TEMPERATURE MAPPING OF MECHANICALLY VENTILATED CAGE LAYER HOUSES

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 remove carbon dioxide, supply oxygen, remove ammonia and other harmful gases, remove moisture and provide a uniform 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 may 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. The number or percentage of the birds that are located within the extremes is of more importance. 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 or 3,000 at that temperature.

House Temperature and Microclimates

Every poultry house will have temperature micro-climates (areas where temperature differs from the house average for the house). Our goal is to minimize these micro-climate differences as much as possible so that when we set the average temperature to say 80°F, nearly all the birds are in that environment.
Factors Affecting Average House Temperature

Housing design will effect the average house temperature and temperature uniformity. Average temperature is affected by air flow, outside temperature and humidity, and the cooling efficiency of the pad system used. Regular cleaning of the pads and maintenance of the water distribution system is important in maintaining cooling efficiency of the cooling system. Air flow is affected by static pressure difference between the inside and the outside of the house. Static pressure is affected by the amount of air pumped in or out by the fans (fan capacity) and the air inlet or outlet area. When airflow and inlet or outlet area are properly balanced the ventilation system will operate at optimum efficiency. Fan capacity may be reduced if fan blades and louvers are dirty or if fan belts are not properly adjusted.

Factors Affecting Temperature Uniformity

The design of the ventilation system (inlet design, location and inlet air speed) and location of cages and other obstructions to air flow often affect temperature uniformity within the house. Major factors affecting temperature uniformity are the distance which air travels between the inlet and the exhaust and the amount of heat added to the air by the birds. Longer distances for airflow and greater numbers of birds producing heat usually result in larger temperature variations. Air speed through the inlets is governed by the static pressure difference between the inside and outside of the house. Higher air speeds usually produce more turbulence in the house which results in better air mixing and greater temperature uniformity. However, higher static pressure difference reduces air exchange volume so a balance needs to be found which will optimize temperature uniformity for each house.

Temperature Mapping

Various 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. Usually temperature extremes will be the widest at times when the house is being operated under minimal ventilation conditions. 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), prevailing wind pattern and differences in elevation from one end of the house to the other can have an effect on temperatures within the house.

**Pilot Field Study**

In 1997 two recently built houses in California were mapped. 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.

![Airflow pattern](image-url)
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 or below the mode, respectfully. With temperature rounded to the nearest degree, there was a minimum of 8°F difference between the hot and cold zones (Table 1).

The outside temperatures in each case ranged between 95°F and 104°F during mapping, and both ventilation and cooling systems were operating at their maximums. Mapping took approximately 2 hours in each case.

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

### Table 1. Temperature Zones

<table>
<thead>
<tr>
<th></th>
<th>House A</th>
<th>House B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode</td>
<td>86°F</td>
<td>84°F</td>
</tr>
<tr>
<td>Comfort Zone</td>
<td>83°F-89°F</td>
<td>81°F-87°F</td>
</tr>
<tr>
<td>Hot Zone</td>
<td>90°F plus</td>
<td>88°F plus</td>
</tr>
<tr>
<td>Cold Zone</td>
<td>82°F minus</td>
<td>80°F minus</td>
</tr>
</tbody>
</table>

### Table 2. House temperatures and zone distributions

<table>
<thead>
<tr>
<th></th>
<th>House A</th>
<th>House B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside Temperature</td>
<td>95-104°F</td>
<td>100-104°F</td>
</tr>
<tr>
<td>Temperature Set Point</td>
<td>81°F</td>
<td>78°F</td>
</tr>
<tr>
<td>Mode Temperature</td>
<td>86°F</td>
<td>84°F</td>
</tr>
<tr>
<td>High Temperature</td>
<td>93°F</td>
<td>90°F</td>
</tr>
<tr>
<td>Low Temperature</td>
<td>79°F</td>
<td>75°F</td>
</tr>
<tr>
<td>% in Comfort Zone</td>
<td>54</td>
<td>42</td>
</tr>
<tr>
<td>% in Hot Zone</td>
<td>26</td>
<td>27</td>
</tr>
<tr>
<td>% in Cold Zone</td>
<td>20</td>
<td>30</td>
</tr>
</tbody>
</table>
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 long enough period of time, would be expected to cause significant differences in feed consumption between birds located within the extreme environments.

**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 providing a uniform environment for the birds. Many of these systems have never been systematically mapped in detail, and so there performance is not known.

We plan to evaluate as many types of mechanically ventilated layer houses as possible over the next two years in order to determine which designs provide the best temperature control and uniformity. Because houses perform differently during hot and cold conditions, each house will be mapped once during the summer (maximum ventilation and cooling), and once during the winter (minimum ventilation).

**D. R. Kuney**  
Area Poultry Farm Advisor

**Proposed CEQAP Changes**

Please read the letter on page 6 carefully. We would like input from plan participants or potential participants (egg and pullet producers). You can telephone any of the numbers in the letter, FAX me at 530/752-8960 or c-mail racrnat@ucdavis.edu. The FAX number for David Goldenberg is 916/358-2961; e-mail golden59@idt.net.

If this change is made producers would be required to test the environment of each flock once. The CVDLS would charge you about $100 for culturing. Sampling materials would cost about $25. If a consulting veterinarian was hired to do the sampling, this cost is estimated at $400.

