

The Five Key Comfort Zones of the Dairy Cow

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There are five key comfort zones that a cow interacts with on a daily basis. They are the stall area, the barn environment, the feeding area, the flooring and the lighting. This talk will focus on improving cow comfort in each of these five zones.

There was a time when the best way to observe cow behaviour was to pull up a chair and take up residence in the barn, and watch the cows. Then came modern technology, and we could use time-lapse video photography to observe cows going about their routines. This makes a tremendous research and trouble shooting tool, but most of us don't have that luxury when we are called in to solve a problem in a dairy barn. We are usually limited to the snapshot approach. So if we are only given a snapshot of a barn to evaluate, what can we observe in a short period of time that will help us solve a challenge for a producer, or recognize a behaviour before it becomes a challenge.

First of all, cow comfort isn't confined to just the stall area. A great deal of study has been undertaken on the cow's interaction with her bed, bedding, and partition. This is indeed a very important part of the cow's environment, and it is one of what I consider to be the five comfort zones. But, when we are thinking about cow comfort it is also important to observe the cow's interaction with her environment, feed area, flooring, and lighting, which I consider to be the five key comfort zones.

Stall Area

The stall area in a tie stall or a free stall barn is the resting zone, and consists of the cow platform,

made up of a base, bedding and a partition, or divider. My colleagues and I have spent many years arguing about optimum base and bedding combinations, the merits of different divider shapes, and the various dimensions of the stall parameters. We concluded when it came to stall dimensions it really was a game of inches. As over the years we have concluded that an inch or two either way could make the difference of how well a cow used her stall. And over time we also agreed that dimensions and divider types for sand bedded free stalls could be different from those we recommended for stalls with mattress or other synthetic bases (Figure 1, Figure 2, Figure 3).

One of the goals of any dairy is to produce as much high quality milk as possible. We need a clean, dry udder to accomplish this. So one of our goals in the resting area is to provide a clean dry place for a cow's udder, another is to provide the comfort so that a cow will rest 12 to 14 hours per day in a stall to maximize milk production, and the third is to allow her the ability to lie down, and rise and move in and out without the fear of injury.

Base and bedding

The purpose of the base and bedding is to provide a clean dry place for the udder, but also to provide traction and cushioning for the cow. There is no question that sand bedding is ideal in terms of providing superior traction and fewer injuries than stalls with mattresses or other synthetic materials. But for one reason or another, not all producers will use sand, due to availability issues, wear and tear on equipment and maintenance requirements. Increased interest in biogas production from manure may also discourage sand use. But stalls that

have been designed for sand can also be bedded with separated solids from digesters.

There will continue to be a place for cow mattresses, and other synthetic materials. I believe that new materials will continue to be developed that will improve traction durability and cushioning. As of yet we do not have a material that doesn't require bedding. It is important to use adequate bedding with mattresses for absorbency and to reduce friction.

Lunge space

My colleague Dr. Neil Anderson (Anderson, 2007) has done much to improve the plight of the dairy cow in Ontario, and around the world. In his INFOSheets he discusses the merits of 18' platforms for head-to-head configurations of free stalls versus the traditional 16' to provide adequate lunge space, and to avoid cows not using stalls directly across from each other.

If a cow has her choice, she will choose to lunge straight ahead when rising, but if this is not possible a stall partition or divider type must be used to allow her to lunge through the stall. The purpose of the divider is to position cows on the platform in such a way that they keep their bed as clean as possible while not interfering with or injuring the cows beside them. Many different divider designs are available. On mattress or synthetic based stalls it is important to use a divider with a wide loop to allow freedom to lunge through if needed. The superior traction provided by sand bedding allows the use of a narrow loop divider which will position the cow straighter in the stall to keep it cleaner, while still allowing the freedom the cow needs to rise and lie down normally. Sloping the stall down at the back allows cows to turn as they exit the stalls without interference.

Neck rail

The neck rail should be positioned to allow the cow the freedom of standing with all four feet in the stall, but far enough back, so if she manures, it will fall into the scrape alley.

Brisket locator

Similar to the neck rail, the brisket locator positions the cow when she is lying down so that she lies on the platform completely in the stall, but again if she manures, it will be in the alley and not in the stall bed.

Traditional sloped brisket boards reduce stall use (Tucker et al., 2006). The rounded poly brisket locators are more desirable than the sloped boards, as they do not interfere with the cow's lunging motion, or her ability to stretch her neck or head to the front, or even to stretch her legs to the front.

Brisket locators are not generally used or needed in sand bedded free stalls as they are difficult to fasten and can become obstacles as the sand level changes.

Maintenance

Whatever the base and bedding used, regular maintenance is required. Cows will do a certain amount of their own house cleaning in sand bedded free stalls, as they will kick sand out of the rear of the stall as they get up and lie down. However, it is still important to rake any manure out from the rear of the stall and to level the stall to maintain the correct dimensions within reason. If sand bedded free stalls are not bedded often enough, cows end up in a hollow in front of the rear curb. This results in a reduced platform length for lunging and can trap moisture. If stalls are only filled occasionally with a great mound of sand, the cow will be pushed back on the platform.

Stalls with mattresses should also be cleaned on a regular basis to maintain a good mat of bedding beneath the cow for absorbency and to reduce friction.

