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Poultry Housing Tips

Understanding Radiant Brooders

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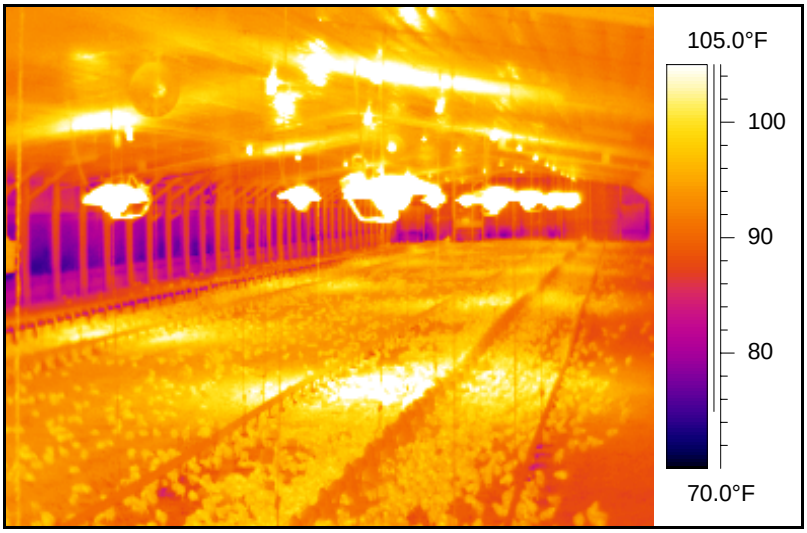

Figure 1. Thermal image of brooding area with radiant brooders.

One of the keys to providing optimal house/floor temperatures while keeping heating costs to a minimum during cold weather is to understand how a heating system actually heats a house. Forced air furnaces are quite simple to understand. A forced air furnace pulls air from the house, heats it up, and then blows it back in to the house. How radiant brooders, and conventional brooders for that matter, heat a house is a little more involved. Though they produce a fair amount of hot air, which heats the air in a house, they also produce radiant heat which heats the floor and birds directly. Since radiant brooders heat the floor directly, floor temperatures in the vicinity of the radiant brooder can be significantly higher than air temperature. Just how much warmer the floor in a particular area of a house will be above air temperature is a function of its distance from a radiant brooder.

When installing a radiant brooder heating system it is important to keep in mind the fact that radiant brooders produce both radiant heat and hot air. To take full advantage of the radiant heat produced, radiant brooders should be installed in such a way that the feed and water lines receive a majority of the radiant heat produced by the brooders. It is equally important that a sufficient number are installed to make sure that an adequate air temperature can be maintained for those birds outside the “radiant heating zone” of a radiant brooder. To achieve these goals a few basic guidelines should be taken into account when installing and operating radiant brooders:

1) The typical 40'X 250' brooding area in a dropped-ceiling house should have a minimum of 14 40,000 Btu’s/hr radiant brooders. Fourteen radiant brooders will insure that the majority of floor space is receiving a significant amount of radiant heat and that the producer will have sufficient heating capacity to maintain a minimum air

temperature of 90°F when outside air temperature drops into the teens.

2) If radiant brooders are used on the nonbrooding end of a 40' X 500' house, a minimum of eight 40,000 Btu's/hr radiant brooders should be installed.

3) Radiant brooders should be installed over the feed and water in order to obtain the maximum benefit from the radiant heat produced by the radiant brooders. Most radiant brooders only produce a significant amount of floor heating within a radius of approximately eight to ten feet. By placing the radiant brooders over the feed and water chicks will have access to a wide range of comfort zones where feed and water are present. Radiant brooders installed over the feed and water should be installed in an alternating pattern. Two brooders should be installed directly across from one another near the end wall and brooding curtain to offset the additional heat loss in these areas of the house.

4) Propane gas lines should be sized to insure that a minimum pressure of 11 inches of water column can be maintained at all locations in a house with all the brooders operating (7" natural gas). Without proper gas line sizing heat output of the brooders will be reduced, leading to smaller radiant heat zones and low air temperatures during cold weather.

5) The edge of the radiant brooder canopy should be approximately six feet above the floor to insure the radiant heat produced by the brooders is spread out over a large area minimizing the possibility of a hot spot directly underneath the brooder.

The importance of these guidelines is often overlooked because of the difficulties involved with evaluating the performance of radiant brooders. We can get some idea of how good of a job radiant brooders are doing heating the floor by observing chick activity or using an infrared thermometer to check floor temperatures in various areas of the house. But, the fact is that chicks will sometimes sit in an area of the house where floor/air temperatures are less than optimal and an infrared thermometer, if a producer has access to one, only measures floor temperature in a very limited area.

Probably the best method of evaluating how good of a job any heating system is doing heating the floor in a broiler house is through the use of a thermal imaging camera. Unlike an infrared thermometer which provides floor temperatures in a numerical format, a thermal imaging camera essentially measures 17,000 floor temperatures at one time and provides a color picture which correlates to temperature. By examining the images produced by a thermal camera it is very easy to see the thermal environment within a house. Over the past year thermal images have been taken in nearly 100 houses, many of which had radiant brooders. The images taken with the camera provide a convincing argument of why following the above guidelines is beneficial.

