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Poultry Housing Tips

Basic Power-Ventilated Broiler House Operation

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Over the years the poultry industry has become increasingly concerned with control over environmental conditions within poultry houses. For instance, forty years ago the typical poultry producer was not overly concerned about precisely controlling the environment within his poultry houses. For the most part, environmental control meant trying to keep chicks from freezing to death during the dead of winter and trying to prevent market age birds from dying of heat exhaustion during the heat of summer. Producers started adding a little ceiling insulation to help keep their houses a little warmer during the winter and cooler during the summer to limit mortality as well as to improve feed conversion. Curtains were added to increase a grower's ability to bring fresh air into the house during warmer weather and to help better regulate house temperature during the cooler times of the year. Circulation fans were added to increase bird cooling during hot weather and to help mix the air in the house during colder weather. Over the years more fans, better insulation, curtain machines, exhaust fans, thermostats, air inlets, tunnel ventilation, etc., have all been added to gain more and more control over the house environment. Today we have progressed to the point where we are not only trying to precisely control house temperature year round, but a number of other environmental factors as well:

1) Relative Humidity: By controlling relative humidity a grower can become proactive instead of reactive when it comes to controlling litter moisture and ammonia. Birds are continuously adding moisture to the litter. If the relative humidity of the air in the house is too high, very little of the moisture added to the litter by the birds will evaporate from the litter, and cake will form. Caked litter results in ammonia. If a grower monitors the relative humidity of the air in his house and ventilates to keep it low (below 70%), he will insure that enough moisture will evaporate from the litter to limit the formation of cake and therefore minimize ammonia. If he finds the relative humidity is too low (below 50%), he can reduce his timer fan settings to insure that he does not remove too much moisture from the litter which could lead to dusty conditions.

2) Air Movement: Controlling air movement within a poultry house allows a grower to increase or decrease bird cooling. During hot weather tunnel ventilation is used to produce maximum air flow over the birds. With older birds a producer wants an air speed of between 400 and 500 ft/min moving over the surface of the birds to produce a 10^{o}F windchill effect as well as to pull trapped heat from between the birds. With younger birds the producer may only need to provide 200 or 300 ft/min of air speed to accomplish the same goals. Conversely, during cold weather adjustable side wall inlets are used direct the incoming cold fresh air along the ceiling and away from the birds. The incoming cold, fresh air mixes with the warm air that accumulates

at the ceiling, thus minimizing bird chilling.

3) Lighting: Controlling light intensity and day length throughout a growout provides a grower with some degree of control over bird activity, health, growth rates and therefore bird performance. A grower may start out with one or two foot candles of light 24 hours a day when the birds are placed. The light intensity may be gradually decreased to less than a half of a foot candle over the course of a few days and day length decreased to 16 hours or less. Day length is then gradually increased throughout the growout so that during the last couple weeks of production day length is increased to approximately 24 hours. Low light intensity is usually maintained from seven days to market age.

In response to the desire for an increased level of environmental control, the number of tunnel/side wall inlet ventilated broiler houses with dark curtains has increased dramatically over the past few years. In the new modern broiler house the side wall curtains, if there are any, remain closed year round and are there primarily for safety. Producers power ventilate their houses using tunnel ventilation with evaporative cooling pads during warm weather, and adjustable side wall inlets with a combination of side wall and tunnel ventilation fans during the spring, winter and fall, offering an unprecedented level of environmental control year round.

There is of course a downside to the trend towards an increased level of environmental control. To achieve the desired level of environmental control a modern broiler house may have nine tunnel fans, a fogging pad cooling system with three lines of nozzles, 60 interior fogging nozzles, four side wall or end wall 36" fans, 60 side wall inlets, an inlet machine, tunnel curtain machine, 12 radiant brooders, a couple of furnaces, and an environmental controller. Managing all of these devices to obtain ideal environmental conditions while keeping energy costs to a minimum can be somewhat overwhelming.

Much of the confusion related to the operation of a modern broiler house is due to a lack of basic understanding of poultry house environmental control. The purpose of this newsletter is to hopefully alleviate some of the confusion about operating a modern broiler house by going over some of the basic rules of heating/ventilation system operation. If a producer follows these ten basic rules he will find it easier to handle almost any situation.

