ood Management Practices For Animal Handling And Stunning

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Written by
Temple Grandin, Ph.D.
Dept. of Animal Science
Colorado State University

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(December 2002 Edition)

by
Temple Grandin, Ph.D.
Dept. of Animal Sciences
Colorado State University
Fort Collins, CO 80523-1171

These Good Management Practices are a supplement to the American Meat Institute's *Recommended Animal Handling Guidelines for Meat Packers,* which was updated in 2002.

The main emphasis of this guide is on the use of welfare performance standards that can be objectively scored instead of specifying practices or equipment design. Scoring procedures for accessing animal welfare and recommendations which will help improve animal welfare are described. The recommended scoring procedures are simple enough to be conducted easily under commercial conditions and they should be undertaken at least once a week. Scoring should be done at both the beginning and the end of a shift to determine the effect of employee fatigue.

If a score falls below the acceptable range specified in the guide, plant management should take steps to correct the problem. The results of the 1996 Survey of Stunning and Handling in Federally Inspected Beef, Pork, Veal and Sheep Slaughter Plants (sponsored by USDA's Animal and Plant Health Inspection Service) indicated that the recommended minimum acceptable levels specified in this guide can be achieved easily with a minimal of expense (Grandin, 1997). Additional data collected during audits of beef and pork plants have further verified that the minimum standards are easily attainable (Grandin, 2000).

Objective scoring should be done in the following areas which are the critical control points for good animal welfare (Grandin, 1998). The minimum acceptable percentage scores in this guide were determined by the author based on over twenty years of practical experience in over 100 different slaughter plants and are realistic goals for a properly run plant.

1. Percentage of pigs, cattle, and sheep where the electric stunner was placed in the wrong position.
2. Percentage of cattle which had to be shot more than once with the captive bolt stunner.
3. Percentage of sensible and partially sensible animals on the bleed rail.
4. Percentage of animals falling down or slipping.
5. Percentage of cattle vocalizing in the stunning chute area, which includes the stunning box, restrainer, lead-up chute, and crowd pen.
6. Percentage of pigs vocalizing in the stunning pen or restrainer conveyor.
7. Percentage of animals prodded with an electric prod.
8. Non-ambulatory animal procedures.

Poor performance with respect to any one of the above critical points would result in reduced animal welfare. These guidelines also contain criteria for stunning equipment and recommendations which will enable a plant to maintain acceptable welfare scores. Other areas of animal welfare concern that will be covered are ritual slaughter and the handling of non-ambulatory animals.

Stunning

Electrical Specifications for Electric Stunning – Electric stunning equipment must operate within the electrical parameters that have been verified by scientific research to induce instantaneous insensibility. Scientific research has shown that an electric stunner must have sufficient amperage to induce a grand mal seizure to insure that the animal will be made instantly insensible. Insufficient amperage can cause an animal to be paralyzed without losing sensibility. For market pigs (not mature sows or boars) a minimum of 1.25 amps is required (Hoenderken, 1982, Gregory, 1988). For sheep a minimum of one amp is required (Gregory and Wotton, 1984; Gilbert et al., 1991). These amperages must be maintained for one second to give instant insensibility. The Council of Europe (1991) recommends the above minimum amperages.

There must be sufficient voltage to deliver the recommended minimum amperage; 250 volts is the recommended minimum voltage for pigs to insure insensibility (Troeger and Woltersdorf, 1989). Amperage is the most important variable to measure. The voltage that will be required will depend on the wetness of the animal and whether or not it is dehydrated.

Research has shown that too high of an electrical frequency will fail to induce insensibility. Warrington (1974) found that insensibility was most effectively induced at frequencies of 50 cycles. Frequences from 2000 to 3000 hz failed to induce instant insensibility and may cause pain (Croft, 1952; Van der Wal, 1978). However, in pigs weighing under 200 lbs (80 kg), Anil and McKinstry (1994) found that a high frequency 1592 hz sine-wave or 1642 hz square wave head; only stunning at 800 ma (0.80 amp) would induce seizure activity and insensibility in small pigs. One disadvantage is that the pigs regained sensibility more quickly compared to stunning at 50 to 60 cycles. The pigs in this experiment weighed one-third less than comparable U.S. market pigs and this probably explains why the lower amperages were effective.

Equipment is commercially available for stunning pigs with 800 hz applied across the head by two electrodes and a second stun with 50 to 60 hz from head to body. Research has shown that 800 hz is effective when applied across the head (Bergaus and Troeger,1998; Lamboij et al., 1996 and Wenzlawowicz et al., 1999).

Some plants stun animals below the Council of Europe recommended minimum amperages in an attempt to reduce blood spots in the meat. Stunning market pigs with less than 1.25 amps should not be permitted (Hoenderden, 1982; Grandin, 1994a) unless the results of lower amperages are verified by either electrical or neurotransmitter recordings taken from the brain. Since only a one-second application at 1.25 amps is required to induce instant insensibility in market pigs, it is the author's opinion that

plants should be permitted to use circuits which lower the amperage setting after an initial, one second stun at 1.25 amps for pigs and one amp for sheep. Plants should also be encouraged to use electronic constant amperage circuits that prevent amperage spiking. Both practical experience and research has shown that these types of circuits greatly reduce petechial hemorrhages (blood spots) (Grandin, 1985; Blackmore and Peterson, 1981).

