



L.B.WHITE



SMART SENSE[®]

an Automatic Variable-Rate Heat Solution

U.S. Patent No. 9,328,937

Recommendations for Management of Variable Heat Output Devices in Swine Production Facilities

- Consistent Room Temperature
- Reduction in Cold and Hot Spots
- Improved Comfort and Environment
- Increased Energy Efficiency



Smart Sense[®] provides peak comfort and environment while reducing energy consumption and putting \$\$\$ back into YOUR pocket!

INNOVATIVE HEATING SOLUTIONS.

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I highly recommend variable heat output devices such as the Guardian® and Smart Sense® furnaces and Smart Sense® brooder panel. Use of devices such as these allows for more consistent temperatures in the pig zone and in many cases a reduction in fuel usage compared to fixed output or high/low brooder panel controls. The use of Smart Sense® technology equipped devices allows for automatic adjustment of heat output making for even more consistent temperatures in the pig zone than what can be provided by the manually adjusted Guardian® furnaces.

In wean-finish facilities, brooders equipped with the Smart Sense® control panel resolve the common complaint of brooders operating at high heat output and fans increasingly ramping up in response to excessive heat. Smart Sense® controller panel brooders maintain consistent temperatures in the pig zone and because of their linkage to the facility ventilation controller often result in significant energy savings versus conventional brooder control panels.

Dr. Mike Brumm

Recommendations for Management of Variable Heat Output Devices in Swine Production Facilities

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The goal of furnace sizing and operation is to provide the amount of heat necessary to achieve the desired temperature and, in conjunction with the ventilation system, maintain a relatively consistent temperature in the animal space.

'Burn' cycle is the time the furnace is called upon by the ventilation controller or thermostat to furnish heat to an animal space. The length of the burn cycle is determined by the amount of heat produced by the furnace and the amount of heat required to achieve and maintain the desired temperature and the ability of the system to mix the air so that the temperature sensors 'see' a representative and accurate number. The longer the furnace run-time per 'burn' cycle, the greater the uniformity of the heat distribution within the animal space.

The larger the heat output of the furnace is relative to the need, the shorter the 'burn' cycle. The shorter the 'burn' cycle, the greater the variation of temperature within the heated space. Thus sizing of furnaces, location of furnaces and management of the heat output from the furnaces following installation are all critical to maximizing the uniformity of heat distribution within the animal space.

The vast majority of gas fired furnaces sold by L.B. White for installation in swine production facilities have the capability for the heater's output to be varied. In the case of the conventional Guardian™ series, this is a manual adjustment performed by the operator. In the case of the Smart Sense™ series, in conjunction with an approved Smart Sense™ control (such as Maximus, AP Edge or Expert Series 2, Genius, Dicam or SmartBox™), this is an automated adjustment that occurs while the heater is in operation.

Furnace Sizing

The amount of heat energy required to heat an animal space is determined by many factors: indoor temperature requirements and outdoor winter design temperature for the geographic location, building or room size, material selections with associated insulation values, application of insulation, and ventilation or air exchange rates. Heaters are then selected based on their output to provide the required heating capacity: smaller heaters for smaller rooms, multiple heaters for large spaces and typically one or two heaters for medium sized spaces.

The net result is providing sufficient heat output for the coldest expected conditions; however, there is typically too much heat available for the majority of the heating season. This results in shorter burn cycles and increased temperature variation. It is not uncommon with typical 'on/off' heating control to experience temperature variations of 4°F to 7°F in the room as displayed on the ventilation controller.

Furnace Location

The area nearest to the minimum fan(s) will be the warmest locations in the animal space during minimum ventilation. This is because the fan(s) will bring in cold/dry outside air through the inlets (most often ceiling locations) in negative pressure ventilated facilities. Once the air is 'jetted' into the animal space by the restriction in the inlet opening, the air will gradually move towards the minimum exhaust fan, gaining both heat and moisture during this movement.

When a furnace activates in response to the call for heat from the ventilation controller or thermostat, the furnace fan distributes the heat in the animal space. The warmed air from the furnace is thrown (blown) away from the furnace. The colder air that is displaced by this warmed air is then drawn back to the furnace as makeup air which enters the L.B. White furnaces from the underside of the suspended furnace. Thus when furnaces first operate, the warmest air is thrown (blown) away from the furnace by the furnace fan, making the animal space directly underneath the furnace colder as the cold air from the rest of the room is displaced by the warm air from the furnace.

Furnace location within the animal space can have a major impact on the uniformity of air temperature within a room. In general, L.B. White furnaces should be installed somewhat near the minimum ventilation fan(s) with the blower of the furnace directed towards the coldest location(s) within the room.

