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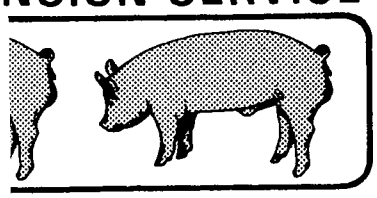

Swine Update

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GRAVITY-DRAIN MANURE HANDLING SYSTEMS[1]

Over the past several years, there has been a significant move to storing manure from farrowing and nursery facilities outside of the building rather than in deep pits under them. Most people agree that better air quality can be maintained in buildings where manure is stored outside of the unit.

Manure can be flushed, scraped, or drained to the outside storage area. Systems that flush the manure in gutters to outside holding areas require large quantities of either fresh or recycled water. Thus, the most compatible storage area with a flushing system is a lagoon, since recycled water can be used. Mechanical scrapers have been used to remove manure from the barn to the outside storage unit. However, the equipment has been plagued by high maintenance requirements. A gravity-drain system uses very little extra water and requires almost no mechanical equipment. In such a system, liquid manure is allowed to accumulate for a short period of time, generally a week, in gutters. A plug is then pulled and the manure drains out by gravity through a PVC pipe to the outside concrete storage pit or earthen lagoon. The only requirement is that an adequate grade (1 percent) be provided to allow the manure to flow to these holding areas.

The gravity-drain system has been popular with producers because of its simplicity and because it can be adapted to both new and remodeled facilities. Several different gutter designs can be used in a gravity-drain system. There are Y-shaped, modified Y-shaped and rectangular gutters.

Y-Shaped Gutters

The Y-shaped gutter was developed at the University of Wisconsin and is a modification of the deep, narrow gutter developed at Iowa State University in the early 1960's (see figure 1). Although the deep, narrow gutters empty quite well, their main disadvantage was dirty pen floors,

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[1]Adopted from an article entitled "Gravity-Drain Discharge System for Removing Swine Manure" by A. J. Muehling in Proceedings of the Illinois Waste Management Conference, March 23-23, 1983, Champaign, IL.

since the design required that the hogs move the manure into the narrow six-inch wide opening. The Y-shaped gutters have the same six-inch wide slot but with a wider opening (2-1/2 to 3 feet) at the top for a larger dunging area. The Y gutter sides should be angled at 45^{0} (slope of 1 to 1) and relatively smooth to prevent manure from sticking. Slope the bottom of the gutter approximately one inch for every 25 feet of length towards the drain. This slope (1"/25') is critical, since too steep of a grade will allow liquid to drain off too rapidly leaving solids in the gutter. Exceptionally long gutters may not work as effectively as shorter lengths, but gutters as long as 80 feet have functioned adequately.

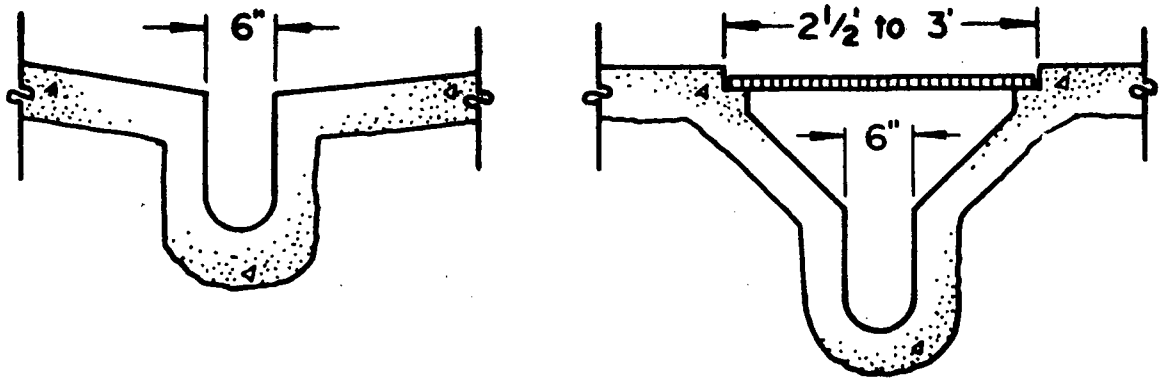

Figure 1. Deep, narrow gutter (left) and Y-gutter (right).

The use of gravity-drain Y-shaped gutters has primarily been restricted to farrowing and nursery facilities. Figure 2 shows two typical designs where Y-shaped gutters are used with farrowing crates. The raised crate option is most common with either woven-wire or plastic-coated expanded metal as the flooring. Gravity drained gutters for nursery pens present more problems since small piglets tend to dirty the entire pen. Figure 3 shows a possible method of providing drained gutters under a raised nursery deck.

