Mechanical Ventilation of Barns

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Types of Mechanical Ventilation

- Positive Pressure
  - Fans blowing into barn, control release of air.
- Neutral Pressure
  - Fans blowing into barn and fans pulling air out of barn
- Negative Pressure
  - Fans pull air through barn, control the inlets.

What are we controlling?

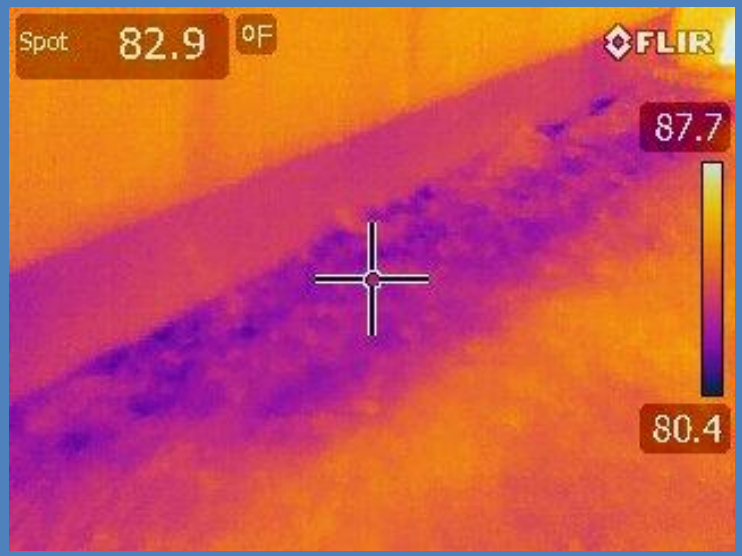
- Dust
- Ammonia
- Carbon Dioxide
- Moisture or Relative Humidity
- Excess Heat

System Design

- Minimum Ventilation
  - Calculation
  - Fans
  - Inlets
  - Static Pressure
- Maximum Ventilation
  - Tunnel Ventilation
  - Air Exchange
  - Cooling
  - Inlets / Light traps
- Controllers
  - What's the Difference?
  - Which one is right for my application?

Rule #1
Make your barn as air tight as possible!

- New construction should pay attention to any joints requiring caulk and adhesive.
- Utilizing an existing building should strongly consider spray foam application.



Minimum Ventilation

- Bring in air to remove ammonia, CO_2 and moisture.
  - 40 – 75% RH for Litter and Paw health.
- Smaller fans for minimum ventilation.
  - The longer a fan runs, the more consistent the flow of air and therefore the interior environment.
- 0.1 to 1 cfm per bird depending on age, outside temp, body weight, etc.
    - Ex. 10,000 chicks will only need 1000 cfm.

