FACT SHEET 19.45.07
Extension Bulletin E-1281, February 1979

pork industry handbook

COOPERATIVE EXTENSION SERVICE • MICHIGAN STATE UNIVERSITY

Supplemental Heat For Swine

Authors
Charles N. Hinkle, Purdue University
Al H. Jensen, University of Illinois
Charles K. Spillman, Kansas State University
Richard F. Wilson, Ohio State University

Reviewers
David B. Gerber, Ohio State University
H. W. Jones, Purdue University
Charles F. Pierson, Jr., Livingston, Montana
T. T. Traywick, Jr., Cope, South Carolina

During some phases of the pig's growth from birth to market or replacement herd and for some types of management systems, the pig's normal heat production is insufficient to maintain a productive air temperature within the building. Under such conditions, supplemental heat is needed. Supplemental heat is heat added to the swine building to supplement the normal heat production of the animal, thus maintaining a productive environment.

In some buildings, such as the farrowing house, supplemental heat is regularly used, and permanent types of heating systems, such as unit heaters or make-up (ventilation) air heaters, should be considered. On an occasional need basis, a temporary heater that could be moved into the building for several days or a week will get a producer through a cold spell or a partial load period.

Permanent Heating Systems

Unit Heaters

A unit heater has all the components assembled into one container and needs only to be hung in the building and connected to a source of fuel and electricity. (See Fig. 1.) The basic unit heater consists of some type of fan, either propeller or centrifugal, and a heating element. Sometimes air intake filters, directional discharge louvers and vanes, automatic temperature controls and safety controls are included. Unit heaters are generally installed overhead and thus do not use valuable floor space in the swine building. Most unit heaters use 100% recirculated air.

Several types of heating elements are available for use with unit heaters. For swine buildings, however, probably the direct-and/or indirect-fired gas burners and electric heating elements are the most common. Another choice would be a hot water element, especially in a farrowing or nursery building where underfloor hot water heat will be or already is used.

Since most unit heaters use recirculated air, dust could be a problem, depending upon the management and feeding systems used. If filtration of the circulated air is desired, a centrifugal blower would work better than a propeller fan against the higher static pressure caused by the filter.

The size and number of heaters needed depend upon the heat requirement and floor area of the particular swine building. As an example, a 26 ft. x 76 ft., 28-sow farrowing

Figure 1. The discharge side of a typical centrifugal fan unit heater. Heater is hung from the ceiling and placed near an outside wall.