**Ralph Ernst**  
Poultry Specialist
July 17, 1998

TO: CALIFORNIA EGG QUALITY ASSURANCE PLAN PARTICIPANTS
    ALL CALIFORNIA EGG AND PULLET PRODUCERS

FROM: David J. Goldenberg, CEQAP Facilitator

The California Egg Quality Assurance Plan (CEQAP) may soon undergo a major change. When the plan was adopted in 1995, the egg industry provided for revisions when conditions were warranted. In recent months there has been a recognized need to incorporate a validation component to the plan to assure the program is working on individual farms.

Unfortunately, SE food illnesses continue to be a problem in California and the nation. As the CEQAP program has progressed, there is now a recognized need to validate our program. A subcommittee of egg and agency representatives drafted a proposal which will be deliberated at the next CEQAP meeting scheduled September 1st, at the Country Suites by Ayres, 1945 East Holt Ave, Ontario, California.

The proposed changes are listed below:
1. Monitor the environment with manure drag swabs for Salmonella enteritidis at least once during the life of a lay flock while in production or 2-3 weeks before push out.
2. Manure drag swabs may be pooled for culture.
3. A properly certified flock owner or his/her designee may collect the samples.
4. Samples will be sent to the California Veterinary Diagnostic Laboratory (CVDLS) or another equivalent laboratory as approved by the California Department of Food and Agriculture (CDFA). The CVDLS will have a system in place to ensure confidentiality.

The CEQAP is acclaimed as one of the top quality assurance programs in the nation. In addition to our Partnership Agreement with USDA, FDA, CDFA and the Calif. Department of Health Services, we have been recognized by Vice President Al Gore to receive the prestigious FDA Hammer Award on October 8 in Modesto. We anticipate that adding this validation component will enhance the industry’s ability to show that farms participating in the CEQAP are not a major source of SE. It will also help justify continued efforts to educate food handlers.

The University of California Cooperative Extension will develop workshops to teach proper sample collecting techniques. This will assure that all samples are collected using comparable procedures. Our educational program is one of the major differences that sets our program apart from the rest of the nation’s egg quality assurance programs.

We understand that you may have questions about the proposed changes. We welcome you to attend the September 1 meeting in Ontario to discuss this issue. In the meantime if you have any questions please call upon the following individuals: David J. Goldenberg, CEQAP Facilitator (916) 985-1122; UC Extension Ralph Ernst (530) 752-3513; Don Bell (909) 787-4555; and Doug Kuney (909) 683-6491 Ext. 226. You may also contact the CEQAP Advisory Committee: Arnold Riebli, Chairman (209) 545-1988; Carlton Lofgren, Vice-Chairman (909) 797-0144; Mark Oldenkamp (209) 669-5600; John Demler (909) 654-8166; Ernie Gemperle (209) 667-2651, and Tom Friend (909) 928-1305.

The CEQAP program has at this point in time certified California farms that control approximately 85 percent of the state’s layer production. If you haven’t signed up we recommend that you take this opportunity to join.
Why a Quality Assurance Program for Eggs?

Everyone who depends on the egg business as a source of income should take note! The following quote demonstrates the political climate in which you are operating.

"Stats on Salmonella enteritidis in Eggs Corrected -- An estimated one in 20,000 eggs are contaminated with Salmonella, according to a USDA report released on June 4. Reuters had erroneously reported one in 20 eggs contained the pathogen, the wire service said. USDA on June 9 corrected the number of human illnesses resulting from consumption of eggs each year to 661,633, about 200,000 less than the figure incorrectly reported in the news release announcing publication of the report. USDA "applied risk assessment formulas to five modules or areas of concern [regarding Salmonella enteritidis]: egg production, shell eggs, egg products, preparation and consumption, and public health," USDA said in the news release. An estimated "2.3 million of 46.8 billion shell eggs produced each year in the United States are infected with SE, resulting in [661,633] human SE cases," the corrected news release stated."

The industry continues to suffer this kind of publicity about egg safety. Regardless of the "facts" or whether we agree with the numbers or details of these kind of releases, we must face reality. This kind of publicity is not good for egg sales. There is something you can do! If you are not a member, join the California Egg Quality Assurance Program now!

Ralph Ernst
Poultry Specialist

Coming Events

August 2-5, Poultry Science Association Meetings, Pennsylvania State University, University Park, PA. For more information contact PSA office, 217/356-3182.

August 20, Critical Threats to California Animal Agriculture Conference, 1309 Surge III, University of California, School of Veterinary medicine, Davis CA. For more information call 530/752-0853.

August 25, UC 38th Annual Fall Turkey Conference, Kearney Agricultural Center, Parlier. For more information contact John Voris or Diana 209/646-6500.

*September 1, CRQAP Industry/Agency Advisory Team Meeting, Country Suites by Ayres, 1945 East Holt Ave., Ontario, CA. For details contact Anne Downs, PePa 916/441-0801.


September 24, Poultry Waste Management Meeting, DoubleTree Hotel, Modesto, CA. For more information contact CPIF 209/576-6355.

September 24-25, California Poultry Industry Federation annual meeting and conference, DoubleTree Hotel (formerly Red Lion) Modesto, CA. Contact CPIF at (209) 576-6355 or email mlouker@ainet.com for more information.

October 19-21, National Poultry Waste Management Symposium, Springdale, AK. For more information contact Ralph Ernst 530/752-3513.


*Programs approved for California Quality Assurance Program credit.

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California Poultry Letter

July 1998

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