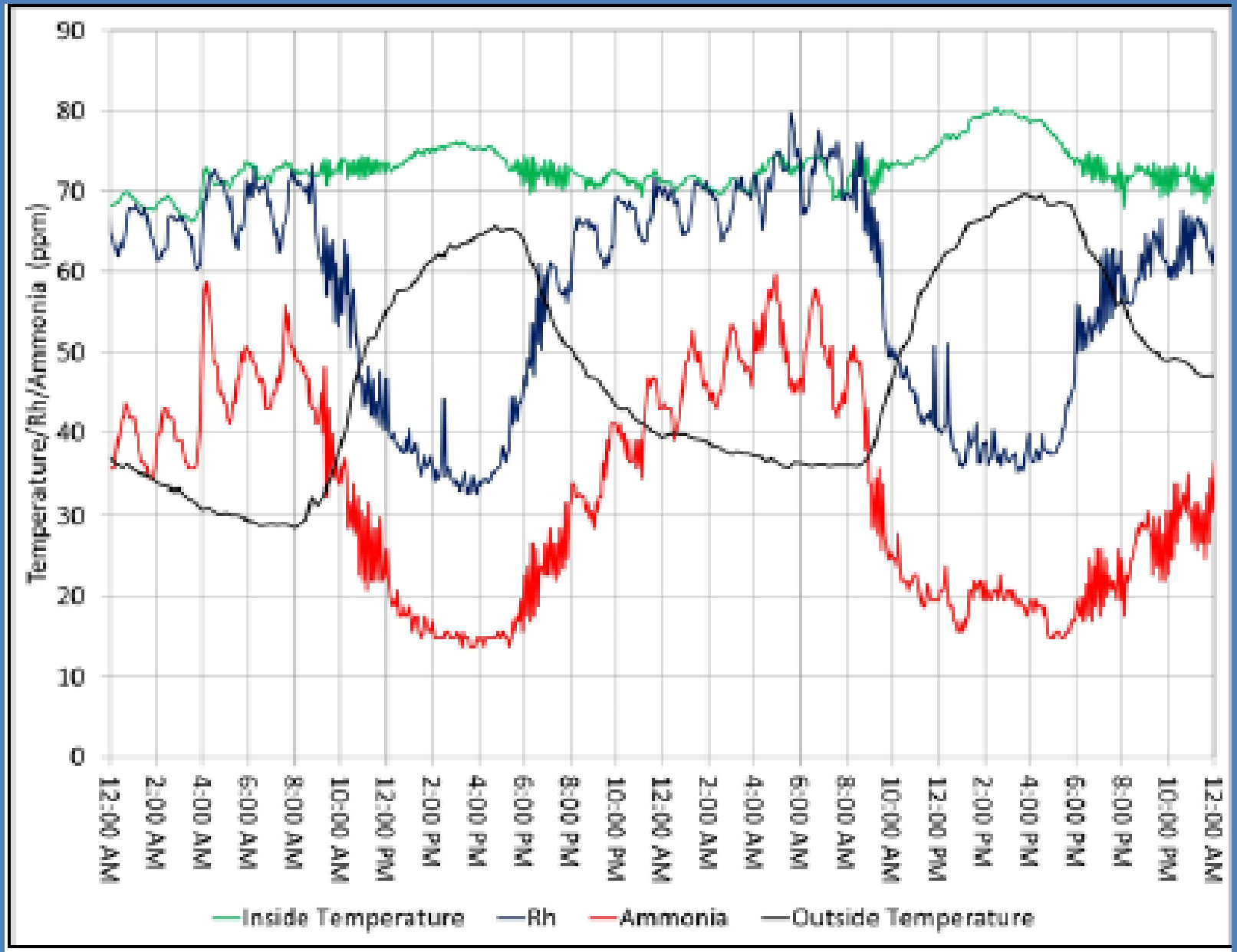


Figure 4. Inside/outside temperature, ammonia, and relative humidity for a house with three-week-old birds (November 3 - 4)

Minimum Ventilation

- Fans
- Bess Laboratories
  - http://bess.illinois.edu/search.asp
- Criteria
  - Output at 0.1 inwc will match needed cfm
    - Can use larger fans run on a vfd, triac, or timer
    - Don't run less than 50% voltage on triacs
    - Run at least one minute on timers
  - Select fans with an Air Flow Ratio higher than .70
    - Output at 0.20 inwc / output at 0.05 inwc = AFR

Fan Performance Data

Power Supply 1 phase 230V, 60 Hz

Manufacturer
- All Manufacturers
- Acme Engineering & Mfg. Corp.
- Airstream Ventilation Systems
- American Coolair
- Better Air

Fan Diameter Any Size

Air Flow (cfm) 1000 - 3000

VER (cfm/Watt) Any VER

Submit Reset

University of Illinois, Department of Agricultural and Biological Engineering
332 Agricultural Engineering Sciences Building
1304 W. Pennsylvania Avenue
Urbana, Illinois 61801
Ph. 217-333-9406
Fax 217-244-0323
bess-info@illinois.edu