Research has shown that stunning pigs with frequencies higher than 50 to 60 cycles is effective (Anil and McKinstry, 1994). In this experiment, the pigs were stunned with a head only applicator. High frequency stunning has never been verified to induce instant insensibility when applied as a single stun with a head to body electrode. This is the type of electrode used in many large U.S. pork slaughter plants. Plants should be permitted to use frequencies up to 800 hz applied by two electrodes across the head (Wenzlawowicz et al., 1999).

Unlike pigs and sheep, electrical stunning of cattle requires a two-phase stun. Due to the large size of cattle, a current must first be applied across the head to render the animal insensible before a second current is applied from the head to the body to induce cardiac arrest (Gregory, 1993). Modern systems may have a third current to reduce convulsions (Wotton et al., 2000). A single 400 volt, 1.5 amp current passed from the neck to the brisket failed to induce epileptic form changes in the brain (Cook et al., 1991). To insure that the electrodes remain in firm contact with the bovine's head for the duration of the stun, the animal's head must be restrained in a mechanical apparatus. The Council of Europe (1991) requires a minimum of 2.5 amps applied across the head to induce immediate epileptiform activity in the electro-encephalogram (EEG) of large cattle. A frequency of 60 or 50 cycles should be used unless higher frequencies are verified in cattle by either electrical or neurotransmitter measurements taken from the brain. A more recent study has shown that 1.15 amps sinusoidal AC 50 hz applied for one second across a bovine's head is effective (Wotton et al., 2000).

Electrodes must be cleaned frequently to ensure a good electrical connection. The minimum cleaning schedule is once a day. For personal safety, the electrode wand must be disconnected from the power supply before cleaning. Adequate electrical parameters for cardiac arrest stunning cannot be determined by clinical signs, because cardiac arrest masks the clinical signs of a seizure. Measurement of brain function is required to verify any new electrical parameters which may be used in the future. Common causes of a return to sensibility after electric stunning are: 1) wrong position of the electrode, 2) amperage that is too low, 3) poor bleedout, or 4) poor electrode contact with the animal (Grandin, 2001). Other factors that may contribute to poor electrical stunning are: dirty electrodes, insufficient wetness, electrode contact area that is too small, animal dehydration and long hair or wool. Interrupted contact during the stun may also be a problem (Gregory, 2000). For all species plants with an excessively long stunning to bleed time are more likely to have return to sensibility problems.

Vocalizations such as squeals, moos, and bellows in cattle and pigs are signs of discomfort and stress (Dunn 1990; Grandin 1998; White et al., 1995 and Warriss et al., 1994). To prevent vocalizations the electrodes must be in firm contact with the animal prior to being energized. Squealing of pigs during electric stunning was more frequent in plants that had return to sensibility problems (Grandin, 2001). Data collected in 19 commercial pork slaughter plants indicated that approximately half of the plants had

0% squealing during stunning (Grandin, 2001). Vocalization scores should be used for cattle and pigs. Vocalization scoring is not recommended for sheep.

Electric Stunning – Electrode Placement Efficacy Criteria for Scoring (Score a minimum of 100 pigs, cattle or sheep in large plants and 50 in small plants. In very small plants score 1 hour of production.)

- Excellent – 99.5 to 100% correct placement of stunning wand or tongs and no vocalization due to energizing the electrode before it is firmly positioned.
- Acceptable – 99.4 to 99% correct placement and 1% or less of the animals vocalize in response to electrode placement.
- Not Acceptable – 98 to 96% correct placement and 2 to 3% of the animals vocalize due to energizing the electrodes before the are firmly positioned.
- Serious Problem – Less than 96% correct placement or more than 4% vocalization in response to electrode placement.

Use the whole numbers for 100 and 50 animal audits. For data collection on large numbers of animals, the fractional percentages can also be used.

If head only stunning is used, the tongs must be placed so that the current passes through the brain (Croft, 1952; Warrington, 1974; Anil and McKinstry, 1998 and Velarde et al., 2000). Tongs may be placed on both sides of the head or one tong on the top and the other on the bottom of the head. Another scientifically verified pair of locations for head only stunning is one electrode placed under the jaw and the other placed on the side of the neck, right behind the ears. For cardiac arrest stunning of pigs and sheep with a single stunning current, one electrode must be placed on the body and the other one must be placed on the forehead, side of the head, top of the head, or in the hollow behind the ear. Placement of the head electrode on the jowl below the pig's ear resulted in eye reflexes in 0.5% of the pigs (Grandin, 2001). The head electrode must never be placed on the neck because this would cause the current to bypass the brain. Electrodes must not be applied to sensitive areas such as inside the ear or in the eye or rectum. Electrodes must be placed firmly against the animal because breaking electrical contact during the stun may reduce the effectiveness of the stun.

Captive Bolt – Stunning Efficacy Criteria

(Score a minimum of 100 animals in large plants and 50 in small plants. In very small plants score one hour of production). For a more accurate assessment in small plants data, collected over a period of time should be averaged.

- Excellent – 99 to 100% instantly rendered insensible with one shot
- Acceptable – 95 to 98% instantly rendered insensible with one shot
- Not Acceptable – 90 to 94% instantly rendered insensible with one shot
- Serious Problem less than – 90% instantly rendered insensible with one shot

If one shot efficacy falls below 95%, immediate action must be taken to improve the percentage.