Behaviour to observe

When you enter a barn, always try to observe the cows before they become aware of your presence. This may be easier said than done, but you want to try to get that snapshot of how the cows are behaving in their current environment. Try to observe:

1. The cow's use of the stall
 - Is the stall empty?
 - Is the cow standing with two feet in the stall (perching)?
 - Is the cow standing with all four feet in the stall?
 - Is the cow lying in the stall?
 - Is the cow lying in the alley?
2. The cow's position in the stall while lying
 - Is the cow lying straight?
 - Is she lying on a diagonal?
 - Are her feet outstretched?
 - Is she curled up?
 - Is she intruding in the space in the next stall?
3. The condition of the cow in terms of injuries
 - What is the condition of her hocks?
 - Is there hair loss?
 - Are there any swollen joints?
 - Does she appear lame?
4. The condition of the cow in terms of cleanliness
 - Are her feet dirty?
 - Are her legs dirty?
 - Are her flanks dirty?
 - Is her udder dirty?
5. Cows lying down or rising
 - Does she lunge straight ahead, or to the side?
 - Are there obstructions she encounters?
 - Does she bang herself abruptly?

Options to consider

Stall use is a function of stall dimensions, obstructions in the stall area, and lack of bedding. Neil Anderson (2007) in his three INFOSheets on tie stall and free stall dimensions, and cow behaviour describes the various problems and solutions.

Environment

The cow's environment or breathing zone is another important area for determining the comfort of a cow. Temperature, humidity and air quality all have an effect on a cow's health, milk production, and reproduction. These parameters are controlled through the ventilation system of the barn, but the environment may be further modified with sprinkler, misting or other air conditioning systems.

During cold weather the goal is to provide enough ventilation to control moisture in the barn. Cows respire moisture; moisture is given off from manure and urine in the cow alleys or gutters, or from water spilled around drinkers. A minimum amount of ventilation is necessary to remove the moisture to keep the humidity level under control. A dairy cow would rather be cold and dry than warm and damp.

In producing milk cows generate a lot of heat. Most dairies rely on natural ventilation to remove heat, but it may be necessary to provide supplemental ventilation to cool cows during periods of heat stress. Additional cooling can be provided through sprinkler systems.

Air quality is also very important in terms of providing an environment free from harmful or irritating gases. Generally when we provide enough ventilation to control heat and moisture we will also be removing gases and replacing them with fresh air.

The ideal ambient temperature for a dairy cow is between 5°C to 25°C (40°F to 77°F). At temperatures above 25°C (77°F) cows show signs of heat stress as they have to use energy to cool themselves. Their primary means of cooling is by heat loss through surface skin and the respiratory tract. As the ambient temperature and humidity increase, it becomes more difficult for a cow to cool herself. Cows that suffer from heat stress have reduced feed intake and consequently milk production. High producing cows are especially susceptible to heat stress. Pregnancy rates are also

affected by heat stress. They decrease sharply when the air temperature exceeds 30°C (86°F).

Heat loss from a cow occurs primarily by conduction and convection, as well as by evaporation. As the temperature rises, it becomes increasingly difficult for a cow to dissipate heat. Rising relative humidity also affects a cow's ability to lose heat via evaporation. Since heat loss depends both on temperature and relative humidity, a temperature-humidity index (THI) has been developed to indicate the amount of heat stress a cow is subject to.

Although there is some variation in the numbers that researchers use, generally a cow subject to a THI:

< 72	experiences little heat stress
72 to 79	mild heat stress
80 to 89	medium heat stress
> 90	severe heat stress

Options to cool cows

There are four primary ways for cows to dissipate heat: conduction, convection, radiation, and evaporation. Heat conduction is the transfer of heat between two bodies at different temperatures in contact. Convection includes heat loss between two objects, one of which is moving, such as exposure to wind or currents of water. Heat dissipation by radiation involves the exchange of thermal energy by electromagnetic waves. The final means that a cow uses to dissipate heat is through evaporation. This is when heat is given off as water changes from a liquid to a vapour.

The most effective ways for improving heat dissipation for dairy cows is to increase the convective heat transfer rate by increasing the air speed over the cow, and to increase the evaporative cooling rate by wetting the cow, or the air around the cow.

Most free stall dairy barns are naturally ventilated, and will remain reasonably cool and fresh as long

as there is adequate wind blowing to provide air movement. But often during hot muggy weather there is not enough wind blowing to produce adequate air flow through the barn to keep it fresh and cool. The solution, then, is to speed up the air flowing over the cows using supplemental cooling fans.

Panel or basket fans

Panel or basket fans are usually selected for cooling. Typically, these fans are 24 to 48 inches in diameter and provide low volumes of air but at a high speed (LVHS). Fans from a reputable supplier effectively maintain airflow a distance of 10 times the fan diameter. Therefore, install fans 10 times the fan diameter apart:

- 2' dia fans – 20' apart
- 3' dia fans – 30' apart
- 4' dia fans – 40' apart

Fans should also be selected on the basis of their capacity, and the air velocity they produce. Select fans that will provide:

- At least 500 cfm per cow up to 1000 cfm per cow
- Air velocities should be in the range of 220 to 500 fpm (2.5 to 5.5 mph)

Mount the fans high enough to provide clearance for any equipment used in the alleys, and mount them with about 8 ft. clearance above the free stalls to keep the cows from damaging them. Fans should be placed to blow air in the direction of the prevailing winds, and spaced 10 times their diameter apart. Fans should be tilted downwards to aim their airflow at a point directly below the next fan in line (Figure 4). In holding areas or when blowing across the width of the barn, install fans 8–12' apart and use 18" to 24" fans.

Big ceiling fans

A recent alternative to the panel fan for extra hot weather ventilation has been the high volume, low

speed (HVLS) ceiling fan. Typically 20' to 24' diameter fans are installed 60' apart down the centre of a free stall barn. Fans run at approximately 50 rpm, and will move about 150,000 cfm of air.