Test #	Model	Size	Cone	Shutter	Air Flow (cfm) 0.05" SP	VER (cfm/W) 0.05" SP	Air Flow (cfm) 0.10" SP	VER (cfm/W) 0.10" SP	Air Flow Ratio*
J & D Manufacturing									
12654	VFT141131	16"	N	B	2190	8.6	2050	7.7	0.57
04046	VFA20P	20"	N	A	3190	11.8	2940	10.9	0.72
04047	VFP20P	20"	N	P	3110	11.6	2840	10.5	0.69
12650	VFT141132	20"	N	B	2930	11	2630	9.7	0.68
Munters Aerotech									
00384	AT09Z2CP	9"	Y	P	1090	5.8	1070	5.6	0.91
06168	AT16ZCA	16"	Y	A	3100	13.5	3000	12.5	0.81
06169	AT16ZCP	16"	Y	P	3100	13.2	2900	12.1	0.77
Prairie Pride Polyfan									
99124	TR12F	12"	N	P	1860	7.3	1750	6.9	0.73
99126	TR16F	16"	N	P	2820	8.6	2680	8.3	0.78
PW Aire									
10275	EF1200FS	12"	Y	P	1530	8.9	1470	8.4	0.86
03107	EF1200MT w/cone	12"	Y	P	2340	9.5	2260	8.8	0.89
10277	EF1600FS	16"	Y	P	3100	11.6	2990	10.9	0.89
Schaefer									
96222	PFM0900-1	9"	N	P	1090	4.9	1060	4.7	0.92
96221	PFM1200-1	12"	N	P	1540	7.3	1450	6.9	0.46
96220	PFM1600-1	16"	N	P	3090	9.2	2950	8.7	0.84

Inlets

- Inlets (ft^2) are matched with the fans (cfm) intended to run them.
  - Most inlet ratings are at a 0.125
- Jet throw
  - Incoming air travels approximately 2 ft for every .01” of Static Pressure
  - Desire a velocity higher than 600 fpm.
- Allowing air to warm will increase its ability to hold water.
  - 68* F holds 15 g/ kg of air, 86* F holds 28 g/kg

Inlets

- Correct opening for volume of air
  - Too open and air falls to the floor instead of following ceiling.
- Soffit openings for Ceiling/ Attic inlets
  - Use bird wire versus commercial soffit covering
  - 400 - 500 cfm per sq ft of soffit opening
- Placement
  - Width of room will dictate the type of inlet.
  - Don’t want cold air hitting anything and causing condensation.

