FREESTALL BARN DESIGN AND MANAGEMENT FOR COW COMFORT

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Summary

Proper design, construction, and care of freestalls are essential to cows using the stalls and realizing their potential benefits for comfort and health. Freestall dimensions depend upon particular designs and are compromises between ensuring optimum cleanliness and providing a spacious area for the ultimate in cow comfort. Freestalls designed to meet these fundamental needs will be most used. Most likely, no perfect freestall design exists. Rather, several freestall designs may satisfy the basic requirements of the cow perfectly well!

(Key Words: Freestall, Cow Comfort, Bedding.)

Introduction

A freestall is an integral component of a complex system that can be used to enhance profitability on a dairy farm. The freestall itself is a system made up of individual parts that function together to become a vital element of the cow's environment. Therefore, understanding relationships between the cow and the freestall as well as the interactions among individual freestall components is important to design.

Basis for Freestall Design

Cleanliness and comfort are two basic prerequisites that must be satisfied in freestall design and construction. Cleanliness relates to clean, dry conditions, especially the stall bed in the vicinity of the udder. Comfort means a comfortable bed and roomy dimensions to accommodate the cow's ability to move easily in and out of the stall and allow her to lie comfortably therein.

In simplest terms, the main purpose of a freestall is to reduce exposure of the teat ends to mastitis-causing organisms. So every effort is made to provide a clean, dry place for the udder on the freestall bed. Then we expect the cow to choose a freestall for a place to lie down. An effective freestall must be sufficiently appealing to a cow to cause her to choose to lie in a stall 10 to 14 hr per day.

A freestall should enable a cow to rise and lie down naturally (See Figures 1 and 2 for illustrations of the rising movements of a cow). A 1400-lb cow requires 66 inches for body space and about 18 inches for head space. This adds up to 84 inches (7 ft), a commonly recommended freestall length.

Freestalls also must provide lunge space for cows. This space ranges from 10 to 22 inches added to the combined 84 inches for body and head space. Or, the space is 28 to 40 inches measured ahead of the foreknees. Accounting for this lunge space is the first and most important aspect of stall design. It is the key to providing stalls that cows will use readily.

Whether the lunge space is provided either forward or to the side determines both the type of partition to use and the overall length of the stalls. If the forward lunge is to occur within the stall envelope, the recommended length overall is at least 8 ft. Or, if space for the lunge is provided to the side into an adjacent stall space, overall stall length need be only 7 ft. Other

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alternatives are to allow the cow to lunge forward into a stall space opposite the cow or into an adjoining alley or even to the outside of the barn itself.

Types of Freestalls and Components

Depending upon provisions for the thrust of the cow's head during the lunge, freestalls may be in one of two categories—forward lunge or side lunge. Figure 1 shows two examples of forward-lunge stalls and Figure 2 illustrates side-lunge stalls. Certainly, other designs may satisfy the concepts and principles of freestall design equally well. Therefore, an evaluation of a particular freestall begins with assessing its merits in meeting the basic needs of the cow from the standpoint of comfort and cleanliness.

Side-lunge and forward-lunge freestalls differ in partition shape and in stall base design at the front. Designs are similar at the rear of the stall. To reduce injury, both types provide space beneath the lower rail to minimize contact with the hip and pelvic area of the cow.

In a side-lunge freestall, the cow turns and thrusts her head into an adjacent stall space as she rises. The lower rail of the partition is either high enough in the front to allow the cow to thrust her head under the lower rail or low enough to allow the cow to thrust her head over the lower rail without interference. If the cow thrusts her head under the partition rail, the bottom partition rail should be installed a minimum of 28 inches above the stall surface. If the cow thrusts her head above the bottom rail, the bottom partition rail should be a maximum of 7 inches above the stall surface. In the figures, these values are greater, because the dimensions are measured from the top of the back curb, a more stable reference point especially in sand-based freestalls.

In a forward-lunge freestall, additional stall length is needed to allow the cow to lunge forward—either within the stall envelope or through an open front to space beyond. If the lunge is within the stall envelope, the stall must be at least 8 ft long. If the lunge is through an open stall front, provide a minimum of 21 inches of open vertical space.