Dave Kammel (Kammel et al. 2003) an agricultural engineer from Wisconsin studied installations of HVLS fans on five different farms including a 3 row, a 4 row, and a 6 row free stall barn. Air speeds were monitored using a digital anemometer in a grid pattern throughout the barns. The air speed profiles were then mapped for each of the barns, similar to Figure 5.

A four row head to head barn was studied in detail. This barn used 20 ft diameter fans spaced 60 ft apart. From this barn and the others studied he concluded that the following air velocities existed:

- over 100 fpm: over most of the barn
- 200-299 fpm: over the feed alley in a 4 or 6 row barn
- 100-199 fpm: over the interior row of free stall platforms for a 4 or 6 row
- less than 100 fpm: over the outside row of free stall platforms in a 6 row barn

The average energy use was measured to be 14.5 kWh per fan per day.

Another study in California (Schultz and Williams, 2002) compared HVLS fans with Low Volume High Speed Fans (LVHS) or panel fans. They concluded:

- both types of fans were better than no fans at all
- in some cases the cows produced more milk with the LVHS, and in others they produced more milk with the HVLS
- power use was much less with the HVLS fans

Both the California and Wisconsin studies concluded:

- High Volume Low Speed (HVLS) fans reduced heat stress in dairy cattle
- HVLS fans used less energy than the LVHS fans
- HVLS fans were much quieter
- Spacing the fans 60 ft apart seemed to work well for 20 ft or 24 ft diameter fans.

Tunnel ventilation

Tunnel ventilation (Figure 6) systems first became popular in poultry broiler barns as a means of reducing heat stress. With a tunnel ventilation system large fans (usually 48" dia. or greater) are used to move air through a barn at an air speed fast enough to provide convective cooling of the livestock or poultry. Air enters the barn at one end, and then is exhausted at the other. Since the air speed depends on the cross section of the barn, long, narrow barns tunnel ventilate most efficiently.

General recommendations

The following are general recommendations for tunnel ventilation in tie stall barns:

1. Air Speed: 200 to 500 feet per minute (fpm)
2. Air Exchange: 500 to 1000 cubic feet per minute (cfm) per cow; < 1 air change per minute
3. Air Inlet Air Speed: < 500 fpm

Fan capacity

The formula $Q = VA$ can be used to calculate ventilation requirements at different air flow rates. Where Q = Quantity of air (cfm); V = Air Speed (fpm); A = Area of building (ft²).

Inlet size

Inlet size (based on inlet air speed of < 500 fpm):

$A = Q/V = \text{fan capacity cfm} / 500 \text{ fpm} = \text{area of inlet in ft}^2$

Operation of tunnel fans

- Fans should be controlled with a thermostat, but they should also have on/off switches for emergency shut-off
- Operation of fans should start at 24°C (75°F)
- All fans should be running when the barn temperature reaches 27°C (80°F)
- Thermostats should be set to turn fans on at every 1°C interval (1 to 2 °F)
- As fans turn on they should no more than double the previous airflow
- Some tunnel ventilation fans are available with two speed motors. This would allow for some cooler weather operation. This may help with air distribution in the barn during cold weather.
- During cold weather when the fans are not operating it will be necessary to cover them with insulated panels to minimize heat loss and air leakage
- Fans can be located in the hay mow if necessary, and then boxed down into the stable area.
- It is important that the box does not restrict air flow
- Locating the fans in the mow will reduce the noise level in the stable area

Tunnel ventilation can also be used in free stall barns, but free stall barns require lots of fan power because of their large cross sectional area and interior volume (Figure 7).

Fan capacity is directly proportional to the cross section of the barn. If the cross section can be reduced, fewer fans will be required to provide the desired air speed. Producers have achieved some success by hanging curtains from the ceiling to reduce the cross section. Curtains should be no more than 40 ft apart.

In theory, all wall openings should be closed between the exhaust fans at one end of the barn and the end wall openings at the other. In practice

opening the curtain slightly (about 2 inches) from the bottom provides some fresh air along outside rows of stalls.

Sprinkler systems

Using sprinkler systems with fans is the next step to provide additional cooling if needed. The sprinklers create droplets that wet the cow's hair coat to the skin. Fans force air over the cow's body causing evaporative cooling to take place on the skin and hair coat. Heat from the cow's body causes the moisture to evaporate. The droplet size should be large enough to wet the skin surface and must be applied intermittently to allow time for the moisture to evaporate from the skin.

A sprinkler system uses components that are fairly simple, readily available, and easily maintained. A system should

- Use a timer to run sprinklers 1 to 3 minutes on per 15 to 30 minute cycle
- Provide enough water to soak the skin but not wet the udders
- Turn sprinklers off for a period to allow for evaporation
- Use low pressure (20 to 40 psi) nozzles
- Use solid-cone coarse droplet spray nozzles with flow rates between 0.2 and 0.5 USgpm
- Use 180° nozzles (half circle) along feed bunk
- Use 360° nozzles (full circle) over holding area
- Start system at temperatures over 25 to 27 °C (78 to 80 °F)
- Harner et al. (2007) recommends a soaking frequency of:
 - 21-27 °C (70-80 °F) Every 15 minutes
 - 27-32 °C (81-90 °F) Every 10 minutes
 - >32 °C (>90 °F) Every 5 minutes

Fans should run continuously when the sprinklers are on. If water is being blown on the feed or on the stalls, the droplet size is too small or the fans need to be repositioned.

