



GUIDELINES FOR THE HUMANE EUTHANASIA OF CATTLE

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OVERVIEW

Livestock caretakers have an obligation to ensure the welfare of animals under their care. Euthanasia of an animal that is suffering from irreversible disease or injury is a primary responsibility caretakers assume. As per the “AVMA Guidelines for the Euthanasia of Animals (2013)” euthanasia is defined as: “ending the life of an individual animal in a way that minimizes or eliminates pain and distress.” When properly conducted, euthanasia results in a rapid loss of consciousness followed by cardiac and respiratory arrest and death. The contents of this guideline are intended to aid animal caretakers and owners, livestock market operators, animal transporters and veterinarians in choosing effective euthanasia methods.

The “AVMA Guidelines for the Euthanasia of Animals (2013)” recognizes and accepts three primary methods of euthanasia for cattle:

- **Intravenous (IV)** administration of a lethal dose of a barbiturate or barbituric acid derivative to induce a transition from consciousness to unconsciousness and death.
- **Gunshot** using an appropriate firearm, ammunition and anatomic site to cause physical disruption of brain activity by direct destruction of brain tissue.
- **Penetrating captive bolt (PCB)** to induce unconsciousness in combination with an adjunctive step such as exsanguination, intravenous administration of a saturated solution of either potassium chloride or magnesium sulfate, or pithing (increasing destruction of brain and spinal cord tissue) to ensure death. Non-penetrating captive bolt can be used for the euthanasia of neonates and calves less than 2-3 months of age when followed by use of an adjunctive method to assure death.

When properly applied, the above euthanasia methods cause rapid loss of consciousness and death with no detectable distress to the animal.

CONSIDERATIONS FOR SELECTION OF METHOD OF EUTHANASIA

When euthanasia is the most reasonable option for a compromised animal, the following elements should be considered to aid in the selection of the appropriate method:

- **Human Safety** The first consideration in the choice of euthanasia method is human safety. For example, the use of a firearm carries greater safety risks when compared to other methods.



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- **Animal Welfare** All methods of euthanasia should produce a rapid death with no detectable pain and distress. Select a euthanasia technique that considers human safety as well as animal welfare and is appropriate for the specific situation.
- **Restraint** When performing euthanasia procedures, appropriate methods of restraint should be used. Some methods, such as captive bolt, require excellent restraint of the animal. Quality and availability of cattle chutes, halters, gates or other forms of restraint make certain forms of euthanasia more practical than others.
- **Practicality** An appropriate euthanasia technique must also be practical to use. For example, not all individuals responsible for carrying out euthanasia procedures have access to pharmaceuticals or firearms.
- **Skill** Certain techniques require skill and training to accomplish correctly. Individuals responsible for conducting euthanasia should be trained in proper euthanasia protocol and should have access to appropriate, well-maintained equipment and/or medications.
- **Cost** Euthanasia options vary in cost. Certain techniques, such as the use of firearms or captive bolt, require a larger initial investment, which may be defrayed over time.
- **Aesthetics** Certain euthanasia techniques, such as use of a barbiturate overdose, may appear more humane to the general public when compared to other techniques. Some methods, such as a penetrating captive bolt, may cause significant involuntary movements by the animal that may be misinterpreted as a voluntary painful response to those inexperienced in bovine euthanasia. When selecting a euthanasia method, potential negative reactions by the animal or observer should be considered.
- **Diagnostics** The selected euthanasia method should not compromise diagnostic sample collection.
- **Carcass Disposal** Carcass disposal is a critical consideration when selecting a euthanasia technique. Carcasses must be handled and disposed of in accordance with state and federal regulations. Options may include rendering, burial, composting, incineration and potentially landfills. Cattle euthanized using a barbiturate overdose may not be accepted at rendering facilities since the drug persists in residual material following the rendering process. In some regions, regulations require animals euthanized with barbiturates to either be incinerated or buried. Appropriate disposal of the carcass prevents scavenging and potential toxicity issues among wildlife. Gunshot or captive bolt is often a viable option that may facilitate ease of disposal. Euthanized animals make up a very small percentage of renderers intake, but because of use of barbiturates and lead shot, comprise a very large risk. If the cattle industry hopes to have access to renderers for disposal of dead stock, we have to take this risk seriously when making euthanasia method decisions.