The Rules

Rule #1: Tunnel ventilation is for cooling. If you are not trying to cool your birds do not use tunnel ventilation. Sounds simple, but this rule is frequently violated. Often the comment is made “If I leave my tunnel curtain open all the way at night, the birds in the front of the house get too cold. So, I close it up so the cold air does not blow directly on the birds”. If you are worried about cold air blowing on the birds, you are obviously not trying to cool them and should not be using tunnel ventilation. When trying to decide whether you should tunnel ventilate your birds ask yourself one question, “Am I trying to cool my birds?” If the answer is no, do not use tunnel ventilation.

Rule#2: Side wall inlets with side wall/tunnel fans should be used whenever you are not trying to cool your birds. In a side wall inlet or negative pressure ventilation system exhaust fans draw fresh air into the house as well as exhaust stale air from the house. Air inlets are used to help direct the incoming cold air toward the ceiling and away from the birds to help preheat the incoming air as well as “dry it out” before the air moves toward the floor and over the birds. Interval timers on the exhaust fans are used to control the amount of fresh air that is brought into the house and thermostats turn on the fans in case the house becomes too warm. Inlet machines insure that side wall inlets open the proper amount for the number of fans operating.

There is a fair amount of confusion about the use of side wall inlets and tunnel fans. “Tunnel fans” are really only true “tunnel fans” when used with the tunnel curtain opening. When used with side wall inlets they are exhaust fans that happen to be installed in the end wall. In a negative pressure ventilation system air is drawn in uniformly through all air inlets no matter how far they are from an exhaust fan. Therefore, the same amount of air will enter an inlet ten feet from an exhaust fan as from an inlet 500' from an exhaust fan. Hard to believe, but it is true. Since air enters through all the side wall inlets the same, air quality and temperature uniformity are determined by how far a bird is from an air inlet not how far a bird is from an exhaust fan.

Now, of course the fact that the same amount of air will come in each inlet only holds true if all the inlets are opened the same amount. If the inlets at one end of the house are opened twice the amount as the inlets on the opposite end of the house, the birds on one end of the house will receive twice the fresh air as those on the other end. It is possible to end up with a situation where the air on one end of the house is cold and the air at the opposite end of the house is warm and stuffy. This is why it is so important that all the side wall inlets are adjusted to open the same amount.

Rule #3: The goal of a negative pressure system is for all of the air drawn into a house by the exhaust fans to enter through the side wall inlets. Air entering through cracks and holes in the end and side walls does not mix with the warm air near the ceiling and therefore, tends to make the house drafty leading to chilled chicks, caked litter, and increased fuel usage. Therefore, you want to make sure your house is as tight as possible. One way to check the tightness your house is to do a static pressure test. With all the side wall inlets closed and the inlet machine off, turn on one 48" fan. The higher the static pressure you obtain, the tighter the house. **In order for an inlet ventilation system to work properly you need to be able to obtain a static pressure of at least 0.08" with one 48" fan operating.**

Another benefit of a tight house is that it is much easier to achieve consistent house temperature from end to end. If a house is loose, outside winds can push air in the house from one end to the other causing significant variations in house temperature as well as air quality.

Rule #4: Fresh air mixing is maximized by having the side wall inlets opened two to three inches for side wall inlets (one to two inches for ceiling inlets) and having a static pressure of between 0.05" and 0.10". When side wall inlets open less than this the air tends to bounce off the ceiling and quickly drop to the floor. Likewise, if the static pressure is below 0.05" the air does not have enough speed to make it to the middle of the house before dropping to the floor. In either case the air does not stay next to the ceiling long enough to warm and dry sufficiently before moving to the floor. An easy and effective way to see how air moves as it enters the house is to hang pieces of cassette tape from the ceiling, three and ten feet from a side wall inlet. When the static pressure is between 0.05" and 0.10" and the inlet is opened a couple of inches, both pieces of tape will float in the air stream showing the cold air is making it to the middle of the house and warming before dropping to the floor. When the static pressure is too low or the inlets are not opened enough, the strands of tape will just hang limply when a fan comes on indicating the incoming cold air is not mixing with the warm air near the ceiling.

Rule #5: The timer fans in the coldest area of a house should be used for minimum ventilation. Using timer fans in the coldest area of a house tends to help draw warm towards that area. For instance, the end of the house near the tunnel fans tends to be cold due to all the air leaking in from the 48" shutters. By using a 48" fan as a timer fan the air leaking in through the shutters is quickly exhausted from the house and warm air from the rest of the house is pulled into that end of the house.

