

TEMPERATURE MAPPING OF CAGE LAYER HOUSES

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The goal of every ventilation system is to provide uniform air quality to each chicken in the poultry house. More specifically, the goals are to exchange carbon dioxide for oxygen, remove ammonia and other harmful gases and vapors, and to provide a uniform environment in terms of temperature.

Uniform temperature is essential to maximizing overall flock performance and economic efficiency. Feed consumption can be significantly influenced by minor differences in temperature (one or two degrees). Feed consumption in turn, directly influences egg size, shell thickness, body weight and rate of lay. Because each bird within the house is fed the same ration at any given time, birds located in different temperatures within the house will eat different amounts of feed. Rations are formulated based on flock average information (feed consumption of the previous period, phase within the lay cycle, rate of lay, etc.). If a ration is fed to a flock in a house with widely varied temperatures, the ration may not meet the nutritional needs of birds in warm temperatures and will be overly dense and wasteful for birds at cooler temperatures.

The temperature range (minimum and maximum) within a house at any given point in time may be of interest, but it is not the most important measure of uniformity. More importantly, is the number or percentage of the birds that are located within the extremes. Consider the relative importance of 10 birds at one extreme temperature out of a flock of 30,000 hens versus 10 percent of the flock at that temperature.

House Temperature and Micro-climates

Every poultry house will have temperature micro-climates (areas where the temperature departs **from** the average temperature of the house). Our goal is to minimize these micro-climate differences as much as possible, so that when we set the average house temperature to say 80⁰ F, nearly all the birds are in **that** environment.

First, let's discuss the main factors that influence house temperature. The birds themselves have a major effect on temperature because they release heat energy in order to maintain their body temperature. The amount of heat released depends on several factors including the number of birds, their body weight and the **amount** of work they do (exercise, etc.).

Outside environmental factors, mainly the outside temperature and humidity, will obviously affect the inside house temperature. Outside heat warms the house by radiant energy through the roof and sides of the house. Outside air also is the source of fresh air to the birds and must be cooled during the summer and limited during the winter in order to achieve the desired house temperature. The amount of moisture in the outside air (humidity) will determine the amount of evaporative cooling capacity the house cooling system will have.

Housing design can not only affect the average house temperature but also the uniformity of temperature at different locations within the house. The number of fans, their size, speed and efficiency determine the volume of airflow into and out of the house (air exchange). Cooling pad size and number and the degree of wetting determine the amount of cooling that can be accomplished on the volume of air that is brought into the house from the outside. House static pressure (the difference in pressure between outside and inside the house) will determine the flow rate and velocity of air movement. Any unintentional air leaks will reduce the static pressure, altering the intended airflow. Length of the air pathway in part determines the air temperature along the pathway. Long pathways have a chance to pick up more heat energy and so are warm at the end, just before they reach the exhaust. Cage design or any other structural factor that may impede airflow could create airflow dead spaces where very little cooling takes place. Because heat rises, elevation differences within the house will effect temperature, The amount of insulation in the house helps to buffer the inside temperature against changes in outside temperature. And finally, the temperature set point that management has chosen ultimately determines the average house temperature.

Micro-climates can be caused by differences in any of the above mentioned factors within the house. For the most part, cage density and bird size are uniform, however this might not always be the case. House temperature set points are always the same within any given house. Elevation differences, airflow pathway distance and most obstructions are usually set by the design of the house. The main factors we need to be concerned with are: airflow obstructions, air distribution, and pad and fan **efficiency**. Air distribution and rate can sometimes be modified by adjusting air inlets. Pad and fan efficiency problems are relatively easy to correct. Fan maintenance (changing belts, cleaning blades and louvers) and maintenance of cooling pads (cleaning and /or replacement, maintaining water systems to assure complete wetting) should be done routinely.

Micro-climates can come and go. A brand new house with its first flock may have 'minimal micro-climates in the beginning and then later develop wider extremes and several pockets of cool and warm areas. The key is to locate these differences as they develop because they usually indicate that a louver, fan or cooling pad is not operating

properly. Walking the house with a rapid registering temperature measuring device is an easy and relatively fast way of locating problem areas.

Temperature Mapping

Geographical regions within the house should be taken into consideration when mapping a house. Measurements should be taken at each end of the house, at different deck levels, along the distance of the air pathways, opposite air intakes and exhaust regions, along both central and external rows and near potential air flow obstructions.

Sometimes the primary purpose of mapping is to measure maximum temperature differences and to locate where the minimum and maximum temperatures are. Identifying airflow pathways and still air regions are most important for this type of mapping. High temperatures will be located at the ends of the airflow pathway and at the upper decks of still air regions. Cool areas will be just the opposite. While this method will locate the extremes, it will usually not provide a good measure of uniformity within the house relative to the flock.

