Properly designed, maintained and operated livestock handling facilities are more humane and more efficient in ensuring a steady uninterrupted flow of livestock to the slaughter line, and will usually pay for themselves by reducing bruises, injuries and lost work time. Down time or lost work time in a large slaughter plant is expensive since a five minute delay can cost over $500 in lost meat production. Another benefit of good systems is increased safety for the employees, many serious accidents have occurred when agitated cattle turn and trample a handler.

Although specific recommendations vary for different species, certain general principles of equipment design should be observed in all cases. These include the provision of secure flooring and a smooth transition from yard to holding pen to restraint and stunning areas, as well as consideration of natural species behavior and the importance of minimizing stress when choosing a particular type of equipment.

The recommendations and information in this article are based on five years of observations and practical experience by the author in beef, pork and sheep slaughter plants, feedlots and ranches throughout the United States.

Cattle Facilities

Stockyard Layout

The stockyards at a beef slaughter plant should be able to hold the number of cattle which can be slaughtered on one 8-hour shift and should be designed so that all of the cattle traffic is one-way. A curved and diagonal stockyard layout will handle large numbers of cattle with a minimum of stress (Grandin, 1977).

The shape of the pen may be equally as important as the space allotted per animal (Grandin, 1978, 1980a; Strickland et al., 1979). The most efficient designs utilize long, narrow pens which are constructed on a 60° angle (Grandin, 1977, 1979, McFarlane, 1976) [Figure 1]. In slaughter plants where area is limited or when a plant is being remodeled, the curved and diagonal layout may have to be modified. The pens may be laid out straight instead of on a diagonal, and although there will be a slight loss of efficiency, such a design is more efficient than a square pen stockyard. An existing square pen system may be improved by providing one gate for cattle to enter each pen and another gate through which the cattle exit. Another good design is the pie-shaped stockyard layout (Figure 2). The capacity of either layout can be increased or decreased by adding or subtracting pens. The diagonal layout will utilize the space inside a building more efficiently than a pie-shaped stockyard. The layout which will best fit the building site should be chosen.

Space allowances differ for steers which have been raised together in the same feedlot pen. For fed 1000-1200 lb (450-540 kg) steers, a minimum of 17 sq ft (1.6 sq m) is recommended for polled (Rider et al., 1974), and 20 sq ft (1.8 sq m) for horned steers (Grandin, 1979). Observations indicate that given these allowances, the animals do not appear stressed, and the incidence of dark cutting beef in the United States is only 0.5% in fed steers (Epley, 1975).

FIGURE 2—Round stockyard layout with pie-shaped pens. Each wedge-shaped pen will hold two truckloads (100 animals) in a space 80 ft (24 m) long, 28 ft (8.2 m) wide at the perimeter, and 14 ft (4.1 m) wide at the center. The animals enter through a drive alley along the perimeter and exit through a drive alley in the center which leads to the crowding pen and lead-up chute to the restrainer. If pens which will hold only one 50-head truckload are desired, each pen can be shortened to 50 ft (15.2 m).

(2.3-2.8 sq m) per animal, but a greater percentage of the animals are brought to the plant in small groups, and more space may be required if strange cattle are mixed. When new stockyards are being designed, the author recommends the English standards only for mature cows and bulls. Homogeneous groups of fed steers can be housed in a smaller space.

These pen space recommendations should serve only as a guide and should not be used as a basis for laws governing stockyard construction. Much more research needs to be conducted to determine the optimum space allowance for each animal, pen shape, pen size, and water trough locations to aid in minimizing stress to the animals.

After the cattle leave the diagonal pens, they pass into a curved holding alley (Figure 3) which holds one double deck truck load (50) 1000 lb (450 kg) steers. In plants slaughtering more than 80 cattle per hour, a curved holding lane should be used as a basis for laws governing stockyard construction. Much more research needs to be conducted to determine the optimum space allowance for each animal, pen shape, pen size, and water trough locations to aid in minimizing stress to the animals.