Fogging systems

Fogging systems are equally as effective in cooling the cows. Fogging systems use high pressure nozzles (200 psi) to inject moisture directly into the air stream. The nozzles are usually installed in a ring directly in front of the fan. Fogging systems cool the air around the cows without wetting the cows or the surroundings directly. The amount of cooling achieved depends on the air temperature, relative humidity, and the amount of moisture evaporated.

Behaviour to observe

1. Air quality
 - Does the air feel heavy or humid?
 - Does it feel stale with little to no air movement?
 - Is there a noticeable smell of ammonia or other gases?
2. Cows panting
 - Are cows panting or showing other signs of heat stress?
3. Cows bunching
 - Cows may bunch where they feel air movement
 - They may also bunch where there is no air movement
 - They may also bunch to get out of direct sunlight
4. Cows clustered around waterers
 - Cows may splash water to try to cool themselves
 - They may lie around waterers if water has been spilled
5. Response to sunlight
 - Cows will avoid direct sunlight during hot weather
 - Generally in the northeast we orientate our barns north south to be perpendicular to prevailing winds, but in the southwest they will orientate their barns east west to avoid sun penetration into the barn

- A four row head-to-head layout will keep direct sunlight out of the stall area

Options to consider

Most of the behaviour we have discussed today is related to heat stress. Follow a three step process to reduce heat stress in free stall barns. First of all, ensure that the natural ventilation system is working as well as it can be. Reduce any barriers to natural air flow around buildings. Check the wall design. Some screening used to keep birds out can greatly reduce the air flow.

Second, provide adequate water space and volume. Water consumption increases as temperature increases. Therefore, it is important to have the water where the cows need it, and have an unrestricted supply when they need it.

Third, supply supplemental cooling in the form of fans over the cows, and sprinkler systems when necessary. When natural ventilation alone can no longer look after the heat load, one option is to install supplemental fans. Fans over the cows can increase their convective cooling rate significantly. If heat stress is still a problem, sprinkler or fogging systems can be used to increase the evaporative cooling rate.

Feed Area

Comfort in the feed zone is necessary to maximize feed intake. It is surprising how many nutritional problems are actually cow comfort problems resulting from the cow's interaction with restrictions, obstructions or poor quality surfaces in the feed zone.

Our goal in the feed zone is to provide unrestricted access to feed for as long as possible. We don't want cows standing in the alleys, so we have to control their access to feed without restricting this. Access has a lot to do with the type of feed barrier we use, and again, the dimensions that position it. The cow also needs a clean, durable, smooth surface to eat from. Old pitted concrete that harbours bacteria is not a very appetizing surface to eat from.

The other aspect of the feed zone is to have sufficient space for all cows to eat at once, or if that is not possible, as in a three row or six row barn, to keep the feed pushed up so that there is feed there when the cow chooses to eat. Pushing feed up also seems to stimulate the cow eating.

Unrestricted comfortable access to water is also very important. As well, the water needs to be clean and available in the quantity that cows need to be able to drink as much as possible when they want to.

Cows should have unrestricted access to feed and water, both in quality and quantity, and when they want it. It has been determined that raising the feeding surface about 4" to 6" above where the cow is standing (Figure 8) puts the cow at a more natural feeding position and increases the amount of saliva that the cow produces.

The feed manger surface should be smooth, hard and durable to resist pitting from acidic feeds. At one time, it was common to install ceramic tile in the manger for durability. Now high strength concrete is often used. High Silica Fume (HSF) concrete is very hard and durable, and also very expensive. Many producers save costs by pouring regular strength concrete up to the feed barrier, but only to about half the thickness in the 3' to 4' next to the feed barrier. They then come along and pour the HSF concrete on top and finish it all together. This results in a layer of high strength, durable concrete where the cow eats.

A pipe located about 48" above where the cow is standing makes an excellent feed barrier. This pipe should be mounted on the post away from the cows and possibly use a spacer to move it 6" to 8" beyond where the cow is standing. This provides a bit of extra reach without allowing the cow too much room to walk into the feed manger.

Providing rubber matting next to the feed manger to encourage improved feed intake is becoming more common. Cows are more comfortable on rubber and will stand longer (Telezhenko et al.,

2007, Tucker et al., 2006), but the economic benefits are still not clear.

Behaviour to observe

1. Do cows have bumps on their necks?
2. Do cows have swollen knees?
3. Are the mangers pitted and black with rotting feed?

Options to consider

Bumps on the necks of cows can often be an indication that the neck rail is too low, or that the cow is straining to reach feed. Swollen knees can again be a sign that the cows are reaching for feed or they could be related to injuries in other parts of the barn. Pitted mangers need to be resurfaced to provide a hard, durable eating surface.

Flooring

When a cow isn't eating, resting or being milked, she is standing or travelling around the barn. We need to provide good traction so that she can move without slipping and injuring herself, and display normal heats. And we need to consider the merits of providing additional comfort, especially at the feed manger, in the holding area and in the parlour.

Our goal with the flooring is to provide sufficient traction without being too aggressive, and to provide cushioning where cows will be standing for extended periods of time.

Floor surfaces need to have a finish with enough texture to provide traction for the cow as she walks, but smooth enough to clean properly. In some cases, the floors have been so smooth that the cows are slipping and injuring themselves and in other cases the floors have been so rough that they are developing foot and leg problems. There is a fine balance between traction and cleanability.

Concrete

Alley floors need to be strong and durable to resist manure acids and repeated cleaning. Start by us-

ing a minimum of 25 MPa concrete with 6% air entrainment. Air entrainment is a concrete additive that makes the concrete more durable.

Floor finishes

A good floor finish combines surface texture and grooves to provide traction. There are two primary ways of providing this combination. One way is to finish the concrete and form grooves in the surface while it is still wet. The other is to cut grooves in the floor after it has cured.

