Please note: Numerous reference articles are cited in these comments. If you require access to any of them, please contact Zack Strong at zack@awionline.org.

Annex 24

CHAPTER 7.6.

**ANIMAL WELFARE AT THE TIME OF KILLING FOR PURPOSES OTHER THAN SLAUGHTER**

Article 7.6.1.

Introduction

Animals are killed for a variety of reasons, including those that may not make the transport for *slaughter* or the safe use of their products possible. Such reasons may include for contagious disease control, in cases where their welfare may be compromised due to ~~of~~ natural or ~~man-made~~ human-made disasters, when they are otherwise suffering from disease or injuries or for economic reasons. It is important to ~~consider~~ optimise their welfare during such killing for purposes other than slaughter ~~this process~~.

Article 7.6.2.

Scope

This chapter identifies hazards to animal welfare during *killing* forpurposes other than *slaughter* and provides recommendations for the appropriate procedures for such *killing*. It provides animal-based and other measures to assess the level of welfare during the process and recommends appropriate remedial actions to be applied.

This chapter applies to the killing of domestic and *captive wild* ~~ruminants, equids, birds, pigs, rabbits, camelids and mustelids for all purposes, except for slaughter which is covered by Chapter 7.5. Animal welfare during slaughter~~ mammals and birds (hereafter animals). Killing of reptiles is covered by Chapter 7.14.Killing of reptiles for their skin, meat and other products and killing of dogs for population management is covered by Chapter 7.7. The numbers of animals killed is situation dependent and could range from an individual to a large scale population.

This chapter should be read in conjunction with the guiding principles for *animal welfare* provided in Chapter 7.1.

Article 7.6.3.

General principles ~~for the operations regarding the~~ *~~killing~~* ~~of animals~~

The decision as to whether to kill animals should not be delayed if there is any risk to the welfare of those animals. The recommendations in this Chapter are based on the premise that a decision to kill the animals has been made and they address the need to ensure the welfare of the animals until they are dead.

During decision making and prior to *killing* the animals, appropriate husbandry, especially supply of feed and water and thermal comfort, should be maintained until the animals are killed. Medical care should be provided if needed.

Advanced planning for various scenarios, including adverse events, should clearly identify operational procedures and responsibilities.

For large scale killing, specific plans should be in place and adequate preparedness measures taken to ensure ready access to higher-welfare methods of depopulation.

The decision maker should be clearly identified to ensure decision making is not delayed.

All personnel involved in the killing of animals should have the relevant skills and competencies, acquired through training or experience.

As necessary, operational procedures should be evidence-based adapted to the specific circumstances in the affected locations or on the premises and should address, apart from animal welfare, effectiveness, and the speed of implementation of the method, operators’ safety and mental health, biosecurity and environmental aspects relevant to the species.

~~During decision making and prior to killing the animals, normal husbandry, especially supply of feed and water, should be maintained until the animals are killed.~~

Animals might be killed on site or moved to a dedicated place for killing. The handling and movement of animals should be minimised and carried out in accordance with the recommendations described below.

When restraint is required ~~Animal restraint~~ it should be sufficient to facilitate effective killing, and in accordance with animal welfare and operator safety requirements~~. When restraint is required~~, and killing should follow without ~~minimal~~ delay. The type and size of restraint deployed should be appropriate for the age, size and species of animal to be killed. When herding or corralling is applied, a low-stress method using appropriate apparatus to facilitate the safe and effective killing of animals should be used.

Killing methods used should result in immediate death or loss of consciousness lasting until death. When loss of consciousness is not immediate, induction of unconsciousness ~~should involve as little aversion as possible and~~ should not cause avoidable distress, fear and pain. A backup procedure must be immediately available and used to kill the animal if the first method does not result in death or unconsciousness.

~~Young animals should be killed before older animals on which they are dependent to reduce potential distress.~~

Planning should take into account the order in which animals are killed. Where possible vulnerable animals should be killed as a matter of priority, which may include:

• groups with symptomatic animals,

• animals that are unable to obtain feed or water,

• animals that have compromised housing or are without shelter,

• young [REF] or unweaned animals should be killed before older animals on which they are dependent,

• potentially dangerous or aggressive animals, such as bulls, sows with litters, or boars,

• animals in late stage of pregnancy or in parturition, and

• animals in-utero may need to be ~~humanely~~killed following the killing of the dam if the amniotic sac is ruptured.

~~For disease control purposes and for biosecurity considerations, infected animals should be killed first, followed by in-contact animals, and then remaining animals.~~

There should be continuous monitoring of the operational procedures to ensure they are consistently effective regarding animal welfare, operator safety and mental health ~~and~~, *biosecurity* and environmental aspects.

When large scale or disease control ~~the~~ operational procedures are concluded, there should be a debriefing session or written report describing the practices adopted and their effect on animal welfare, operator safety, *biosecurity and responsible personnel*. The report must also describe and assess potential means by which (1) vulnerability to the circumstances necessitating the large scale killing can be reduced, and (2) means by which negative animal welfare impacts can be reduced in the future.

Article 7.6.4.

**Organisational structure for the operations ~~regarding the~~ of large scale killing or killing for disease control of animals**

Plans for large scale killing or killing for disease control should contain details of responsibilities, management structure, contact details, disease control strategies, operational procedures and necessary equipment and resources. *Animal welfare* considerations should always be addressed as a priority in these plans. The plans should include a strategy to ensure that an adequate number of personnel competent in the *killing* of animals is available.

The personnel responsible for the handling, moving, restraining and killing the animals should follow the recommendations of this chapter.

In case of disease control, o~~O~~perational activities should be led by the *Competent authority* who has the authority to ensure the required *animal welfare* and *biosecurity* standards.

The Competent authority should nominate a responsible agent for all activities across one or more affected locations or premises who should be supported by coordinators for planning operations and logistics to facilitate efficient operations.

The nominated responsible agent ~~of the~~ *~~Competent authority~~* should provide overall guidance to personnel and logistic support for operations at all affected locations or premises to ensure consistency in adherence to the *Terrestrial Code’s* *animal welfare* and animal health recommendations.

A specialist team, led by a team leader answerable to the nominated responsible agent ~~nominated by the~~ *~~Competent Authority~~*, should be deployed to work on each affected location or premises. ~~In some situations,~~ When needed personnel may be required to fulfil more than one function. Each team should contain a competent *veterinarian* or have access to veterinary advice at all times.

~~Emergency plans should be in place and contain details of responsibilities, management structure, disease control strategies, operational procedures and necessary equipment and resources.~~ *~~Animal welfare~~* ~~considerations should always be addressed in these emergency plans. The plans should include a strategy to ensure that an adequate number of personnel competent in the~~ *~~killing~~* ~~of animals is available.~~

~~Depopulation under disease control emergency plans should be performed under the supervision of~~ *~~Competent Authority~~* ~~and address any~~ *~~animal welfare~~* ~~issues that may result from standstill or any other animal movement restriction~~.

In considering the *animal welfare* issues associated with *killing* animals, the key personnel, their responsibilities, and competencies required are described in Article 7.6.5.

In ~~other~~ situations that do not necessarily involve the *Competent Authority*, the personnel responsible should follow the recommendations of this chapter.

Article 7.6.5.

Responsibilities, training and competencies of the specialist team for the operations regarding the ~~mass~~ killing of animals

All personnel have a crucial role to play in ensuring good animal welfare conditions through to the killing. Training for all personnel should emphasise the importance of animal welfare and their responsibility in contributing to the welfare of the animals.

Competencies may be gained through a combination of formal training and practical experience. These competencies should be assessed by the *Competent Authority* or by an independent body recognised by the *Competent Authority*

1. Team leader
2. Responsibilities
3. plan overall operations on affected location or premises;

(ii) determine and address requirements for *animal welfare*, operator safety and *biosecurity*;

(iii) organise and manage team of people to facilitate *killing* of the relevant animals on the location or premises in accordance with national regulations and these recommendations;

1. determine logistics required;

(v) monitor operations to ensure *animal welfare*, operator safety and *biosecurity* requirements are met;

(vi) seek and use veterinary advice;

(vii) report upwards on progress and problems;

(viii) provide a written report at the conclusion of the *killing* operation, describing the practices adopted and their effect on *animal welfare*, operator safety, efficacy of *biosecurity* and environmental impact.

1. Training and c~~C~~ompetencies
2. ~~knowledge~~ understanding of and experience with relevant animal husbandry practices and behaviour of the species, and knowledge of anatomical or physiological characteristics of the species that may impact the effectiveness and animal welfare impacts of potential killing methods;
3. ~~knowledge~~ understanding of *animal welfare,* impact of *~~,~~* different killing methods, and the details, planning and implementation of the *killing* operation~~,~~ ; ~~and the underpinning behavioural, anatomical and physiological processes involved in the~~ *~~killing~~* ~~operation;~~
4. leadership and ability to ~~skills to~~ manage all activities on the location or premises ~~and deliver outcomes on time~~;
5. awareness of psychological effects on farmer, team members or person(s) in charge of animals [AVMA, 2019], and general public;

~~iv)~~ v) awareness of fatigue effects on those carrying out repeated killing of large numbers of animals and on the effectiveness of the procedure [AVMA, 2019].