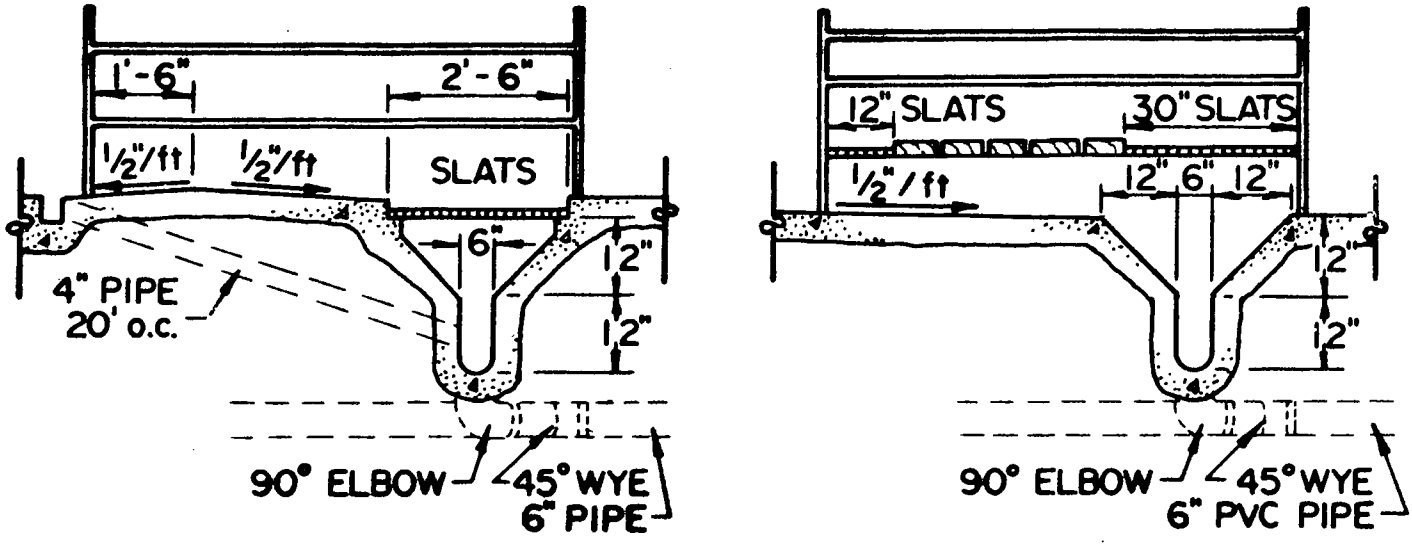

Figure 2. Y-shaped gutters used with floor-level (left) and raised (right) farrowing crates.

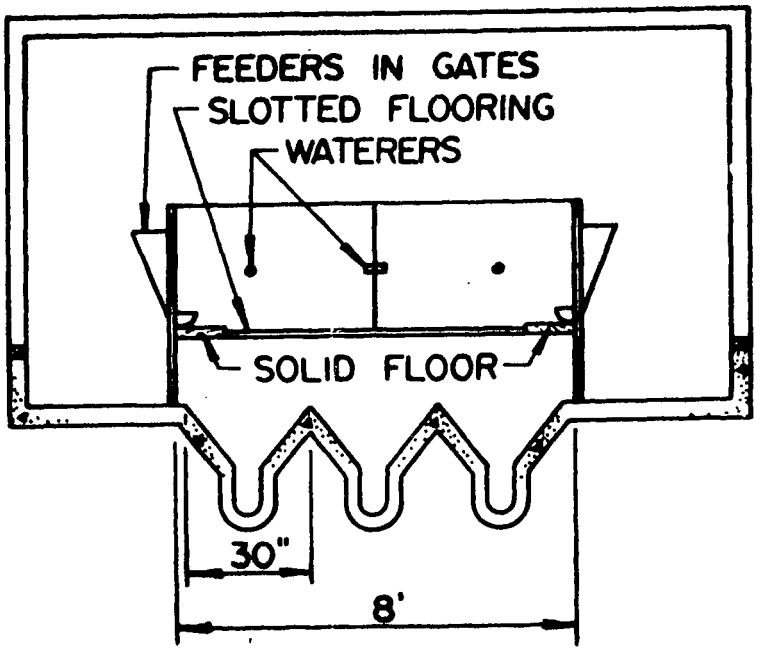

Figure 3. Y-shaped gutters used with raised nursery decks.

The primary disadvantages of the Y-shaped gutters are the cost and the difficulty in construction. The concrete forming for a Y-shaped gutter can present a certain amount of problems from both strength and construction standpoints. A concrete contractor is probably needed if a poured-in-place gutter is installed. There are commercially available Y-shaped gutters made of pre-stressed concrete and rigid fiberglass. The pre-cast concrete sections need to be handled with loaders or booms and the fiberglass sections need joints properly sealed to avoid leakage.

Modified Y-Shaped Gutter

Several variations of the Y-shaped gravity-drain gutters have been developed. One common type is shaped more like the letter "V" as shown in figure 4. This shows a low-sloped gutter to a center drainage area which is fabricated by cutting a PVC pipe in half. Figure 4 shows the V-shaped gutter under a raised deck floor which could either hold farrowing sows or nursery pigs. Figure 4 also gives another variation, the so-called J-shaped gutter. This design is also compatible with raised flooring.

