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Key Considerations in Fan Cooling Dairy Cows

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Dog dead hot summer days provide a particular challenge in keeping cows comfortable, healthy, and sustaining production of high quality, high volume milk. High air temperatures and humidity, intense solar radiation, and/or little or no natural air movement contribute to stressful conditions. These conditions are particularly stressful to dairy cattle and we see the effects in reduced milk production, decreased feed efficiency, reduced conception rates, and compromised growth rates of neonatal calves. Losses combine to cause huge economic impacts, even in the Northeast.

While the economic nature of the dairy business (a commodities-based supply and demand product) does not allow the capital and operating base to house cows in environments that totally mitigate the effects of heat stress, we can significantly reduce the effects of heat stress on many summer days.

Components of a heat stress abatement system include:

- Ensuring all cows always has free access to clean, fresh water
- Providing shade from sun's solar energy
- Increasing barn ventilation (air exchange) rate
- Providing air directly on cows in strategic locations
- Increasing evaporative heat loss by intermittently soaking cows' hair coats
- Adjusting feed ration composition

There are many key items to consider as part of thinking through fan cooling dairy cows – below is a listing and some thoughts on those that are most important.

Locating Fans

A goal of fan cooling cows is to provide targeted air speeds in areas where cows perform beneficial activities. This means fans should be strategically located over cow feeding, resting, and watering areas along with in the milking center holding area. In freestall barns, this means rows of fans should be centered over feeding cows and also over cows lying in each row of freestalls as shown in Figure 1. Fans that are not centered over feeding or resting cows can result in significant air flow in nonproductive areas; cows will stand in these areas during stressful conditions to increase heat loss.

Target Air Speed at Cow Level

Research has shown that target air speed over cows' bodies should be 400 to 600 fpm. Most agricultural fans marketed for cooling cows can easily exceed this target velocity, even at many feet away from the fan. However, cows are like boulders in a river; water flow in the river is impacted by the boulders and air flow in a barn is impacted by cows. Moving air that strikes a cow is slowed down and its flow direction is changed.

Fan Spacing within a Row of Fans

Cooling fans need to have a good 'throw', meaning airflow should be maintained a good distance away from a fan. This implies that air must be expelled in a fairly tight cone. Fans in rows spaced longitudinally about 10 blade diameters (30' for 3' diameter fan, 40' for 4' diameter fan) maintain affective velocity when blowing on cows. The fans can easily move air further than this but the initial cows cooled by the fan discharge air sufficiently interrupt the flow that cows further away do not reap the benefits.

Fan Details - Size

Any size fan providing target air speed at cow level is much better than a possible alternative of no cooling fans in the barn at all. But when evaluating how to maximize cooling at cow level there are key considerations: blade diameter, motor size, and achieve the goal of target air speed at cow level. With all things considered, 3' diameter fans with a 1/2-hp motor generally do a good job at meeting the goals. Fans are closer together (due to the 10 blade diameter rule) and thus cows are less likely to affect the fan's discharge airflow pattern and speed and thus have a better chance of providing the target air velocity on more cows than less but larger fans do. Larger fans require 3/4 hp or larger electrical motors thus costing more to operate than 3' fans. Four-foot diameter fans may be a good choice when barns are overstocked and thus the wider 'swath' of air movement will impact cows that are not able to lie down or make it to the feed bunk.

Fan Details – Electrical Supply

If the farm has 3-phase power, than in almost all cases it is best to purchase fans with 3-phase motors. Three-phase motors will last longer and generally speaking are more efficient than single phase motors. And, in the case where a "soft start" may be needed due to electrical service size limitations, 3-phase fans can more easily be soft started than single phase motors.

Fan Details - Belt-drive or Direct-drive

In most cases, direct-drive fans are preferred for fan cooling cows primarily because the desired performance of these fans is more easily maintained over extended periods of use than with belt-driven fans. Belt-drive fans have excellent airflow capacities and operate with comparatively little noise when the fans are first installed. However, their performance falls off with time as the belts wear. Producers that are committed to regular fan maintenance schedules can choose between either fan types.

Fan Details - Performance

Contrarily to barn ventilation fans that provide air exchange, where fan efficiency – fan air output per unit of energy input (cfm/Watt) is an important consideration, cow cooling fans are harder to evaluate as the goal is air speed at cow level. An ideal efficiency measure for cooling fans would be beneficial area covered at the meaningful velocity per Watt (sq. ft./Watt). In this case, beneficial area is an area in the barn where cows are productive. Fan shrouds are known to assist in focusing air velocity and therefore improve performance. Fans with ½-Hp motors can have good cow cooling performance. Selection of energy efficient motors is also an important consideration with cooling fans; if it is good under some static pressure it will be better at 0" of sp.

