

Humane Slaughter Systems

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Humane handling of livestock prior to slaughter is not only legally required (Humane Slaughter Act of 1978) and morally mandated, but it may help to improve meat quality and increase public health. In 1999, the beef industry lost an average of \$68.82 per head of cattle (National Cattle and Beef Association, 2004). If humane handling markedly decreases bruising and downgrading of carcasses this could help reduce these losses. Further, pre-slaughter stress has been shown to decrease the quality of pork in multiple studies (D'Souza et al, 1998) (Grandin, 1980) (van der Wal, et al 1999) (Warriss et al, 1990).

Studies have shown the meat from pigs injected with epinephrine 15 hours prior to slaughter, and from pigs that were injected with epinephrine 15 hours prior to slaughter and then ran on a tread mill was more likely to support bacterial growth than control pigs and pigs that were just run on a tread mill (Junter D, et al; 2002). This brings human health concerns into the equation. Epinephrine is a neurotransmitter that is released when the body has a fight or flight response. Inhumane treatment of livestock prior to slaughter will likely induce the fight or flight response and therefore epinephrine release, which may increase the risk of pork supporting bacterial growth. Further, HA Channon; et al (2000) showed that certain types of pigs would develop pale, soft and exudate meat when stressed. Pale, soft and exudative meat is of poor quality and is generally unacceptable to the consumer (Channon et al, 2000).

To facilitate humane handling, a system should be implemented by slaughter houses that will ensure that humane handling from the time that the animals enter the plant on the truck up until the time that they are stunned and bled. In order to properly implement this system, it should be broken down into components with a system of checks and balances that will work together to ensure humane handling. The components of the humane handling system are briefly outlined below with references that may be utilized for more information.

Basics of Humane Handling of Livestock:

Humane handling will benefit the animals, the employees and the owners of the livestock plant. Humane handling will decrease worker injury due to stressed animals that are difficult to handle. Decreased worker injury will decrease workmen's compensation costs for the owner of the plant.

All workers should be trained on how to properly handle livestock. If the workers understand the basics of how to move livestock, then the amount of stress that the animals and workers endure will decrease. This will help to maintain the flow through out the plant and improve the function of each component of the humane handling system.

Employees of the plant should undergo training, so they are familiar with basic principals of livestock handling. They should become familiar with the reactions that livestock will have due to the fact that they are prey animals. They should be trained and understand the point of balance, the flight zone, the field of vision that each species has, things that will cause animals to balk, and the basics of facilities design (Grandin, 1993). The flight zone is the distance around an animal which will cause the animal to move away when a person steps into the flight zone. The size of the flight zone depends on the animal's previous experience with people and the size of the enclosure that the animal is contained in (Hutson, 1982) (Hargraves and Hutson, 1990). The point of balance is at the shoulder of the animal. When a person moves from the point of balance towards the animals head, it will move backwards (Grandin, 1993). If a person moves from the point of balance towards the rear end of the animal, then it will move forward (Grandin, 1993). If a person stands outside the flight zone at the point of balance, the animal will not move (Grandin, 1993). All livestock animals have wide-angle panoramic vision; they have much better peripheral vision than humans do (Grandin, 1993). Cattle can see around them except for a small area directly behind them (UC Davis, 2004). Cattle should not be approached from directly behind them because this will startle them (UC Davis, 2004). If it is necessary to approach an animal from the rear, then one should speak in a quiet voice so the animal knows you are approaching (UC Davis, 2004). Realizing that animals have good panoramic vision explains why livestock move better through facilities with solid sides (Grandin, 1993). Further, the fact that livestock are species of prey dictates that they are flighty and will move away from things that are unfamiliar. Loud noises are also stressful to livestock (Grandin, 1993) (Ames, 1974). Employees of the livestock plant should move animals without yelling, prodding and clanking things. Livestock are herd animals, so they feel more secure in groups. If an animal becomes separated and is by itself, it is more likely to run over a handler than if it were in a group (Grandin, 2003). Training employees to move animals in groups and to be more cautious of animals that are alone may help to decrease the number of serious injuries that occur due to isolated herd animals that panic.