The surface of the concrete should be finished with a texture. A stiff broom can be used to produce a “broom” finish. Another way is to use an “expanded metal” roller to imprint the surface. These rollers are used when finishing concrete to push the surface stones down, but they can also be used to imprint the surface.

Wet grooving

In addition to the texture on the surface, the concrete should be grooved to complete the surface finish. Grooves can be floated into the concrete when finishing. A float can be made from a 2” x 6” covered with galvanized sheet metal with ½” copper pipe wrapped around it to produce the grooves (Fig. 9). Grooves are usually ⅜” to ½” deep by ⅜” to ½” wide, spaced 4” to 8” apart. Grooving in a diagonal pattern provides maximum traction for the cow. Research indicates that a groove spacing of 3” to 4” on centre improves traction. This closer groove spacing may be justified in critical areas, like the parlour holding area.

It is an art to form the grooves in the wet concrete. If they are formed when the concrete is too wet, the grooves will not hold their shape. If the concrete becomes too dry, it will be difficult to form the grooves, and the surface finish may be harmed.

It may be necessary to remove the initial roughness of freshly poured concrete floors that have been wet-grooved. One method is to drag several concrete blocks behind an “all terrain vehicle” until the sharp edges are worn off the concrete

(Fig. 3). Another method is to use a steel scraper on the surface. Either method will remove sharp edges, and help “age” the floor surface and reduce the chance of causing sore feet.

Cutting grooves

The other method of finishing the floor, is to texture it as before, and then after the concrete has cured, cut the grooves into the floor (Figure 10). It is easier to obtain more consistent results with this method.

Surface treatment

Cows may also experience problems if they are put on concrete before it is finished curing. High surface alkalinity may irritate the skin of the feet, causing pain and possibly making cattle more susceptible to foot infection. To avoid this problem, allow the concrete to cure properly for 28 days. After this time the concrete is almost totally cured. Hydration, the chemical reaction that takes place during curing, will have slowed down. The concrete can be washed off and cattle can be put on it with little or no effect on their feet. If cows have to be put on before 28 days, allow the concrete to cure for at least 7 days, then wash it with a solution of 40 parts of water to 1 part of Muriatic acid. The acid will neutralize the alkalinity of the floor. The floor should then be thoroughly washed with water to remove the residue.

Some producers have found that spraying the concrete surfaces with linseed oil helps to seal the surface, and prevent foot injuries. A 50:50 mixture of boiled linseed oil and diesel fuel can be used for this purpose.

Slats

If slats are to be used in the new barn, choose a slat that offers a good non slip surface. Smoother slats clean better, but it is important to have adequate traction.

Manure equipment

Manure removal equipment should not polish the concrete floor. In a free stall barn, using a rubber

tire scraper, or adding a piece of durable rubber to the bottom of the scraper blade, will protect the floor finish.

Treating worn floors

Concrete floors can become too smooth from repeated scraping for manure removal. Traction on slippery floors can be improved by saw cutting grooves into the floor in a diagonal pattern similar to a new floor. Another method is to grind or mill small grooves into the entire surface. Figure 11 shows a surface that was previously grooved, but has been milled to improve the surface traction.

Sand bedding & effect on flooring

Cows “kick” sand out of the stalls into the alleyways when getting up and down in the stalls. The sand that ends up in the alley improves cow traction on the floor. This works well unless the barn layout results in an alley without stalls exiting onto it. These alleys won’t have the same amount of sand on them, and consequently, cows will slip on them more than other alleys in the same barn with more sand on them.

Rubber surfaces for flooring

Rubber or similar products are increasingly being used on alley floors to provide a softer surface than concrete for the cow to stand on. It is hoped that cows will spend more time at the feed manger standing on rubber, in comparison to time spent on a concrete surface. Cows definitely show a preference for standing or walking on the rubber surfaces. Research is just starting to come out showing the benefits of rubber flooring (Telezhenko et al., 2007). The economic benefits of rubber at the feed manger or in the walk alleys is still not clear.

It is important to use a material that is not too slippery. Some materials can be grooved to improve traction. It is also important to have the material fastened down properly so that manure removal equipment will not catch on it. Finally, hoof care is of greater concern on floors with all, or some, rubber. Hooves will not wear the same

as on concrete. Cows may require more frequent foot trimming.

Hoof management

It is important to consider the condition of the cows’ hooves before they are put in a new barn. Cows should not be trimmed prior to being moved to a facility with new concrete. Their feet will be too tender and injuries will occur. If feet need to be trimmed, make sure there is adequate time for them to toughen up before they are moved to the new barn.

Behaviour to observe

1. Do cows slip and slide?
 - Cows slipping and sliding, especially when they are spooked or in heat, is an indication of slippery floors
2. Do cows show caudal licking
 - Caudal licking, on the other hand, is an indication that the cow is quite comfortable with her footing
3. Are regular heats not being observed?
 - Cows not showing normal heats can again be an indication that the cows are just finding the floor too slick to exhibit normal behaviour
4. Do cows walk very tentatively?
 - This may be an indication that the floor is too slippery
 - If there are slatted areas and the slats wobble, this will frighten the cows
 - Cows may be lame from floors that are too rough

Options to consider

Floor finishes are important for cow comfort and safe movement. Alley floors need to be strong and durable, while providing good traction for cows. Surface texture and grooving can be used on concrete and rubber products to provide the traction necessary to keep cows from slipping and injuring themselves. Floors that are too slippery from repeated cleaning can be grooved or have the

surface milled to improve traction. Make sure that cows can move confidently on your floors.