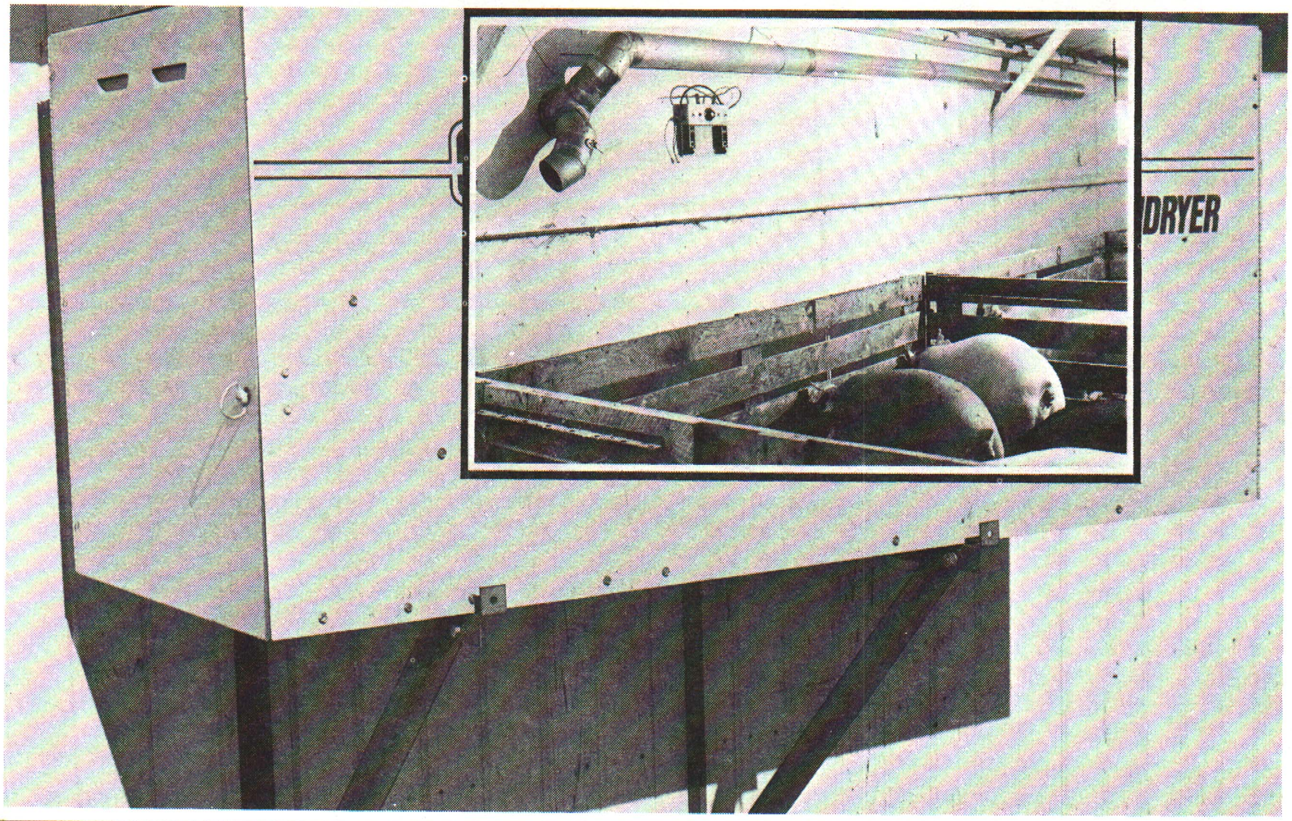

Figure 2. A direct-fired propane make-up air heater attached to the outside wall of a swine building. The insert shows the controls and a simple air distribution duct within the building.

house located in central Illinois indicated a need (when empty) of 35,000 BTU per hour of supplemental heat (R walls, 12; R ceiling, 15). The two smallest gas-fired, propeller fan unit heaters available from one manufacturer are 24 MBH (24,000 BTU per hour) and 40 MBH (40,000 BTU per hour) units. Thus, one 40 MBH or two 24 MBH unit heaters should be used. Electric unit heaters are available in smaller sizes than gas-fired. Small sizes of 2, 3, 4, 5 and 7.5 kW are generally available (6.8, 10.2, 13.6, 17.1 and 25.6 MBH).

The term blow (or throw) relates to the horizontal distance that the warm air is projected from the heater. In the previous example, since the 24 MBH and the 40 MBH unit heaters have about the same blow, the 40 MBH unit would not produce a uniform temperature throughout the house. Two 24 MBH heaters would do a better job of distributing the heated air, thus creating a more uniform inside temperature. Another choice for more uniform temperature would be a unit heater with a fan capable of operating at higher static pressures and some type of simple duct work or air tube to distribute the heated air along the length of the house. Perhaps better than the duct would be to divide the farrowing house into two smaller rooms with one 24 MBH heater per room.

More uniform inside conditions are obtained when the unit heater is installed to blow along the coldest wall. The warm air will intercept the cold drafts from that wall. Where several heaters are used, they should be so arranged that the discharge from each helps create a general circulatory motion of air within the building. Ceiling-mounted units with the outlet louvers properly set should deliver the heated air to the occupied zone (pig level) at temperature and velocities which are not objectionable.

Because of the potential dust and high humidity atmosphere, a regular maintenance schedule must be established. In the beginning, weekly inspection for dust build-up should be made until a maintenance schedule can be predicted for your particular operation. This will assure maximum economy of operation and maintenance of heating capacity. The heating elements, fan blades and output louvers can be kept clean for effective operation by periodic brushing or blowing with high-pressure air. Whenever the building is cleaned with a high-pressure water or steam cleaner, the heater, if so constructed, should also be cleaned. (Totally disconnect electric power before cleaning, and be sure no moisture remains in the electrical boxes before restoring the power.) The fan motor should be a totally enclosed motor. All electrical wiring and fuel line connections should be inspected annually.

