Reducing Heat Stress in the Holding Pens

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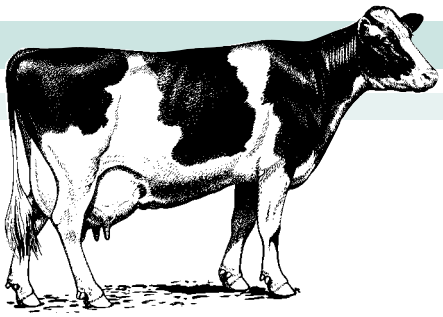


Dairy cows experience heat stress when the temperature humidity index (THI) exceeds 72. This index is based on the relationship of temperature and relative humidity. Many dairies use shades, fans and/or sprinklers for cooling cows at the feedline and in the lounging areas. An area often overlooked is the holding pen where cows may be standing from 2 to 6 hours per day depending on milking parlor performance and group size.

Cooling needs to be considered in the milk parlor holding pen. Research has shown that, without cooling, the body temperature of a cow increased 3°F within 20 minutes after entering the holding pen. When an overhead spray system and fans were installed, the cow's body temperature was lowered by 3.5°F during the time the cows were in the holding pen.

Cooled cows produced 1.7 pounds more milk per day than uncooled. Another research trial showed an increase in milk production of 5 pounds per day when the cows were cooled five times per day for 30 minutes in the holding pen.

Heat stress not only affects milk production during the hot periods but also can affect reproduction and milk production into the cooler months. Cows give off approximately 4,500 BTUs per hour when temperatures exceed 80°F. About half of this energy is expelled from their lungs as evaporative moisture or latent heat. The remainder radiates from the hide. This heat production per cow is similar to a 1,500-watt hair dryer blowing continuously at a high speed.

Altering Milking Group Numbers

Modern dairies strive to limit the time cows are away from feed and water to no more than 2 to 3 hours per day. Many small dairies house cows in one large group. As a result, cows may be away from feed and water from 4 to 6 hours per day, or 15 to 25 percent of the time. Gates, electric fences or panels are an economical way to subdivide the cow herd into multiple groups during the summer months to reduce time spent standing in the holding pen.

Proper group sizing can help reduce heat stress with minimal investment in equipment or facilities. Cows should be grouped together so they are in the holding pen less than 1 hour per milking when milking two times. Herds milking three times should remain in the holding pen less than 45 minutes per milking. To estimate group size, multiply the total number of milk stalls by 4.5.

Adjusting Milk Parlor Schedule

Dairies with milk parlors not used at full capacity, or more than 12 hours per day, may be able to alter their milking schedules. The objective is to avoid milking from 1 p.m. to 7 p.m. For example, a dairy milking two times per day may switch from a 5 a.m. and 5 p.m. milking to a 10 a.m. and 10 p.m. milking. A herd being milked three times per day, may be switched to a 3 a.m., 11 a.m. and 7 p.m. schedule to avoid having cows in the holding pen during the heat of the day.

Dairies may consider changing the order of the

groups of cows being milked. Heifers are better able to tolerate heat than mature cows. High-producing groups should be milked during the cooler periods of the day.

Providing Fresh Water for Cows Leaving the Parlor

Cows should have access to fresh water immediately upon exiting the milk parlor. In double 25's or smaller, one 8-foot trough usually is sufficient. In parlors larger than double 25's, two 8-foot troughs are needed. It is important to provide fresh, cool water, so watering troughs must be easy to empty for cleaning. A water trough that is warmed by the afternoon sun should be emptied immediately before the afternoon milking and refilled with fresh water. Watering troughs at the exit lanes should be placed in the shade or have shade constructed over them.

Sidewall Openings

Holding pens should have sidewalls open at least 60 percent to enhance natural ventilation. Be careful to ensure that no structural damage is done to the holding pen if the sidewalls are modified. Sidewall curtains or hinged doors can be used to protect the cows during cold weather.

Ridge Ventilation

Heat naturally rises and becomes trapped near the ceiling or peak of the holding pen. Removing the ridge cap or opening the ridge can help release heat accumulating in the peak of the building. Large roof vents, wind turbines or mechanical roof ventilators may be used if the ridge cannot be opened. Removing trapped heat may also help maintain a cooler milk parlor. The ridge opening should be 2 inches per 10 feet of building width.