One of the most common misunderstandings pertaining to radiant brooders is the floor area directly heated by each brooder. Though it is commonly believed that a radiant brooder installed down the center of a 40' wide house will produce significant radiant floor heating from side wall to side wall, it is simply not the case. The actual size of the radiant heating zone is approximately 15 to 20 feet in diameter. Within this area the chicks/floor will receive varying amounts of radiant heat depending on their distance from the radiant brooder. Outside this zone the chicks/floor are being heated primarily by the hot air produced by the radiant brooders. In other words, chicks outside the radiant heat zone of a radiant brooder are very dependent on house air temperature for their comfort much like a house with forced air furnaces.

Figure 2: A single 40,000 Btu/hr radiant brooder installed at a height of six feet in the center of a 50' wide house, provides a good illustration of the amount of floor space that receives a significant amount of radiant heat from a radiant brooder. The initial air temperature in the house was approximately 70°F when the brooder was turned on. At the end of 20 minutes the thermal image in Figure 2 was taken. Figure 3 is a graph of floor temperatures along the blue line in Figure 2 and is approximately 15' in length. Though the radiant brooder does an excellent job of heating the floor well above air temperature in the immediate vicinity of the brooder, you can see that there is a leveling off of floor temperature after the second water line, approximately eight to ten feet from the brooder, indicating very little radiant heating of the floor is taking place (the temperature spike at the left side end of the Figure 2 graph is the outside water line). Chicks within eight to ten feet of the radiant brooder would find feed and

water of varying temperatures while outside this area floor temperature would be determined by house air temperature.

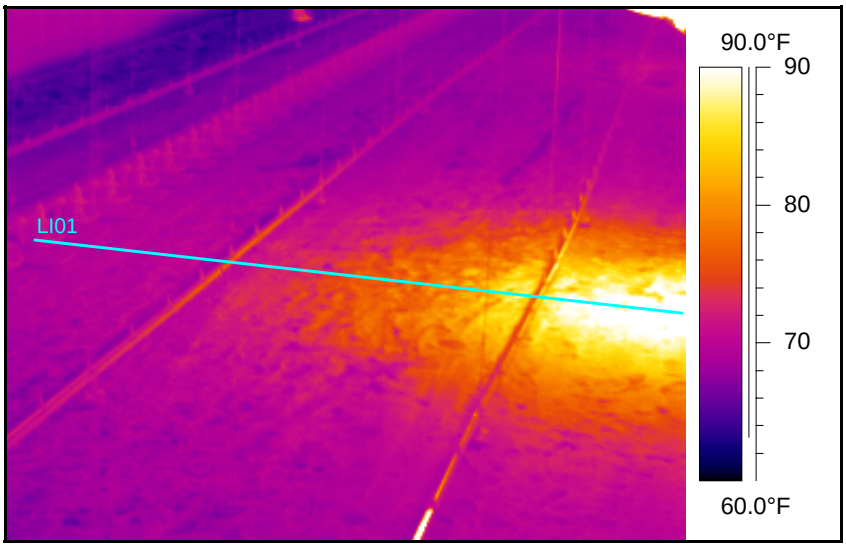

Figure 2. Single radiant brooder is 70°F house.

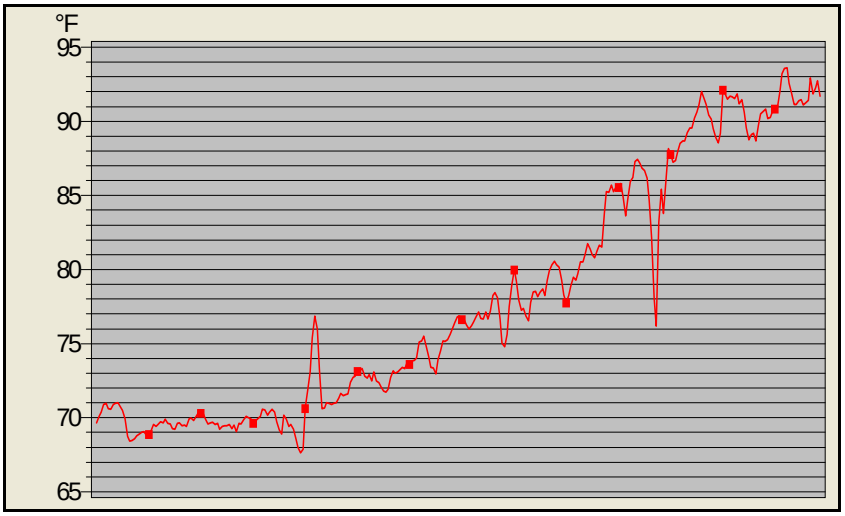

Figure 3. Floor temperatures along blue line in Figure 2.

Figures 4 through 8 were taken on two farms with 40' X 250' curtain-sided broiler houses heated exclusively with radiant brooders during cold weather. Figures 4 and 6 were taken in a house a day prior to chick placement while Figures 5 and 7 were taken in a house the day after the chicks were placed. An air temperature of approximately 90°F was being maintained in all houses when the images were taken. Figures 4 and 5 illustrate floor conditions in the center of the house while Figures 6 and 7 illustrate side wall floor temperatures. In Figures 5 and 7 floor temperatures toward the center of the house ranged between 88°F and 105°F, whereas side wall floor temperatures ranged between 105°F and the low eighties (Figures 6 and 7). As you see in Figures 5 and 7, birds appeared fairly evenly spread out where the floor temperature was in the mid eighties to the high nineties. Birds were noticeably absent from the side walls where floor temperatures dropped to the low eighties.