Rule #6: It is better to run fewer fans longer, than more fans for a shorter period of time. The more fans you put on a timer the more you will shock the house with cold air every time the fans operate potentially chilling the birds and causing the heating system to run. It’s similar to sitting in a nice hot bath tub of water and having the choice of some

one dumping a gallon of cold water in the tub all at once or adding it slowly over a five minute period. What this means in practice is that it is better to operate a 48" and 36" fan on a timer, than two 48" fans on a timer, provided you can meet the requirements of Rule #4.

Rule #7: The shorter the timer cycle, the more consistent the environment. A five minute interval timer will produce half the variation in house temperature and air quality that a ten minute timer will produce. With half the variation in house temperature furnaces/brooders are much less likely to come on as a result of the fans operating. Furthermore, wide variations in air quality caused by ten minute timers may stress birds more leading to an increased likelihood of disease.

Rule #8: If your house is stuffy, you should increase the timer fan(s) setting, not the number of fans. The greater the number of fans you place on a timer the more house temperature and air quality will vary and the more likely your heating system will be forced to operate (see Rule #6).

Rule #9: There should be a minimum of a four-degree difference between heating and cooling thermostat settings. Less than a four-degree temperature differential can cause excessive fuel usage as cooling fans and heaters fight one another.

Rule #10: It is very difficult to obtain uniform house temperatures if the birds are not evenly spaced throughout a house. If there are more birds in an area of a house more inlets should be used in that area. For instance, after turning birds out into full house there may be 30% more birds in the brooding end. If this is the case, there should be 30% more inlets in use in the brooding end than in the nonbrooding end.

Putting the Rules to Work - Ventilation/Heating System Operation

It is crucial to a producer's bottom line that the poultry house be properly preheated before the chicks arrive. Numerous studies have shown that final bird weights can be decreased by as much a ½ pound if chicks are placed in a house where the air temperature is in the mid seventies. Though you might never let you house get this cold, you may be giving up some bird performance if your are only preheating your house to the low eighties.

Before the chicks arrive:

1) Turn on your heating system a <u>minimum</u> of 24 hours, preferably 48 hrs, prior to the arrival of the chicks. Set thermostats/controller so that a house temperature of approximately 88°F-90°F is maintained. Place your heater thermostats or sensors a maximum of 18" off the floor. If the litter is wet you may have to preheat the house for more than 48 hours.

2) Place thermometers on your floor to insure that you are achieving proper litter warming. Remember, to a day old chick, litter temperature is more important than air temperature.

3) If you have mixing fans you may want to consider operating them while you are preheating the house to aid in the heating/drying of the litter.

In order to obtain the proper mixing of the cold incoming air with the warmer air near the ceiling so that bird chilling as well as fuel usage is minimized, it is very important that the inlet machine opens the side wall inlets the proper amount each time the exhaust fans come on. The following is one method of setting side wall inlet machines and inlets to obtain these goals.

Inlet Machine Setup:

1) Clean timer fan blades, housing and shutters. Make sure the belts are properly tensioned and are not worn.

2) Check to make sure that your inlet machine controller is calibrated properly and indicates a static pressure of 0.00" when the exhaust fans are off.

3) If you have a dial type of pressure gauge on your inlet machine, set the high needle at 0.10" and the low needle at 0.05". If you have a digital static pressure gauge on your inlet machine, set the target pressure for 0.075" with a 0.02" differential.

4) Since there will be no birds on the nonbrooding end of the house for the first couple of weeks of the growout, the inlets on this end of the house should be latched closed.

5) During cold weather, when only a minimal number of exhaust fans will be operating, half the inlets on the brooding end of the house can be latched closed. This should leave approximately 15 inlets that will open when the inlet machine is activated.

   The reason we do this is that we want to get an inlet opening of about two inches to insure proper air mixing with the minimum number of exhaust fans possible (Rule #4). If we only use half of the inlets on the nonbrooding end we will be able to use fewer timer fans to get the inlets to open the proper amount. For instance, let's say we are going to use two 36" timer fans on the nonbrooding end of the house. Every time the fans come on the inlet machine opens the inlets about 1 inch. In order to get the inlets to open two inches we would have to use an additional timer fan which goes against Rule # 6. But, if we only use half the number of inlets they will open twice the amount every time the fans come on. This does limit the number of fans you can operate when in half house, but during cold weather the timer fans are the only fans which tend to operate anyway.