DECISION MAKING

Actions involving compromised cattle include treatment, slaughter or euthanasia. The following criteria should be considered when making a decision:

- Pain and distress of animal
- Likelihood of recovery



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- Ability to get to feed and water
- Drug withdrawal time
- Economic considerations
- Condemnation potential
- Diagnostic information

Part of meeting our responsibility to reduce pain and suffering must be to see that euthanasia is provided promptly once the decision has been made to euthanize. No more than four hours should elapse between the making of the decision and performing of the euthanasia.

INDICATIONS FOR EUTHANASIA

The following conditions or situations may lead to an animal being compromised to such an extent that euthanasia is indicated:

Indications for euthanasia

- Fracture, trauma or disease of the limbs, hips or spine resulting in immobility or inability to stand
- Disease conditions for which no effective treatment is known (i.e. Johne's disease, lymphoma)
- Diseases that involve a significant threat to human health (i.e. rabies)
- Disease conditions that produce a level of pain and distress that cannot be managed adequately by medical means

Euthanasia should be a consideration if

- Emaciation and/or debilitation from disease, age or injury resulting in an animal being too compromised to be transported or marketed
- Loss of production and quality of life (advanced age, severe mastitis, etc.)
- Advanced ocular neoplastic conditions ("cancer eye")
- Disease conditions for which treatment is cost-prohibitive

- Extended drug withdrawal time for clearance of tissue residue
- Poor prognosis or prolonged expected recovery

MECHANISMS OF EUTHANASIA

The agents of primary or adjunct euthanasia cause death by one of the five following mechanisms:

1. Direct depression of the central nervous system or organs necessary for life function (barbiturate overdose).
2. Hypoxia associated with agents or procedures that displace or block the uptake of oxygen (such as that caused by exsanguination when used as an adjunctive method).
3. Physical disruption of brain activity (such as that caused by gunshot, penetrating captive bolt, or pithing).
4. Cardiac arrest triggered by intravenous administration of saturated potassium chloride (only acceptable as an adjunctive method following confirmation of unconsciousness)
5. Neuromuscular blocking of breathing by intravenous administration of saturated magnesium sulfate (only acceptable as an adjunctive method following confirmation of unconsciousness)

RECOMMENDED PRIMARY EUTHANASIA METHODS

1. **Gunshot** When properly executed, gunshot induces instantaneous unconsciousness and death, is inexpensive and does not require close contact with the animal. It should be emphasized that this method should only be attempted by individuals trained in the use of firearms and who understand the potential associated dangers. Firearm options include handguns (pistols), rifles or shotguns. Current recommendations suggest that the .22 caliber handgun or rifle



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Table 1: Recommended methods for practical euthanasia

Method	Risk to Human Safety	Skill Required	Potential Public Perception Issues	Adjunctive Method Required
Gunshot	high	moderate*	moderate:	no
Penetrating captive bolt	moderate	moderate*	some blood and motion	yes
Barbiturate overdose	low	moderate*	perceived well	no

*Operator Training Required

loaded with a solid-point bullet is sufficient for calves, but may not be the best choice for consistent use on adult animals. The “AVMA Guidelines for the Euthanasia of Animals (2013)” recommends the use of solid-point bullets. Muzzle energy available from a .22 long rifle is in the range of 100 to 150 ft./lb. (135 to 216.8 joules), whereas larger calibers such as the .38 special, .357 magnum or 9 mm will push muzzle energies well above the 300-foot pounds (407 joules or greater) range. Rifles are capable of higher muzzle energies compared with handguns and are often a better choice in situations where a fractious animal must be shot from a distance. Finally, shotguns are very lethal at close range (less than three feet from point of intended entry) whether loaded with shot-shells or slugs. The 12-, 16-, and 20-gauge shotguns are a good choice for euthanasia of adult cattle. The 28 or .410 gauge shotgun is an excellent choice for use in calf euthanasia. If using a shotgun loaded with shot shells the operator should be very conscious of the distance from the gun barrel to the animal as projectiles will spread out into a larger pattern. Ideally, to obtain maximum consistency and efficacy of euthanasia, it is desired that the

BBs from the shot shell make contact with the skull as a compact mass. When using a handgun, the firearm should be held within one-to-two feet of the intended target and the bullet should be directed perpendicular to the front of the skull to minimize the likelihood of ricochet. In cattle, the point of entry of the projectile should be at the intersection of two imaginary lines, each drawn from the outside corner of the eye to the base of the opposite horn as shown in Figure 2 in Landmarks and Placing the Shot.

2. Penetrating captive bolt Captive bolt devices (“guns” or “stunners”) are either penetrating or non-penetrating. Only penetrating captive bolt



Figure 1a. Penetrating captive bolt gun.



