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MEAT HYGIENE DIRECTIVE
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DIRECTIVE DE L'HYGIENE DES VIANDES
2011-18

SUBJECT: Chapter 12 – Annex A

OBJET : Chapitre 12 - annexe A

New document

Nouveau document

ENGLISH VERSION

VERSION ANGLAISE

Please add Annex A of Chapter 12 to your Manual of Procedures.

Veuillez ajouter l'annexe A du Chapitre 12 à votre Manuel des Méthodes.

FRENCH VERSION

VERSION FRANÇAISE

Please add Annex A of Chapter 12 to your Manual of Procedures.

Veuillez ajouter l'annexe A du Chapitre 12 à votre Manuel des Méthodes.

Richard Arsenault
Director
Meat Programs Division

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Directeur
Division des programmes des viandes

Att./p.j.

Canada

ANNEX A

SPECIES-SPECIFIC STUNNING GUIDELINES - RED MEAT SPECIES

Knowledge is not static.

Knowledge, understanding and commitment are indispensable for success.

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Annex A - Species-Specific Stunning Guidelines - Red Meat Species

1 Cattle

1.1 Mechanical

Important factors:

- Handling and restraint facilities must meet current OIE and industry standards.
- Cattle, especially mature males with horns, have very thick frontal bones overlaying the brain.
- Plan the trajectory so that the bolt or projectile travels through the brain (cerebral hemispheres, midbrain, brainstem). The most significant of these are the midbrain and brainstem, which are at the level of the bottom of the attachment of the ears.

Note: Together the **midbrain** and **brainstem** are responsible for eye movement and body movement, the level of consciousness and maintaining vital body functions, such as breathing and heart rate. (The cerebral hemispheres are associated with higher brain functions.)

- The trajectory is especially important when a firearm is used and the shooter is at **ground level** in front of the animal. Be aware that the trajectory of the projectile must pass through the midbrain and brainstem. (See [b].)

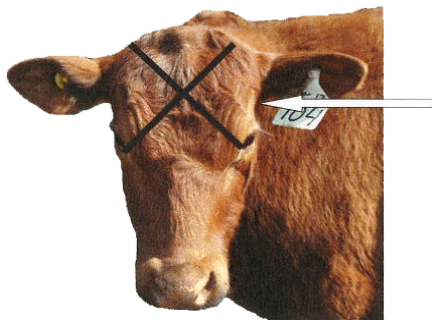
1.1.1 Landmarks and approaches

1.1.1.1 Perpendicular to the front of the head approach

- The **intersection** of diagonal lines from the middle of the attachment of each horn, or the nuchal crest (the ridge at the back of skull where the neck muscles attach to the head) to the medial canthus (middle corner) of the opposite eye. (See [a] and [b].)
- This is the approach used with captive bolt stunning devices (pneumatic and cartridge fired). This approach is sometimes used with firearms. (See pictures [a] and [b] below.)

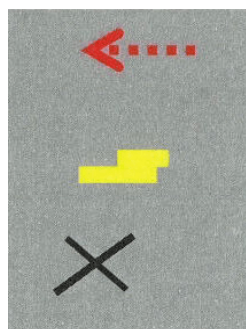
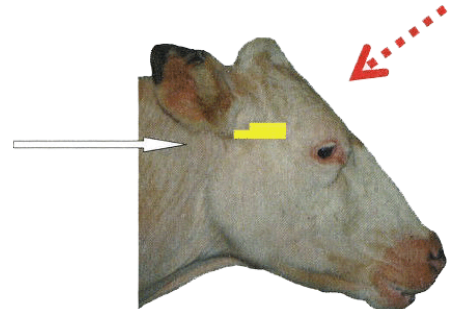
Perpendicular to the Front of the Head Approach

(a) Frontal View



foramen magnum
brain stem
and
midbrain
[in the centre
of the skull]

(b) Side View



Landmark and angle relative to the front of the skull when cattle are stunned with either a penetrating captive bolt stunning device or firearm. They are discharged perpendicular to the front of the head.

Location of the foramen magnum, **brainstem** and midbrain in centre of the skull.

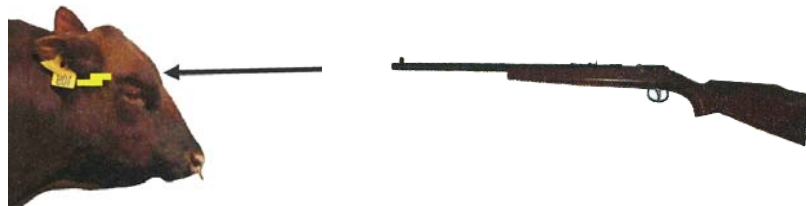
Intersection of the diagonal lines indicates the entry point for the bolt or projectile of a mechanical stunning device held perpendicular to the front of the skull

1.1.1.2 Firearm discharged with the operator standing at ground level in front of the animal

- When an animal is stunned with the operator standing at **ground level** in front of the animal, the entry point of the projectile into the front of the head (skull) must be much lower than what is used with the perpendicular approach, if it is to penetrate the midbrain and brainstem. (See pictures [a] and [b] below.)
- The midbrain and brainstem are the central and lower portions of the brain. They are located in the central and lower portion of the cranial vault [space containing the brain]. (See [a] and [b] below.)

Ground Level Approach

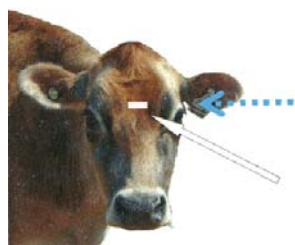
[a]



Side View

[firearm and projectile aimed at the midbrain and brainstem]

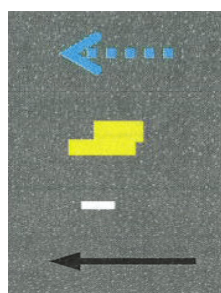
[b]



Brainstem - located in the middle of the skull, at the level of the bottom of the ears

Entry point at the front of the head (in white) - with the operator standing at ground level - if the projectile is to penetrate the midbrain and brainstem

Front view



Level of the brainstem - in the middle of the skull

Location of the brainstem and midbrain - middle of the skull

Entry point of the projectile (bullet) if the operator is standing at ground level

Trajectory of the projectile as it travels to the midbrain and brainstem

1.1.2 Mechanical Stunning Devices

1.1.2.1 Captive bolt

- Use the appropriate landmarks. (See 1.1.1.1.)
- **Do not** stun from the top of the head or behind the ears, due to the risk of pithing the animal.
- Discharge the stunning device perpendicular to the front of the head.
- For class of animals other than veal calves, the bolt length must be at least 12 cm (4 ¾ in.). The bolt length for bulls must be 15 cm (6 in.)
- Calibres (diameter) available for the cartridge bolts include .22, .25, and .33.
- The .25 calibre and larger captive bolt stunning devices with heavier charges are far more effective on bulls than the .22 calibre. (Temple Grandin recommends .25 calibre or larger.)
- Trigger and contact firing options are available.
- Use the manufacturer's recommended charge, cleaning, maintenance and stunning protocols.
- Assess bolt velocity by using the manufacturer's bolt velocity testing device, or similar means. (daily)