These figures are a good illustration of the advantage of installing radiant brooders over the feed and water as opposed to directly down the center of the house. With the radiant brooders installed at a height of approximately six feet above the feed and water lines chicks formed large circles over the feed and water. There was feed and water at a range of temperatures within the radiant heat zone of the brooders. The range of floor temperatures in the vicinity of one of the radiant brooders in the house is illustrated in Figures 8 and 9. Though there is a small hot spot

directly underneath the radiant brooder it only represents 2.5% of the total area outlined by the blue box in Figure 8. Over 92% of the area of the radiant heat zone of the brooder, indicated by the blue box, was between 90ºF and 106ºF. The chicks can be seen spreading out throughout the entire radiant heat zone of the brooder, indicating a significant range in temperature preferences.

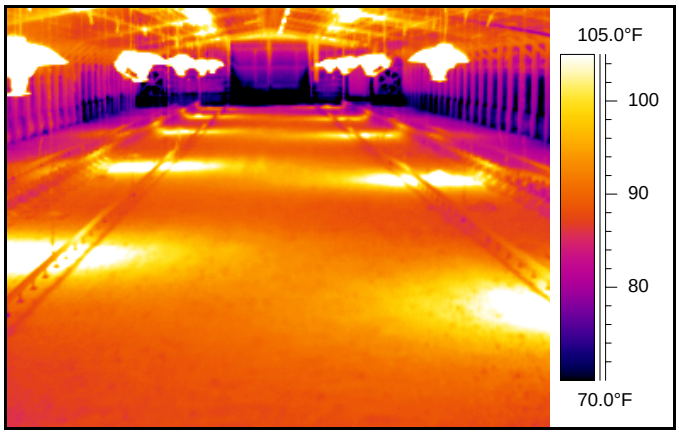

Figure 4. Center of the house floor temperatures.

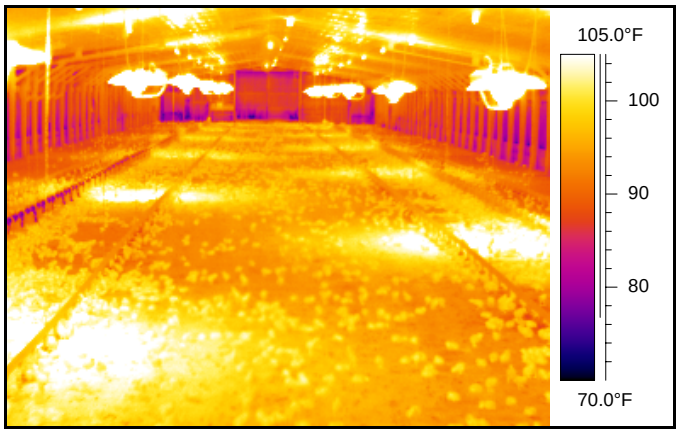

Figure 5. Center of house with chicks.

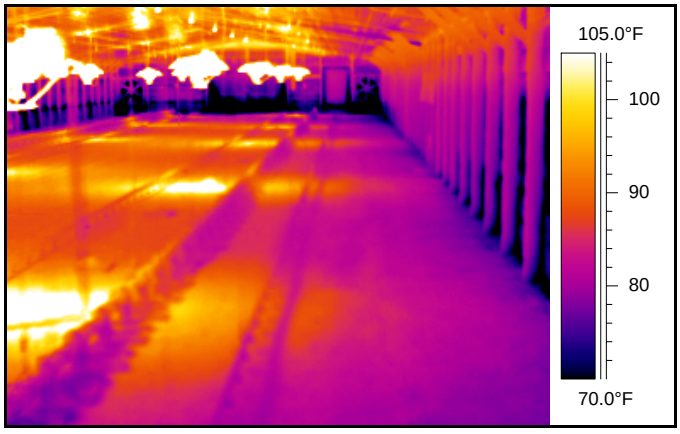

Figure 6. Side wall floor temperatures.

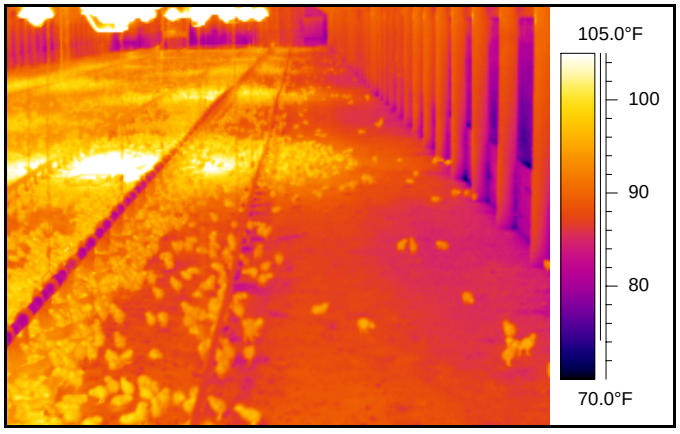

Figure 7. Thermal image near side wall with chicks present.