Crowding Pens

Cattle are moved out of the holding pens into a crowding pen before going into the slaughter plant. A crowding pen is a narrow pen which funnels the lead-up chute. For cattle it is important that the transition between the crowding pen and the single file lead-up chute is gradual to prevent the animals from bunching and jamming. All crowding pens should have high solid sides, a solid crowding gate and be constructed from either concrete or steel so that they can be easily washed. A catwalk should be provided alongside the crowding pen and along the inner radius of the single file lead-up chute. Overhead catwalks should be avoided. The recommended catwalk dimensions are 42 in (100 cm) from the catwalk platform to the top of the fence (Figure 3). In plants where the single file chute is inside the building and the crowding pen is outside, the single file lead-up chute should extend at least 15 ft (4.5 m) past the beginning of the building since cattle will enter the building more readily if they are already lined up in single file.

The circular crowding pen (Figure 1) is usually more efficient than the funnel pen. The circular pen has a crowding gate which swings around a central post, and the gate is equipped with a ratchet latch mechanism. The crowding gate, which forms the radius of the pen, should not be shorter than 12 ft (3.5 m) nor longer than 14 ft (4.1 m) and for greater efficiency and increased safety for the drover, be equipped with a hydraulic drive unit to advance and open the gate. The crowding gate never should be used to push the cattle up the single file lead-up chute by force, and sufficient area should be provided for cattle to turn around. Funnel pens which are 10 ft (3 m) wide are recommended for smaller
plants and plants where a circular crowding pen cannot be accommodated in a small restricted space. On a funnel crowding pen, one side of the funnel should be a straight continuation of the single file leadup. The other side of the funnel should be on a 155° angle in relation to the lead-up chute (Grandin, 1976a). This configuration should not be used for pigs—both sides should be angled.

**Lead-Up Chutes**

The most efficient single file lead-up chutes to the stunning pen are curved, with an ideal inside radius of the curve being 17 ft (5 m), but not tighter than 12 ft (3.5 m). The last 6-10 ft (1.8-3 m) of the curved chute (where it joins the stunning pen entrance) should be straight to orient the animal directly into the stunning pen or restrainer.

In plants which slaughter 175 cattle per hour or less, a curved single file chute is strongly recommended. In very high-speed plants which handle 175 to 300 cattle per hour, a straight single file chute can be used efficiently since the animals are always kept moving and their natural following behavior will facilitate the flow along the straight chute. If space permits, a gentle curve is recommended. For large steers (over 1000 lb; 450 kg), the sides of the chute should be vertical and spaced 30 in (75 cm) apart. “V”-shaped lead-up chutes are recommended in plants which handle a variety of different sized cattle weighing under 1000 lbs (450 kg). Recommended dimensions are 20 in (50 cm) bottom; 32 in (80 cm) top, with the top measurement taken at 5 ft (1.5 m) level (Grandin, 1979, 1977).

Slaughter plant designers should avoid constructing a single file lead-up chute which is too short. The chute should be long enough to take advantage of the animal's natural following behavior. Observations indicate that there is an optimum ratio between single file lead-up chute length and the number of cattle slaughtered per hour (Table 1). A plant will usually be more efficient and humane if these recommended lengths are adopted. In a 100-cattle per hour plant, a 100 ft (30 m) lead-up chute will hold 20 fed steers which will take 12 minutes to slaughter. If the drovers and handlers have a problem with balky cattle, they have sufficient time to correct the problem and prevent rough treatment of the animals.

In large plants where over 100 cattle are slaughtered per hour, the installation of two single file chutes side-by-side is recommended. If the animal lies down in one of the lead-up chutes, the plant can still continue to operate while the downed animal is being removed. A double lead-up chute in a high speed plant will help prevent the cruel practice of allowing cattle to walk over the top of a downed cripple.

To prevent the cattle from backing up in the lead-up chute, one-way gates should be installed (Figure 4). One-way gates are superior to vertical sliding gates since they reduce bruising, although a sliding gate is a necessity at the stunning pen entrance. Vertical sliding gates, counterweighted to prevent slamming cattle and padded on the bottom, are recommended over horizontal sliding gates, especially for fed steers to avoid loin bruises. Horizontal sliding gates which are easier to operate may be used in plants handling calves.

**Flooring**

In order to prevent the cattle from falling down and injuring themselves, concrete floors in stockyards, scales and crowding pens should be deeply scored to make them nonskid. The recommended groove pattern for new construction is a pattern of 8 in (20 m) diamonds with grooves 1-2 in (2.5-5 cm) deep. In existing stockyards, where the floors have been worn smooth by the animals, grooves can be chipped in the floor with a pneumatic hammer. If this is not possible, a grid of 1 in (2.5 cm) steel rods can be constructed instead; however smaller rods should not be used.