The longer the furnace operates per 'burn cycle', the more effective it is in aiding the mixing of air in the room. If the furnace does not run a relatively long time (the ventilation controller via location of temperature probes or the location of the thermostat call for the furnace to stop adding heat to the animal space), the warmed air from the furnace doesn't complete the cycle of being blown from the furnace and being drawn back to the furnace as warmed make-up air. However, because of the inlets and negative pressure minimum exhaust fan(s), the warmed air will gradually return to the pens nearby the furnace location(s).

If the furnace is installed in the colder locations in the animal space, the warmed air from the furnace is blown towards the warmer parts of the animal space, heating them more while the colder areas of the space remain relatively cold. When the furnace(s) shut off there is now no natural air movement associated with the ventilation system that causes the warmer air to move to the colder locations in the room. Instead, cold air continues to enter these locations via the ventilation inlets. The result is greater temperature variation within the animal space because of where the furnace is located.

Variable Heat Output Technology

The conventional Guardian® series furnaces incorporate a manually adjustable valve (Figure 1). Adjusting this valve to its lower range can result in longer burn cycles depending on the amount of heat required. Even with the valve adjusted to its minimum setting, it is still an on/off heater with the associated temperature variation that occurs in conventional on/off style heating.

The Smart Sense® heater, in conjunction with an approved Smart Sense® controller, has the valve automatically adjusted by the ventilation controller to meet the heating needs at any given time (Figure

2). The range of output for the AW250 or AD250 heaters is from 65,000 Btu/h to 250,000 Btu/h – more than 2x as broad as the manually adjustable Guardian® heater.

Managing Guardian® Series Furnaces with Manual Output Adjustment Valves

The most commonly installed Guardian® Series furnace installed in gestation, nurseries, wean-finish and grow-finish facilities in the upper Midwest is the Guardian®-250. The manually adjusted output valve on this furnace can vary the heat output from 160,000 to 250,000 Btu/hr.

In general, when this furnace is installed in production facilities in the upper Midwest, the variable output valve should be set to the lowest output setting at the beginning of the heating season (generally mid-September). The valve should only be adjusted for higher amounts of heat output when the furnace(s) in the animal space fail to provide sufficient heat in a reasonable period of time (generally 15-30 minutes). That is, if the furnace shuts off one or more times per 15-30 minute time period, the furnace is putting out sufficient heat and is being turned off by the thermostat or ventilation controller in response to the temperature rise as a result of the added heat.

If the valves are adjusted during the heating season for a higher level of heat output, they should be readjusted as the outside temperatures increase late in the heating season. If the coldest temperatures occur during mid-December to mid-February, it is logical that the status of the variable valve be reevaluated by early to mid-March.

When more than one furnace is used to provide heat to an animal space, another option to increase the length of the 'burn' cycle is to vary the number of furnaces that are called upon for heat by the ventilation controller.

A large number of the wean-finish facilities in the upper Midwest typically house 1000-1250 pigs per room/barn when the pigs are single stocked at weaning. They often have 3 Guardian® -250 furnaces distributed in the animal space.

If the ventilation controller has enough on/off relays available, install the 2 furnaces at the ends of the room as 1 heating stage and the furnace in the middle of the room as the other heating stage.

When pigs are placed in the animal space in warmer times of the year (May to September), use the center furnace as the primary heat source. Set the furnace on/off temperatures in the controller for this heating stage normally. Set the on/off temperatures for the other heating stage 2°F lower. In this way, the single furnace will have to run 3 times as long as when 3 furnaces are operating, resulting in relatively long 'burn' cycles and greater temperature uniformity in the animal space. If the furnace fails to keep up because of unusual conditions such as a rapidly moving cold front or record low nighttime temperatures, the other 2 furnaces are available to prevent temperatures from falling more than 2°F lower.

During the colder seasons of the year, set the on/off temperatures in the controller as normal for the circuit with the 2 furnaces and set the on/off 2°F lower in the circuit with only 1 furnace. Again, if heating needs are greater than what can be provided by only 2 furnaces, the 3rd furnace is in place to provide added heat if the temperature drops an additional 2°F in the animal space.

If all of the furnaces are connected to a single heating relay in the controller, some producers are gaining extended run times by manually unplugging differing numbers of furnaces depending on the time of the year and heating needs of the animal space. The disadvantage of manually unplugging furnaces is that the back-up capability of these furnaces is no longer available in the event conditions change.

A combination of using the variable heat output valve and varying the number of furnaces operating will result in long 'burn' cycles and increased uniformity of temperatures in the facility.