Employees should be trained how to properly use electric prods. In a facility that is designed properly to minimize balking the use of an electric prod should rarely be necessary. If it is necessary to use an electric prod, it should be applied to the back and rump of an animal only. At no point in time should an electric prod be used on an eye, in a mouth, on the ears or in an orifice (Grandin, 2003). Realistic and achievable goals for hogs are 15% or less and for cattle are 5% or less (Grandin, 2004). An animal in the rear of a crowd should never be prodded because it has no where to go. The animals in the front may need to be prodded. The follow the leader instinct should be utilized. Once you have the leader of the pack moving forward, then others will follow. Using driving devices other than electric prods can help decrease or eliminate their use. Shaking plastic streamers made from a garbage bag at the head of cattle can easily turn them around and start them moving in the other direction (Grandin, 2004). A large flag on a stick can be used to move pigs and a rattle can be used to drive sheep (Grandin, 2004). Guidelines for quality assurance and to self audit electric prod use refer to the American Meat Institute Foundation: Good Management Practices for Animal Handling and Stunning by Dr. Temple Grandin (2003).

Facilities Design for Humane Handling of Livestock:

Training employees how to handle livestock will work hand in hand in with properly designed facilities to ensure that the humane handling system works effectively and smoothly. Facilities must be designed to ensure that livestock can be moved through them efficiently and safely with a minimal amount of stress on the animals.

One of the first key features of a livestock handling facility is non-slip flooring. Animals become agitated and stressed when they slip and fall (Grandin, 2004). A grooving machine or concrete rougher can be used to improve footing on slippery floors (Grandin, 2004). Further, a grid made from 1 inch steel bars can be used to provide better footing in high traffic areas (Grandin, 2004). New floors should be made from durable concrete with diamond or square patterns stamped into them (Grandin, 2004). Dr. Temple Grandin and the American Meat Institute Foundation (2004) have developed quality control monitoring parameters that can be used to monitor the severity of slipping in slaughter houses.

Another key point in a humane handling system is to have facilities that are designed not to have sharp edges and protrusions that may bruise animals. Bruising and damage to the hides not only cause the animals discomfort, but they are also part of the \$68.81 loss per head of beef that the industry incurred in 1999 (National Cattlemen's Beef Association, 2004). When looking for points that may be causing bruising on animals, look in the shoots for areas that have tufts of hair attached to them (Grandin, 2004). The walls of the shoot should be solid, with nothing protruding from them. If it is necessary to have gate tracts in the shoot, then they should be recessed (Grandin, 2004).

Designing a facility design to reduce balking is important in a humane handling system. Balking is stressful for both the animals and the employees who want to move the livestock. Solid walls in the chutes will prevent animals from balking due to movement of people and objects around the chutes (Grandin, 2004). Lighting should be uniform through out the facility, or it should gradually increase as you approach the stun box. Animals tend to move from dark to light (Grandin, 2004). The flooring should be uniform through out handling facilities. Animals will balk at puddles reflecting light and changes in the texture of the floor (Grandin, 2004). The fences and floors should be free from debris. Something as simple as removing a paper cup or an article of clothing hanging on a fence can decrease bulking. Loud noises should be avoided. Hissing from an air gun or the clanking of a chain on a fence can cause animals to balk (Grandin, 2004). For a more complete list and ideas on how to trouble shoot problems with balking refer "Recommended animal handling guidelines for meat packers" by Dr. Temple Grandin (2004).

A quality assurance program should be implemented by the industry to ensure that the humane handling system is working appropriately. Animals vocalize when they are distressed. Dr. Temple Grandin and the American Meat Institute Foundation (2003) recommend monitoring the amount of vocalizing that occurs at different points in the system to determine if it is working correctly. If vocalizations are not within recommended parameters, then the components of the humane handling system should be analyzed to determine the cause of the problem. Once the problem is identified, then steps should be taken to correct the problem.