   During warmer times of the year when a fair number of exhaust fans or tunnel ventilation may be required to keep the young birds cool, it is typically best not to latch closed any of the inlets on the brooding end of the house. If the inlets only open one inch, this should not cause any problems considering the fact that the air entering through the inlets tends to be fairly warm.

6) To test the tightness of your house and to determine how may fans you should use as timer fans, **temporarily**, turn the inlet machine to "manual" so that the inlets will not open when you turn your fans on.

7) Turn on two 36" fans (one on the brooding end, one on the nonbrooding end) or one 48" fan on the nonbrooding end of the house with half house curtain left loose.

8) Check the static pressure

9) If the static pressure is above 0.13" your inlet machine should open the inlets approximately two inches when it is switched to automatic. **Switch the inlet machine to automatic**. Go to step #12

10) If the static pressure is below 0.13" add a 36" fan. If the pressure is now above a 0.13", **switch the inlet machine to automatic** and go to step #12.

11) If the static pressure is still below 0.13" you could switch to use four 36" fans or two 48" fans as timer fans, but the problem is that your house is too loose to use inlet ventilation effectively. **You must work on getting**

your house tighter to keep your fuel costs as well as drafts to a minimum.

12) If you have a digital static pressure controller, go to 12 a. If your static pressure controller is the mechanical type, skip to 12 b.

    a) Digital static pressure controller: If the inlets do not quite open a couple of inches then lower the target static pressure 0.07" or 0.06". If the inlets open more than three inches raise the target static pressure until the inlets only open the proper amount. A target pressure as high as a 0.10 is permissible. (Remember, ceiling inlets need only open about an inch to obtain proper air mixing as opposed to the two to three inches required for side wall inlets)

    b) Mechanical static pressure controller: If the inlets do not quite open a couple of inches then lower the upper limit to 0.09" or 0.08". If the inlets open more than three inches, increase the upper limit to 0.12". (Remember, ceiling inlets need only open about an inch to obtain proper air mixing as opposed to the two to three inches required for side wall inlets)

13) Set your timer fans to operate a minimum of 45 seconds out of five minutes to remove the moisture and ammonia from the house that tend to build up during the preheating process.

14) Hang strips of cassette tape from the ceiling in front of an inlet or to check to see if you are obtaining proper air mixing (see Rule #4).

When the chicks arrive:

1) Set the timer fans according to the charts on the following pages. If the ammonia is high or the relative humidity is above 70%, increase timer fan setting by 50%. (For example if your timer fans are set for 60 seconds out of five minutes, increase the setting to 90 seconds out of five minutes.)

2) Set timer fan thermostats four degrees above desired air temperature (i.e, 92^{o}F-94^{o}F). Ideally, if you are going to use a 48" fan for minimum ventilation, the thermostat/sensor for this fan should be in the brooding end of the house.

3) If one end of the brooding area is too cold, you may have excessive leakage in that area and you should see what you can do to tighten the house up and/or close an inlet or two. If you have one area of the brooding area which is too warm, you may have too many birds in that area of the house and you may need to unlatch an inlet or two in this area of the house. Ideally, you need to keep the birds spread evenly throughout the brooding area and may need to put up migration fences to do so.

4) Adjust timer fans according to relative humidity. Target relative humidity is approximately 65%. If humidity rises above 75% for a prolonged period of time, increase timer fan settings. If humidity falls below 55% for a prolonged period of time, decrease timer fan settings. If ammonia is high (ammonia is high if you can smell it at all), increase timer fan settings.

5) Over the course of the first six days decrease house temperature gradually to approximately 85^{o}F.

24 hours prior to turn out from partial house brooding:

1) Set brooder/furnace thermostats on the nonbrooding end of the house to desired temperature.

2) Set up one 48" fan or one 48" fan and one 36" fan, ideally in the nonbrooding end, as your timer fan(s).

3) Loosen the half house curtain so the 48" fan can pull the warm air to the nonbrooding end of the house.

12 hours prior to turn out:

Raise the half house curtain.

Turnout:

Remove the half house bird boards.