The most common cause of a low captive bolt stunning efficacy score is poor maintenance of the captive bolt stunners. Stunners must be cleaned and serviced per the manufacturer's recommendations

to maintain maximum hitting power and prevent misfiring or partial firing. If a test stand is available for measuring bolt velocity for your brand of stunner its daily use is strongly recommended. Each plant should develop a system of verified maintenance for captive bolt stunners.

Another major cause of failure to render animals insensible with one shot is a poor ergonomic design of bulky pneumatic stunners. Aversive methods of restraint which cause three percent or more of the cattle or pigs to vocalize must not be used as a substitute for improvements in gun ergonomics. Ergonomics for stunning in a conveyor or restrainer can be improved with a handle extension on the stunner and hanging the pneumatic stunner on an angle. Still another cause of poor stunning is damp cartridges. Cartridges must be stored in a dry place.

Electrical immobilization must never be used as a method for restraining sensible animals prior to or during stunning. Several scientific studies have shown that it is highly aversive (Lambooy 1985; Pascoe, 1986; Grandin et al., 1986; Rushen, 1986). Vocalization scoring is impossible in electrically immobilized animals because paralysis prevents vocalization. Electrical immobilization must not be confused with electric stunning. Properly done, electric stunning passes a high amperage current through the brain and induces instantaneous insensibility. Electrical immobilization keeps a sensible animal still by paralyzing the muscles. It does not induce epileptiform changes in the EEG (Lambooy, 1985).

Another cause of missed captive bolt shots is an overworked or fatigued operator. Scoring at the end of the shift will pinpoint this problem. In some large plants two stunner operators may be required. Rotating the stunner operator to other jobs throughout the day may help prevent errors caused by fatigue.

CO_2 Stunning Handling Criteria

The efficacy of CO_2 and other types of gas stunning methods is determined when insensibility is scored. The critical control point is that the animal remain insensible after exiting the chamber. However, the gas system must also be evaluated for animal handling. The gondolas, elevator boxes or other apparatus used for moving the animals in and out of the gas must not be overloaded.

Score 50 gondolas in large plants to determine the percentage of gondolas (elevator boxes) that are overloaded. In small plants score 25 gondolas. A gondola or elevator is to be scored as overloaded if there not sufficient space for the animals to stand or lie down without being on top of each other. Score on a per gondola basis:

- Excellent – No gondolas are overloaded on a 50 animal audit
- Acceptable – 4% of gondolas are overloaded
- Not Acceptable – More than 4% overloaded
- Serious Problem – The person moving the animals forces more than one pig to jump on top of the other pigs in the gondolas with an electric prod or by hitting, shoving or kicking.

For gas systems where the animals ride head to tail on a continuous conveyor that does not have separate animal compartments, do not use this scoring system. Omit this score and score the percentage of animals prodded with an electric prod. Electric prod scoring is discussed in another section of these guidelines.

Gas Stunning Parameters

In the scientific literature there are conflicting results on how pigs react to the induction of CO_2 anesthesia. Forslid (1988) found that purebred Yorkshire pigs have a calm induction and that convulsions and excitation occur after the pig becomes unconscious. Some genetic types of pigs actively attempt to escape from the container when they first sniff the gas and others have a calm anesthetic induction (Grandin, 1988). Dodman (1977) observed that the reaction of pigs to CO_2 was highly variable. A Dutch researcher found that the excitation phase occurred prior to the onset of unconsciousness (Hoenderken, 1983). Australian researchers found that being shocked with an electric prod was more aversive than inhaling CO_2 (Jongman et al., 2000). Research in people indicates that genetics affect the aversiveness of CO_2 inhalation (Griez et al., 1990; Bellodi et al., 1998). Differences in genetics probably account for the conflicting results between studies. British researchers recommend the use of argon for stunning pigs (Raj et al., 1997).

In evaluating gas stunning, one must look at the whole system which includes pig genetics, the handling system, and the gas mixture. One advantage of gas stunning is that gas stunning systems can be designed to eliminate the need for pigs to line up in single file chutes. Lining up in single files is a natural behavior for cattle, but pigs get stressed in a single file line. Regardless of gas type or mixture, the pigs should have little reaction when they first contact the gas and convulsions should begin after the pigs collapse.

If conscious pigs squeal, struggle vigorously or attempt to escape when they first contact the gas, this is a serious problem. Correcting this problem may require changes in either pig genetics or gas mixture. Observations in several plants indicate that elimination of the stress Halothane gene may reduce problems with stressful anesthetic induction. The gas parameters for each plant should be evaluated for ease of anesthesia induction by observing the behavior of the animals. The gas mixture is not acceptable if the pigs attempt to climb out of the container. It is normal to have violent kicking and convulsions after the pig falls over.

Stunning to Bleed Interval

Captive Bolt Stunning to Bleed Interval – This parameter does not have to be measured for welfare reasons unless non-penetrating captive bolt is used. Both penetrating and non-penetrating captive bolts are effective. However, non-penetrating bolts will cause less damage to the brain (Finnie et al., 2000). Practical experience has shown that for non-penetrating captive bolts to be effective the aim must be more precise. Animals stunned with a non-penetrating captive bolt should be bled within 60 seconds.

Electric Stunning to Bleed Interval – Cardiac Arrest – Sixty seconds maximum. All large plants are already using less than this interval.