Downers Cows:

The best way to deal with downer cows is to prevent them. Good treatment of livestock on the farm will help to prevent animals that are too sick to support their own weight being sent to slaughter. Lameness and emaciation are two of the big risk factors for becoming a downer cow (Grandin, 2001b). Dairy cow selection should not only be for milk production, but should also include selection for good sound footing (Grandin, 2001b). Non-slip flooring and humane handling will help to prevent animals from falling and hurting themselves. Animals that are stressed and have the a fight or flight response are more likely to panic and hurt themselves.

Humane Transport of Livestock:

A humane handling system for live stock should include provisions for humane transport of the livestock. This includes protecting livestock from weather extremes, educating truck drivers and planning between the plant and the truckers. This system should also have a quality control mechanism.

During the summer, animals should be transported early in the day or in the evening, when it is cooler. The trucks should be covered to protect animals from direct sunlight, but open to allow air flow to keep the animals cool. The trucks should be moved as quickly as possible because temperatures in the trucks climb rapidly and can result in heat stress losses. If it is necessary to park a truck for a short time period, it should be parked in the shade. Stocking density should be decreased by 10% during the hot summer (Pig Welfare from Farm to Abattoir, Department of Agriculture South Wales). When the temperature is >60 degrees use wet sand or shavings to keep hogs cool (Grandin, 2004). If the temperature is >80 degrees, then hogs should be sprinkled to keep them cool too (Grandin, 2004). In the winter, animals should be transported during the day when the temperatures are higher and the trucks should be enclosed to protect the animals from the cold. In the cold weather hogs should be bedded deeply with straw to prevent frost bite, and half of the air holes in the truck should be plugged or covered with panels (Grandin, 2004). The drivers of the trucks should understand the effect that high humidity has on heat, and the wind chill factor that is introduced when driving in cold weather (Grandin, 2004). Animals should not be over loaded during any time of the year because this increases bruising in all livestock and PSE in hogs (Grandin, 2004).

The times that livestock are shipped should be planned with the packing plant to be sure that the animals spend the shortest amount of time possible on the trucks. Once they arrive at the slaughter house, they should be unloaded immediately into pens that contain sufficient room to allow driving of livestock from the pens and to allow livestock to lie down. Further, the livestock should have access to water immediately and if they are kept for more than 24 hours then they should be provided with a good quality ration.

Design of the truck will play an important role in the humane transport of livestock. Double deck trucks should have ramps between the decks, so that if an adjustable ramp is not available, then livestock can still be unloaded. The decks should have divisions so that different ages, genders and sizes of livestock are not mixed. This will prevent injuries from fighting.

The truckers and the livestock plant should apply quality control measures. Some values that may be assessed include: vocalization of animals, number of animals that slip and fall, and the number of downer animals. Temple Grandin and the American Meat Institute Foundation (2003) may be helpful in setting up quality control measures.

Unloading of Livestock:

Unloading humanely requires good ramp design, planning and good animal handling. There should be a sufficient number of unloading ramps and proper scheduling of truck arrival to allow unloading of livestock immediately upon entrance to the plant. The ramps should have a flat step at the top to allow the live stock to step out onto them (Grandin 2004). The ramps should be stable, solid, and should be 6-10 feet wide (Grandin 1979). If the bottom of the ramp is not solid, then this may cause animals to balk. Further, the slope of the ramps should not exceed 20 degrees (Grandin, 2004) (Department of Agriculture South Wales). Unloading ramps must provide stable footing to prevent animal injury. Concrete ramps should have stair steps to provide stable footing. The recommended dimensions for cattle are a 3 1/2 inch rise and a 12 inch tread (Grandin, 2004). The recommended dimensions for pigs are a 2 1/2 inch rise and a 10 inch tread (Grandin, 2004). There should be solid sides on the ramps, so that animals do not balk. Workers should not rush animals and should handle them in manners that are previously discussed in the section on the basic of humane handling of livestock.