~~Iv)~~ vi) ability to communicate effectively with different audiences ~~communication skills~~;

~~vi)~~ vii) capacity to evaluate the environmental impacts caused by their operation.

1. Veterinarian
2. Responsibilities
3. advise on ~~determine~~ and supervise the implementation of the most appropriate *killing* method to ensure that animals are killed ~~without avoidable pain and distress~~ minimising pain, fear and suffering;
4. determine and implement any necessary ~~the~~ additional requirements for *animal welfare*, including the order of *killing*;
5. ensure that confirmation of the *death* of the animals is carried out by competent persons as soon as possible ~~at appropriate times~~ after the *killing* procedure;
6. minimise the risk of disease spread within and from the location or premises through the supervision of *biosecurity*;
7. ~~continuously monitor~~ ensuring *animal welfare* and *biosecurity* during killing process;
8. collaborate with the team leader on the written report at the conclusion of the *killing*.
9. Training and c~~C~~ompetencies
10. understanding of ~~ability to assess~~ *animal welfare* and ability to assess it;
11. ~~Understanding~~ knowledge of ~~especially~~ the effectiveness of the *killing* process and ~~the~~ ability to correct any deficiencies;
12. knowledge of the different killing methods and their impacts on animal welfare, and the underlying anatomy, physiological and behavioural processes involved in the killing operation.
13. ability to assess *biosecurity* risks.
14. Animal handlers
15. Responsibilities
16. review on-site facilities in terms of their appropriateness;
17. design temporary animal handling facilities, when required;
18. move and restrain animals;
19. report *animal welfare* and *biosecurity* issues to the *veterinarian*.
20. Training and c~~C~~ompetencies
21. understand the species-specific behavioural patterns of the animals they are working with and the underlying principles for carrying out the required tasks;

ii) ~~animal handling in emergency situations and in close confinement is required;~~ capable to identify signs of distress, fear, and pain and to take preventive and corrective actions;

iii) understanding of *biosecurity*.

1. Personnel in charge of killing animals
2. Responsibilities

i) k*illing* of the animals using an appropriate method in a manner that protects animal welfare;

ii) when applicable confirm the unconsciousness of the animals;

iii) confirm the death of the animals.

1. Training and c~~C~~ompetencies
2. Safely and correctly use and maint~~e~~ain~~ance of relevant~~ equipment;
3. Operate ~~familiarity with the techniques of~~ restraining and killing equipment for the species involved;
4. ~~knowledge~~ ability to assess effective killing, to recognize signs of recovery of consciousness, and the skill to take immediate corrective action;.
5. ~~Personnel in charge of disposal of dead animals~~
6. ~~Responsibilities~~

~~i) An ensuring efficient dead animal disposal so that (to ensure~~ *~~killing~~* ~~operations are not hindered) should be ensured~~

~~ii) understanding of biosecurity and ensuring compliance with Chapter 4.13~~

1. ~~Training and Competencies~~
2. ~~The personnel should be competent to safely use and maintain available equipment and apply techniques for the species involved.;~~
3. ~~Recognise signs of life.~~

5. Breeder, owner, farmer or keeper ~~or manager~~

1. Responsibilities
2. assist when requested.
3. Training and c~~C~~ompetencies
4. specific knowledge of ~~his/her~~ the animals that ~~are~~ they are responsible for and their ~~environment~~ premises.

**Article 7.6.6.**

**Considerations in the planning of the operations regarding the ~~mass~~** **large scale killing of animals**

Many activities will need to be conducted on affected locations or premises, including the *killing* of animals. The team leader should develop a plan and prepare for large scale *killing* of animals on the location or premises which should include consideration of:

1. minimising handling, restraint and movement of animals;
2. *killing* the animals on the affected locations or premises; however, there may be circumstances where the animals may need to be moved to another location for *killing*; when the *killing* is conducted at a *slaughterhouse/abattoir*, the recommendations in Chapter 7.5. should be followed;
3. the species, number, age and size of animals to be killed, species-specific anatomical, physiological, and behavioural considerations relevant to potential killing methods and procedures, and the order of *killing* them;
4. methods of *killing* the animals~~, and their cost~~;
5. available resources, including cost, staff numbers, and any other practical elements
6. description of the assessment of state of consciousness and signs of life;
7. housing, husbandry, location of the animals as well as accessibility of ~~the farm or~~ the place they are situated;
8. the availability and effectiveness of equipment needed for *killing* of the animals, as well as the time necessary to kill the required number of animals using such methods;
9. the availability on the locations or premises of facilities that will be used to assist with the *killing*, and the necessity of any additional facilities;
10. potential *biosecurity* and environmental impact of the operations;
11. the health and safety of personnel conducting the *killing*;
12. ~~any legal issues that may be involved, for example where restricted veterinary drugs may be used, or where the process may impact on the environment;~~
13. ~~the presence of other nearby premises holding animals;~~
14. ~~possibilities for removal and disposal of dead animals.~~

The plan should minimise the negative animal welfare impacts of the *killing* by taking into account the different phases of the procedures to be applied for *killing*.

Competences and skills of the personnel handling and *killing* animals should be included in the operational plan.

**Article 7.6.7.**

**Hazards to animal welfare**

~~For the purpose of this chapter,~~ *~~hazards~~* ~~to~~ *~~animal welfare~~* ~~means a factor with the potential to adversely affect~~ *~~animal welfare~~*~~.~~

When killing animals, they may be exposed to different hazards to *animal welfare* ~~hazards~~ including improper ~~restraining~~ restraint, rough handling, forced movement, absence of or improper design of premises, inadequate construction and maintenance of premises, adverse weather conditions, unexpected loud noise and use of ineffective *killing* methods or killing methods that cause, or are applied in a manner that causes, negative affective states, such as pain, fear, anxiety, breathlessness (respiratory distress), frustration, overheating, chilling, hearing discomfort, nausea, debility, fatigue, helplessness, panic, exhaustion.

Exposure to multiple hazards to a*nimal welfare* can have a negative cumulative effect on the animals [Moberg and Mench, 2000].

 Hazards to animal welfare can be minimised by appropriate design of premises and choice of equipment, and method of killing ~~and through~~, good management, training and competency of personnel.

**Article 7.6.8.**

**Measures to assess animal welfare at the time of** **killing for purposes other than slaughter**

~~Hazards to a~~Animal welfare at the time of killing for purposes other than slaughter should be assessed using animal-based measures. However, consideration should be given to the resources provided as well as the design and management of the method.

Measures to assess welfare during handling and restraint in Chapter 7.5 are applicable to this chapter.

These animal-based measures should be routinely used in the monitoring of the state of consciousness and death, with the most appropriate to be used in relation to the method applied.

1. The following animal-based measures can be useful indicators of animal welfare. These measures can be considered as tools to monitor the efficiency of design and management, given that they can affect animal welfare. Multiple indicators should be used to determine effectiveness of the method.
2. Immediate collapse

Effective ~~stunning~~ loss of consciousness can be recognised from the immediate loss of posture leading to collapse of the animal. ~~Ineffectively stunned~~ Conscious animals, on the other hand, will fail to collapse or will attempt to regain posture after collapse. ~~Some ineffectively stunned animals, may occur, for example, if captive bolt shooting position is wrong or electrically immobilised animals lose posture, but remain conscious~~. The absence of immediate collapse is always indicative of consciousness.

1. Tonic–clonic seizures

Effective electrical and in some cases captive bolt methods ~~stunning often~~ result in the presence of tonic–clonic seizures. Tonic seizures can be recognised by an arched back and rigidly flexed legs under the body and will last for several seconds. It is followed by clonic seizures lasting for seconds and manifested as leg kicking or paddling. The absence of tonic–clonic seizures may be indicative of consciousness [Van der Wal, 1971].

1. Righting reflex [Atkinson et al, 2013; Terlow et al, 2016]

The righting reflex refers to any reflex that tends to bring the body into its normal upright position. ~~Ineffectively~~ For example effectively ~~stunned~~ killed animals ~~and those recovering consciousness~~ will not attempt to raise ~~their heads~~ or shake their heads ~~after stunning, which is referred to as righting reflex~~.