After turnout:

1) Over the next week the birds will slowly move toward the nonbrooding end of the house. As they do so, inlets in the rear of the house will need to be unlatched. The number of inlets unlatched in the nonbrooding end of the house should be proportional to the number of birds in the nonbrooding end of the house. For instance, if you have 15 inlets unlatched in the nonbrooding end of your house and only ½ of the number of birds are in the nonbrooding end of the house as the brooding end, you should have about half the number of inlets unlatched in the nonbrooding end of the house (i.e, seven or eight). When the birds are spread evenly throughout the house there should be as many inlets opened in the nonbrooding end as in the brooding end of the house.

2) As the inlets in the nonbrooding end are unlatched, you will find that the static pressure will decrease and thus the inlets will not open as much as they did when the birds were in half house. You will probably need to add another 36" timer fan. Depending on house tightness you will typically have to use either three or four 36" timer fans or a combination of 36" and 48" timer fans. At no time should you use more than four 36" fans or two 48" fans as timer fans (see Rule #6).

3) In order to maintain uniform house temperatures as well as to insure proper bird to feeder/waterer ratios, it is crucial to keep your birds spread evenly throughout the house. The more birds there are in one end of the house the warmer that end of the house will be. Ten percent more birds in one end of the house can produce the same amount of heat as two or three brooders resulting in significant temperature differences. Furthermore, just a 10% difference in bird density from one end of the house to another can result in a 10 point difference in weight as well as a 3 point difference in feed conversion.

   If the birds are not spread out evenly within a week of turnout, you may have to “push” the birds to the rear of the house and install migration fences. In general, tunnel ventilated houses should have a minimum of three fences installed year round.

4) As the birds get older, thermostats may activate additional fans to maintain the proper house temperature (i.e, four 36" fans and a couple of 48" fans or four 48" fans). At this point additional side wall inlets will need to be unlatched. Generally speaking, during moderate weather with older birds, 75% or more of the side wall inlets will need to be unlatched (50 - 60 inlets).

5) Timer fan and exhaust fan thermostat settings should be adjusted according to the charts on the following pages. These charts provide a starting point and adjustments to those recommendations will be required from time to time to obtain the best environment at the lowest cost. For instance, the timer settings provided on the charts should be regarded as minimum. If the relatively humidity exceeds 70% for a day or more or if ammonia levels begin to climb, the timer fan settings should be increased. If the house becomes too dry (relative humidity below 55%), timer fan settings may need to be decreased.

6) With young chicks a grower should be much more concerned about the birds getting too cold as opposed to too warm. For this reason it is important that the difference between your desired temperature and the temperature when your heat comes on (heating offset) should be very small, approximately one degree. This insures that as soon as the house temperature starts to drop below the desired temperature, the heat will turn on and warm the house. Timer fan thermostats should be set three to four degrees above the desired air temperature because we are not really that concerned about the birds becoming too warm. Furthermore, if the timer fan thermostats are set too close to the brooder/furnace thermostat settings you could get in to a situation where the heaters and exhaust fans fight one another. The heaters/brooders heat the house, followed a minute later by the timer fans trying too cool the house. It is for this reason that there should be a four to five degree temperature difference between the temperature at which the heaters/brooders come on and the temperature at which the cooling fans are activated.

   As the birds get older, concern shifts from chicks being too cold, to birds becoming too warm. With older birds we want the fans to come on more quickly to keep the house temperature from rising and to keep the air fresher. For these reasons, we want the timer fan thermostats to be set relatively close the desired house temperature. Conversely, if the temperature drops a few degrees below our desired temperature, we don't necessarily have to panic because older, well-feathered birds are more tolerant of cooler temperatures. Brooder/furnace thermostat settings do not have to be really close to the desired house temperautre. For this reason the difference between the brooder/furnace thermostats setting and the desired house temperature should be one degree the first week and two degrees the second week, three degrees the third week, etc (one degree added per week). Conversely, the timer fan thermostat settings should start at three or four degrees above the desired house temperature week one and decreased about one degree per week. Obviously, timer fan thermostats should not be set lower than the desired air temperature.

7) If litter in your houses begins to show signs of caking, increase your timer fan settings and make sure your heaters/brooders can come on if need be. You should not decrease your thermostat settings to bring in more fresh air. Fresh air will only dry out a house if the air is warmed. For instance, lowering your fan thermostats five degrees actually makes more difficult to dry out the house because cold air will not absorb moisture as well as warmer air. As a result, you end up chilling your birds and not drying out your litter. When it comes to drying out a house it is quality not quantity of fresh air that determines how effective it will be at helping to dry out the litter.