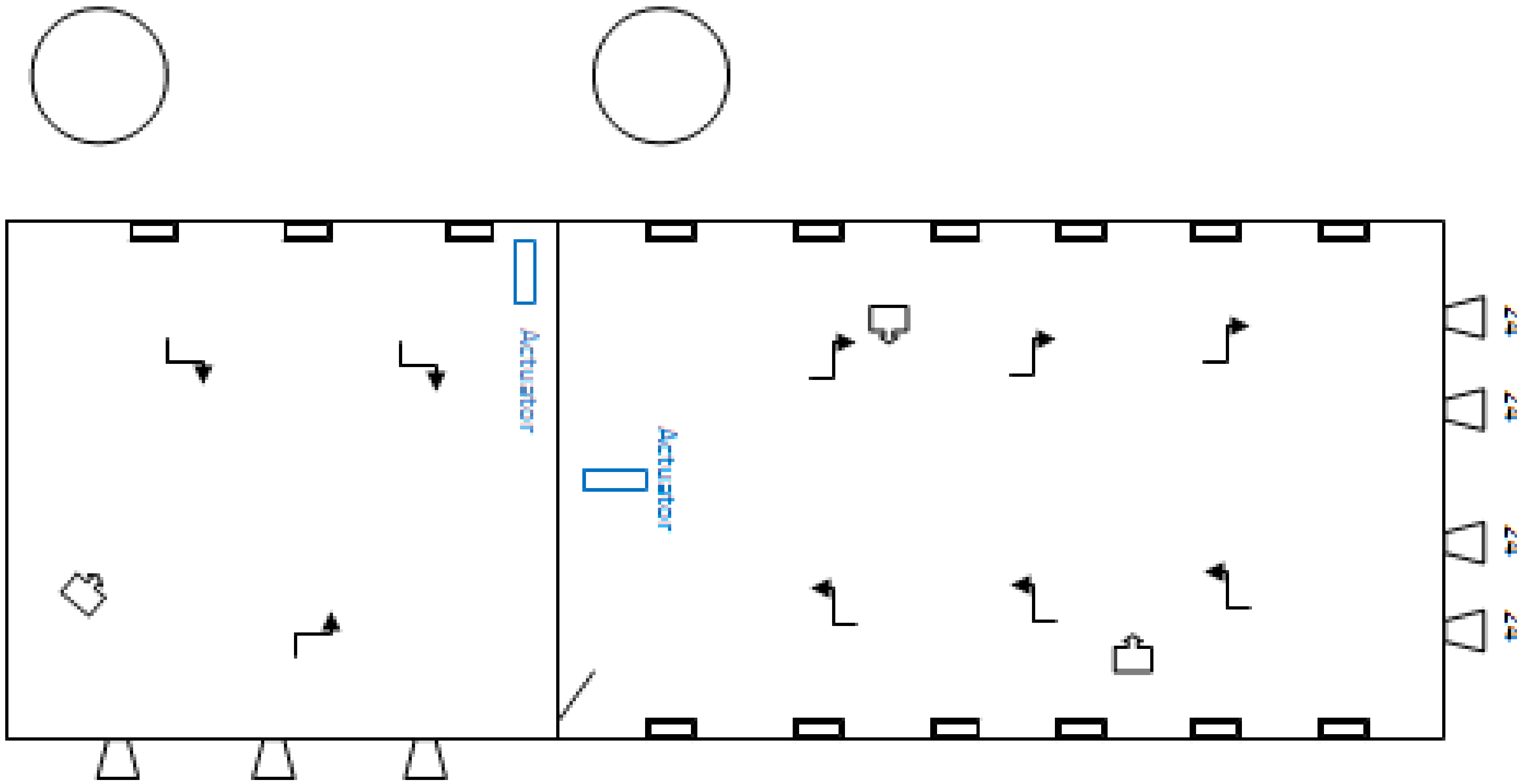
How do they all relate?

- Static pressure is the difference in pressure between the outside and the inside. (think sucking through a straw or blowing up a balloon)
- We control incoming air by restricting the opening which generates a higher pressure.
- Inlets are proportional to fan output. Not enough inlet? Restricted air! Higher SP!
- Static pressure will stack. This means for everything air has to pass through there is a resistance or pressure created.


Spot 87.8 °F
FLIR
107
84.1

Stir Fans

- Sometimes small exhaust fans won’t generate much pressure .
- Stir fans help to break up stratification by mixing the air in rooms more uniformly.
- Save money by preventing heat build up at ceiling and can be pointed towards bigger birds to help cool.
- Layout in Race Track or Criss-Cross pattern.


Actuator
Actuator

Maximum Ventilation

- Tunnel Ventilation
  - Takes advantage of wind chill factor
  - Calculated between 300 and 500 fpm (cfm/sqft)

- Air Exchange
  - One complete air exchange every two minutes

*At least 5 cfm per bird as a rule at 0.05 inwc

Cooling

- Cool Cells
  - Most efficient way to cool but also the most expensive.
- Misters/ Foggers
  - Slowest form of cooling and adds humidity to room
  - Must have air velocity in order to work.
- Sprinklers
  - Only used on older birds for a short cycle, adds the most moisture to the room and works by evaporation
  - My preferred method