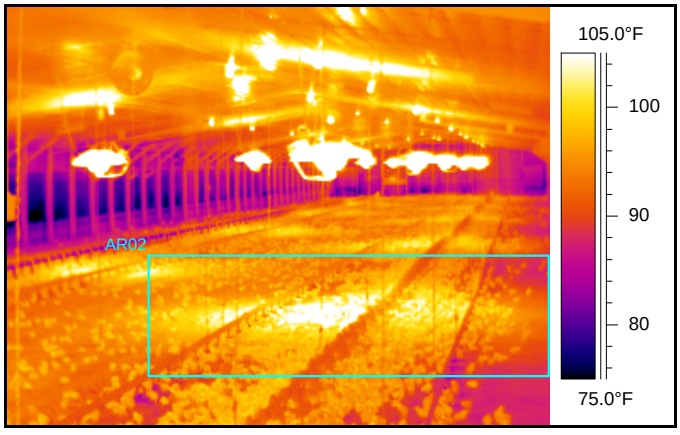

Figure 8. Radiant brooders over feed and water.

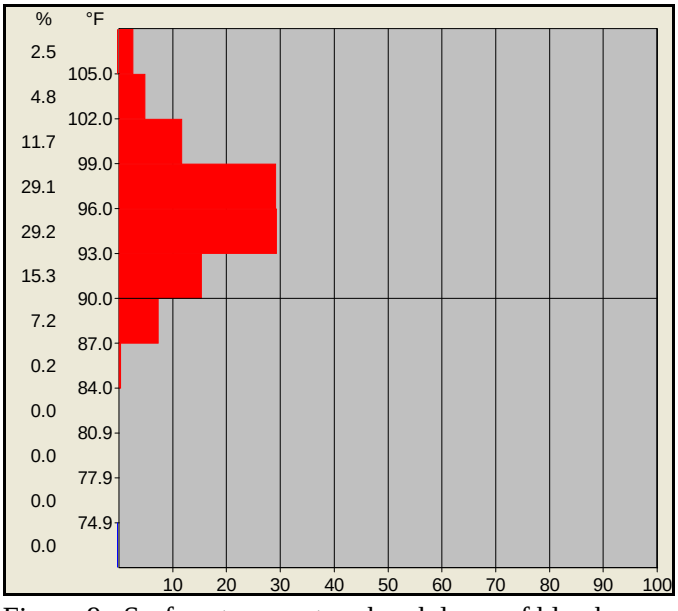

Figure 9. Surface temperature breakdown of blue box area in Figure 8.

It is important to note that had the radiant brooders been installed down the center of the house as opposed to staggered over the feed and water lines there would have been very little water and essentially no feed within the radiant heat zone of the brooders. The floor temperature near the feed and water would have been dictated primarily by house air temperature, much as is the case when forced air furnaces are used. Furthermore, the side walls would have been significantly cooler because there would have been no radiant heat to help offset the heat loss from the curtain side wall. To minimize this problem the producer would have needed to run a higher house air temperature to insure adequate heat on the side wall thus leading to very high floor temperatures in the center of the house. Though this is not necessarily a problem, the question is whether this method of installing radiant brooders is taking full advantage of the radiant heat produced by the brooders.

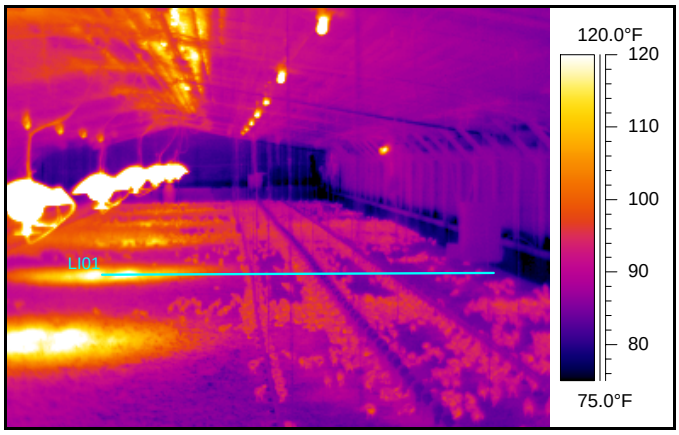

Figure 10. Radiant brooders down center of a house.

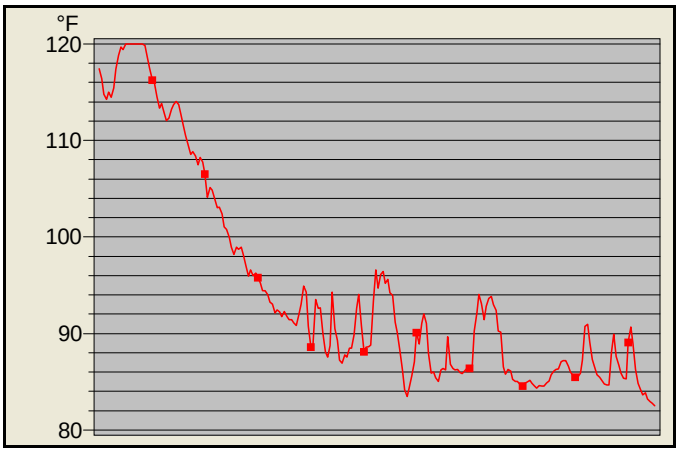

Figure 11. Floor temperature along blue line in Figure 10.