**Restraint and Stunning of Cattle**

In order to stun an animal humanely, it must be restrained in either a stunning pen or a restrainer which should not be located directly in the stunning room. The more the animal can be kept isolated from the noise and blood odors of the plant, the calmer it will remain.

**Stunning pens:** A common type of stunning pen for cattle consists of a narrow stall with solid sides where the stunner operator reaches over the top of the pen to stun the animal (Figure 5). Such a pen is humane as long as only one animal is placed in the pen at a time. There are several techniques which can be employed to help keep the animal still for accurate humane stunning. A light installed at the front of the stunning pen will cause the animal to look up whereby it can be easily stunned. A better technique is to cut a small 12 x 12 in (30 x 30 cm) window in the front wall and place a diffuse, nonglaring, light behind it. The bottom of the window should be 3 ft (0.9 m) from the floor. Most cattle will stand and look out the window, which makes the stunning easier and more efficient. The window will also entice the animals to enter the pen; however, the window should not look out into the slaughter room. Another method is to install either a neck stanchion to restrain the head or a movable squeeze side.

A multi-animal stunning pen is not recommended, and in the author's opinion, is not humane. In some of the larger plants in the United States two or three animals are placed together in a single long compartment. The economic loss

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**TABLE 1 — Optimum Ratio between Single File Lead-Up Chute and Number of Cattle Slaughtered**

<table>
<thead>
<tr>
<th>Number Cattle/Hr</th>
<th>Length of Chute*</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 to 20</td>
<td>20 ft (6 m)</td>
</tr>
<tr>
<td>20 to 50</td>
<td>50 ft (15 m)</td>
</tr>
<tr>
<td>75</td>
<td>75 ft (22 m)</td>
</tr>
<tr>
<td>100</td>
<td>100 ft (30 m)</td>
</tr>
<tr>
<td>150</td>
<td>150 ft (45 m)</td>
</tr>
<tr>
<td>175</td>
<td>175 ft (52 m)</td>
</tr>
<tr>
<td>Over 200</td>
<td>200 ft (60 m)</td>
</tr>
</tbody>
</table>

* Length 100 ft (30 m) or over can be divided between two lead-up chutes.
caused by bruising and safety hazards to employees in this kind of system will usually enable a plant to replace the multi-animal stunning pen with a more humane system and pay for the new equipment within two years.

**Conveyor Restrainer:** In plants where 100 to 300 fed steers or mature cattle are slaughtered per hour, the system of choice in all new construction is the conveyor "V" restrainer system manufactured by Cincinnati Butcher's Supply Company [Helen and Blade Sts., Cincinnati, OH] (Figure 6). The first conveyor restrainer system for cattle was constructed at Armour & Company in Omaha, Nebraska (Edwards, 1971; Schmidt, 1972; Willems and Markey, 1972). It is one of
The conveyor restrainer system is expensive, costing in excess of $100,000 to install, but in many over 100 head per hour slaughter plants, it can pay for itself in less than three years, and in some instances, in less than two years. Several conveyor restrainers have been installed in existing plants which were using multiple animal stunning pens. One plant which was slaughtering 165 fed steers per hour in a multiple animal stunning pen eliminated serious injuries to its employees after replacement of the pen with a conveyor restrainer, and the system also reduced bruise and trim losses.

Even though the major components of the system are commercially available, many critical parts of the system have to be constructed at the plant, and proper installation and construction is essential for a humane, safe and efficient system. A well designed approach chute with a ramp (not exceeding a 20° slope) and small stair steps provides the most positive footing for the cattle. The steps must be grooved to prevent slipping (Grandin, 1979). The point at which the single file lead-up chute joins the conveyor restrainer is critical. There should be a smooth and gradual transition between the vertical approach chute sides and the "V" shape of the conveyor restrainer. The approach chute should be tapered only on the bottom where it joins the conveyor restrainer and it should be level for at least 6 ft (1.8 m) and have a cleated nonskid floor. This enables the animal to be on a level surface when it enters the restrainer (Figure 6).