Fan Sizing and Placement

The fan system in the holding pen should be capable of moving 1,000 cubic feet of air per minute per cow (cfm / cow). The total ventilation rate is based on the maximum number of cows in the holding pen.

Most 30- and 36-inch fans will move between 10,000 and 12,000 cfm per fan, so install one fan per 10 cows or 150 square feet of holding pen area. A 48-inch fan will move approximately 20,000 cfm of air per fan. One 48-inch fan is required per 20 cows or 300 square feet of pen space.

Use 48-inch fans only if the clearance from the bottom of the fan cage to the floor is at least 8 to 9 feet for equipment clearance. Also, it may be better to use more 30- or 36-inch fans than 48-inch fans to minimize dead air zones in the holding pen.

Many older dairies have holding pens less than 24 feet wide with 8- to 10-foot sidewall openings. These holding pens can be mechanically ventilated by installing 30- or 36-inch fans in the side walls and positioning fans to take advantage of prevailing winds. Using the design guideline of one fan per 150 square feet, holding pens less than 24 feet should have fans installed 6 to 8 feet on center along the sidewalls.

It may be better to install 60 to 70 percent of the required fans closer together in the half of the holding pen closest to the milk parlor. Figures 1 and 2 show fan placement for holding pens of different widths.

Install fans near the eave of the sidewalls tilted downward at 15 to 30 degrees. Adjust the angle so that air movement directly in front of the fan can be felt the width of the holding pen and at the height of a cow's back. Holding pens that have a ceiling can use sprinkler systems on the fan cages or mount the plumbing to the ceiling providing it does not interfere with equipment. Ceilings do not allow heat to rise and exit ridge vents, so the ventilation system should be designed to provide a minimum of one air change in the holding pen per minute.

Holding pens with sidewall heights higher than 10 to 12 feet are probably best mechanically ventilated by installing rows of fans perpendicular to the cow movement into the milk parlor. Table 1 shows common holding pen sizes based on the number of cows within the holding pen and the approximate number of fans required. This table was developed based on providing 1,000 cfm / cow.

Figure 2 shows a common fan layout for 24-foot and wider holding pens. Spacing between the rows may be adjusted based on where the fan-mounting brackets are attached to the structure. The distance between fans within a row is 6 to 8 feet regardless of fan size. The distance between fan rows is 20 feet for 30- or 36-inch fans and 40 feet for 48-inch fans. As with smaller holding pens, it may be a good idea to install 60 to 70 percent of the required fans closer together in the half of the holding pen closest to the milk parlor.

Sprinkler Systems

Sprinkler systems may be used to wet cows' backs and keep them cool in the holding pen. Sprinklers should never

be installed without a mechanical ventilation system because the increase in humidity and THI can cause severe stress on the cows.

At humidities and temperatures above 70 percent and 90°F, cows will suffer severe heat stress in the holding pen because of their inability to release heat through breathing.

The sprinkler system should be capable of providing 0.03 gallons of water per minute per square foot of area. Table 2 shows the water requirements for different size holding pens and the required flow rate of the water system.

The well or water system must be able to supply this water above and beyond the normal water requirements for the milk parlor and waterers. The flow rate from the well is based on supplying the water during a 2-minute period. In the holding pen, shorter on cycles with 1 minute on and 6 minutes off are recommended. But many water distribution systems may not be able to handle the high flow rate demands of the sprinkler system regardless of whether nozzles or spray lines are used. Another option in larger holding pens is to program the nozzles so that only a portion of them are on at one time. The time the sprinkler nozzles are on may need to be reduced if the cows' udders are getting wet.

Table 2 also shows the number of 360° nozzles required if the nozzle spray diameter is 8 feet. Approximately one nozzle per three cows is required. In the holding pen, spray nozzle overlap is not as critical as in the lounging area or along the feedline. The nozzle spacing is equal to the spray diameter. If the spray diameter is 8 feet, then the nozzles are placed in an 8-foot by 8-foot grid. The nozzle should have a rating of at least 25 gallons per hour to deliver 0.03 gallons per square foot within a 1-minute period. Larger diameter nozzles may be used, but spray patterns should overlap 10-20 percent.

