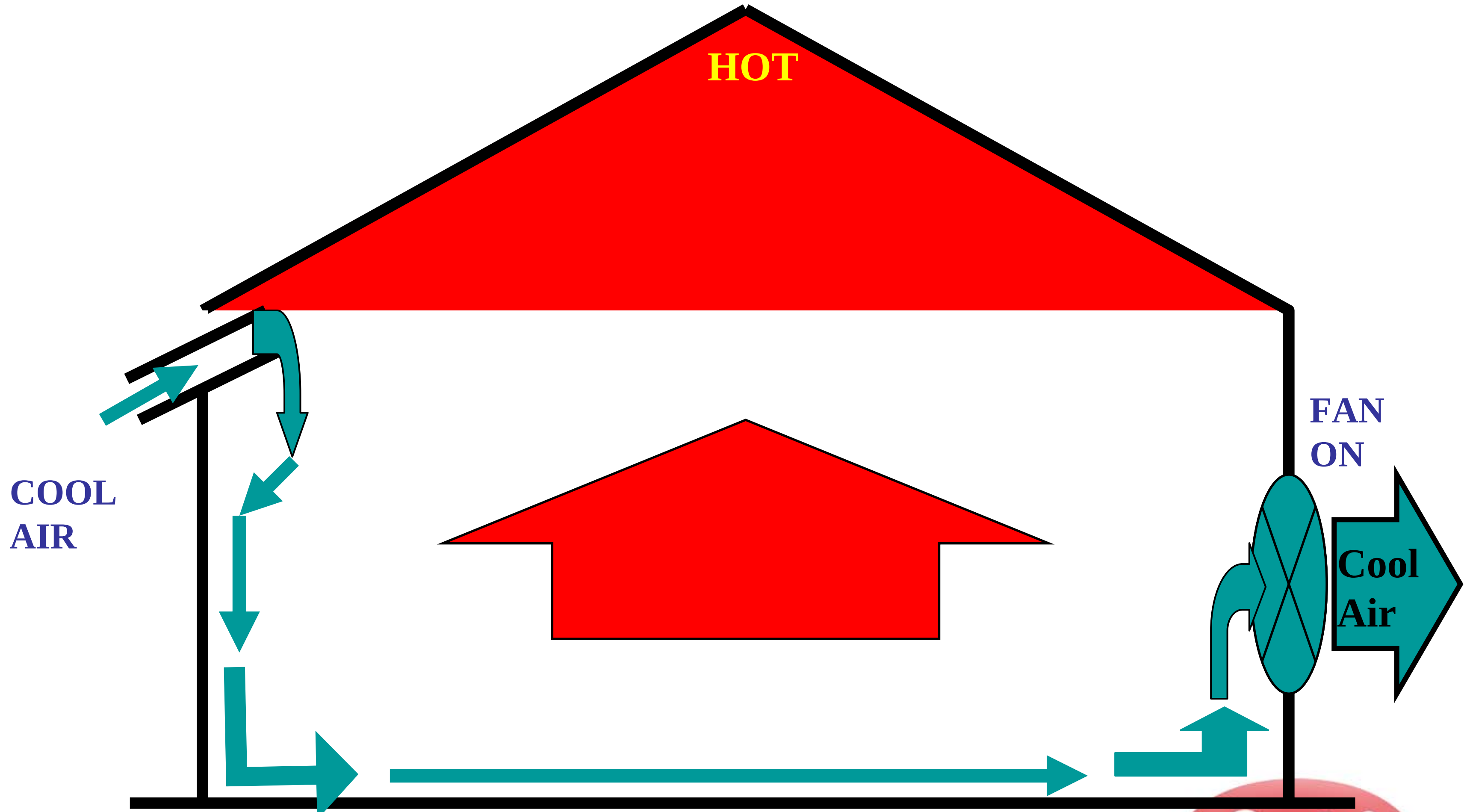

Restrictions on the ceiling just over the inlets making the incoming air be directed directly back down to the floor.
open ends

Poor Inlet Openings !!



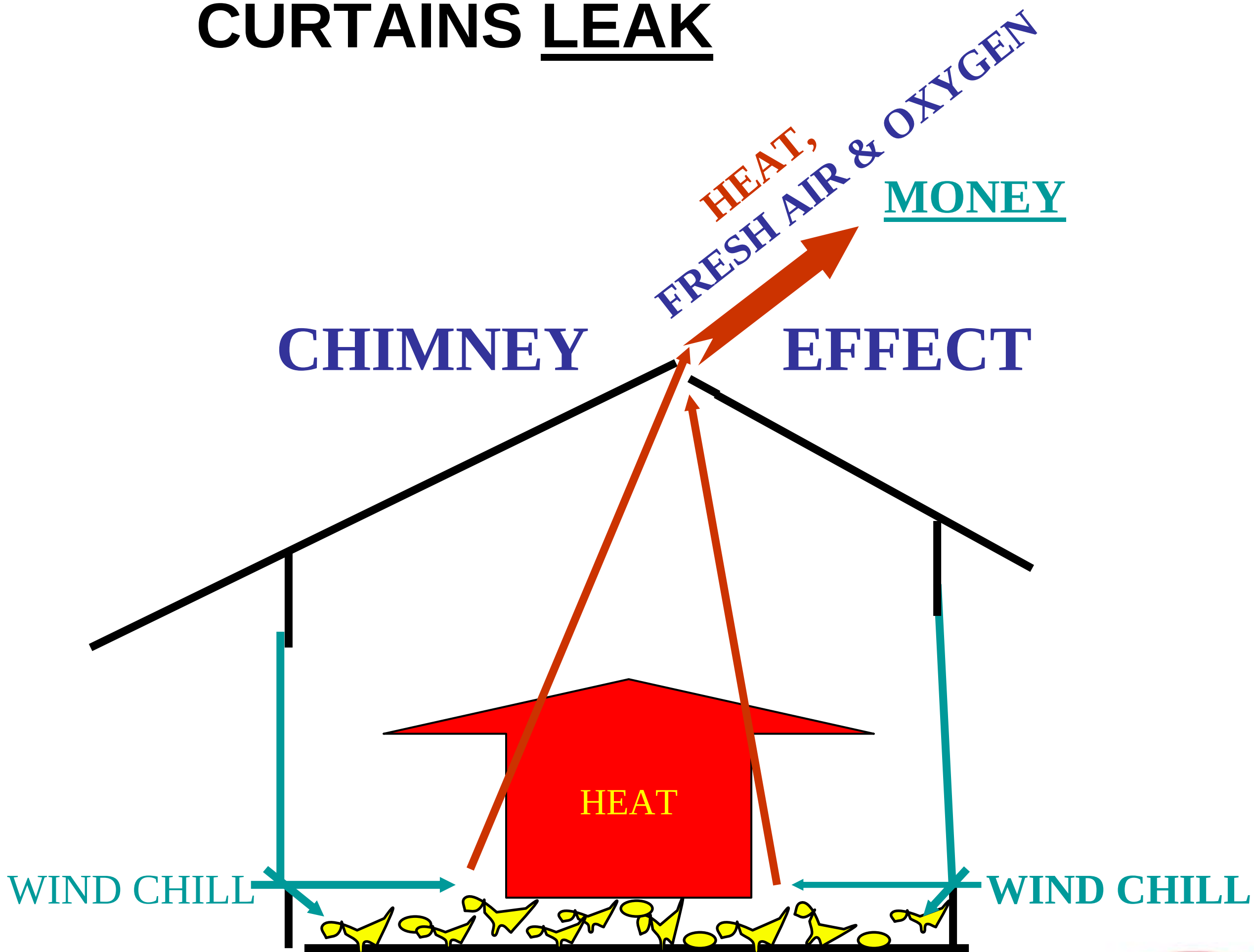
- Air inlet opening based on # fans in operation and not pressure controlled. This concept does not work well and should be avoided.
- * Observe slot along bottom of inlet
- Is expensive and does not work properly for minimum ventilation.

Cross-flow Ventilation
With very low pressure drop across inlets



COLD WET FLOORS, WINDCHILL STRESS ON CHICKS,
NO USE OF EXISTING EN\ERGY, HIGH UTILITY COSTS

WHEN TOP OF HOUSE & UNDER THE SIDEWALL CURTAINS LEAK

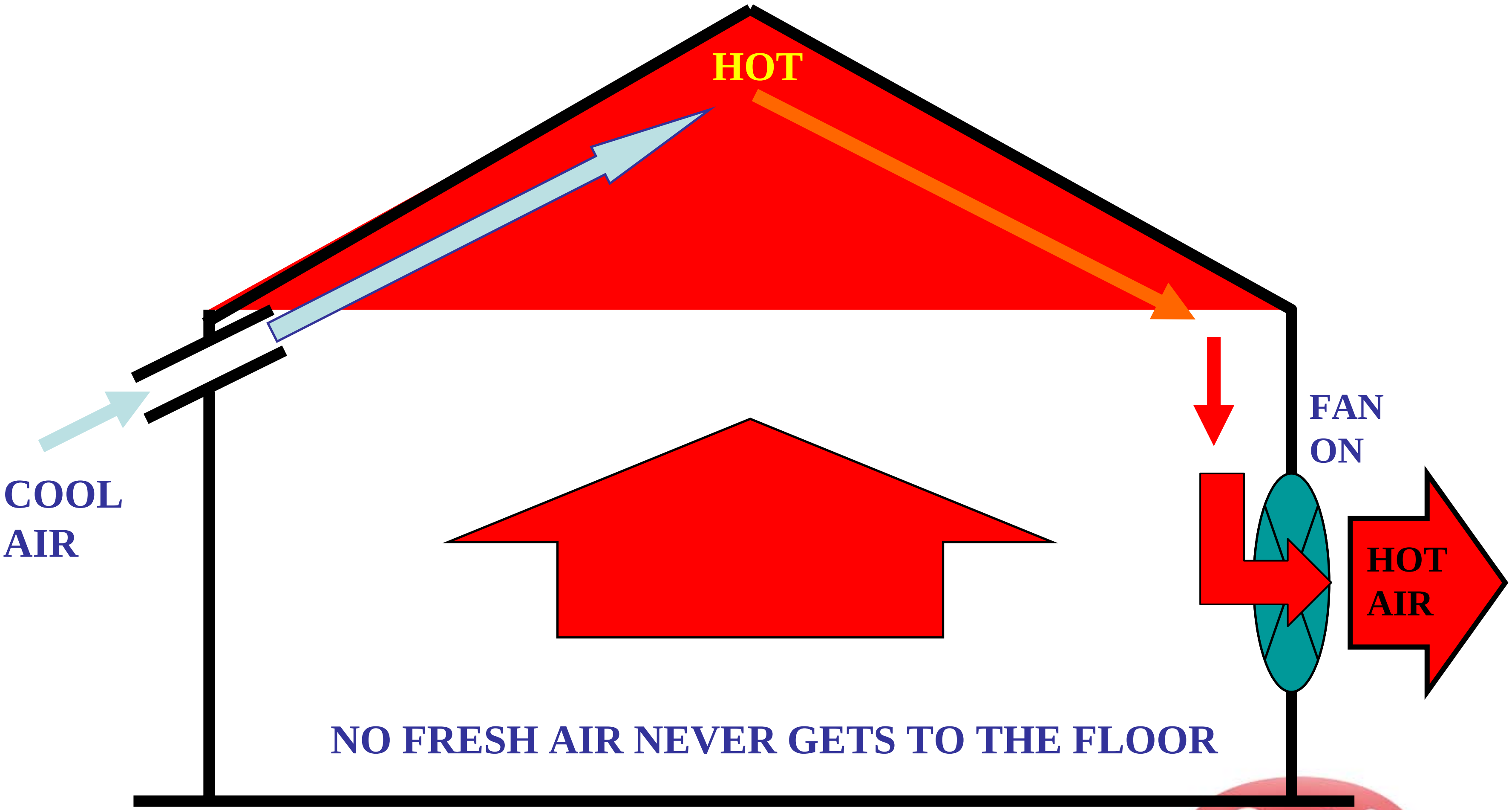


COLD WET FLOORS, STRESS CHICKS, AMMONIA, HIGH UTILITY COST, ASCITES AND BAD OVERALL PERFORMANCE

Solutions When Inlet Pressure Is Too Low

- **Seal as many house leaks as possible permanently.**
- **Make sure belts are tight on belt drive fans.**
- **Make sure all shutters are kept clean.**
- **Make sure all summer fan shutters are in good state of repair and will seal when fan is off.**
- **Increase fan capacity until the proper pressure is obtained.**
- **In blackout houses make sure the light traps are larger enough for the fan capacity and the distance between the fan and shutter is adequate.**
- **Make sure fan being used is capable of working against the necessary pressure.**
- **With VF48 inlets insure the weights are on the air inlet louvers and they are correct weight.**

Cross-flow Ventilation
Very high negative pressure across inlets



COOL FLOORS, HIGH AMMONIA, HIGH UTILITY COSTS, LACK OR OXYGEN AT FLOOR LEVEL

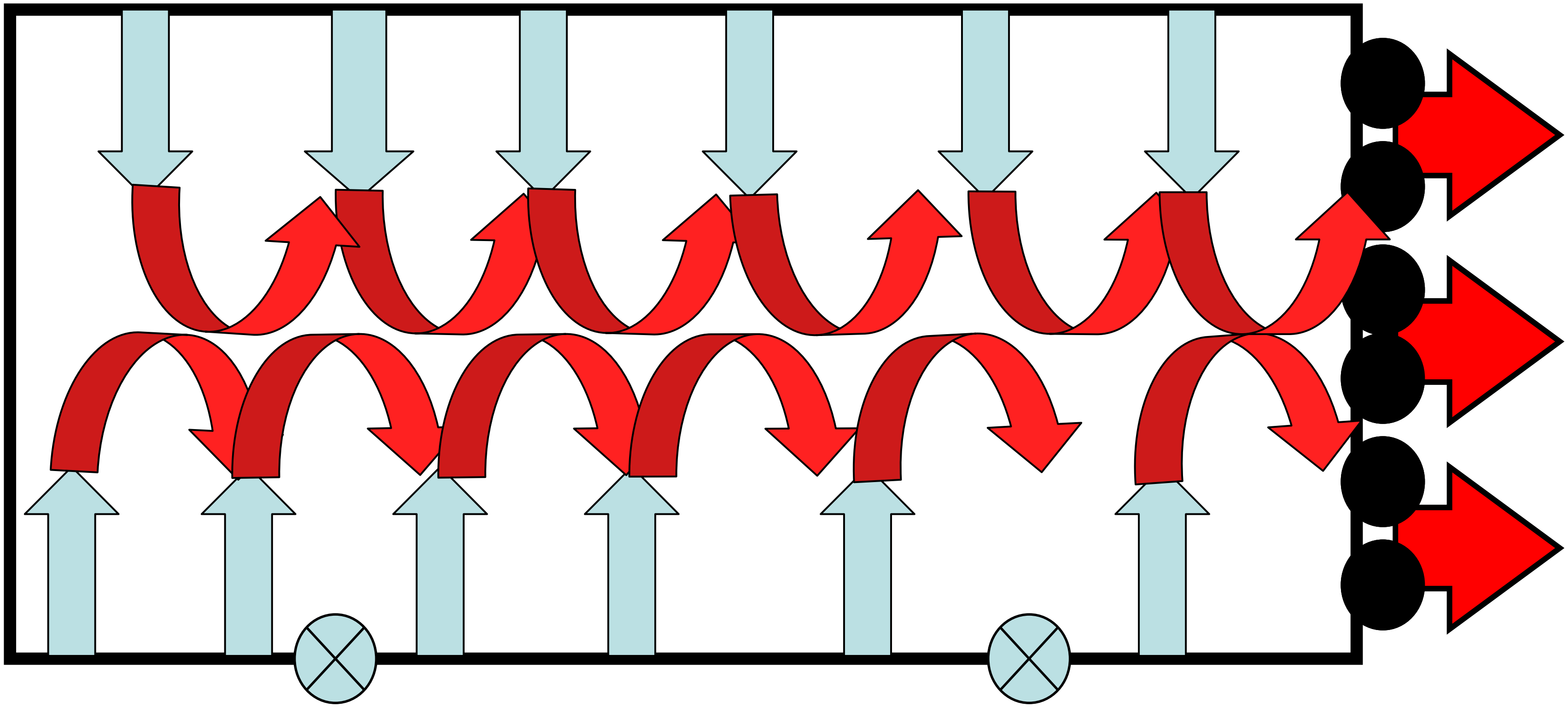
Solutions When Inlet Pressure Is Too High

- **Increase inlet capacity in the house.**
- **Decrease the fan capacity as long as the minimum volume is being met.**
- **Decrease inlet pressure setting on solid state control.**
- **Make sure temperature override has not turned on too much fan capacity for minimum inlets.**
- **Check to see that birds hasn't built nests in inlets.**
- **See that light traps are not stopped up with dirt.**

TRANSITION VENTILATION SYSTEM

1. This system must have enough (minimum) sidewall inlets equally placed on both sides of the house from end to end to meet the volume capacity of at least 3 of the tunnel ventilation fans and are controlled by counter weights or negative pressure. ***With fans on one end of the house and inlets evenly placed on each side of the house from end to end the air velocity across the birds will be ¼ of what it is with inlets on the opposite end of the house.**
2. The inlets must still direct the air into the peak of the house to prevent wind chills on the floor.
3. Once the summer (tunnel) ventilation system begins to operate the (minimum) sidewall inlets should close and the summer inlets begin to open and maintain the proper inlet pressure for good air distribution down through the house.

Transition Ventilation For A Better Air Exchange Without High Air Velocity



EVEN AIR DISTRIBUTION

FORMULA FOR FIGURING INLETS FOR MINIMUM/TRANSITION VENTILATION

1. CHOOSE THE INLETS YOU ARE GOING TO USE FOR THIS APPLICATION
2. DETERMINE THE AIR VOLUME OF EACH INLET BASED ON THE ACTUAL PRESSURE YOU ARE GOING TO BE USING
3. INSTALL ENOUGH INLETS EQUALLY SPACED ON EACH SIDE OF THE HOUSE TO MATCH THE CAPACITY OF THE NUMBER OF FANS TO BE USED AT THE ACTUAL WORKING PRESSURE
4. THE INLETS SHOULD BE STAGGERED FROM SIDE TO SIDE DOWN THROUGH THE HOUSE
5. INSTALL A STATIC PRESSURE INLET CONTROL ON EACH SIDE OF THE HOUSE IF THEY ARE BEING OPERATED MECHANICALLY
6. WHEN IN MINIMUM VENTILATION ACROSS THE HOUSE, ONLY ONE SIDE OF THE INLETS SHOULD BE OPEN OPPOSITE THE FANS.
7. ALL THE SIDEWALL INLETS SHOULD BE CLOSED WHEN IN FULL TUNNEL VENTILATION


TRANSITION INLETS ON BOTH SIDES OF THE HOUSE

When Cycle Timer Is Used With Transition Ventilation

- **Make sure fresh air entering the house passes the next inlet as it moved down through the house to insure fresh air is introduced from one end of the house to the other.**

- **The minimum run time on the timer still must be at least 20% of the time on a 5 or 10 minute timer.**

- **The inlet pressure is just as important as when going across the house for minimum ventilation.**

- **Inlets must always direct air into the peak of the house.**

- **Insure wind chill is not too high for chicks when fans are in operation based on age and size.**

Contributing Factors To Wet Floors In Environmental Controlled Houses

1. Water System Leaks (Faulty valves, too high/low pressure, improper height of waters, too many birds per drinker.)
2. Cold Wind Drafts On The Floor (Air leaks from outside being directed down to the floor.)
3. Low Inlet Pressure (Allowing cold air to fall to the floor.)
4. Low Air Volume (Lack of volume or run time on fans to allow for adequate air exchange and pressure drop in house.)
5. Cold House Temperature (Must have the ability to expand the cold air (supplemental heat above 55 degrees) to increase the moisture holding capacity.)

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Contributing Factors To Wet Floors In Environmental Controlled Houses Continued

6. Loose Excreta From Birds (Blood line,high water intake, or feed formulation.)
7. Depth And Type Of Litter (Litter must have adequate absorption capacity for excreta and respiration of birds.)
8. Misuse Of Cooling Systems (Running pumps when temperature is too cool, relative humidity is too high, or air speed through pads is too high or low.) Foggers or evaporative cooling.