Figure 1b. Placement of captive bolt for optimal point of entry.

devices are approved for euthanasia of mature bovines and, according to “AVMA Guidelines for Euthanasia of Animals (2013)”, must not be used as the sole method of euthanasia. The bolt gun must be placed firmly against the skull at the same entry point previously described for a gunshot. Since use of the captive bolt gun requires close proximity to the animal, adequate restraint and prior sedation or tranquilization may be required. It is critical to maintain and clean the bolt gun as described by the manufacturer. Additionally, selection of cartridge strength may vary among manufacturers and the appropriate type and strength for the size of the animal must be



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used. Store cartridges in a cool dry area, away from humid environments. Exposing cartridges to moisture can affect burning of the propellant and thus lower the bolt speed and penetrating force. The optimal point of entry for the penetrating captive bolt is depicted in Figure 1b.

Landmarks and placing the shot

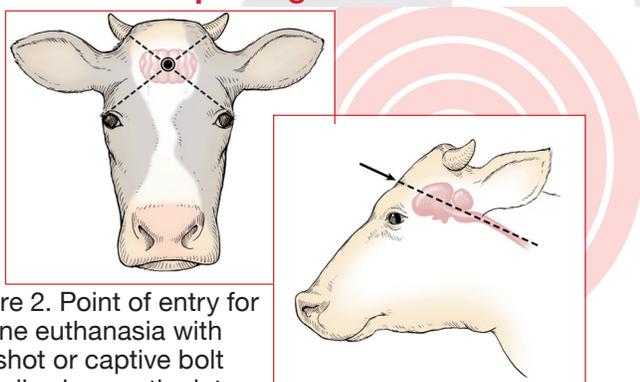


Figure 2. Point of entry for bovine euthanasia with gunshot or captive bolt described as on the intersection of two lines each drawn from the lateral canthus (outer corner) of the eye to the center of the base of the opposite horn (or where the horn would be).
Courtesy J.K. Shearer of the Cash Special Euthanizer Kit® for euthanasia of cattle Anim. Welf. 2012, 21, 00-102

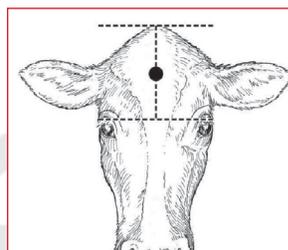
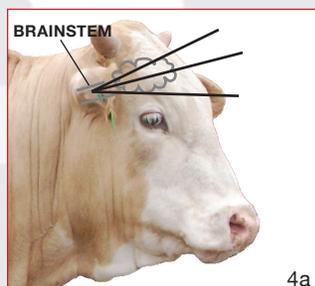


Figure 3. Alternate method: Selecting the proper anatomic site is to place the shot midway between a line connecting the lateral canthus of the eye and the poll on midline. *Gilliam, J.N., et al; Captive-bolt euthanasia of cattle: Determination of optimal-shot placement and evaluation*



4a



4b

Figures 4a and 4b. The trajectory should be aimed on midline between the base of the ears at the level of the external meatus and directed perpendicular or slightly downward (no more than 45 degrees). The angle may be modified as shown in Figure 4a to accommodate orientation of animal and caretaker, particularly when using a firearm. Penetrating captive bolts are typically discharged after holding the device flush and perpendicular with the frontal bone.
Courtesy R. Dewell, et al. 2016

3. Barbiturate and barbituric acid derivatives

When properly administered by the intravenous route, barbiturate overdose results in rapid loss of consciousness and death. When using sodium pentobarbital for this purpose, an appropriate dose is typically 60-80 mg/kg. When choosing a barbiturate for euthanasia, the barbiturate selected should be potent, long-acting and stable in solution. The carcass of barbiturate treated animals is considered unfit for human or animal consumption. Ingestion of pentobarbital contaminated tissues by wildlife or rendered material consumed by domestic pets can induce toxicities. Finally, as mentioned previously, the use of pharmaceuticals limits carcass disposal options

as renderers are less likely to accept animals euthanized by these methods. FDA-CVM 2003 [http://www.fda.gov/AnimalVeterinary/news Events/CVM updates/ucm119205.htm](http://www.fda.gov/AnimalVeterinary/news%20Events/CVM%20updates/ucm119205.htm)

COMMENT ON POLL SHOOTING OR STUNNING

Anecdotally, some veterinarians and producers have reported a preference for use of the poll as an anatomical site for stunning. However, poll-position stunning with a penetrating captive bolt is not recommended because research has shown that the depth of penetration and concussion in this region is less than that observed with frontal sites. Furthermore, research indicates that



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the use of penetrating captive bolt at the poll is prone to operator error and misdirection of the bolt into the spinal cord instead of the brain (Humane Slaughter Association 2013).

