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Humane Slaughter Association

Technical Note No 12

Poultry Slaughter Using Controlled Atmosphere Stunning (CAS) Systems

Summary

Most UK processing plants slaughter poultry using Controlled Atmosphere Stunning (CAS). This process eliminates some of the welfare concerns associated with electrical waterbath stunning, including handling stress associated with unloading live birds, inversion, live shackling, pre-stun electric shocks and ineffective stunning.

Any person involved with stunning, slaughtering or killing poultry has a legal obligation to ensure that *'animals shall be spared any avoidable pain, distress or suffering during their killing and related operations"*.

Council Regulation (EC) No. 1099/2009 on the protection of animals at the time of killing. Chapter 2, Article 3 (1)

All staff involved with these procedures must have the knowledge and skills necessary to understand fully the operation of the equipment they are using and how to deal with any problems that might arise.

This leaflet focuses on the principles of controlled atmosphere killing and the advantages and disadvantages of the different systems used during poultry slaughter in the UK. It aims to provide constructive, practical advice to maximise bird welfare. CAS systems used in situations other than slaughter is covered in more detail in TN11: On-Farm Killing of Large Poultry Flocks.

Operators must be trained to identify signs of an ineffective slaughter process and must know the appropriate action to be taken to prevent birds from suffering unnecessarily.

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Background

Gas systems are commonly used to kill poultry. Delivery of gas(es) to the birds is done using Controlled Atmosphere Stunning (CAS). CAS systems kill birds by gradual exposure to an anoxic (without oxygen) and/or hypercapnic (with elevated carbon dioxide) gas mixture. This renders the birds unconscious and subsequently kills them, after which they can be shackled and bled without experiencing pain and distress. Birds do not become unconscious immediately on exposure to the gas mixture; therefore, it is important to ensure the induction of unconsciousness causes the least amount of stress possible. The type of gas mixture used, and the exposure profile (the concentration of each gas and how it is delivered over the time), are key to bird welfare". Research continues into the optimal gas mixtures and exposure profiles for bird welfare.

Some countries operate CAS systems where birds are only stunned whilst in the gas. In these systems birds remain in the gas until they are unconscious, then they are removed, shackled and bled, which kills the birds due to blood loss before consciousness returns. However, UK legislation requires birds to be killed whilst they are still in the gas mixture, and before they are shackled, to avoid any potential for regaining consciousness before death.

The Welfare of Animals at the Time of Killing (England) Regulations 2015.
Schedule 2. Additional requirements for killing animals other than in slaughterhouses.
Part 5: Stunning and killing operations, (41) Exposure to gas- poultry.

Another CAS stunning method that uses decompression rather than exposure to gas mixtures can also be used to stun and kill birds. **Low Atmospheric Pressure Stunning (LAPS)** involves exposure of conscious birds to gradual decompression. As the pressure in the sealed container gradually drops, the available oxygen is reduced to less than 5%. Birds become unconscious from progressive hypoxia, a lack of oxygen to the brain and other organs; they remain in the LAPS environment until they are dead.

Legislation

Council Regulation (EC) No. 1099/2009 on the protection of animals at the time of killing.
Annex 1. Ch. 1, Table 3: Controlled atmosphere methods. Annex 2. (6) Gas stunning equipment.

The Welfare of Animals at the Time of Killing (England) Regulations 2015.
Schedule 2. Additional requirements for killing animals other than in slaughterhouses.
Part 5: Stunning and killing operations, (41) Exposure to gas - poultry.

Legal requirements for exposure to gas include:

- Each bird must be exposed to the gas for long enough to ensure it is killed

- Gas mixtures can be –

  (i) **Carbon dioxide in two phases**: Successive exposure of conscious birds to a gas mixture containing up to 40% of carbon dioxide, followed by a higher concentration of carbon dioxide when they have lost consciousness.

  (ii) **Carbon dioxide associated with inert gases (e.g. argon, nitrogen etc.)**: Direct or progressive exposure of conscious birds to a gas mixture containing up to 30% (in an abattoir), or 20% (outside an abattoir) of carbon dioxide associated with inert gases leading to anoxia. In an abattoir, there must be a maximum of 2% total oxygen by volume, outside of an abattoir the maximum oxygen concentration must be 5% by volume or less.

