Electrical and CO₂ Stunning, Handling, and Determining Insensibility in Pigs and Sheep, 2nd Edition

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All animals are rendered insensible to pain by a single blow or gunshot or an electrical chemical, or other means that are rapid and effective.
All Methods of Stunning

Definitely Conscious

- Remains standing
- Head or body right reflex
- Voluntary vocalization
- Spontaneous blinking (do not confuse with nystagmus)
- Eye pursuit
- Response to threat test-No touching

(Terlouw, et al., 2016)

If any one of these indicators is present, the animal is conscious.
All Methods of Stunning

- Definitely unconscious – Brain dead
- Absence of corneal reflex to touch
- Absence of eyelid reflex to touch
- Absence of rhythmic breathing (do not confuse with gasping)

(Terlouw et al., 2016; Verhoeven, et al., 2016)
All Methods of Stunning

- Situations where a second shot application of the electric stunner prevents return to sensibility.
- Weak corneal reflex
- Eyelid reflex
- Rhythmic breathing
- All indicators of definite consciousness must be absent.
All Methods of Stunning

- Before invasive dressing procedures start after bleeding
- All indicators of definite consciousness and definitely unconscious or brain dead must be absent
Trouble Shooting Handling

1. Distractions that cause balking
2. Slick floor causes agitation
3. Facility design problem
4. Employee training issue
5. Lame pigs
6. Pens not walked on the farm
Most Common Distractions

1. Reflections on water or metal
2. Air blowing towards approaching pigs
3. Moving people or equipment
4. Chute entrance too dark
5. Visual cliff in conveyor restrainer
Electric Prod Use on Pigs Was Reduced By Adding Lighting at the Restrainer Entrance

All handlers were well trained and only pigs that balked or backed up were prodded.
Indirect Lighting Works Best

This lamp is pointed in the same direction as the pigs
Pig Baulking at Metal Strip
Quiet handling in the stunning chute = 10% less PSE
<table>
<thead>
<tr>
<th>Handling</th>
<th>Blood Lactate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggressive</td>
<td>25 mmol/L</td>
</tr>
<tr>
<td>Quiet</td>
<td>4 mmol/L</td>
</tr>
</tbody>
</table>

Benjamin et al., 2001
Driving livestock “minimize excitement and discomfort”

“Any use of such implements (referring to electric prods or other driving implements) which, in the opinion of the inspector is excessive, is prohibited”
Big Question: When Does Tapping Become Beating?

- Video “Proper Use of Livestock Driving Tools with Temple Grandin”

- Demonstrates hitting an empty corrugated cardboard box. When it starts to crush, tapping has become beating.
1. Flight Zone Principles
2. Point of Balance
3. No Yelling
4. Move Pigs in Small Groups
5. Fill Crowd Pen Half Full
6. Get Electric Prods Out of People’s Hands
Use
Alternative
Driving Aids
Trouble Shooting
Electric Stunning

1. Excessive electric prod use due to distractions
2. Stunner settings
3. Employee training
4. Wand ergonomics
5. Line speed
6. Poor bleeding
Both sides of restrainer must run at the same speed
Two Types of Electric Stunning

- Head Only – Must bleed within 15 sec.
- Cardiac Arrest – Must bleed within 60 sec.
Head Only Reversible Stun Correct Position
The extended wand tips and extra star wheels (spurs) assure correct stun wand contact with brain.

Locate wand as close to the ear as possible, in the thin crevice. Note that this wand has two sets of star wheels for small and large pigs.

Longer, wider wand tips help to facilitate secure contact on the head of larger pigs.

Credit: Erika L. Voogd
For pigs larger than 200 pounds, extend wand tips to assure correct stun wand contact.

Extended tips with extra star wheels. Stainless steel star wheels (spurs) conduct better than carbon steel.

Credit: Erika L. Voogd
Procedure for Small Plants

After head only stunning, apply electrode to the heart to prevent return to sensibility

Vogel et al., 2010
Insulate the stun box to prevent grounding during stun

Truck rubber mats on floor and wall. Coated metal gate

Plastic lining in stun box area to insulate electrical current

Credit – Erika L. Voogd
Head to body cardiac arrest stunner
In small plants, many pigs that are head only stunned regain sensibility because the hoist is very slow. A simple solution to the problem is to apply the stunner to the head first and then apply it a second time to the chest to stop the heart (photograph courtesy of Erika Voogd)
Incorrect Head/Heart Saddle Stunner Placement
Electrodes must be positioned so the current goes through the brain.

Location of Pig Brain
EEG brainwaves used to determine that a proper stun induces a grand mal epileptic seizure.
### Minimum Stunner Amperage Settings

<table>
<thead>
<tr>
<th></th>
<th>Amps</th>
<th>Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25 amps</td>
<td></td>
<td>for pigs</td>
</tr>
<tr>
<td>1.00 amps</td>
<td></td>
<td>for sheep and cattle</td>
</tr>
</tbody>
</table>
Waveform of a good stun where the animal receives the full intensity and duration of the current.