1. Rhythmic breathing [Atkinson et al, 2013; Kamenik et al, 2019, Vecerek et al, 2020]

Effective ~~stunning~~ killing will result in immediate onset of apnoea (absence of breathing). Ineffectively ~~stunned~~ killed animals and those recovering consciousness will start to breathe in a pattern commonly referred to as rhythmic breathing, which may begin as gagging and lead to respiratory cycles of ~~inspiration~~ inhalation and ~~expiration~~ exhalation. Breathing can be recognised from the regular flank, abdominal, ~~and/~~or mouth and nostril movements. Recovery of breathing, if not visible through these movements, can be checked by holding a small mirror in front of the nostrils or mouth to look for the appearance of condensation due to ~~expiration~~ exhalation of moist air. Rhythmic breathing is not to be confused with agonal breaths.

1. Corneal reflex:

The corneal reflex is elicited by touching or tapping the cornea. ~~Ineffectively stunned~~ Conscious animals and those recovering consciousness will blink in response to the stimulus. Effectively ~~stunned~~ killed ~~and stuck (bled)~~ animals show the absence of the corneal reflex ~~during any key stage. On the other hand, ineffectively or poorly stunned animals and those recovering consciousness prior to sticking or during bleeding are expected to show the presence of the corneal reflex at any key stage. It is worth noting that placement of electrical stunning tongs (electrodes) over the eyes of animals may render this indicator invalid~~.

1. Palpebral reflex

The palpebral reflex is elicited by touching or tapping a finger on the inner/outer eye canthus or eyelashes. ~~Correctly~~ ~~stunned animals will not show a palpebral reflex~~. ~~Ineffectively stunned~~ Conscious animals and those recovering consciousness will blink in response to the stimulus ~~at any key stage. It is worth noting that placement of electrical stunning tongs (electrodes) over the eyes of animals may render this indicator invalid~~. Effectively killed animals will not show a palpebral reflex.

1. Eye movement

Eye movements and the position of the eyeball can be recognised from close examination of eyes after stunning. Conscious animals and those recovering consciousness will show eye movements. ~~Correctly stunned~~ Effectively killed animals will show fixed eyes, and this can be recognised from wide open and glassy eyes with clearly visible iris/cornea in the middle. ~~Eyeballs may be obscured in some animals owing to rotation into the eye socket following effective stunning. Ineffectively stunned Conscious animals and those recovering consciousness will show eye movements [EFSA AHAW Panel, 2013, Kamenik et al, 2019]~~

1. The following animal-based measures can be used as indicators of consciousness but are not sensible to indicate unconsciousness. Therefore, they can be use in addition to the previously mentioned animal-based measures:
2. ~~Response to painful stimuli~~

~~Poor stunning can be recognised from the response to painful stimulus. The absence of response to a painful stimulus indicates unconsciousness following stunning. [Terlow et al, 2016. Kemenik et al, 2018]~~

a) ~~b)~~ Spontaneous blinking

Conscious animals may show spontaneous blinking and therefore this sign can be used to recognise ineffective ~~stunning~~ killing or recovery of consciousness after stunning. However, not all the conscious animals may show spontaneous blinking. ~~Spontaneous blinking can be used as an indicator at all key stages of monitoring. It is worth noting that placement of electrical stunning tongs (electrodes) over the eyes of animals may render this indicator invalid.~~ [Gregory et al, 2007; Terlouw et al, 2016, Kamenik et al, 2018]

b) ~~c)~~ Vocalisation

Vocalisation is expected only in conscious animals ~~and can be used as an indicator in all key stages of monitoring~~. However, not all conscious animals will vocalise, and hence the absence of vocalisation does not always mean that the animal is unconscious. [Atkinson et al, 2013; Kamenik et al., 2018]

1. The following animal-based measures can be used as the confirmation of death before carcass disposal:
2. Muscle tone

Immediately after killing, dead animals will lose muscle tone, which can be recognized from the completely relaxed legs, floppy ears, relaxed tongue and relaxed jaws.

1. Heartbeat

Onset of death leads to permanent loss of heartbeat, which can be ascertained physically by using a stethoscope or by heart or arterial palpation, where possible. [Vogel et al., 2011]

1. Dilated pupils

Dilated pupils (mydriasis) are an indication of death.

Article 7.6.9.

**Handling of animals**

Handling is the process of preparation of the animals for killing, and may include moving them to the killing point. Handling and moving can be stressful to animals, especially when they are isolated out of their primary home area or from their group. [Gavinelli et al. ,2014].

1. Animal welfare concerns

Exposure to novel environments (e.g. noise, lighting, flooring, smell) may cause fear and reluctance to move, or turning back. Poorly designed facilities and inappropriate handling (e.g. inappropriate use of electrical goads, kicking, hitting with a stick) will cause *distress*, fear and *pain*.

1. Animal-based and other measures:
	1. animals slipping, falling and piling up;
	2. animals turning around or moving backwards, attempting to escape or reluctant to move;
	3. animals vocalising;
	4. animals that collide with facility structures;
	5. animals with broken or otherwise injured limbs;
	6. animals that are unable to move by themselves due to reasons other than broken or injured limbs;
	7. use of force by personnel;
	8. inappropriate use of electrical goads.
2. Recommendations

Design of the facilities should promote the natural movements of animals, and, as far as possible, minimise human interaction.

Floor should be clean, dry and not slippery.

Raceways should be well lit so that animals can see where they are going.

The design of raceways should minimise distractions that may cause animals to stop, baulk or turn back(e.g. shadows, changes in flooring, moving objects, loud or sudden noises).

Animals that are injured, sick or unable to rise require immediate action and, when necessary, emergency [*killing*](https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/index.php?id=169&L=1&htmfile=glossaire.htm#terme_mise_a_mort) should be performed without moving them and without delay. Animals should not be dragged, nor should they be lifted or handled in a way that might cause further [*pain*](https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/index.php?id=169&L=1&htmfile=glossaire.htm#terme_douleur) and suffering or exacerbate injuries.

Personnel should be calm and patient, assisting animals to move using a soft voice and slow movements.

Animals should be moved in groups as this decreases fear and makes use of their natural tendency to follow other animals.

Handling aids such as panels or flags should be used in a manner to encourage and direct movement of the animals without causing [*distress*](https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/index.php?id=169&L=1&htmfile=glossaire.htm#terme_detresse), fear or [*pain*](https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/index.php?id=169&L=1&htmfile=glossaire.htm#terme_douleur).

Electric goads must not be used routinely, but only in extremely rare circumstances when other measures have been ineffective, the animal has no injury or other condition that makes moving uncomfortable, there is room for the animal to move forward, and prompting the animal to move is necessary for the safety of other animals or human handlers.

Only low-voltage goads should be applied to the hindquarters of adult pigs and large ruminants, and never to sensitive areas such as the eyes, mouth, ears, ano-genital region, udders or belly. Such instruments should not be used on equids, camelids, ratites, sheep and goats, pregnant animals or on calves or piglets. Shocks should not be used repeatedly if the animal fails to respond and should not last longer than one second.

The manual lifting of animals should be avoided; if it is necessary, animals should not be grasped or lifted in a manner which causes [*pain*](https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/index.php?id=169&L=1&htmfile=glossaire.htm#terme_douleur) or suffering and physical damage (e.g. bruising, fractures, dislocations).

Animals should not be forced to move at a speed greater than their normal walking pace to minimise injury through slipping or falling.

Article 7.6.10.

**Killing Methods**

The following killing methods are globally available, in use, and comport with the requirement in Article 7.6.3. that “Killing methods used should result in immediate death or loss of consciousness lasting until death. When loss of consciousness is not immediate, induction of unconsciousness should not cause avoidable distress, fear and pain.” The main purpose of this part of the chapter is to ensure that where killing methods are in use that they are undertaken in a manner that optimises animal welfare and to ensure clarity surrounding which killing methods are unacceptable on animal grounds.

For each killing method the description of the killing method and its use in animal species, animal welfare concerns, identification of animal-based and other welfare measures, recommendations for effective use to optimise welfare, and any species-specific recommendations are presented in Articles 7.6.11. to 7.6.32.

Standard operating procedures should be in place that define key operating parameters and follow the manufacturer's recommendations for stunning or killing.

The killing methods covered are divided into two broad categories. Manual, individual killing methods which involve a human operator or operators manually performing a killing procedure on individual animals (Articles 7.6.11. to 7.6.22.); and automated large scale killing methods which involve automated procedures for large scale killing of many animals either sequentially (e.g. water baths) or simultaneously (e.g. atmospheric modification) (Articles 7.6.23. to 7.6.32).

Article 7.6.11.

**Firearms**

Firearms that fire free projectiles such as a shotgun, rifle, or handgun can provide a quick and effective method for killing when used properly. They require minimal or no restraint and can be used to kill from a distance by properly trained and competent marksmen or markswomen.

A firearm can be used from long range and may be aimed to penetrate the skull or soft tissue at the top of the neck of the animals (high neck shot) and to cause irreversible concussion and death and should only be used by properly trained and competent marksmen. The firearm may also be aimed to penetrate the thoracic cavity and heart causing respiratory and heart failure and death.