Plumbing must be sized to provide the necessary flow rates to each of the distribution lines. If the holding pen is less than 100 feet long, the main distribution line can be located at one end of the holding pen. Longer holding pens should have the main distribution pipe installed at the center with branched lines to distribute water to either end. Following these guidelines and the nozzle layout shown in Figure 3 suggests using 3/4-inch pipe in the branch lines if the total holding pen capacity is 200 cows or less and 1-inch pipe for larger holding pens. Table 3 shows the recommended pipe size for different flow rates based on distance from the water source to the distribution or branch lines.

Another option is to install a spray line or mister on the fan cages. The spray line should be able to deliver 3 to 4 gallons per minute (gpm). Water requirements from the well or water supply are determined by multiplying the number of fans by three. Fans should be waterproof and grounded to avoid electrical shock.

Installation

Install the ventilation system and sprinkler controllers according to the National Electric Code to prevent electrical problems. Dairies not following electrical codes risk causing electrical shock to workers or stray voltages. The system must not interfere with manure handling equipment and crowd gates. Cooling equipment is usually mounted at least 7 to 8 feet above the floor or out of reach of curious cows. The roof and support structures must be able to bear the additional weight of the fans.

New Facilities

Milk parlor holding pens for new facilities should be open sidewalls at least 12 feet high. Curtains can be used to provide winter protection. During construction, make provisions for adding artificial cooling, including mechanical ventilation and sprinkler systems. Roofs should have 4 in 12 slope with a ridge opening of 2 inches per 10 foot of building width. Trusses should be manufactured to carry the dead load created by the fans hanging from the lower chord. Fans may weigh up to 100 pounds each depending on size, horsepower, type and construction method.

Summary

The holding pen next to the milk parlor is the most stressful area on the farm for dairy cows. Cows producing large amounts of body heat are brought into small confined areas for extended periods two to three times per day. Artificial cooling in these areas can reduce summer heat stress.

Here are five management steps to minimize heat stress in the holding pen:

1. Reduce group size to minimize time in the holding pen.
2. Alter milking times if the parlor is not used at full capacity.

3. Open up holding pen sidewalls and ridge to enhance natural ventilation.
4. Install fans to mechanically ventilate the holding pen on hot, still summer days.
5. Install sprinkler systems to increase the evaporative cooling from the cows.

Table 1. Ventilation requirements based on holding pen capacity.

Holding Pen Capacity	Typical Pen Size (feet by feet)	Total Fan Capacity (cfm)	Number of 30- to 36-inch fans	Number of 48-inch fans
40	24 by 32	40,000	4	NR*
60	24 by 42	60,000	6	NR
80	24 by 50	80,000	8	NR
100	32 by 48	100,000	10	NR
120	32 by 56	120,000	12	NR
160	32 by 75	160,000	16	8
200	32 by 96	200,000	20	10
300	32 by 144	300,000	30	15
400	32 by 192	400,000	40	20
500	32 by 240	500,000	50	25

* Not recommended.

Table 2. Sprinkler nozzle requirements based on holding pen capacity.

Holding Pen Capacity	Typical Pen Size (feet by feet)	Water Required (Gallons)***	Minimum Flow Rate (gpm)*	Number of 360° Nozzles Required**
40	24 by 32	20	10	14
60	24 by 42	25	12	20
80	24 by 50	30	15	27
100	32 by 48	40	20	34
120	32 by 56	45	23	40
160	32 by 75	60	30	54
200	32 by 96	80	40	68
300	32 by 144	120	60	102
400	32 by 192	150	75	136
500	32 by 240	200	100	170

* Flow rate based on a 2-minute on cycle with 10 minutes off.
** Assume nozzles have an 8-foot spray diameter and 0.5 gpm capacity.
*** Assumes application of 0.025 gallons (0.04) of water per cycle per sq. ft. of pen area.

Table 3. Recommended maximum PVC pipe length based on pipe diameter and flow rates and limiting the pressure drop to 5 psi with no allowances made for fitting or couplings.

