Designing Meat Packing Plant Handling Facilities for Cattle and Hogs

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ABSTRACT

THE design of more efficient animal handling facilities which are labor saving and reduce bruise losses is discussed. The facilities discussed are unloading chutes, holding pens, single file leadup chutes and slaughter restraining chutes. Observations by the author in over 75 meat packing plants, and feedlot shipping areas throughout the United States, indicate that stockyard layouts utilizing curved drive alleys and diagonal pens are most efficient. Most of the animal traffic should be oneway. Single file chutes, crowding pens and other areas where animals are crowded should have high solid side fences to prevent the animals from observing people, vehicles and other distracting moving objects outside the facility.

INTRODUCTION

The Livestock Conservation Institute (1974) estimates that the livestock industry loses $46,000,000 every year due to bruises on livestock. Bruised meat cannot be used for human consumption. It must be trimmed from the carcass.

One of the major causes of bruised meat is poorly designed handling facilities at meat packing plants. A well designed handling system will take advantage of an animal's natural behaviors instead of working against them. Ewbank (1961) reported that the natural tendency of cattle to follow the leader can be used to facilitate the flow of cattle through a chute. McFarlane (1976) reported on the advantages of curved and diagonal layouts in stockyards. The handler should work from a catwalk located along the inner radius of a curved chute. This facilitates handling because it takes advantage of the animal's natural tendency to circle around the handler and maintain visual contact with the handler. (Williams, 1978). Cattle have wide angle 360 deg vision and they can detect movement behind themselves without turning their heads, (Prince, 1970). Kilgour (1972) found that vision was an important variable in livestock handling. The relationship between animal behavior and handling is reviewed in more detail in Grandin (1978a) (1978b) and Ewbank (1968).

OBSERVATIONS

The recommendations and designs in this paper are based on observations which were conducted by the author during a five year period in over 75 meat packing plants and feedlot shipping facilities. The author actually worked with the employees in order to gain a more complete understanding of the practical problems.

UNLOADING CHUTES

Since the unloading chute at a packing plant is only used for unloading it should be wide and straight as shown in Fig. 1. This design will encourage the animals to leave the truck because they can see a clear unobstructed path in front of them. A wide unloading chute is not recommended for loading livestock into a truck. A curved narrow chute is more efficient for loading. Unloading chutes for cattle or hogs should be between 1.8 m (6 ft) to 3 m (10 ft) wide. For all species of livestock a stairstep ramp is the safest and most efficient. The recommended stairstep dimensions for both cattle and hogs are a 0.09 m (3.5 in.) to 0.10 m (4 in.) rise and a 0.30 m (12 in.) tread width. The angle of a stationary nonadjustble ramp should not exceed 20 degrees. Steep ramps are a major cause of injuries.

Unloading chutes should be designed to accomodate tractor trailer trucks which unload from either the rear or the side. The type of trailer used depends on state determined length and weight limitations. Side unloading trailers are popular in the western U.S. where longer heavier trucks are allowed.

For both cattle and hogs the first 1.5 m (5 ft) at the top of the unloading chute should be level. This will provide the animals with a flat place to walk on when they first step off the truck.

In large beef packing plants the majority of cattle will arrive in tractor trailer trucks, and a 1.20 m (48 in.) high stationary unloading chute will accomodate them. In smaller beef plants which do custom slaughtering, facilities must be provided for unloading low goose-neck trailers and pickup trucks. In all hog plants regardless of size, facilities must be provided for all

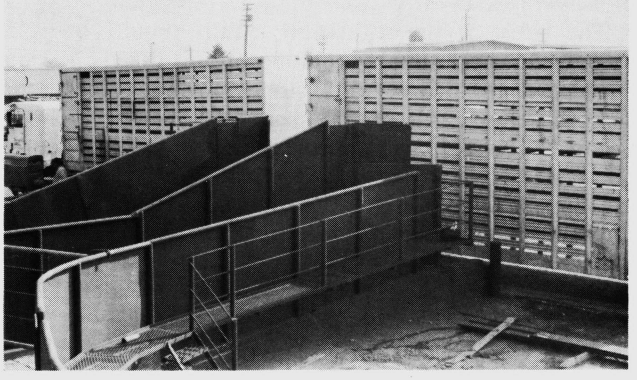

FIG. 1 Straight wide unloading chute.