Penetrating Captive Bolt			
Animal	Calibre	Bolt Lengths	Muzzle Velocity (ft/s)
Calves	.22	Depends on size	Depends on size
Steers, heifers, cows	.22, .25, .33	12 cm (4 ¾ in.) or 15 cm (6 in.)	≥ 55 m/s (183 ft/s)
Young bulls	.22, .25, .33	15 cm (6 in.)	≥ 72 m/s (236 ft/s)
Mature bulls	.25, .33	15 cm (6 in.)	≥ 72 m/s (236 ft/s) (> 100 m/s preferred)

1.1.2.2 Firearms

- Use the slowest velocity and minimum energy required to effectively stun the animal.
- Maximum velocity < 2000 ft/s to help prevent ricochet from the surface of the skull.
- Maximum energy < 1000 ft/lbs to help prevent skull perforation (exiting the opposite side of the skull).
- Plan the trajectory so the projectile travels through the midbrain and brainstem, which are located at the level of the bottom of the attachment of the ears. See 1.1 “Important factors” above.

Rimfire Rifle Cartridges				
Animal	Calibre	Grain	Muzzle Velocity (ft/s)	Energy (ft/lbs)
Calves	.22 S (short) ¹	29	1095	77
	.22 LR (long rifle) ¹	40	1255	140
Steers, heifers, cows	.22 LR (long rifle) ¹	40	1255	140
	.22 Winchester Magnum	40	1910	324
Bulls	.22 Winchester Magnum	40	1910	324

¹ Do not use hollow point.

Centrefire Rifle Cartridges				
Animal	Calibre	Grain	Muzzle Velocity (ft/s)	Energy (ft/lbs)
Large Bulls	.30 Remington Carbine	110	1990	967 ²

² Upper limit of energy as the projectile may perforate the skull and enter the neck muscle.

Shotgun Shell					
Animal	Gauge	Length	Slug	Muzzle Velocity (ft/s)	Energy (ft/lbs)
Large Bulls	.410	2 ½ in.	¹ / ₅ oz (87 gr)	1830	651
	.410	3 in.	¹ / ₄ oz (108 gr)	1800	788

Ammunition



1.2 Electrical

Important Factors:

- Handling and restraint facilities must meet current industry standards.
- Individual animal restraint is required.
- The electrodes are firmly pressed against the animal until stunning is complete. This is to ensure they remain in contact and to facilitate current flow.
- A water spray is to be used to improve contact.
- Immediate post stun sticking is required (before or after hanging on line).
- OSH provisions required due to high amperage and voltage.

1.2.1 Landmarks and approaches

- Electrodes are firmly pressed against the top of the head (nuchal crest), the chin and the brisket.
- A two stage stunning technique must be used; a third stage **may** be used if required.

1.2.1.1 Phase I - Head-to-head

- In this stage a current is sent through one electrode that is firmly pressed against the **top of the head** (usually behind the nuchal crest) and a second electrode is firmly pressed against the **chin**. (See [a] below.)

1.2.1.2 Phase II - Head-to-brisket (body)

- Follows phase I
- In this stage a current is sent through an electrode firmly pressed against the **top of the head** and a third electrode that has been firmly pressed against the **brisket** [heart area]. (See [a] below.)

1.2.1.3 Phase III (Optional)

- Follows phase II
- This is an **optional** phase of electrical stunning in bovine.
- Current is sent from the electrode pressed against the top of the head to a fourth electrode pressed against the spine.
- This phase is used to minimize post stun kicking. (See [a] below.)

Recommended Electrical Stunning Parameters – Cattle

Phase I - Head to Head

1. Check the electrical settings as per the following table.

Electrical Settings			
Amperage	Frequency	Volts	Time
2.0 - 2.5	50 - 60 Hz	400	4 seconds

2. Apply current; when insensible (unconscious), start Phase II.



Phase II - Head to Brisket

1. Check the electrical settings as per the following table.

Electrical Settings			
Amperage	Frequency	Volts	Time
3 - 4	50 - 60 Hz	450	4 - 15 seconds

2. There is less kicking with a longer stun, and/or use Phase III spinal depolarization.

**Phase III (Optional) - Head to Spine**

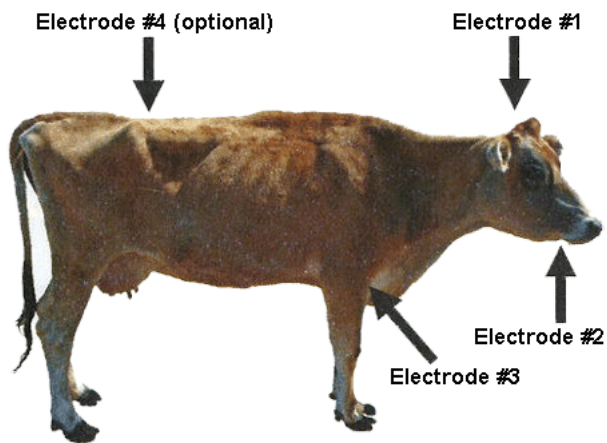
1. Check the electrical settings as per the following table.

Electrical Settings			
Amperage	Frequency	Volts	Time
3 - 4	50 - 60 Hz	450	as required

2. Apply current as required.

Landmarks for electrical stunning

[a]



2 Swine (hogs, sows, boars, wild boar)

2.1 Mechanical

Important factors:

- Handling and restraint facilities must meet current OIE and industry standards.
- Pigs have small brains relative to the size of their head.
- Sows and boars have very thick frontal bones in their skull.
- **Note:** There can be breed variation in head shape in mature animals. “Yorkshire” type animals (not necessarily a Yorkshire hog) have a prominent curvature in the front of their head. (See [e] below.)
- Immature animals and mature animals with a straight front to their head can be stunned by holding the stunning device perpendicular to the front of their head. (See [d] below.)
- This approach may need to be modified in “Yorkshire” type animals with a pronounced curvature to the front of their head, or if an animal is stunned with a firearm. (See [e] below.)
- **Plan the trajectory** so the bolt or projectile travels through the brain (cerebral hemispheres, midbrain and brainstem) The most significant of these are the midbrain and brainstem which are located in the centre of the skull at the level of the bottom of the attachment of the ears (See [b], [c], [d] and [e] below.)
- Use precise landmarks. (See all below.)