Lighting

What role does lighting play in cow comfort? A certain quantity of lighting is necessary for cow management. Research has also shown that we can increase milk production by manipulating light levels in the milking barn. But are there more subtle things that will affect a cow's behaviour?

Our goal with lighting is to provide sufficient lighting for good cow management which indirectly affects the comfort of the cow (Figure 12). Table 1 gives recommended illumination levels for dairy barns for improved worker operator efficiency, comfort and safety.

We can also manipulate light levels to increase milk production. Research has shown that milk production can be increased by regulating the dairy cow's exposure to light. Milking cows exposed to 16 to 18 hours of light followed by 6 to 8 hours of darkness have consistently shown milk yield increases of 8 to 10%. A well lit barn also improves operator efficiency, comfort and safety. Dan McFarland dealt with this topic in his workshop on "Long-Day Lighting Systems for Dairy Cows."

We need to be sensitive to other more subtle things like shadows, or light and dark areas, or obstructed vision to improve cow movement. Dairy producers can learn much from their beef producer counterparts when it comes to handling and moving cattle. Dr. Temple Grandin is one of the world leaders when it comes to animal behaviour and movement, and handling. She offers practical information on her website such as these tips on identifying common distractions which affect animal movement:

1. Sparkling reflections on puddles
2. Reflections on smooth metal
3. Chains that jiggle
4. Metal clanging or banging

5. High pitched noise
6. Air hissing - should be silenced with mufflers or piped outside
7. Air drafts blowing towards approaching animals
8. Clothing hung on the fence
9. Piece of plastic that is moving
10. Fan blade movement
11. Seeing people moving up ahead
12. Small object on the floor - such as a coffee cup
13. Changes in flooring and texture
14. Drain grate on the floor
15. Sudden changes in the color of equipment. Colors with high contrast are the worst.
16. Race entrance is too dark. Animals will move from a darker place to a brighter place.
17. Bright light such as blinding sun. Animals will move from a darker place to a brighter place, but they will not move toward blinding light.
18. Animals may balk at one-way and back-up gates. Install them two to three body lengths away from the crowd pen. Equip one-way gates with a remote controlled rope so that they can be held open when the single file race is filled.

Many of these tips can be applied to cow movement through traffic lanes and sort facilities. Another big distraction to cows is shadows, so it is important when you come up with a lighting plan based on timing and intensity that it considers uniform placement of lights to avoid shadows.

Behaviour to observe

1. Are cows fearful in approaching certain areas of the barn?
2. Do cows balk when they pass through handling facilities?

Options to consider

Look for distractions to cow movement in traffic lanes and handling facilities. Look for shadows or bright light that may cause cows to balk or be spooked.

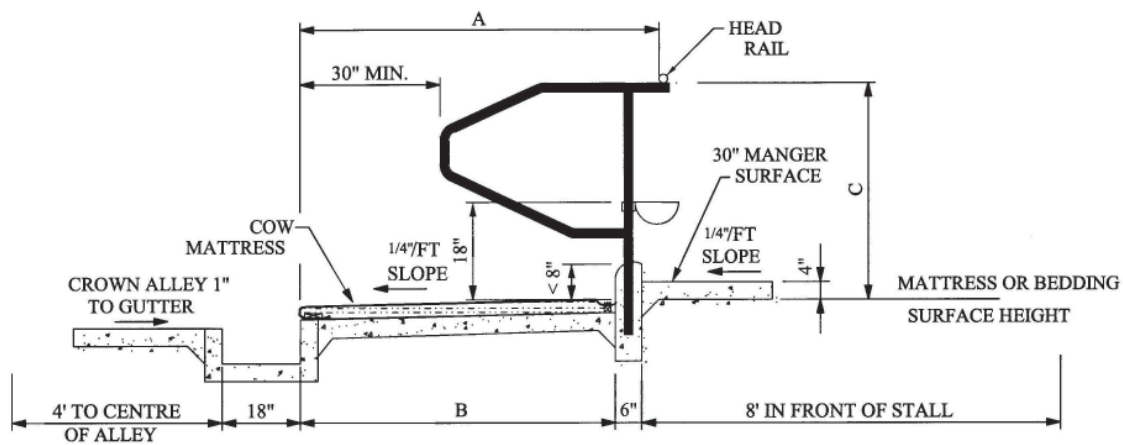
Summary

There are five key comfort zones that a cow interacts with on a daily basis. They are the stall area, the barn environment, the feeding area, the flooring, and the lighting. This talk will focus on comfort indicators in each of these five zones, and how to optimize the comfort of the dairy cow in each.

We have discussed five key comfort zones that cows interact with on a daily basis, but the list does not stop here. There are many other things such as barn layout, manure removal system, etc. that have an indirect effect on cow comfort. It is important for the dairy producer, and those of us giving advice, that “cow comfort” becomes a “mindset” where we consider the well being of the cow in all aspects of her environment and our interaction with her. Small changes can make big improvements.