Animal Holding Pens:

There should be sufficient space in holding pens so that animals are unloaded immediately upon arrival at the stockyard. Confinement to the trucks can exacerbate exposure to inclement weather. Further, the pens should provide access to water immediately upon arrival. The pens should be adequately lit and of an adequate size to allow ante-mortem inspection. Recommended pens sizes are as follows: 20 sq ft (1.87m) per 1200 pound (545kg) cow or 6 sq ft per hog. These pen sizes allow for adequate space for handlers to drive livestock safely, and for all the animals to lie down.

Ramps to the Knocking Box:

Ramps to the knocking box should have non-slip flooring and solid walls as was previously discussed. For cattle a pen that is rounded and single file is recommended (Grandin, 2004). This will utilize the natural circling instinct of cattle. The curvature of the shoot should not be so great that it creates the appearance of a dead end because this will cause cattle to balk (Grandin, 2004).

Stunning of Livestock:

Proper stunning of livestock is required by the Humane Slaughter Act of 1978 prior to shackling, casting, hoisting, throwing or cutting of livestock. Further, studies have shown that properly stunning livestock does not decrease meat quality and may improve it (Onec and Kaya, 2003) (Gregory, 1998). (Velarde et al, 1999) (Verlage et al, 2003) (Verga and Gallego, 2000).

Assessment of Sensibility:

The efficacy of stunning is an important humane handling concern point. Proper stunning is defined as: "rendering an animal instantly insensible to pain and keeping them insensible until the time of slaughter." Signs that an animal has been properly rendered insensible to pain include:

- the tongue is flaccid (limp) and hanging out of the mouth; the jaw is flaccid (limp) and hangs open
- lack of response to painful stimuli (a nose pinch, or touching the scalding water)
- loss of a menace or blinking reflex; the eyes should be wide open; expect in electrically stunned pigs which may clamp their eyes shut for a few seconds after stunning, then open them, there should be no blinking at all in captive bolt stunned animals
- irregular respirations
- when hung, the animal should hang with its head straight down and a straight back

it is normal to have some kicking a few seconds after captive bolt and electrical stunning that may last for 20 seconds; in CO2 stunned animals should be immediately flaccid (limp); animals slaughtered by ritual slaughter may also kick for a few seconds

- captive bolt stunned animals should have a 10-20 second long period of rigidity of followed by a period of kicking that will gradually subside
- there should be no vocalizing (mooring, bellowing or squealing)
- a relaxed and flaccid (limp) tail
- (Grandin, 2003) (Humane Slaughter Association, 1993)

Signs of sensibility to pain and incomplete stunning include:

- the tongue is moving in and out of the mouth, or the tongue is curled, the jaw has muscle tone
- responsive to painful stimuli (response to a nose pinch or touching the scalding water (a nose pinch will avoid confusion with spinal reflexes)
- when an animal has a natural blink (look at live animals in the holding pens to see a natural blink)
- rhythmic breathing (ie: a normal breathing pattern with a consistent amount of time between inspiration (breathing in) and expiration (breathing out)
- when hung, the animal flexes it's neck and back
- a captive bolt stunned animal that kicks immediately after being stunned
- any vocalizations (mooring, bellowing, squealing)
- a twitching nose (like a rabbit moves its nose)
- excessive tone or tail movement
- (Grandin, 2003) (Humane Slaughter Association, 1993)

Signs that are normal and should not be confused with incomplete stunning:

- a withdrawal reflex (bending of the limb when the toe is pinched to cause pain) should not be mistaken for conscious pain perception
- epileptic or seizure like activity that is normal following electrical stunning

If any signs of sensibility are present after stunning the animal should be immediately re-stunned. All slaughter houses should have a second stunning device that is of the appropriate caliber to render the animal being slaughtered insensible; in case there is a failure of the first stunning device. Even one conscious animal sent to the bleeding rails is unacceptable and illegal. Proper application of stunning devices, proper maintenance of stunning devices and ergonomic design of the stun box will help to reduce the incidence of ineffective stunning (Grandin, 2001) (Grandin, 2002).