The brisket board defines the space for the body of the lying cow and discourages her from moving too far forward into the stall when she is in a lying position. A brisket board is essential in a stall where space for the lunge is provided ahead of the cow.

A neck rail across the top rail of the stall partition is important to maintaining stall cleanliness. The neck rail encourages cows to back up when rising and stops cows from moving too far forward when standing without being a nuisance to them. A neck rail that is too low hinders the rising movement. Neck rails should be 66 inches ahead of the alley side of the curb and at least 40 inches above the stall bed.

With side-lunge stalls, make sure that cows have easy, natural access to the lunge space. When the recommended freestall length is used, the partition is mounted such that the cow can easily reach the lunge space. However, making the freestall longer than necessary, say 7.5 ft vs. 7 ft, positions the lunge space 6 inches farther forward in the stall, well ahead of where it should be for cow comfort. Without a brisket board, the cow will move too far forward in the stall, increasing the likelihood of her defecating and urinating in the stall. A brisket board will help position cows to prevent dirty stalls. But cows will still have to reach forward awkwardly to use the lunge space in a longer stall.

Recommended Dimensions

Dimensions chosen for freestalls represent a compromise between cow comfort and cow cleanliness. Stalls must enable cows to lie down and get up naturally and comfortably. Stalls should be wide enough that cows normally do not contact stall partitions in any way that could cause injury or that could damage the partitions. But stalls that are too wide may allow cows to turn around in them or lie diagonally. Stalls that are too long may allow lying too far forward, unless brisket boards are used. All of these conditions increase the possibility of manure being deposited on the stall bed.

Table 1 shows a range in the recommended stall widths and lengths. In our opinion, the lower values of the ranges in the table represent a livable compromise between cow comfort (high rate of stall usage) and cow cleanliness. The upper values, which provide for wider and longer stalls, favor cow comfort over cleanliness and will result in more time being spent in stall maintenance.

Table 1. Suggested Freestall Dimensions

Cow Weight	Freestall Width[1]	Freestall Length[2] Side-lunge	Freestall Length[2] Forward-lunge	Neck Rail Height above Stall Bed	Neck Rail and Brisket Board Distance from Alley Side of Curb
- - - lb - - -	- - inches - -	- - - - - - - inches	- - - - - - -	- - - inches - - -	- - - - inches - - - -
800-1,200	42 to 44	78	90 to 96	37	62
1,200-1,500	44 to 48	84	96 to 102	40	66
over 1,500	48 to 52	90	102 to 108	42	71

[1]Width: “center-to-center” with 2-inch pipe partitions.

[2]Length: alley side of the curb to the front of the stall.

With two rows of freestalls placed head-to-head and designed for space-sharing, stall partitions usually are mounted on posts. This allows for unrestricted open space for the forward lunge into the adjacent stall space. When a row of building support posts is located down the center of the two facing rows, spacing between the support posts must be a multiple of the freestall width, 45 inches on center for typical Holstein herds. Otherwise, building support posts will be located periodically in the forward lunge space needed by the cow. Freestall width should determine building post spacing, not vice versa.

In hot climates, consideration to heat buildup in the freestall area may lead to wider freestalls of 48 inches. Although, in a well-ventilated building equipped with cooling fans, the advantage of wider freestalls has not been established.

Freestall Base and Bedding

The stall base and bedding act together to provide a resilient bed with a clean, dry surface. Of all the factors that discourage use of freestalls, the condition of the bed is likely the most important. Avoid beds that are too hard (concrete, concrete with a rubber mat, compacted earth). Swollen hocks and knees result from a bed that does not provide sufficient cushion. Avoid beds with mounds, lumps, or holes. Such conditions reduce comfort for the cow, but, worse yet, can cause difficulties for the rising cow. Lack of comfort and difficulty in rising both discourage freestall use.

Slope the base upward 4% from the rear to the front. Use a curb that puts the stall beds 6 to 10 inches above the alley. The curb must keep scraped manure or flush water out of stalls.

Bedding material added on top of the base absorbs moisture and manure tracked into the stall. It also adds resilience, making the stall more comfortable, and reduces the potential for injuries. Possible materials are straw, sawdust, wood chips, sand, composted manure, ground limestone, shredded newspaper, rice hulls, corn stalks, and peanut hulls. Choice of bedding material may influence selection of a manure handling and storage system. Too much straw or other organic material can build up a substantial crust in a storage area, creating problems with agitation at emptying. The use of short, fine bedding material reduces the amount dragged into the manure alley.