Although these types of gutters are generally easier to construct than the true Y-shaped gutters, a certain amount of specialized concrete work is still needed to fabricate the floors. Although they do not clean as well as the Y-shaped gutters, they still do a good job of solid removal except on the low-sloped areas which need to be periodically washed down or scraped.

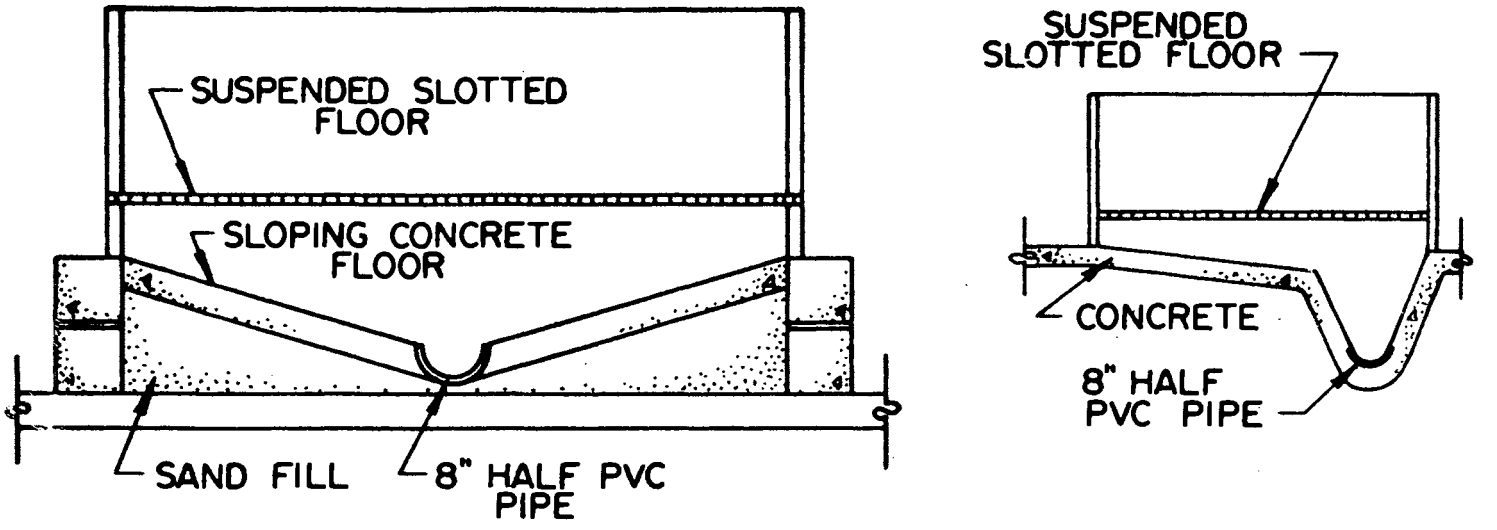

Figure 4. V-shaped gutter (left) and J-shaped gutter (right) under suspended slatted floors.

Rectangular Gutter

A rectangular gutter is a further simplification of a gravity-drain system. Either relatively narrow gutters, 16 inches to 2 feet wide, or wider gutters, 4 to 8 feet, can be used. Gutter depth varies between 1 and 2 feet.

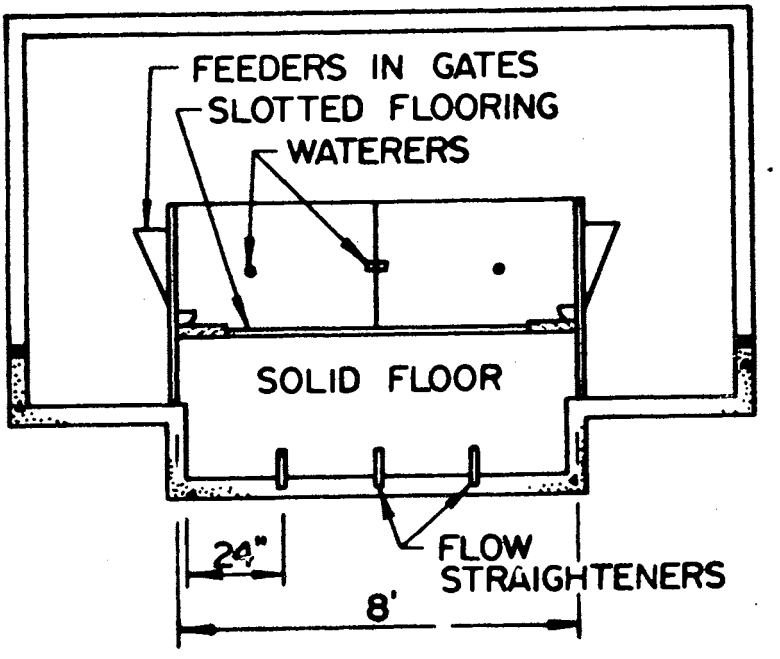

Figure 5. Wide rectangular gutter, with flow straighteners, under suspended flooring.