  (iii) **Inert gases (e.g. argon, nitrogen etc.):** Direct or progressive exposure of conscious birds to an inert gas mixture leading to anoxia. There must be a maximum of 2% total oxygen by volume

  (v) **Carbon dioxide at high concentration (only permitted for situations other than slaughter):** Direct or progressive exposure of conscious birds to a gas mixture containing more than 40% carbon dioxide. **Cannot be used for ducks and geese**.

- Gases must not enter into the chamber, or the location where birds are to be stunned and killed, in a way that it could create burns or excitement by freezing or lack of humidity

- The gas stunner must be equipped to maintain the gas concentration, as appropriate, in the gas stunner and be designed, constructed and maintained so as to avoid injury to any birds

- There must be a means of visually monitoring birds in the gas stunner

- There must be a means of flushing the gas stunner with atmospheric air with the minimum of delay

- There must be a means of access to any poultry with the minimum of delay

- Gas stunners must be equipped with devices to -

  (i) measure and continuously display the gas concentration, as appropriate, in the gas stunner
  (ii) give clearly visible and audible warning signals if the gas concentration falls below the required level

- Poultry must not be passed through or allowed to remain in the gas stunner at any time when the visible and audible warning signals have been activated, or when there is any defect in the operation of the gas stunner

- Poultry must not be shackled before they are dead

- When using inert gas mixtures or inert gas only in an abattoir, birds must not enter the gas stunner if -

  (i) the displayed concentration of oxygen is above 2% by volume (except that the concentration of oxygen may occasionally rise to a concentration of not more than 5% by volume for not more than 30 seconds)
  (ii) the displayed concentration of carbon dioxide is above 30% by volume

Legal requirement for exposure to LAPS:

Council Regulation (EC) No. 1099/2009 on the protection of animals at the time of killing.
Annex 1. Ch. 1, Table 3: Controlled atmosphere methods.
Annex 1. Ch. 2. Specific requirements for certain methods (10) Low atmospheric pressure stunning (LAPS).
Annex 2. Layout, construction and equipment of slaughterhouses (7) LAPS

This method is only legally permitted for broiler chickens up to 4kg liveweight. When this method is used the following requirements must be met:

- During the first phase, the decompression rate must 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 a second phase, a minimum standard sea level atmospheric pressure of 160 Torr must be reached within the following 210 seconds

- The pressure time curve must be adjusted to ensure that all birds are irreversibly stunned within the cycle time

- The chamber must be leak tested and pressure gauges calibrated before each operational session and at least once a day

- Records of absolute vacuum pressure, time of exposure, temperature and humidity must be kept for at least one year

Principles of CAS killing

Killing poultry by CAS methods does not result in an immediate loss of consciousness, therefore it is important to ensure the induction of unconsciousness minimises stress to the birds.

For gas methods the type of gas used must be suitable for a commercial environment. The characteristics of an ideal, humane and efficient gas mixture include that it must:

- be non-aversive (causes no detectable signs of distress)
- induce loss of consciousness in birds as rapidly as possible
- be capable of killing birds within the system (in the UK)

- be reasonably cheap and safe to use in commercial conditions
- be relatively easy to contain within an open container
- have no side effects on meat quality

Gas mixtures
From these specifications and further research, potentially suitable gases have so far been narrowed down to carbon dioxide, argon and nitrogen.

Carbon dioxide
Gas stunning systems involving carbon dioxide gas are most commonly used.
For slaughter, carbon dioxide can be used either in conjunction with inert gases, or alone with progressive exposure, only reaching above 40% once the birds have lost consciousness.

Carbon dioxide is heavier than air (therefore easy to control in a commercial operating system), relatively cheap and an anaesthetic gas which produces rapid unconsciousness when inhaled at high concentrations. It is an acidic gas and induces unconsciousness by increasing the acidity of the cerebrospinal fluid, which disrupts nerve cell function, and ultimately leads to death. As it is an anaesthetic gas, which acts on the spinal cord as well as the brain, the level of post-stun convulsions is supressed, which is beneficial for meat quality compared to purely anoxia-based controlled atmosphere methods.