Pipe Diameter	Flow Rate (gallons/minute)					
(in)	10	20	30	40	50	100
n	50					
36588	75					
1	180	40				
1 1/4	700	200	100	60		
1 1/2	1500	400	200	120	80	
2	4000	1400	660	400	240	80

Figure 1. Example of fan placement in a holding pen less than 24 feet wide. The holding pen shown has an approximate capacity of 80 cows.

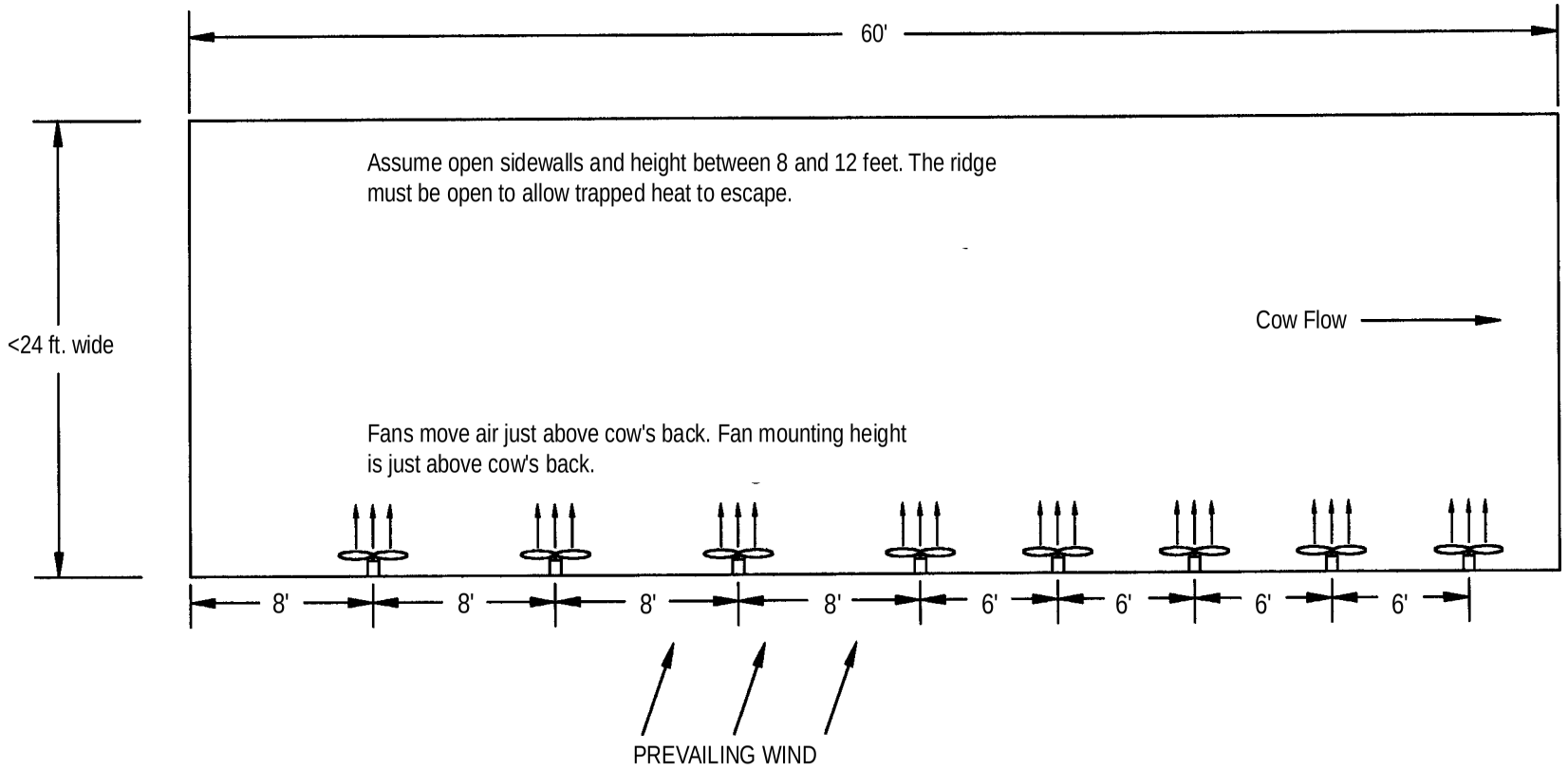


Figure 2. Example of fan placement in a holding pen 24 feet or wider. The holding pen shown has an approximate capacity of 80 cows.