When using a gravity-drain rectangular gutter it is important to either restrict it to a two-foot width or, when a larger dunging area is necessary (as seen in figure 5), flow straighteners should be added to form two-foot wide channels. These flow straighteners can be strips of rigid PVC or fiberglass panels or some other material which will not rot or decay.

Although flat-bottom gutters are simpler to construct and less costly, they do not perform as well as the Y-shaped gutters. However, several design features and management procedures are recommended when using rectangular gutters. The first item is the placement of baffles at ten-foot intervals as shown in figure 6. The baffles are placed 6 inches from the bottom of the gutter which causes a scouring action as the liquid is forced to go underneath it. Another management recommendation is to add a small amount of either waste or fresh water to cover the bottom of the gutter preventing manure from sticking to that surface. It is also critical that the proper slope (1"/25') be followed, since a larger slope will allow liquids to drain away, leaving the solids behind.

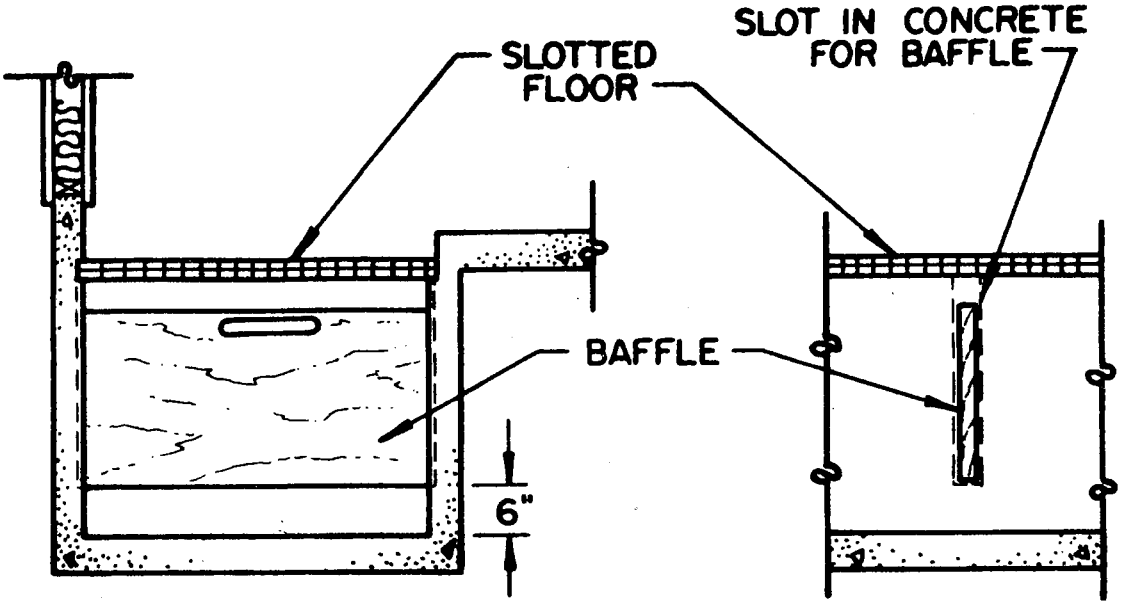

Figure 6. Baffles placement in rectangular gutter to aid in solids removal.

Drain Plugs

The effectiveness of any gravity-drain gutter system is dependent upon the use of a watertight plug. No matter which gutter design is used, if the plug is not watertight, liquid will seep away leaving the gutter full of solids. Figure 7 shows two common types of drain plugs used in gravity-drain systems. One uses two plastic pails which fit together tightly and the other a weighted plug with a rubber gasket. Since no commercial company makes plugs specifically for this purpose, a producer generally has to fabricate it.