Waveform of a correct stun.
Neville Gregory 2001
Waveform of bad stuns

Poor contact with the animal

Interrupted current (double stunning) and poor contact

Waveforms of poor stuns - Neville Gregory 2001
Blood Splash Caused By Poor Electric Stunning
Center Track Restrainer

May have less blood splash than a V Conveyor because there is less pressure on the body
Electric Stunning Troubleshooting
Blood Splash (manual and automatic)

1. Sliding wand during the stun
2. Hot wanding
3. Frayed wires inside the cords
4. Corroded switches
5. Water in switches or cords
6. Dirty electrodes
7. Animal grounds out through restrainer
8. Hold Down pushing down on the animal
9. One side of restrainer runs faster

Blood splash trouble shooting
Automatic Electric Stunners
Properly Stunned Insensible Pigs
Righting Reflex in a Fully Sensible Pig

Picture not from U.S.
Differences in Reactions of Insensible Animals

- Nystagmus (vibrating) eye must not be confused with natural spontaneous blinking. Nystagmus is permissible after electric or CO$_2$ stunning. It must be absent after captive bolt.

- Gasping like a fish out of water must not be confused with true rhythmic breathing. Gasping is permissible after electric or CO$_2$ stunning. It must be absent after captive bolt.

- Corneal Reflex must be completely absent after captive bolt.
Interpreting Eye Blinks in Electrically Stunned Pigs

Under plant conditions, avoid touching the eye with fingers. Watch for normal blinks which look like blinks on a live pig. The following are not blinks:

1. Nystagmus – vibrating eye or lid
2. Eye clenched shut – pops open
3. Opens when touched but does not close

In captive bolt stunned cattle, nystagmus is a sign of a possible poor stun
Troubleshooting Return to Sensibility Signs in Electrically Stunned Animals

1. Insufficient amperage
2. Poor bleeding
3. Poor initial contact that results in insufficient time
4. Interrupted current which results in insufficient time
5. Wrong placement on the head
6. Stunning-to-bleed interval too long with head only stunning

Trouble shooting return to sensibility
Improving Stun Wand Surface Area Can Increase the Stun Efficacy
Prone bleed may reduce blood splash because the stun to bleed interval is under 10 seconds.
Bleeding

Good bleeding with high blood flow

Poor bleeding with small blood flow
Correct position for shooting swine with a captive bolt or a firearm. Many old diagrams show a position that is too low (diagram by J.K. Shearer)
Captive Bolt Stunners for Non-Ambulatory Pigs are Often Neglected

- Store cartridges in a dry place and bring to the yards, a one-day supply of cartridges
- If the stunner has been used, it must be cleaned and serviced at the end of the shift
Genetics May Affect Pig's Reaction to CO$_2$

CO$_2$ Stunner
Low Stress Group Handling With CO$_2$
Best Practice:

Inspection port on CO₂ machine for observing anesthesia induction
Control of forward movements of crowd gate by a person prevents overcrowding
CO$_2$ Pigs Limp and Floppy

Slight limb movements and gasping may occur
### Order of Events During Return to Sensibility in CO<sub>2</sub> Stunned Pigs

<table>
<thead>
<tr>
<th>Event</th>
<th>Average Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corneal reflex (touch eye)</td>
<td>42 sec</td>
</tr>
<tr>
<td>Rhythmic breathing</td>
<td>68 sec</td>
</tr>
<tr>
<td>Excitation</td>
<td>76 sec</td>
</tr>
<tr>
<td>Nystagmus (vibrating eye)</td>
<td>86 sec</td>
</tr>
<tr>
<td>Spontaneous natural blinking (don’t touch)</td>
<td>93 sec</td>
</tr>
<tr>
<td>Conscious movement (righting reflex)</td>
<td>171 sec</td>
</tr>
<tr>
<td>Attempt to stand up</td>
<td>387 sec</td>
</tr>
</tbody>
</table>

These events are very variable

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Danish Meat Research Institute, Holst (2001)

CO<sub>2</sub> return to sensibility sequence
There is Zero Tolerance for Hoisting an Animal that is Showing Obvious Signs of Sensibility

There is Zero Tolerance for:
Skinning, Scalding, Dehairing or Removal of any Body Part on an Animal that Shows any Sign of Partial Return to Sensibility

It MUST be brain dead
Signs of Brain Death

- No corneal reflex
- Do not use finger – must use pen
- Eyelash reflex – Touch eyelashes only
- No rhythmic breathing
- Do not confuse with nystagmus (vibrating eye)
- Do not confuse with grasping
# Numerical Scoring System for Cattle

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stunned with one captive bolt or gun shot</td>
<td>95%</td>
</tr>
<tr>
<td>Insensible</td>
<td>100%</td>
</tr>
<tr>
<td>Electric prod - Acceptable</td>
<td>25%</td>
</tr>
<tr>
<td>Electric Prod – Excellent</td>
<td>5%</td>
</tr>
<tr>
<td>Falling down</td>
<td>1%</td>
</tr>
<tr>
<td>Vocalizing</td>
<td>3%</td>
</tr>
<tr>
<td>Vocalizing with head holder</td>
<td>5%</td>
</tr>
</tbody>
</table>
USDA/FSIS Robust Systematic Approach for Humane Slaughter Requirements

- Written Procedures – SOPs for staying in compliance, includes corrective action for a noncompliance
- Written Records of evaluations, internal NAMI audits, stunner maintenance log and employee training
- FSIS – Review of records and written procedure
- Is similar to a HACCP Plan
USDA/FSIS Definition of Egregious Inhumane Treatment

“An egregious inhumane treatment is any act or condition that results in severe harm to animals.”

FSIS Directive 6900.2, Revision 2
Useful FSIS Sources on the Internet

- Humane Interactive Knowledge Exchange (HIKE) Scenarios
- Humane Handling Enforcement Actions – List All Regulatory Actions
- Type titles into Google