1. Animal Welfare Concerns

This method has the potential for non-lethal wounding of the target animal and lethal or non-lethal wounding of non-target animals. This may occur because of inappropriate cartridge, calibre or type of bullet or incorrect shooting position.

1. Animal-based and other measures

Animal-based measures of an effective shot include [HSA, 2016b]:

1. immediate collapse
2. apnoea
3. carcass appearance (tonic or relaxed)
4. duration of convulsions
5. absence of eye movement
6. glazed expression
7. absence of corneal reflex
8. Recommendations

Firearms and ammunition should be selected based on the species and the distance to shoot the animals. The correct cartridge, calibre and type of bullet for the different species age and size should be used.

Firearms are suitable for killing agitated animals in open spaces.

Firearms should not be used if trying to preserve brain tissue for diagnosis of diseases or when leakage of body fluids may present a biosecurity risk.

Training is essential for ensuring effective killing with firearms. This training must include approaches that ensure skilled marksmanship; an understanding of safety principles, animal anatomy, animal behaviour; animal handling; use of appropriate combinations of firearms and bullets for the intended purpose; and appropriate judgment under field conditions.

At short range, the marksman or markswoman should ensure that the animal is not moving and in the correct position to enable accurate targeting and the range should be as short as possible (5–50 cm for a shotgun) but the barrel should not be in contact with the head or other part of the animals.

Animals that are not killed by the initial shot, should be re-shot or killed by a backup method.

The method is suitable for all species covered by this chapter.

1. Species-specific recommendations

None identified

Article 7.6.12.

**Penetrating captive bolt**

The aim of this method is to produce a state of unconsciousness and cause severe damage to the brain by the impact and penetration of a captive bolt using a mechanical device. The captive bolt should be positioned on the skull to penetrate the cortex and mid-brain of the animal. The force of impact and the physical damage caused by the passage of the bolt should result in immediate unconsciousness. Physical damage to the brain caused by penetration of the bolt may result in death; however, a secondary intervention such as pithing, bleeding or lethal injection should be performed as soon as possible after the shot to ensure the death of the animal.

A penetrating captive bolt is fired from a gun powered by either compressed air or a blank cartridge, designed to fire a retractable metal bolt into the animal’s cranium. The bolt should be recessed into the body of the pistol to get the proper velocity required to penetrate the skull of the animal.

1. Animal welfare concerns

An incorrect shooting position or incorrect captive bolt parameters (not hitting the skull with sufficient force) will mis-stun the animal, leaving it conscious and leading to serious wounds and consequently distress, fear and pain.

Regaining of consciousness before death due to delay in applying the secondary intervention.

1. Animal-based and other measures

Animal-based measures of an effective shot include:

1. immediate collapse
2. apnoea
3. tonic seizures
4. absence of eye movement
5. absence of corneal reflex
6. absence of palpebral reflex
7. absence of righting reflex
8. Recommendations

For cartridge powered and compressed air guns, the bolt velocity and the length of the bolt should be appropriate to the species and type of animal, in accordance with the recommendations of the manufacturer.

Captive bolt guns should be frequently cleaned and maintained in good working condition. Regular check-up of the bolt velocity is recommended for effective stunning, operator safety, and improved animal welfare.

More than one gun may be necessary to avoid overheating with repeated use, and a back-up gun should be available in the event of an ineffective shot.

Animals should be restrained and the operator should ensure that the head of the animal is accessible. The method is difficult to apply in agitated animals.

Proper positioning of the captive bolt equipment is required as incorrect positioning causes inefficient stunning leading to pain and distress in animals.

Animal-based measures should be monitored continuously after application until *death* to ensure the absence of brain stem reflexes.

Suitable training and experience of operators in the application of captive bolt pistol, ergonomics and workload conditions should be considered for reducing fatigue in operators.

Penetrating captive bolt should not be used if preservation of brain tissue for diagnosis of diseases or when leakage of body fluids may present a biosecurity risk.

The secondary intervention should be performed without delay after the shot to ensure the death of the animal.

The method is suitable for equids, camelids, cattle, sheep, goats, pigs, poultry, ratites, rabbits and *captive wild animals*.

1. Species-specific recommendations

The size of the skulls and the thickness of the skull bones should be taken into account when selecting parameters such as bolt diameter, bolt length and cartridge power in penetrative captive bolt stunning.

Heavily horned animals should be stunned with penetrative captive bolt in the occipital position using a heavy-duty contact-fired captive bolt gun directed forward at the nose.

In new world camelids the device should be placed at the crown position (highest point on the head) aiming downward to the base of the jaw [AVMA, 2020].

In turkeys the placement of the device should be directly on the midline of the skull and at the highest/widest point of the head with the captive bolt aimed directly down toward the brain.

In chickens (and poultry with comb development) the placement should be directly behind the comb and on the midline of the skull with the captive bolt aimed directly down.

In ratites a device with a short penetrating bolt and the smallest charge appropriate for poultry or rabbits should be applied to the top of the head at the midpoint of an imaginary line between the outer “ear” openings.

Article 7.6.13.

**Pithing**

Pithing is not a standalone killing or stunning method, it’s a secondary method of *killing* animals which have been stunned by a penetrating captive bolt, without immediate *death*.

Pithing physically disrupts the central nervous system by the insertion of a flexible rod. The rod can be inserted caudally through the brain stem and spinal cord following stunning by penetrative captive bolt or cranially through the spinal cord and brain stem following decapitation. Pithing can be used as a primary killing method for animals which have been stunned by a penetrating captive bolt, without immediate death or as a secondary method to ensure rapid death.

1. Animal welfare concerns

Since pithing must only be performed in unconscious, previously stunned animals, it doesn’t have any welfare concerns of its own. However, it shares the welfare concerns of the primary method of killing or stunning.

1. Animal-based and other measures

Absence of brain stem reflexes and other muscle movements (following initial violent muscle contractions) can be used to confirm successful pithing.

1. Recommendations

Pithing is an adjunct method that can be used in conjunction with penetrative captive bolt stunning or decapitation to ensure that an animal is dead (in the case of penetrative captive bolt stunning) or that an animal is no longer conscious (in the case of decapitation).

1. Species-specific recommendations

The pithing rod selected must be of a suitable size to be able to fit within the spinal canal of the animal.

Article 7.6.14.

**Non-penetrating captive bolt** **followed by a secondary killing method**

Non‐penetrating captive bolt have a ‘mushroom headed bolt" which impacts the skull but does not enter the brain. It administers a blow to the animal’s skull of sufficient force to render the animal immediately unconscious. The gun should be placed on the front of the skull to deliver a percussive blow which produces instantaneous unconsciousness. A secondary intervention such as bleeding, cervical dislocation or lethal injection should be performed without delay after the shot to ensure the death of the animal.

1. Animal welfare concerns

An incorrect shooting position or incorrect captive bolt parameters (not hitting the skull with sufficient force) will mis-stun the animal, leaving it conscious and leading to serious wounds and consequently distress, fear and pain.

Regaining of consciousness before death due to delay in applying the secondary intervention.

1. Animal-based and other measures

Animal-based measures of an effective shot include:

1. immediate collapse
2. apnoea
3. tonic seizures
4. absence of eye movement
5. absence of corneal reflex
6. absence of palpebral reflex
7. absence of righting reflex
8. Recommendations

For cartridge powered and compressed air guns, the velocity and diameter of the bolt should be appropriate to the species and type of animal, in accordance with the recommendations of the manufacturer.

Non-penetrating captive bolt guns should be frequently cleaned and maintained in good working condition. Regular check-up of the bolt velocity is recommended for effective stunning, operator safety, and improved animal welfare.

More than one gun may be necessary to avoid overheating, and a back-up gun should be available in the event of an ineffective shot.

Animals should be restrained and the operator should ensure that the head of the animal is accessible. The method is difficult to apply in agitated animals.

Proper positioning of the non-penetrating captive bolt equipment is required as incorrect positioning of the captive bolt causes inefficient stunning leading to pain and distress in animals.

Animal-based measures should be monitored continuously after application until death to ensure the absence of brain stem reflexes.

Suitable training and experience of operators in the application of non-penetrating captive bolt pistol and ergonomics and workload conditions should be considered for reducing fatigue in operators.

The secondary intervention should be performed without delay after the shot to ensure the death of the animal.

This methods is suitable for turkeys, chickens, ratites, rabbits, lambs and goats kids ( approximately up to 4.5 kg) and piglets (approximately up to 10.9 kg).

1. Species-specific recommendations

In turkeys the placement of the device should be directly on the midline of the skull and at the highest/widest point of the head with the captive bolt aimed directly down toward the brain.

In chickens (and poultry with comb development) the placement should be directly behind the comb and on the midline of the skull with the captive bolt aimed directly down.

In ratites a device with the smallest charge appropriate for poultry or rabbits should be applied to the top of the head at the midpoint of an imaginary line between the outer “ear” openings.