Head Only Reversible Electric Stunning to Bleed Interval – Fifteen seconds is strongly recommended (Blackmore and Newhook, 1981), 30 seconds maximum (Hoenderken, 1983). Scientific

research clearly shows that pigs will start returning to sensibility after 30 seconds when stunned by the head only method. When frequencies of greater than 50 to 60 hz are used, these times may need to be shortened. When head only electric stunning is used for cattle or sheep the animal should be bled within 10 seconds.

Bleed Rail Insensibility – Criteria for stunned animals possibly showing partial sensibility such as eye reflexes or nose twitching (Score a minimum of 100 animals in large plants). When a 100 animal audit is performed, 100% must be rendered insensible. Use these figures when averaging the scores of many audits.

- Excellent – Cattle less than 1 per 1,000, Pigs and sheep less than 1 per 2,000
- Acceptable – Cattle less than 1 per 500, Pigs and sheep less than 1 per 1,000

There is a zero tolerance for beginning any slaughter procedure such as skinning the head, leg removal or scalding on an animal that shows any sign of return to sensibility. It must be immediately shot with a captive bolt stunner.

The signs of returning to sensibility are: 1) rhythmic breathing, 2) vocalizations while hanging on the bleed rail, 3) eye reflexes in response to touch, 4) eye blinking, 5) arched back righting reflex with the head bent straight back (Grandin, 1994; Gregory, 1988).

Animals should hang straight on the rail and have a floppy head. A head that flops upward for a brief moment when the legs kick should not be confused with a righting reflex. Old cows will sometimes have a sideways neck flexion that will relax out in less than 60 seconds. This must not be confused with a righting reflex. Limb movements should be ignored in animals stunned with electricity or captive bolt. If the tongue is hanging straight out and is limp and soft, the animal is definitely insensible. Gasping in electrically stunned animals is a sign of a dying brain and should be ignored (Gregory, 1988). However, twitching noses, or the tongue moving in and out are signs of a possible return to sensibility.

There must be a zero tolerance for hanging a fully sensible, unstunned animal in an inverted position on the bleed rail. Touching the eye and observing the corneal reflex is a good method for determining insensibility in animals stunned with captive bolt. In electrically stunned pigs, touching the eye may cause it to pop open suddenly which may be misinterpreted as a blink. The person scoring insensibility should look for spontaneous natural blinks, which look like the blinks in unstunned pigs (Grandin, 2001). A pig that blinks spontaneously would be scored as sensible. Nystagmus, or vibrating eyelids, is a sign of a poor stun in captive bolt stunned animals. However, in electrically stunned animals, it is permissible to have some animals with vibrating lids or eyes.

How to Determine Insensibility

In both captive bolt and electrically stunned animals, kicking will occur. Ignore the kicking and look at the head. To put it simply, THE HEAD MUST BE DEAD. When cattle are shot with a captive bolt, it is normal to have a spasm for 5 to 15 seconds. After the animal is rolled out of the box or hung up, its

eyes should relax and be wide open. Pigs stunned with CO_2 should be completely limp and floppy with no kicking or natural spontaneous eye blinking that occurs without touching the eye.

Below are the signs of a properly stunned animal:

1. The legs may kick, but the head and neck must be loose and floppy like a rag. A normal spasm may cause some neck flexing, but the neck should relax and the head should flop within about 20 seconds. Check eye reflexes if flexing continues. Animals stunned with gas stunning equipment should be completely limp and floppy.
2. The tongue should hang out and be straight and limp. A stiff curled tongue is a sign of possible return to sensibility. If the tongue goes in and out this may be a sign of partial insensibility.
3. For all methods of stunning, when the animal is hung on the rail, its head should hang straight down and the back must be straight. It must NOT have an arched back righting reflex. When a partially sensible animal is hung on the rail it will attempt to lift up its head. Sometimes the head will flop up momentarily when a back leg kicks. This should not be confused with a righting reflex.
4. When captive bolt is used, the eyes should be wide open with a blank stare. There must be no eye movements. Immediately after electrical stunning, the animal will clamp its eyes shut but should relax into a blank stare.
5. When captive bolt is used, the animal must NEVER blink or have an eye reflex in response to touch. In electrically stunned pigs, eye movements can be misinterpreted when un-trained people indiscriminately poke at the eyes. It is often best to observe without touching the eye. For all stunning methods, if the animal blinks with a natural blink where the eye closes and then re-opens, it is not properly stunned. If you are not sure what a natural blink looks like, look at live animals in the yards (lairage) before assessing insensibility.
6. Rhythmic breathing must be absent. Gasping is a sign of a dying brain and is OK. A twitching nose (like a rabbit) may be a good sign of partial sensibility.
7. In captive bolt-stunned animals, insensibility may be questionable if the eyes are rolled back or they are vibrating (nystagmus). Nystagmus is permissible in electrically stunned animals, especially those stunned with frequencies higher than 50 to 60 cycles.
8. Shortly after being hung on the rail, the tail should relax and hang down.
9. No response to a nose pinch. When testing for response to a painful stimulus the pinch or prick must be applied to the nose to avoid confusion with spinal reflexes. Animals entering a scald tub must not make a movement that is in direct response to contact with the hot water. For all types of stunning, this is an indicator of possible return to sensibility.
10. No vocalization (moo, bellow, or squeal).

These methods can be used for determining insensibility for all types of stunning and for ritual slaughter which is done without stunning. Just remember, kicking reflexes are normal in captive bolt-stunned animals, electrically stunned animals and after ritual slaughter. They should be absent for CO_2. Captive bolt stunning induces instant insensibility by both concussion and physical destruction of the brain. Stunner maintenance is essential to maintain maximum hitting power.