PRIORITIES FOR SUMMER VENTILATION

1. AIR SPEED ACROSS THE BIRDS (450 TO 550 FPM)(2.3 TO 2.79 MPS)
2. AIR EXCHANGE IN THE HOUSE (LESS THAN 1.2 MINUTES)
3. CONTROL OF RELATIVE HUMIDITY (BETWEEN 45 TO 65%)
4. PRESSURE DROP ACROSS INLETS (AIR SPEED ENTERING THE HOUSE BASED ON WIDTH OF THE HOUSE)
5. TEMPERATURE CONTROL (USE EFFECTIVE TEMPERATURE NOT DRY BULB ALONE)
6. RUN ALL FANS BEFORE PUMPS (LAST FANS RUN 78°F/25.5°C)
7. RUN PUMPS ONLY WHEN NEEDED (NEVER BEFORE 82°F/27.8°C OR IF RELATIVE HUMIDITY IS ABOVE 70%)
8. YOU CANNOT CONTINUE TO TRY AND DROP DRY BULB TEMPERATURE AND INCREASE THE RELATIVE HUMIDITY TOO HIGH

FORMULA TO FIGURE SUMMER FANS FOR TUNNEL VENTILATION

EXAMPLE HOUSE 40 FEET X 400 FEET X 10 FEET = 160,000 CUBIC FEET OF AIR TO BE HANDLED

TAKE CROSS SECTION OF HOUSE X DESIRED AIR SPEED = TOTAL CFMS OF FAN CAPACITY NEEDED THEN DIVIDED TOTAL CFMS NEEDED BY RATING OF FAN TO BE USED AT PROPER PRESSURE DROP

(400 SQUARE FEET CROSS SECTION X 450 FEET PER MINUTE = 180,000 CFMS DIVIDED BY 21,500 CFMS PER FAN) = 8 FANS

WHEN THIS METHOD IS USED YOU MUST NOW CHECK THE AIR EXCHANGE BY DIVIDING THE CUBIC VOLUME OF THE HOUSE BY THE ACTUAL FAN VOLUME = AE

EXAMPLE

(8 FANS X 21,500 CFMS PER FAN = 172,000 TOTAL CFMS

160,000 CUBIC FEET DIVIDED BY 172,000 CUBIC FEET = .93 OF A MINUTE AIR EXCHANGE)

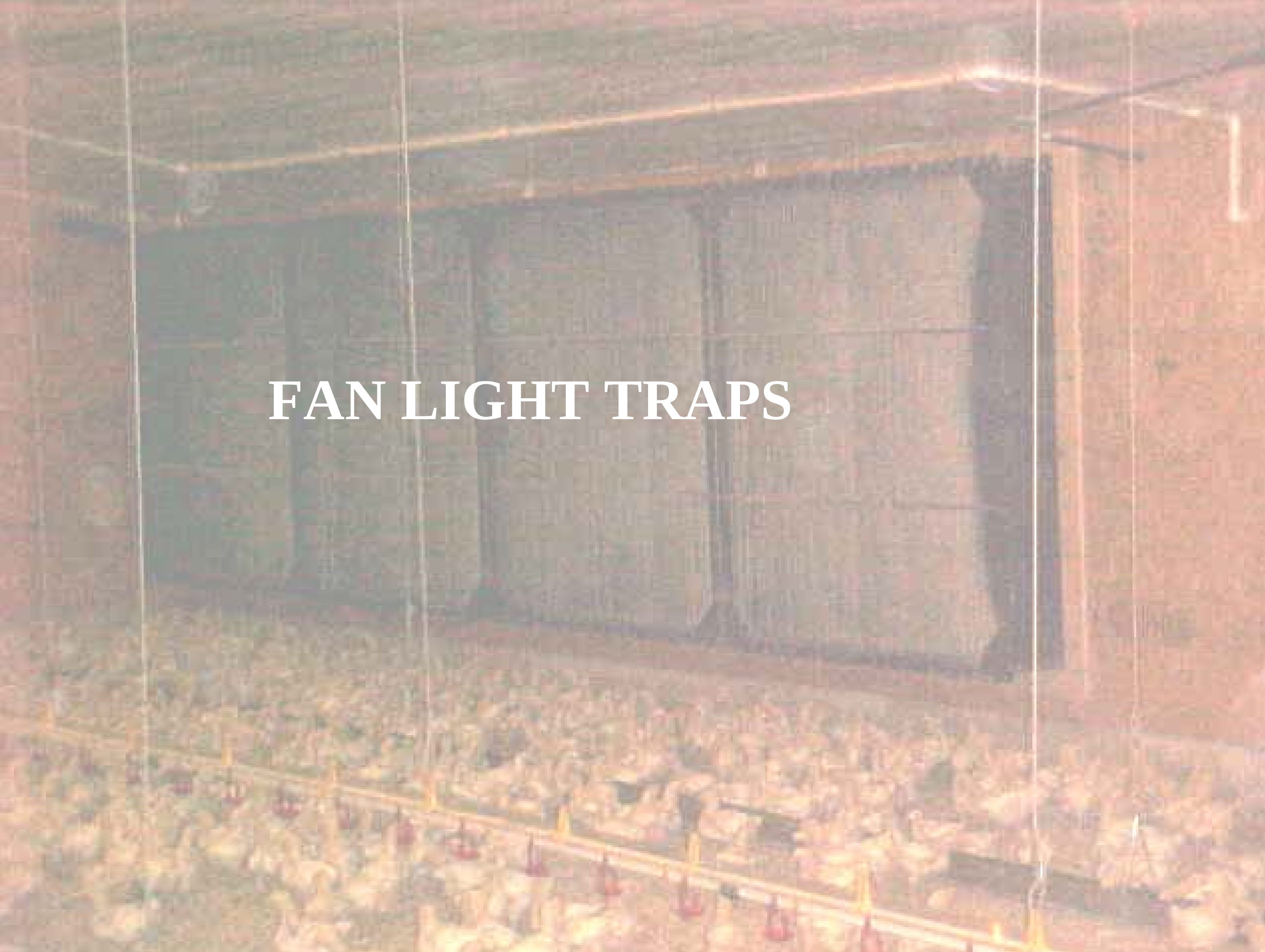

SLANTWALL
CONE FANS

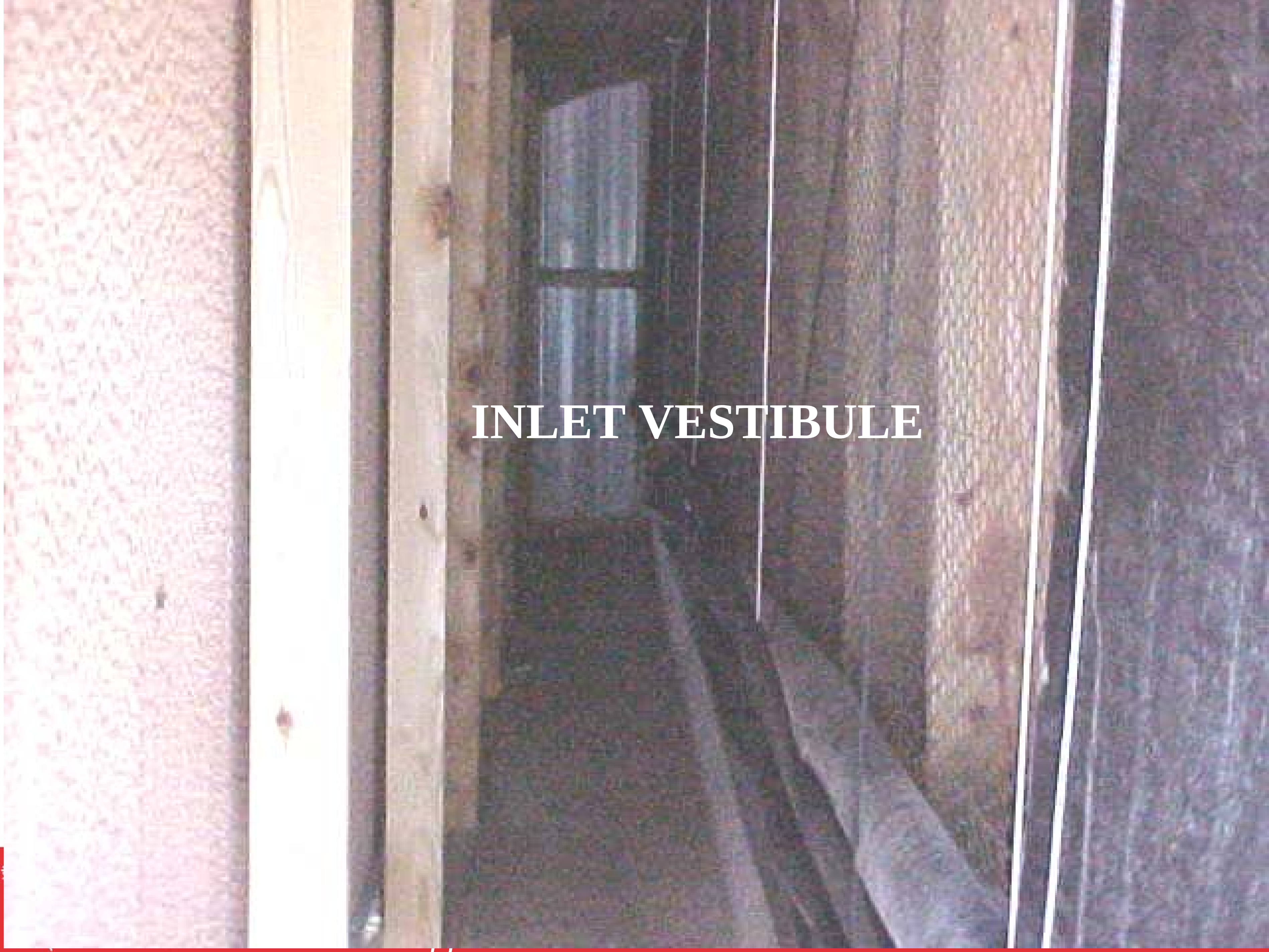

SUMMER
FANS
FAN VESTIBULE
ENTER HOUSE
FAN VESTIBULE


Off Set

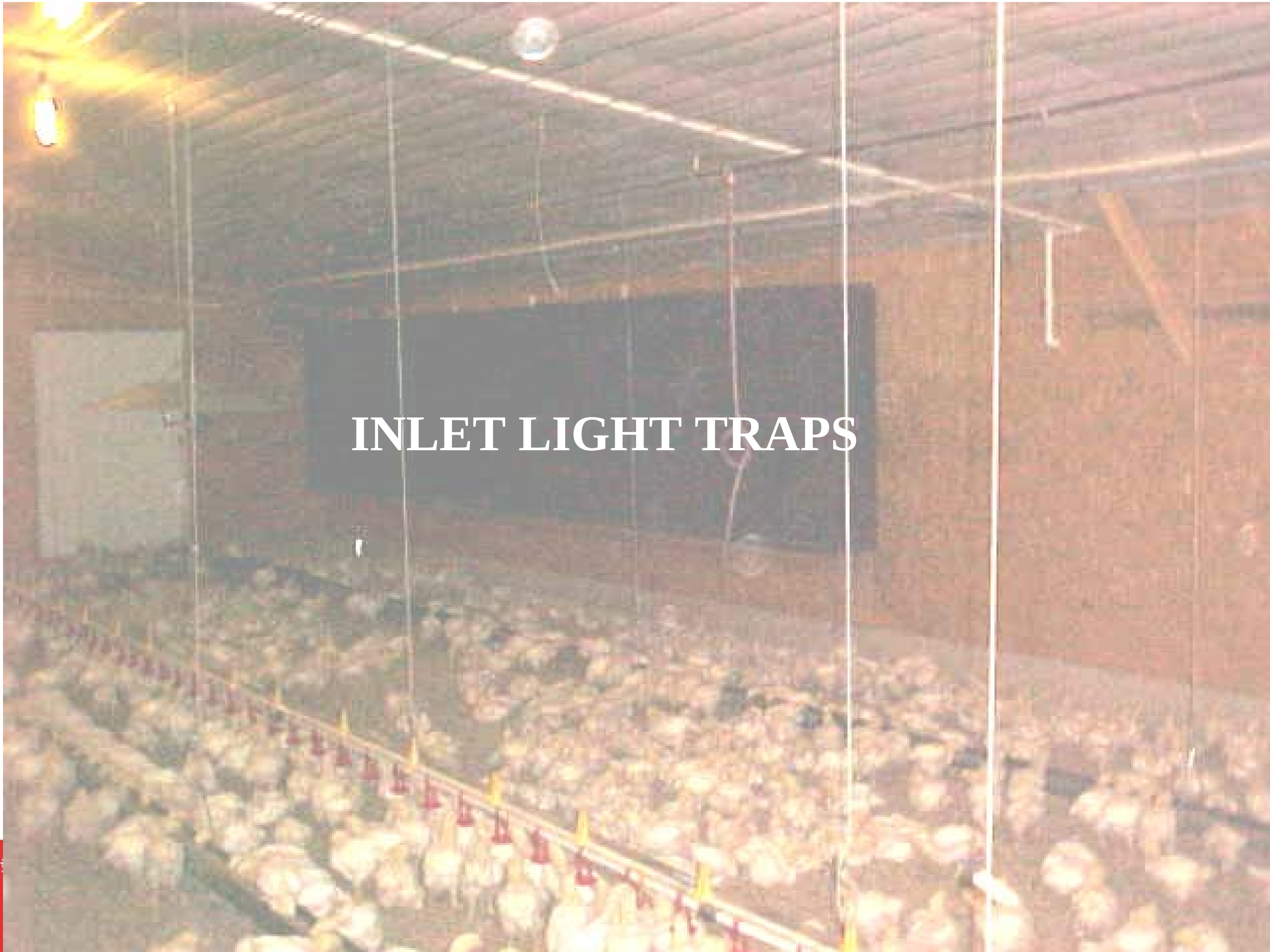

FAN VESTIBULE

FAN LIGHT TRAPS




INLET VESTIBULE

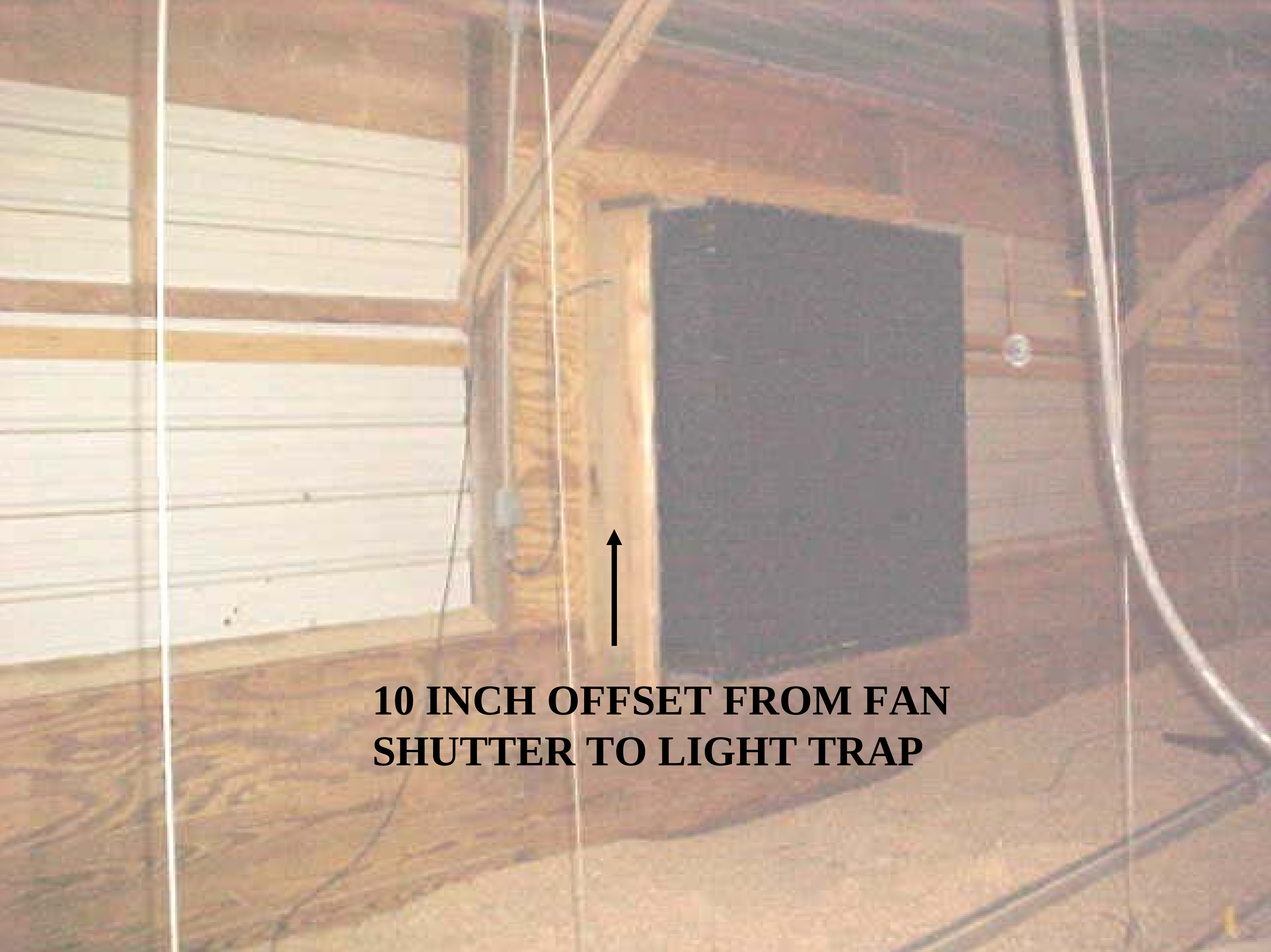
INLET LIGHT TRAPS



56 INCH X 56 INCH
TRAP / 36-INCH FAN


SUMMER FANS
LIGHT TRAPS
VESTIBULE

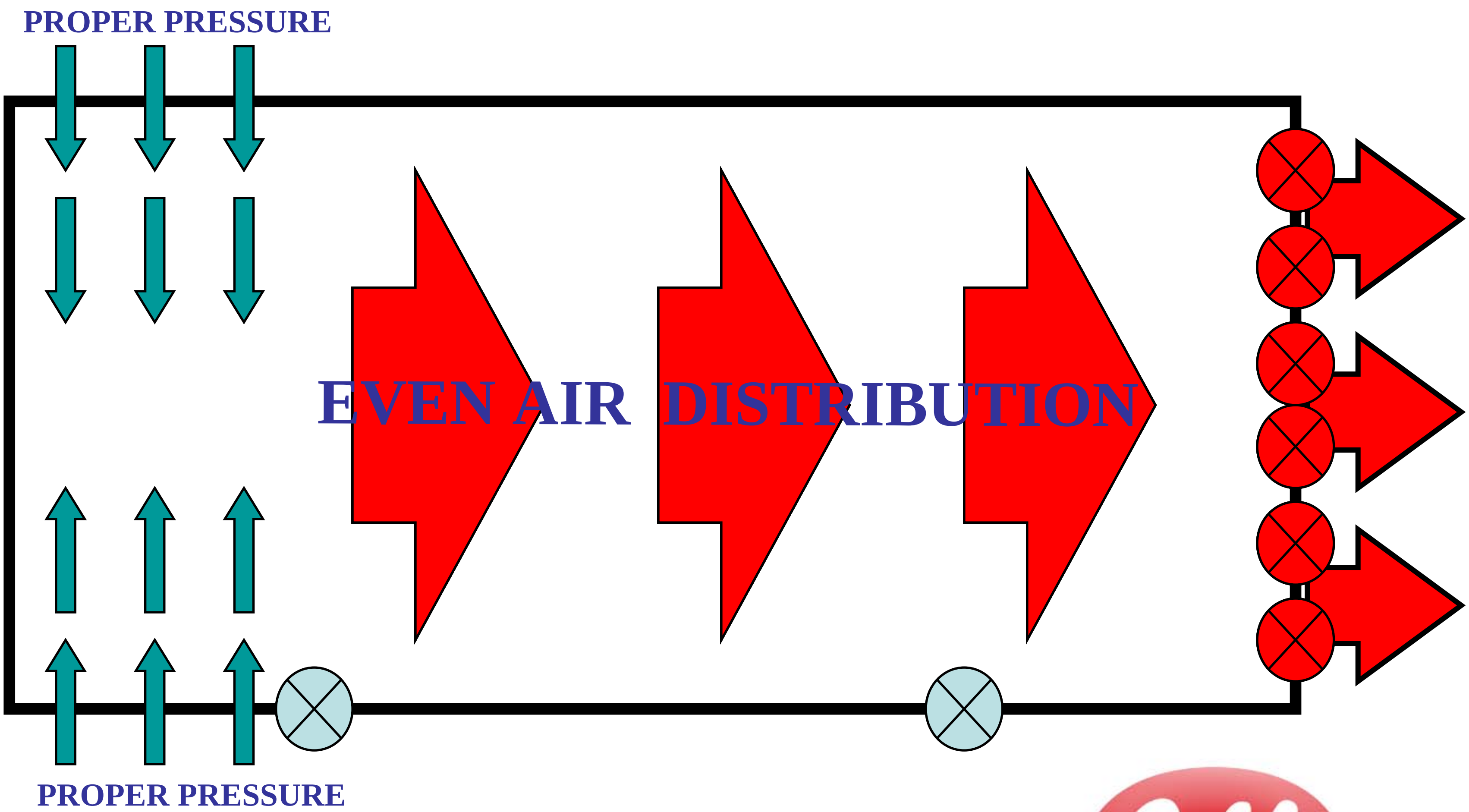

SLANT WALL FANS
FAN VESTIBULE
Cones have since be added to these fans.