If using a gunshot behind the poll, the shot should be directed toward the base of the tongue. Whether poll shooting is conducted by penetrating captive bolt or gunshot, there is substantial potential for misdirection of the bullet or bolt so that damage to the brain to achieve unconsciousness or death is not assured. It should be noted that in the European Union use of the poll for euthanasia or slaughter is prohibited.

COMMENT ON THE USE OF ALPHA-2 AGONISTS

The injection of xylazine or any other alpha-2 agonist has not been shown to induce anesthesia and is not acceptable to use for euthanasia either as the sole means or as the primary method before applying an adjunctive method.

DETERMINATION OF UNCONCIOUSNESS

A state of apparent unconsciousness must be established immediately following the initial euthanasia procedure. In the field, the surrogate to unconsciousness is “lack of response” described below, as true unconsciousness can only be determined by EEG. The person performing euthanasia must be prepared to immediately reapply an accepted euthanasia technique if any sign of consciousness is detected by the observer or demonstrated by the animal. Secondary or adjunctive euthanasia methods must not be used until the animal has been determined to be unconscious.

SIGNS OF UNCONCIOUSNESS

- Absence of corneal reflex
- Absence of vocalization

- Absence of gag reflex (no voluntary tongue movements or swallowing)
- Lack of rhythmic respiration
- No coordinated attempt to rise or right itself

SECONDARY OR ADJUNCT EUTHANASIA METHODS

Exsanguination, pithing and rapid intravenous injection of a concentrated solution of potassium chloride (KCl), magnesium sulfate (MgSO₄) or magnesium chloride (MgCl₂) are acceptable adjunctive methods. A second shot (penetrating captive bolt or gunshot) is an acceptable secondary choice of adjunctive method when the above primary adjunctive methods are not available.

1. Exsanguination This method can be used to ensure death subsequent to stunning, anesthesia, or unconsciousness. It must not be used as a method for euthanasia of conscious animals. The most common exsanguination method in the bovine is to lacerate both the jugular veins and carotid arteries. A 6-inch long sharp knife is fully inserted behind the point the jaw and directed downwards until blood is freely flowing. Alternatively, in calves severing blood vessels of the brachial plexus may be performed by lifting a forelimb, inserting the knife deeply at the point of the elbow and cutting skin and vasculature until the limb can be laid back against the thorax of the animal. Third, the aorta can be transected via the rectum, by a trained individual, so that blood pools within the abdominal cavity.

2. Pithing Pithing is an adjunctive technique designed to cause death by increasing the destruction of brain and spinal cord tissue. It



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is performed by inserting a pithing rod or similar tool through the entry site produced in the skull by a bullet or penetrating captive bolt device. The operator manipulates the pithing tool to destroy both brain stem and spinal cord tissue, which results in death.



Figure 5. Pithing

3. Potassium Chloride (KCl) Rapid IV administration of a saturated solution of potassium chloride (KCl) induces cardiac arrest. Cattle must be anesthetized or unconscious prior to administration. The use of a captive bolt is also acceptable if a state of unconsciousness is achieved. The specific dose of KCl will vary according to the size of the animal, but an injection of 250 ml of a saturated KCl solution is usually sufficient for most mature cows. The KCl solution should always be given to effect (i.e., until death).

Potassium chloride can easily be sourced in the form of water softener salts and also can be ordered in bulk off of the internet from sites such as Amazon. The typical concentration of KCl for use as a secondary method of euthanasia in ruminants is between 75-100 mg per Kg of body weight. Use a mortar and pestle (or some other method) to grind the KCl crystals into a coarse powder. Dissolve appropriate amount of KCl crystals in hot water (about 60 mls of water per 20 g of KCl). For reference, 1 tablespoon of KCl weighs approximately 20 grams. Maintain the KCl solution at room temperature to avoid pre-

cipitate formation. If precipitate forms, rewarm and remix the solution.

4. Magnesium sulfate or magnesium chloride Similar to potassium chloride (KCl), use of intravenous saturated solutions of magnesium sulfate ($MgSO_4$) or magnesium chloride ($MgCl_2$) is acceptable only in unconscious animals. Compared to the use of Intravenous KCl, death is usually much slower.