Scoring or Slipping and Falling

Good animal welfare and quiet calm handling is impossible if animals slip or fall on the floor. All areas where animals walk should provide non-slip footing. Animals should be observed during all phases of handling and if slipping or falling is observed, steps should be taken to correct the problem. Slipping on scales, unloading ramps and stunning boxes can often be corrected by installing a grating built from steel bars. A concrete grooving machine is one good method which can be used to roughen an existing floor. Since the survey results indicated that the greatest slipping and falling problems were in the stunning chute area, scoring should be done in this area.

Scoring of Slipping and Falling in the Stunning Chute Area (All Species) (Score a minimum of 50 animals in large plants). In many plants, formal data collection is not required. In most plants that have non-slip flooring, falling seldom occurs. Problems with slipping or falling are usually a big problem or almost no problem. Formal scoring should be done if slipping or falling is observed. If many animals become agitated in the stun box or single file chute, formal scoring of slipping should be done.

Score in the restrainer entrance, stunning box, lead up chute and crowd pen. Observation without formal scoring should be made in the stockyard pens, scales and unloading ramps.

- Excellent – No slipping or falling
- Acceptable – Slipping of less than 3% of the animals
- Not Acceptable – 1% falling down (body touches floor)
- Serious Problem – 5% falling down or 15% or more slipping

Vocalization Scoring of Cattle

Vocalization is an indicator of cattle discomfort during handling, restraint and stunning (Grandin, 1988b, 2001b). Dunn (1990) reported that significantly more cattle vocalized when they were held in a restraint device that inverted them on their backs, compared to upright restraint.

The 1996 USDA survey results indicated that the percentage of cattle which vocalized in the stunning chute area ranged from three percent or less of the cattle in the three best plants to 12 percent to 32 percent in the two worst plants. Cattle vocalizations in the stunning chute area were caused by prodding with an electric prod, slipping in the stunning box, missed captive bolt stuns or excessive pressure applied by a restraint device. The survey results showed that plants with a high percentage of cattle vocalizing could easily reduce this percentage. The average vocalization percentage in the two roughest plants was reduced from 22 percent of the cattle to 4.5 percent by reducing electric prod usage.

The 1996 survey results clearly showed that cattle seldom vocalize during handling or stunning unless an easily observed aversive event occurred. A total of 1,125 cattle were vocalization scored and 112 animals vocalized (Grandin, 1998b). Only two animals vocalized that were not responding to an aversive event such as electric prodding, slipping, falling, missed stuns, or excessive pressure from a restraint

device. Other aversive events which can cause vocalization are hitting cattle with gates or pinching an animal in a restraint device. This indicates that vocalization is an indicator of discomfort. Additional data indicates that vocalizations are associated with equipment problems such as excessive power in electric prods, excessive pressure from a restraint device and problems with chutes and restrainers that caused cattle to balk and refuse to move (Grandin, 2001). Cattle that balk and back up have to be prodded more with an electric prod. Equipment with sharp broken edges that stick into cattle will increase the percentage of animals that vocalize.

Criteria for Vocalization of Cattle in the Crowd Pen, Lead-up Chute, Stunning Box or Restraint Device (Score a minimum of 100 animals in large plants and 50 in smaller plants. For data collection on large numbers of animals the fractional percentages can be used.)

- Excellent - Zero to 0.5% or less of the cattle vocalize
- Acceptable – 3% or less of the cattle vocalize
- Not Acceptable – 4% to 10% vocalize
- Serious Problem – Over 10% vocalize

When vocalization is being evaluated, cattle from more than one feedlot or ranch should be observed. There are variations in the tendency of some cattle to vocalize (Watts and Stooky, 2000). To make the scoring simpler, each animal should be classified as either a vocalizer or a non-vocalizer. Vocalization scoring of 5806 cattle in 48 commercial slaughter plants indicates that an acceptable score of 3% or less of the cattle vocalizing is easily achievable (Grandin, 2001).

Cattle vocalizations should be tabulated during handling in the crowd pen, lead up chute, restrainer or stunning box while the animals are being actively handled. Vocalizations occurring in the yards should not be tabulated because cattle standing quietly in the yards will often vocalize to each other. In one plant, hungry Holsteins vocalized and turned to face a man bedding a pen with sawdust. It appeared that they perceived the sawdust as feed.

Cattle should be stunned immediately after they enter a stun box or restrainer. Isolated animals will often vocalize. The author has observed that vocalization scoring is very efficient for identifying plants with cattle handling or equipment problems. Vocalization scoring works well in packing plants because cattle are stunned quickly after they are restrained.

Observations at a sheep slaughter plant indicated that vocalization during handling is absolutely useless as a measure of handling problems in sheep. Sheep walking quietly up the stunning chute often vocalized to each other. Sheep which balked and had to be pushed by a person never vocalized. This is a species difference between cattle and sheep and neither the presence or absence of vocalization should be used as a measure.

Vocalization Scoring of Pigs

Research conducted in commercial pork slaughter plants indicated that the intensity of pigs squealing

in the stunning chute area is correlated with physiological measures of stress and poorer meat quality (Warris et al., 1994). Squealing was measured with a sound meter. White et al. (1995) also found that the intensity of pig squeals is correlated with discomfort.