A hold down guard rack, which can be adjusted for different size cattle, should be installed to prevent the cattle from jumping up on each other (Figure 7) [Grandin, 1976b]. The rack also forces the cattle to settle down into the conveyor. If extremely fat cattle are being slaughtered, the floor of the restrainer entrance may have to be raised to enable the animal's briskets to clear the narrow "V" formed between the bottom of the conveyors. All restrainer systems should be equipped with a small declining entrance ramp (Figure 6) at the restrainer entrance. As the cattle walk into the conveyor restrainer, they walk down the declining ramp which is located between the two conveyors which form the restrainers. This enables the conveyors to ease in the animals. The recommended angle for this ramp is 25-30° (Grandin, 1976b).

After stunning and shackling, the animal is discharges from the conveyor restrainer onto a downward sloping 'take away' conveyor (Figure 8). An inclined conveyor hoist then transports the animal to the bleeding area. The inclined hoist which conveys the stunned cattle to the bleed area should be angled over the moving conveyor instead of being located alongside it. This keeps the stunned animal centered on the moving conveyor and it helps to maintain tension on the leg chain in order to avoid jamming where the shackle trolley enters the base of the inclined conveyor hoist. It should operate at a higher speed than the conveyor restrainer.

Some large plants have eliminated the inclined hoist conveyor by building the conveyor restrainer at the same height as the bleeding rail. Even though this...
FIGURE 8—Stunned animal being discharged from the conveyor restrainer onto a downward sloping 'take away' conveyor. The slat conveyor or a belt conveyor of the same basic dimensions is the best type system. The moving conveyor should be 16 ft (4.7 m) for short shackle chains, at least 18 ft (5.5 m) for longer shackle chains, and 5 ft (1.5 m) wide. The angle of the conveyor must not exceed 15° to prevent a jerky operation.

FIGURE 9—The diagram illustrates a kosher version of the restrainer with a chin lift. For nonkosher slaughter, the chin lift would be removed. The lifting chute restrainer consists of two solid stationary sides which form a "V" which is open on the bottom. After the animal enters, the entire restrainer lifts up and the animal is securely restrained with its feet hanging out through the bottom. The system does not contain conveyors and up to 100 animals could be stunned per hour with a captive bolt.

eliminates the inclined hoist conveyor, this type of system has many problems. A much longer ramp is required to get the cattle up to the 16-18 ft (4.7-5.5 m) bleed rail height, and this type of installation requires more floor space. Observations in plants with the high type restrainer system indicate that it has no advantages over the standard system using the inclined conveyor hoist. The high type system is not usually recommended for new installations.

**Lifting Chutes:** Plants which slaughter 30-100 fed steers or mature cattle per hour should consider using a nonkosher version of the lifting chute (Figure 9). A prototype version constructed by Cincinnati Butcher's Supply Company indicated that it provided many of the advantages of the larger, more expensive restrainer systems at a quarter of the cost for smaller plants. The design of the restrainer was further developed by the author to make the system practical. The lifting chute would also make the shackler's job much safer, and since the animal is securely held in the restrainer, the stunner operator can stun more accurately.

**Pig and Sheep Facilities**

**Stockyard Layouts**

The same basic layouts for cattle can also be used for sheep or pigs. However, there are two important differences: pork stockyards usually have to be under a roof to protect the animals from weather extremes, and they need to have facilities for waiting pens (Figure 10). When the pigs arrive at the plant, the smaller market pigs are often mixed with large sows and boars and must be sorted before the animals are weighed and marked to identify their owners. This process is time consuming. The waiting pens allow trucks to unload the pigs and thus prevent the animals from becoming overheated from standing in parked trucks. A sorting chute facilitates the separating of market pigs, sows and boars. All pork stockyards must be equipped with either sprinklers or foggers to keep the pigs cool during hot weather (Grandin, 1980b).