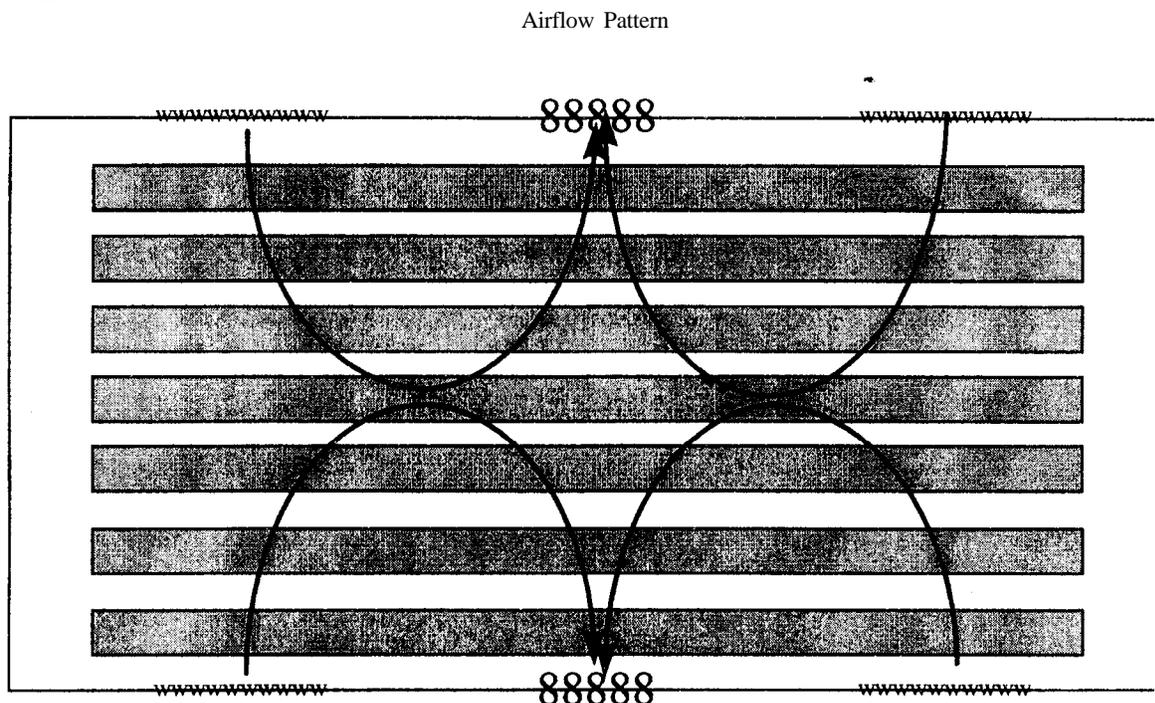
If the goal of temperature mapping is to measure uniformity, temperature readings should be geometrically representative of the space where the birds are located. This method requires identifying a set of bird grids that represent the length, width and elevation throughout the house. If for example a grid represents a linear run of 20 cages, each measurement (by row and deck) will be taken at the center of that run (between the 10th and 11th cage). The number of grids and their size will depend on the size of the house and the degree of precision desired. Because each grid represents approximately the same number of birds (assuming cage density is constant throughout the house), the percentage of birds in any given temperature range can be easily determined.

Regardless of the method of temperature mapping, do not assume the house is symmetrical. While most houses today are built symmetrically, their temperatures may not be. Direction of the house orientation (north, South, east or west) and differences in house length elevation can have an effect on temperatures within the house.

Pilot Field Study

We mapped two recently built houses in California in 1997. These were environmental single story pad and fan negative pressure houses. The two houses were similarly designed with sets of pads located along the sides of the house toward the ends and with fans located at the center length on each side of the house (figure 1). The airflow can be seen coming into the house through the cooling pad toward the center of the house and exiting through the fans along the side wall. One house had 8 rows and 5 cage decks, while the other had 7 rows and 4 decks.

Figure 1. Airflow pattern



The mapping method we used was a combination of the minimum/maximum discovery and the geometrical representation methods described earlier. Measurements were taken at multiple decks near the ends of the cage rows, center of the pad, between the pad and fans and opposite the center of the fans. Every other cage row was measured.

Both sets of house temperatures were nearly normally distributed. The most frequently measured temperature (mode) was within 1° F of the average, and 95 percent of the temperatures were within plus or minus two standard deviations of the average temperature. Three zones (comfort, hot and cold) were arbitrarily defined for the purpose of this discussion. The comfort zone was defined as plus or minus 3° F of the mode temperature (6° F range). Hot and cold zones were defined as 4° F or more above and below the mode, respectively. Because temperatures were rounded to the nearest degree, there was a minimum of 8° F difference between the hot and cold zones (table 1).