Since it is impossible to count individual pig squeals when a group of pigs is being handled, vocalization scoring of individual pigs can only be conducted in the restrainer. The 1996 USDA survey results indicated that there were two major causes of pig vocalizations. They were misapplied electric stuns and pinching in the restrainer. The 1996 USDA survey results indicated that vocalization in the restrainer ranged from zero percent to 14 percent of the pigs. Out of 11 plants, 72 percent (8 plants) had no pigs squealing due to mis-applied electric stuns. In two plants, two percent to four percent within a plant squealed during stunning. Sound level meters can be used for monitoring pig vocalizations during handling. Due to difference in machinery noise and the numbers of pigs in the stunning area in each plant, decibel levels for acceptable handling would have to be determined by collecting data in each plant.

Another simple method for monitoring continuous improvement within a plant is estimating the percentage of time that the entire stunning room is quiet. As each pig is stunned the person doing the scoring checks off whether or not the room was quiet. The score is the percentage of stunning cycles where the room was quiet. When CO_2 stunning is evaluated, a stunning cycle consists of the time to fill a gondola. Due to many variables such as the number of pigs in the stunning room and stunning room layout, absolute comparisons between pork plants is difficult. However, one can conclude that a plant that has continuous constant squealing has pig welfare problems. This method is excellent for within plant monitoring over time.

Criteria for vocalization of pigs in conveyor restrainers on this parameter. Do not score vocalizations caused by a mis-applied stunner.

Score a minimum of 100 pigs in large plants and 50 pigs in smaller plants.

- Excellent – 0% of the pigs vocalize
- Acceptable – 1% or less of the pigs vocalize due to the restrainer; none do to a misapplied stunner
- Not Acceptable – 2% or more vocalize in the restrainer
- Serious Problem – 5% or more vocalize in the restrainer

When 50 or less pigs are scored, a single squealing pig is acceptable. When more data is collected and averaged used the 1% level for an acceptable rating.

Restraint Device Principles Which Reduce Stress on Animals and Help Reduce Vocalization

In several different publications the author has outlined the behavioral principles of low stress animal restraint and handling (Grandin, 1991, 1994, 1995, 1996, 2000, 2001c). Pigs and cattle should enter a restraint device easily with a minimum of balking. Correcting problems with animal restraint devices can also help reduce bruises and meat quality defects such as blood splash. The basic principles of low stress restraint which will minimize vocalization and agitation are:

1. For cattle, block the animal's vision with shields so that they do not see people or objects that move while they are entering the restrainer. Install metal shields around the animal's head on box type restrainers to block the animal's vision.
2. Block the animal's vision of an escape route until it is fully held in a restraint device (Grandin, 1991). This is especially important on restrainer conveyors. A flexible curtain made from discarded conveyor belts at the discharge end of the conveyor works well. Cattle often become agitated in a conveyor restrainer if they can see out from under the solid hold down cover before their back feet are off the entrance ramp. Extending the solid hold down cover on a conveyor restrainer will usually have a calming effect and most animals will ride quietly. Solid hold downs can also be beneficial for pigs on conveyor restrainers.
3. Eliminate air hissing and other distractions such as clanging and banging. Refer to the section on distractions.
4. The restraint device must be properly lighted. Animals will not enter a dark place or a place where direct glare from a light is blinding them. To reduce balking at the entrance of a conveyor restrainer, install a light above the entrance. The light should be above the lead-up chute. It should illuminate the entrance of the restrainer, but it most not glare into the eyes of approaching animals. Light coming up from under a conveyor restrainer should be blocked with a false floor to prevent animals from balking at the "visual cliff effect."
5. Provide non-slip flooring in box-type restrainers and a non-slip cleated entrance ramp on conveyor restrainers. Animals tend to panic and become agitated when they lose their footing. Stunning boxes should have a non-slip floor.
6. Parts of a restrainer device operated by pneumatic or hydraulic cylinders that press against the animal's body should move with a slow steady motion. Sudden jerky motion excites animals. On existing equipment, install flow control valves to provide smooth steady movement of moving parts that press against the animal.
7. Use the concept of optimum pressure. The restraint device must apply sufficient pressure to provide the feeling of being held, but excessive pressure that causes pain should be avoided. Install a pressure regulator to reduce the maximum pressure that can be applied. Very little pressure is required to hold an animal if it is fully supported by the device. If an animal bellows or squeals in direct response to the application of pressure, the pressure should be reduced.
8. A restraint device must either fully support an animal or have non-slip footing so the animal can stand without slipping. Animals panic if they feel like they may fall. Restraint devices should hold fully sensible animals in a comfortable, upright position.
9. Restraint devices must have controls that enable the operator to control the amount of pressure that is applied. Different sized animals may require differing amounts of pressure. Hydraulic or pneumatic systems should have controls that enable a cylinder on the device to be stopped in mid stroke.
10. Never hold an animal in a head restraint device for more than a few seconds. The animal should be stunned or ritually slaughtered immediately after the head holder is applied. Head restraint is much more aversive than body restraint. Animals can be held in a comfortable body restraint for longer periods. The animal's reaction should be observed. If the animal struggles or vocalizes, it is an indication that the device is causing discomfort.
11. Restraint devices should not have sharp edges that dig into an animal. Parts that contact the

animal should have smooth rounded surfaces and be designed so that uncomfortable pressure points are avoided.