10 INCH OFFSET FROM FAN
SHUTTER TO LIGHT TRAP

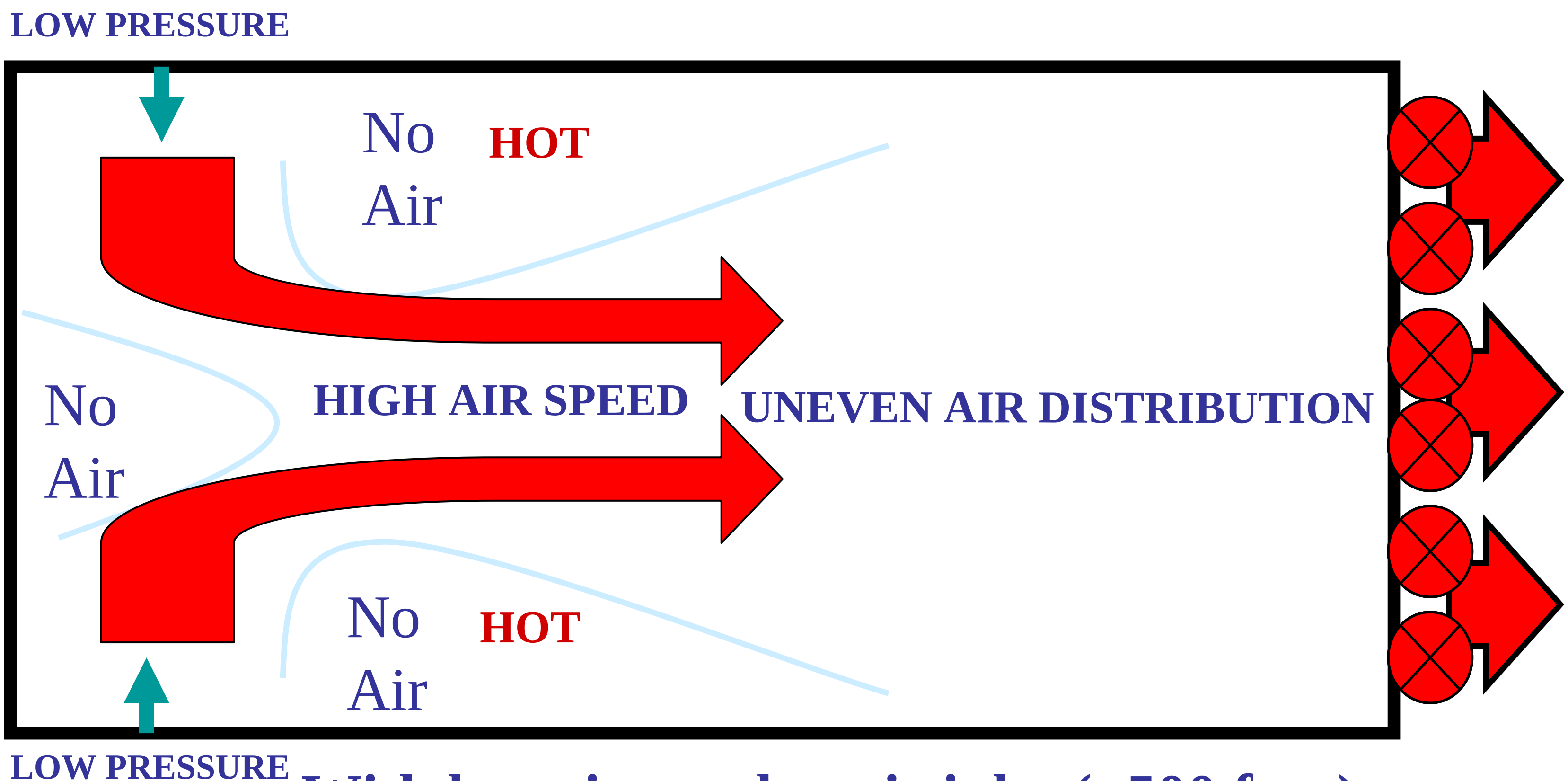

Minimum and Summer Fans


INSIDE HOUSE
VESTIBULE

Tunnel for Hot Weather Ventilation

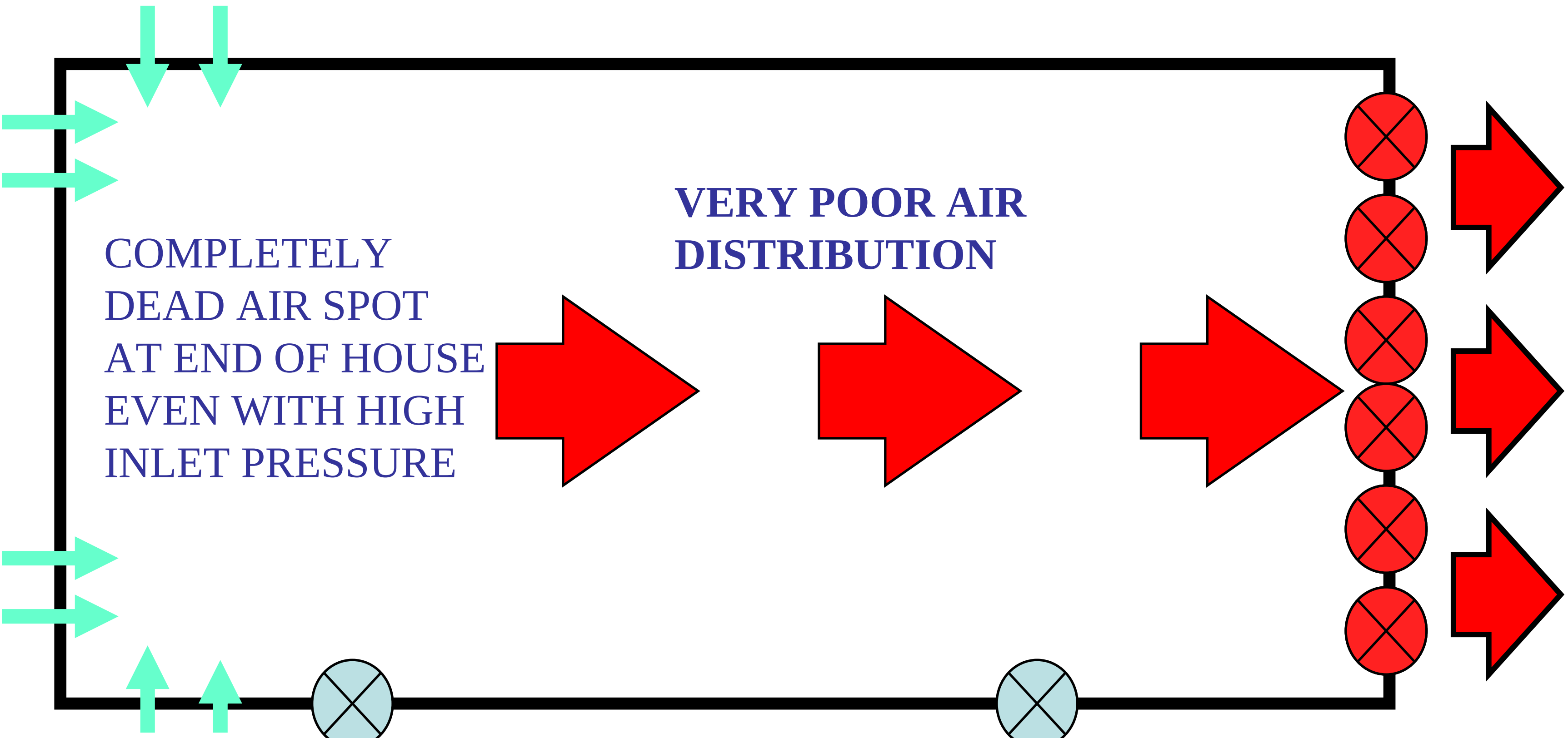


Tunnel Ventilation With Low Inlet Air Speed



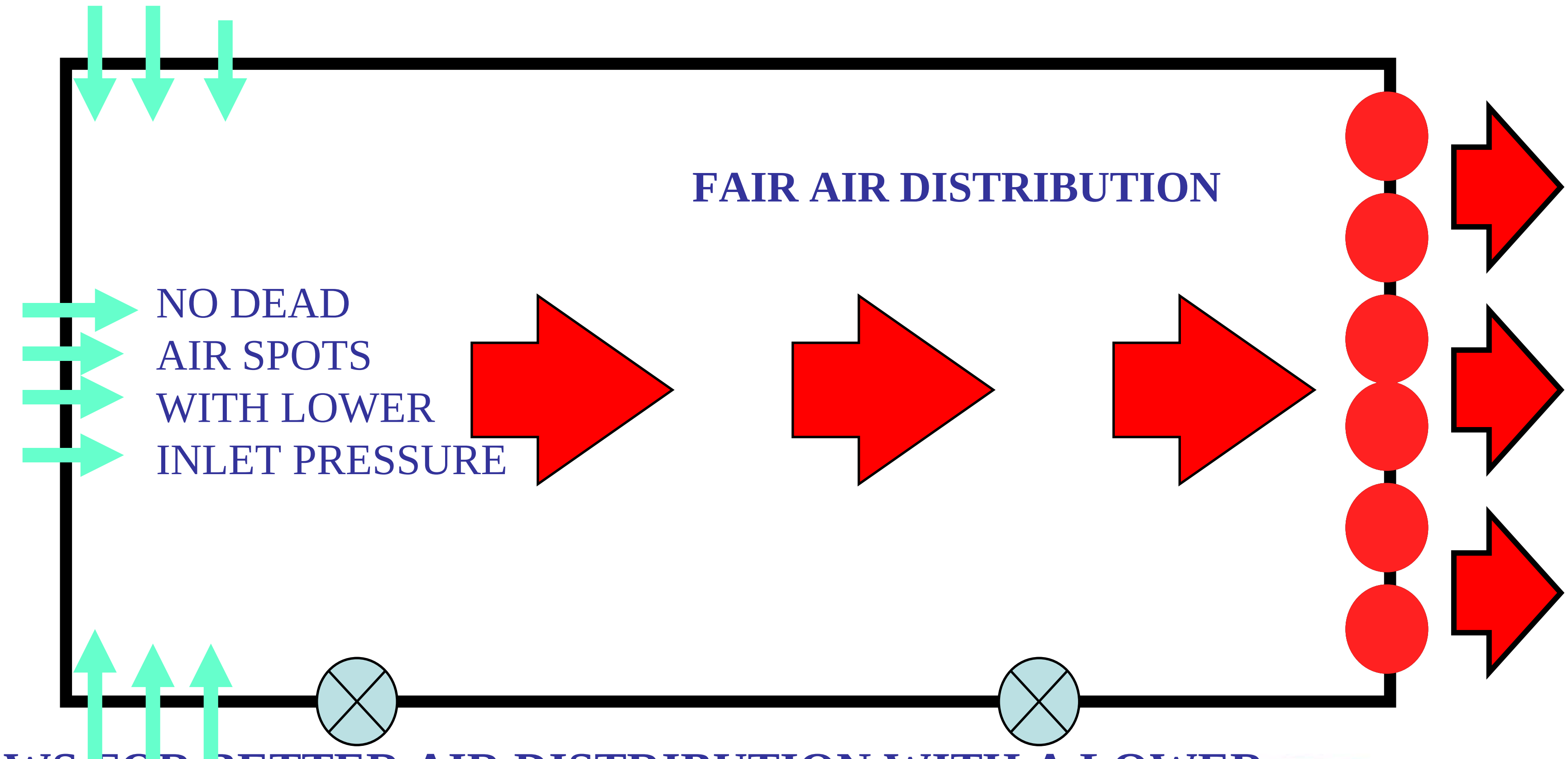
With low airspeed at air inlet (<500 fpm) dead spots will appear in the house and air velocity in center will be very high

NEVER WRAP TUNNEL VENTILATION INLETS AROUND END OF HOUSE



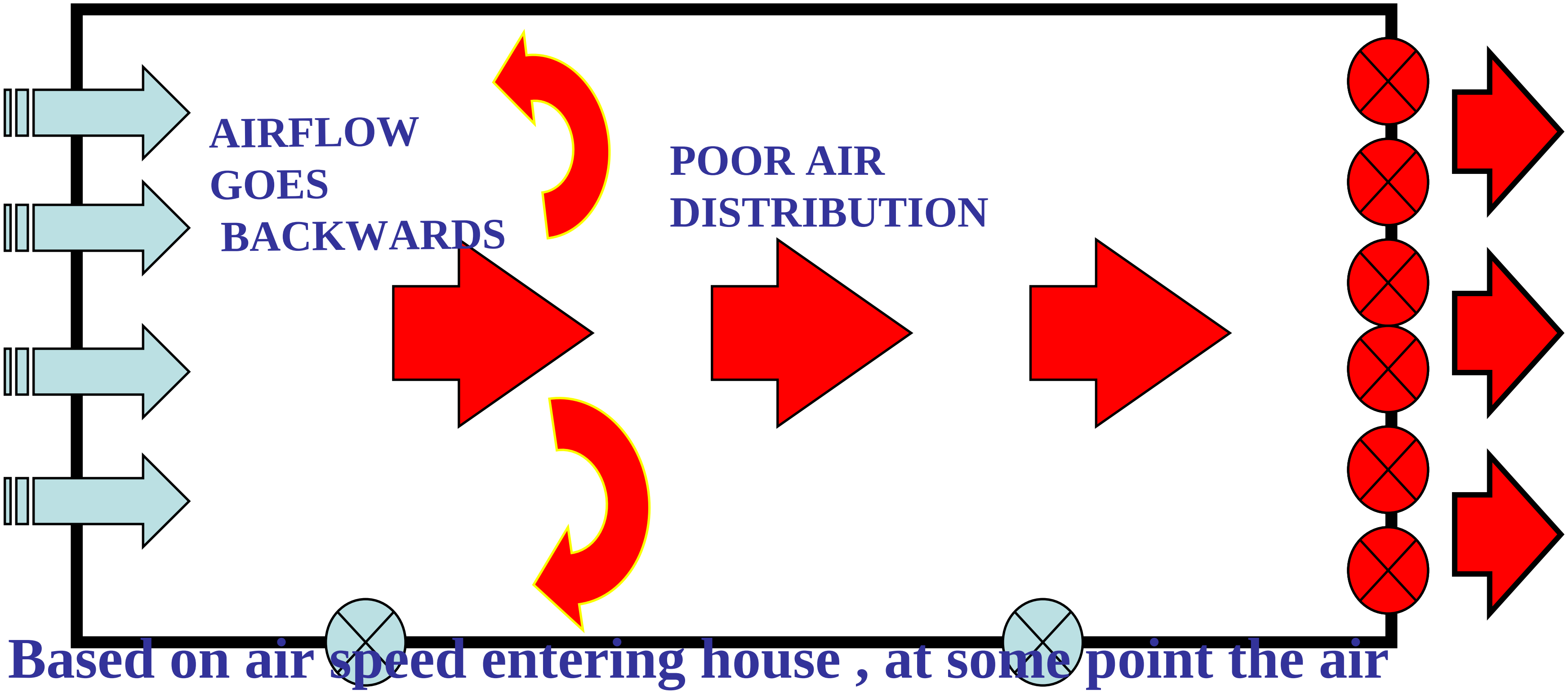
IMPOSSIBLE TO MOVE AIR IN TWO DIRECTIONS AT ONE TIME CREATING TURBULENCE IN CORNERS AND CUTTING OFF AIR EACH WAY

ON TUNNEL VENTILATED HOUSES WIDER THAN 15 METERS PLACE INLETS ON SIDEWALL AND END OF HOUSE



ALLOWS FOR BETTER AIR DISTRIBUTION WITH A LOWER INLET PRESSURE WI NO DEAD SPOTS ON END OF HOUSE

TUNNEL VENTILATION WITH INLETS ON END OF HOUSE



Based on air speed entering house , at some point the air will drop and move along the floor in the opposite direction. Causing bird migration

SOLIDWALL BLACKOUT REARING HOUSE

Summer Ventilation Problems

- **When air speed though the house is too slow you either must check all leaks, check all belts on fans, make sure inlet opening is not restricted too much (high pressure), check all shutters on fans, check the size and location of light traps, insure evaporative pads are not dirty and stopped up,install baffles, or install more fans.**
- **If air speed up toward fans house is leaking from end to end.**
- **If air slows down toward fans inlet capacity is more than the ability of the fans to deliver the inlet volume of air.**
- **When baffles are installed too low the pressure drop will reduce the volume of all the fans and actually slow the air speed through the house down.**
- **When inlet pressure (air speed) is too low close the inlet opening until proper pressure is obtained. Set pressure on solid state control properly. Control static pressure setting will be from .015 to .02 higher than actual inlet pressure.**
- **With VF48 inlets and they stay open make sure the weights are on the louvers and are correctly sized.**

Proper Use Of Evaporative Cooling Or Foggers.

- REMEMBER YOU GET NO COOLING FROM WATER BUT THE EVAPORATION OF THE WATER
- When evaporative cooling is used the cooling pad surface area should match the fan volume for highest evaporation rate. Divide total fan capacity at .10 pressure drop by 400 for 6 inch pads, 250 for 4 inch pads, and 150 for 2 inch fogger pads to determine surface area.
- Pumps should never run below 82°F/28°C or if the humidity is higher than 70%.
- Anytime free flowing water can be seen running down the surface area of the pads the pumps should not be in running. (Poor evaporation)
- When foggers are used the mist should dissipate by 5 feet/1.5 meters from the floor.
- Nozzles should never be concentrated in a small area of the house.
- The mist from one fogger line or nozzle should never pass the next line or nozzle down the house.
- The mist should never be allowed to go all the way down to bird level. (When this is allowed to happen you will stratify all the heat and humidity down at bird level creating high heat index numbers on floor.)