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TABLE 1. STOCKYARD SPECIFICATIONS FOR CATTLE AND HOGS

	Mature cattle	Hogs
Fence height	1.5 m (5 ft) English 1.8 m (6 ft) Brahman	0.9 m (3 ft) Butchers 1.2 m (4 ft) Boars
Flooring	Deeply scored concrete 0.025 m (1 in.) deep grooves	Broom finish concrete
Drive alley width	3 m (10 ft) to 3.5 m (12 ft)	2.4 m (8 ft) to 3 m (10 ft)
Bruise hazard zone Distance from floor	0.70 m (28 in.) to 1.35 m (52 in.)	ground level to 0.9 m (36 in.)
Space per animal in holding pen	1.6 m^2 (17 ft^2) polled cattle 1.85 sq. m (20 sq. ft.) horned cattle	0.8 m^2 (5 ft^2)
Single file chute width Inside Measure	0.70 m (28 in.) to 0.75 m (30 in.) Use straight sided chute for 4450 N (1000 lb) steers. In plants handling cows and bulls use a V chute. 0.50 m (20 in.) bottom 0.80 m (32 in.) top. The top measurement is taken at the 1.5 m (5 ft) level.	0.45 m (18 in.) wide chute with straight sides, or commercially available tapered chute.
Shelter over pens	Shelter is usually not required in the Southeastern and Southwestern U.S. Shelter is required in the Northern U.S., to protect the animals from snow.	Hog stockyards must be covered to protect the animals from both hot and cold weather.
Sprinklers	Usually not needed except in the desert Southwest where summer temperatures exceed 38 °C (100 °F)	Hogs must be sprinkled when the temperature exceeds 26 °C (80 °F)

types of vehicles. Low gooseneck trailers are popular and the most efficient unloading facility is a simple drive through with no ramp. The farmer can drive through and unload his hogs without having to back the trailer up to a chute. In hog plants an adjustable chute must be provided for unloading the top decks tractor trailers. The best type of adjustable chute is the type where the entire chute can be raised up and down as a unit using an electric winch. The type of adjustable chute where just the floor moves up and down is not recommended, because a hog can catch its foot between the moveable ramp floor and the side of the chute.

Adjustable chutes should not exceed a 25 deg angle when they are raised to the top deck of a trailer. The cleats on an adjustable ramp should be spaced 0.20 m (8 in.) apart. This is the spacing from the edge of one cleat to the edge of the next cleat. The recommended height for the cleats in 0.04 m (1 ½ in.) to 0.05 m (2 in.) high, (Mayes 1978).

The sides of the unloading chute should be solid to prevent the animals from becoming distracted and frightened by people and other moving objects outside the chute. All of the structural members should be on the outside. This provides a smooth surface on the inside to help prevent bruising (Fig. 1). Unloading chutes which are used by trailers which unload through a rear door should have telescoping side panels and a spring loaded dock bumper to close up the gaps between the trailer and the chute, (Rider, 1974).