**Crowding pens**

A round crowding pen (Figure 11) is one of the most efficient ways to force either sheep or pigs into the single file lead-up chute. A jointed articulated gate is used to urge the animals toward the funnel entrance which leads to the single file chute. For sheep it is important that there be a gradual transition between the round crowding pen and the lead-up chute in order to avoid bunching and jamming. For pigs it is strongly recommended to have two or three lead-up chute entrances side-by-side to prevent the pigs from jamming and fighting over a single entrance. Research conducted in Europe indicated that when only one entrance is used, the pigs will enter more easily if the transition between the lead-up chute and the crowding pen has a stair-step shape. This forces one pig to wait while another enters (Hoenderken, 1976; W. Sybesma [Research Institute for Animal Husbandry, Netherlands] personal communication). Articulated gates should not be used with cattle due to the strength and size of these animals, but a jointed crowding gate is more efficient than a straight crowding gate for sheep and pigs. In plants where space is limited the funnel shaped crowding pen can be used for either pigs or sheep. However, it is recommended that the funnel crowding pen width be decreased to 8-10 ft (2.4-3 m).
FIGURE 10—Design for pork stockyard with one-way traffic and a diagonal (60° angle) layout which can be constructed in a rectangular building. The stockyard layout shown has an 1800 pig capacity based on 5 sq ft (0.46 sq m) per pig. In warm weather, when the temperature is over 80°, each pig should be allowed 7 sq ft (0.65 sq m). As discussed in the section on cattle, pen shape may be just as important as the square footage allotted per animal. The Meat and Livestock Commission in England (1974) recommends 6 sq ft (0.56 sq m) for market pigs weighing under 250 lbs; sows and boars should have 8 sq ft (0.74 sq m). The Meat and Livestock Commission (1974) recommends 6 sq ft (0.56 sq m) per animal for sheep in the holding pens. The drive alleys for driving groups of sheep or pigs should be 8-10 ft (2.4-3 m) wide.

Lead-Up Chutes

The dimensions of the single file lead-up chute for both sheep and pigs are basically the same, 18 in (46 cm) wide or a commercially available tapered chute. There are some important differences. For sheep, the single file lead-up to the stunning area definitely should be curved (Court, 1976). The recommended inside radius is 12-17 ft (3.5-5 m) for sheep, while for pigs the curve is not important. Another basic difference is that pigs can be handled more easily with a minimum of excitement in short (25-35 ft, 7.4-10.5 m) single file lead-up chutes as compared to longer (50 ft; 15 m) single file chutes for sheep. For pigs, two or three lead-up chutes side-by-side are recommended (Figure 11).

For both sheep and pigs the single file chute should have solid outer sides, although where two single file chutes are located adjacent to each other, the common fence in between should permit the animals to see through so that when an animal moves up, the animal in the adjacent chute will also move up (Grandin, 1980a). All one-way gates, sliding gates and divider gates in the single file chute should be constructed so that the animals can see through them (Court, 1976). In pig single file chutes, one-way gates installed every 10 ft (3 m) will prevent the animals from backing up or bunching toward the rear of the chute.

The movement of the animals through the single file chute can be highly automated. One of the best types of automatic systems for driving pigs through the single file chute is a series of electrified chains which are hung at 10 ft (3 m) intervals in between the one-way gates. The chains can be connected to a timing device which will electrify each chain for about 1 second in a sequential series. There are large differences in body resistance of pigs and their response to electric prods or chains; therefore, the charge on the chains should be set as slow as possible to make the pigs simply move away and not violently jolt the animal. This system is more humane as it reduces the number of handlers poking the pigs.
with electric prods; however, the electrified chain system is not recommended for sheep.

**Flooring**

The flooring in a pork stockyard should be broom-finish concrete and not deeply scored; deep grooves in the floor will hurt the pigs’ feet. A broom finish is made by brushing wet cement with a broom before the concrete sets. A large majority of swine in the United States are raised in confinement and will move more easily on a concrete floor. Wood or metal should not be used on the floor in a pork stockyard as the animals tend to hesitate and slip on such surfaces. Drains should be located around the perimeter of the stockyards outside the alley and pen fences so that the animals do not have to cross over them.

In a sheep stockyard the floor should be grooved with a diamond pattern. The grooves should be 1/2 in (1.25 cm) in depth and spaced 4 in (10 cm) apart. A good method of grooving the floor is to push a grid made from 1/2 in (1.25 cm) rods into the wet cement to form the pattern.

**Restraining and Stunning for Pigs and Sheep**

**General**

The transition between the single file lead-up chute and the restrainer entrance should be smooth and gradual to prevent bruising and jamming. The sides of the single file chute should gradually slope to conform to the “V” shape of the conveyor restrainer, and the same basic design as the restrainer equipment for beef cattle can be used for pigs and sheep. The different types of equipment which can be used to restrain pigs and sheep for either electrical or captive bolt stunning are discussed.