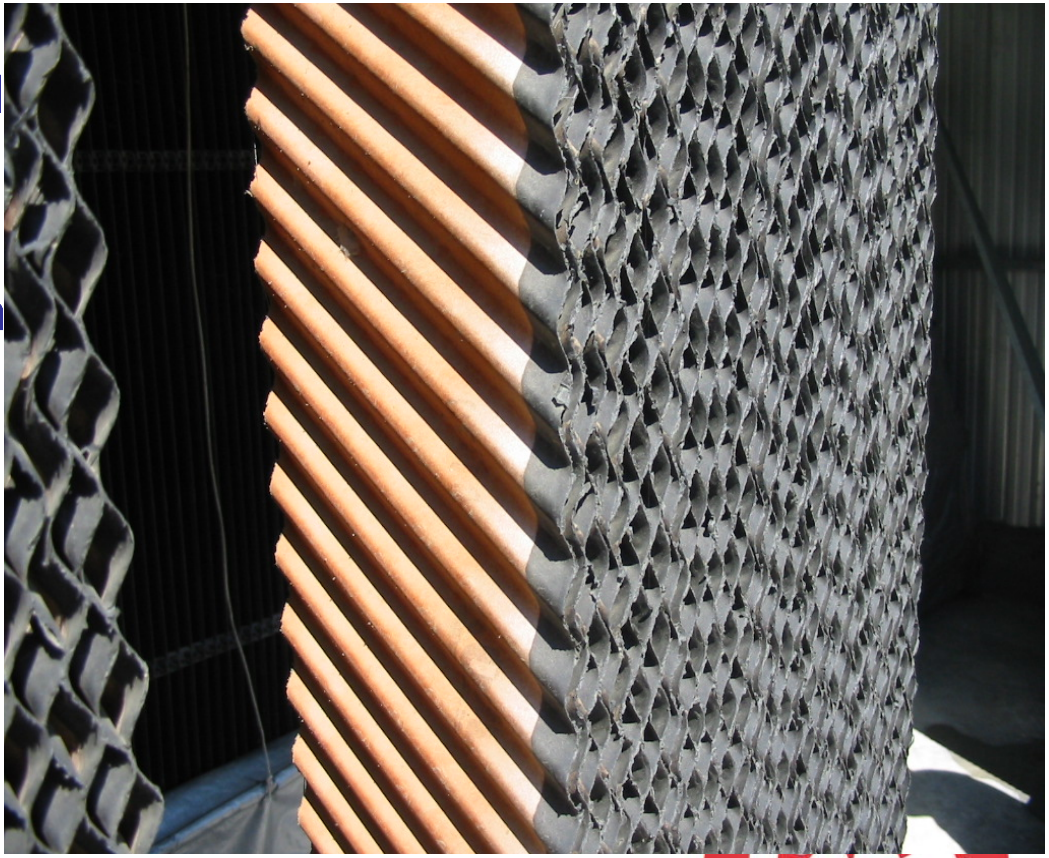
MISUNDERSTANDING AND MISUSE OF EVAPORATIVE COOLING SYSTEMS

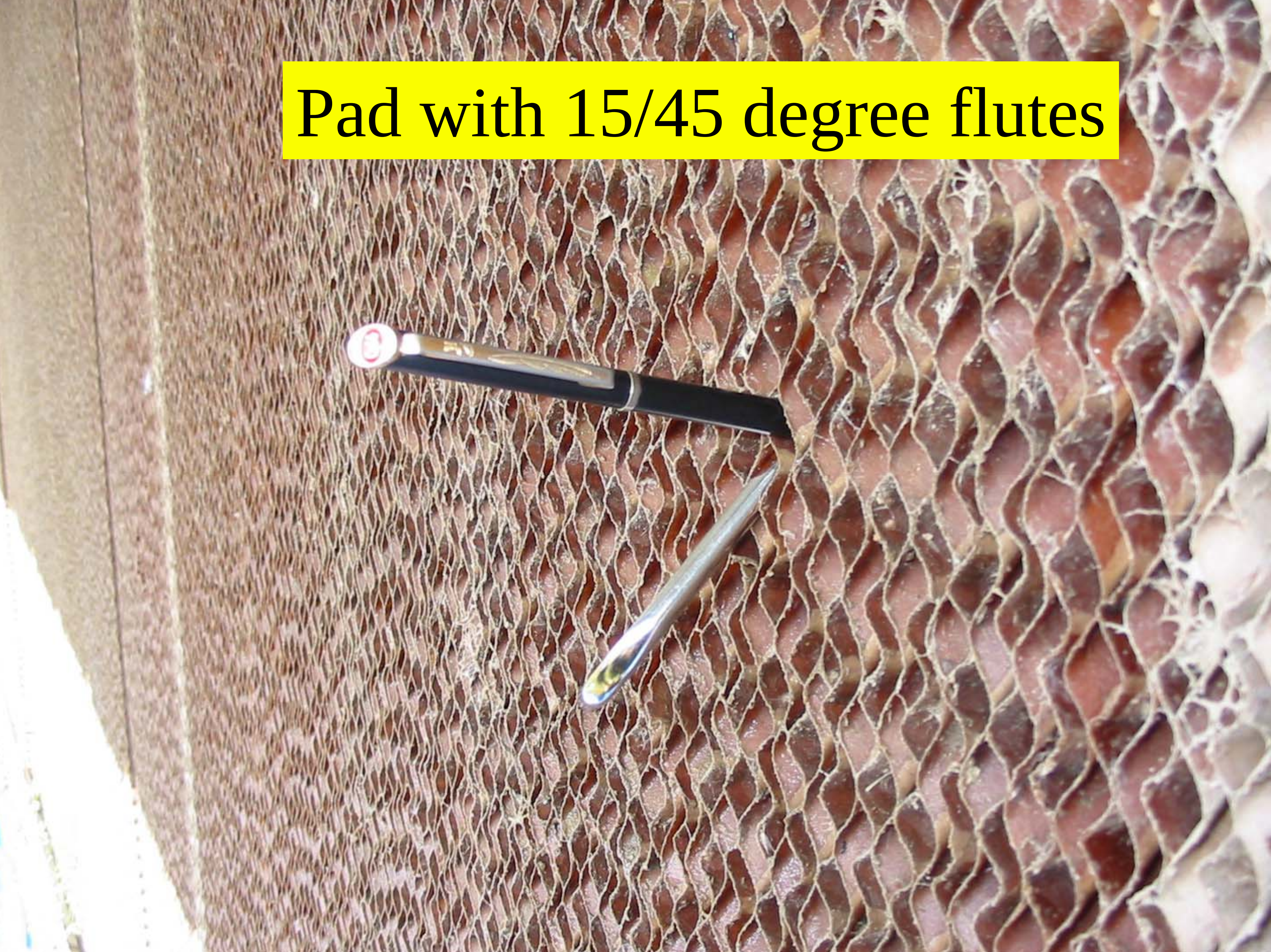
- 1. PADS INSTALLED IN WRONG DIRECTION, DAMAGED, AND DIRTY
- 2. OVERRUNNING PUMPS ON PADS WHEN HUMIDITY IN INCOMING AIR IS TOO HIGH
- 3. PURGE SYSTEMS REGULARLY TO DELUTE % OF SOLIDS IN WATER RECOVERY SYSTEM
- 4. PROPER TYPE AND ARRANGEMENT OF PADS IN COOLING UNITS
- 5. PAD SPACE TO MATCH FAN CAPACITY AT THE PROPER PRESSURE DROP
- 6. WATER TEMPERATURE ON PADS AND THE EFFECTS ON EVAPORATION

2 Pad Slopes Available

Pad slope 30-30, most of the time used with 6 inch thick and in mid to high humid areas.

Pad slope 45-15, used more in very dry environment in which the 45º inclination is directed outwards to give more evaporative capacity (dry up faster).




Pad with 15/45 degree flutes


Never shade the pads or cover with a net
23 9 2002

Never bury the water recovery systems - Please!

Buried water reservoir for the pads. Temperature of the water stays too cool and evaporation on pads below normal, increasing the RH in the house and with that mortality.


Severe over use of fogging system

Over use of evaporative cooling

Birds panting

HEAT INDEX NUMBERS HIGH

FORMULA FOR FIGURING 6 INCH COOLING PADS FOR TUNNEL VENTILATION HOUSES

- TAKE TOTAL FAN CAPACITY DIVIDED BY **400 FEET PER MINUTE PER SQUARE FOOT = TOTAL SQUARE FEET OF PADS NEEDED DIVIDED BY THE HEIGHT OF THE PADS = TOTAL LENGTH
- (8 FANS X 21,500 CFMS EACH = 172,000 CFMS DIVIDED BY 400 = 430 SQUARE FEET DIVIDED BY 5 FOOT HIGH = 86 FEET LONG)
- YOU THEN PLACE ½ ON EACH SIDE OF THE HOUSE ON OPPOSITE END OF HOUSE FROM FANS

- ** <u>6</u> INCH PADS DIVIDE BY 400 **<u>4</u> INCH PADS DIVIDE BY 250 **<u>2</u> INCH PADS DIVIDE BY 150

FORMULA FOR FIGURING CURTAIN INLET OPENING FOR HOUSE WITH 6 INCH COOLING PADS FOR TUNNEL VENTILATION HOUSES

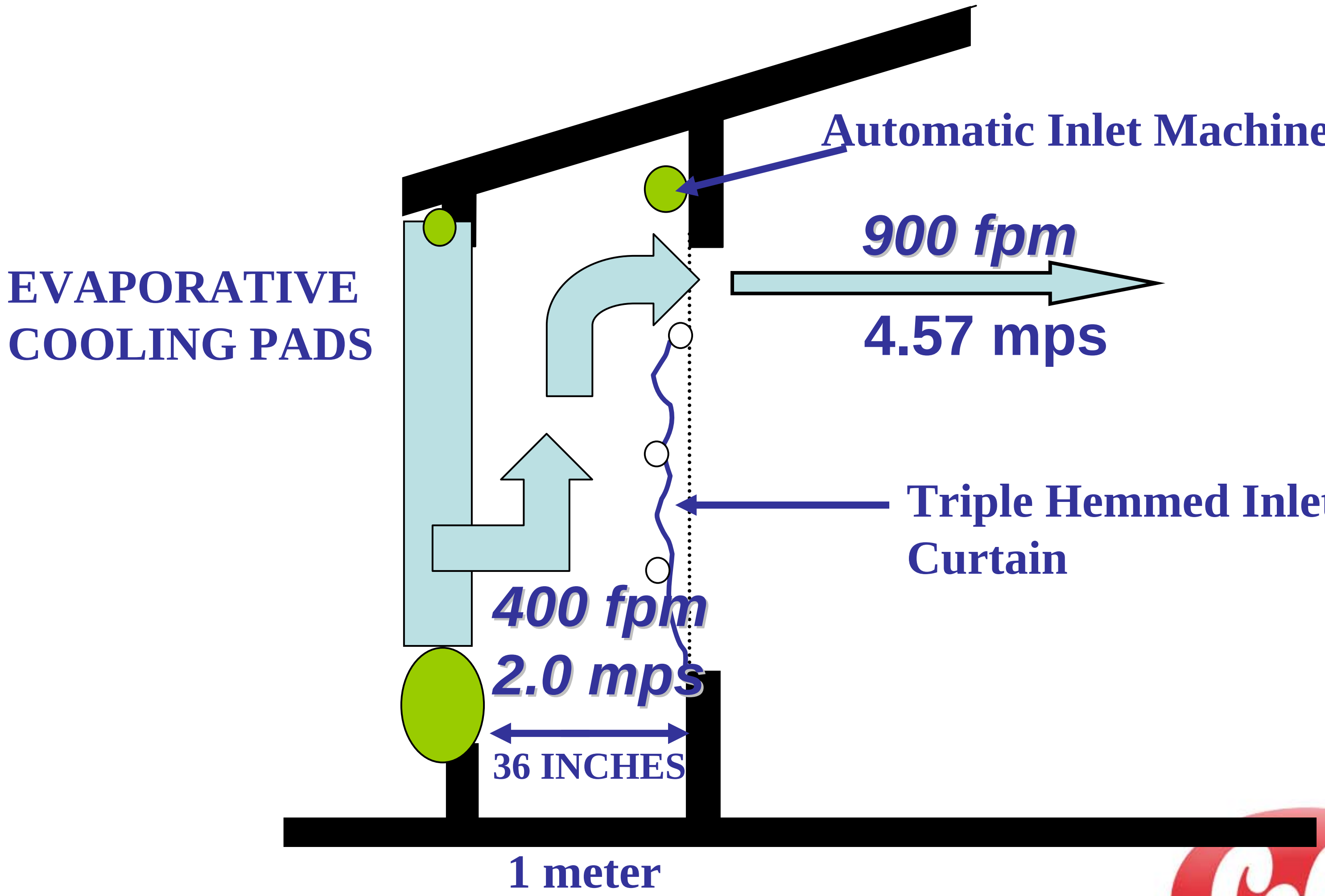
- TAKE TOTAL FAN CAPACITY AT ACTUAL WORKING PRESSURE DIVIDED BY 5 DIVIDED BY 144 DIVIDED BY TOTAL LENGTH OF PADS = WIDTH OF OPENING FOR 40 FOOT WIDE HOUSE   (See Negative Pressure Scale)

  - EXAMPLE

- (172,000 TOTAL CFMS DIVIDED BY 5 DIVIDED BY 144 DIVIDED BY 86 FEET LONG = 2.8 FEET)

- As long as the cross section of the inlet opening equals the cross section of the house based on air speed across the inlet and air speed though the house it will not effect air speed through the house.

Doghouse Design Installation Cooling Pads




MAXIMUM INLET OPENING
SUMMER INLET CURTAIN

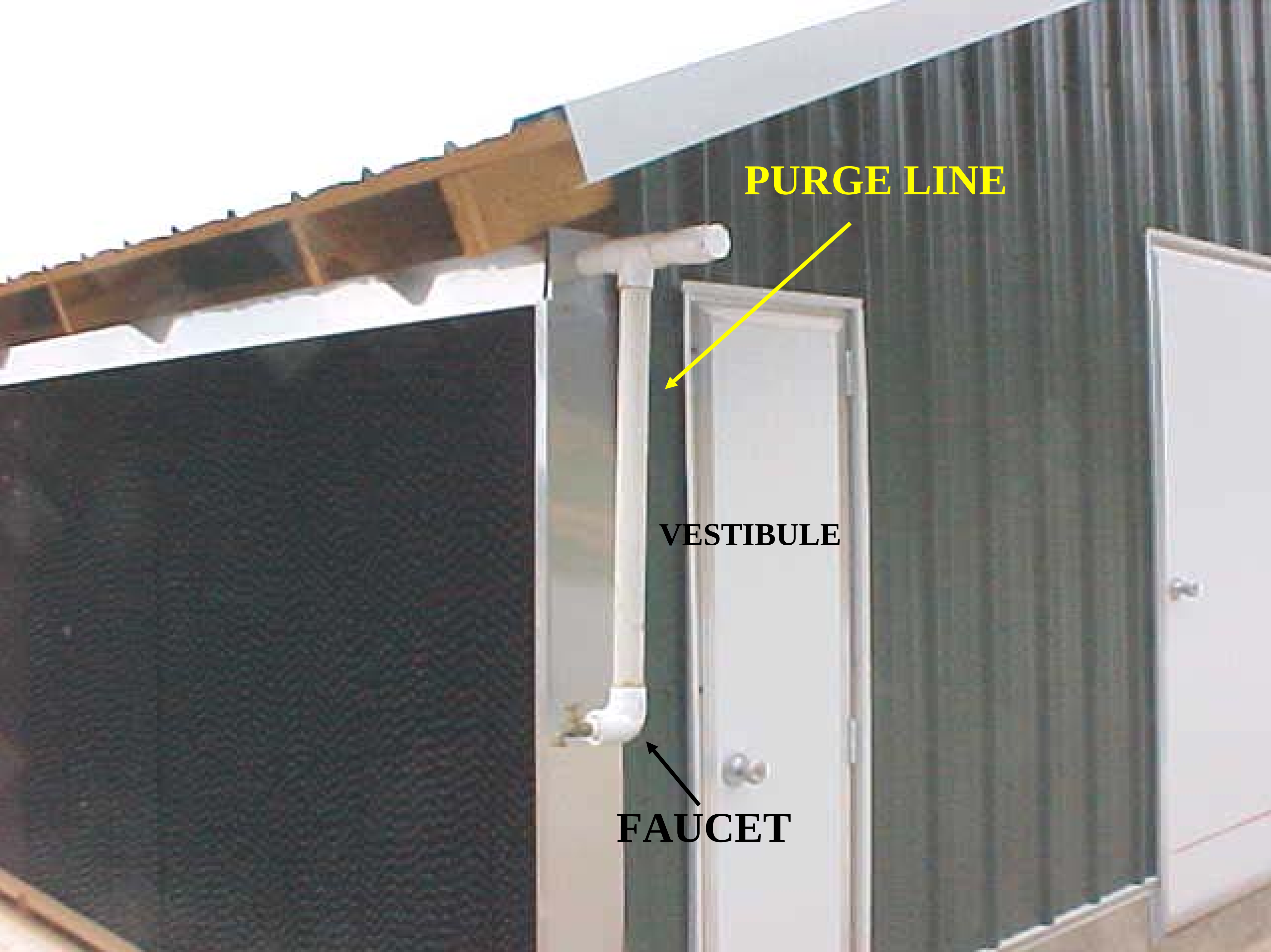
MINI CURTAIN


Top hem behind mini curtain.
Second hem down 1 foot from top hem.
Third hem down 1.5 feet from second hem.

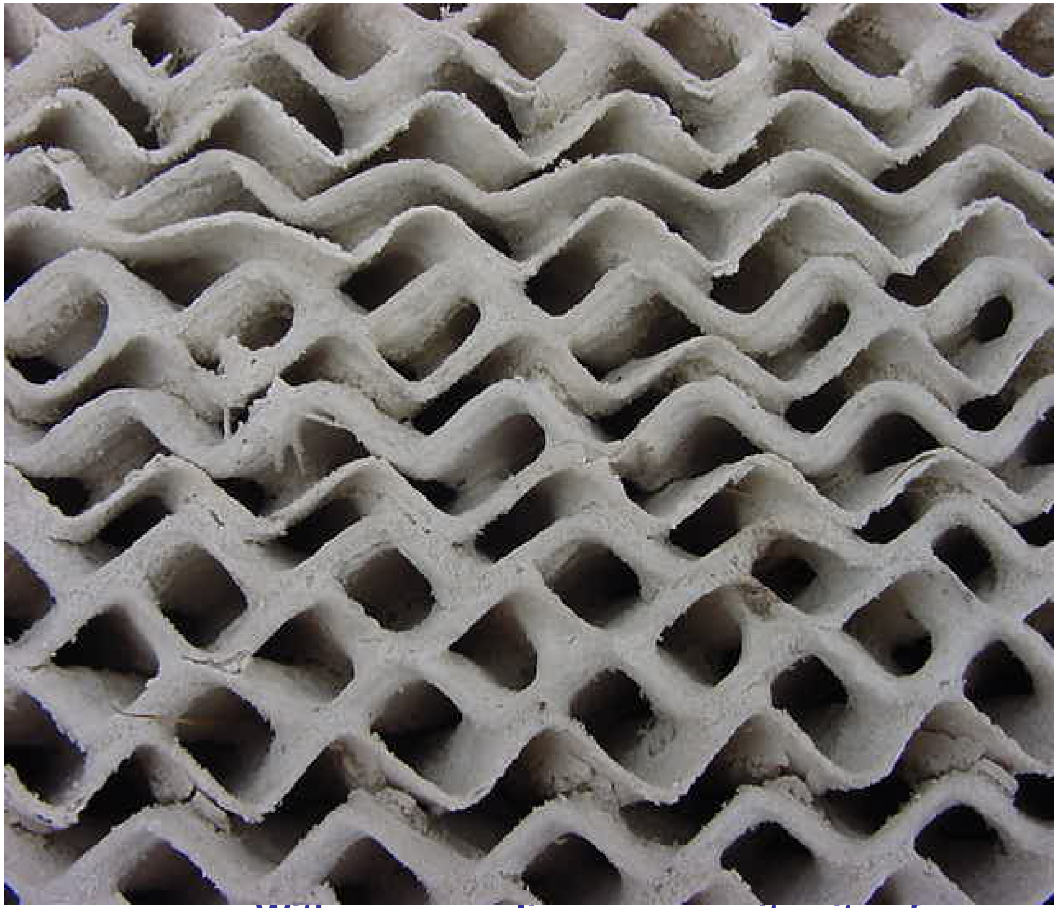
Automatic Inlet Machine
For summer inlet curtains

EVAPORATIVE COOLING MAINTENANCE

1. INSURE PADS ARE INSTALLED IN THE RIGHT DIRECTION.
2. SEAL ALL AIR LEAKS AROUND EVAPORATIVE PADS.
3. USE ONLY ABOVE GROUND WATER RECOVERY SYSTEM.
4. PROTECT STANDING WATER IN PUMP TANK FROM DIRECT SUNLIGHT. (Retards algae growth)
5. PROTECT CLEAR FILTER UNITS ON SYSTEM FROM DIRECT SUNLIGHT. (Retards algae growth)
6. CLEAN SYSTEM AT LEAST YEARLY WITH SURFACTANT.
7. WASH SYSTEM GOOD WITH LOW PRESSURE WATER HOSE IN THE DIRECTION OF THE FLUTES.
8. INSURE THERE IS A GOOD PURGE SYSTEM ON ALL EVAPORATIVE COOLING SYSTEMS ON OPPOSITE END FROM PUMP UNIT. THE PURGE SYSTEM SHOULD BE DRAINED AT LEAST WEEKLY.