2.1.1 Landmarks and approaches

2.1.1.1 Market Hog

Intersection of diagonal lines from the *midpoint* of the attachment of each ear to the medial canthus (middle corner) of the opposite eye. This is approximately 2 ½ cm or 1 in. above the eyes. (See [a] and [b] below.)

2.1.1.2 Sow or boar

Intersection of diagonal lines from the *top* of the attachment of each ear to the medial canthus (middle corner) of the opposite eye. (See [c] below.)

Note: Regardless of the entry point, the angle of the stunning device with the front of the head must result in a **path** of the bullet or bolt that **will intersect with an internal line from the base of one ear to the other, running through the brain stem.** (See [a], [b], [c], [d] and [e] below.)

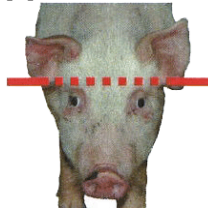
Frontal View

[a]



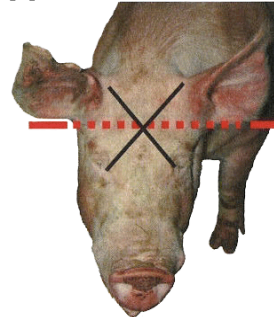
Immature

[b]



Immature

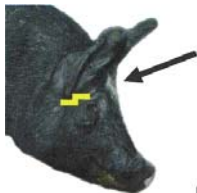
[c]



Mature

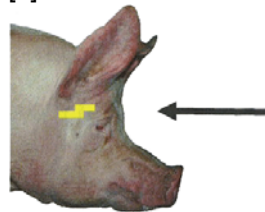
Side View

[d]



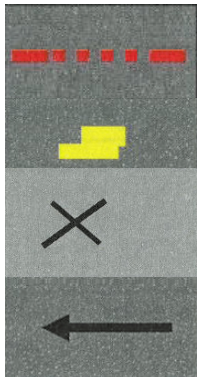
Market Hog (“non-Yorkshire”)
Straight front

[e]



Mature (“Yorkshire” type)
Curved front

Note: Breed and age effect on curvature of the front of the head in the side view. (See [d] and [e] above.)



Level of the brainstem - in the middle of the skull.

Location of the brainstem and midbrain – in the middle of the skull.

Intersection of the diagonal lines indicates the entry point for the bolt or projectile of a mechanical stunning device held perpendicular to the front of the skull.

Trajectory of the projectile as it travels to the midbrain and brainstem.

2.1.2 Mechanical Stunning Devices

2.1.2.1 Captive bolt

- Bolt length must be at least 12 cm (4 3/4 in.) for hogs. Bolt length must be 15 cm (6 in.) for sows and boars.
- Calibres (diameter) available for the cartridge bolts include .22, .25 and .33.
- Larger bolt diameters (.25 and .33) are far more effective for larger animals.
- Use manufacturer’s recommended charge, operation, cleaning and maintenance program.
- Assess bolt velocity by using the manufacturer’s bolt velocity testing device, or similar means (daily).
- See 2.1.1, Landmarks and Approaches, above.

Penetrating Captive Bolt			
Animal	Calibre (options)	Bolt Lengths	Muzzle Velocity (ft/s)
Hogs	.22, .25, .33	12 cm (4 3/4 in.)	≥ 55 m/s (183 ft/s)
Sows and Boars	.25, .33	15 cm (6 in.)	≥ 72 m/s (236 ft/s)

2.1.2.2 Firearms

- Use the slowest velocity and minimum energy required to effectively stun the animal.
- Planning the trajectory is particularly important if the stunner operator is shooting from a standing position on the ground.
- See 2.1.1, Landmarks and Approaches, above.

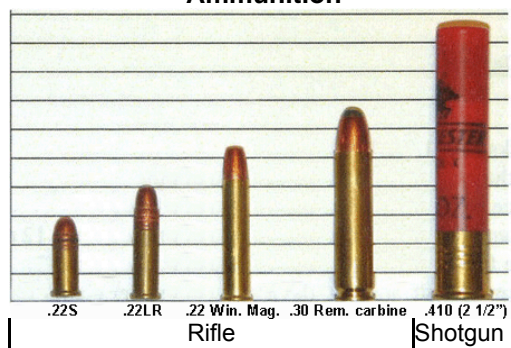
Rimfire Rifle Cartridges				
Animal	Calibre	Grain	Muzzle Velocity (ft/s)	Energy (ft/lbs)
Hogs	.22 LR (long rifle) ¹	40	1255	140
Sows and Boars	.22 LR (long rifle) ¹	40	1255	140
	.22 Winchester Magnum	40	1910	324

¹ Do not use hollow point

Centrefire Rifle Cartridges				
Animal	Calibre	Grain	Muzzle Velocity (ft/s)	Energy (ft/lbs)
Very Large Boars	.30 Remington Carbine	110	1990	967

Shotgun Shell					
Animal	Gauge	Length	Slug	Muzzle Velocity (ft/s)	Energy (ft/lbs)
Large Sows and Boars	.410	2 ½ in.	1/5 oz (87 g)	1830	651
	.410	3 in.	¼ oz (108 g)	1800	788

Ammunition



2.2 Electrical

Important factors:

- Handling and restraint facilities must meet current OIE and industry standards.
- Constant amperage and variable voltage is to be used. (See minimum values below.)
- Electrodes must be firmly applied and not moved during the stunning process.
- The application of automated electrodes must not injure the animals.
- Dampen the hog (mist or spray) to improve electrical conduction (do not use an excessive amounts).

2.2.1 Landmarks and approaches

2.2.1.1 Head-to-head

- Span the brain by placing the electrodes **behind** the eyes on each side of the head, **or**
- Span the brain by placing the electrodes just **under the base** of each ear, **or**
- Place the electrodes **on** the bony process of the skull behind each ear.
- Do not** place the electrodes on the neck.

- Bleeding must start in less than **30 seconds**.
- With **high frequency** (> 350 hz), **low amperage**, head-only stunning bleeding must start within **15 seconds**.

2.2.1.2 Head-to-body

Option #1: Place two electrodes on the head (see 2.2.1.1) and a third electrode behind the heart on the 4th rib. Current is first directed to the two head electrodes, which is followed by applying current to the head and chest electrodes.

Option #2: Place one electrode on the front of the skull, or on the bony process behind the ear (see 2.2.1.1) and place the second electrode behind the heart on the 4th rib. Current is applied head to chest.