12. On V conveyor restrainers, both sides should move at the same speed.

In conclusion of this animal restraint section, in most plants it is possible to modify existing restraint devices to lower vocalization and agitation scores. Balking at the entrance is also easy to reduce. Most of the modifications that would reduce animal agitation and vocalizations can be installed at a minimum expense. The estimated cost to modify a system is usually between $200 to $2,000.

Electric Prod Use

Reducing the use of electric prods will improve animal welfare. Shocking pigs with electric prods significantly raises heart rate, open mouth breathing and many other physiological measures (Benjamin, 2001). Many well-managed plants have totally eliminated electric prods in the holding pens and the crowd pen that leads to the single file chute. In beef plants with well-trained handlers, the survey showed that 90 to 95 percent of the animals could be moved through the entire plant without the use of an electric prod. USDA regulations require that electric prods have a voltage of 50 volts or less.

An easy way to test an electric prod to determine if it delivers too intense a shock is to touch an animal for one second with the prod. If it causes animals to vocalize, the power should be reduced. Prods which have sufficient power to knock an animal down or paralyze it must not be used. Electric prods must never be applied to sensitive parts of the animal such as the eyes, ears, nose or anus.

Electric Prod Scoring Criteria for Cattle
Percentages of Animal Prodded

Excellent	5% or less
Acceptable	25% or less
Not Acceptable	26% to 49%
Serious Problem	50% or more

Electric Prod Scoring Criteria for Pigs
Percentages of Animals Prodded

Excellent	10% or less
Acceptable	25% or less
Not Acceptable	26% to 79%
Serious Problem	80% or more

CO2/Group Stunning System for Pigs - No Single File Chute

Excellent	0%
Acceptable	0%

* Electric Prods should never be used on sheep.

Revisions to this standard are based on data collected from 26 plants which were audited by McDonalds during 1999 and 2000 (www.grandin.com). In 2000 sixty-eight percent of the plants used no electric prods in the crowd pen and 62% used an electric prod on fifteen percent or less of the pigs at the restrainer entrance.

Handing Recommendations to Reduce Electric Prod Use and Maintain Efficient Handling

1. **Remove Distractions That Cause Balking** – This includes air hissing, shadows, reflections off shiny metal, ventilation drafts blowing in the faces of approaching animals, and seeing either moving people or moving machinery up ahead. Get down in the chutes and look to find out what the animals are balking at. Install shields or strips of discarded conveyor belting to prevent animals from seeing movement up ahead as they approach the restrainer or stunning box. Reflections can sometimes be eliminated by moving a light. Ventilation drafts blowing down the chute toward the animals may make it impossible to reduce electric prod use. The plant ventilation system may need to be adjusted.

2. **Provide Adequate Lighting** – Animals may refuse to enter a dark place. Entry into a restrainer can be facilitated by aiming a light into the entrance. The light must NOT shine into the eyes of approaching animals. Animals may be difficult to drive out of the crowd pen if the pen is brightly illuminated by sunlight and the chute is inside a darker building. Lighting problems can make quiet handling almost impossible. Another common lighting problem is that a handling system may work well when lamps are new, but the animals will balk more and more as the lamps dim with age. Experiment with portable lights to find the most efficient lighting. Animals may also balk at shiny reflections off a piece of metal or sparkling water on the floor. Moving a light will often eliminate the reflections.

3. **Reduce High-Pitched Noise** – Animals are very sensitive to high-pitched noise. Reducing high-pitched motor and hydraulic system noise can improve animal noise which can improve animal movement. Clanging and banging metal should be reduced and hissing air should be muffled. Yelling and whistling is stressful to cattle (Waynert et al, 1999; Rushen et al., 1986). Animals with a nervous, excitable temperament are more sensitive to high pitched noise and rapid movement (Lanier et al., 2000). Handlers should be calm and avoid yelling and waving of their arms.

4. **Move Animals in Small Groups** – When cattle and pigs are being handled, the crowd pen and the staging areas which lead up to the crowd pen should never be filled more than three-quarters full. Half full is best. Do not push crowd gates up tight against the animals. Cattle and pigs need room to turn. For sheep, large groups may be moved and the crowd pen can be filled all the way up.

5. **Using Other Driving Aids** – Electric prods should be replaced as much as possible with other driving aids such as plastic paddles, a stick with a flag on the end or large flags for pigs. An electric prod should never be a person's primary driving tool and electric prod should only be picked up when an animal refuses to move. In most plants, the only place an electric prod is needed is at the entrance to the stun box or restrainer. The animals should move easily and handlers should not hit them. Cattle and pigs

can often be moved along a chute when the handler walks by them in the opposite direction of desired movement, taking advantage of the point of balance at the animal's shoulder.

6. **Problems with Excitable Animals** – There are some animals which have a very excitable temperament and are difficult to drive. Some lean pigs are very excitable. These animals will often have high vocalization scores. Plant management needs to work with producers to solve this problem. Pigs with excitable genetics can be made easier to handle at the meat packing plant if producers walk through the pens during finishing. This trains excitable pigs to handling. Producers should be encouraged to produce animals that will be reasonably easy to handle.