Make-up Air Heaters

Whereas the unit heater uses 100% recirculated air, the make-up (ventilation) air heater most commonly used heats 100% outside air entering the conditioned space or building. Since the make-up air heater heats air entering the building (see Fig. 2), some air must also be exhausted or removed from the building. Make-up air heaters are generally located outside of the space or building they are heating.

Make-up air heaters are sized either by rate of air flow through the unit, by the maximum energy input to the heating element, or by both methods. Typical farm application sizes range from about 600 to 2,000 cfm. with gas as the usual fuel choice. They are generally equipped with some type of automatic modulating gas flow valve which permits a turn-down ratio of 10 to 20. Modulation of the fuel flow permits a rather constant exit air temperature from the heater as the entering air temperature fluctuates. Most heaters have a potential of 120-230F temperature rise for the air passing through the heater when the fuel flow is at a maximum value.

The most common heater used in agriculture applications is the direct-fired propane gas heater which burns the gas directly in the air stream entering the building. Thus, all the products of combustion enter the building along with the heated air. This is why the unit must only be used in a ventilated building. Approximately 92% of the energy burned in these heaters is heat available for a temperature increase. Since the heater is the primary source of air inlet to the building during its time of operation, it should be mounted to exclude rain and be fitted with a screen to exclude birds, paper, and other foreign materials. It should also be located so that the cleanest possible air is available for use, i.e., high enough from the ground so that blowing dust will not create a problem and far enough from an air exhaust from any building.

Operation of these heaters during winter is either as a part of the ventilation system or as the total ventilation system. The partial ventilation consideration is normally applied when an exhaust fan system is used for the building. The total ventilation system is generally a pressurized system.

Air distribution within an exhaust-ventilated building is greatly affected by the type and location of the air inlet. When the make-up air heater is operational, most of the air will enter at one point instead of being uniformly distributed around the building. This could cause air temperatures within the building to become uneven. Since the centrifugal fans generally used on make-up air heaters are capable of operating against higher static pressures, some type of simple interior duct work (see insert, Fig. 2) would permit the heated air to enter the space at several locations, thus improving air distribution within the building and restoring temperature uniformity.

Controls

Careful consideration should be given to the safety controls of heating equipment. If gas is the fuel used, some type of gas and fan shut off is needed if ignition by the electrical igniter does not occur within approximately one minute. Also, some type of manual reset flame sensor is needed that will shut down the unit in case the gas supply is exhausted. A sail switch, one sensitive to the flow of air, will make sure that the blower is functioning or that air is passing through the unit before the ignition circuit is even activated. If for some reason air flow stops after activation, the main gas valve should close. There should also be a high temperature switch to shut down the unit if the temperature at the discharge and/or at the burner becomes too great. The usual electrical safety equipment, such as circuit breakers, should be available to protect the blower motor from possible overload damage.

During the time when supplemental heaters are used, the ventilation system and the heaters are performing opposing tasks. The ventilation system provides a means to cool the building while heaters obviously provide heat for the building. If both systems operate simultaneously, energy use will increase drastically and neither of the intended purposes will be achieved.

A minimum level of ventilation must be maintained in a swine building; thus, there will always be some overlap with the heating system. The controls used should be set so that heating starts after the inside temperature has decreased below the minimum ventilation rate setting. When several persons are involved in a swine operation *only one* should have the responsibility of adjusting the thermostat.

Temporary Heating Methods

The greatest need for temporary heating generally occurs when a building is understocked, perhaps at the start or end of a farrowing or nursery cycle, or when there are only a few animals in a large pen. A sudden cold spell could also require some type of quick, temporary heat.

Move-In Heaters

Most heaters moved into a building for temporary heating are direct-fired gas or oil. These heaters have their own fuel supply in an accompanying tank; no flue is necessary; and only 115 volt power is needed for fan and control operation. (See Fig. 3.) Sizes are available from about 30 MBH to 100 MBH. The size on hand will seldom fit the exact task to which it will be put, but most available sizes could get an operator through an emergency period without disaster.

The operating thermostat is usually located at the unit which will cause greater temperature fluctuations within the building. It is also difficult to coordinate such a unit with the normal ventilation controls to keep the two from acting against each other. Any unit employed in an animal shelter should have some type of "flame-out" control that will automatically shut off the fuel supply if the flame goes out for any reason. Loss of electrical power should cause a full shut down of the burner.