Recommended Electrical Stunning Parameters - Swine				
Animal	Amperage	Volts	Frequency	Time (sec)
Hogs (head only)	≥ 1.25	> 250-300	50-60	1-3
Hogs (head to body)	Head: ≥ 1.25	> 250-300	50-60	1-2
	Body: ≥ 1.30	> 300	50-60	3
Sows or Boars	≥ 2.0	> 300	50-60	3

Note: Other **voltages**, **frequencies** and **times** may be used if:

- The plant operator presents documentation by a recognized animal welfare specialist outlining the protocol **and** demonstrable evidence that the method(s) used are consistently effective and humane; or
- A trial period of stunning is undertaken; or
- The procedure consistently meets animal welfare stunning requirements; or
- Amperage (current) stuns; therefore, use constant amperage and variable volts.

2.3 Controlled Atmospheric Stunning (CAS) (CO₂ and Gas Mixtures)

Important Factors:

- Pre-stun handling stress has a significant impact on animal response during induction of anaesthesia.
- Induction with CAS can be highly stressful, especially for some genetic strains of hogs.
- Pre-existing pneumonia can prolong the induction of anaesthesia.
- Handling, restraint and stunning facilities must meet current OIE and industry standards.
- Design and function of the **lairage** and **pre-stun** handling area are important to minimize prestun stress in animals, which minimizes stress during the induction of anaesthesia.
- **Gas stunner** design and operation play an important role in minimizing stress during the induction of anaesthesia.
- Exposure time to the gas and the time between stunning and bleeding are important to ensure there is no return to sensibility before death. (See the stun-to-stick interval chart below.)
- The bleeding rail length is critical. There must be sufficient room to accommodate and stick stunned animals exiting the gas chamber during a kill line stoppage.
- Prior to installation of the CAS, planning must include provisions for possible increased line speeds.
- Stocking density of the chamber must be optimal: pigs must be able to stand without being on top of one another.
- Monitoring **during** pre-stun handling, induction of anaesthesia, sticking and bleeding is critical.
- Induction must be monitored by means of a camera or observation portal. Monitoring must occur at start up, after breaks in production and at the beginning of each lot of hogs. More frequent monitoring may be required if there are problems with induction.
- Gas concentrations, startup gas mixing procedures and stunning procedures must conform to the manufacturer's recommendations. For alternate procedures see below.
- A maximum stun to stick interval must be validated.
- If hogs regain sensibility the gas concentration, and /or exposure time (to the highest concentration of gas), must be increased until all animals are properly stunned. (Backup mechanical stunners must be available and used when needed.)

- **Example guidelines. Note:** these times will vary with the system, genetic of hogs, etc. Monitoring return to sensibility is required. Time of exposure to the gas and stun to stick time must be adjusted if animals are returning to sensibility.

Stun - to - Stick Interval	
First Stop 70-80% CO ₂ Total Time of Exposure [dwell time] (sec)	Second Stop > 90% CO ₂ Stick within (sec)
120	30
130	45
140	60
150	75
160	90

Note: Time is counted from last stop just before exiting the gondola.

2.3.1 Carbon dioxide (CO₂) and Gas Mixtures

Concentration

1. It is an OIE requirement that no less than 80% concentration of CO₂ be used (90% is preferable).
2. Exposure time to the gases must be sufficient to ensure no pigs regain sensibility before death occurs due to cardiac arrest or bleeding.
3. Stun to stick interval must be as per the stun-to-stick interval chart. (Shorter time frames may be required if there are return to sensibility problems.)
4. Stunning
 - The gas mixture and induction of anaesthesia must be non-aversive and must not be distressing.
 - The chamber and methods of conveyance through it must avoid stress to the animals.
 - The density of animals in the gondola must be such that animals do not fall or lay on each other during the stunning operation.
 - The chamber must be lit.
 - The chamber must be designed so that the animals in the chamber can be monitored at all times by direct observation ports, cameras, or similar means.
 - The chamber must be equipped to continuously measure and display the CO₂ concentration (or other gas used in the stunning process) at the point of induction and the maximum concentration.
 - The system must provide visible and audible warnings if the gas concentration falls below the required levels.
 - Stunning must be as per the manufacturer's stunning protocol. See below for alternate stunning procedures. Pigs usually require 3 minute exposure time to the concentrations indicated below.

Controlled Atmosphere Stunning (CAS) - Hogs				
Type	Method of Stunning	Gas(es)	Concentration	Other Gases
CO ₂	High blood levels of CO ₂ (Hypercapnia)	CO ₂	≥ 80% 90% (preferred)	oxygen, nitrogen, etc.
Gas Mixtures	Low blood levels of O ₂ (Hypoxia)	O ₂	≤ 2% (O ₂)	carbon dioxide, argon, nitrogen
	Low blood levels of O ₂ and High blood levels of CO ₂	O ₂ , and CO ₂	≤ 2% (O ₂) ≤ 30% (CO ₂)	argon, nitrogen, etc.

Note: Other gas mixtures and concentrations may be used if:

- The plant operator presents documentation by a recognized animal welfare specialist outlining the protocol and demonstrable evidence that the method(s) used are consistently effective and humane.
- A trial period of CAS stunning is not undertaken.
- The procedure consistently meets CAS animal welfare stunning requirements.

3 Sheep, Lambs, Goats

3.1 Mechanical

Important factors:

- Handling and restraint facilities must meet current OIE and industry standards.
- There is a marked variation between the thickness of the skulls of horned and hornless animals.
- Horned animals, especially mature males, have very thick frontal bones.
- Know the approximate location of the brain in the skull.
- Use the appropriate landmarks. (See below.)
- Plan the trajectory so the bolt or projectile travels through the following parts of the brain (cerebral hemispheres, midbrain, brainstem). Of these the midbrain and brainstem are the most important. They are located in the centre of the cranium at the level of the attachment of both ears. (See [e] below.)

3.1.1 Landmarks and approaches

3.1.1.1 Hornless

- Hold and discharge the mechanical stunning device so that the bolt/bullet enters **the top** of the skull **at the midpoint of an imaginary line drawn between the animal's ears** (See [a], [b] and [c] below.)