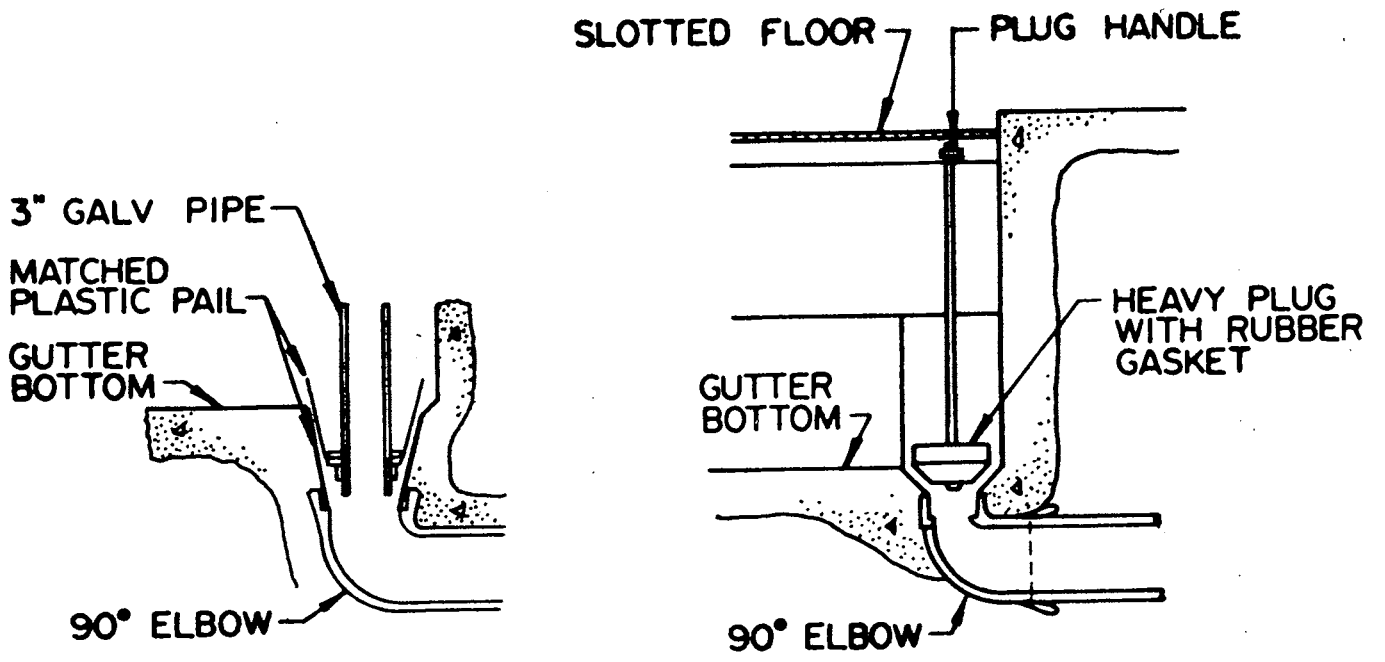

Figure 7. Plastic pail (left) and weighted gasket (right) plugs used in gravity-drain systems.

Storage

The manure from the gravity-drain system may be contained in a pit under an adjacent building, in an underground tank outside of the building, in an above-ground tank, or an outside holding pond. Many times the waste from a farrowing/nursery unit may be drained into the pit under an adjacent growing/finishing or sow gestation facility. Other than reducing storage time in those facilities, one should be concerned about proper pit ventilation since the addition of waste may slightly agitate an existing pit and result in some release of gases. The most common situation is an underground pit adjacent to the facility. A concrete pit with a lid should have an air release valve so that gases do not build up in the pit which may be released when the plug is pulled in the drain gutters. In some instances buried concrete pits cannot be constructed because of high water tables or unsuitable geological conditions. In these cases, an above-ground tank can be used. It is then necessary to have a small concrete sump which is filled by the gravity-drain system and later pumped into the above-ground storage unit. The same pump can be used for agitating the manure in the tank and for loading tank wagons. In a few cases, an outside storage or lagoon would receive the manure from a gravity-drain system. It is generally recommended that the inlet pipe in the outside storage pond be above the lagoon level so as not to provide a back pressure once the plug is pulled in the drain gutters.

The use of gravity-drain manure systems has become very popular in farrowing and nursery units in Minnesota. Their use is also being tried in some growing and finishing facilities. No matter which design is chosen, it is critical that the management recommendations mentioned be followed in order that these manure handling systems function properly.

VIDEO TAPES ON ANIMAL WASTE MANAGEMENT

Animal waste management is discussed in three half-hour video tapes. The subject matter of the tapes includes fundamentals, characteristics, collection, storage, transportation, treatment, and utilization of livestock manures. The tapes were produced by the University of Minnesota Media Resources for the program Issues in the Environment in cooperation with the Agricultural Engineering Department. They can be obtained by contacting Chuck Clanton in the Department of Agricultural Engineering, University of Minnesota, 1390 Eckles Avenue, St. Paul, MN 55108.

WINTER VENTILATION AND HEATING

Proper environment control of swine facilities during the heating season is critical to the health and performance of the housed animals. A mechanically ventilated (warm) swine barn needs adequate insulation, proper selection of fans, sufficient air inlets, and in the cases of farrowing and nursery facilities, a correctly sized furnace. Most of these ventilation components need to be controlled properly by either automatic (thermostats) or manual (inlets) methods to make the system function.

Insulation

A mechanically ventilated building needs insulation in a flat ceiling and in the sidewalls (see figure 8). Insulation is provided in these areas to prevent condensation from occurring on the inside surfaces during periods of cold temperatures. Massive amounts of insulation (R=40), as recommended in residential houses, is not economically beneficial in a livestock housing unit. Figure 8 also shows insulation around the building's foundation. Insulation in this location provides a much warmer floor which is critical for facilities which house small animals.

Fan Selection

The proper amount of air exchange during the heating season is balanced between providing sufficient fresh air for the animals and conserving heat to maintain a reasonable temperature. Table 1 gives the swine ventilation rates that are recommended for Minnesota. The cold and mild weather rates are the levels used during the wintertime or heating season. A facility should have two separate fans, one delivering the cold weather or minimum rate and another the additional mild weather rate.