OSHA requires that fans be covered with a guard that has openings no larger than one-half (1/2) inch (see below for details). While guards may be required provide for worker and cow safety, they also are notorious for accumulating dirt and debris that significantly affect their performance. If fans are not going to be cleaned at least a few times during a summer, it is likely better for them to be mounted so the guards are not required under OSHA.

Fan Mounting Height

Operating fans can be dangerous to cows and workers and in recognition of this OSHA section 1910.212(a)(5) states: "When the periphery of the blades of a fan is less than seven (7) feet above the floor or working level, the blades shall be guarded. The guard shall have openings no larger than one-half (1/2) inch". It is in the best interest of the cows to be cooled for the lowest point of the fan blade (6 o'clock) to be no more than 7' above the floor or the working level (freestall base). Fans along the feed bunk or over the stalls may need to be mounted higher than 7' to provide required clearance for stall bedding delivery or manure gathering/removal equipment and in this case, mount fans just high enough to provide the necessary clearance.

Fans Mounting Angle

Fans should be tilted from the vertical so they are aimed at the bottom of the next fan down the line as shown in Figure 2. The higher the fan is mounted above the floor, the greater the angle from the vertical needed.

Locating Fans in the Milking Center

Cooling fans should be oriented in holding areas to direct airflow 180 degrees away from the parlor (preferred) or across the pen in the direction of prevailing summer breezes. (In many older holding pens, clearance is limited by low-lying truss chords or ceilings. Smaller (18- and 24-inch) fans are commonly used in these applications with a relatively close spacing between fans.

Do not blow air from the holding pen into the parlor since this can be unsanitary and moves hot, humid air into the milking area, which leads to uncomfortable conditions for milkers.

Use the 10 times the fan blade diameter rule to determine longitudinal spacing. Laterally, fans should be spaced 2 to 3 times their blade diameter.

Fan Maintenance

Developing and implementing a regular maintenance schedule will go a long way towards sustained fan operation when the cows need it the most. Suggested maintenance for supplemental cooling fans includes:

- Regular examination of belts and belt replacement on belt-drive fans
- Quick repair of bent or broken fan blades and fan housings
- Cleaning of fan blades and housings before dirt sufficiently accumulates
- Intermittent monitoring of thermostats and cleaning of sensors

Fan Controls

Fans are best controlled by a dedicated fan controller or by an overall barn environmental management controller. Automated controllers, with proper settings selected, with result providing cows with cooling air when they needed it but turn the fans off when they don't. Since the East, especially the Northeast, is subject to significant swings in daytime/night time temperatures, it is important to consider a controller that makes control decisions based on accumulated heat loading a cow may have experienced over a given period of time. Controllers that merely making decisions based on *instantaneous* barn air temperature only will result in cooling fans being turned off before the cows are cooled on many days of the summer. A Time Integrated

Variable (TIV) controller will account for and make control decisions based on the duration of cow heat stress and barn air temperature, and therefore, is a very appropriate control technology for fan cooling. Consider setting the threshold temperature for cooling fans to come on at 65 to 70°F and adjusting to a lower temperature if cows show immediate signs of heat stress – labored/excessive breathing.

If I cannot afford to install all fans, where should I start?

When locating fans at your facility, use the following guideline presented in order of importance when incrementally installing fans:

1. Calving area
2. Close up dry cows
3. Holding area
4. Milking area
5. Fresh cows
6. High producers
7. Low producers

Fans incrementally installed in a lactating cow barn can be located in the following order:

1. Over the inner rows of stalls
2. Over the feed alley
3. Over the outer row of stalls

Return on Investment

Calculating the net return on investment for a heat stress mitigation system is not easily accomplished. Consider some of the effects of heat stress:

- Depresses Appetite
- Slug Feeding - Acidosis, Laminitis
- Decreased Nutrient Absorption
- Reproductive Problems
- Compromised Unborn Calf Growth
- Future Milk Production
- Calving Difficulties

It is difficult to put a complete economic value as a result of the above heat stress effects but that is not to say we cannot give it some consideration. When cows continue to lie down in freestall or tie stalls for during environmentally challenging times as a result of air movement at cow lying level and consequently continue to produce pre-environmental stress levels of milk, we can call this sustained production. Dr. Rick

Grant, President of Miner Institute, has shown that an hour of cow lying time means about 2.5 to 3.5 lbs. of milk per cow for every hour over 10 hours of lying time. So, if the fan cooling system contributes to sustained cow lying time and milk production, we can look at the economic impacts of fan cooling fans from a milk production only perspective.