Two methods have emerged as top candidates: i) mattresses with bedding on top and ii) a deep layer of sand. In our opinion, sand can be considered as the gold standard for a freestall base and bedding. If other materials are to be considered as alternatives and are to be evaluated on the basis of cow comfort, sand is the basis for comparison. The only logical reasons for not using sand would be the difficulty it adds to the manure system or limited availability of high quality sand.

As a cushion or for resilience, loose sand conforms to the shape of body components, e.g., knees or hocks. This reduces pressure on projecting bones and body parts by distributing downward force or weight over a larger area. This is important to the lying cow—her total weight is transferred to the lying surface via the contact point of her body.

Spreading the cow's weight over a larger area also protects her front knees during rising. A cow rising from a lying position lunges forward, transferring the weight of her body forward so she can more easily rise on her hindquarters. The knees act as the fulcrum for this teeter-totter action, and the stall bed provides the cushion for the knees. During the lunge, the weight transfer process increases the downward force on each knee from 350 lb (about 25% of her weight) to 500 lb or more—on each knee! As the sand conforms to the shape of the knee, increasing the area over which this downward weight is distributed, it lowers the potential for injury to the knee.

Loose sand serves to distribute consistently the downward weight probably better than any other material or combination of materials currently in use. Thus, loose sand represents the standard of comparison when evaluating stall beds of various materials for their cushioning effect.

Good footing in the freestall is essential to the cow's ability to lie down and rise easily. In this case, "footing" means not only reducing the tendency to slip, but allowing the cow to more-or-less embed her foot in the surface so as to provide good leverage. When a cow can rise more confidently, rising time is reduced. In addition, the tendency to rock back and forth is lessened, and rising is accomplished more smoothly, reducing trauma to the legs. Loose sand provides excellent "footing". Beds of other materials must be equivalent

A bed of loose sand (6 inches minimum) maintained in the stall area acts as both base and bedding. Sand contributes to cow comfort, good udder health, and cleanliness. In addition, sand kicked into the alleys improves footing. However, the sand should not contain small rocks or pebbles, which could cause damage to the hoof or lameness.

Every 1 to 4 wk, sand should be added to the front of the stall bed, allowing the cow to work it toward the rear of the stall. Sand should be replenished before the front of the stall bed becomes lower than the rear, a condition that makes it difficult for cows to rise and causes them to lie diagonally in the stall. This tends to put more manure in the stalls and leads to dirtier cows.

Sand bedding has many advantages for cow comfort and health, but it may greatly complicate the manure-handling system. Good planning—including selection of a handling system, storage needs, and equipment—is essential.

A dry surface is essential to minimize bacterial growth. The surface of a sand bed stays dry through its infiltration capacity. Dryness of the surface of a bedding mattress is assured only by the presence of dry bedding, e.g., chopped straw or sawdust. Thus, dry bedding on the surface is an essential aspect of a mattress system.

Bedding mattresses, 3 to 4 inches thick, placed over hard stall bases such as concrete or well-compacted earth can provide a satisfactory cushion. A bedding mattress consists of bedding material sandwiched in a fabric—heavyweight polypropylene or other material. Various materials are used as filler—long or chopped straw, sawdust, shavings, and shredded or ground rubber. Mattresses need to be covered with bedding to reduce friction and to keep them dry. Small amounts of bedding (chopped straw) maintained on top of the mattress help keep the surface dry and improve cow comfort.

When the lying cow tends to slide around while lying down, the friction between her hide and the lying surface can be abrasive. Chopped straw or similar material on a bedding mattress acts as a lubricating layer to reduce abrasions to the skin. Sand sliding over sand has a similar positive effect.

The search goes on for the ultimate freestall bed. Meanwhile, a bed of loose sand and rubber-filled mattresses with organic bedding on top are two methods for satisfying the requirements for freestall beds that promote cow comfort and good udder health. Sand appears to have the advantage. However, either system, properly installed and maintained, can contribute to a desirable environment for the dairy cow.