In rabbits the device should be placed in the center of the forehead, with the barrel in front of the ears and behind the eyes. The device should be discharged twice in rapid succession at the pressure recommended for the age and size of the rabbit.

In lambs and goats kids up to approximately 4.5 kg the preferred shooting position is with the muzzle of the non-penetrating captive bolt on the midline behind the poll (e.g., between the ears) with the chin tucked into the neck.

In piglets, non-penetrative captive bolt provides immediate and irreversible loss of consciousness and brain death in piglets up to 10.9 kg with a single application on the frontal–parietal position [Grist et al., 2017, 2018a].

Article 7.6.15.

**Bleeding**

Bleeding is a method of *killing* animals through the severance of the major blood vessels in the neck or chest that results in a rapid fall in blood pressure, leading to cerebral ischaemia and *death*.

1. Animal welfare concerns

The process of *bleeding* requires significant tissue trauma and this may be painful if the animal has not been rendered unconscious prior to the procedure [Gibson et al. 2009]. Consciousness may persist for periods of up to 20 or 60 seconds (depending on species) following blood vessel transection [Johnson et al. 2015]. Animals may experience fear, pain and *distress* during this period.

1. Animal-based and other measures

Animal-based and other measures that indicate loss of consciousness include all the following: absence of muscle tone; absence of corneal or palpebral reflex; absence of rhythmic breathing. Unconsciousness should be reassessed until death is confirmed. In addition, cessation of bleeding after a continuous and rapid blood flow can be used as an indicator of death.

1. Recommendations

Bleeding should only be used in animals that can be rendered unconscious prior to severance of the blood vessels.

1. Species-specific recommendations

None identified

Article 7.6.16.

**Lethal injection**

Lethal injection is a procedure that involves injecting one or more drugs into an animal to cause rapid death.

The animal is injected intravenously with a lethal dose of anaesthetic drugs and may also receive an initial injection of a sedative. In practice, barbiturates in combination with other drugs are commonly used. They induce a smooth transition from consciousness to unconsciousness and death by causing depression of the central nervous system and respiratory centres in the brain leading to cardiac arrest (Shearer, 2018).

The preferred route of administration is intravenous (HSA 18; AVMA, 2020), but in some cases it may be given intramuscularly, intracardially or intraperitoneally. Drugs that cause tissue damage or necrosis with extravasation or subcutaneous administration must not be administered by intramuscular route and should only be administered by intraperitoneal or intraorgan routes in unconscious animals. Due to the potential for pain, use of intracardiac or other intraorgan routes must only be used in unconscious animals.

1. Animal welfare concerns

If routes of administration are inappropriate, consciousness may not be lost rapidly before death, causing pain and fear.

If doses of administration are not correct (sub-lethal), consciousness may not be lost rapidly before death, causing fear.

Some combinations of drug type and route of administration may be painful and should only be used in unconscious animals.

During rapid injection, some drugs may cause pain, irritation and paralysis, which can cause the suppression of respiration while the animal is still conscious [EFSA, 2004].

Intracardiac administration can be extremely painful if penetration of the heart is not successful on the ﬁrst attempt (EFSA, 2004).

Personnel lacking appropriate training and skills, or personnel suffering fatigue, or fractious animals unable to be properly restrained, may cause ineffective administration and be detrimental to animal welfare (Søren et al., 2020).

1. Animal-based and other measures

Each animal should be examined carefully to conﬁrm loss of consciousness and death:

Posture, breathing, heart auscultation, corneal or palpebral reﬂex, vocalization and eyes movements.

Absence of brain stem reflexes.

1. Recommendations

A calm injection process and smooth transition to unconsciousness should be provided for the animal, if necessary via provision of a sedative, anxiolytic, or anesthetic prior to administration of the lethal injection.

Lethal injection should only be performed by a qualified veterinarian or under their direct supervision.

Personnel performing this method should be trained and knowledgeable in anaesthetic techniques.

Personnel should be trained to use appropriate presentation of the animal and skilled intravenous administration to avoid extravasation of the drug and to use the correct dose according to the species and the animal live weight.

Personnel should be trained to use appropriate restraint in case it is necessary.

Intravenous administration is preferred, but intraperitoneal or intramuscular administration may be appropriate, especially if the agent is non-irritating.

The intracardiac route may be used in previously anesthetized small animals only.

Examine individual animals for signs of consciousness or life and apply a secondary killing method as a corrective measure, by ensuring the route of administration is correct and then giving an additional lethal injection; if the animal is conscious, a sedative or anesthetic can be administered, if necessary, prior to the lethal injection.

The carcass of an animal that has been killed by lethal injection has to be disposed of properly and cannot be used for or where there may be a risk of human or animal consumption because of harmfulness of the used drugs.

This method is suitable for killing small numbers of dogs, cats, cattle, sheep, goats, pigs, equids, poultry, captive wildlife, but it can be used in all species.

1. Species-specific recommendations

The method is suitable for killing individual or small numbers of dogs, cats, cattle, sheep, goats, pigs, equids and poultry, but it can be used in all species.

In some species like cattle, restraint may be necessary prior to injection, if possible, to allow effective administration.

Venous access can be difficult in very small or young animals or animals with low blood pressure taking considerable veterinary skill and experience.

Article 7.6.17.

**Cervical dislocation**

Manual or mechanical cervical dislocation comprises stretching and twisting the neck, resulting in the separation of spinal cord from the brain and *death* from cerebral anoxia due to cessation of breathing or blood supply to the brain [AVMA, 2020].

1. Animal welfare concerns

When improperly performed, cervical dislocation even with separation of the spinal cord fails to produce immediate loss of consciousness and in this case animals may die due to asphyxiation [Gregory and Wotton, 1990; Martin et al 2018; Martin et al 2020].

For heavy rats and rabbits, the large muscle mass in the cervical region makes manual cervical dislocation physically more difficult

1. Animal-based and other measures

Animal-based measures of an effective application of cervical dislocation are signs of death.

1. Recommendations

If this method is performed in larger-bodied species or by someone who has not demonstrated technical competency, it should only to be used in unconscious animals.

Consistent results when performing manual cervical dislocation requires strength and skill so team members should be rested regularly to avoid fatigue and ensure consistently reliable results.

Cervical dislocation should result in separation of the skull from the vertebral column at C0-C1 and sever both carotid arteries without damaging the exterior of the bird; it must not involve crushing of vertebrae and spinal cord.

Animals should be monitored continuously until death to ensure the absence of brain stem reflexes.

The method is suitable for small birds, poultry, mice, rats and rabbits.

1. Species-specific recommendations

Manual cervical dislocation is applicable in birds weighing up to 3 kg. and in rats up to 200 g

Mechanical cervical dislocation is applicable in birds weighing up to 5 kg.

None identified

Article 7.6.18.

**Decapitation**

Decapitation using a guillotine or knife results in death by cerebral ischaemia.

1. Animal welfare concerns

The process of decapitation requires significant tissue trauma and this may be painful if the animal has not been rendered unconscious prior to the procedure [Kongara et al. 2014]. There is evidence that decapitation may not itself cause immediate loss of consciousness, which [Bates 2010] may persist in decapitated animals for as long as 30 seconds [Mikeska and Klemm 1975].

1. Animal-based and other measures

Successful decapitation completely separates the head from the rest of the body and can be confirmed by visual inspection.

1. Recommendations

Decapitation should only be used in animals that can be rendered unconscious prior to decapitation.

1. Species-specific recommendations

Equipment used for decapitation should be of sufficient construction and sharpness to complete the procedure quickly and without undue force.

Article 7.6.19.

**Electrical — two-stage application**

A two-stage application of low frequency electric current (50 Hz) comprises firstly an application of current to the head by scissor-type tongs that spans the brain, immediately followed by an application of the tongs across the chest in a position that spans the heart.

The application of sufficient electric current to the head will induce ‘tonic-clonic’ epilepsy and unconsciousness. Once the animal is unconscious, the second stage will induce ventricular fibrillation (cardiac arrest) resulting in death.

1. Animal welfare concerns

The main hazards preventing effective electrical stunning and killing are: incorrect electrode placement, poor contact, a dirty or corroded electrode, electrical arcing, high contact resistance caused by hair or dirt on the animal surface, too short exposure time and inappropriate electrical parameters (low voltage/current or high frequency).

The second stage should only be applied to unconscious animals to prevent unacceptable levels of pain.

1. Animal-based and other measures

Before the application of the second stage, unconsciousness should be assessed with the following animal-based measures: immediately collapse, tonic-clonic seizures; apnoea; absence of corneal or palpebral reflex.

Animal-based measures of ineffective stun or recovery of consciousness are: vocalisation; spontaneous blinking; righting reflex; presence of corneal or palpebral reflex; rhythmic breathing; spontaneous swallowing and head shaking.