PURGE LINE
VESTIBULE
FAUCET

No Purge Lines in Cooling pad System



- With no purge line on opposite site of pump, mineral deposits will accumulate on the pads and render them useless when they become mineralized.

Temperature reduction that may be accomplished with evaporative cooling when dry-bulb temperature and relative humidity are known.

*** With a good fogging system you can expect about 55% of this.**

Dry Bulb — **Relative Humidity**

F°	C°													
70	21.1	86	77	68	59	51	44	36	29	22	15	9	3	0
72	22.2	86	77	69	61	53	45	38	31	24	18	12	6	0
74	23.3	86	78	69	61	54	47	39	33	26	20	14	8	3
76	24.4	87	78	70	62	55	48	41	34	28	22	16	11	5
78	25.6	87	79	71	63	56	49	43	36	30	24	18	13	8
80	26.7	87	79	72	64	57	50	44	38	32	26	20	15	10
82	27.8	88	80	72	65	58	51	45	39	33	28	22	17	12
84	28.9	88	80	73	66	59	52	46	40	35	29	24	19	14
86	30.0	88	81	73	66	60	53	47	42	36	31	26	21	16
88	31.1	88	81	74	67	61	54	48	43	37	32	27	22	18
90	32.2	89	81	74	68	61	55	49	44	39	34	29	24	19
92	33.3	89	82	75	68	62	56	50	45	40	35	30	25	21
94	34.4	89	82	75	69	63	57	51	46	41	36	31	27	22
96	35.6	89	82	76	69	63	58	52	47	42	37	32	28	24
98	36.7	89	83	76	70	64	58	53	48	43	38	34	29	25
100	37.8	89	83	77	70	65	59	54	49	44	39	35	30	26
102	38.9	90	85	78	72	67	62	56	51	46	42	36	32	28
104	40.0	90	85	78	72	67	62	56	52	47	43	38	33	29
106	41.1	90	85	78	73	67	62	57	52	47	43	39	34	30

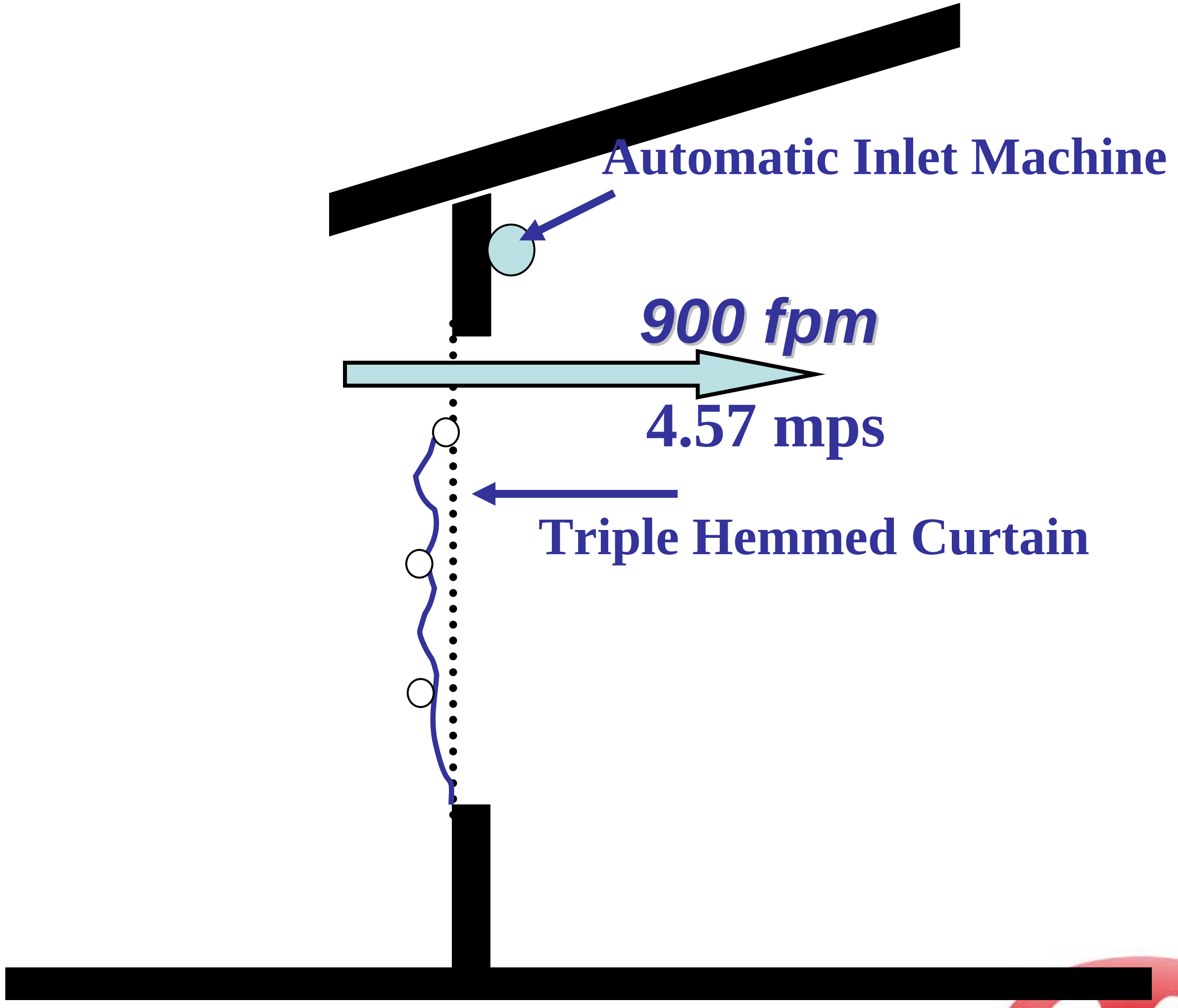
Potential cooling for a given temperature and relative humidity

Drop in º F	3	5	7	9	11	13	15	17	19	21	23	25	27
Drop in º C	1.7	2.8	3.9	5.0	6.1	7.2	8.3	9.4	10.6	11.7	12.8	13.9	15.0

FORMULA FOR FIGURING CURTAIN INLET OPENING FOR TUNNEL VENTILATED HOUSES WITH FOGGERS

- TAKE TOTAL FAN CAPACITY AT ACTUAL WORKING PERSSURE DIVIDED BY 5 DIVIDED BY 144 DIVIDED BY 2.5 FEET MAXIMUM OPENING = LENGTH OF OPENING FOR 40 FEET WIDE HOUSE
  - EXAMPLE
- (172,000 TOTAL CFMS DIVIDED BY 5 DIVIDED BY 144 DIVIDED BY 3 FEET (1 meter) = 80 FEET (24 METERS) LONG)
- AS FANS STAGE ON AND OFF THE INLET OPENING SHOULD CHANGE TO MAINTAIN THE SAME PRESSURE DROP ACROSS THE INLET AT ALL TIMES.
- **To figure inlet opening based on number of fans in operation now take the actual fan capacity divided by 5 divided by 144 divided by length of opening = width of opening needed.

Tunnel Inlet Control Using Foggers



Evaporative Cooling Problems When Floors Get Wet Or Humidity Goes Too High

- **Air speed through pads too fast. Not enough pad space for fan capacity or pads are dirty and/or stopped up.**
- **Air speed through pads too slow. Running the pumps with less than all the fans in operation or pad space to little for fan capacity.**
- **Running pumps when temperature is too low.**
- **Running pumps when relative humidity is too high.**
- **Pads in the system backwards. Steepest angle of flutes must be toward the ground toward the outside of the house.**
- **Too much run time on the pump and pads become completely saturated.**
- **Summer inlet curtain all the way to the floor and inlet air speed too slow.**

Formula For Figuring Fogger Nozzles

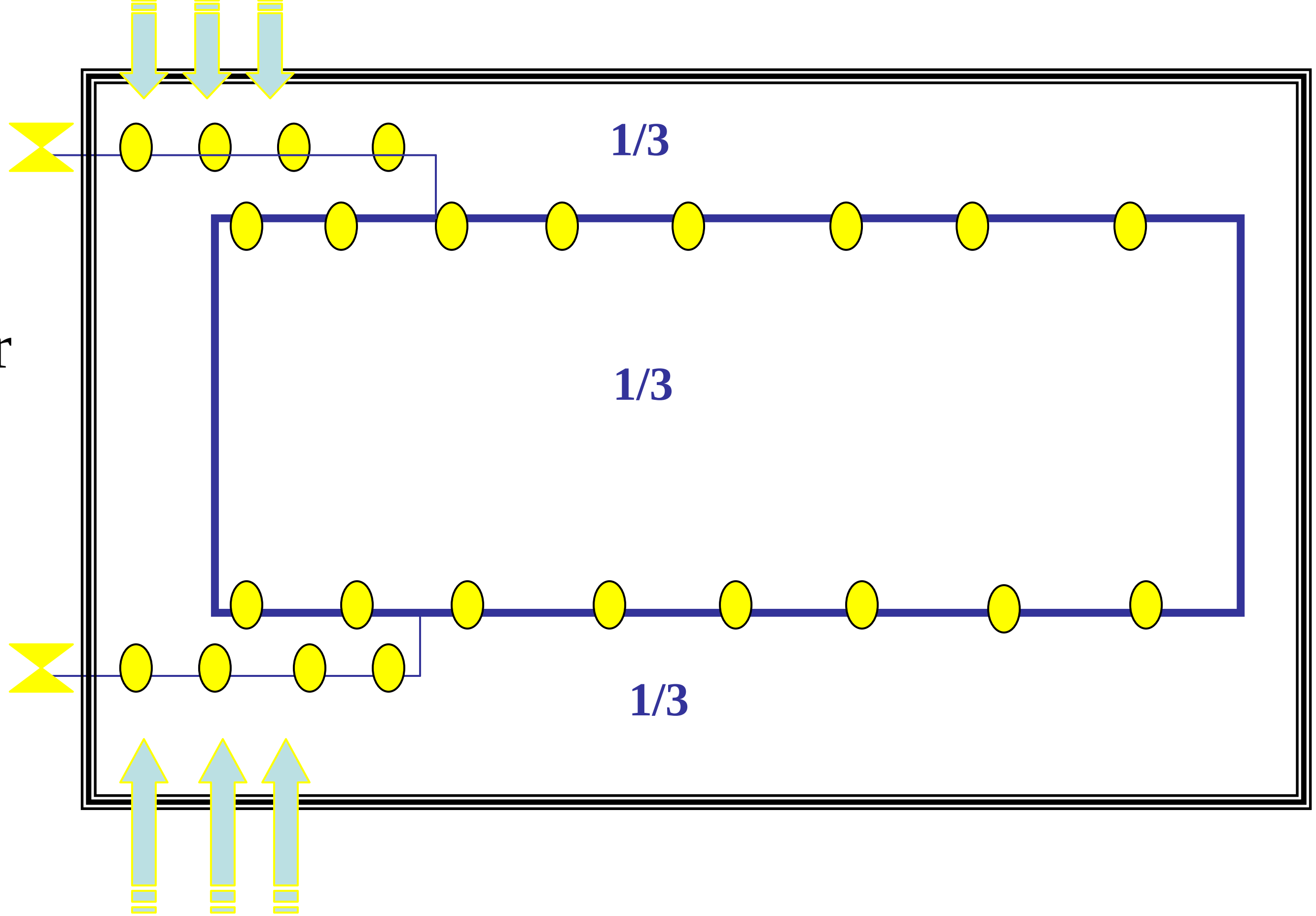
- In houses that are less than 13.7 meters (45 feet) wide there should be two rows of nozzles through out the house with each line being 1/4 the distance from each sidewall. In houses wider than 13.7 meters (45 feet) wide there should be 3 lines evenly spaced.
- There should be 2GPH nozzles installed pointing straight down on 3 meters (10 feet) centers on each line and staggered from side to side through the house.
- The fogging lines should be installed in a complete loop through the house.
- There should be a automatic drain valve installed on each line to evacuate the water outside the house when the pump goes off.
- The fogger nozzles should never be installed lower than 2.3 meters (7.5 feet) from the floor.

Formula For Figuring Fogger Nozzles

- The fogger nozzles should never be installed higher than 2.6 meters (8.5 feet) from the floor.
- On tunnel ventilated houses there should be a line Teed off the two lines to install a line in front of the tunnel inlet 1.5 meters (5 feet) out from the inlet opening with 2 GPH nozzles on 1.5 meter (5 foot) centers.
- Never introduce mist (water vapor) into air moving faster than 2.54 mps (500 fpm).
- There should be a ¾ inch supply water line from the pump to the main fogger line.
- The pump should be run based on temperature and humidity combination and never temperature only. A humidistat or cycle timer should be used in conjunction with the thermostat.

House >12 m or 40 feet wide.

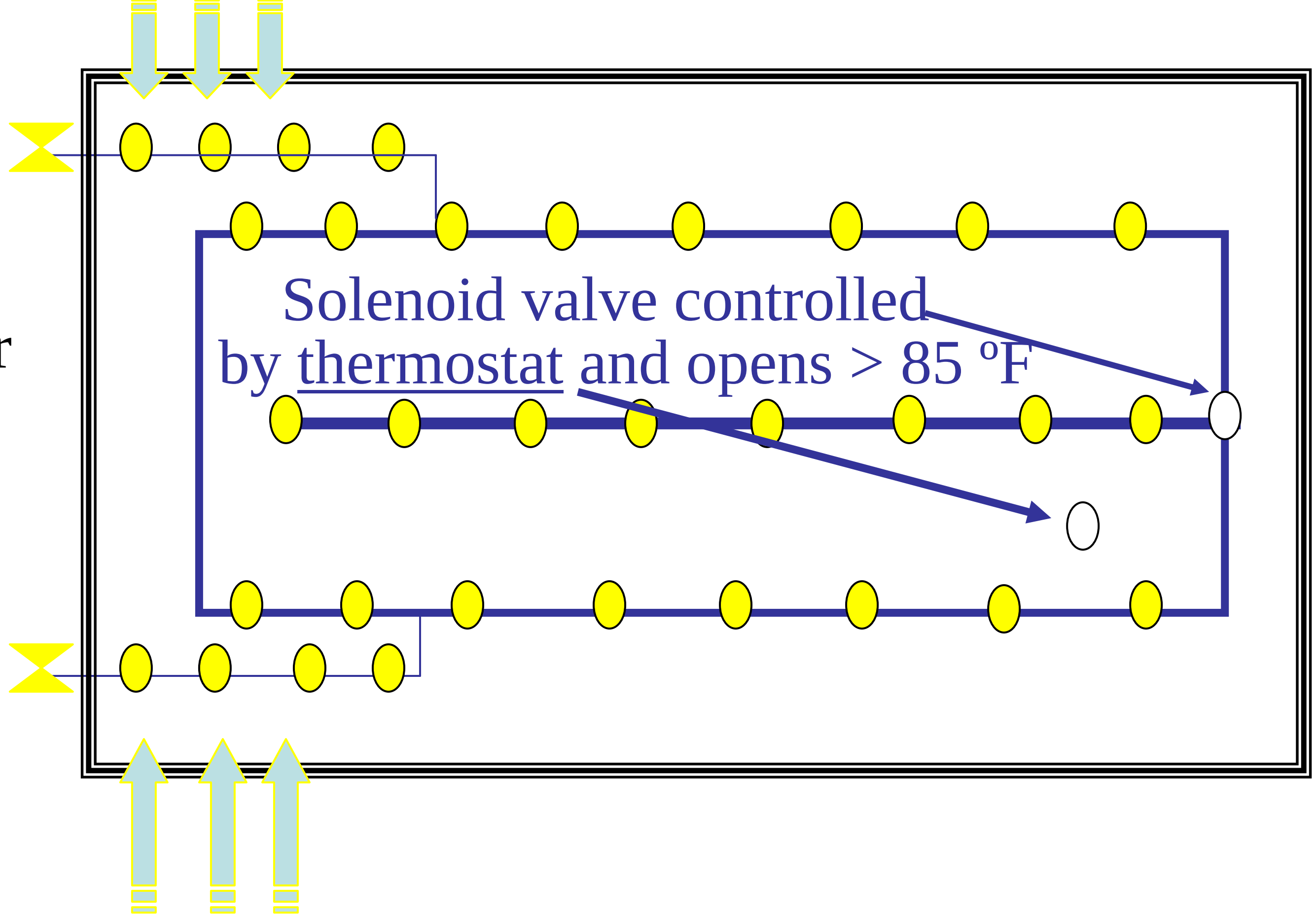
Automatic drain valves



150 PSI nozzles with capacity of 2 gallons/hr (R&C or Monarch)
From pomp to main line is ¾" pipe, loop is ½ " pipe.
Loop is needed to avoid dripping and fogging at the same time and the drain valves are needed to avoid dripping when pump is shut down. Fogger loop starts working > 82 ºF.

House >15 m or 49 feet wide.

Automatic drain valves



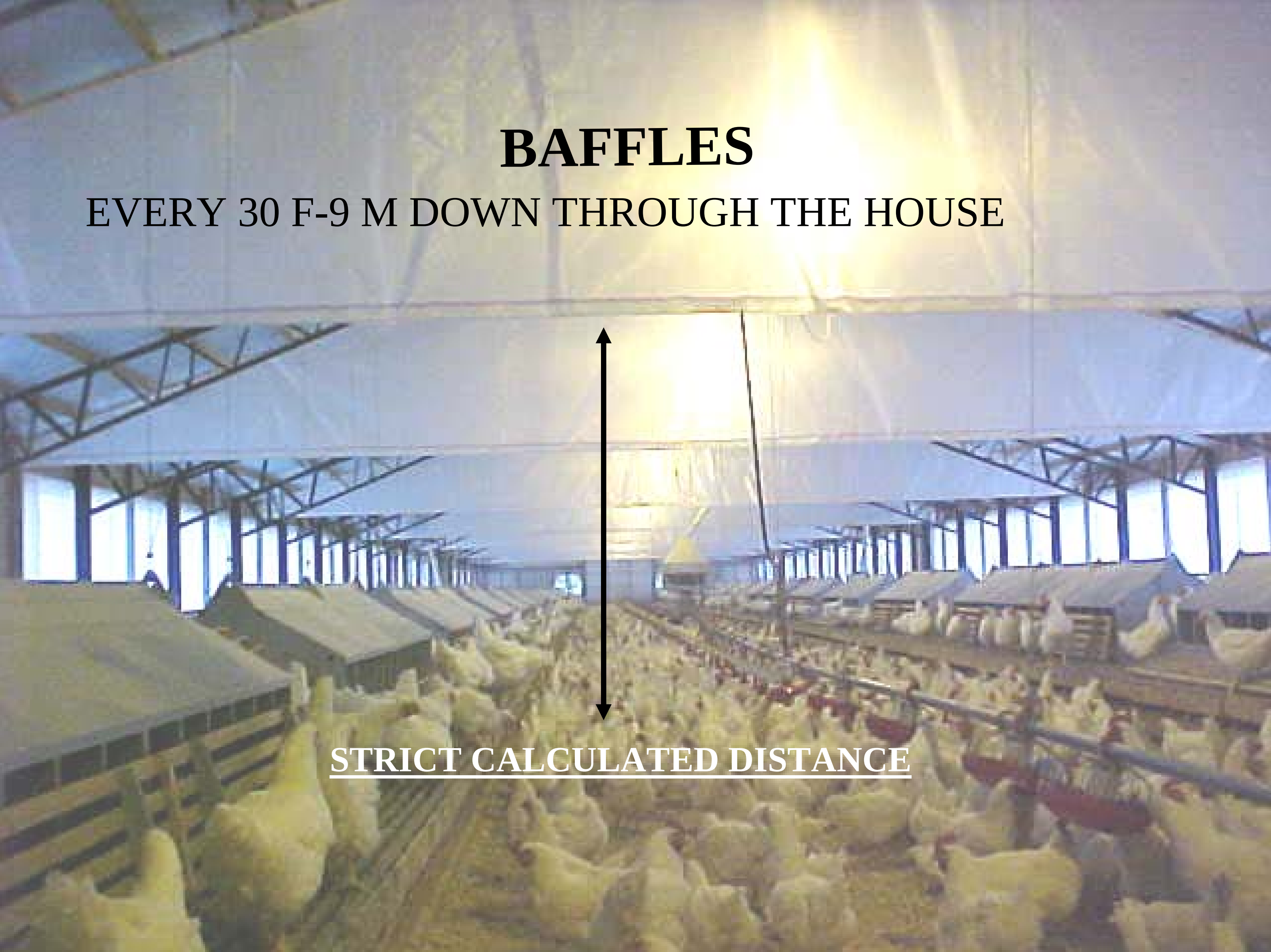
150 PSI nozzles with capacity of 2 gallons/hr (R&C or Monarch)
From pomp to main line is ¾” pipe, loop is ½ “ pipe.
Loop is needed to avoid dripping and fogging at the same time and the drain valves are needed to avoid dripping when pump is shut down. Fogger loop starts working > 82 ºF.