Freestall Care

Proper freestall care includes daily inspection and removal of wet bedding and manure, besides adding dry bedding periodically. Neglected freestalls with excessive moisture or accumulations of manure can lead to an increased incidence of mastitis.

For stalls with bases such as sand that must be replenished, upward slope of the base toward the front always should be maintained. This upward slope helps position cows more squarely in the stall when lying down, and this contributes to cleaner stalls and cleaner cows.

Selecting and Locating Freestall Barns

Selecting the type of freestall housing is an important decision that should be made with the lactating cow in mind. Several options are available when selecting freestall housing for lactating dairy cows. Some of the options include 2-row, 3-row, 4-row, or 6-row freestall barns. Access to feed and water is reduced by 33% if the length of the feedline and the number of waterer stations are not increased. The advantage of 2-row or 4-row freestall barns is access to feed and water. The advantage of 6-row barns is cost; however, producers should be concerned about the level of heat stress and the limited feeding area. Producers building 6-row barns should seriously consider cooling systems during periods of heat stress.

Proper ventilation is essential in a freestall barn. Freestall housing should be constructed to provide good natural ventilation. Sidewalls should be 12 to 14 ft high to increase the volume of air in the housing area. The sidewalls should have the ability to open 75 to 100%. Fresh air should be introduced at the cow's level. Curtains on the sides of freestall barns allow greater flexibility in adjusting the environment around the cow. Because warm air rises, steeper sloped roofs provide upward flow of warm air. Roof slopes for freestall housing should range from 4/12 to 5/12. Roofs with slopes less than 4/12 may have condensation and higher internal temperatures in the summer. Providing openings on the end walls in addition to alley doors will improve summer ventilation. Gable buildings should have a continuous ridge opening to allow warm air to escape. The ridge opening should be 2 inches for each 10 ft of building width. Naturally ventilated buildings should have a minimum of 100 ft between structures. In the midwest, freestall barns are typically oriented east to west to take advantage of sun angles and provide afternoon shade. Producers who construct barns north to south will find an overhang on the west side desirable to produce shade for stalls on the west side of the barn during the afternoon. Freestall barns should be located as close to the milking center as possible without restricting ventilation. The goal is to reduce the distance that cows have to walk to and from the milking parlor. Field observations indicate that the distance from the gate of the housing area to the gate of the holding pen should be a maximum of 1000 ft for 2x milking, 700 ft for 3x milking, and 500 ft for 4x milking.

Water Availability

High-producing dairy cows can consume between 30 and 50 gal of water/day. Water should be provided to cows leaving the milking parlor. In parlors that are double 25's or smaller, one 8-ft trough is usually sufficient. In freestall housing, water should be located at every crossover. There should be one waterer or 2 ft of tank perimeter for every 10 to 20 cows.

The water system must be able to provide 75 to 100 gal/cow/day. Peak flow rate is determined by number of waterers, assuming 100% utilization or milk parlor usage during cleaning. A minimum size well is probably 10 gpm, with 20 to 30 gpm, being preferred.

How Many Crossovers Are Needed?

Crossovers should be provided every 120 to 160 ft, or every 30 to 40 stalls. Crossovers are typically 10 to 12 ft wide. However, if a waterer is located in the crossover, consider increasing the width to 14 ft to allow passage behind other cows that are drinking. Producers often will reduce the number of crossovers in freestall barns to reduce construction costs. This is not a good alternative from a cow's point of view. Reducing the number of crossovers limits access to feed and water. It also reduces the total length available to construct the feedline. Very few producers stock freestall barns at one cow per stall. The tendency is to overstock freestall facilities. Therefore, reducing the number of crossovers or the width of crossovers restricts access to feed and water and limits the space for cows at the feed line. The bottom line is that the cows suffer when the number of crossovers is reduced.

Groups of Cows

Typically, large dairies have eight strings or groups of milking cows. They also would have pens for slow milking cows, mastitis cows, fresh cows, dry cows, and springers. The slow milking pen would have capacity for 2% of the milking cows. The fresh pen and mastitis pen would each have the capacity for 1% of the milking cows. Also, a minimum of two dry-cow pens and one pen for springers usually is constructed.