In really hot weather, fans just blow around hot air, what then?

The best way to cool a cow in the East when it is hot is to use a combination of cooling fans and sprinklers. The role of the sprinkler system is to wet the cow's hair coat down completely to the skin in 2-3 minutes of an overall 10 to 15 minute wetting/drying cycle. The overall governing process is to use cow body heat to evaporate the applied moisture (evaporative cooling) thus reducing her temperature; it takes about 890 Btu's of energy to evaporate one pound of applied water.

Note: the nozzles used should produce large water drops that penetrate the hair coat and soak the skin to be effective. Small water droplets are to be avoided as they settle on the surface of the hair coat impeding heat transfer from the body.

The role of the fans, when used in conjunction with a sprinkler system, is somewhat different than when used for fan cooling cows. In this case, the fans are used to provide fresh and moving air to the hair coat so additional applied water can be evaporated by the cow; air movement increases the evaporation rate. If fresh air is not provided to the hair coat, then the evaporation process will be sufficiently hindered to the point where no additional evaporative cooling will take place. Therefore, a good air exchange – not just circulating air – is required to remove the moisture added to the animal space.

Initiate evaporative cooling at a higher temperature setting (usually 78-80°F) than used for supplemental cooling fans. Water should not be added in any situation where adequate air exchange and airflow around cows are lacking since the benefit achieved will be minimal and excess water will likely be present and cause problems.

In closing, it is important to remember that ***cow cooling fans <u>are not</u> positioned in a barn to provide barn air exchange (ventilation)***. Barns must have an effective natural ventilation system or mechanical ventilation system in order to provide suitable air quality for cows. Barns that lack suitable air quality need to be reviewed to determine the best way to provide requisite air exchange rates.