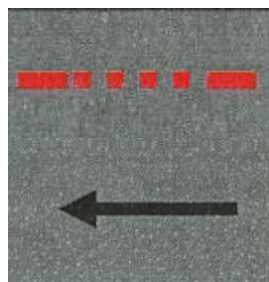
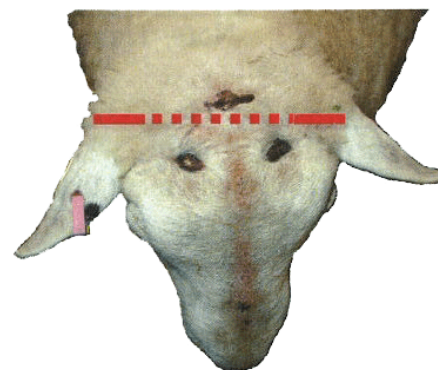
[a]



[b]



[c]

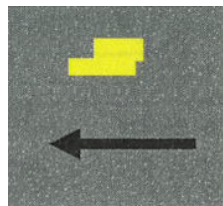
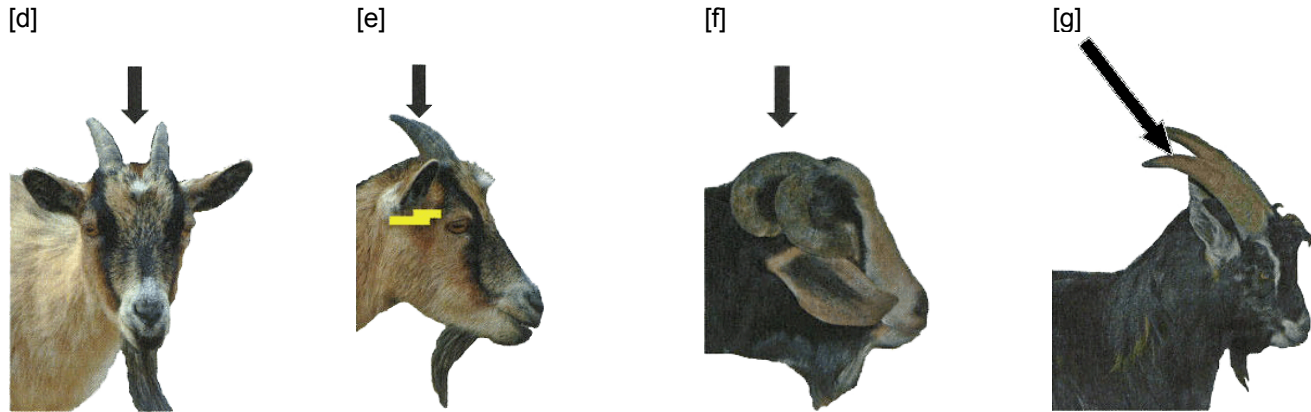


Line connecting the base of the two ears. The midpoint of this line indicates the location of the brainstem in the middle of the skull.

Trajectory of the projectile as it travels to the midbrain and brainstem.

3.1.1.2 Horned

- Horned sheep and goats must be stunned from the **top of the head** (see 3.1.1.1 “**hornless**” for landmarks), **unless** the presence of horns prevents the use of this approach (see [c], [d], [e] and [f] for the **top of the head** approach).
- If the configuration of the horns make it necessary to stun from **poll position**, discharge the mechanical stunning device so that the bolt/bullet enters the skull **just behind** the midpoint of the nuchal crest and is directed towards the animal's mouth. (See [g].)
- Stunning in the poll position (just behind the horns or on the nuchal crest) can result in a rapid recovery of consciousness. Therefore, bleeding must be commenced within 15 seconds by cutting both carotid arteries, or the vessels from which they originate. (See [g].)



Location of the brainstem and midbrain – in the middle of the skull.

Trajectory of the projectile as it travels to the midbrain and brainstem.

3.1.2 Mechanical Stunning Devices

3.1.2.1 Captive Bolt

- Use the manufacturer’s recommended charge, cleaning, maintenance and stunning protocols.
- Use 4 ¾ in. bolt. A shorter bolt may be used on small lambs.
- Bolt velocity and charge must be appropriate to the species, animal size and the presence or absence of horns.
- Assess bolt velocity daily by using the manufacturer’s bolt velocity testing device, or similar means.

3.1.2.2 Firearms

- Use the slowest velocity and minimum energy required to effectively stun the animal. (See below).

Stunning Device	Hornless	Horned
Captive Bolt	Small charge	Appropriate charge
Firearm	.22S ¹ is sufficient	.22 LR ²

1 = .22 short, 2 = .22 long rifle **Do not** use hollow point cartridges

Ammunition



3.2 Electrical

Important factors:

- Handling and restraint facilities must meet current OIE and industry standards.
- Sheep can be the most difficult animals to stun electrically - due to the resistance of wool.
- Mature large animals have greater resistance to the flow of electrical current through their body; therefore, greater amperage and voltage must be used to effectively stun them. (See below).

3.2.1 Landmarks and approaches

3.2.1.1 Head-Only

- Electrodes must be **placed over** each temple (between the eye and ear) to span the brain.
- Placing the electrodes over the occipital condyles (behind the ears) is **not effective** with head-only stunning.
- Electrodes must be **designed** to facilitate penetrating the wool and making good contact with the animal's head.
- Electrodes and contact location must be **wet** (or water flow) to facilitate conduction of the electrical current.
- Current must flow **for** 3 seconds.
- The animal must be stuck **within** 15 seconds as recovery from **head-only stunning is rapid**.

3.2.1.2 Head-to-Body

- Head-to-body stunning is far more effective than head-only stunning (head to body is preferred).
- Electrodes must be **designed** to facilitate penetrating the wool and making good contact with the animal's head.
- Electrodes and contact location must be **wet** (or water flow) to facilitate conduction of the electrical current
- Current must flow **for** 3 seconds
- The head and back (body) electrodes are placed 25 to 40 cm (10 in. - 16 in.) apart.
- **Options include:**
 - a) Place two contacts on top of the head (between the ears) with a third contact placed over the spine.
 - b) Place one contact on each side of the head (spanning the temples) with a third “saddle” contact placed over the spine. (**Note:** using the condyles is far **less** effective than the temple area)
 - c) Place one contact on top of the head with a second contact made over the left chest (arm pit).

Minimal Electrical Stunning Parameters for Sheep, Lambs and Goats				
Animal	Amperage	Volts	Frequency	Time (sec)
Lambs (shorn) and kids	0.6	250-350	50-60	3
Sheep and goats	1.0	300-400	50-60	3

3.3 Gas, Gas Mixtures

These are not commonly used to stun sheep as the wool absorbs a lot of gas, making the system very inefficient.

4 Bison

4.1 Mechanical

Important Factors:

4.1.1 Handling and restraint

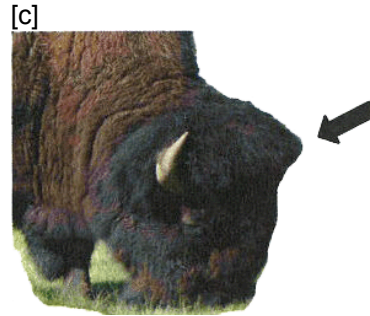
- Handling and restraint facilities must be **sturdy** and **meet current industry standards for bison**, including safety measures and sight lines.
- Suitable facilities are essential.
- Restraint must facilitate stunning the animal from the **front** of the head.