Table 1. Temperature Zones

	House A	House B
Mode	86° F	84° F
Comfort Zone	83°-89° F	81°-87° F
Hot Zone	90° F plus	88° F plus
Cold Zone	82° F minus	80° F minus

The outside temperatures in each case ranged between 95° and 104° F while the mapping took place, Mapping took approximately 2 hours in each case.

A summary of the house temperatures measured are given in Table 2.

Table 2. House temperatures and zone distributions

	House A	House B
Outside Temperature	95-104 ⁰ F	100-104 ⁰ f
Temperature Set Point	81 ⁰ F	78 ⁰ F
Mode Temperature	86 ⁰ F	84 ⁰ F
High Temperature	93 ⁰ F	90 ⁰ F
Low Temperature	79 ⁰ F	75 ⁰ F
% in Comfort Zone	54	42
% in Hot Zone	26	27
% in Cold Zone	20	30

Figures 2 and 3 show the locations of the hot and cold zones.

Figure 2. Temperatures in house A

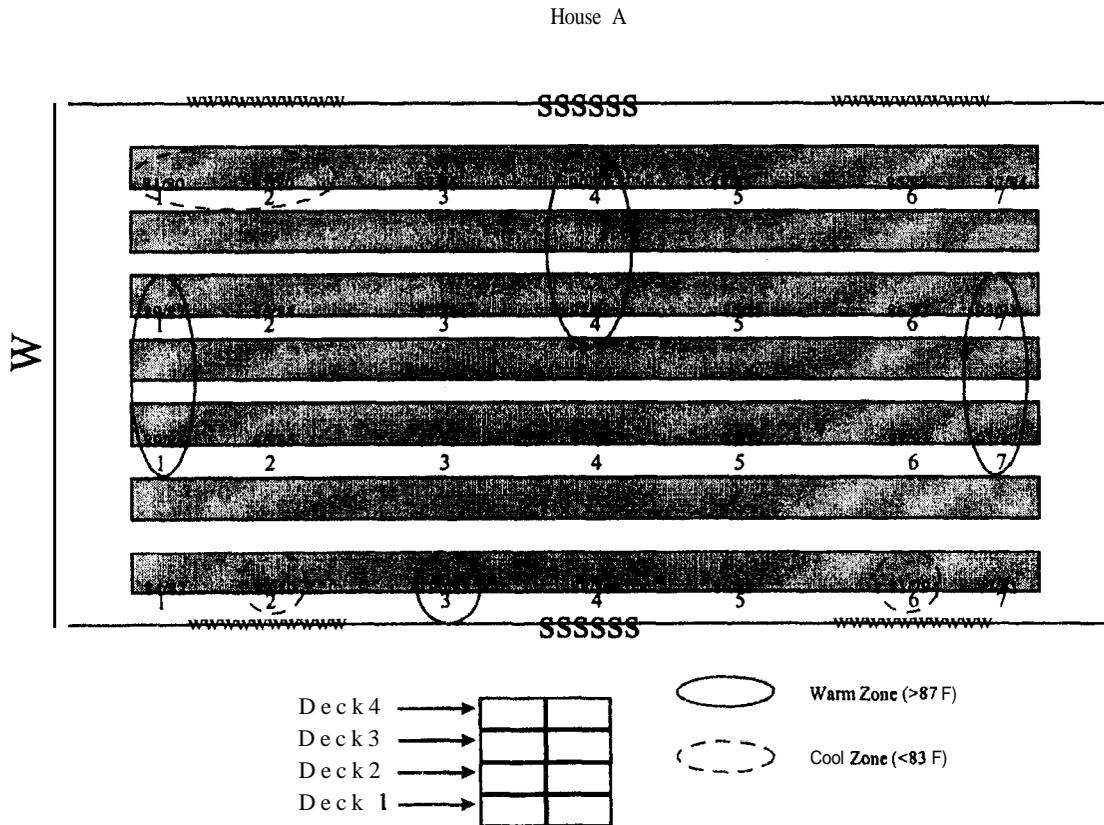
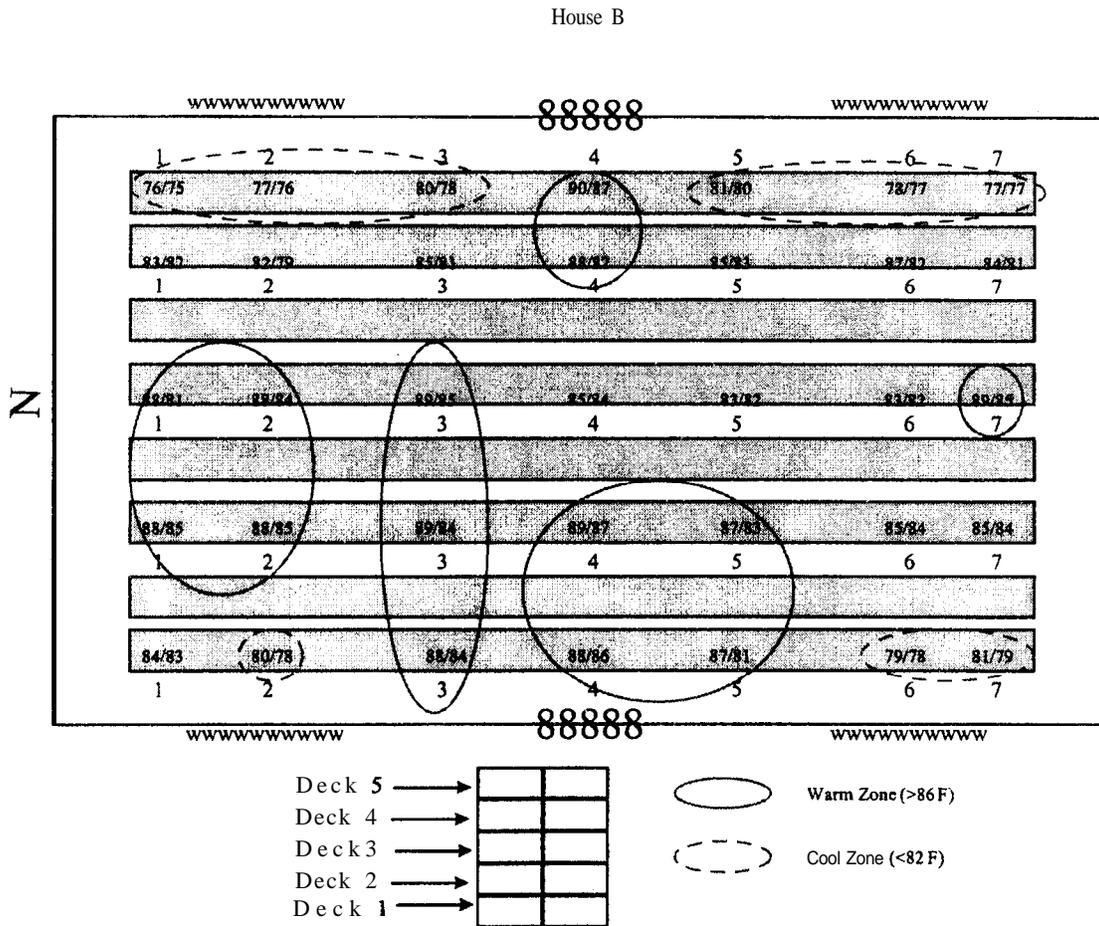