Radiant Heaters

Radiant heaters could be discussed either with temporary heating methods or with permanent systems. They have the special advantage that because heat is transmitted by radiation, like light rays rather than air heating, they can be used in open front buildings. The most common energy source is either gas (see Fig. 4) or electric.

Radiant heat is converted to normal heat when it strikes an object in its path. Thus, radiant heat shining on a pig is converted to heat, and the animal is comfortable even though the surrounding air, by itself, is too cool for comfort. Comfort can be provided without heating all the building air. This permits establishment of a dual environment in a farrowing house where the thermostat is set to maintain a

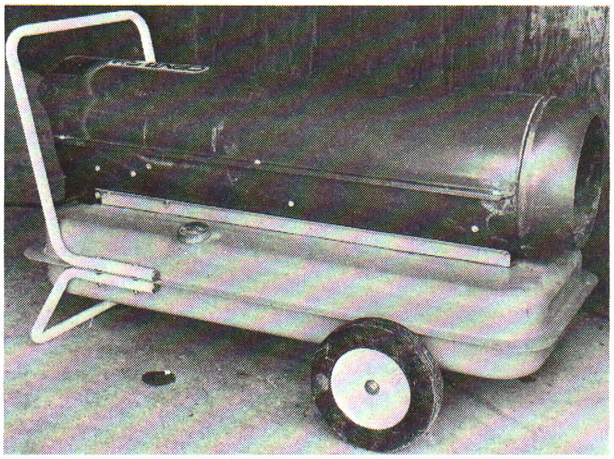

Figure 3. Temporary-type portable heater using fuel oil as the energy source. Blower and controls connect to 115 volt outlet.

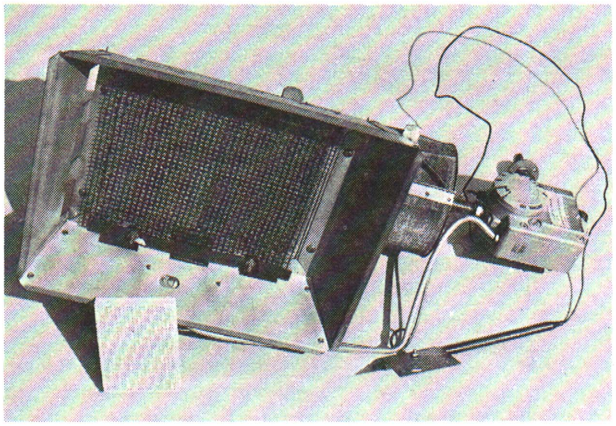

Figure 4. Underside of large gas-fired ceramic core radiant heater. Temperature control and automatic gas shut-off attached on right. Sample piece of perforated ceramic core element shown in foreground.

60F value, best for the sows, and radiant heat is added to the pig creeps to provide an 80-85F equivalent environment for the small pigs, the best for them.

Tests at Purdue University have shown that for nursery-aged pigs housed at 40F, average daily gains equivalent to that achieved at 70F can be obtained if 120 BTU per hour of radiant heat, measured at the pig level rather than energy input to the heater, is provided for each square foot of sleeping area. Radiant heat in an open front building could also replace the need for bedding or underfloor heat. A good indication of achievement of the desired thermal environment is obtained by visual signs of pig comfort. Additional suggestions for use of radiant heaters are shown in Table 1.

Creep area heating requires a localized high temperature source which is generally supplied by electrical heat lamps or gas-fired radiant heaters. (See Fig. 5.) Heat used in the creep area is ultimately added to the building and reduces space heating requirements. Space heating, as discussed earlier, can be accomplished with any of the fuels listed in Table 2. Efficiency of converting the fuel energy to heat depends on whether the heater is direct-or indirect-fired and on the fuel used. More of the energy is added to the space with a direct-fired heater, but only clean burning fuels can be used and only in ventilated buildings where permitted by insurance or code regulations.

Fuel Selection

The choice of fuel used in swine buildings depends on availability, price and special requirements. The main sources of energy in most regions of the United States are propane and electricity. The relative availability of different fuels may change in coming years, especially in local situations, so some thought should be given to long-term supplies before making final decisions about equipment.