FORMULA FOR FIGURING INLET AREA BASED ON HOUSE PRESSURE AND/OR WIDTH OF THE HOUSE

- THE HOUSE WIDTH SHOULD DETERMINE THE PRESSURE DROP YOU USE FOR BEST RESULTS AND TO FIGURE INLET SPACE FOR BEST DISTRIBUTION OF AIR THOUGH THE HOUSE
    - EXAMPLES OF PRESSURE DROPS USED
- PRESSURE -INLET SPACE -WIDTH OF HOUSE--AIR SPEED
- .03 1 SQ.IN. 4.0 CFMS 10.4 M 34 F 700 FPM 3.55 MPS
- .04 1 SQ.IN. 4.5 CFMS 10.9 M 36 F 800 FPM 4.06 MPS
- .05 1 SQ.IN. 5.0 CFMS 12.2 M 40 F 900 FPM 4.57 MPS
- .06 1 SQ.IN. 5.5 CFMS 13.7 M 45 F 1000 FPM 5.08 MPS
- .07 1 SQ.IN. 6.0 CFMS 15.2 M 50 F 1100 FPM 5.59 MPS
- .08 1 SQ.IN. 6.5 CFMS 18.3 M 60 F 1200 FPM 6.10 MPS
- ** 144 square inches in one square foot

FROMULA FOR FIGURING BAFFLES TO GET INCREASED AIR VELOCITY THROUGH HOUSES WITH LOW AIR SPEED

- FIRST YOU MUST KNOW THE TOTAL CFMS OF SUMMER FAN CAPACITY AT ACTUAL WORKING PRESSURE BASED ON (BESS LABS BOOK)
- TAKE TOTAL FAN CAPACITY DIVIDED BY DESIRED AIR SPEED = CROSS SECTION OF HOUSE NEEDED
- NOW DIVIDE CROSS SECTION BY HOUSE WIDTH OF HOUSE = HEIGHT BAFFLE SHOULD BE FROM FLOOR.
- * BAFFLES SHOULD ALWAYS BE PLACED 30 FEET APART
- EXAMPLE
- 140,000 TOTAL CFMS OF FAN CAPACITY DIVIDED BY 450 FEET PER MINUTE = 311 SQUARE FEET CROSS SECTION DIVIDED BY 40 FEET WIDE = **7.8** FEET FROM THE FLOOR
- ** IF BAFFLES ARE INSTALLED TO LOW THE PRESSURE DROP IN THE HOUSE WILL BE TO HIGH, WHICH WILL INCREASE OPERATING COST AND REDUCE AIR VOLUME


BAFFLES
EVERY 30 F-9 M DOWN THROUGH THE HOUSE
STRICT CALCULATED DISTANCE

Formula For Figuring Light Traps For Blackout Rearing Houses

- AT FAN AREA OF THE HOUSE TAKE THE TOTAL FAN CAPACITY AT 0.15 PRESSURE DROP DIVIDED BY 4 = SQUARE INCHES OF LIGHT TRAPS NEEDED -- NOW DIVIDE BY THE SIZE OF THE LIGHT TRAP TO BE USED = TOTAL NUMBER OF LIGHT TRAPS NEEDED (When possible place light traps on solid wall 3 feet from fans)
- AT THE INLET AREA OF THE HOUSE TAKE THE TOTAL FAN CAPACITY AT 0.15 PRESSURE DROP DIVIDED BY 5 = SQUARE INCHES OF LIGHT TRAPS NEEDED – NOW DIVIDE BY THE SIZE OF THE LIGHT TRAP TO BE USED= TOTAL NUMBER OF LIGHT TRAPS NEEDED
- * WITH THE EXCEPTION OF MINIMUM VENTILATION FANS NEVER INSTALL A LIGHT TRAP OVER A FAN IF POSSIBLE
- ** LIGHT TRAPS SHOULD ALWAYS BE INSTALLED A MINIMUM OF ¼ THE DIAMETER OF THE FAN AWAY FROM THE FANS

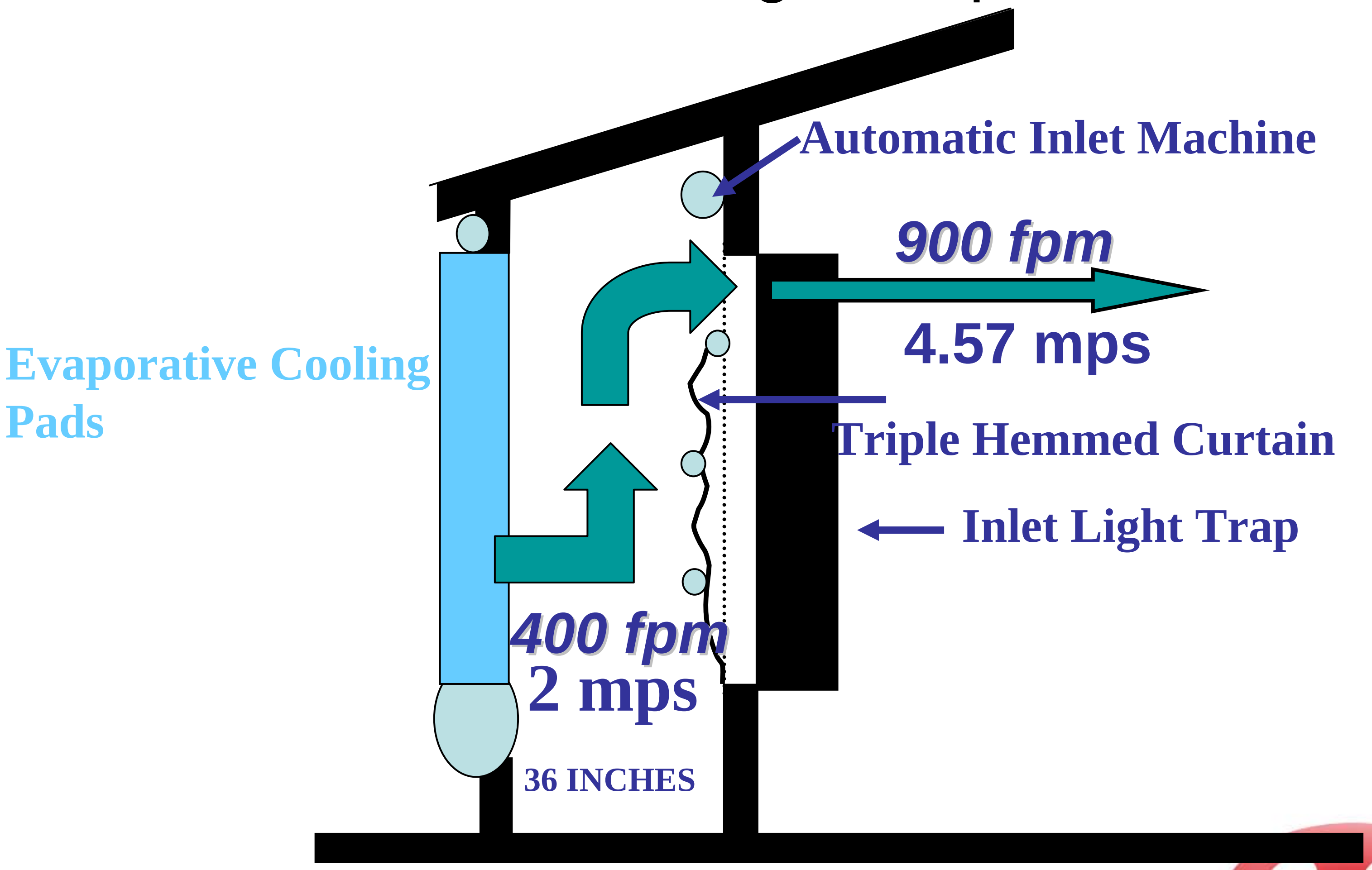
EXAMPLE FOR FIGURING LIGHT TRAPS FOR BLACKOUT REARING HOUSES

- FAN AREA OF THE HOUSE HOUSE
- 3 Fans X 21,500 cfms each = 64,500 total cfms divided by 4 =16,125 square inches of traps needed divided by 4,096 (64 X 64 inch trap) = 3.96 traps (**4 traps needed)**

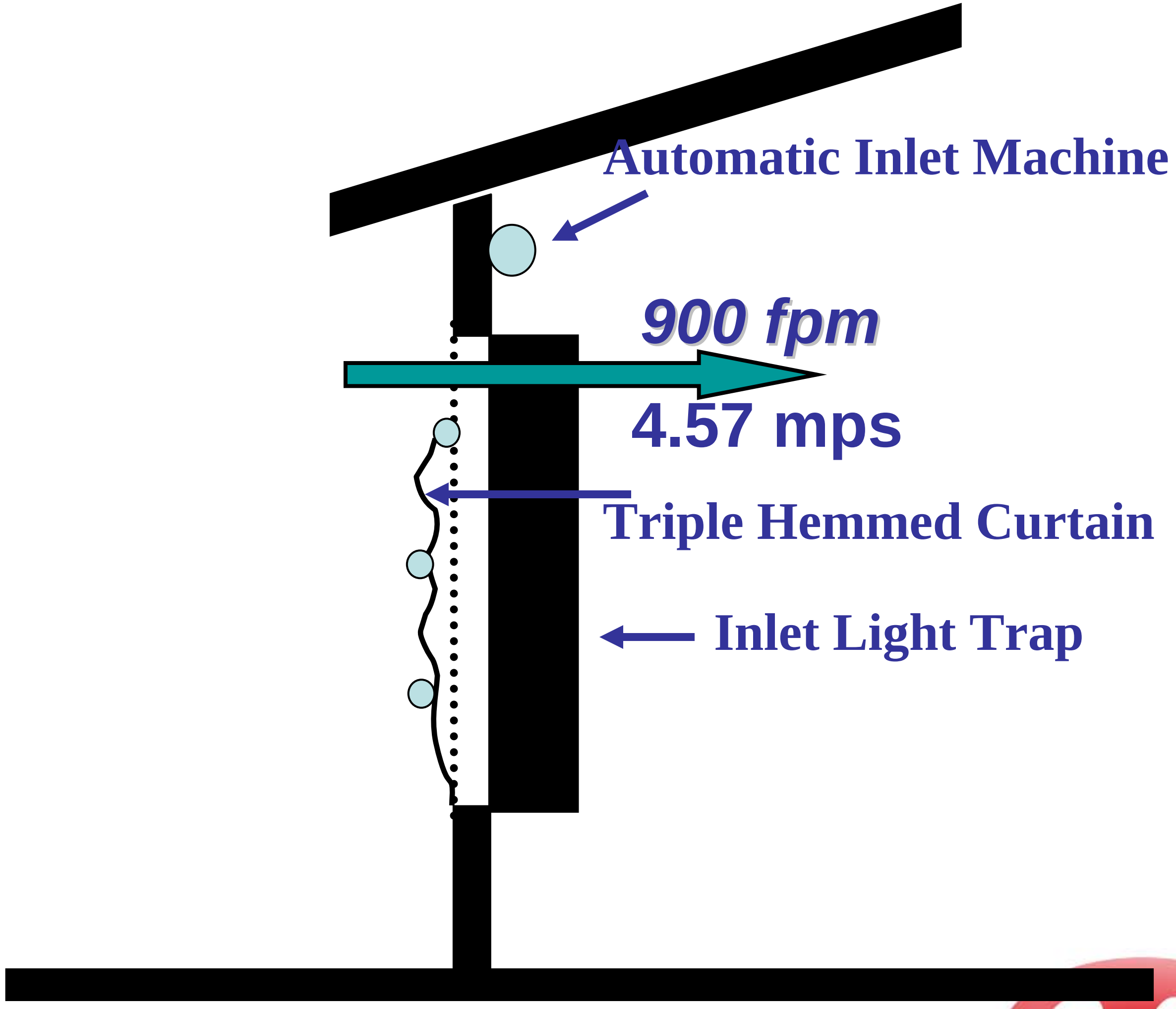
- INLET AREA OF THE HOUSE
- 3 Fans X 21,500 cfms each = 64,500 total cfms divided by 5 = 12,900 square inches of traps needed divided by 4,096 (64 X 64 inch trap) = 3.15 traps (**3 traps needed**)

- *When placing light trap over evaporative cooling pads since the length is fixed the height of the pads only has to be what is necessary to get the total square inches needed.

Dog House Design Installation Cooling Pads and Light Traps



Inlet Light Trap Installation No Pads



Criteria For Selecting Fans

1. Cfm ratings at actual operating pressure drop
2. Energy factor CFM/WATT
3. Shutter should always be behind fan (pull open)
4. All negative pressure fans should have slant wall housing
5. All negative pressure fans should have discharge cones
6. All fans above 36 inch should be belt drive
7. Unless a specific need, all fans should be fixed volume
8. Quality control of fan from fan supplier
9. All belt drive fans above 36 inch should have automatic belt tightness adjusters
10. Purchase price of fan to be used

** Based on BESS LABS FAN MANUAL

EXAMPLE OF A POOR 36 INCH (91 cm) FAN

STATIC PRESSURE	SPEED	AIRFLOW	EFFICIENCY
IN. WATER	RPM	CFM	CFM/WATT
0.00	863	9,780	21.0
0.05	859	9,090	18.7
0.10	855	8,400	16.2
0.15	848	7,590	13.9
0.20	844	6,680	11.7
0.25	836	5,640	9.3
0.30	828	4,420	7.0

EXAMPLE OF A GOOD 36 INCH (91cm) FAN

STATIC PRESSURE IN. WATER	SPEED RPM	AIRFLOW CFM	EFFICIENCY CFM/WATT
0.00	740	12,570	19.6
0.05	784	11,680	17.4
0.10	772	10,630	15.1
0.15	762	9,510	13.2
0.20	754	7,990	10.7
0.25	757	6,520	8.9
0.30	764	4,260	6.0

EXAMPLE OF A GOOD 48 INCH (122cm) FAN

STATIC PRESSURE	SPEED	AIRFLOW	EFFICIENCY
IN. WATER	RPM	CFM	CFM/WATT
0.00	473	23,800	22.5
0.05	472	22,700	20.6
0.10	471	21,600	19.0
0.15	470	20,300	17.2
0.20	470	18,600	15.4
0.25	469	16,700	13.6
0.30	468	14,100	11.0

EXAMPLE OF A POOR 48 INCH (122cm) FAN

STATIC PRESSURE IN. WATER	SPEED RPM	AIRFLOW CFM	EFFICIENCY CFM/WATT
0.00	530	19,000	19.8
0.05	530	17,800	18.1
0.10	528	16,500	16.2
0.15	528	14,900	14.3
0.20	525	12,500	12.0
0.25	525	9,500	8.5
0.30	523	6,100	4.9

EXAMPLE OF A GOOD 50 INCH (127 cm) FAN

STATIC PRESSURE IN. WATER	SPEED RPM	AIRFLOW CFM	EFFICIENCY CFM/WATT
0.00	587	28,500	24.4
0.05	585	26,800	21.7
0.10	583	24,600	19.0
0.15	582	22,300	16.7
0.20	582	17,800	13.2
0.25	584	15,800	12.6
0.30	587	10,900	10.6

EXAMPLE OF A GOOD 52 INCH (132 cm) FAN

STATIC PRESSURE	SPEED	AIRFLOW	EFFICIENCY
IN. WATER	RPM	CFM	CFM/WATT
0.00	650	29,600	26.3
0.05	649	27,900	23.2
0.10	648	26,400	20.7
0.15	646	24,700	18.5
0.20	645	22,800	16.3
0.25	643	20,500	14.2
0.30	642	18,000	12.0

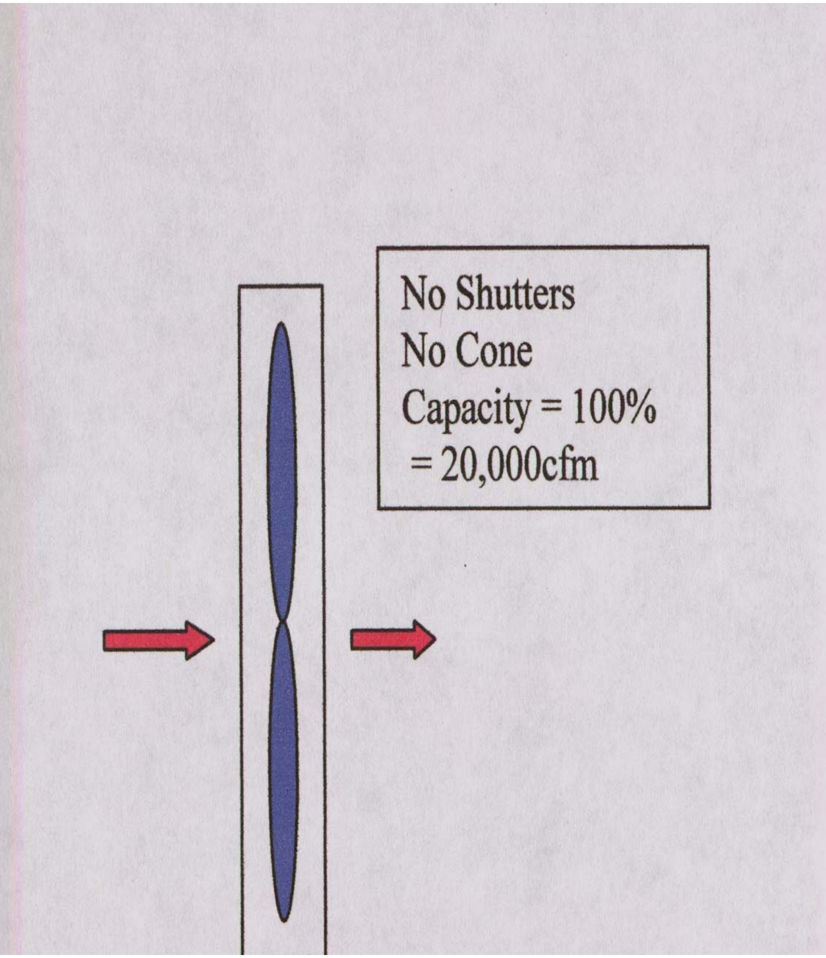
Example of good smaller fans at .10 inches of water pressure drop.