Electrical Stunning Specifications:

Improper placement or setting of the electrical parameters can result ineffective stunning that may lead to a paralyzed, but sensible animal going down the rails. The electrical parameter should be set according to manufacturers guidelines, and according to published scientific studies. Hoekenderken (1982) and Gregory (1988) found that a minimum of 1.25 amps is required to induce insensibility in market weight pigs (not sows or boars). Gregory and Wotton (1984) and Gilbert et al (1991) found that a minimum of 1 amp is necessary to render a sheep instantly insensible. These amperages must be maintained for a minimum of 1 second and a minimum of 250 volts must be supplied in order to induce insensibility. Warrington et al (1978) found that 50 cycles were most effective at induce insensibility. Further, Croft (1952) and van der Wal (1978) found that frequencies from 2000-3000 Hz would not induce insensibility and would induce pain. In cattle, a 2.5 amp, 1 second long current with a frequency of 50-60 Hz is recommended by the Council of Europe (1991) and Grandin (2003) to induce insensibility. A second current must be applied across the body to induce cardiac arrest (death) (Gregory, 1993). However, a study conducted by Wooten et al (2001) indicated that a 1.15 amp sinusoidal AC 50 Hz current applied across the head for 1 second is sufficient to induce insensibility in cattle.

The electrode should not be energized before it is firmly placed against the head because this will cause vocalizations and pain (Grandin, 2003). Further, good contact between the electrode and the skull must be maintained through out the time the electrical stunner is fired to prevent ineffective stunning (Grandin, 2003). The head of livestock should be restrained to help with proper placement and to allow for a sufficient contact time with the electrode. The electrode should be unplugged from the power supply and cleaned a minimum of once daily. If there are problems with ineffective stunning, then the electrode may need to be cleaned more often. Other problems that often lead to ineffective stunning include: operator fatigue, incorrect electrode placement, the amperage is too low, poor contact between the electrode and the skin, soiled electrodes, the contact area of the electrode is too small, animal dehydration, interrupted contact with the electrode, and long hair/wool (Grandin, 2001 and 2003). If the stunning score as explained below, is not at least acceptable, then action should be taken immediately to increase the effectiveness of stunning. The operator should not be leaning down over a wall to stun animals, as this causes fatigue quickly and leads to ineffective stunning. Further, the source of the problem must be identified and corrected rapidly. If improper training is a source of the problem, then the personal should be re-trained or replaced with more skilled stunners. If the equipment is failing, then better maintenance should be implemented, or the equipment should be replaced.

Evaluating the efficacy of electrical stunning:

Dr. Temple Grandin and the American Meat Institute feel that these are achievable and realistic goals for the meat industry:

Excellent: 99.5-100% of the electrical stunning wand or tongs are placed correctly and there are no vocalizations due to the energizing the electrode before it is accurately in place.

Acceptable: 99.4-99% correct placement with 1% or less of animals vocalizing

Not acceptable 98-96% correct placement with 2-3% of the animal vocalizing due to premature electrode energizing

Serious problem less than 95% of the time the wand is correctly placed or more than 4% of animal vocalize

Captive Bolt Stunning:

Some of the major causes for failure of captive bolt stunning to render an animal insensible to pain include: poor maintenance of the stunner, damp cartridges, poor ergonomic design of bulky pneumatic stunner, and operator fatigue (Grandin, 2003). Carbon deposits and failure to maintain the firing chamber can lead to a decrease in the velocity of the bolt and ineffective stun (Humane Slaughter Association, 1993). Even a small decrease in the velocity of the bolt can render the stunner ineffective (Humane Slaughter Association, 1993). The Humane Slaughter Association (1993) recommends that the stunners be dismantled cleaned and lubricated at least once daily. Some of the problems with stunning can be solved by following the manufacturers guidelines for maintenance of the stunner, by hanging heavy pneumatic stunners, applying extension handles to heavy stunners, rotating stunners to other positions through out the shift and storing cartridges in a dry place (Grandin, 2003). Further, restraint that causes >4% of animals to vocalize is not an acceptable means by which to improve the efficacy of stunning (Grandin, 2003).