Fuel costs appearing in Table 2 are for one million BTU of energy added to the space. Price of fuel varies in different regions. Actual cost should be used for comparisons. A calculation for cost per million BTU at the new price can be made by setting up a ratio like the following example. Assume the cost of fuel oil is 50¢ per gallon instead of 45¢ as used in the table. Then,

$$\text{my cost per million BTU} = \text{my price per gal.} \times \frac{\text{Table 2 cost}}{\text{Table 2 price}}$$

$$= 50¢\ \text{per gal.} \times \frac{\$3.88}{\$0.45}$$

$$= \$4.31$$

The cost of operating electric heat lamps or non-controlled gas-fired radiant heaters in a farrowing house is easily determined on an hourly use basis because the rate of energy consumption is constant. A 250-watt heat lamp uses ¼ kWhr during each hour of use. If electricity cost 3¢ per kWhr, then the cost of operation is ¾¢ per hour or 18¢ per day. A 4,000 BTU per hour gas-fired radiant heater uses slightly over 1 gal. of propane per day and operating cost at 40¢ per gal. is about 1½¢ per hour or 40¢ per day. Since 1 gas unit is normally used for 2 stalls, the operating cost is the same as for electricity.

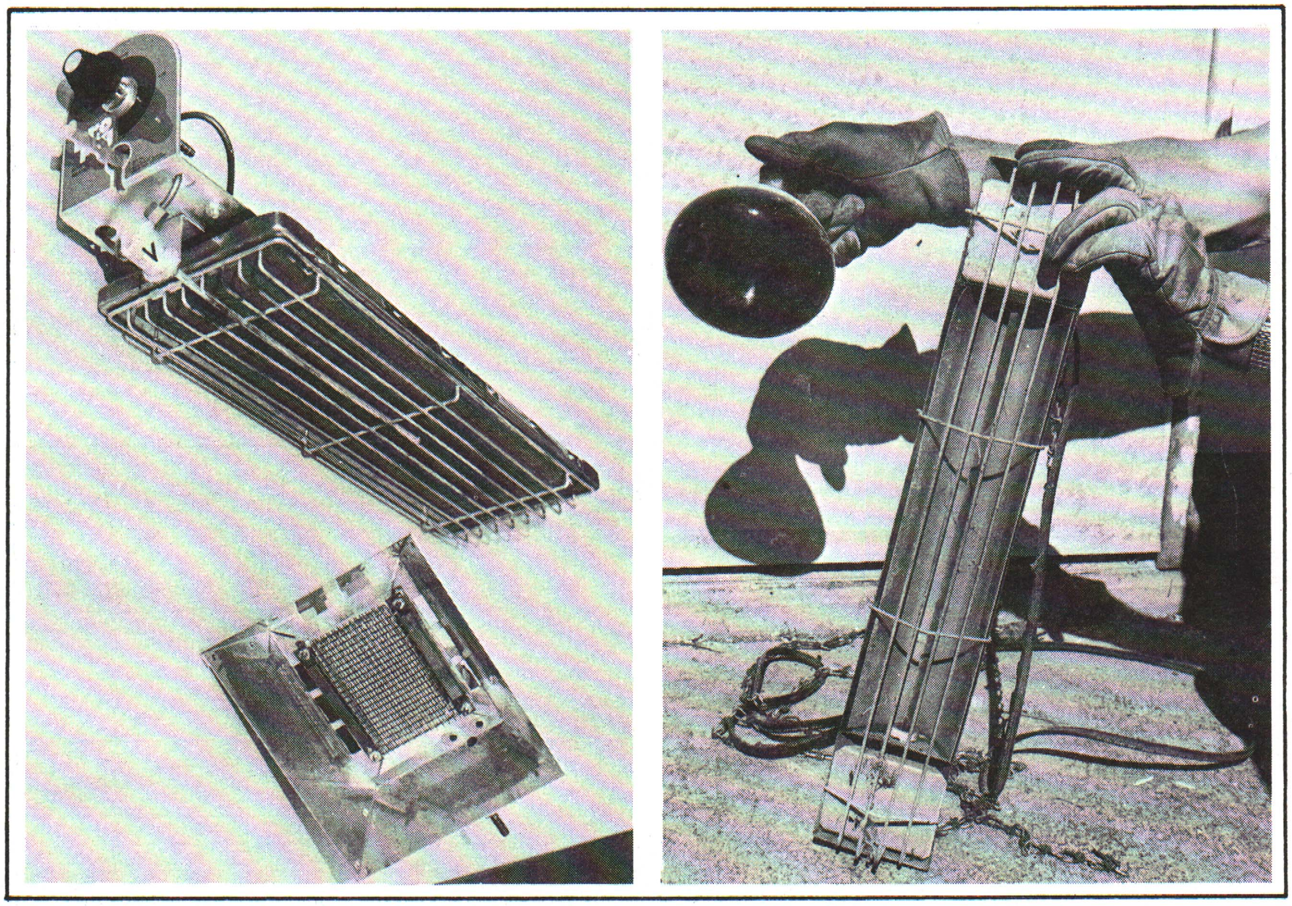

Figure 5. Four types of commonly used pig creep area heaters, gas-fired on the left and electrical on the right. Upper left is a catalytic burner having a temperature controlled gas valve and automatic shut-off. Lower left is a single element ceramic core burner, usually used uncontrolled. Held in the right hand is a common 250 watt reflector base infrared bulb. The left hand holds a short metal sheath infrared unit also operating on 115 volts.

Comparison of fuel cost for heating air to maintain inside temperature is illustrated by the following example. Assume that a 22-stall farrowing house typically takes 1500 gal. of propane per heating season, using an indirect-fired heater. What would be the cost per heating season and the amount that might be saved with a heater burning fuel oil? With propane at 40¢ per gal., total fuel cost for the year would be 1500 gal. × 40¢ per gal. = $600. This $600 for propane would purchase 110 million BTU. That is, $600 ÷ $5.45 per million BTU = 110 million BTU. Fuel oil at 45¢ per gal. to purchase 110 million BTU would cost 110 million BTU × $3.88 per million BTU = $427 and the reduction in fuel cost would be $600 - $427 = $173.