	Static pressure – In. water	Speed RPM	Airflow CFM	Efficiency cfm/watts
36 inch	.10	633	11,200	17.1
24 inch	.10	1086	6,500	12.0
18 inch	.10	1412	2,060	11.3
16 inch	.10	1605	2,330	10.9
14 inch	.10	1566	1,500	10.2
12 inch	.10	1661	1,150	9.6
10 inch	.10	3422	1,130	5.8

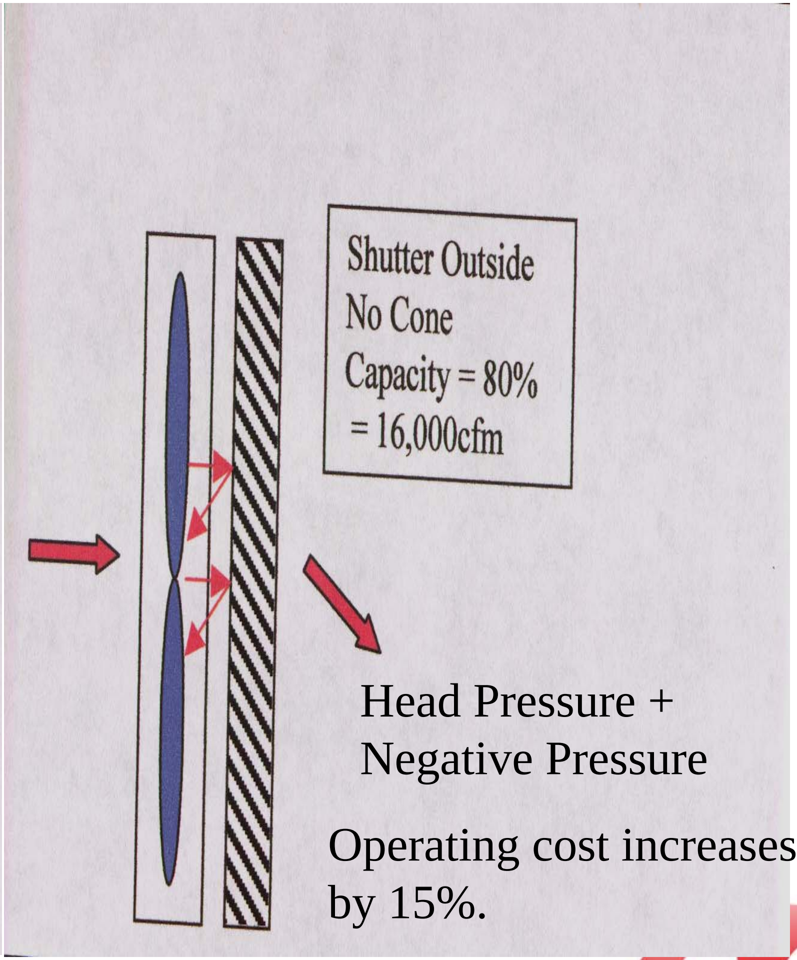
- All these numbers are based on the fans running at 100% capacity on full voltage.

All Panel Fans Rated @ 20,000cfm at Zero Pressure

PANEL FAN ONLY

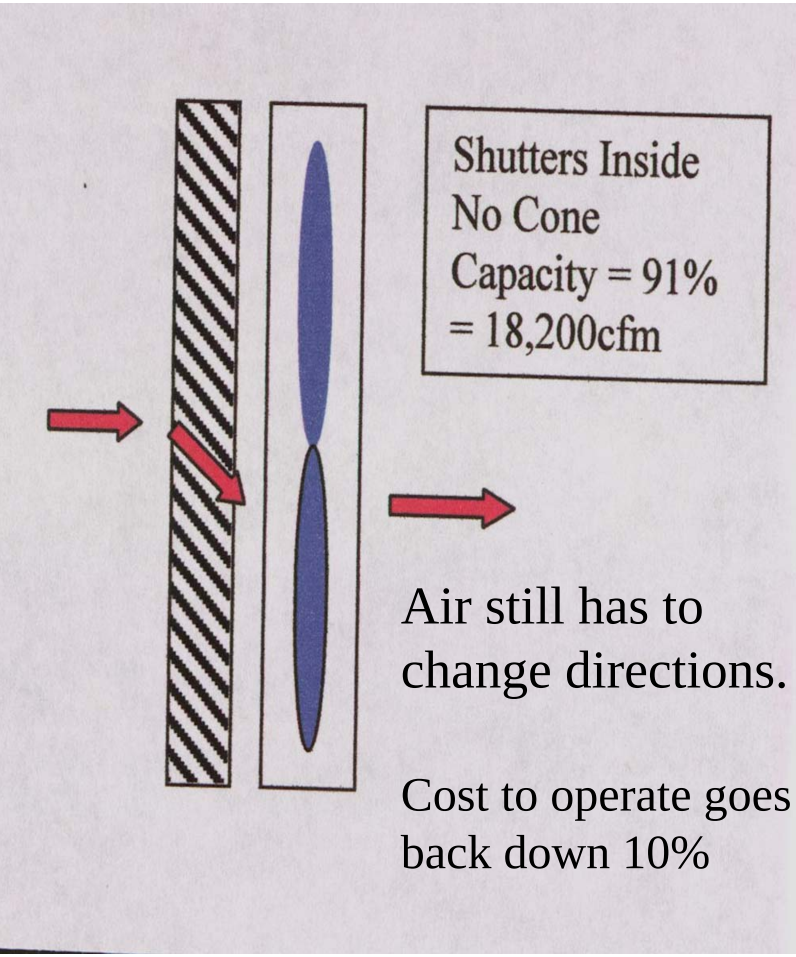


PANEL FAN WITH SHUTTER ON FRONT

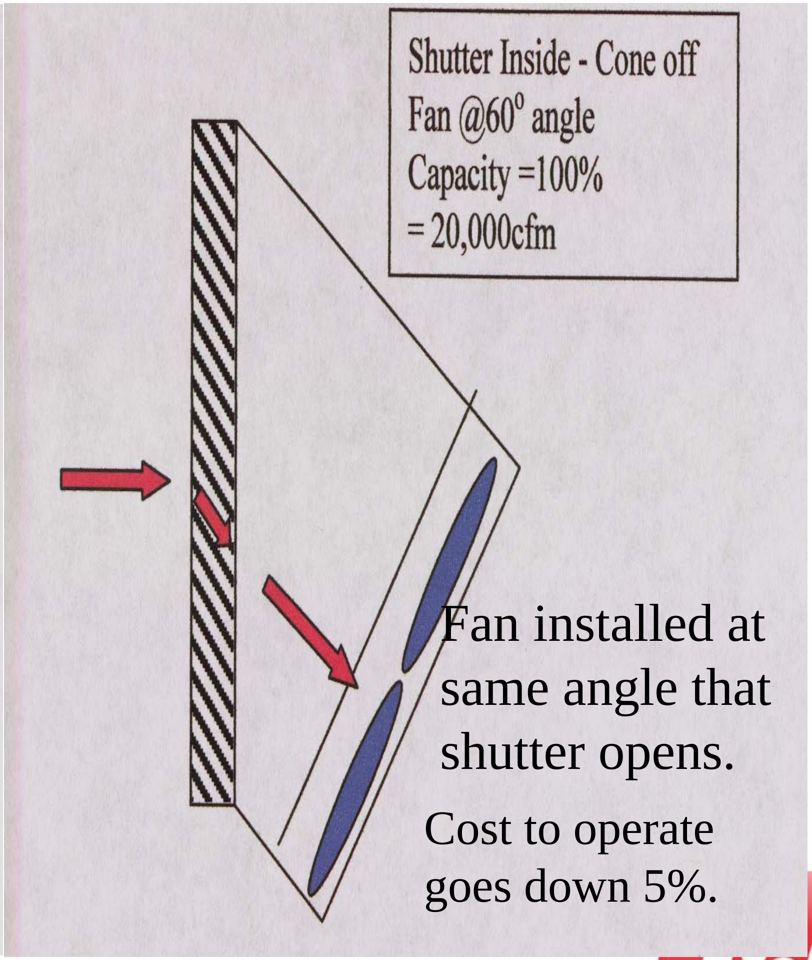


All Panel Fans Rated @ 20,000cfm at Zero Pressure

PANEL FAN WITH SHUTTER BEHIND FAN

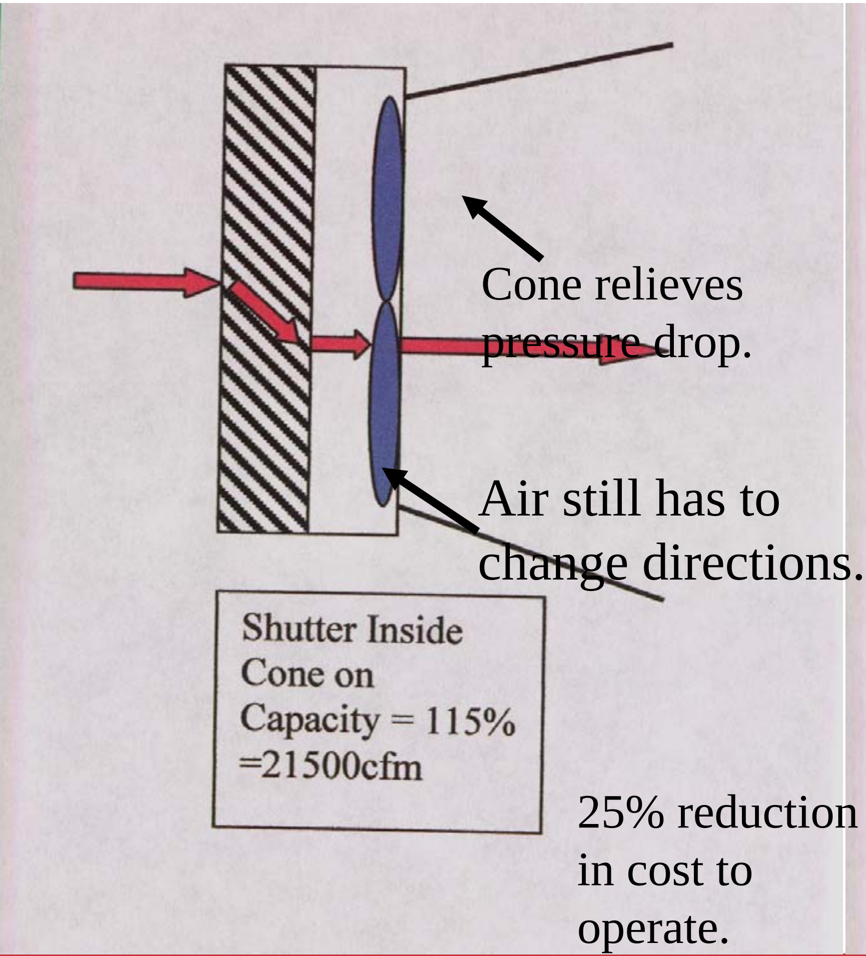


SLANTWALL FAN SHUTTER BEHIND FAN

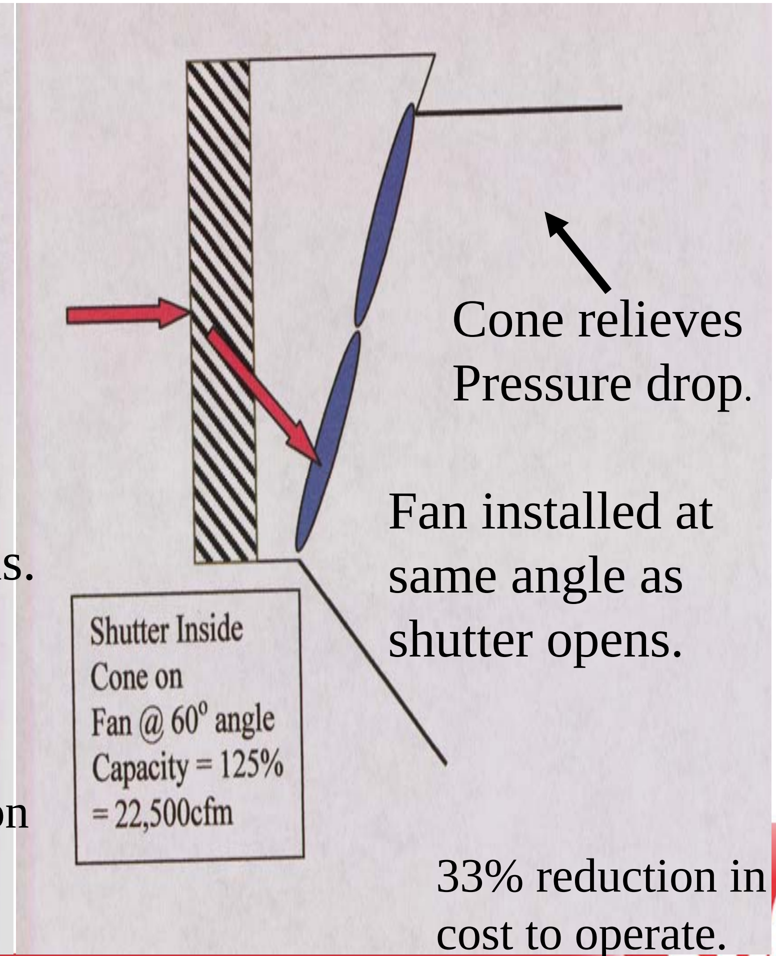


All Panel Fans Rated @ 20,000cfm at Zero Pressure

STRAIGHT WALL CONE FAN



SLANT WALL CONE FAN



EFFECTIVE TEMPERATURE

- DRY BULB TEMPERATURE WITH RELATIVE HUMIDITY AND AIR SPEED (WIND CHILL INDEX) ACROSS THE BIRDS FACTORED INTO THE EQUATION

EFFECTIVE TEMPERATURES CHART

ACTUAL TEMPERATURE		RELATIVE HUMIDITY		AIR VELOCITY FEET PER MINUTE					
F°	C°	50%	70%	0	100	200	300	400	500
85		*		85+	80	76	73	70	68
	29.4	*		29.4	26.6	24.4	22.8	21.1	20.0
85			*	89	86	81	78	76	74
	29.4		*	31.6	30	27.2	25.5	24.4	23.3
80		*		80+	76	72	70	66	65
	26.6	*		26.6	24.4	22.2	21.1	18.9	18.3
80			*	83+	79	76	74	69	67
	26.6		*	28.3	26.1	24.4	23.3	20.5	19.4
75		*		75+	73	70	68	64	62
	23.9	*		23.9	22.8	21.1	20	17.7	16.6
75			*	78	76	74	72	68	66
	23.9		*	25.5	24.4	23.3	22.2	20	18.8
70		*		70+	66	65	64	62	61
	21.1	*		21.1	18.9	18.3	17.7	16.6	16.1
70			*	74	69	67	66	65	63
	21.1		*	23.3	20.5	19.4	18.8	18.3	17.2

EFFECTIVE TEMPERATURES CHART CONTINUED

ACTUAL TEMPERATURE F°	ACTUAL TEMPERATURE C°	RELATIVE HUMIDITY 50%	RELATIVE HUMIDITY 70%	AIR VELOCITY FEET PER MINUTE 0	100	200	300	400	500
95		*		95+	90	80	76	74	72
	35	*		35	32.2	26.6	24.4	23.3	22.2
95			*	101	96	87	84	79	76
	35		*	38.3	35.5	30.5	28.8	26.1	24.4
90		*		90+	85	78	75	73	70
	32.2	*		32.2	29.4	25.5	23.8	22.7	21.1
90			*	96	91	84	81	78	74
	32.2		*	35.5	32.7	28.8	27.2	25.5	23.3
85		*		85+	80	76	73	70	68
	29.4	*		29.4	26.6	24.4	22.8	21.1	20.0
85			*	89	86	81	78	76	74
	29.4		*	31.6	30	27.2	25.5	24.4	23.3

EFFECTIVE TEMPERATURE

80F	50%	0	82F
80F	70%	0	86F
80F	50%	400	66F
80F	70%	400	69F

EFFECTIVE TEMPERATURE CONTINUES

95F	50%	0	97F
95F	70%	0	101F
95F	50%	400	74F
95F	70%	400	79F

IDEAL EFFECTIVE TEMPERATURES FOR BEST RESULTS

- BROILER BREEDER 65°F (18.3°C) 50% RH
- Equivalent 82° F (27.8°C) DB 450 FPM air 50% RH
- Air exchange must be less than 1.2 minutes.

- BROILERS 65° TO 70° F (18.3°-21.1°C) 50% RH
- Equivalent 85° F (29.4°C) DB 550 FPM air 50% RH
- Air exchange must be less than 1.2 minutes.

- BLACKOUT REARING 75° F (23.9° C) 50% RH
- Equivalent 85° F (29.4°C) DB 400 FPM air 50% RH
- Air exchange must be less than 1.3 minutes.
- ** DB – Dry Bulb temperature

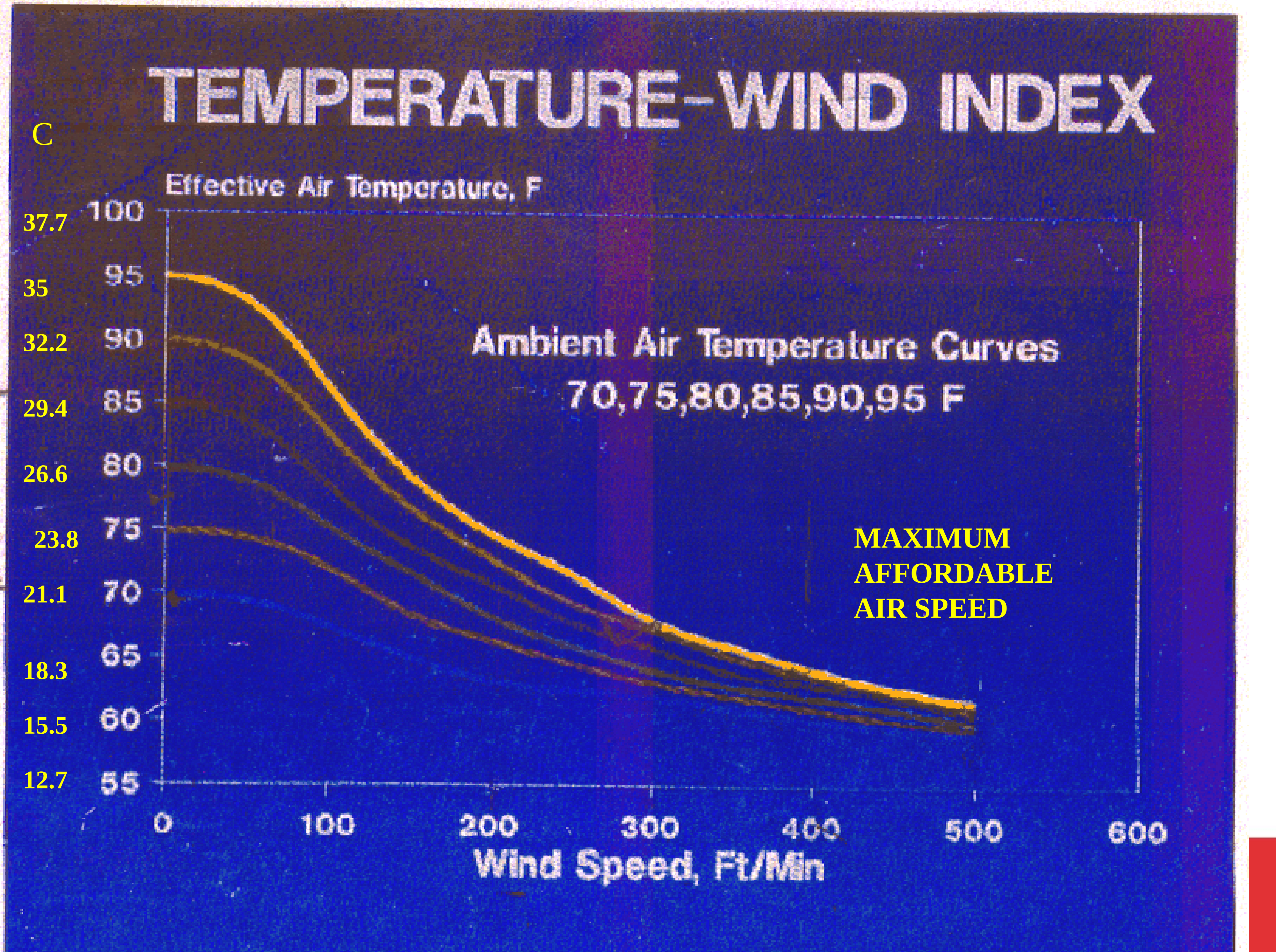
IDEAL EFFECTIVE TEMPERATURES

- LAST SUMMER FANS SHOULD BE RUNNING BY 78° F (25.5°C)

- PUMPS ON COOLING SYSTEM SHOULD NOT RUN BELOW 80° F (26.7° C) (82° F (27.8°C) is recommended)