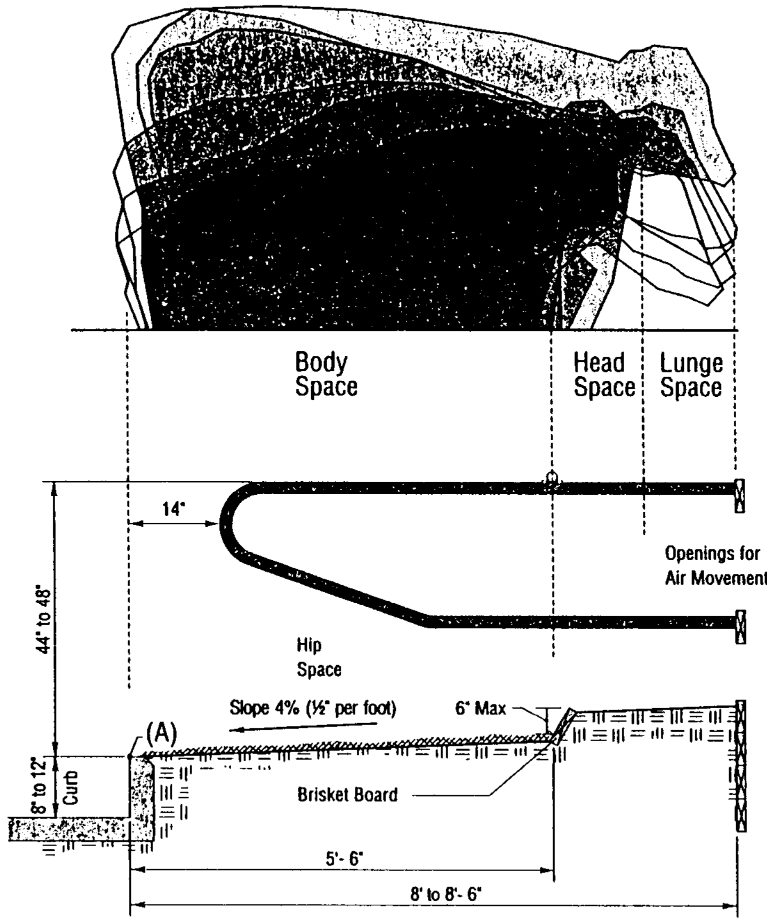

Figure 1a. Single loop partition.
A longer free-stall partition allows the Cow to thrust her head forward.

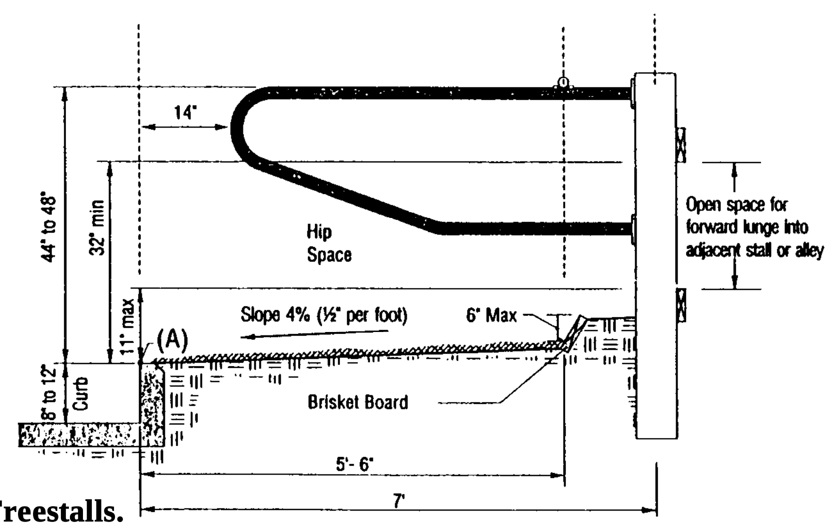

Figure 1b. Head-to-head partition.

Partitions are mounted on posts and the cow thrusts her head forward using the space left open between facing freestalls or into an adjacent alley.

Figure 1. Forward-Lunge Freestalls.

Top of curb (A) is used as the primary reference point for measurements, except when the stall bed is elevated. When the stall bed is elevated, the apparent top of the stall bed at the curb is the reference point. Dimensions are for a 1,400 lb cow. Refer to Table 1 for proper freestall size. This page is adapted from Dairy Freestall Housing and Equipment, MWPS-7, Sixth Edition, 1997, MidWest Plan Service, Ames, IA. Original drawings by W.G. Bickert.