STOCKYARD DESIGN

Observations and practical experience indicate that

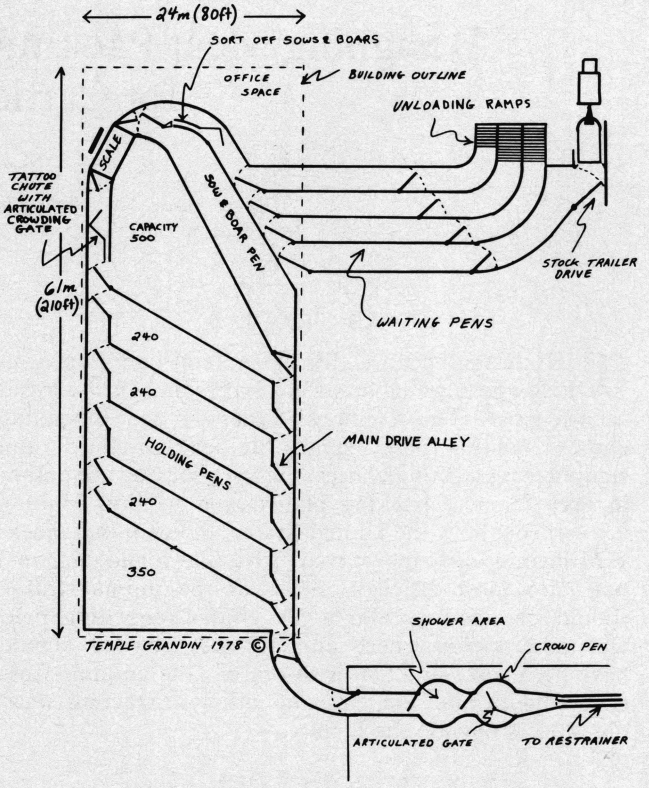

FIG. 2 Packing plant stockyard for hogs.

an efficient stockyard layout for either cattle or hogs should have oneway traffic flow, curved drive alleys, diagonal pens, and a minimum of corners. The animals should enter through one end of a diagonal pen and leave through the other. Basic specifications for cattle and hog stockyards are given on Table 1.

The basic principles of stockyard layout for both cattle and hogs are similar but there are some differences which will effect the design. Hogs are sensitive to both hot and cold weather and a hog stockyard has to be inside a building but maintain a oneway traffic flow. Cattle stockyards do not need as much protection and they can be more spread out to obtain good traffic flow.

The handling procedures for cattle and hogs are different. Most cattle arrive in tractor trailer trucks and after weighing, each truck load of cattle is placed in a separate pen in order to maintain the identity of the load. Each truck load usually contains uniform cattle from a single source. The handling of hogs is complicated by the fact that sows and boars are often mixed with butcher hogs on the same truck. They have to be sorted out after the hogs are unloaded. After sorting and weighing each hog is tattooed to identify it. The hogs are then placed in large pens and no attempt is made to place each truck load into a separate pen because each hog is identified by a tattoo.

HOG PLANT STOCKYARD

Fig. 2 illustrates a stockyard system for a hog plant processing over 500 animals per hour. Most of the hog traffic is oneway. The pens are on a 60 deg angle and 3 m (10 ft) gates are used on a 2.4 m (8 ft) drive alley. This design eliminates a corner where the hogs enter

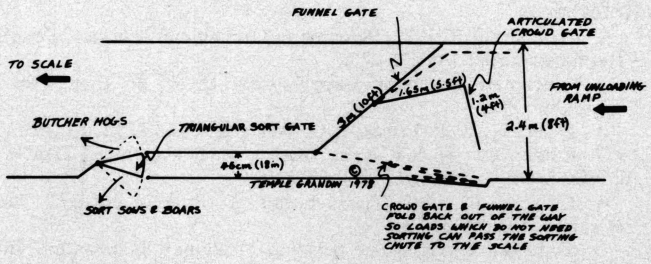

FIG. 3 Hog sorting chute with articulated gate.

the pen. After unloading, the hogs move into the waiting pens. Waiting pens are important in a hog facility because they make it possible for three or four tractor trailer trucks to unload without having to wait for hogs which had been unloaded previously to be sorted, weighed and tattooed. A sorting chute (Fig. 3) with an articulated crowd gate can be used to separate the sows and boars from the butcher hogs before they cross the scale. The sorting chute is equipped with a funnel gate which can be opened up across the alley. This gate can be folded back against the fence so that groups of hogs which do not require sorting can bypass the sorting chute. An articulated crowd gate which is hinged in the middle is the most efficient way to crowd hogs into the sorting chute.