After the application of the second stage, death should be assessed with the following animal-based measures: absence of muscle tone, apnoea, absence of corneal reflex, dilated pupils and absence of heartbeat.

1. Recommendations

Two team members are recommended, the first to apply the electrodes and the second to manipulate the position of the animal to allow the second application to be made.

Animals should be restrained, at a minimum free-standing in a pen.

The tongs should be of the correct design and size for the animal;

A stunning current should be applied in a position that spans the brain for a minimum of 3 seconds; immediately following the application to the head and after ensuring that the animal is unconscious, the electrodes should be transferred to a position that spans the heart and the electrodes applied for a minimum of 3 seconds.

Electrodes should be applied firmly for the intended duration of time with pressure not released until the stun is complete.

Animals should be monitored continuously after stunning until death to ensure the absence of brain stem reflexes.

Electrodes should be in good condition and cleaned regularly during and after use, to enable optimum electrical contact to be maintained.

The wool or hair should be entirely dry; if wet the electricity may flow (shunt) through the wet wool or hair rather than contacting the skin and passing through the brain or body.

Wetting the bare skin (not wool or hair) application area with water (especially salted water) can increase electrical contact.

Ineffective application of the first stage of the method should be followed by a backup method or the repetition of the first stage.

The method is suitable for calves, sheep and goats, and pigs.

1. Species-specific recommendations

Effective electrical parameters should be determined based on scientific evidence for different types of animals.

For electrical stunning of the head, minimum parameters are recommended for the following species:

* 1.5 A for bovines,
* 1.3 A for pigs,
* 1.8 A for sows and boars,
* 1.0 A for small ruminants.

Good placement of the tongs can be difficult on animals with horns and on sheep with woolly heads. Using electrodes with pins or with wet pins for woolly animals would help to overcome the problem. Alternatively, the wool should be removed from the area where the electrodes will be positioned on the animal.

Article 7.6.20.

**Head to body electrical killing**

Head-to-body electrical killing (electrocution) comprises the single application of sufficient electrical current to the head and back, to simultaneously stun the animal and fibrillate the heart. Provided sufficient current is applied in a position that spans both the brain and heart at the same time, the animal will not recover consciousness.

1. Animal welfare concerns

The main hazards preventing effective electrical killing are: incorrect electrode placement, poor contact, dirty or corroded electrode, electrical arcing, high contact resistance caused by hair or dirt on the animal surface, too short exposure time and inappropriate electrical parameters (low voltage/current or high frequency).

1. Animal-based and other measures

Effective head to body electrical killing is characterise by tonic seizures during exposure to the method. After the exposure animals may have clonic seizures.

After application death should be assessed with the following animal-based measures: absence of muscle tone, apnoea, absence of corneal reflex, dilated pupils and absence of heartbeat

Animal-based measures of ineffective electrical killing are: absence of tonic-clonic seizures, presence of rhythmic breathing, presence of corneal or palpebral reflex or vocalisation.

1. Recommendations

Animals should be restrained to avoid movement that can lead to interrupted contact with the electrodes.

The device should be of the correct design and size for the animal.

A current should be applied in a position that spans the brain and the heart at the same time, continuously for a minimum of 3 seconds.

The device should be applied firmly for the intended duration of time and pressure not released until the stun is complete.

Animals should be monitored continuously after stunning until death to ensure the absence of brain stem reflexes.

Electrodes should be in good condition and cleaned regularly during and after use, to enable optimum electrical contact to be maintained.

The wool or hair should be entirely dry; if they are wet, the electricity may flow (shunt) through the wet wool or hair rather than through the brain or body.

Wetting the bare skin application area with water (especially salted water) can also increase electrical contact.

Ineffective application of the first stage of the method should be follow by a backup method or the repetition of the first stage.

The method is suitable for sheep and goats, and pigs.

1. Species-specific recommendations

Effective electrical parameters should be determined based on scientific evidence for different types of animals.

For head-to-body stunning, minimum parameters are recommended for the following species:

* 1.3 A for pigs,
* 1.8 A for sows and boars,
* 1.0 A for sheep and goats.

Article 7.6.21.

**Head only electrical stunning followed by a secondary killing method**

Comprises the single application of sufficient electrical current to the head of the animal in a position that spans the brain, causing unconsciousness; this needs to be followed by a killing method such as cervical dislocation or bleeding.

1. Animal welfare concerns

The main hazards preventing effective electrical stunning are: inappropriate handling, inversion when applicable, incorrect electrode placement, poor contact, dirty or corroded electrode, electrical arcing, high contact resistance caused by hair or feathers or dirt on the animal surface and inappropriate electrical parameters (low voltage/current or high frequency).

An additional hazard could occur when second intervention doesn’t kill the animal.

1. Animal-based and other measures

Multiple indicators should be used to determine whether a stun is effective and the animal is unconscious.

Animal-based measures of an effective stun are: tonic-clonic seizures; apnoea; absence of corneal or palpebral reflex.

Animal-based measures of an ineffective stun or recovery of consciousness or for ineffective killing are: vocalisation; spontaneous blinking; righting reflex; presence of corneal or palpebral reflex; rhythmic breathing.

1. Recommendations

Animals should be stunned as soon as they are restrained.

In the case of ineffective stunning or recovery, animals should be re-stunned using a backup system or be killed immediately. Ineffective stunning or return to consciousness should be systematically recorded and the cause of the failure identified and rectified.

Stunning equipment should be used, cleaned, maintained and stored following the manufacturer's recommendations.

Constant current stunners ensure that the minimum current is provided to the animal independently from individual impedance and should always be preferred to constant voltage stunners.

Regular calibration of the equipment according to the manufacturer's procedure is recommended.

For the killing methods to be use after stun refer to Articles 7.6.X and 7.6.X.

This method is suitable for chickens, turkeys, ducks, geese and rabbits.

1. Species-specific recommendations

For head-only stunning, minimum parameters are recommended for the following species:

* 240 mA for hens and broiler chicken,
* 400 mA for turkeys,
* 600 mA for geese and ducks,
* 400 mA for rabbits.

Article 7.6.22.

**Water bath killing**

Electrocution leading to death can be achieved by drawing inverted and shackled poultry through an electrified water bath. Electrical contact is made between the water and earthed shackle and, when sufficient current (50 Hz AC) is applied, poultry will be simultaneously stunned and killed.

1. Animal welfare concerns

In electrical water-bath killing, inverting and shackling conscious poultry by the legs can cause pain and fear.

Hazards that increase the likelihood of animals experiencing pre-stun shocks are: poor handling at shackling, inappropriate line speed, physical contact between birds, incorrect angle of entry ramp, entry ramp wetted by charged water, incorrect water-bath height, and shallow immersion.

Hazards that may prevent effective electrical killing are: lack of contact between head and water, differences in individual bird resistance, improper system grounding, pre-stun shocks due to wings contacting water before the head, and the use of inappropriate electrical parameters (low voltage/current or high frequency) or too short exposure time.

Factors affecting individual bird resistance include the resistance between the shackle and the leg (leg/shackle interface), shackling on top of a severed foot, shackling by one leg, poor shackle position, incorrect shackle size, dry shackles, scale on the shackle surface, and keratinised skin on the legs (e.g. older birds).

Where insufficient electrical killing parameters are used, conscious animals are at risk of being electro-immobilised or paralysed causing pain and suffering.

1. Animal-based and other measures

Multiple indicators should be used to determine whether killing is effective.

Animal-based measures of an effective electrocution are: absence of muscle tone; apnoea; and absence of corneal or palpebral reflex; absence of vocalisation and absence of righting reflex.

1. Recommendations

Poultry should be shackled by both legs. Shackles should match the species and size of the birds to guarantee a good contact.

Pre-stun shocks should be prevented and can be reduced by having a smooth shackle line and entry to the water-bath and by adjusting the water level of the bath to minimise overflow. Proper waterbath design, including a non-conductive entrance, will also help eliminate pre-stun shocks. Measures to calm the birds or to reduce the frequency of wing flapping can be put in place such as: breast rubs, low lighting, smooth transition into the waterbath and gentle shackling such that this does not trigger wing flapping.

Poultry should be submerged into the water up to the base of the wings.

A low frequency (50 Hz) current with a minimum of 400 mA per bird should be applied for a minimum of 3 seconds [EFSA, 2019].

Death should be confirmed before disposal.

In the case of ineffective killing, animals should be killed without delay using a backup system.

1. Species-specific recommendations

None identified

Article 7.6.23.

**Maceration**

Maceration, utilising a mechanical apparatus with rotating blades or projections, causes immediate fragmentation and death in day-old birds and for embryonated eggs.

1. Animal welfare concerns

Pain, suffocation and distress due to a slow rotation of blades or rollers, overloading and rollers set too wide.