The Value of Smart Sense® Technology

Conventional ventilation controllers call for heaters to be turned 'on' and 'off' based on temperatures compared to the set point. They do not make any judgments as to the amount of heat required - they only know on/off. With typical offsets and differentials the average temperature during the heating phase is 2-3 °F below the controller set point and temperature variations of 4 to 7 °F are experienced.

Smart Sense® is a 'heat to demand' system. Only the amount of heat necessary to maintain the desired temperature at any given point in time is provided. Approved controllers with Smart Sense® capabilities monitor the room temperature and adjust the heater output in small increments as needed to maintain room temperature – they make judgements as to the amount of heat needed at any point in time. As a result, the heater burn cycle is significantly extended over conventional Guardian® heaters: with or without use of the manual valve.

Rather than manually adjusting valves, changing controller settings based on the season, or plugging and unplugging heaters in an effort to attain more temperature uniformity, Smart Sense® technology allows the approved ventilation controller to make the necessary adjustments to the variable output valve automatically.

In wean-finish facilities, installation of the Smart Sense® brooder control panel (Figure 3) greatly increases the uniformity of heat in the brooder zone. Conventional brooder control panels vary heat output by switching between high and low gas pressures resulting in either high or low heat output. If the control panel isn't linked to the facility ventilation controller it is quite common for the brooders to operate at 'high' output while the fans are increasing the ventilation rate in response to the increased heat output resulting in higher fuel usage. Smart Sense® equipped panels by being linked to the ventilation controller vary their heat output over the entire high/low range. When correctly set up in the controller the ventilation system won't begin to increase its output until the brooder panel is at minimum heat output. This results in very uniform temperatures in the pig zone and in most installations a savings in fuel usage.

Because farrowing and nursery rooms rely on heaters for much of the year due to the temperature needs of the young pigs, use of Smart Sense® technology can provide for more consistent temperatures in the pig zone and reduce fuel usage because of the reduction in temperature variation. The ability to have long burn cycles in both January and May from the same furnace(s) when the heat input needs are quite different greatly improves pig comfort.

Figure 1 - Guardian® series manual adjustable heat output valve.



Figure 2 - Smart Sense® series adjustment valve operated by approved controllers.

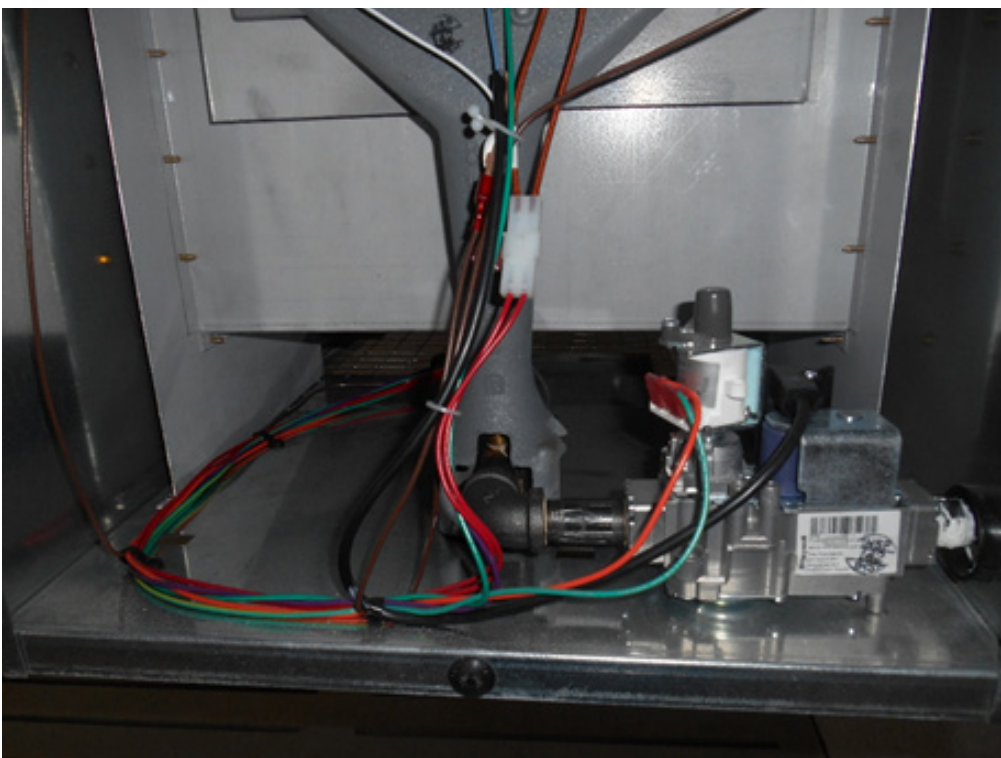


Figure 3 - High Capacity Smart Sense® equipped brooder panel control.



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