After the hogs are weighed they then proceed to the tattoo chute. As each hog walks through in single file it is slapped with a tattoo. A chute similar to the one in Fig. 3 can be used for tattooing. After the hogs are tattooed they are placed in a holding pen. The pens in Fig. 2 are 6 m (20 ft) wide and 24 m (80 ft) long. The area enclosed by the dotted line shows the location of a weather tight building. The waiting pens and the unloading chutes can be sheltered by an open shed. The offices are located around the circumference of a curved drive alley to enable the yard manager to observe truckers when they unload the hogs.

GENERAL PURPOSE SMALL STOCKYARD

Small plants which process both cattle and hogs on a custom basis can benefit from the same principles used to design efficient stockyards for large plants, (Fig. 4). The pens are laid out in a diagonal design and all of the animal traffic is oneway. The layout in Fig. 4 is designed for plants which process less than 30 cattle or 50 hogs per day. The layout can be expanded for larger operations by adding diagonal pens. The pens are on a 60 deg angle and they are 9 m (30 ft) long and 3 m (10 ft) wide. The end gates are 3.5 m (12 ft) long on a 3 m (10 ft) drive alley. The block gates are 3 m (10 ft) long.

In a small plant where animals from many different owners are processed, it is important to provide enough pen space so that each customer's animals can be kept separated to avoid fighting. Strange animals will fight to establish a new social order. Barehom (1975) states that this can cause stress. A study conducted by the author indicated that fighting between strange cattle was one of the major causes of dark cutting meat (Grandin, 1978c). This is particularly a problem with animals which have been raised individually. A custom packing plant will process many individually raised animals and they should be kept in separate pens. Animals which have been raised together in large groups seldom fight.

BEEF STOCKYARD

Stockyards for large beef plants should hold enough cattle to supply the plant for an eight hour shift. Unlike hogs a group of cattle will readily follow the leader and move in unison as a group. A well designed cattle stockyard enables the cattle to flow through it and corners which can disrupt the flow of cattle are eliminated.

Fig. 5 illustrates a stockyard layout for a large beef plant with a curved and diagonal layout. Each pen is 22 m (75 ft) long and 3.5 m (12 ft) wide and is set on 60 deg angle. Each large diagonal pen will hold one truck load of 4450 N (1000 lb) steers. A double deck tractor trailer truck holds 45 to 50 animals. The maximum recommended length for the diagonal pens is 24 m (80 ft). If the pens are too long the cattle will bunch up. The recommended dimensions for gates and drive alleys for truck load lot pens are 4.1 m (14 ft) gates on a 3.5 m (12 ft) drive alley. Diagonal pens which are used to handle small groups of ten or less animals

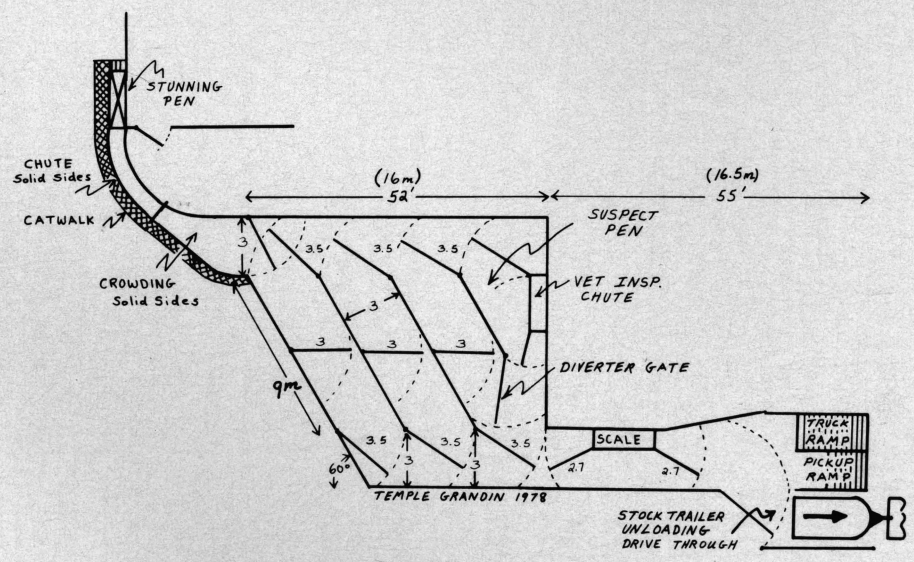

FIG. 4 Small plant stockyard.