4.1.2 Landmarks and approaches

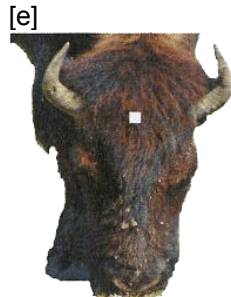
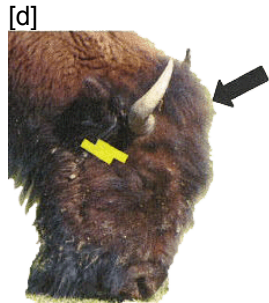
- Mature bulls have very thick frontal bones overlaying the brain. The **hide over the frontal bone** and the **frontal bone itself** can **each** be up to 1.5 in. (3.8 cm) thick.
- Mature bulls frequently have long thick hair on their heads, which makes it difficult to see landmarks other than the horns.
- Bison typically hold their heads lower than cattle.
- Know the approximate location of the brain in the skull.
- Plan the trajectory so that the bolt/projectile travels through all parts of the brain (cerebral hemispheres, midbrain, brainstem). Of these the midbrain and brainstem are the most important parts of the brain. They are located in the centre of the brain at the level of the attachment of the ears. (See [d].)
- **Landmarks** are very important and they are **NOT** the same as for cattle. (See [a] to [i] below.)
- **Intersection** of the **midpoint** of the front of the head and a **line** running between the **lower part** of the **attachment** of each horn. (See [b], [e], [f] and [h] below.)
- Discharge the stunning device perpendicular to the front of the head. (See [a], [c], [d], [g] below.)
- **Do not** stun from the top of the head or behind the head, or behind the ears, due to the risk of pithing the animal instead of properly stunning it.
- Discharging the mechanical stunning device at the locations on the skull other than the front of the head is **NOT** permitted due to the risk of missing the appropriate sections of the brain.
- **Stunning problems** are usually due to **using improper landmarks** and/or holding the mechanical stunning device at an angle other than perpendicular to the skull. (See [a] to [i] below.)

Proper Landmarks for Stunning

Mature male



Immature male



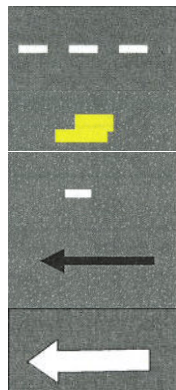
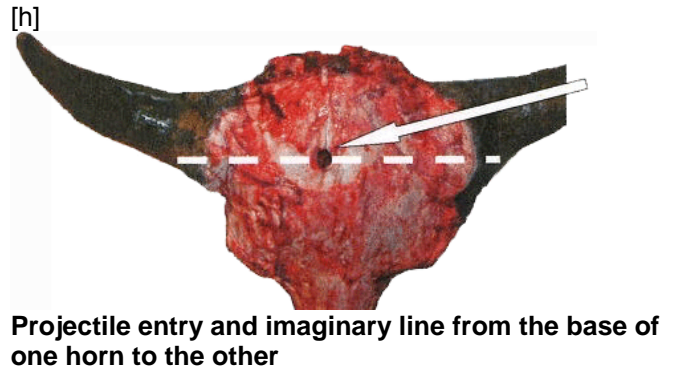
Landmarks



Mature female



Landmarks



Line running from the base of one horn to the other.

Location of the brainstem and midbrain – in the middle of the skull.

Entry point of the projectile (bullet).

Trajectory of the projectile as it travels to the midbrain and brainstem.

Arrow indicating projectile entry point to the skull and brain cavity.

Improper Landmarks for Stunning

Bison Skull

[i]



Note: This is an example of the impact of using **improper landmarks**. This bison skull contained 10 bullet holes. They were in the front, side and back of the skull. Most of the bullet holes in the front are too low (bovine landmarks), or too much off the midline of the skull (thereby missing the midbrain and brainstem) to be effective.

4.1.3 Mechanical Stunning Devices

4.1.3.1 Captive Bolt

- The bolt length for immature animals must be at 12 cm (4 ³/₄ in.); the bolt length for animals over one year of age must be 15 cm (6 in.).
- The .25 calibre and larger captive bolt stunning devices with heavier charges are far more effective.
- Use the manufacturer's recommended charge, cleaning, maintenance and stunning protocols.
- Assess bolt velocity daily by using the manufacturer's bolt velocity testing device, or similar means.
- Can be used on **immature** animals.
- See 4.1.2, Landmarks and Approaches, for stunning problems.

Note: Standard bolts are **not** long enough for large bulls.

Penetrating Captive Bolt				
Animal	Calibre	Bolt Length	Muzzle Velocity (ft/s)	Energy (ft/lbs)
Immature	≥.25	≥12 cm (4 ³ / ₄ in.) or 15 cm (6 in.)	>72 m/s (236 ft/s)	Heavy Charge
Over one year of age	≥.25	15 cm (6 in.)	>72 m/s (236 ft/s)	Heavy Charge

4.1.3.2 Firearms

- Perforation and ricochet are a safety concern with high velocity calibre firearms.
- Use the slowest velocity and minimum energy required to effectively stun the animal.
- Maximum velocity < 2000 ft/s to help prevent ricochet from the surface of the skull.
- Maximum energy < 1000 ft/lbs to help prevent skull perforation (exiting the opposite side of the skull).
- Plan the trajectory so that the bullet travels through the midbrain and brainstem, which are located below the horn and between the ears.
- See 4.1.2 above for stunning problems.

5 Horses

5.1 Mechanical

Important factors:

5.1.1 Handling and Restraint

- Horses vary a great deal in size.
- Handling and restraint facilities must meet current OIE and industry standards, including OSH requirements.
- Restraint facilities must be adaptable and appropriate to the size variation of the animals slaughtered.
- The restraint facilities must be suitable for the operator to stun the animal in an effective manner.

5.1.2 Landmark and approaches

- **Just above the intersection** (1 in.) of imaginary diagonal lines from the attachment of each **ear** to the medial canthus (middle corner) of the **opposite eye**. (See [b] and [c] below.)
- Plan the trajectory so that the bolt travels through the brain (cerebral hemispheres, midbrain, brainstem). The most significant of these are the midbrain and brainstem which are at the level of the bottom of the attachment of the ears. (See [a] below.)
- Hold and discharge the stunning device perpendicular to the front of the skull.
- The frontal bone over the brain is quite thin.