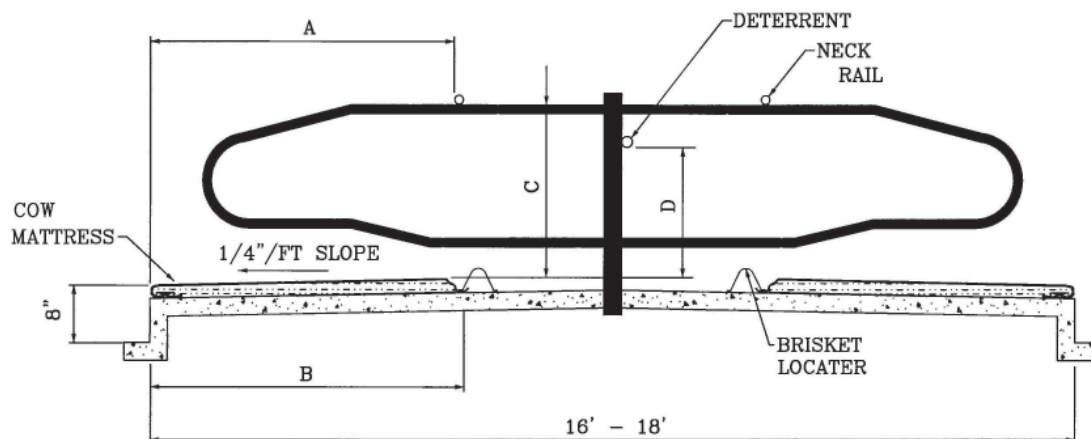
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	DIMENSIONS (IN)				
Holstein Cows	A	B	C	WIDTH	CHAIN LENGTH
First Lactation	84	70	46	54	C - 8
Milking	86	72	48	54	C - 8
Dry Cow	86	72	48	60	C - 8

Figure 1. Dimensions for Tie Stall Partition

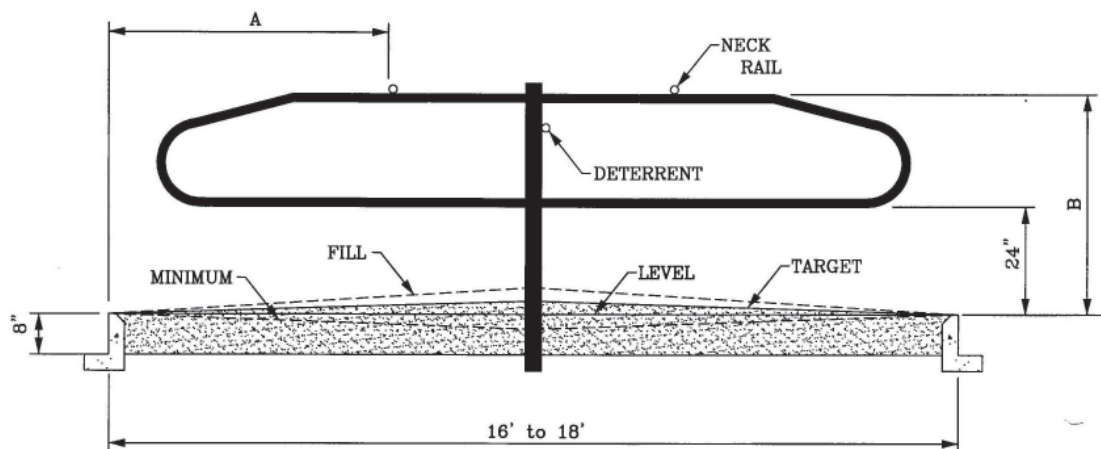


Holstein Cows	A	B	C	Width	Weight	Rump	Hook Bone Width
First Lactation	68"	70"	48"	48"	1450 lbs	58"	22"-24"
Milking Cows	70"	72"	50"	52"	1650 lbs	60"	24"-26"
Dry Cows	70"	72"	50"	54"	1700 lbs	60"	24"-26"

Note: D = 40" for 8' Stall

D = 34" for 9' Stall

Figure 2. Dimensions for Head to Head Free Stall Partition with Mattresses



Holsteins	A	B	Min. Width
First Lactation	68"	46"	46"
Milking Cows	70"	48"	48"
Dry Cows	70"	48"	50"

Sand Bedding Levels
 Target = 2" to 3" above level
 Minimum = 3" below level
 Fill = 6" above level

Note: DETERRENT: 43" above level for 16' stall platform
 37" above level for 18' stall platform

Figure 3. Dimensions for Free Stall Head-to-Head Partition with Sand Bedding

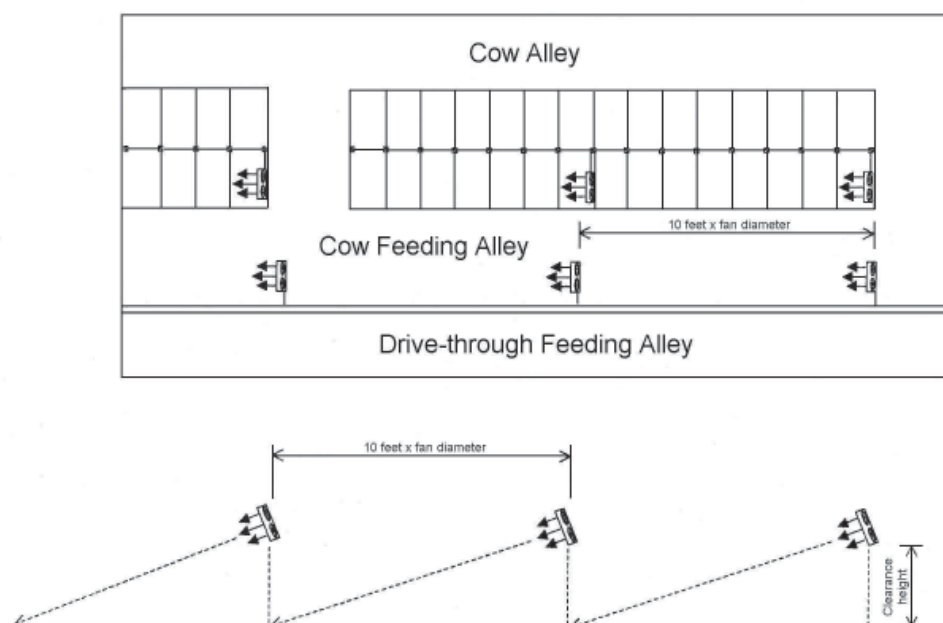


Figure 4. Placement of Panel or Basket Fans in a Free Stall Barn (Stowell, 2000)