8) Houses with tunnel curtain machines should be set to go into tunnel ventilation year round. If something goes wrong with the side wall inlet machine and the side wall inlets do not open, the house will eventually heat up. If this happens you want the tunnel curtain to open so the birds will receive the fresh air they need.

9) Make sure that you raise thermostat and controller sensors to keep them out of the reach of the birds as they grow.

10) Watch your birds. They are the best indicator of whether your temperatures are set right. They will tell you if they are too cold or too warm.

11) Review “The Rules” from time to time to see if you are on track.

It is important to note that the ventilation system charts provided in this newsletter offer a point from which to start. After watching the birds in your houses you may want to have your fans/heaters to come on a little sooner or later, or you may need to adjust your desired temperature up or down. Furthermore, the desired temperatures listed on the charts may need to be modified according to the size and breed of bird your growing. **Be sure to check with your field representative before making any changes.**

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Power-Ventilated Broiler House With Fogging Pads Operational Guidelines (11/1/98)

Day 1 - 7

Equipment	Thermostat Settings (F°)	Minimum Timer Setting (seconds out of five min.)
Brooders/Furnaces	87	
Desired Temperature	88 to 90	
one 48" fan or two 36" fans or one 36" & one 48"	91	45 45 45
one 48" fan	93	
tunnel curtain	97	
top row of fog	99	

Day 8 - 14

Equipment	Thermostat Settings (°F)	Minimum Timer Setting (seconds out of five min.)
Brooders/Furnaces	81	
Desired Temperature	83	
one 48" fan or two 36" fans or one 36" & one 48"	85	60 60 45
one 48" fan	87	
one 48" fan	88	
tunnel curtain	91	
top row of fog	95	
bottom row of fog	99	

Day 15 - 21

Equipment	Thermostat Settings (°F)	Minimum Timer Setting (seconds out of five min.) (b.b. = big bird) (s.b. = small bird)
Brooders/Furnaces	78	
Desired Temperature	81	
one 36" & one 48" fan	83	90 (s.b) 60 (b.b)
one 48" fan	85	
one 48" fan	86	
tunnel	89	
one 48" fan	90	
top row of fog	93	
bottom row of fog	96	

Day 22 - 28

Equipment	Thermostat Settings (°F)	Minimum Timer Setting (seconds out of five min) (s.b. = small bird) (b.b. = big bird)
Brooders/Furnaces	74	
Desired Temperature	78	
one 36" and 48" fan	79	120 (s.b.) 90 (b.b.)
one 48" fan	81	
one 48" fan	83	
tunnel	86	
one 48" fan	87	
one 48" fan	89	
top two rows of fog	90	
bottom row of fog	93	

Day 29 - 35

Equipment	Thermostat Settings (°F)	Minimum Timer Setting (seconds out of five min.) (s.b. = small bird) (b.b. = big bird)
Brooders/Furnaces	70	
Desired Temperature	75	
one 36" and one 48"fan two 48" fans	76	120 (b.b) 160 (s.b) 150 (s.b.) 110 (b.b)
one 48" fan	78	
one 48" fan	80	
tunnel	83	
one 48" fan	84	
one 48" fan	86	
top two rows of fog	87	
bottom row of fog	90	

Day 36 - 42

Equipment	Thermostat Settings (°F)	Minimum Timer Setting (seconds out of five min.)
Brooders/Furnaces	65	
Desired Temperature	71	
two 48" fans	72	180 / 120 (s.b.) 120 / 180 (b.b.)
one 48" fan	74	
one 48" fan	76	
tunnel	79	
two 48" fans	80	
one 48" fan	82	
top two rows of fog	83	
bottom line fog	86	

Day 43 +

Equipment	Thermostat Settings (°F)	Minimum Timer Setting (seconds out of five min.) (b.b. = big bird)
Brooders/Furnaces	63	
Desired Temperature	70	
two 48" fans	71	150 / 150 (b.b.)
one 48" fans	73	
one 48" fan	75	
tunnel curtain	78	
two 48" fans	79	
one 48" fan	81	
two rows fog one 48" fan	82	
bottom row fog	85	