5. Second shot A properly aimed shot, with an appropriate firearm or captive bolt, will reliably produce unconsciousness, but especially in the case of the captive bolt, may not lead to death. A second shot in an unconscious animal creates significant additional brain trauma, intracranial hemorrhage and substantial intracranial pressure. This increase in pressure often impairs respiratory and cardiac function within the medulla oblongata which leads to death. If the first shot does not lead to immediate unconsciousness, a second shot is required immediately, and is not optional.

CONFIRMATION OF DEATH

Confirmation of death following a euthanasia procedure is absolutely essential regardless of what

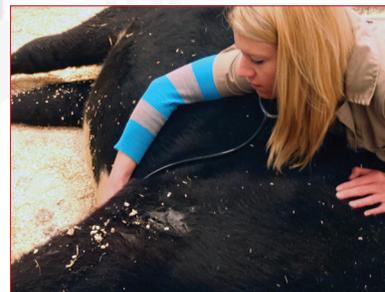


Figure 6. Confirmation of death

method of euthanasia is chosen. Keep personal safety in mind when confirming death because animals can make sudden involuntary movements. The primary indicator for



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confirmation of death is cardiac arrest. Lack of heartbeat and respiration for three-to-five minutes should be used to confirm death. The presence of a heartbeat can be best evaluated with a stethoscope placed under the left elbow. It should be noted that the heart continues to beat for a period of time with either captive bolt or firearm euthanasia, because heartbeat is controlled by the sino-atrial node and not the brain. Continued cessation of rhythmic breathing is considered a secondary indicator of death, and observation for movement of the chest can be used as an indicator of respiration in addition to lack of a heartbeat. However, respiration rates may be very erratic in unconscious animals; therefore, one must be cautious in the interpretation of respiration for confirmation of death. If respiration is not absent or the animal begins respiring again, a second shot is required. The corneal reflex may be tested by touching the surface of the eye. Normal or conscious animals will blink when the eye's surface is touched. Lack of a corneal reflex alone is not sufficient for confirmation of death, and by itself only proves the animal is unconscious. Continued monitoring of animals for a period of 20 to 30 minutes after euthanasia has been performed is also good advice to livestock owners and managers.

CONSIDERATION FOR EUTHANASIA OF CALVES AND BULLS

Calves and bulls require special consideration in selecting the proper method of euthanasia. Ethical considerations do not change for the calf because it is small or more easily handled. Blunt trauma by physical blow to the head is not acceptable for euthanasia of calves because the skull is too hard to consistently achieve immediate and lethal



Figure 7. Consideration for bulls

destruction of brain tissue. This method is also difficult to consistently apply because of restraint and complications in positioning the calf for effective use of blunt force trauma methods. In addition to the methods outlined in Table 1 for mature bovines, the use of a purpose-built non-penetrating captive bolt stunner is an acceptable (with conditions) method of euthanasia for calves, but should be followed with an adjunctive step to assure death. Euthanasia of bulls presents unique challenges because of their size, temperament, and thickness of their skull. Operator safety is of primary concern in euthanasia of bulls, and for certain techniques such as barbiturate overdose or captive bolt, proper restraint is critical. Bulls may be euthanized with specialized heavy-duty captive bolt guns or firearms capable of muzzle energies of 1,000 ft/lb, or by barbiturate overdose.

CONSIDERATIONS FOR EUTHANASIA OF BISON AND BUFFALO (From J.K. Shearer)

The recommended method for the euthanasia of a bison is gunshot. A minimum of 1356 Joules (J) (1000 ft/lb) of muzzle energy is required for euthanasia of yearlings, cows and mature bulls. This limits the firearm options to higher caliber centerfire rifles (e.g. 30-30, 270, 30-06 and others). The majority of handguns produce muzzle energies well below 1356 J (1000 ft/lb)



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and would not be appropriate for euthanasia of mature bison (Canadian Code of Practice, 2017).

The preferred anatomical site for entry of a bullet is on the forehead approximately 2.5 cm (1 inch) above an imaginary line connecting the bottom of the horns, which places the shot in a similar location to recommendations for mature cattle. Ideally, the angle of entry should be perpendicular to the skull. If it is necessary to shoot the animal from a distance, targets may be the head (frontal or lateral side) or the thorax (heart shot) (Canadian Code of Practice, 2017).