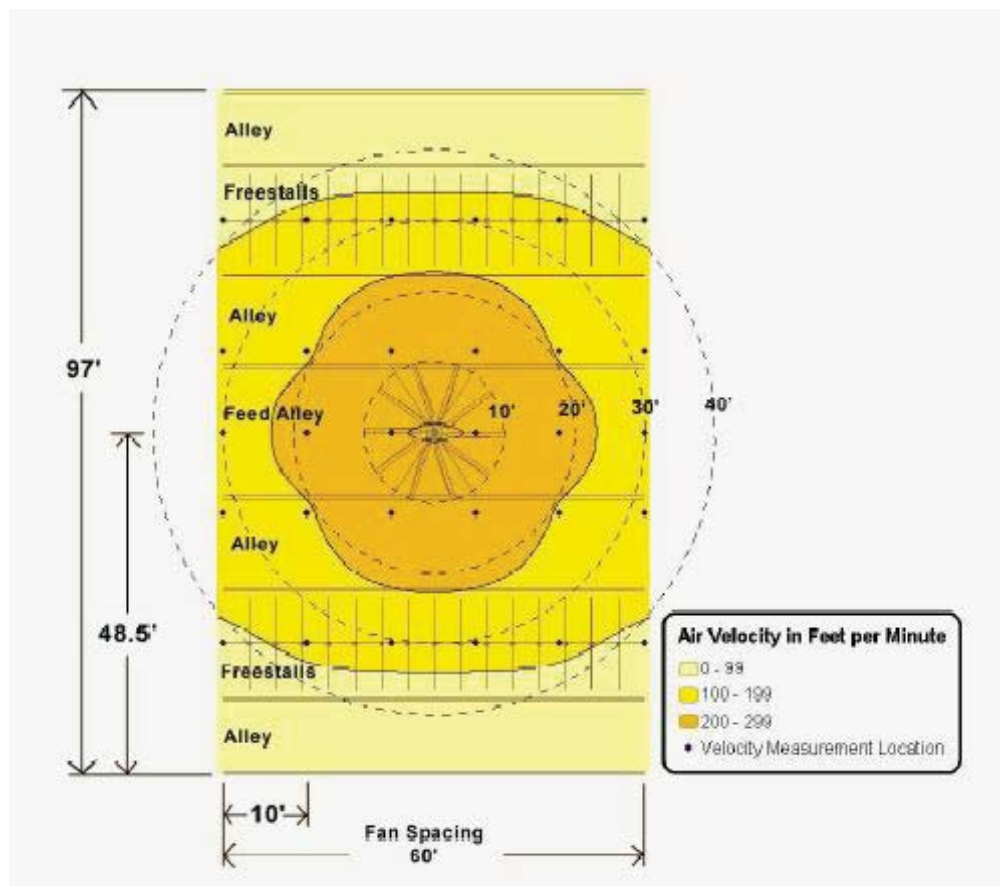


Figure 5. Composite Velocity pattern of a 20' HVLS Fan mounted at 16' with a 60' spacing



Figure 6. Tunnel ventilation in a tie stall barn



Figure 7. Tunnel ventilation in free stall barns requires lots of fan power

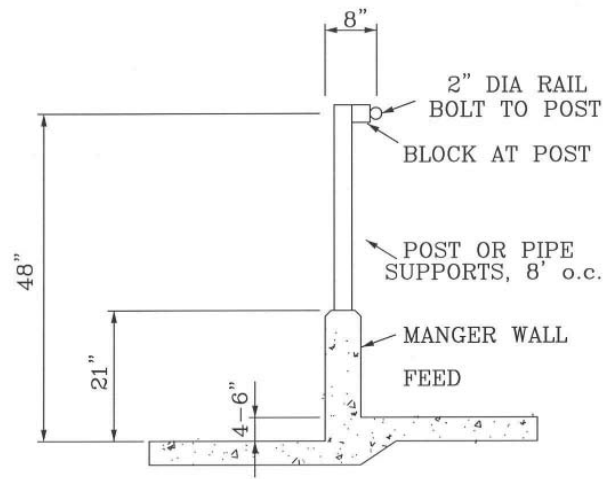


Figure 8. Post and Rail Feed Barrier



Figure 9. Wet grooving



Figure 11. Surface milling to improve traction



Figure 10. Grooves cut in finished concrete



Figure 12. A well lit barn improves efficiency, comfort and safety

Table 1 Recommended Illumination Levels for Dairy Barns
(ASAE Standards, 1993)

Work Area or Task	Illumination Level	
	fc	lux
Parlour: General Lighting	20	215
Operator's Pit	50	538
Holding Area	10	108
Milk Room: General Lighting	20	215
Washing Area	100	1,076
Bulk Tank Interior	100	1,076
Loading Platform	20	215
Utility or Equipment Room	20	215
Office: General Lighting	50	538
Supplemental Task Lighting	70-100	753-1,076
Toilet	20	215
Treatment and Maternity Area		
General Lighting	10	108
Treatment or Surgery	100	1,076
Tie Stall Barn: Manger Alley	10	108
Milking Alley	25-30	270-324
Free Stall Barn: Feed Alley	20	215
Free Stall Area	10	108