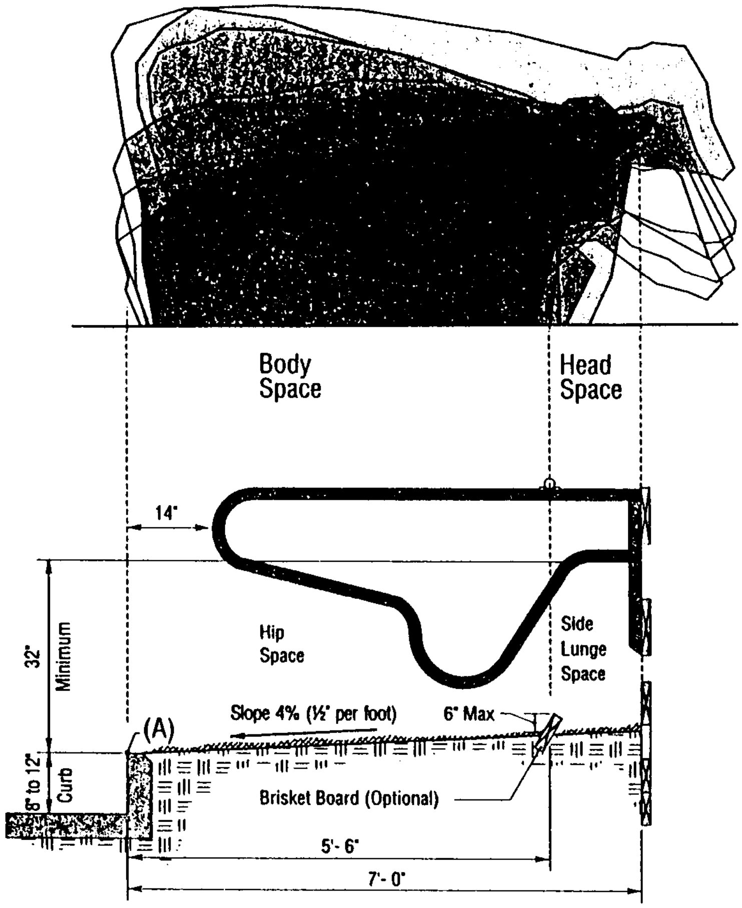

Figure 2a. Side lunge partition.
Cow thrusts her head under the lower of the partition into the adjacent free stall space.

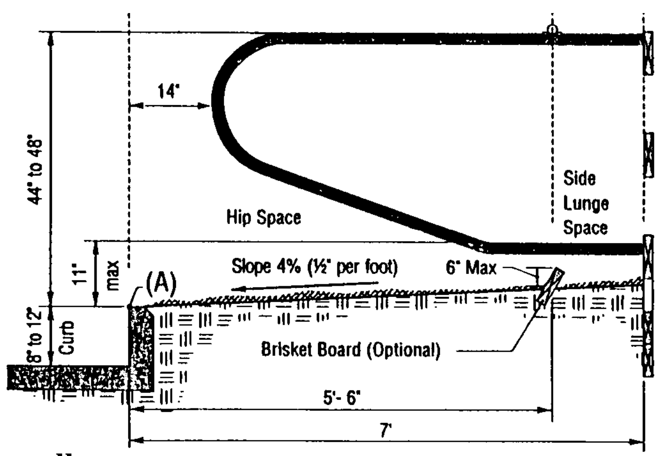

Figure 2b. Wide loop partition.
Cow thrusts her head over the lower rail of the partition into the adjacent stall space.

Figure 2. Side-Lunge Freestalls.

Top of curb (A) is used as the primary reference point for measurements, except when the stall bed is elevated. When the stall bed is elevated, the apparent top of the stall bed at the curb is the reference point. Dimensions are for a 1,400 lb cow. Refer to Table 1 for proper freestall size. This page is adapted from Dairy Freestall Housing and Equipment, MWPS-7, Sixth Edition, 1997, MidWest Plan Service, Ames, IA. Original drawings by W.G. Bickert.