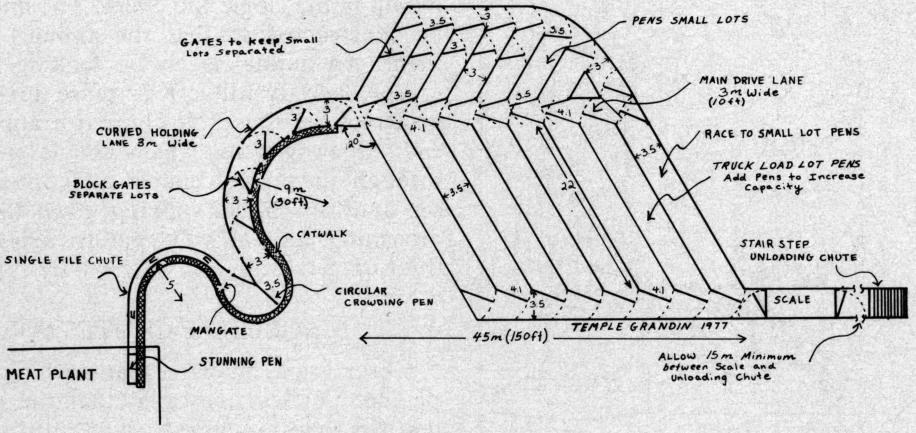

FIG. 5 Large beef plant stockyard.

should have 3.5 m (12 ft) gates on a 3 m (10 ft) drive alley. The main drive alley down the center of the stockyard in Fig. 5 is 3 m (10 ft) wide. Making the gates longer than the drive alley is wide eliminates corners. The capacity of the yard can be increased by adding more pens.

After the cattle leave the pens they pass into a curved holding lane which leads to the plant. Cattle will follow a curved path more readily than a straight one, as reported by McFarlane (1976) and Rider (1974). Block gates at 6 m (20 ft) intervals are used to keep the cattle from different truck loads separated. The curved holding lane is 3 m (10 ft) wide and the inside radius can vary between 7.5 m (25 ft) to 12 m (40 ft) (Fig. 5). The block gates and the sides of the curved holding lane should be solid to prevent the cattle from becoming aggitated and frightened by distractions outside the lane.

CATTLE CROWDING PENS

The curved holding lane in Fig. 5 terminates in a round crowding pen which is used to force the cattle into the single file chute (Fig. 6). Round crowding pens are recognized as one of the most efficient methods of forcing cattle into a single file chute (Rider, 1974). Observations by the author indicate that the recommended radius for a round crowding pen is 3.5 m (12 ft). With a round crowding pen the handler urges the cattle to enter the single file chute by advancing a crowding gate which catches on a ratchet device on the walls of the round pen. Crowding gates longer than 3.5 m (12 ft) should not be used because they are too cumbersome. A gate shorter than 3.5 m (12 ft) is not recommended because it reduces the useful capacity of a crowding pen.

The walls of the crowding pen and the crowding pen gate should be solid. A solid crowding gate is recommended otherwise the cattle will turn and face the crowding gate instead of facing the entrance to the single file chute. In Fig. 6 the round crowding pen had been equipped with catwalks and mangates for the handler's safety. The fences should be solid in all areas where cattle are crowded, and a catwalk should be constructed alongside the fence. Over head catwalks are not recommended in areas where cattle are crowded. Catwalks are recommended along the curved holding lane, crowding pen and single file chute. The recommended dimension for a catwalk in a cattle stockyard is 1 m (42 in.) from the catwalk platform to the top of the fence. This brings up the top of the fence to belt buckle height on the average man. The catwalk platform should be at least 0.45 m (18 in.) wide.