Before the advent of stunning methods for pigs and sheep, these animals were herded into a shackling pen and hung by one rear leg on the shackling hook while they were still fully conscious. Shackling fully conscious animals and then hoisting them up in the air is both cruel and inefficient. Before the large plants in the United States started stunning pigs, many hams were ruined because struggling pigs jerked their joints apart. Shackling fully conscious animals and then hoisting them up in the air is both cruel and inefficient. Before the large plants in the United States started stunning pigs, many hams were ruined because struggling pigs jerked their joints apart. Shackling fully conscious animals and then hoisting them up in the air is both cruel and inefficient.

It is nearly impossible to place the electrodes correctly on a pig’s head when the animal is running around in the shackling pen, and, it is labor-inefficient. The excitement and commotion spreads to all the pigs in the shackling pen, which increases the chance of injury. It has been reported that, in large (5,000-16,000 pigs per week) pork slaughter plants in Germany using a restrainer, the animals had no shoulder fractures during electrical stunning while pigs electrically stunned without a restrainer had 1.5-2.2% shoulder fractures. (Van der Wal, 1976, D. Aren-dale [Electronics Unlimited, Memphis, TN] personal communication.)

Large slaughter plants which slaughter 100 or more sheep per hour should use the conveyor restrainer system for either captive bolt or electrical stunning. In small slaughter plants for sheep, the group stunning pen, used in conjunction with electrical stunning, appears to be a good method from a handling standpoint.

Sheep are gentle animals and do not jump around and fight like pigs do. The pen should have a crowding gate so that the sheep can be kept together and stunned without having to be chased. As the crowding gate is advanced, the sheep nearest the fence are stunned and then removed through a flexible flap, similar to the flap in a shearing shed. Group handling may be less stressful because the sheep can remain together as a flock. (Kilgour, 1976 and 1978). If more than 30 sheep per hour are being stunned by captive bolt, a restrainer definitely should be used because accurate placement of the stunner is extremely difficult unless the animal is relatively still.

When a decision is being made concerning the most humane and efficient system, one must examine the whole system. The group stunning pen is a situation in which there is a trade off between electrical stunning accuracy and prestunng stress. It may be better to lose some stunning accuracy, but reduce the prestunning stress of being isolated. The humane stunning of sheep is a controversial subject and it will be discussed in issue No. 4 of this journal.

**Conveyor systems**

The best system for slaughter plants which slaughter more than 100 pigs or sheep per hour is the conveyor restrainer (Figure 12) which can be used with either electrical or captive bolt stunning. This system was first patented in 1936 by R.W. Regensburger of the American Institute of Meat Packers. In a pig or sheep conveyor restrainer system, the stunned animal is shackled after being ejected from the restrainer. There are three different types of shackling and bleeding systems which can be used with the conveyor restrainer. The group stunning pen is a situation in which there is a trade off between electrical stunning accuracy and prestunng stress. It may be better to lose some stunning accuracy, but reduce the prestunning stress of being isolated. The humane stunning of sheep is a controversial subject and it will be discussed in issue No. 4 of this journal.

When market pigs (200-250 lb; 90-110 kg) are being slaughtered, the hold down rack on the conveyor restrainer should be installed level, and there should be approximately 25 in (62 cm) from the underside of the hold down rack to the insulated bottom edge of the conveyor restrainer flights. When the rack is in the full down position, it should be level. The rack should not be sloped like the one on the beef restrainer. The hold down rack should cover approximately three quarters of the length of the 14 ft (4.1 m) long conveyor restrainer. This will ensure that the pigs or sheep are settled down into the conveyor restrainer and thus be less likely to jump out. The hold down rack should be spring-loaded so that it will give when the animals push against it. This is especially important for pigs.

When large sows and boars are being slaughtered, the hold down rack will need to be raised 6-8 in (15-20 cm).

For both pork and sheep slaughter operations, the conveyor restrainer should be equipped with a foot switch which will enable the stunner operator to stop, start and reverse the conveyors. The reverse feature will help prevent an unstunned animal from escaping. For electrical stunning of pigs, the restrainer should be electrically insulated from the ground. If the pigs are electrically grounded, current leakage to ground may make humane stunning impossible.