7. **Non-Ambulatory Animals** – Each plant should develop guidelines and procedures for handling non-ambulatory animals in a humane manner. Dragging sensible non-ambulatory animals is a violation of the Humane Slaughter Act regulations. Stunned, non-ambulatory animals may be dragged. If a skid steer loader (Bob Cat) is used to transport non-ambulatory pigs or sheep, the animal must be rolled into the bucket by a person. Loading a non-ambulatory animal into the bucket by shoving it up against a wall or fence is not acceptable. Bare forklift forks shoved under non-ambulatory cattle is not an acceptable method for moving them.

The AMI and the USDA should develop ways to safely inspect non-ambulatory animals that can't walk off the trucks so they do not have to be removed from the truck prior to anti-mortem inspection. Animal welfare would be greatly improved because non-ambulatory animals could be inspected and stunned on the truck.

Plant personnel should develop procedures to help reduce the occurrence of non-ambulatory animals on the premises. Non-slip flooring is essential. Mounting activity and animal fights can cause injuries. This is especially a problem with bulls and boars. Bulls which are mounting other animals should be placed in separate pens. Mounting by bulls is a common cause of bruises and crippling injuries on cows. Producers need to work to reduce the occurrence of non-ambulatory animals which are caused by either poor management or neglect.

There are three basic types of non-ambulatory animals which may arrive at a packing plant. The first type is a nonambulatory animal that will not readily recover because of its condition due to injury, neglect, severe lameness or emaciation. Many of these animals are both welfare and food safety concerns. The second type is a healthy animal with a recent severe injury. The third type of non-ambulatory animal is a stress non-ambulatory pig which may recover if allowed to rest. These pigs are a welfare concern but are not a food safety concern. Stressor pigs can be caused by excessive electric prod use and rough handling (Benjamin, 2001). Pigs that are free of the stress gene will have a lower incidence of death losses (Murray and Johnson, 1998).

Ritual Slaughter (Kosher and Halal)

Cattle, calves, sheep or other animals that are ritually slaughtered without prior stunning should be restrained in a comfortable upright position. The throat cut should be made immediately after the head is retrained. Small animals such as sheep and goats can be held manually by a person during ritual slaughter. Plants which conduct ritual slaughter should use the same scoring procedures except for stunning scoring, which should be omitted in plants which conduct ritual slaughter without stunning. Cattle vocalization percentages should be five percent or less of the cattle in the crowd pen, lead up chute and restraint device. A slightly higher vocalization percentage is acceptable because the animal must be held longer in the restraint device compared to conventional slaughter. A five percent or less vocalization score can be easily achieved. Scoring criteria for electric prod use and slipping on the floor should be the same as for conventional slaughter.

Pen Stocking Density

Pens should be stocked per the AMI 2002 guidelines. All animals must have room to lie down without being on top of each other. All animals should have access to water.

Maintenance

Pens, alleys, chutes, restrainers and other equipment should be kept clean and well maintained. They should be free of protrusions which could injure animals.

Scoring of Very Small Plants

Small beef plants that process 25 or less beef cattle per hour may need adjustments in scoring due to small sample size and differences in cattle behavior. Ideally 50 or more cattle should be scored, but this is often not practical in a plant that processes 5 to 10 cattle per hour. For a plant's own internal audit, data should be pooled and averaged. Pooled small data sets can be scored per the American Meat Institute's guidelines. When a small plant is audited by an outside auditor, sometimes only 10 to 20 cattle are observed. If one stun is missed the plant would not achieve the 95% acceptable score. If passing or failing the stunning audit is based on a single small data set, one miss should be permitted. However on polled data the 95% first shot efficacy score must be maintained. On small data sets of 10 to 20 cattle, all cattle (100%) must be rendered insensible prior to hoisting to pass the audit.

Cattle Vocalization Scoring of Very Small Plants

Cattle will often vocalize and communicate with each other while standing in the yards. This "talking to each other" vocalization is not scored. When cattle are being actually handled and moved, they ususally do not vocalize unless something aversive happens such as being poked with an electric prod. In very small beef plants with line speeds of less than 25 cattle per hour, the animals may stand for long periods in the single file chute (race) and "talk" to each other. Their "talking" vocalizations are not

scored. "Talking" vocalizations in the handling system occur more often at slows line speeds. An animal should be scored as a vocalizer if the vocalization is associated with:

1. Poking with an electric prod
2. Slipping or falling
3. Vocalizing in the stun box
4. Poking by sharp edges on equipment
5. Hitting with gate
6. Excessive pressure from a restraint device
7. Missed stuns
8. Physical abuse by a person
9. Vocalizations associated with signs of agitation such as rearing, jumping, repeated backing up in the single file race or frantic attempts to escape
10. Vocalization associated with isolation of a single animal away from other cattle

Conclusion

An acceptable level of animal welfare can be maintained if scores at the critical control points for stunning, animal insensibility, slipping and falling, vocalization and electric prod use are in the acceptable range. Scoring performance on these variables is simple and easy to do under commercial plant conditions. Electrical stunning equipment must have amperage, voltage and frequency parameters that have been verified by either electrical or neurotransmitter recordings from the brain to reliably induce insensibility.

In conclusion, managers must be committed to good animal welfare. Plants which have managers who insist on good handling and stunning practices also have managers that insist that employees handle and stun animals correctly. You manage the things that you measure. To maintain good handling and stunning practices requires continuous measurement, monitoring and management.

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AMI Foundation
AMERICAN MEAT INSTITUTE
1700 N. Moore Street • Suite 1600
Arlington, Virginia • 22209-1995
Phone 703/841-2400 • Fax 703/527-0938
www.amif.org