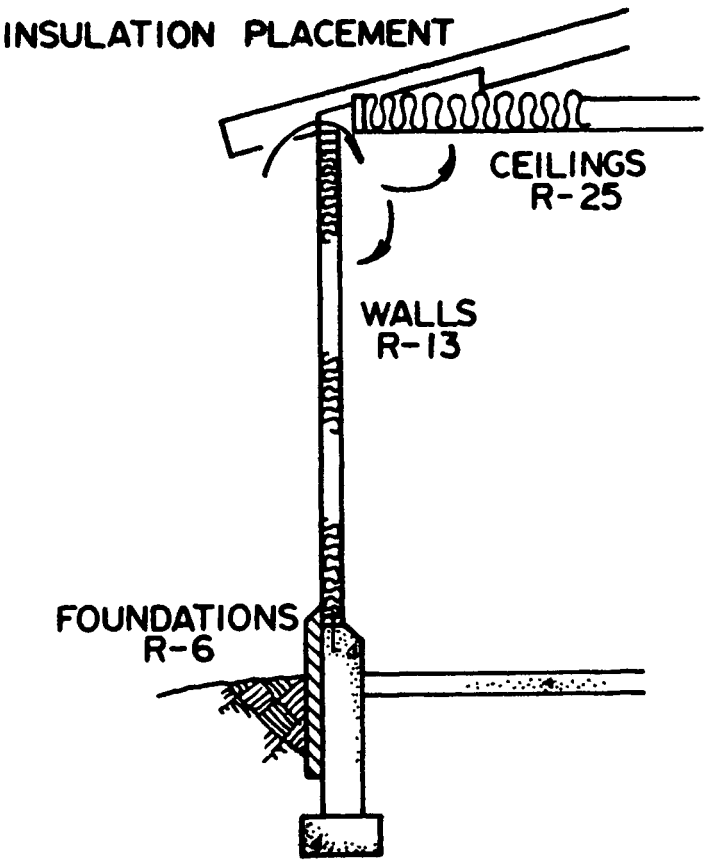

Figure 8. Recommended placement and amount of insulation in a mechanically ventilated barn.

Table 1. Swine Ventilation Rates*

Animal Type	Weight lb	Cold Weather Rate	Mild Weather Rate	Hot Weather Rate
		cfm per head (addition = total)		
Sow and litter	400	20	+60 = 80	+170 = 250
Prenursery pig	12-30	2	+8 = 10	+15 = 25
Nursery pig	30-75	3	+12 = 15	+20 = 35
Growing pig	75-150	7	+17 = 24	+26 = 50
Finishing pig	150-220	10	+25 = 35	+50 = 85
Gestating sow	325	12	+28 = 40	+60 = 100
Boar	400	14	+36 = 50	+100 = 150

*Adopted from Table 7, page 34 of MWPS-8, 1983 edition.

The minimum rate should be delivered by a continuous running fan. In a negative-pressure ventilation system this fan should exhaust air from either a plywood duct (figure 9) or if one is present, from the barn's manure pit. Removing air from a pit or through a duct conserves heat and removes noxious gases. This fan and subsequent air exchange is absolutely essential in any livestock ventilation system.

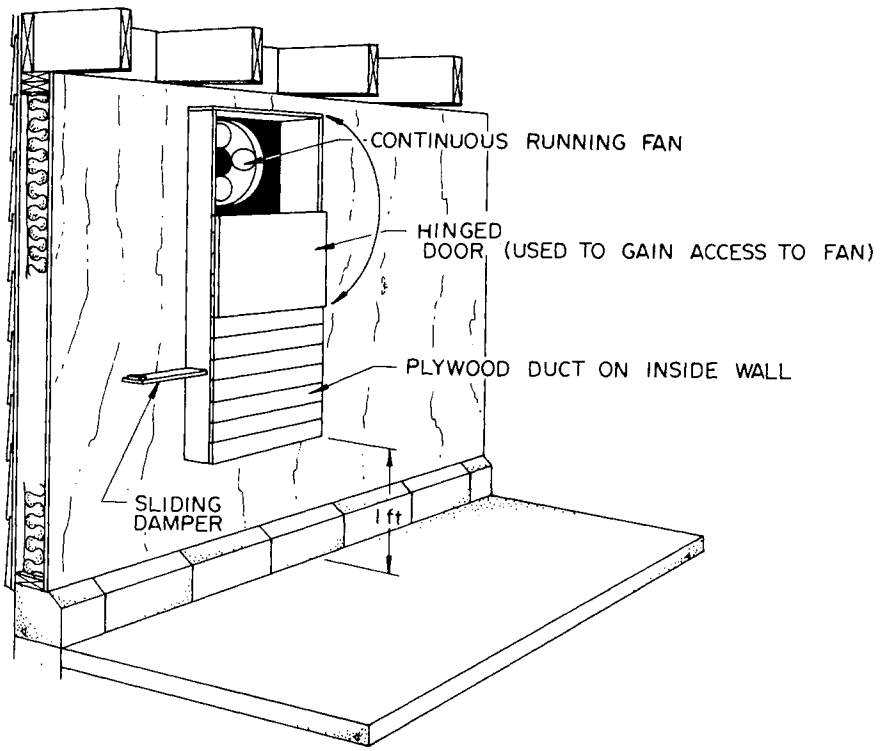

Figure 9. Plywood duct built around the continuously running fan.