Evaluating the Efficacy of Captive Bolt Stunning:

Dr. Temple Grandin and the American Meat Institute feel that these are realistic and attainable goals for the American meat industry:

In large plants score at least 100 animals, 50 in small plants and 1 hour of production in really small plants:

Excellent: 99-100% are instantly insensible to pain in one shot

Acceptable 95-98% are instantly insensible to pain in one shot

Not acceptable 90-94% are instantly insensible to pain in one shot

Serious problem less than 90% are instantly insensible to pain with one shot

If the percentage of animals that are instantly insensible to pain in one shot falls below 95%, then the cause should be identified and action should be taken to improve efficacy immediately. The causes listed above should be investigated and corrected.

Co2 Stunning of Livestock:

For CO2 stunning two humane handling concerns points are: evaluation of insensibility when exiting the stunner, and the loading of the gondolas (Grandin, 2003). There is controversy in the scientific literature on when pigs will react to CO2 stunning. Some pigs will have a smooth induction and then have convulsions when unconscious; while other pigs will kick and squeal during induction, then lay quietly when unconscious (Forslid, 1988) (Grandin, 1988) (Dodman, 1977) (Hodenkeren, 1983). These differences may be due to pig genetics, or gas mixtures (Grandin, 2003). These problems may be corrected by changing the pig genetics, or the gas mixture (Grandin, 2003).

Evaluating CO2 Stunning:

According to Dr. Temple Grandin and the American Meat Institute, the following are realistic and achievable goals for the American meat industry:

Score 50 Gondolas in large plants and 25 in small plants for over crowding. Over crowding is defined as the pigs can not sit or lie down with being on top of each other.

Excellent: no gondolas are over loaded in a 50 gondola audit

Acceptable: 4% of gondolas are overloaded

Not acceptable: more than 4% of the gondolas are over loaded

Serious problem: The persons loading the gondolas force more than one pig to jump on top of each other using an electric prod, kicking, hitting or shoving

If gondolas are not used, then the parameters suggested by (Grandin, 2003) may be applied to the use of an electric prod. Jongman et al (2000) found that the use of an electric prod caused more discomfort to pigs than the CO2 inhalation.

Stun to Bleeding Time:

The time from stunning until the animal is stuck and bleeds out is another humane handling concern point. Regardless of the method of stunning, this time should be minimized (Grandin, 2003). It is unlikely an animal stunned by a penetrating captive bolt will return to sensibility (Grandin, 2003). Further, the following times for the specific methods of stunning are recommended:

Stunning Method

Non-penetrating captive bolt

Penetrating captive bolt

Electric stunning for cardiac arrest

Electric stunning head only in pigs

Electric stunning head only in sheep and cattle

Stun to Bleeding Interval

15 seconds, 30 seconds maximum

as soon as possible

60 seconds

15-30 seconds

10 seconds

Bleed Rail Insensibility:

Another humane handling concern point is sensibility on the bleed rail. The parameters for determining sensibility as previously discussed can be used to evaluate sensibility. The parameters suggested by Dr. Temple Grandin and the American Meat Institute can be obtained from the reference Grandin (2003). Beginning any slaughter procedure (skinning, scalding, limb removable) in a sensible animal is completely and totally illegal and immoral. These acts will not be tolerated.

Conclusion:

If a humane handling system with integrated quality controls is properly employed then compliance with the Humane Slaughter Act of 1978 should occur. It is morally and legally mandated that animals sent to slaughter are handled humanely. This will be beneficial to the industry due to decreased losses from bruising in all species and PSE meat in pigs. It will also help to decrease plant employee injuries and therefore workers compensation costs. The industry at large should embrace these systems, improve on them and evolve in the future to ensure livestock come to a dignified and humane slaughter.

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