There are important anatomical differences that need to be considered when determining the best method of euthanasia for water buffalos compared with cattle. Skull bones are substantially thicker and the frontal and paranasal sinuses noticeably wider in buffaloes compared to cattle. Moreover, measures of the median distance from the frontal skin surface to the thalamus were 14.5 cm (11.7 cm–17.2 cm [4.6 in to 6.8 inches]) vs 10.2 (4 inches) (10.1–12.1 cm [4–4.8 inches]) in water buffalos and cattle, respectively (Schwenk et al, 2016). Bolt length of conventional captive bolt devices is 9 to 12 cm (3.5 to 4.7 inches) meaning that the ability of the bolt to make direct contact with the thalamus and brainstem is less likely using frontal sites in water buffalos compared with cattle. For this reason, use of the PCB at frontal sites in water buffalos is generally less effective.

Anatomic Site for conducting euthanasia of bison The preferred anatomic site for entry of a bullet is on the forehead approximately 1-inch above an imaginary line connecting the bottom of the horns (Canadian Code of Practice, 2017). In

Figure 2, the ideal site is identified on the intersection of lines from the lateral canthus to the top of the horn similar to landmarks used in cattle.

Anatomic sites for conducting euthanasia of water buffalo Recommendations for euthanasia of water buffalo with a firearm using frontal sites are to direct the projectile on the intersection of two imaginary lines connecting the lower edge to the upper edge of the contralateral horn (Schwenk et al, 2016). This site is above a line drawn laterally connecting the bottom of the horns. Depending upon the size of the horns, this will be at a higher or lower location.

UNACCEPTABLE METHODS OF EUTHANASIA

Based on ethical and humane considerations, the “AVMA Guidelines for the Euthanasia of Animals (2013)” considers the following methods unacceptable techniques:

- Manually applied blunt trauma to the head of calves or mature cattle
- Injection of unapproved chemical agents or substances (e.g. disinfectants, non-anesthetic pharmaceutical agents)
- Sedation with alpha-2 agonist such as xylazine followed by potassium chloride, magnesium sulfate, or any other euthanasia method that requires the animal to be unconscious prior to its use
- Air injection into the vein
- Electrocuting with a 120-volt electrical cord
- Drowning
- Exsanguination of conscious animals
- Puntilla: a method whereby a sharp pointed knife is plunged into the back of the neck of the animal to sever the spinal cord by entry into the atlanto-occipital space.



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TRAINING REQUIREMENTS

If euthanasia is to be provided by the owner, employees of the facility or a non-veterinarian third party, the expectation is that those individuals should have annual training and certification on how to recognize animals in need of euthanasia, proper euthanasia technique, how to properly confirm death, safe use of the methods of euthanizing to be employed, as well as how to maintain the equipment after and between uses. Some documented record of this training should be kept in the facilities training records or herd health plan.

RECORDS AND RECORD KEEPING

Keeping accurate and complete records is an important part of providing euthanasia. Records should include, at a minimum, the identification of all animals euthanized, the date, the person providing euthanasia, indication of the reason for euthanasia and the method of carcass disposal utilized. Records should also be kept of the euthanasia equipment. This should include a gun cleaning, captive bolt cleaning and service logs. Properly functioning equipment is critical to rendering the animals immediately insensible.

CONCLUSION

Personnel at sites that routinely handle cattle should be prepared with the knowledge, necessary skills, and well-maintained equipment to conduct euthanasia. Penetrating captive bolt and gunshot are the only two acceptable methods typically available to non-veterinarians for

emergency euthanasia of cattle. Animal transporters should also be properly trained in euthanasia techniques and should have contact information for appropriate personnel in case of an emergency. An action plan for routine and emergency euthanasia should be developed and followed wherever animals are handled. Persons who perform this task must be technically proficient, mentally capable and possess a basic understanding of the anatomical landmarks and equipment used for humane euthanasia of animals. If there is any degree of question or discomfort with a proposed euthanasia procedure, a veterinarian should be consulted.

Livestock markets and sale yards should have written euthanasia protocols to follow and trained personnel should be available for emergency euthanasia during all shifts. When practical, select a location where the carcass can be easily reached by removal equipment. Dead animals should be disposed of promptly and in accordance with all federal, state, and local regulation.

Additionally, it is important to remember that even in death, animals in our care deserve respect, and dead animals should not ever be handled in a manner that would be unacceptable for a live non-ambulatory cow. Acceptable methods for moving the carcass would include placing them onto a sled or rolling them into a bucket. If cattle are to be dumped into a container or pit, care should be taken to use the minimum height possible in order to minimize the distance the carcass will fall.

Approved by the AABP Board of Directors 2019