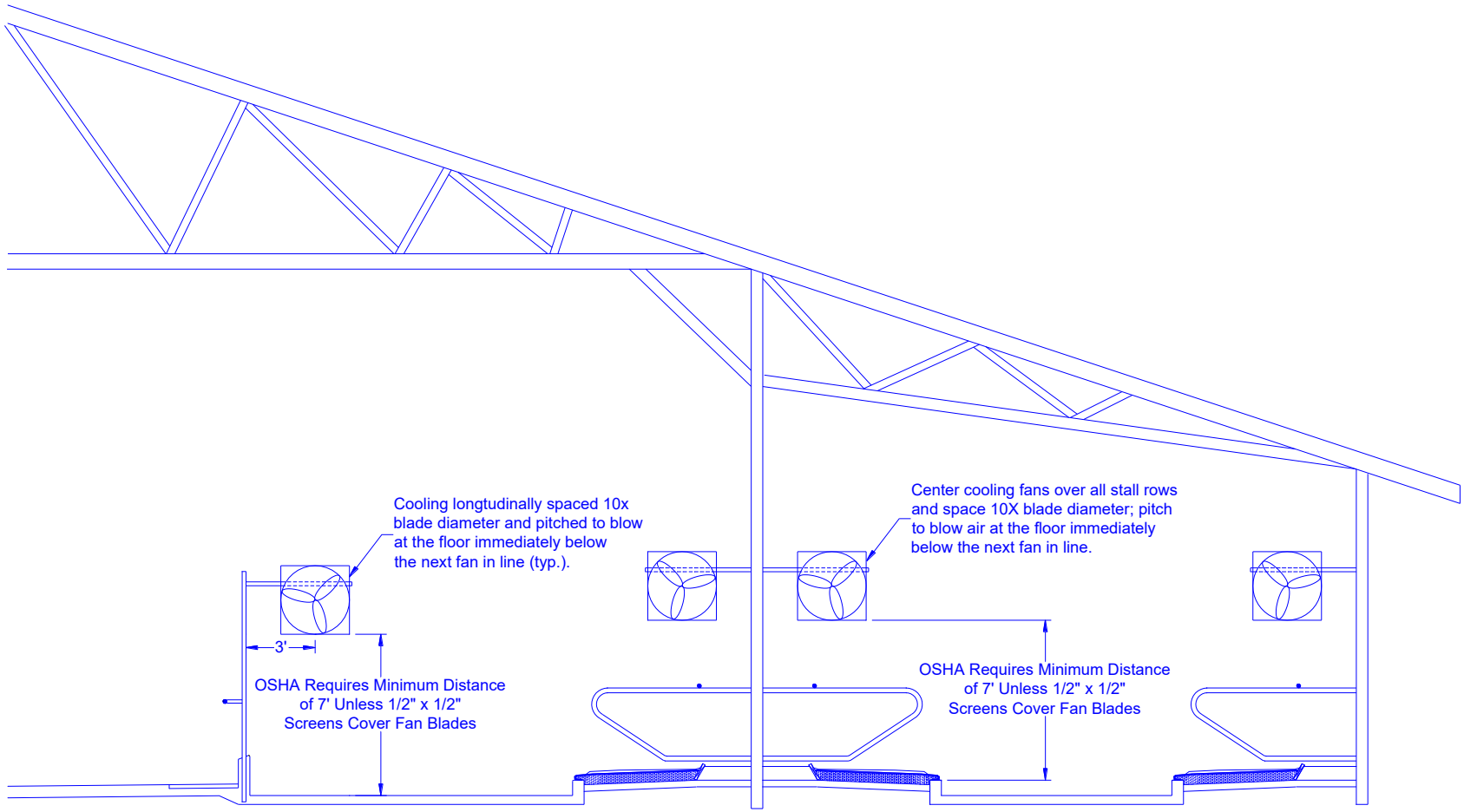

Figure 1. Lateral positioning of cooling fans over feeding cows and lying cows in a freestall barn.

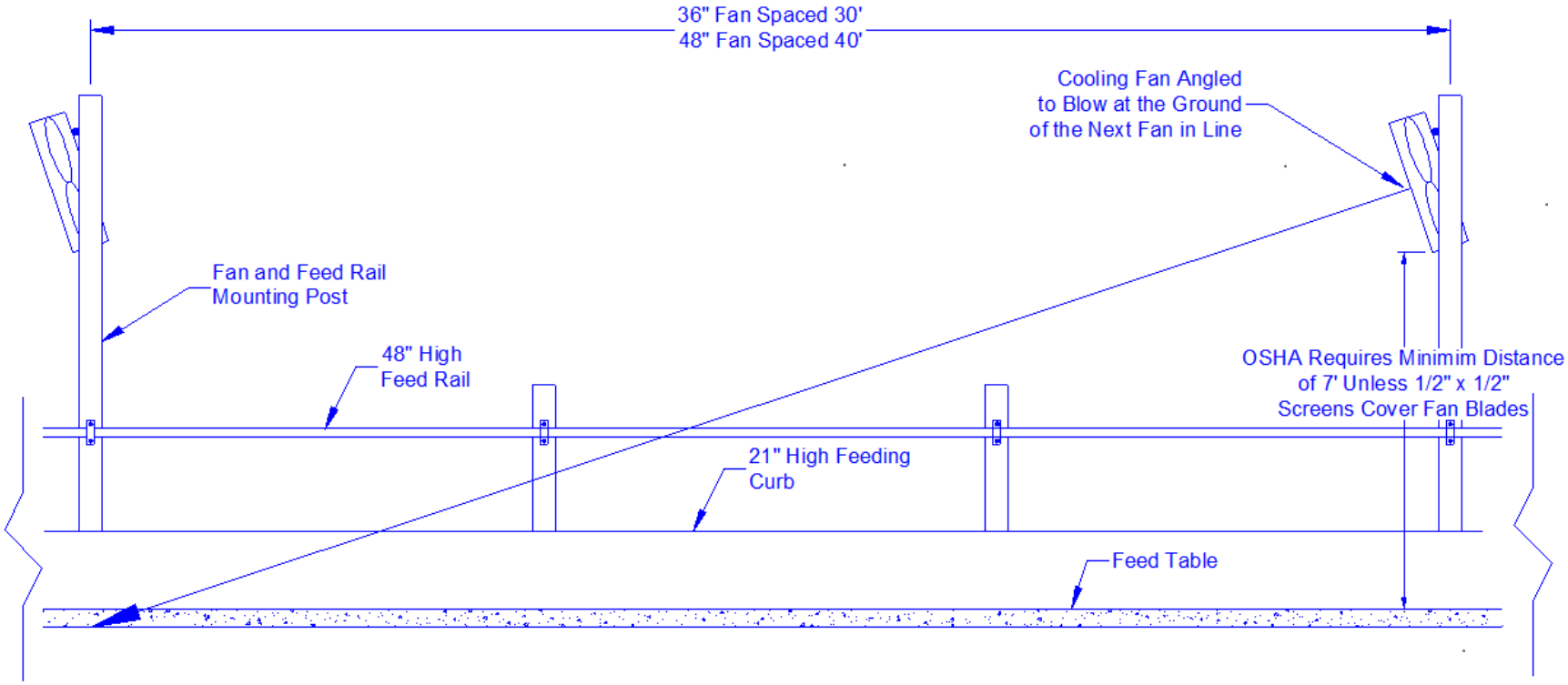

Figure 2. Longitudinal positioning of cooling fans over feeding cows in a freestall barn.