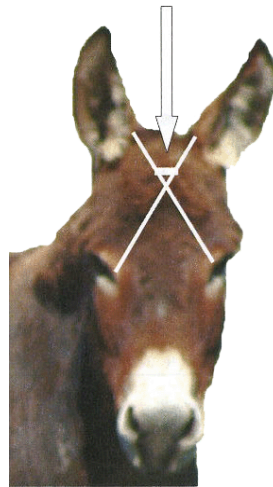
Midbrain and brain stem

Projectile Entry Point

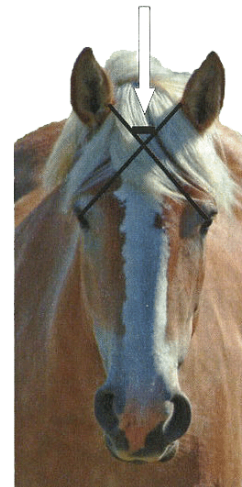
Projectile Entry Point



[a]



[b]



[c]

	Diagonal lines running from the inner corner of each eye to the upper edge of the attachment of the opposite ear.
	Diagonal lines running from the inner corner of each eye to the upper edge of the attachment of the opposite ear.
	Entry point of the projectile which is approximately one inch above the intersection of the diagonal lines.
	Entry point of the projectile which is approximately one inch above the intersection of the diagonal lines.
	Arrow indicating entry point into the skull and brain cavity.
	Location of the brainstem and midbrain – in the middle of the skull.

5.1.3 Mechanical Stunning Devices

5.1.3.1 Captive bolt

- Horses are very effectively stunned with captive bolt devices (e.g. Australia).
- Bolt length 12 cm (4 ³/₄ in.) can be used to stun **all** horses effectively.
- Various types and triggering devices are available.
- Use the manufacturer's recommended charge, cleaning, maintenance and stunning protocols.
- Assess bolt velocity by using manufacturer's bolt velocity testing device, or similar means daily.

Penetrating Captive Bolt				
Animal	Calibre	Bolt Lengths	Muzzle Velocity(ft/s)	Energy (ft/lbs)
All horses	.22, .25, .33	12 cm (4 ³ / ₄ in.)	55 m/s (183 ft/s)	Appropriate charge

5.1.3.2 Firearms

- When a proper restraint system is used firearms are **not** necessary to effectively stun horses.
- Firearm use is discouraged.
- Perforation and ricochet are a safety concern; therefore use the slowest velocity and minimum energy required to effectively stun the animal. (See below.)

Rimfire Rifle Cartridges				
Animal	Calibre	Grain	Muzzle Velocity(ft/s)	Energy (ft/lbs)
All horses	.22 S1*	29	1095	77
	.22 LR2*	40	1255	140

1 = Short

2 = Long rifle

* Do not use hollow point

6 Cervids (Includes elk, fallow deer, white tail)

Elk

6.1 Mechanical

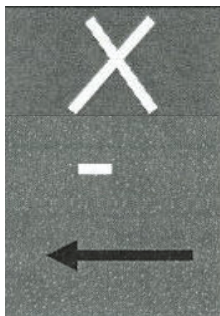
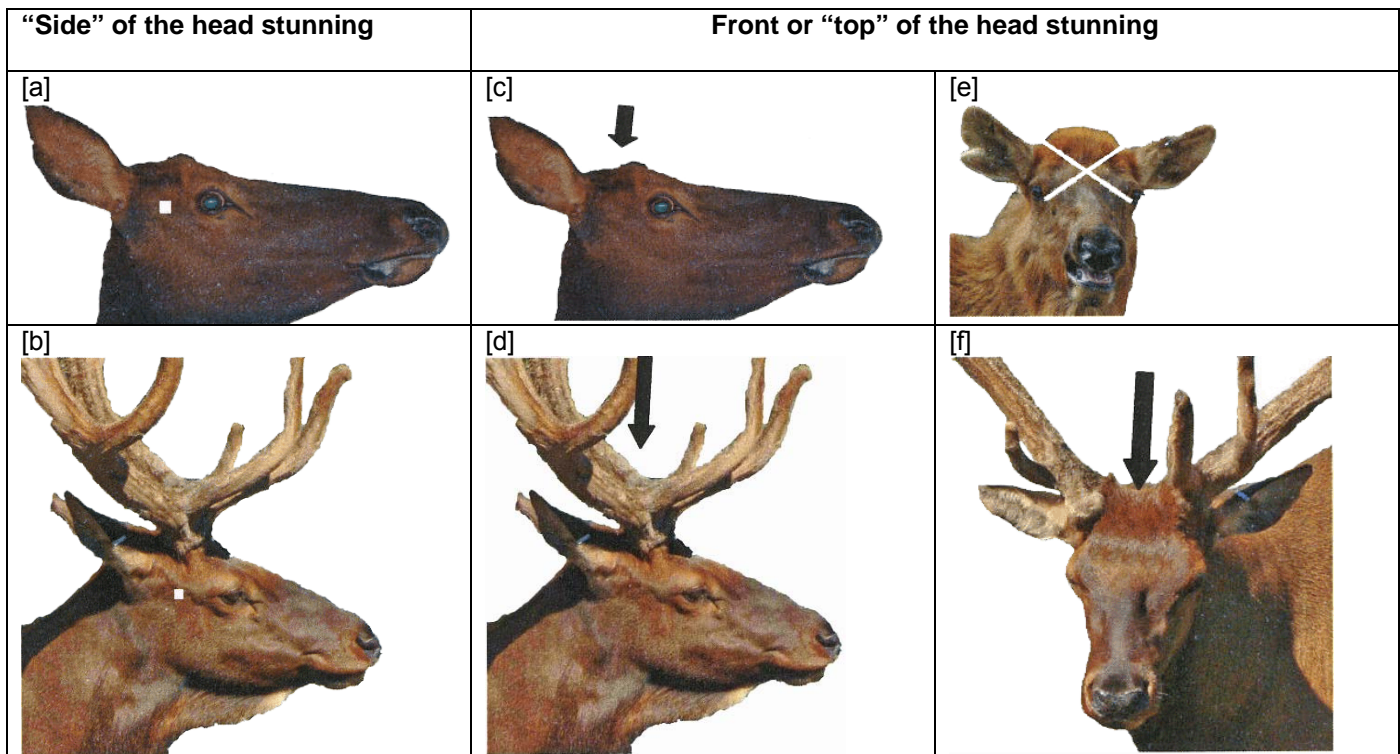
Important factors:

6.1.1 Handling and restraint

- Cervids are flighty and can become stressed easily.
- Appropriate handling, facilities and restraint are imperative. Facilities must meet current OIE and industry standards, including those for OSH requirements and sight lines.

6.1.2 Landmarks and approaches

- Elk hold their head very high, especially when they are alert - so plan your trajectory.
- Plan the trajectory so that the bolt or projectile travels through the brain (cerebral hemispheres, midbrain, brainstem). The most significant of these are the midbrain and brainstem, which are located in the centre of the cranium at the level of the bottom of the attachment of the ears.
- When animals are alert, the surface of the frontal bone is almost horizontal to the ground (see below); therefore, mechanical stunning with the stunner operator standing in front of the animal is difficult.
- Cervids have large brains with thin frontal bones.
- The male frontal bone (1.25 cm) is somewhat thicker than the female frontal bone (0.78-0.97 cm).