1. Animal-based and other measures
* absence of signs of life
* immediate fragmentation
1. Recommendations

The capacity of the apparatus (power and sharpness) should be sufficient to ensure that all day-old -birdsare killed instantaneously, even if they are handled in a large number. The rate of introducing the birds should not allow the equipment to jam. Only purpose built equipment should be used.

The gap between rollers must ensure day-old-birds heads are crushed instantaneously leading to death [HSA, 2005].

Mechanical killing of day-old-birds should result in slurry, rather than recognisable body parts such as internal organs, legs, wings and heads, to ensure day-old-birds that were truly macerated [HSA, 2005].

It is important to ensure that the speed of the equipment is appropriate for the batch size and that the equipment be continuously checked to ensure every day-old-bird is dead when they come out of the machine. If any bird is found to be alive, they must be immediately euthanized by an alternate method and the equipment must be stopped immediately and not used again until the problem is corrected.

Avoid adding more than one layer of day-old-birds at one time or in quick succession, avoid introduction of a batch into the macerator before previous day-old-birds are dead.

1. Species-specific recommendations

Not identified

Article 7.6.24.

**Addition of anaesthetics to feed or water**

An anaesthetic agent which can be mixed with *poultry* feed or water may be used to kill *poultry* in houses. Commonly used general anaesthetic agents are not intended or approved for oral use. . *Poultry* which are only anaesthetised need to be killed by another method such as cervical dislocation.

1. Animal welfare concerns

 Ingestion of an insufficient quantity of the drug or inappropriate drug not leading to unconsciousness.. Failing to implement a secondary killing method before consciousness regained. Exposure of non-targeted animal or birds is a risk[https://www.hsa.org.uk]

1. Animal-based and other measures

Absence of signs of life including breathing, body movement, righting reflex.

1. Recommendations

To ensure that these anaesthetics have been effectively removed from the feeding or drinking water system and that no residue is left behind that could harm the next flock, a very careful cleaning procedure is necessary. Sufficient quantities of anaesthetic need to be ingested rapidly for effective response. Intake of sufficient quantities is facilitated if the birds are fasted or water is withheld. Should be followed by immediate killing if birds are anaesthetised only.

This method is suitable for confined poultry.

1. Species-specific recommendations

None identified

Article 7.6.25.

**General principles of modified atmosphere killing**

Modified atmosphere killing is performed by exposing animals to CO2, inert gases or their mixtures.

This can be performed either by placing the animals in a prefilled gas container, by placing transport modules or crates containing animals in a container and introducing a gas mixture, or by the gas being introduced into a poultry house.

Modified atmosphere killing can also be administered by using high-expansion gas-filled foam, or through low atmosphere pressure (LAPS).

Article 7.6.26.

**Container pre-filled with carbon dioxide**

This method is the exposure of batches of animals to high concentrations of gas in pre-filled containers which can also be waste bins, skips or bags.

In this method, animals are manually caught in small batches and dropped into the container connected to gas cylinders.

The time to onset of death is related to the concentration of the gas and the duration of the exposure, i.e. lower concentration requires longer exposure [Raj and Gregory, 1990a,b].

When animals are exposed to the gas individually or in small groups in a container, the equipment used should be designed, constructed, and maintained in such a way as to avoid injury to the animals and allow them to be observed.

1. Animal welfare concerns

Manual catching and handling of animals cause distress, especially when birds are carried in an inverted position.

If there is no immediate loss of consciousness. Inhalation of high concentrations of carbon dioxide gas while conscious is painful and causes fear and respiratory distress.

The time and distance animals are carried depends on the location of the gas containerss on the premises and on the type and size of the housings.

Overloading may lead to compression and suffocation caused by more animals being dropped into the container without a sufficient interval between two consequent batches of animals. In addition, each batch of animals dropped into the container will displace equal volume of gas into the atmosphere, which will result in fluctuating concentrations of gas.

Injection of cold gas directly to the animals causes hypothermia.

 Verifying *death* while the animals are in the *container* is difficult.

1. Animal-based and other measures

Animal-based measures of an effective kill are: absence of signs of life, such as breathing, righting reflex or body movement.

1. Recommendations

*Containers* should allow the required gas concentration to be maintained and accurately measured.

Each batch of birds dropped in the containers (one layer) should be allowed sufficient time to die before adding the next batch of birds [Webster and Collett, 2012].

*Containers* should not be overcrowded and measures are needed to avoid animals suffocating by climbing on top of each other.

Skilled catching teams are necessary.

This method is suitable for poultry.

1. Species-specific recommendations

Non identified.

Article 7.6.27.

**Gas introduced into a container or trailer**

1. In this method, the crates or modules holding birds or pigs are loaded into a container. Groups of pigs or turkeys may also be walked into the container or a specially designed nitrogen gassing trailer. Once the animals are in the container, a chosen gas, i.e. carbon dioxide, argon, nitrogen or mixtures of these gases, are administered to displace the atmospheric air in the container to create a lethal anoxic or hypercapnic situation (EFSA, 2019). Animal welfare concerns

Manual catching and handling of birds causes distress, especially when birds are carried in an inverted position.

There is no immediate loss of consciousness. Exposure to high concentrations of CO2 required for killing of birds and pigs (e.g. 40% or more) is reported to be aversive and painful to inhale and therefore these animals show escape attempts (EFSA, 2019; 2020).

The lower the CO2 concentration or higher the residual oxygen in inert gases the longer the time to induce death.

Exceeding the capacity of the equipment in terms of number of animals that can be loaded into the container with available floor space leading to overcrowding and animals climbing onto each other which results in injuries.

The time and distance animals are carried depend on the location of the gas containers on the premises and on the type and size of the housings.

Injection of cold gas directly to the animals in the container causes hypothermia.

 Verifying *death* while the animals are in the *container* is difficult.

1. Animal-based and other measures

Animal-based measures related to pain, fear and respiratory distress are head shaking, laboured breathing (gasping), escape attempts and high-pitched vocalisations.

Animal-based measures of an effective kill are: absence of signs of life, such as breathing, righting reflex or body movement.

Animal-based measures are difficult to assess due to container design and the presence of gas.

1. Recommendations

Birds should be caught gently and placed in crates or modules of appropriate size and at appropriate stocking densities to allow all birds to sit down. Pigs should also be moved gently and in small groups into the containers.

Containers should not be overcrowded and measures are needed to avoid animals suffocating by climbing on top of each other.

Containers should allow the required CO2 and inert gases concentrations to be maintained and accurately measured.

Sufficient exposure time should be allowed for animals to die before the door is opened.

Each animal should be examined to ensure they are dead.

Any survivors should be killed without delay.

Staff training to acquire knowledge and skills necessary to proper calibration of equipment and monitoring of gas concentrations and relevant exposure times, to ensure that containers are fit for the purpose, gas is vaporised before injection, the rate of injection is correct and temperature inside the chamber is monitored.

This method is suitable for poultry and pigs.

1. Species-specific recommendations

None identified

Article 7.6.28.

**Gas introduced into the barn or whole house gassing**

This method is the exposure of birds in their housing to an increasing gas concentration. In general, this means that the barn is equipped with gas measuring units and gas tubing for the injection of gas. The barn is closed, and ventilation and other openings are sealed. The gas is injected which results in a gradual increase of the Gas. In practice mainly CO2 is applied as this gas is most easy to apply and the desired concentration of >45% CO2 in the breathing air can be reached relatively quickly. Use of liquid nitrogen or gaseous nitrogen to achieve anoxic (O2<2%) conditions is another emerging method with animal welfare benefits due to nitrogen being nonaversive.

1. Animal welfare concerns

There is no immediate loss of consciousness. Inhalation of increased concentrations of carbon dioxide while conscious cause pain, fear, and respiratory distress.

The induction of the gas makes noise and can lead to a fear response from the birds

1. Animal-based and other measures

Animal-based measures are difficult to assess due to the presence of gas in the whole barn.

Animal-based measures of an effective kill are: absence of signs of life, such as breathing, righting reflex or body movement.

Gas concentrations should be monitored and used as a proxy for animal based measures

1. Recommendations

The barns should be checked before starting the procedure to ensure they can be made air-tight enough for the required gas concentrations can be reached.

Staff entering the barn to prepare the gassing procedure should work calmly to minimize fear reactions from the birds.

Ventilation should be shut down as quickly as possible before starting the gas inlet.

Before removing the gas equipment but after ventilating the barn there should be a check on the effectiveness of the method.

The method is suitable for all poultry species.

1. Species-specific recommendations

None identified

Article 7.6.29.