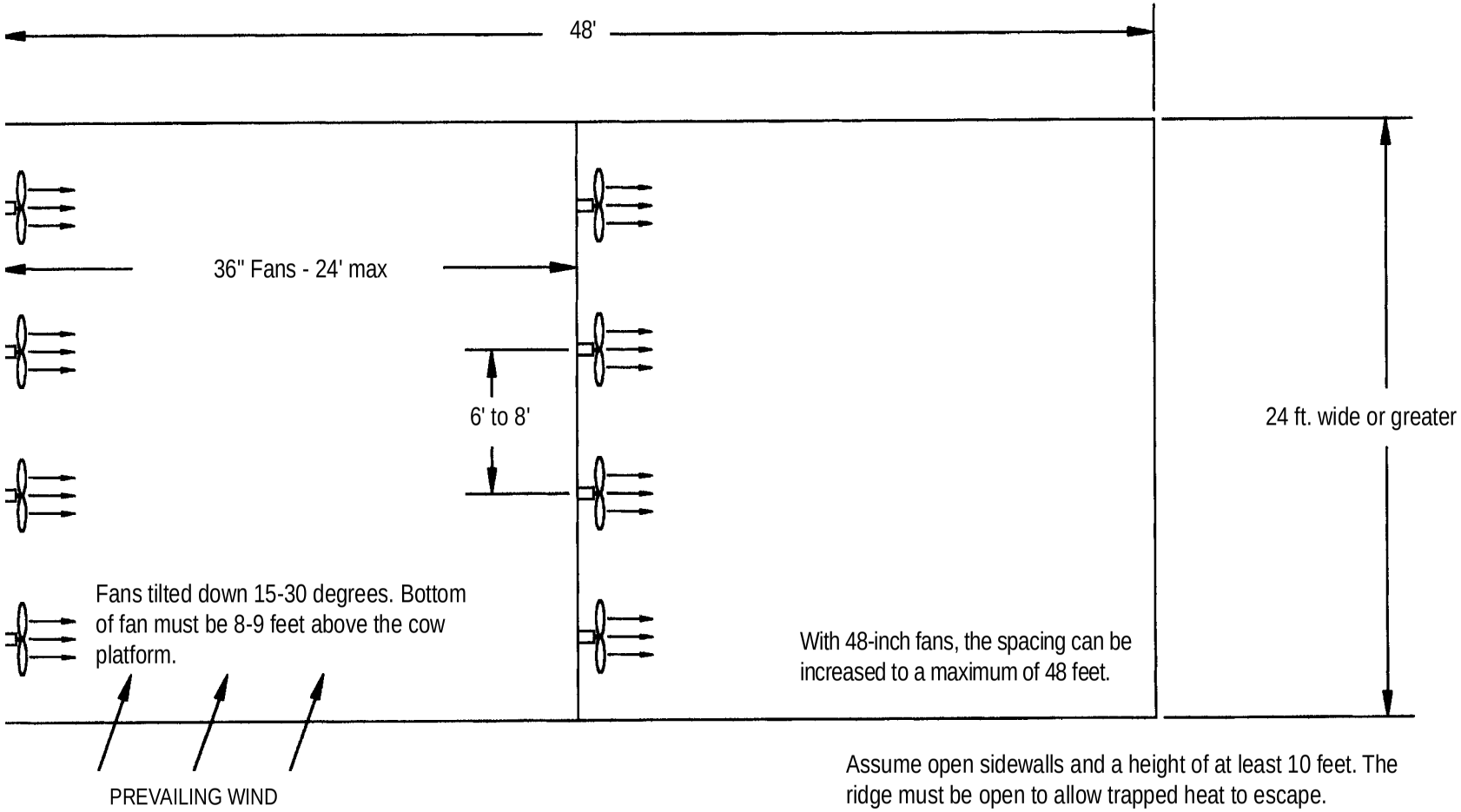
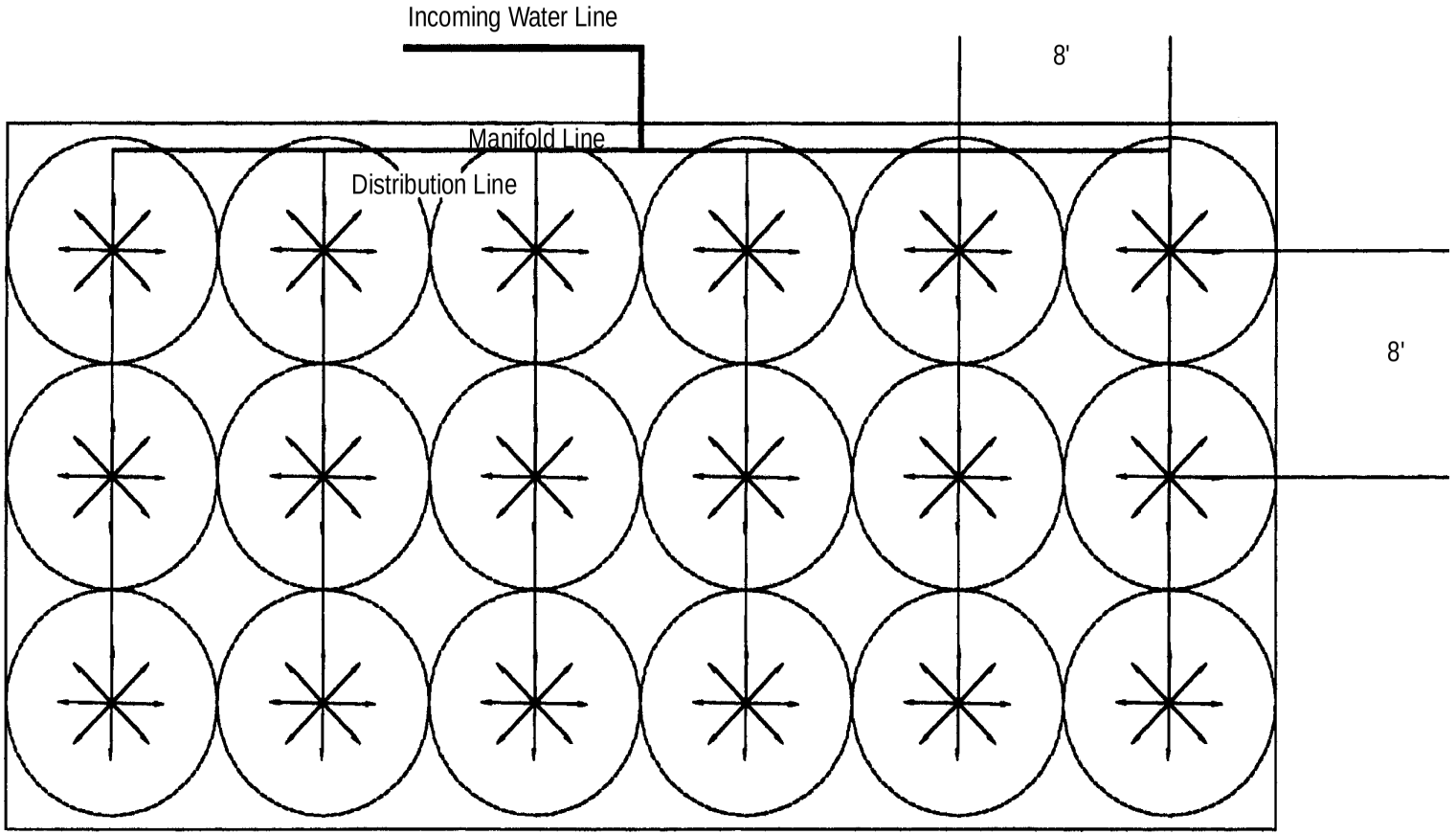


Figure 3. Example of a sprinkler system in a holding pen.



Assumes 25 gph nozzles and 8 foot diameter spray pattern.
Approximately one nozzle is required per three cows.

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

MF2468 September 2000