The transition between the round crowding pen and the single file chute should be gradual to prevent the cattle from bunching and jamming at this point. This design eliminates bruises. The curved holding lane, round crowding pen and the single file chute should form a series of flowing curves.

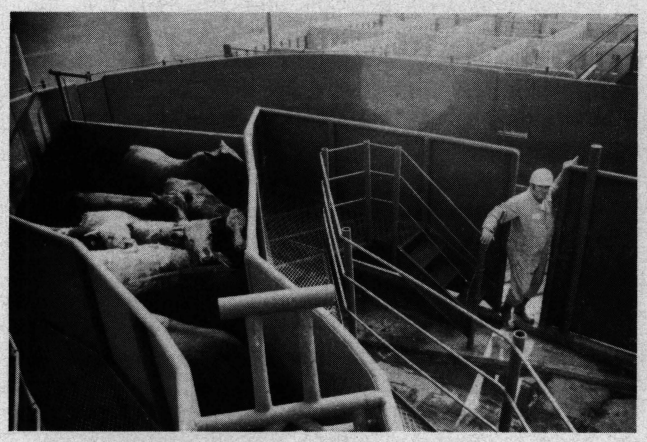

FIG. 6 Round crowding pen.

HOG CROWDING PENS

Fig. 7 is a round crowding pen for hogs with an articulated crowding gate. The crowding pen is preceeded by a shower pen which is needed in plants which remove the hides because the hogs have to be completely cleaned. The round pens can vary in diameter from 3.5 m (12 ft) to 4.7 m (16 ft) depending on the number of hogs processed per hour. A plant which processes 600 hogs per hour should use the larger pen. The round shape avoids corners and the hogs are urged into the

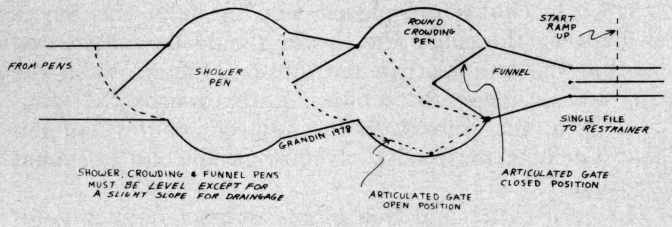

FIG. 7 Hog crowding pen.

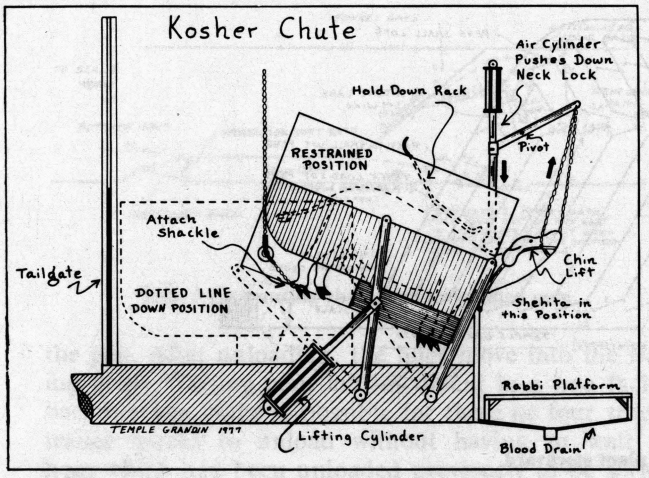

FIG. 8 Lifting V chute.

single file chutes with the jointed articulated gate. The crowding pen walls and the articulated gate should be solid to prevent the hogs from seeing out. Recommended lengths for articulated gates which are jointed in the middle are 2.4 m (8 ft) to 4.2 m (14 ft). Articulated gates longer than 4.2 m (14 ft) are not recommended because they are too cumbersome. Articulated gates are not recommended for cattle due to the size and strength of these animals. An articulated gate is usually more efficient than a straight crowding gate for handling hogs.