All facilities, including those which need supplemental heat (farrowing and nursery) need another fan sized at the additional mild weather rate given in Table 1. This larger fan should be controlled by a thermostat and equipped with good shutters to prevent air from leaking into the barn when not operating. The fan will operate during the heating season only on mild winter days to reduce the temperature in the barn. It does not need a duct built over it and generally should be located in a south or east wall (can be adjacent to the continuous running fan) to avoid prevailing winds.

Inlet Sizing

The most common problem in exhaust ventilation systems is the lack of sufficient inlet area for the existing fan capacities. The recommended amount of inlet area for cold weather operation can be found by dividing the total mild weather rate (minimum rate plus additional mild weather rate) by 800 to obtain the number of square feet needed. This calculated area will allow air to enter the facility at acceptable velocities when both the continuous and thermostatically controlled fans are operating or when just the continuous fan is running. Another recommendation is to provide this inlet area in either a slot or ceiling inlet as shown in

figure 10. This feature distributes the inlet area throughout the barn which allows for proper air mixing in an exhaust ventilation system. It is this feature which provides for air distribution rather than the location of exhaust fans.

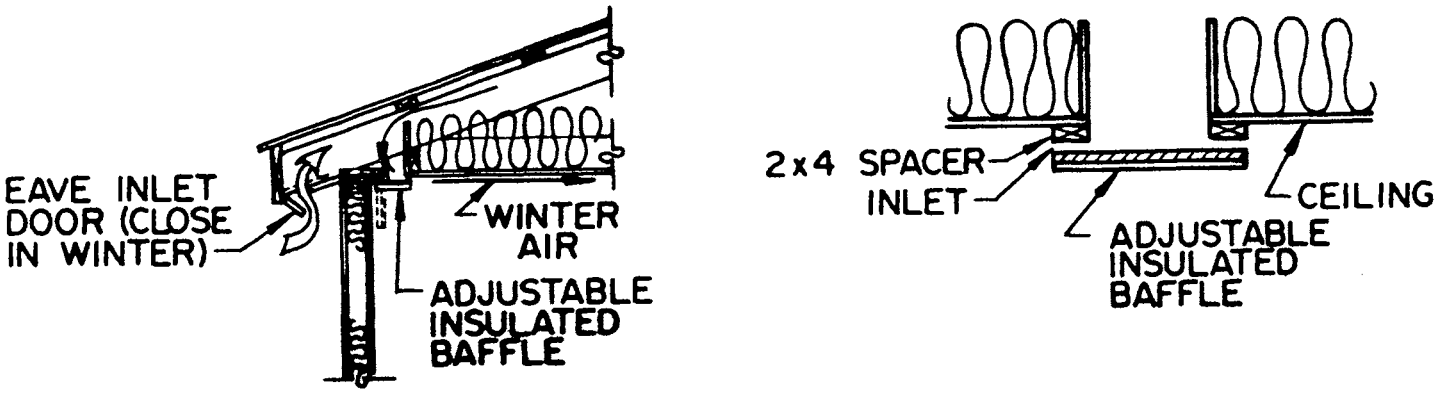

Figure 10. Slot (left) and ceiling (right) air inlets.

Heater Selection and Control

Farrowing and nursery facilities, as well as some gestation units where sows are contained in individual stalls, may need some supplemental heat to maintain a constant and acceptable temperature. Table 2 gives the supplemental heat requirements (furnance output per head) for those facilities. This amount of heat is needed to maintain acceptable air temperatures and should be designed to heat the air rather than a surface. Radiant heaters and floor heat are needed in farrowing and nursery units, but should be in addition to what is given in Table 2.

Table 2. Supplemental Heat Requirements

Animal Type	Inside Temp. ^{o}F	Supplemental Heat BTU/hr/hd.
Sow and litter	70	3000
Nursery	70-85	350
Gestation (stalls)	60	1000

One must be extremely careful that heaters and thermostatically controlled fans do not operate at the same time. Depending upon the quality of the thermostat, it is generally recommended that a 7 ^{o}F to 10 ^{o}F difference be provided between the fan and heater thermostats. In a farrowing barn where 75 ^{o}F temperatures are maintained, the heater's thermostat could be set at 70 ^{o}F while the thermostatically controlled fan should be at 80 ^{o}F.

REMODELING A TOTALLY SLATTED BARN[2]

Many swine facilities built in the late 1960's and early 1970's have fully slatted floors which may be in need of repair or no longer give acceptable performance. Several producers have used the technique of pouring a concrete lid with a curb over the manure pit. This is especially true for farrowing and nursery units where raised floors are gaining popularity plus not storing manure inside the building. This process is described for a typical farrowing stall conversion in figure 11 and for a nursery conversion in figure 12.