The bolts in the wooden slats on a pig restrainer should be countersunk and...
TABLE 2 — Shackle and Bleeding Systems for Conveyor Restainers for Pigs and Sheep

<table>
<thead>
<tr>
<th>Animal Type</th>
<th>System Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigs</td>
<td>Prone and Gut Hanging</td>
<td>Two to three times as much space can be saved over the other two systems.</td>
</tr>
<tr>
<td></td>
<td>Prone Bleeding and Gut Hanging</td>
<td>Requires over 100 ft (30 m) linear floor space. Can be either straight or L-shaped.</td>
</tr>
<tr>
<td>Sheep</td>
<td>L-Shaped Gut Hanging</td>
<td>This system has the longest interval between stunning and bleeding, which is desirable from a meat quality standpoint. It has the benefits of a shortened interval between stunning and bleeding in a system which is less expensive. Not usually recommended for sheep.</td>
</tr>
<tr>
<td></td>
<td>Stackchc First Bleeding Hanging</td>
<td>This system must be used for edible blood collection. This could be shackled while conscious. It is recommended for meat quality of pigs but not for sheep.</td>
</tr>
</tbody>
</table>

C. W. Davis (Univ Tenn, personal communication; Scheper, 1977; Van der Wal, 1978). No possibilities of a conscious pig being shackled and hung damage caused by jerking because the shackle is eliminated. Can enable more edible blood collection. This system could be used in a meat quality standpoint. It is most recommended for pigs used for edible blood collection.

This system is recommended for meat quality standpoint. It is most recommended for pigs used for edible blood collection.
FIGURE 13—Prone bleeding conveyor system. A well designed system will reduce the interval between stunning and sticking to under 5 seconds. After the pig is stuck, the shackle is attached. The discharge slide from the restrainer should be sloped so that the stunned pigs will all face in the same direction. This system is used in many large U.S. plants.

In existing slaughter plants which slaughter more than 20 pigs per day it is strongly recommended that a pig restrainer be installed to individually restrain each animal. A pig restrainer is recommended for all new small plants. For slaughter plants handling up to 50 pigs per hour a rotating cradle type restrainer which is distributed by Alpha International Corp. [118 E. 28th St., New York, NY] can be used. The restrainer consists of two "V" shaped stationary sides. After the pig enters the restrainer the weight of the animal or the stunner operator tripping a lever causes the floor to drop away. The pig is now held in the "V" shape of the restrainer. After stunning, the pig is ejected by rotating the restrainer.

For plants slaughtering 30 to 100 pigs per hour a more automated version of the cradle type restrainer can be obtained from the Cincinnati Butcher's Supply Company. After a pig enters this unit, the floor drops away. The stunned animal is then ejected by flipping the bottom of the restrainer. The Cincinnati restrainer can be automated with an air cylinder to roll out the animal. There should not be any set rules for determining which system should be used. Each individual plant should be individually evaluated. A system which is very stressful in the hands of one person may result in minimal stress in the hands of another person. It would be a grave mistake to attempt to legislate exact systems for handling sheep and pigs in small packing plants.

Another type of restrainer which can be used on either pigs or sheep is the squeeze box system. It was originally patented by Edgar E. Moss in 1962. This system consists of a "V" shaped restrainer with padded sides. After the animal enters it is restrained by being squeezed by the side panels. The stunner operator trips the squeeze by releasing a foot switch.

The squeeze box system can handle 30 to 200 animals per hour. It is less expensive and requires less floor space than the conveyor restrainer system. It is recommended for medium sized plants which do not have enough floor space for a conveyor restrainer.

General Requirements for Livestock

Unloading Chutes and Ramps

Unloading chutes at a slaughter plant should be designed to accommodate double deck tractor trailer trucks which unload through either the rear or the side (Figures 14A and B). When a new unloading dock is being constructed, sufficient space should be provided for both rear unloading and side unloading trucks to maneuver (Stevens and Lyon, 1977).

FIGURES 14 A and B —A. Wide straight chute for unloading only. B. Adjustable unloading ramp for hogs and sheep. The sides of all types of unloading chutes should be sold to prevent the animals from seeing out and becoming frightened or distracted by people and moving objects outside the chute. All structural members should be on the outside of the chute to prevent bruises; the inside is smooth metal or wood. All unloading chutes should be equipped with telescoping side panels or a wing gate to block the gap between the end of the chute and the vehicle to prevent any animal from trying to escape through the gap. A crossover bridge ("bull board") to block the floor gap will prevent serious leg injuries.
Since the unloading chute at a slaughter plant is used for unloading only, it should be wide and straight to allow the animals to see a clear path of escape in front of them. A wide straight unloading chute must never be used for loading livestock into a truck with a narrow door. The recommended width for permanent, nonadjustable unloading-only chutes at a slaughter plant for all species of livestock can vary from 6-10 ft (1.8-3 m).