Figure 10 was taken in a house with one-week-old chicks where the house temperature was in the low to mid eighties. The house had a number of heating-system-related issues which included: too few radiant brooders, installed down the center of the house and at too low of a height. The fact that there were too few radiant brooders was indicated by the fact that though the outside temperature was in the high thirties the radiant brooders never shut off. The low brooder height, approximately five feet, tended to concentrate all the radiant heat in the center of the house where it was needed the least. This fact can be seen in Figure 11 which illustrates the floor temperature along the blue line in Figure 10. The temperature directly underneath the radiant brooder was approximately 125^{o}F while at the inside water line floor temperature had dropped to a little below 90^{o}F. Floor temperature levels off to the low to mid eighties around the feed line indicating that very little radiant floor heating was taking place. The proof that the brooders were too low was verified by the fact that the chicks were avoiding the center of the house. The proof that the air temperature was too low was that the young chicks were packing into tight groups trying to stay warm from the feed line to the house side water line which was outside the radiant heat zones of the brooders.

This brings us to a common dilemma: if the same brooders had been installed over the feed and water at the same height it would likely drive the birds in the vicinity of the brooder off the feed and water due to the excessive floor temperatures. Raising the brooders would have helped the situation, but the fact that too few radiant brooders were installed still would have be problematic. First, the fewer the number of radiant brooders installed, the longer they have to operate during cold weather to maintain the proper house temperature and the more likely the chance that the floor in the vicinity of the brooder may become too hot for the chicks even at a height of six feet. Second, with so few radiant brooders, very little of the floor area is actually receiving a significant amount of radiant heat, essentially making the overall environment not that different from that in a house using forced air furnaces. Last but not least, the fact that brooders were operating constantly and barely maintaining an acceptable temperature indicates that had the outside temperature been any lower, house temperature would have dropped to below an acceptable level for all those birds not in close proximity to a radiant brooder.

Though installing more radiant brooders down the center of the house and raising them all to a height of six feet would have significantly improved the situation, the question still remains whether this is an optimal setup. As mentioned previously, the majority of the feed and water in the house is being heated primarily by hot air, much as a house with forced air furnaces. Secondly, little radiant heat is being put on the litter where we need it the most

when it comes to keeping litter dry. Cake typically first forms near the feed and water lines where the birds tend to deposit most of the manure. When radiant brooders are installed over the feed and water lines the radiant heat tends to heat the litter, thus keeping it drier through out the flock. Last but not least, when radiant brooders are installed down the center of a house, essentially no radiant heat is making it to the side walls of the house where it is most needed. The fact is that the litter near the sides of the house is always cooler than in the center of the house. How much cooler depends on house construction and house tightness. In loose, curtain-sided houses the litter near the side walls can be five to ten degrees cooler than the litter in the center of the house due to cool air leaking into the house, as well as, radiant heat loss from the curtains. Though the problem is not as pronounced in totally enclosed houses it is still present often due to cold and leaky concrete stem walls. The fact is that by installing radiant brooders down the center of the house we are putting the majority of the radiant heat far from where it is needed the most, namely the side wall and putting extra heat where we need it the least, the center of house. It is not that radiant brooders are ineffective when installed down the center of the house, the question is whether this is an optimal installation from both the bird and fuel usage standpoint?

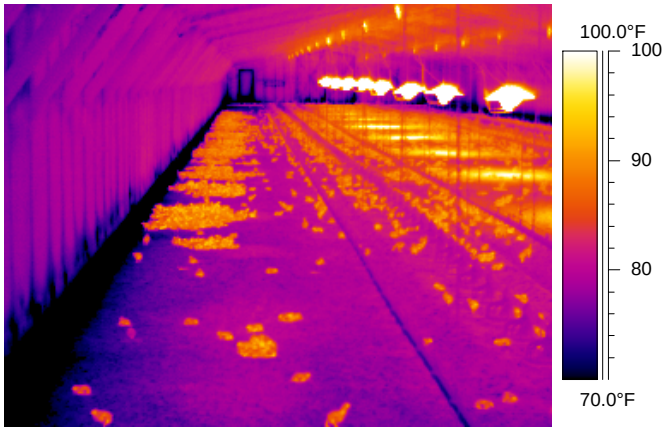

Figure 12. Side wall floor temperatures.

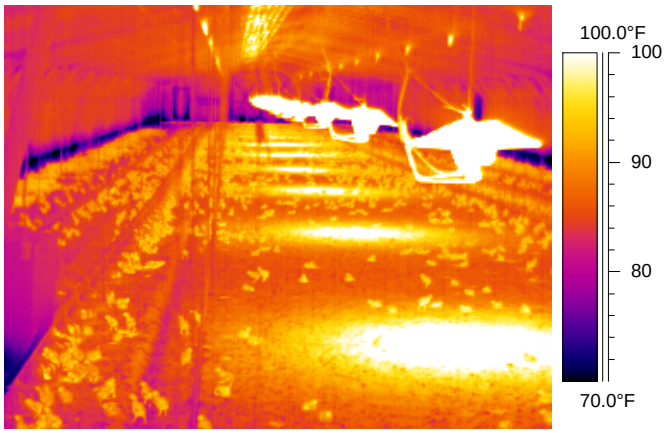

Figure 13. Center house floor temperatures.

Figures 12 and 13 were taken in a totally enclosed house with five-day-old chicks where an environmental controller was programmed to maintain an air temperature of approximately 86°F (controller sensors were near the feed lines). Chicks appeared very comfortable from about the feed lines to the center of the house where floor temperatures ranged from approximately high eighties to 110°F. Floor temperatures from the feed line to the side wall ranged from the high seventies to the mid eighties and the chicks were showing signs they were chilled. The situation could have been improved by simply increasing the controller setting to 90°F and raising the brooders to a height of six feet. Though this may have lead to overheating the center of the house the overall environment would have probably improved.