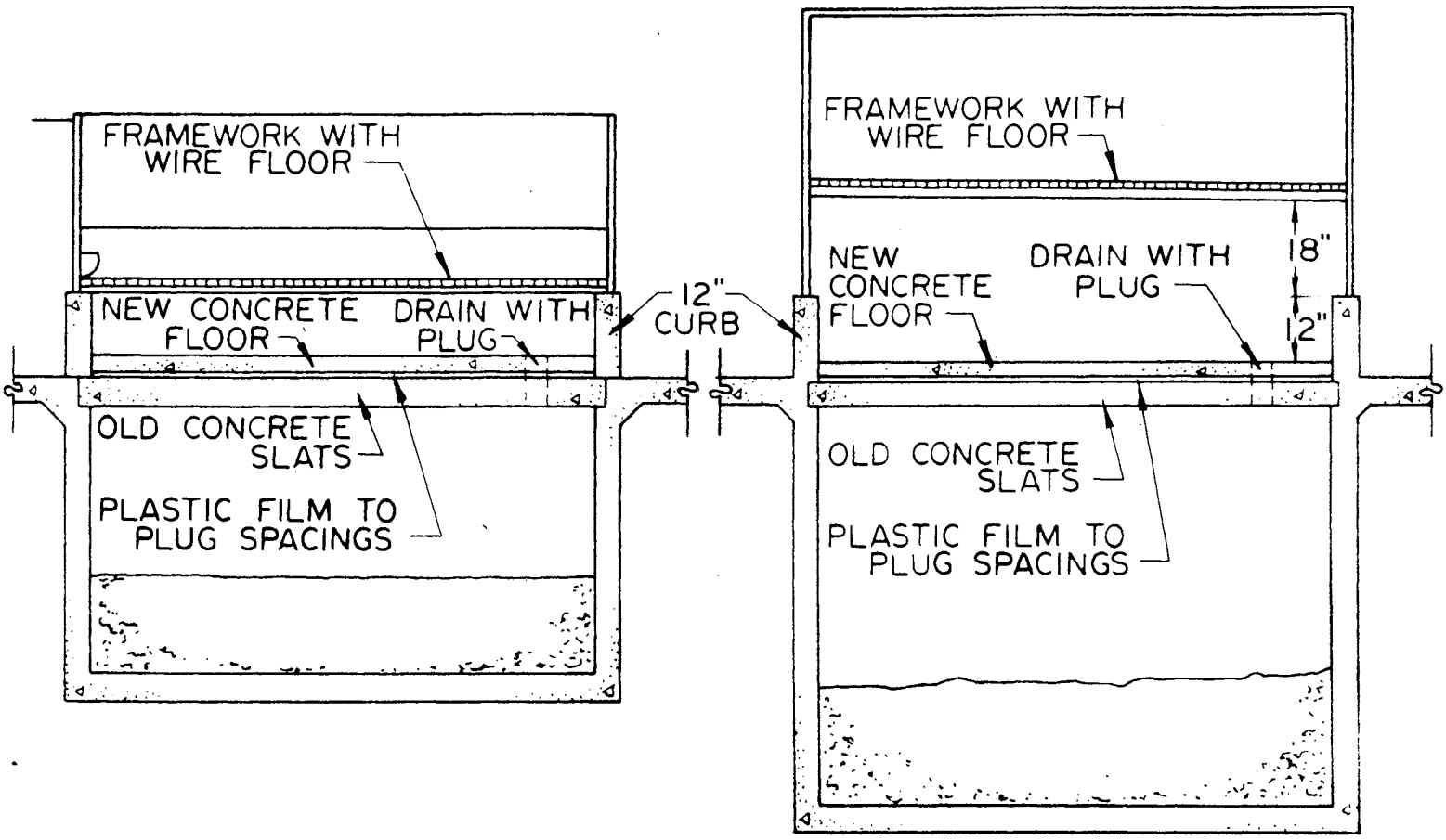

Figure 11. Raised farrowing crate conversion over old pit.

Figure 12. Raised nursery deck conversion over old pit.

[2]Ibid.

The conversion begins by covering the existing floor with 6 mil polyethylene plastic and pouring a new concrete floor, approximately 3 inches thick, over the old slats and plastic film. A four-inch diameter hole to drain manure into the pit needs to be installed in the new floor. The bottom of the shallow gutter should slope slightly toward this drain so manure can flow into the pit when the drain plug is pulled. It is important that the plug or stopper fit tightly so that liquid wastes do not drain away leaving solid manure in the gutter. The plug should be pulled periodically (approximately once a week) to avoid septic or anaerobic digestion and subsesquent odors. The gutter will clean reasonably well each time the plug is pulled, but a thorough cleaning between groups of farrowing or nursery pigs is necessary with this type of gravity drained system.

This modification of an existing structure makes excellent use of the deep manure pit, eliminating the need to dig an outside pit adjacent to the barn. The lid eliminates odors from the manure pit which improves the environment for young pigs. This technique also changes the flooring from concrete slats, which is not that conducive to young piglets, to a more acceptable type such as woven wire or plastic-coated expanded metal.

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