For all species of livestock the unloading chute should have a flat landing at the top (Stevens and Lyon, 1977). This will provide the animals with a flat surface on which to walk when they first step out of the truck. For large cattle it is recommended that the flat landing at the top of the ramp be at least 5 ft (1.5 m). For all species of livestock, stairs are recommended. The steps should have a 3.5 in (9 cm) rise and a 12 in (30 cm) tread width. For pigs and sheep the minimum flat landing would be 3 ft (1 m), and unloading facilities must be available for unloading top decks of the trucks.

**Slopes in Stockyards**

For all species of livestock the crowding pen where the animals enter the single file lead-up chute must never be sloped. If the pen is sloped downward away from the entrance of the lead-up chute, the animals will tend to pile up against the back crowding gate. The crowding pen should be almost level except for a 1/4 in (0.6 cm) slope every 12 in (30 cm) for drainage. The drainage slope will not affect the handling of the animals in the crowding pen. If the crowding pen is sloped in an existing plant, the animals should be provided with a nonslip floor. Installation of a steel grid or chipping grooves in the concrete floor can help.

When a new plant is being designed, it is usually necessary to build a ramp from the level of the stockyard up to the level of the restrainer or stunning pen. All species will move very easily up a ramp in single file, and it is safe to leave the animals standing on a ramp when they are lined up in single file. The best location in the system for the ramp is in the single file lead-up chute; however, the angle should not exceed 20°. Staircases are recommended for an angle over 10°.

In some slaughter plants ramps have to be built in the drive alleys to transfer the animals from the stockyard area to a higher level. In these situations, it is not practical to line the animals up in single file to walk up the ramp. All species of livestock will walk readily up a wide ramp, but they will tend to bunch up and possibly fall down if they are left standing on a wide upward sloping ramp. The animals must be kept moving in an even, steady flow. If animals have to be left standing, they should be driven to a portion of the drive which is level.

**Ante-Mortem Examination and Suspect Area**

The U.S. Department of Agriculture (USDA, 1976) requires that a restraining device be installed so that the veterinary inspector can examine and take the temperature of sick animals. They also require a pen in which to put animals that are diseased or in poor health. This is called the “suspect” pen. In stockyards which are located outdoors, the examination area should be covered with a roof.

All slaughter plants for all species must be equipped with an easily accessible entrance where crippled animals can be brought in. In beef plants the crippled door should be located in the shackling area and in pork and sheep plants it should be located by the shackling and bleeding station. In new plants the system should be designed so that the cripple door can be reached without having to walk up either a ramp or steps. Pigs and sheep can be brought to the cripple door in a wagon or a modified wheelbarrow. Cattle which are too severely injured to walk to the cripple door should be stunned in the stockyards or on the truck before being dragged to the cripple door.

**References**


Epley, R.J. (1975) Dark cutting beef. *Agricaltural Extension Service, University of Minnesota, Minneapolis, MN.*


National Provisioner (1956) Look, no shackles, no bruised hams (April 14) Reprinted in the Hearings before the Subcommittee of the Committee on Agriculture and Forestry, United States Senate 84th Congress on S.1636, May 1956.


Chefras acknowledges that public demand for government involvement in product safety testing necessitates the death of a certain number of animals, but argues that new legislation could help ensure that the smallest number is used in procedures which, through review of existing regulations, can be streamlined to eliminate or reduce tests of dubious value.

Biomedical research, on the other hand, will do better under legislation which guarantees that the needs and rights of animals are considered by researchers who choose to use them, but also preserves the freedom to make that choice.

US Predator Control Policy

Secretary of the Interior Cecil Andrus has issued a document stating the goals of the United States Fish and Wildlife Service’s Predator Control Program as follows:

1. In the near term, preventative control should be limited to specific situations where acceptable high levels of losses have been documented during the preceding 12 months. In the long term, through additional research, our goal should be to minimize and phase out the use of lethal preventative controls, including creation of buffer zones;

2. Emphasize corrective control, utilizing nonlethal, noncapture methods and focusing on offending animals to the greatest degree possible;

3. Reduce conflicts between predators and livestock by encouraging the use of appropriate livestock husbandry techniques which decrease exposure of livestock to predators;

4. Expand the availability of extension services to ranchers.