Another way to have increased side wall floor temperatures in the house pictured in Figures 12 and 13 would have been to install circulation fans. Circulation fans have proven time and time again to improve floor temperatures in houses using hot air to heat the floor which is in fact the primary method of floor heating near the side walls in houses where radiant brooders are installed down the center of the house. But, the fact remains had the radiant brooders been installed over the feed and water lines the chicks near the side wall would have received a significant amount of radiant heat from the brooders, thus reducing the likelihood that a higher house temperature would have been required.

Figures 14 and 15, taken in a house heated with radiant tube brooders on the same farm as Figures 4 and 7, are further illustrations of the inherent challenges of managing any radiant heating system in the center of the house. Though the five, 30' long ceiling-mounted radiant tubes did a better job of distributing radiant heat throughout the brooding area than what is typically seen in a house with a single row of radiant brooders, the amount of radiant heat that made it to the side walls was still rather limited as is evident by the fact that floor temperatures near the side wall dropped into the low to mid eighties. Though not unhappy with the radiant tube heating system, the producer has commented that the birds always seem to be spread out better in the house with radiant brooders. Putting in two rows of radiant tubes in a house would undoubtedly improve radiant heat distribution, but it is highly unlikely the substantial additional cost would be worthwhile. This, of course, is not the case with radiant brooders where installing 14

radiant brooders in two rows over the feed and water lines doesn't really cost any more than installing a single row down the center of a brooding area.

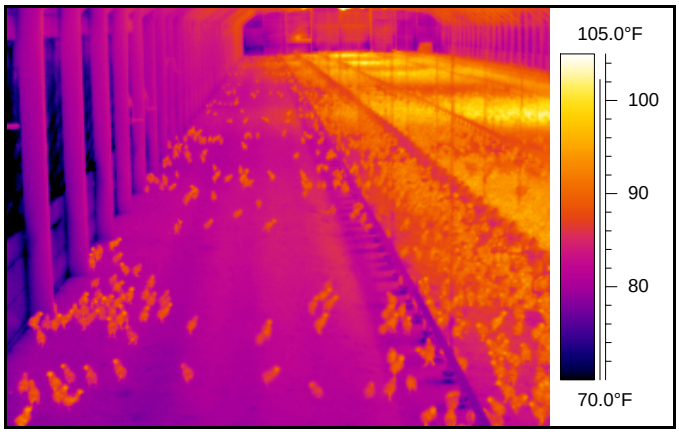

Figure 14. Side wall in house with radiant tube brooders

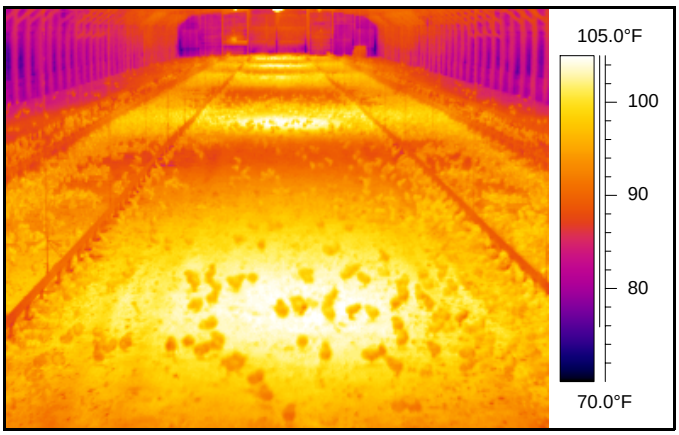

Figure 15. Center of house with radiant tube brooders

One common concern about installing the radiant brooders over the feed and water lines is that the concentrated radiant heat directly underneath the brooders could lead to excessive water temperatures. The fact of the matter is that the water lines directly underneath a radiant brooder are typically shielded from the radiant heat produced by the brooder by the pipe supporting the water line. This fact can be seen in Figure 16 where not only is the water line shaded from the radiant heat emanating from the brooder, but there is actually a small strip of litter that is significantly cooler due to a shadow cast by the water line support pipe.

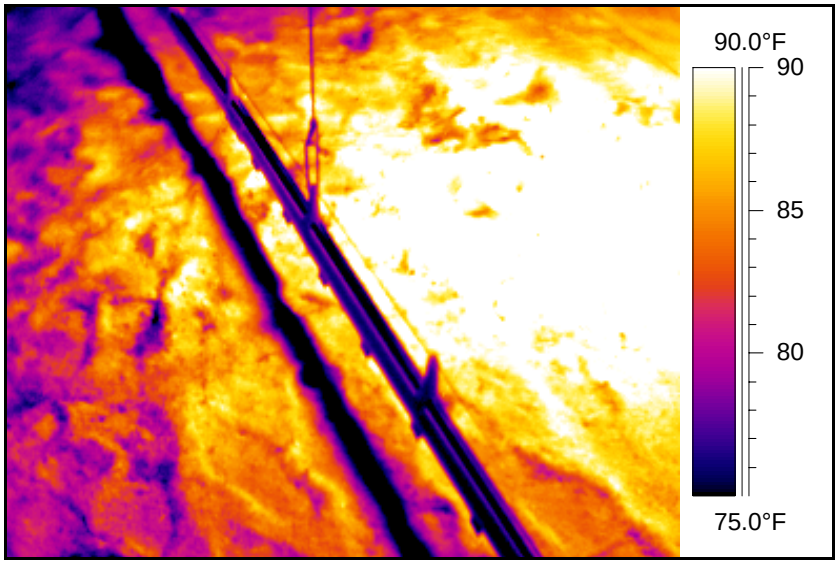

Figure 16. Shadow cast by drinker line.