Application Suggestions

Tables 3 and 4 show the supplemental heat requirements and the recommended systems for the four major groupings of swine. Location of the particular types of heaters was discussed earlier in detail.

Proper control of any heating system is necessary both from an economic standpoint and for safety. Thermostats for unit heaters and make-up air heaters should be hung low but still within easy visual range. They should be located so as not to be biased by the sun, animal mass, or by the output from nearby heaters. When using small radiant heaters, the operator generally assumes the task of the thermostat, turning them on and off as needed.

Table 1. Suggested use, location and control of radiant heaters for swine.

Type and Size	Use	Location and Number	Radiant Output	Control
Gas, Catalytic or Ceramic Core				
4-6 MBH*	Farrowing house	Hung over two adjacent pig creep areas	30-35%**	Uncontrolled: intentionally on or off.
10-12 MBH	Nursery and Growing/Finishing	5-6 ft. above the sleeping area; 1 heater per 100 ft² of sleeping area	40-45%	Mounted air thermostat set at 35-40F in open front building, 50F in closed building. (Should have automatic gas shut-off in case of pilot light failure.)
Electric				
250 W bulb	Farrowing house	One per pig creep	70-75%	Uncontrolled: intentionally on or off.
1-2.5 kW	Nursery and Growing/Finishing	5-6 ft. above the sleeping area	75-80%	Radiant receptive thermostat advisable because of small amount of air heating. Settings similar to gas.
Gas or Electric	Emergency situations and partially loaded buildings	Near ceiling; as many as deemed necessary		Air thermostat set at 45-55F or manual adjustment as necessary.

*Thousand BTU per hour, input rating.

**30-45% of the input energy to gas heaters is given off as radiant heat. The remaining 50-65% of the energy heats the surrounding air. The radiant output of electrical heaters is higher than gas heaters.

Table 2. Representive cost for thermal energy from selected fuels used in heating applications. Typical efficiencies are used,* but equipment owning and maintenance cost is not included.