**Water-based airway-occluding foam**

Water-based airway-occluding foam is a low- to medium-expansion foam created by mixing foam concentrate, water, and air. The principle is that animals in their housing or in a confined area are covered with a blanket of foam and that the animals will die due to occlusion of the airways leading to cessation of brain and heart activity (Benson et al 2009). Due to the density, the foam will not penetrate narrow openings or mesh wire structures. This method requires little human-animal interaction and has the capacity to effectively kill large numbers of animals. However, because of its negative implications for animal welfare, airway-occluding foam should be avoided in chicken and turkeys and must be used only as an absolute last resort for ducks and pigs, for example, in a situation involving a structurally unstable barn that can’t be entered by humans but contains badly burned animals. It must not be used in ruminants.

1. Animal welfare concerns

Animals do not immediately lose consciousness

Animals will experience psychological and respiratory distress as foam fills their upper airway and trachea, resulting in pulmonary edema and alveolar hemorrhage, and presenting exchange of oxygen and carbon dioxide.

Animals may experience fear at the rising level of foam.

1. Animal-based and other measures

Animal based measures are difficult to assess once animals are covered in foam. Distress behaviours such as escape attempts and vocalizations (pigs) may be seen or heard.

Animal-based measures of an effective kill are: absence of signs of life such as breathing, righting reflex or body movement.

1. Recommendations

The temperature of the foam is determined mainly by the temperature of the water. The temperature of water used should be between (15 and 20 °C).

The foam should be produced with foaming agents that are proven to be non-irritating and having no aversive effect.

Foam should be applied after animals are contained.

Personnel should ensure that there is sufficient time allowed for each batch of animals to die before they are removed from the foam.

This method should only be applied to floor-reared animals.

This method effectively kills animals but has negative animal welfare implications for both poultry (particularly Pekin ducks) and mammals. Therefore its use should be avoided in chickens and turkeys and it must be used only as an absolute last resort method of ducks and pigs. Little to no research has been performed on cattle and small ruminants and it must not be used in these species.

1. Species-specific recommendations

None identified

Article 7.6.30.

**Nitrogen gas infused high expansion foam**

A way to create a very low O2 environment in containers or in buildings that are difficult to fill with gas is by using a high expansion foam filled with nitrogen gas. The principle of the method is that animals are exposed to an environment of > 98% of N2 (or other gas) and die due to anoxia. The low oxygen concentration is achieved due to the foam being produced using a gas from a pure source instead of with air. It is essential that the foam have a sufficiently high expansion rate (at least 300:1) and a sufficiently large bubble size (typically 10-15mm) to ensure it functions as a carrier of nitrogen gas and does not negatively impact animal welfare by entering or occluding the airway.

Animals may be kept in their housing, in a confined area or in a special chamber or box. The building, confined area or box is then filled with gas-filled foam until the box is completely filled or the animals are well covered. As the bubbles burst the animals will breathe in an atmosphere containing only the gas released from the foam with less than 1% O2. This very low O2 concentration will induce a rapid loss of consciousness and death.

This method requires little human-animal interaction and has the capacity to effectively kill large numbers of animals however it does require specialized equipment.

1. Animal welfare concerns

Animals do not immediately lose consciousness

Animals may experience fear as foam rises above their heads.

Animals may experience fear if loud equipment is turned on in their immediate vicinity.

1. Animal-based and other measures

Animal based measures are difficult to assess once animals are covered in foam. Distress behaviours such as escape attempts and vocalizations (pigs) may be seen or heard.

Animal-based measures of an effective kill are: absence signs of life, such as breathing, righting reflex or body movement.

1. Recommendations

The foam should be generated with gas from a pure source (preferable >98%).

The gas should be pre-heated to avoid freezing up the nozzles while the foam is generated.

The temperature of the foam is determined mainly by the temperature of the water therefore, the temperature of the water used should be between (15 and 20 °C)

The foam should be produced with a foam agents that is proven to be non-irritating and having no aversive effect.

Foam should be applied as rapidly as possible after animals are contained.

Personnel should ensure that there is sufficient time allowed for each batch of animals to die before they are removed from the foam.

This method is suitable for poultry and pigs.

1. Species-specific recommendations

None identified

Article 7.6.31.

**Low atmosphere pressure (LAPS)**

In this method, the birds are placed in crates or modules into a decompression chamber and are exposed to gradual decompression with a reduction of available oxygen to less than 5% [Martin et al., 2016a,b, c; Holloway and Pritchard, 2017].

When correctly applied, the LAPS procedure leads to loss of consciousness followed by death in all birds. The LAPS procedure does not induce immediate unconsciousness.

Mobile LAPS system can be used for on-farm killing.

1. Animal welfare concerns

No immediate onset of unconsciousness.

Rapid decompression and expansion of gases in the body cavity (i.e., sinuses, gut, or air sacs) can cause pain and respiratory distress. Furthermore, conscious birds might get injured from the convulsions of adjacent unconscious animals (i.e., strong wing flapping and leg paddling).

1. Animal-based and other measures
* Animal- based measures of aversion: escape attempts
* Animal base measures of unconsciousness: loss of posture; loss of posture; absence of movements; tonic-clonic convulsions (wing flapping)
* Animal-based measures of an effective kill are: absence of signs of life such as breathing, righting reflex or body movement.
1. Recommendations

During the first phase, the decompression rate shall not be greater than equivalent to a reduction in pressure from standard sea level atmospheric pressure 760 to 250 Torr for a period of not less than 50 seconds.

During the second phase, a minimum standard sea level atmospheric pressure of 160 Torr shall be reached within the following 210 seconds.

The pressure time curve shall be adjusted to ensure that all animals are irreversibly stunned within the cycle time.

The chamber should be leak tested and pressure gauges calibrated before each operational session and not less than daily during periods of use.

Low atmospheric pressure stunning equipment shall be designed and built to ensure a vacuum within the chamber enabling slow gradual decompression with reduction in available oxygen and holding at minimal pressure.

The system shall be equipped to measure , display and record continuously the absolute vacuum pressure, the time of exposure, the temperature, the humidity and to give a clearly visible and audible warning if the pressure deviates from the required levels. The device should be clearly visible to the personnel.

Rate of decompression, duration of exposure, ambient temperature and humidity are key parameters.

Emergency procedures associated with system failures should be included by the manufacturer in the manufacturer’s instructions for the use of the equipment.

This method is suitable for broiler chickens up to proximately 4kg liveweight.

1. Species-specific recommendations

None identified

The Animal Welfare Institute recommends that the following section be removed from this chapter. Unless the animal is deeply anesthetized, death resulting from hyperthermia/heatstroke will never conform to the requirement above: “Killing methods used should result in immediate death or loss of consciousness lasting until death. When loss of consciousness is not immediate, induction of unconsciousness should not cause avoidable distress, fear and pain.” If the section is retained, we recommend the changes described below.

Article 7.6.32

**Ventilation shut down with supplementation**

Ventilation shut down with supplementation such as active heating must not be used due to its prolonged and severely negative impact on animal welfare and because it is often ineffective in killing all animals.

The method requires shutting down ventilation in animal housings that rely on the ventilation system to maintain constant temperature and air quality. It is a measure that kills animals predominantly by heat stress and lack of fresh air. Active heating of the ambient air or increasing the humidity in the building during ventilation shut down will shorten time to death and increase the effectiveness of the method, however, it will lead to increased pain and discomfort and may cause hot air burns.

This method can be effective at killing large numbers of animals with limited human-animal interaction and few resources. Implementation of the method is rarely effective at killing all animals due to challenges related to ambient temperature at the facility and how well the facility can be sealed. Even after several hours, survivors are likely and will be in a debilitated condition due to prolonged severe heat stress.

1. Animal welfare concerns

It can take multiple hours for animals to lose consciousness, during which time they experience intense suffering. In most barns in which this method has been deployed, some birds have survived after four hours or longer of being subjected to this method.

Animals will experience prolonged heat stress (overheating).

Animals will experience pain.

Animals will experience fear and anxiety.

Animals will experience frustration.

Animals will experience debility and malaise.

Animals will experience respiratory distress.

Animals will likely experience nausea.

Animals will experience thirst.

Animals will likely experience disorientation.

The precise cause of death with VSD+ has not been elucidated, but based on research on similar conditions, causes may include conditions that result in significant pain and distress, including distributive and/or hypovolemic shock, acute respiratory distress syndrome, multiorgan failure and/or disseminated intravascular coagulation.

2. Animal-based and other measures

Animal-based measures may only be assessed via video if available.

Animal- based measures of unconsciousness: Loss of posture, only if accompanied by sustained and complete lack of muscle tone and absence of movements.

Animal-based measures of an effective kill are: absence of signs of life such as breathing, righting reflex or body movement.

3. Recommendations

Ventilation shut down with supplementation must never be used as a method of depopulation, due to the severity of its impacts on animal welfare and the prolonged period (hours) during which animals remain conscious while experiencing, pain, distress, and suffering. In countries where it is relied upon, governments and industry should immediately take measures to ensure higher-welfare methods can be implemented promptly in the event of an emergency necessitating mass killing of poultry.

4. Species-specific recommendations

None identified

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