A similar concern about installing radiant brooders over the feed and water is that it may cause excessive feed and water temperatures for older birds. Though it is true that if the floor temperature beneath the radiant brooders were over 90°F it would be a problem for older birds. It is important to keep in mind that as birds get older, house temperatures decrease and the birds start to produce a significant amount of heat on their own, both of which lead to decreased radiant brooder run time. As a result, floor temperatures typically do not become excessive. Furthermore, keep in mind that floor temperatures under a radiant brooder can be somewhat controlled by brooder height. If floor temperatures become excessive, radiant brooder height can be increased spreading the radiant heat over a larger area. Keep in mind radiant heat from a radiant brooder is not that different from light produced by a light bulb. The higher you install a light bulb above the ground the better a job you will do of distributing light over a wider area and the less likely you will have a bright spot directly underneath the light bulb.

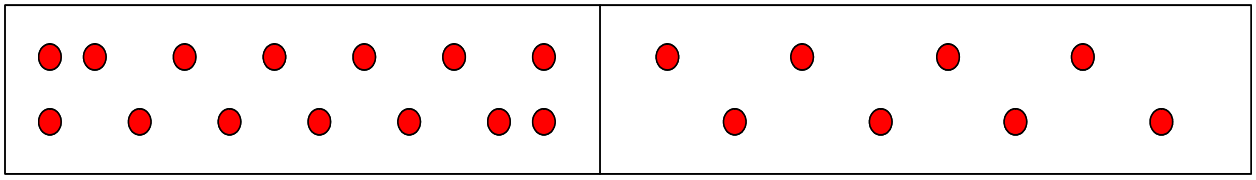

Figure 17 Radiant brooder placement

When installing radiant brooders over feed and water lines they should be staggered with brooders near the end walls and brooding curtain installed directly across from one another (Figure 17). This is good setup for a number of reasons. First, though not a major advantage, staggering brooders tends to spread out the radiant heat a little better than placing them directly across from one another. The slightly improved distribution can be seen in Figures 4 and 5. The radiant brooders in the house of Figure 4 were only offset approximately five feet instead of the normal 20 feet or so. As a result, you can see how the radiant brooders heat the floor in bands more than spread out circles. Furthermore, placing extra brooders directly across from one another near the ends, tends to put extra radiant heat where it is needed the most (Figures 18, 19).

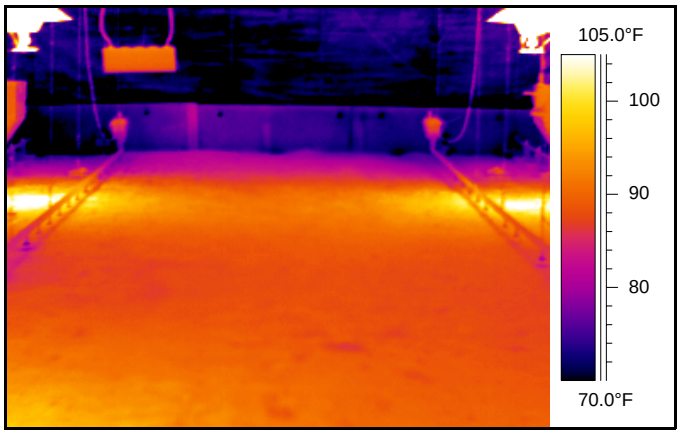

Figure 18. Paired radiant brooders near brooding curtain.

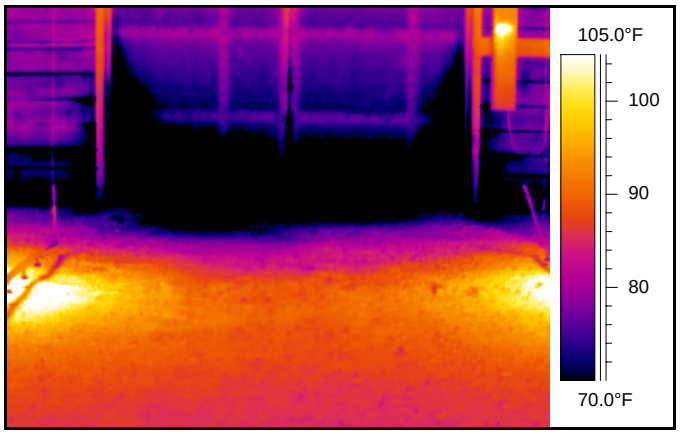

Figure 19. Paired radiant brooders near end wall.

When radiant brooders are used on the nonbrooding end it is very important that a sufficient number are installed. As a general rule in the typical 40' X 500' house, there should be a minimum of eight radiant brooders on the nonbrooding end staggered over the feed and water lines. The eight radiant brooders represent approximately 60% of the heating capacity found on the brooding end of the house. It is important to realize that most producers are turning birds out at seven to ten days, whereas when half-house brooding was first employed, 14 to 21 days was more the norm. Furthermore, desired house temperature at seven to ten days of age is typically in the mid eighties, thus requiring the nonbrooding end to have a fair amount of heating capacity.