Figure 3. Temperatures in house B



The house A temperature set point (the temperature that management wanted to maintain) was 81° F. The average temperature in the house was 85.6° F, and the most frequently measured temperature was 86° F. We observed a 14° F temperature range (79-93° F) during our mapping. Approximately 54% of the measurements fell within our defined comfort zone (83-89° F), while 26% were in the hot zone (90-93° F) and 20% were in the cold zone (79-82° F).

House B had a set point of 78° F. The average temperature was 83.3° F and the most frequent temperature observed was 84° F. This house had a 15° F range in temperatures (75-90° F). The comfort zone (81-87° F) represented 42% of the measurements. Approximately 27% of the measurements were in the hot zone (88-90° F) and 30% were in the cold zone (75-80° F).

In both houses, the hot zones tended to be located near the center of the house opposite the fans and in the center at the ends of the cage rows. Cold zones tended to be located opposite the cooling pads. In houses of this design, we would expect to measure warmer

temperatures opposite the fans because this is the air at the end of the airflow pathway. Likewise, cooler measurements would be expected opposite the cooling pads at the beginning of the airflow pathway. Although air velocity readings were not taken, we believe that the warm temperatures measured in the center at ~~the~~ ends of the cage rows were due to relatively still air. Interestingly, there were no consistent deck effects in either of the two houses.

Both houses had a significant proportion of the flock in the hot and cold extremes. On average, 50% of the birds were in one extreme environment or the other. This 8° F or more difference, if maintained over a period of time, would be expected to have significant effects on feed consumption.

Future Studies

Over the past few years there have been several newly constructed poultry houses that have used varying designs of ventilation and cooling systems. We assume not all of these houses perform equally in terms of cooling and air distribution. Many of these systems have never been systematically mapped in detail, and so their performance is not **known**.

We plan to evaluate as many types of mechanically ventilated layer houses as possible over the next year. We want to measure pad and fan efficiencies, and air distribution within these systems to identify which types of designs perform the best in terms of maintaining temperature within an expected range and providing uniform air temperature to the birds.

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