Inlets and Light Traps

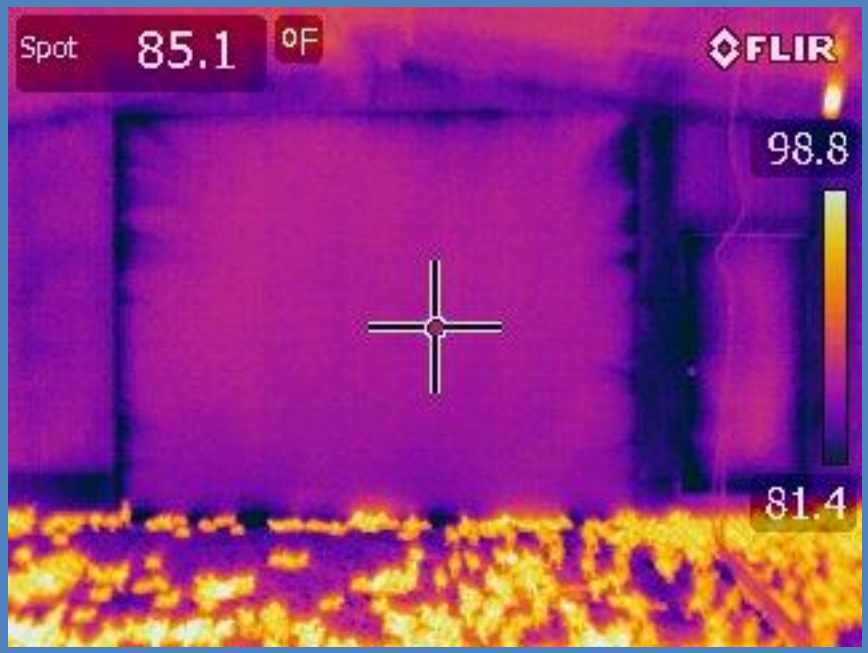
- Inlets
  - Match maximum ventilation output at a 0.05 inwc
  - Tunnel inlets figured at 500 fpm (cfm/sqft)
- Light Traps
  - Restrict air!
  - If using light traps more fans are usually needed to make up for the added pressure. (0.15 inwc)
  - Most manufacturers test airflow per square foot.

Light Trap	Light Reduction Factor	Exhaust Fan Light Trap Requirements (cfm per square foot)	Inlet Light Trap Requirements (cfm per square foot)
Dandy (Black-Air T.M.)	2,300	850	575
Acme (Metal)	8,000	800	550
Munters (MI- T-Dark T.M.)	2,100,000	750	500
Dayton	180,000	700	500
Acme (Plastic)	21,000,000	700	475
W.W.F. Light Deflector	11,000	600	425
Gigola (Night Air - 97 T.M.)	5,000	550	375
Dandy (Black Majic T.M.)	3,100,000	500	350
General Shelters (Light Eliminator T.M.)	4,700,000	400	275

Light Trap Sizing

University of Georgia Cooperative Extension. March 1998


Spot 81.0 °F
FLIR
96.5
80.8


Spot 85.1 °F
FLIR
98.8
81.4


Spot 86.0 °F
FLIR
101
83.2


Spot 93.6 °F
FLIR
95.8
88.2

Controllers

- Very simple to very complex
- Choose a controller that is simple to use and cost effective to purchase and replace.
- Be sure your equipment provider helps you to understand how the system works and has replacement parts on hand.
- Single stage thermostats are a necessary back-up.

Features to consider:

- Internal timer
- Triac
- Inlet stages controlled by time or static pressure
- Number and size of electrical relays needed
  - Inlet machines need two relays (Open/Close)
  - More than one fan may be on a stage.

You get what you pay for!

Staging Fans

- Smallest fans first
  - Stage one needs enough cfm's to ventilate the largest bird the room can hold.
  - Toggle switches can be used to turn off a fan or fans on stage one to achieve a longer run time.
- The increase in cfm's per stage should be gradual.

Understanding the Controller

- Bandwidth
  - Number of degrees it takes to go from minimum output to maximum output
- Differential
  - Number of degrees it takes to increase or decrease a stage
- Motor Curves
  - Not all motors respond to voltage the same. Be sure the control is using the correct curve.

Example of Staging Layout

Stage or Level	Temp setting	Relay	Total CFM's
Heat	-3 below target	Heater, stir fans	1000
Variable 1 (at or below target, minimum ventilation)	Bandwidth 2*	12" fan, stir fans	1000 - 1600
Stage 2	+2* above previous stage	12" fan	3200
Stage 3	+1.5* above previous stage	16" fan	5500
Stage 4	+1* above previous stage	24" fan, stir fans, Sprinkler timer	10000

Questions?