Energy Source	Heating Value	Typical Cost	Cost per Million BTU
1. Electricity			
a. Resistance Heating	3413 BTU per kWhr	3¢ per kWhr	$8.79
b. Heat Pump (COP = 1.8)**	3413 BTU per kWhr	3¢ per kWhr	$4.88
2. Fuel Oil	145,000 BTU per gal.	45¢ per gal.	$3.88
3. Propane			
a. Direct Fired	91,700 BTU per gal.	40¢ per gal.	$4.74
b. Indirect Fired	91,700 BTU per gal.	40¢ per gal.	$5.45
4. Natural Gas			
a. Direct Fired	1,000 BTU per cu. ft.	22¢ per 100 cu. ft.	$2.39
b. Indirect Fired	1,000 BTU per cu. ft.	22¢ per 100 cu. ft.	$2.75

*Efficiencies assumed for the various units are: 100% for electricity; 92% for direct fired propane and natural gas; 80% for indirect fired propane, natural gas, and fuel oil.

**COP = coefficient of performance. The 1.8 means that for every kWhr of electrical input, there is 1.8 kWhr of heat output.

Table 3. Supplemental heat requirements for several groups of swine

Swine Group	Heater Size	Desired Temperature	Comments
Farrowing: Sow and litter	2 MBH* to 3 MBH per farrowing space plus creep heaters	60F, sows 80-85F, pigs	Premature or SPF pigs need 90-95F for first week. Pigs from 1 week to 3 or 4 weeks need 75-80F. No drafts. Conserve heat with insulation under creep area, straw bedding, carpeting etc.
Early weaned pigs, 3 to 4 weeks	¼ MBH per pig	80-85F	Early weaned (3 to 4 weeks) pigs need 80-85F continued for two weeks after which the temperature can be lowered gradually to 70-75F.
Weaning and/or nursery pigs: 5 weeks until 50-60 lb.	¼ MBH per pig	Sleeping area at 70-75F	Heat can be discontinued or reduced when pigs reach 6 to 8 weeks of age. If pigs are with sows, provide creep area at indicated temperature.
Growing/finishing	Generally not needed		May need some temporary heat to get started, during inclement weather or if building is only partially loaded.
up to 60 lb.		70-75F	
60-100 lb.		65-70F	
100-150 lb.		60-65F	
150 lb.--market		60F	
Sow gestation and boar housing	None in corn belt and south	60F	Animals tolerate 40-80F. Provide dry, draft-free sleeping area.

*Thousand BTU per hour

Table 4. Recommended supplemental heat systems for several groups of swine.

Swine Group	Heated Area	Comments
Farrowing: Sow and litter	Room	To maintain minimum room temperature use unit or make-up air heaters.
	Pig Creep	Gas or electric radiant heaters; electrically heated pad on the floor; combination of pad and hover; some type of under floor heat.
Weaning and/or nursery pigs: 3-5 weeks until 50-60 lb.	Solid floor rooms	Similar to pig creep area in farrowing house. (If sows are in pen with pigs, locate heaters so that sows cannot tear them out or have access to them.)
	Totally slotted floor rooms	Use unit or make-up heaters to maintain room temperature.
	Partially slotted floor rooms	Use combination of above suggestions for solid floor and totally slotted floor rooms.
Growing/finishing, Sow gestation and boar housing	Enclosed, insulated building	Usually no heat required. Could use temporary heat during extremely cold weather or partial load periods. For more permanent heat installation, the make-up air heater would have less of a dust problem.
	Open front building	Opening should be on south or east side. Overhead radiant heat, either gas or electric used for sleeping area only. Bedding, a low ceiling, and solid pen sides in the sleeping area will help conserve pig heat and prevent drafts. A low ceiling is not compatible with overhead radiant heat.

All gas lines and/or gas heaters should have safety shut-off valves. If the gas supply is interrupted, all valves should close and require manual resetting unless automatic electric ignition is provided for the heater. Small gas radiant heaters usually do not have pilot lights and safety shut-off valves and thus need to be closely monitored by a reliable operator.

Electrical wiring in and to the swine buildings must be of adequate size if electrical supplemental heaters are to be used. Circuit load capacity is determined by the wire size used and not by the size of the fuse that could be placed in the fuse box. Any changes made in the electrical system should be done by someone capable of determining safe circuit loads.

NEW 9/78