Figures 20 and 21 provide a good illustration of what happens during very cold weather where too few radiant brooders are installed on the nonbrooding end of a house. Though there were six radiant brooders in the 250' nonbrooding end of the house illustrated, only four were working three days after the birds were turned out at ten days of age. As can be seen in Figure 20, the amount of floor covered by each brooder is very small and as result floor temperature was being controlled by air temperature, which the four brooders could simply not maintain sufficiently. The fact of the matter is that had all six been operating it is doubtful on this particular morning when the outside temperature was in the low twenties that the radiant brooders would have produced sufficient heat to maintain acceptable conditions, thus illustrating the need for a minimum of eight radiant brooders in the nonbrooding end of houses.

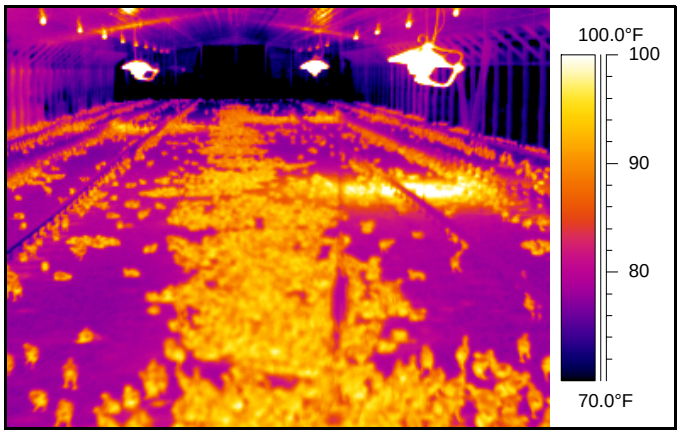

Figure 20. Nonbrooding end.

Figure 21. Brooding end.

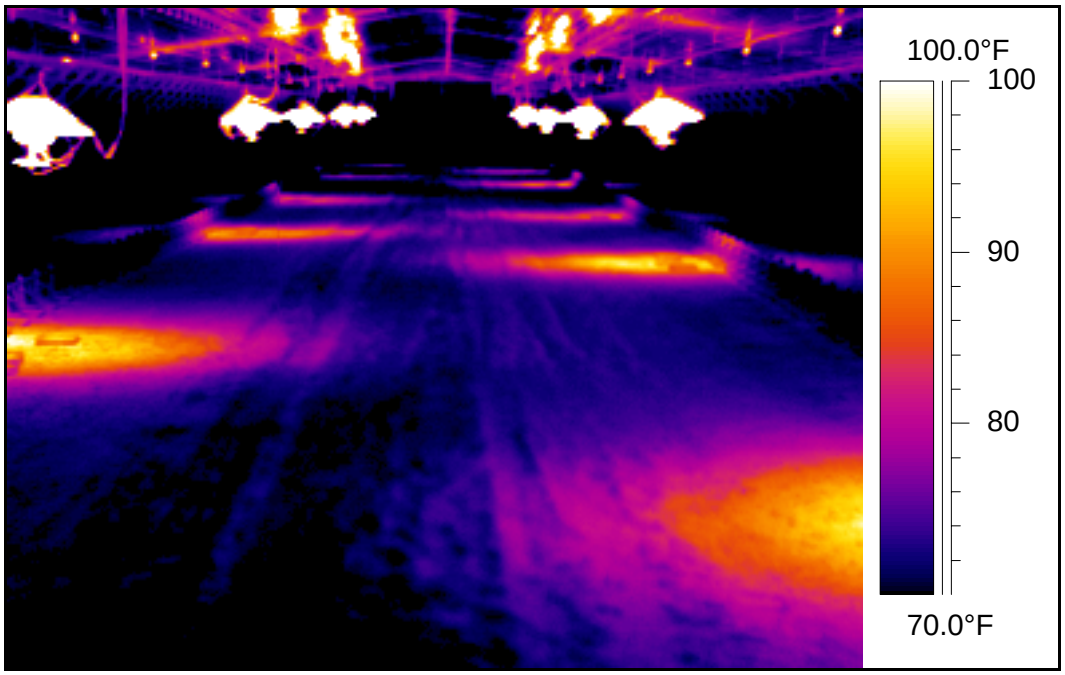

Figure 22. Insufficient gas pressure in house with radiant brooders on a 25°F morning.

Figure 22 provides a good illustration of what happens to floor temperatures in a house with insufficient gas pressure. Due togas plumbing issues, gas pressure to the radiant brooders was well below the recommended 11" of water column. The net result was that the brooders were operating constantly and when it was 25°F outside the maximum air temperature that could be maintained by the brooders was approximately 75°F. Yes, there were floor temperatures near the brooders of 90 to 100°F, but the brooders were simply not producing enough heat to maintain proper floor temperatures for those birds not in the immediate vicinity of a brooder.

Radiant brooders have proven to be used effectively to heat a poultry house. As with any heating system, it is important to understand exactly how a radiant brooder heats a poultry house if you want to maximize its heating efficiency. By keeping in mind that the radiant heating zone of a properly installed radiant brooder is approximately 15 to 20 feet in diameter and for those birds outside this zone maintaining the proper air temperature is crucial in order to maximize bird performance, producers will be able to get the most out their radiant brooder heating system.

Michael Czarick
Extension Engineer
(706) 542-9041 542-1886 (FAX)
mczarick@engr.uga.edu
www.poultryventilation.com

Brian Fairchild
Extension Poultry Scientist
(706) 542-9133
brianf@uga.edu

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