Intersection of diagonal lines running from the inner corner of each eye to the upper edge of the attachment of the opposite ear.

Indicates the entry point for the projectile on the "side" of the animal's head (temple).

Indicates the direction that the stunning device should be pointed and the entry point when the bolt or projectile is directed towards the "top" (front) of the animal's head.

Sex	Side of the head	Front or "top" of the head
Males	<ul style="list-style-type: none"> ▪ Midway between the eye and ear, at the eye level ▪ Stun perpendicular to the head ▪ Easier access from normal standing position ▪ OSH issue as can readily perforate the skull 	<ul style="list-style-type: none"> ▪ Midpoint of the head between the pedicles or antlers ▪ Must approach the animal's head from above
Females	<p>OSH Concerns (therefore only use .22 short)</p> <ul style="list-style-type: none"> ▪ Midway between the eye and ear, at the eye level ▪ Stun perpendicular to the head ▪ Easier access from normal standing position 	<ul style="list-style-type: none"> ▪ Intersection of diagonal lines from the upper edge of the attachment of each ear to the middle of the opposite eye ▪ The stunner operator will have to be high enough to aim the stunning device down to the front or "top" of the almost horizontal head

Best practices include:

- The stunner operator approaches the front of the animal's head from above; **or**
- Stuns the animal from the side of the head (firearms only).

6.1.3 Mechanical Stunning Devices

6.1.3.1 Captive Bolt (only from above head, frontal bone approach)

- Bolt length - standard (4 ¾ in.) or short (3 ⅜ in.).
- All calibres can be used
- Effective for all sizes of cervids
- Use the manufacturer's recommended charge, cleaning, maintenance and stunning protocols (daily).
- Assess bolt velocity daily by using the manufacturer's bolt velocity testing device, or similar means.
- See 6.1.2 "Landmarks and approaches" for stunning problems.

Penetrating Captive Bolt				
Animal	Calibre	Bolt Length	Muzzle Velocity(ft/s)	Energy (ft/lbs)
Female + male	.22	Either	55 m/s (183 ft/s)	Appropriate charge

6.1.3.2 Firearms

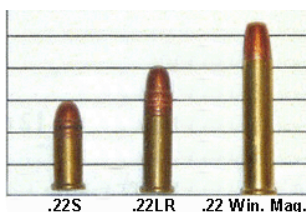
- Ricochet is an OSH concern when elk hold their heads high and the **frontal approach** is used.
- Perforation is an OSH concern when animals are stunned from the **side of the head**.
- **Note:** Perforation occurs when the projectile exits the side of the head opposite to the entry point.
- Use the slowest velocity and minimum energy required to effectively stun the animal. (See below.)
- See 6.1.2, Landmarks and approaches, for stunning problems.

Rimfire Rifle Cartridges				
Animal	Calibre	Grain	Muzzle Velocity(ft/s)	Energy (ft/lbs)
Female	.22 S ¹	29	1095	77
Female	.22 LR ²	40	1255	140
Male	.22 LR ²	40	1255	140
Male	.22 Winchester magnum Note: mature males and frontal "top" approach only	40	1910	324

¹ = .22 short (lead round nose) ² = .22 long rifle (lead round nose)

Do not use hollow point.

Ammunition



Other Cervids (fallow deer, white tail)

6.2 Mechanical

Important Factors:

6.2.1 Handling and restraint - similar to elk

6.2.2 Landmarks and approaches - similar to elk

Frontal bone to the skull is very thin e.g. fallow deer 0.33 - 0.48 cm (0.13 in. - 0.19 in.).

6.2.3 Mechanical stunning devices

6.2.3.1 Captive Bolt

- See elk.
- Appropriate light charge (similar to that used for calves and lambs).

Penetrating Captive Bolt				
Animal	Calibre	Bolt Length	Muzzle Velocity(ft/s)	Energy (ft/lbs)
Female + male	.22, .25, .33	Either	55 m/s (183 ft/s)	Appropriate charge

6.2.3.2 Firearms

- See elk.

Rimfire Rifle Cartridges				
Animal	Calibre	Grain	Muzzle Velocity(ft/s)	Energy (ft/lbs)
Female + male	.22 S ^{1**}	29	1095	77

1 = .22 short (lead round nose) **Do not** use hollow point. **Side of the head not recommended in fallow deer due to the risk of perforation

7 Ratites (Ostriches, Rhea and Emus)

7.1 Mechanical

Important factors:

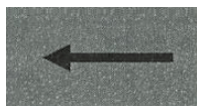
7.1.1 Handling and restraint

- Handling and restraint facilities must meet OIE and industry standards, including OSH requirements and sight lines.

7.1.2 Landmarks and approaches

- Ratite heads are very small for mechanical stunning.
- Top of the head at the midpoint of an imaginary line between the outer ear openings. (See [a].)

[a]



Indicates the direction that the stunning device should be pointed and the entry point at the top of the animal's head.

7.1.3 Mechanical Stunning Devices

7.1.3.1 Captive Bolt

- A captive bolt device may be used if the stunner operator uses the appropriate sized stunning device and the appropriate charge.
- To prevent perforation, use a very short bolt and small charge (see below).

Captive Bolt	
Ratites	▪ short bolt and smallest charge appropriate for poultry or rabbits

7.1.3.2 Firearms

- **Do not** use firearms to stun ratites due to the small head, thin frontal bone (0.5 - 1.0 mm) and risk of perforation.
- Perforation occurs when the projectile exits from the opposite side of the skull from the entry point.

7.2 Electrical Stunning

Important factors:

7.2.1 Handling and restraint

- Handling and restraint facilities must meet OIE and industry standards; including OSH requirements and sight lines is important.

7.2.2 Landmarks and approaches

- Both sides of the head behind the eyes and just over the outer ear openings. (See [b].)
- Use tongs that facilitate grabbing both sides of the head. The current flows from one side of the head to the other.

[b]



Indicates where the electrodes should be applied to each side of the animal's head.

7.2.3 Electrical stunning devices

Electrical stunning - Ratites				
Birds	Amperage	Volts	Frequency	Time (sec)
Ostriches, Rhea, Emus	Not hooded	0.12 - 0.4	230 - 300	50-60
	Hooded	0.4		

7.2.4 Shackling and hoisting

- Shackling occurs either before or after stunning.
- Hoisting occurs after the stun has been completed.
- Avoid injury to operators by the bird's legs.

7.2.5 Sticking

- Head-only stunning, animals regain sensibility quickly; therefore, stun to stick interval must be ≤ **15 seconds**.
- Stick the animal as soon as it has been stunned.
- The sticking options include a complete ventral cut of the neck (both carotids) below the head, **or** at the thoracic inlet.