- THERE SHOULD BE 4°F (2°C) BETWEEN LAST FANS AND PUMPS RUNNING

- PUMPS ON COOLING SYSTEMS SHOULD RUN BASED ON A COMBINATION OF TEMPERATURE AND RELATIVE HUMIDITY

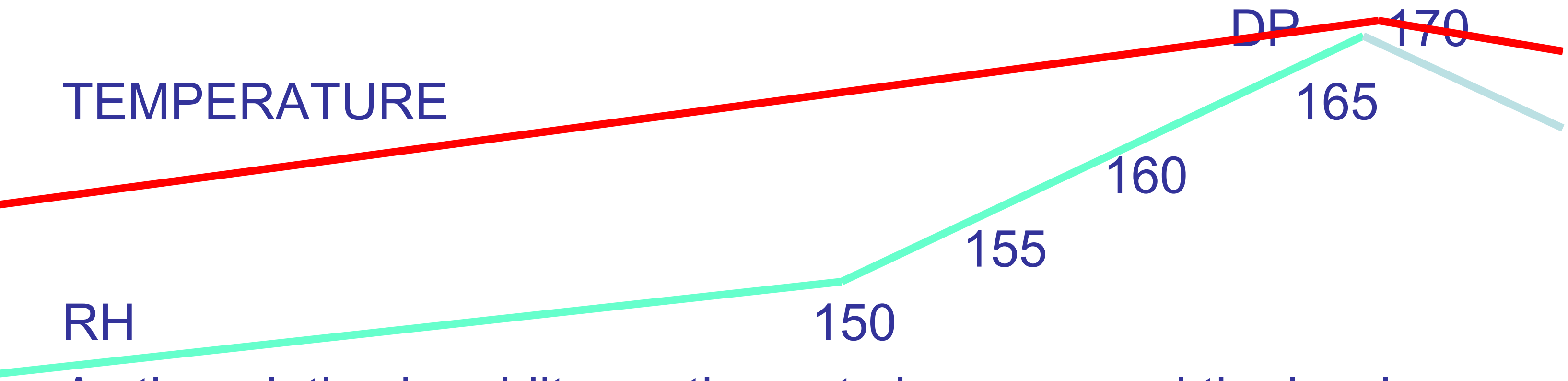

TEMPERATURE-WIND INDEX
C
Effective Air Temperature, F
100
95
90
85
80
75
70
65
60
55
37.7
35
32.2
29.4
26.6
23.8
21.1
18.3
15.5
12.7
Ambient Air Temperature Curves
70,75,80,85,90,95 F
MAXIMUM
AFFORDABLE
AIR SPEED
0
100
200
300
400
500
600
Wind Speed, Ft/Min

HEAT STRESS NUMBERES

- ADD DRY BULB TMPERATURE IN FAHRENHEIT AND RELATIVE HUMIDITY TOGETHER TO GET STRESS INDEX NUMBER TO WORK WITH.
- WHEN THE SUM OF THE TOTAL IS
- 150 OR LESS NO PROBLEM
- 155 ON BORDERLINE OF PROBLEMS
- 160 OFF FEED, INCREASE WATER INTAKE, PRODUCTION LOSS.
- 165 SAME AS 160 WITH FIRST MORTALITY
- 170 SAME AS 160 WITH HIGH MORTALITY

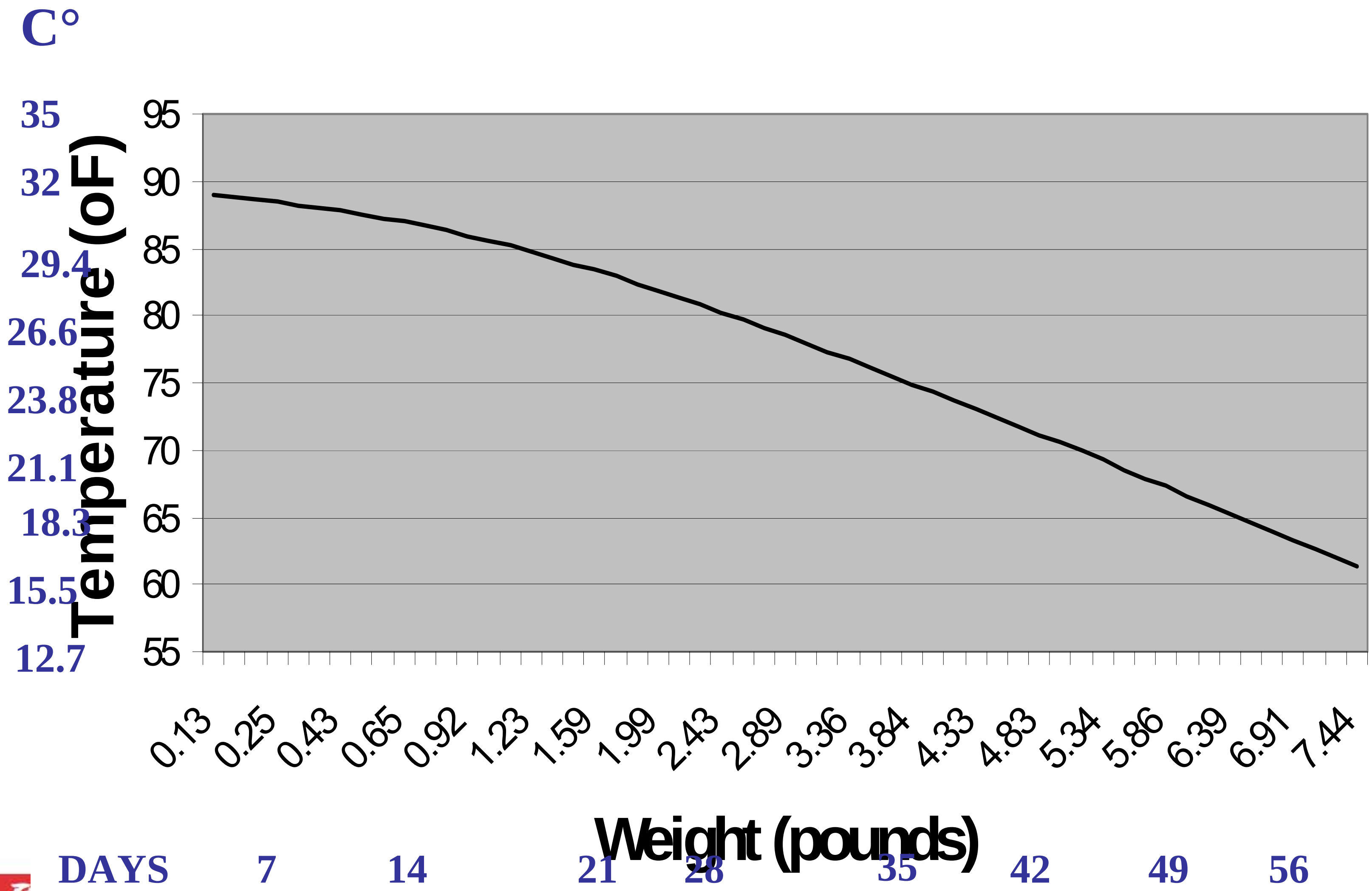
Temperature And Humidity As It Relates To Heat Stress Index Numbers

- There should be a spread of 25° F between relative humidity and dry bulb temperature for chickens to remain within their thermal neutral zone for comfort and performance anytime the temperature reaches 90°F.



As the relative humidity continues to increase and the level begins to get closer to the dry bulb temperature level the heat stress index number becomes higher. The higher the index number the more the birds will suffer and the more performance will be loss and eventually there will be heat prostration mortality.

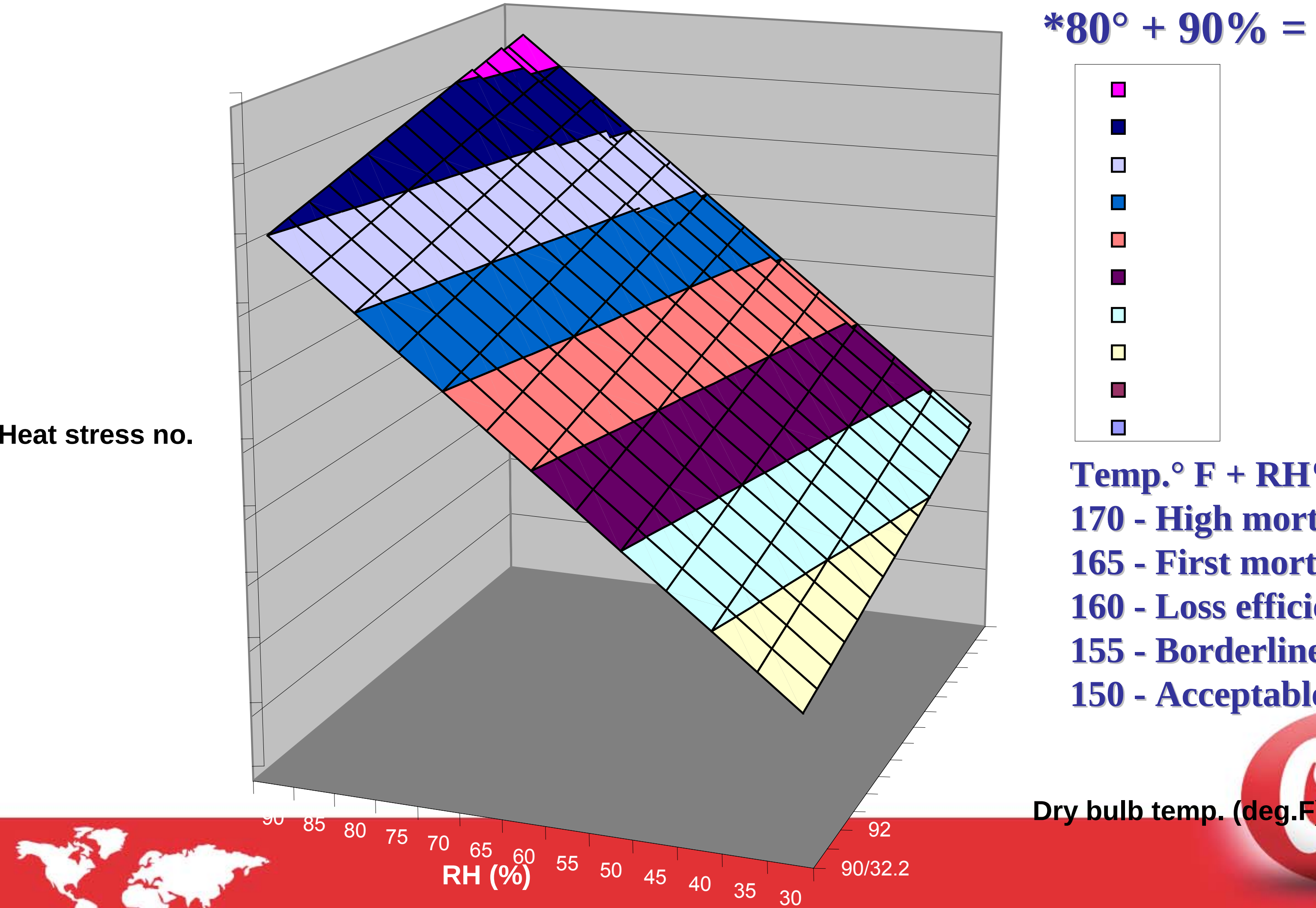
Chickens Thermal Neutral Zone



Heat Stress Numbers

90° + 75% = 165
95° + 60% = 155
***90° + 80% = 170**
***80° + 90% = 170**

***Temperature and Humidity Switch - Results The Same**

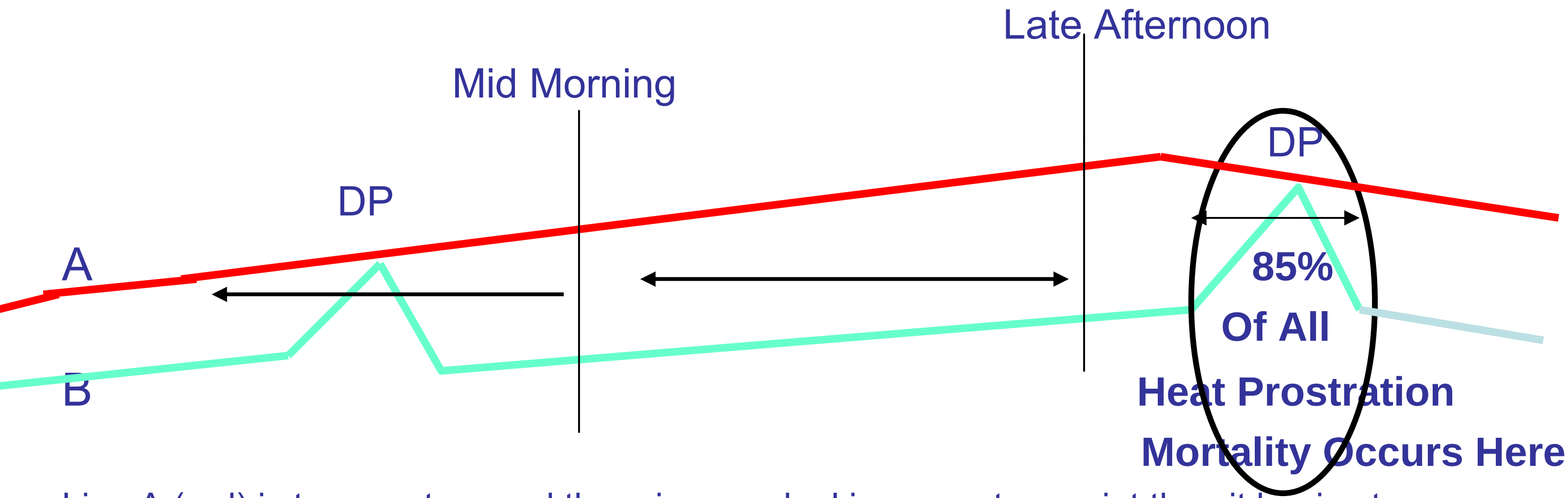


Temp.° F + RH%
170 - High mortality
165 - First mortality
160 - Loss efficiency
155 - Borderline
150 - Acceptable

World Tech Support

Temperature and Humidity Daily Occurrence

This graft covers from midnight to midnight on a daily basis in most areas of the world.
Twice each day in most seasons and most countries the dew point (DP) is reached.



Line A (red) is temperature and there is a gradual increase to a point then it begins to go back down.
Line B (blue) is relative humidity increases to dew point early morning and again in the late afternoon.
From mid morning back to midnight the dry bulb temperature is not high enough to create a problem. From mid morning until late afternoon there is enough spread between dry bulb and humidity not to create a problem. Once the temperature begins to go down and the humidity begins to increase is normally when the problem occurs and mortality goes up.

Heat Stress Index Numbers Too High

- **You can never overrun pumps on cooling system trying to lower the dry bulb temperature at the expense of elevating the relative humidity too high.**
- **Insulation in the top of the house inadequate.**
- **Hot air leaking through ridge cap, over the top of the curtains, or under the curtains.**
- **Bird density too high for capability of ventilation system.**
- **Wind speed through the house across the birds too low.**
- **Pad surface area does not match capacity of fans at actual working pressure.**
- **Pads need clean and/or replacing.**
- **Leaks between and around evaporative cooling pads.**

Recommended Ventilation System
<u>Broiler Breeders</u>

1. Tunnel ventilation with evaporative cooling pads and minimum ventilation cool to moderate climates. In hot climates minimum ventilation may not be necessary.
2. Tunnel ventilation with foggers and minimum ventilation.

- **All minimum ventilation should be across the house unless the house is less than 250 feet (76 meters) long.**
- **All pumps on cooling systems should run based on temperature and humidity combination. (THO)**

Recommended Ventilation Systems
Blackout--Rearing

- Tunnel ventilation with foggers and minimum ventilation. Minimum ventilation inlets should be air cannons and VF48 - TJP2600 second stage inlets with light traps. Fan area of the house must have 1 square inch of light trap for every 4 cfms of fan capacity. Inlet area of the house must have 1 square inch of light trap for every 5 cfms of fan capacity. Foggers should be uniformly distributed through out the house and operated with a (THO) control.
- Cooling pads are optional but hard to justify for parent stock birds.
- All minimum ventilation should be across the house unless the house is less than 250 feet (76 meters) long.

Recommended Ventilation Systems
Broilers

1. Tunnel ventilation with foggers and minimum/transition ventilation.
2. Tunnel ventilation with evaporative cooling and minimum/transition ventilation.
3. Open wall houses with fans in sidewall at a 60 degree angle with foggers and minimum ventilation.
4. Tunnel ventilation with fogger pads and minimum/transition ventilation. Only if pad space is adequate (total fan volume at working pressure ÷ 150) and the pumps are run based on temperature and humidity combination. (THO)

- **All minimum ventilation should be across the house unless the house is less than 250 feet (76 meters) long. All fogger pumps should run based on temperature and humidity. (THO)**

TROUBLE SHOOTING CONDITIONS

- PREVENTIVE MAINTENANCE
- LOCATION AND ACCURACY OF TEMPERATURE/HUMIDITY PROBES (Relative humidity probe should be located on the inlet end of the house in the first 25% of the house (4 feet off the floor). The temperature should be averaged evenly through the house or at the fan end of the house (probes should be located at bird level).)
- SET UP AND CALIBRATION OF ENVIRONMENTAL CONTROLS MUST BE ACCURATE
- RELATIVE SET POINTS FOR CONDITIONS, AGE, AND SIZE OF BIRDS
- ACCURACY OF INLET PRESSURE BASED ON WIDTH OF THE HOUSE
- OBSERVE COMFORT AND REACTION OF THE BIRDS
- ADEQUATE AVALIABILITY OF FEED AND WATER SPACE
- CONDITION OF LITTER

HOUSE SPECIFICATIONS AND FORMULAS

- 500 feet (152 meters) long X 43 feet (13.1 meters) wide X 9.5 feet (2.9 meters) average high = 204,250 cubic feet (5,784 cubic meters) of air to be handled by the ventilation system.
- To find average height sidewall 7.5 feet (2.29 meters) + height of peak 11.5 feet (3.5 meters) = 19 feet (5.79 meters) ÷ 2 = 9.5 feet (2.89 meters).

- This will make the cross section of the house 408.5 square feet (37.95 square meters).

- First stage of minimum ventilation 25,531 cfms (723 cmm) (2 36-inch fans) to run on the cycle timer and temperature override. The minimum run time should be 20% of the total cycle with no less than one minute on during a cycle.
- Maximum of minimum ventilation 40,850 cfms (1,157 cmm) (4 36-inch fans) to run on temperature only.

HOUSE SPECIFICATIONS AND FORMULAS CONT.

- Minimum inlets 4 sidewall fans X 10,500 cfms (297 cmm) each = 42,000 cfms (1,188 cmm) ÷ 2,000 cfms (56.6 cmm)= 21 inlets needed on opposite side of the house from minimum fans. Inlets should be managed by negative pressure not %.

- Transition inlets 4 endwall fans X 23,400 cfms (662.6 cmm) each = 93,600 cfms (2,650 cmm) ÷ 2,250 cfms (63.7 cmm) = 42 inlets needed with ½ on each side of the house for summer fans. Once summer fans begin to run for transition ventilation all sidewall fans should go off. Inlets should be managed by negative pressure not %.

- Summer fans 408.5 square feet (37.95 square meters) cross section X 550 feet per minute (2.79 meters per second) = 224,675 cfms (106 cubic meters per second) needed ÷ 23,400 cfms (11 cubic meters second) per fan = 9.6 (10) fans needed.

HOUSE SPECIFICATIONS AND FORMULAS CONT.

- This will give us an air exchange of .87 of one minute and air velocity of 573 feet per minute (2.9 meters per second).
- Evaporative cooling pads 6 inches thick 10 fans X 23,400 cfms (662.6 cmm) each = 234,000 cfms (6,626 cmm) ÷ 400 cfms per square foot (122 cmm per square meter)= 585 square feet (54.3 square meters) of pads needed ÷ 5 feet (1.5 meters) high = 117 feet (35.66 meters) long ÷ sides of the house = 58.5 (60 feet) (17.83 meters)(18 meters) on each side of the house. The pumps should never run until the temperature reaches 82ºF/28ºC or if the humidity in the house is 70% or more and unless all fans are running. There is never an occasion to run the pumps all the time.
- The water recovery system should always be above the ground and the pads should never be shaded, curtains on the outside or covered with a net.

THE END

THANKS FOR ALLOWING COBB VANTRESS AND ME TO BE A PART OF THIS MEETING AND THANKS FOR THE BUSINESS