SLOPES IN CHUTES AND CROWDING PENS

Observations in both beef and hog packing plants indicated that the ramp upward to the stunning area should not start until the animals are lined up in single file. Crowding pens and wide drive alleys should be level, except for a 0.00625 m (¼ in.) slope every 0.30 m (12 in.) for drainage. If the crowding pen is constructed on a slope, the animals will pile up against the crowding gate and fall down. Observations indicate that the safest place for the animals to stand on an upward slope is when they are lined up in a single file chute. If part of the wide drive alley has to slope upward, flat landings should be provided for the animals to wait on after they have climbed the ramp. A good general rule is that the animals should be kept moving when they are on a ramp unless they are in single file.

SINGLE FILE CHUTES GENERAL RECOMMENDATIONS

The single file chute should have solid sides for both cattle and hogs. There are two exceptions to the principle of using solid sides in single file chutes. Animals tend to follow the leader and a well designed facility will take advantage of this (Hafez, 1969). If two or three single file chutes are placed side by side, the fences in between the single file chutes should be constructed so that the animals can see through them. When the animals in one of the chutes move towards the stunning area, the animals in the adjacent chutes will follow. The outermost sides of the single file chutes should be solid.

In both cattle and hog plants oneway flapper gates are commonly used to prevent the animals from backing up in the single file chute. The oneway gates should be constructed so that the animals can see through them. An animal is always looking for an avenue of escape, and it will often refuse to approach the entrance of the single file chute if it appears to be a dead end. Oneway gates which enable the animals to see through them, will enable an approaching animal to see another animal walking down the chute. The approaching animal will readily follow the animal in front of it.

SINGLE FILE CHUTES FOR CATTLE

Observations in cattle plants which process 175 head per hour or less indicated that the most efficient operations had a curved single file chute. The curve prevents the cattle from seeing the stunning pen until they are almost there. In cattle plants which process over 200 per hour a straight single file chute will work satisfactorily because the animals are kept moving and flowing. If space permits a curved chute is recommended. The recommended inside radius dimensions for a curved single file chute can vary from 5 m (17 ft) to 3.5 m (12 ft).

Observations also indicated that cattle are often reluctant to pass from a well lighted stockyard into a dimly illuminated plant. This is especially a problem when the stockyard is located outside where the sunlight is much brighter than the artifical lighting inside the plant. In plants where the stockyard is outdoors and the single file chute is inside, the single file chute should extend at least 3 m (10 ft) past the beginning of the building. The animals will enter more readily if they are lined up in single file before they enter the darker building. Observations at three beef plants indicated that cattle were balky and difficult to handle because the building wall was located at the junction between the single file chute and the crowding pen. Extending the single file chutes in one of these plants improved the efficiency by 25 percent.

The single file chute should be long enough to take advantage of the animal's natural tendency to follow the leader. In cattle plants killing 10 to 50 head per hour, the single file chute should be 15 m (50 ft) long. The recommended minimum single file chute length roughly corresponds with the hourly kill rate. A plant which kills 100 head per hour plant would need 30 m (100 ft) of chute and a 175 head per hour plant would need 52 m (175 ft). A plant killing 200 head per hour would need two 30 m (100 ft) single file chutes to insure steady supply of cattle to the stunning area. Two large 4450 N (1000 lb) steers will fit in each 3 m (10 ft) section of chute. In plants processing over 100 cattle per hour a double single file chute is recommended, so that the plant can continue to operate if an animal lies down in the chute.

SLAUGHTER RESTRAINERS

Observations in packing plants and a review of the literature by Giger et al. (1977) indicated that there is a need for improved systems for restraining animals during stunning. Many plants have problems in their cattle stunning pens because they are too wide and allow the animals to turn around. Hantover (1975) recommends that a stunning pen for adult cattle should