When carbon dioxide contacts moist mucous membranes such as the eyes and respiratory tract it reacts with water present in the tissues surface and forms carbonic acid. The acidity irritates and stings the airways and birds display head shaking, escape behaviours and gasping.

Scientific research particularly suggests that carbon dioxide concentrations over 30% are aversive. So, if elevated carbon dioxide is used, the **HSA recommends that birds are exposed to a maximum of 30% carbon dioxide in the gas mixture while they are conscious.** In carbon dioxide-only systems, **slowly** increasing the carbon dioxide level is also strongly recommended (e.g. using multiple phases, rather than the legal minimum of two). This has been shown to reduce the aversive response.

While exposing conscious birds to up to 30% carbon dioxide is currently considered acceptable, **systems that avoid any exposure of conscious birds to elevated carbon dioxide likely have the best welfare potential**. Research into this area is ongoing. Further refinements and recommendations may be made in the future.

Inert gases (argon and nitrogen)
Argon is an inert gas (colourless, odourless and tasteless), heavier than air and is non-aversive. Argon is more expensive than both carbon dioxide and nitrogen. **Nitrogen** has the same welfare advantages and properties as argon except it is slightly lighter than atmospheric air, so may be more difficult to contain in high concentrations. Both these gases kill birds by displacing the oxygen in the gas stunner, producing an anoxic environment which is incompatible with physiological function.

Inert gases minimise aversion during the induction of unconsciousness, and so are considered an acceptable and more humane way of killing poultry.

However, inert gases do not supress spinal reflexes in the same way as carbon dioxide, meaning birds show significant levels of post-stun convulsions. This can result in wing damage, which is detrimental for meat quality. Concerns have also been raised about whether birds that lose consciousness later will be negatively affected by convulsions from any adjacent birds that lose consciousness earlier in the process.

Low Atmospheric Pressure Stunning (LAPS)
LAPS is similar to inert-gas-only stunning, in that it kills birds by **reduction of oxygen** Birds are sealed within the system and air is gradually withdrawn, which creates a hypoxic environment. It is a relatively new system that is legal in the UK and EU but is not currently in use within the UK. LAPS systems have been used commercially within the United States. As no additional gas supply is needed, it is cheaper to run than other CAS systems, but more expensive to install initially. Operational cycle times for poultry are similar to those of multi-phase gas systems.

In birds, this system is considered to achieve **welfare outcomes similar to inert-gas-only stunning**. Research has demonstrated that within the LAPS system bird heart rates decrease until death without any spikes, suggesting there is no stress response during the process. As with all methods, it is important it is done correctly and an appropriate rate and level of decompression must be used, as specified by Regulation (EC) 1099/2009.

Birds also show significant levels of post-stun convulsions with this method, as for inert-gas-only stunning. This has the same negative implications for meat quality, and potential welfare concerns, as inert-gas-only methods.

Signs of effective and ineffective killing processes
In the UK, once birds have left the CAS system, they must be checked to ensure they have been killed before being shackled. If any indicators of consciousness are seen, the bird(s) must be killed immediately using a back-up system, e.g. electrical stunning or captive-bolt equipment (guidance on how to use this equipment is available in the HSA Online Guide: Practical Slaughter of Poultry). Further loading of birds into the system must also be stopped until the problem has been rectified. Any birds still within the system should be removed immediately and killed using a back-up method.

Signs that a bird has been **effectively killed** are:

- no rhythmic breathing
- wings drooping
- the absence of a third eyelid (nictitating membrane) reflex when the surface of the eye is touched
- dilated pupils

The signs that a bird has **not** been killed are:

- rhythmic breathing (look for movements in the vent area)
- tension in the neck (ability to control the movement of the head)
- signs of co-ordinated movement

IMPORTANT
If any of these indicators are seen, the bird(s) should be killed immediately, before the neck is cut.

Bleeding
Although CAS systems used in the UK must kill the birds within the system, for meat quality purposes their necks will still have to be cut to drain as much blood as possible from the carcase before any further processing. Blood loss can be achieved by a ventral neck cut across both carotid arteries and both jugular veins.

A sharp, clean blade must be used to cut across the front of the neck just below the head (see Figure 1).

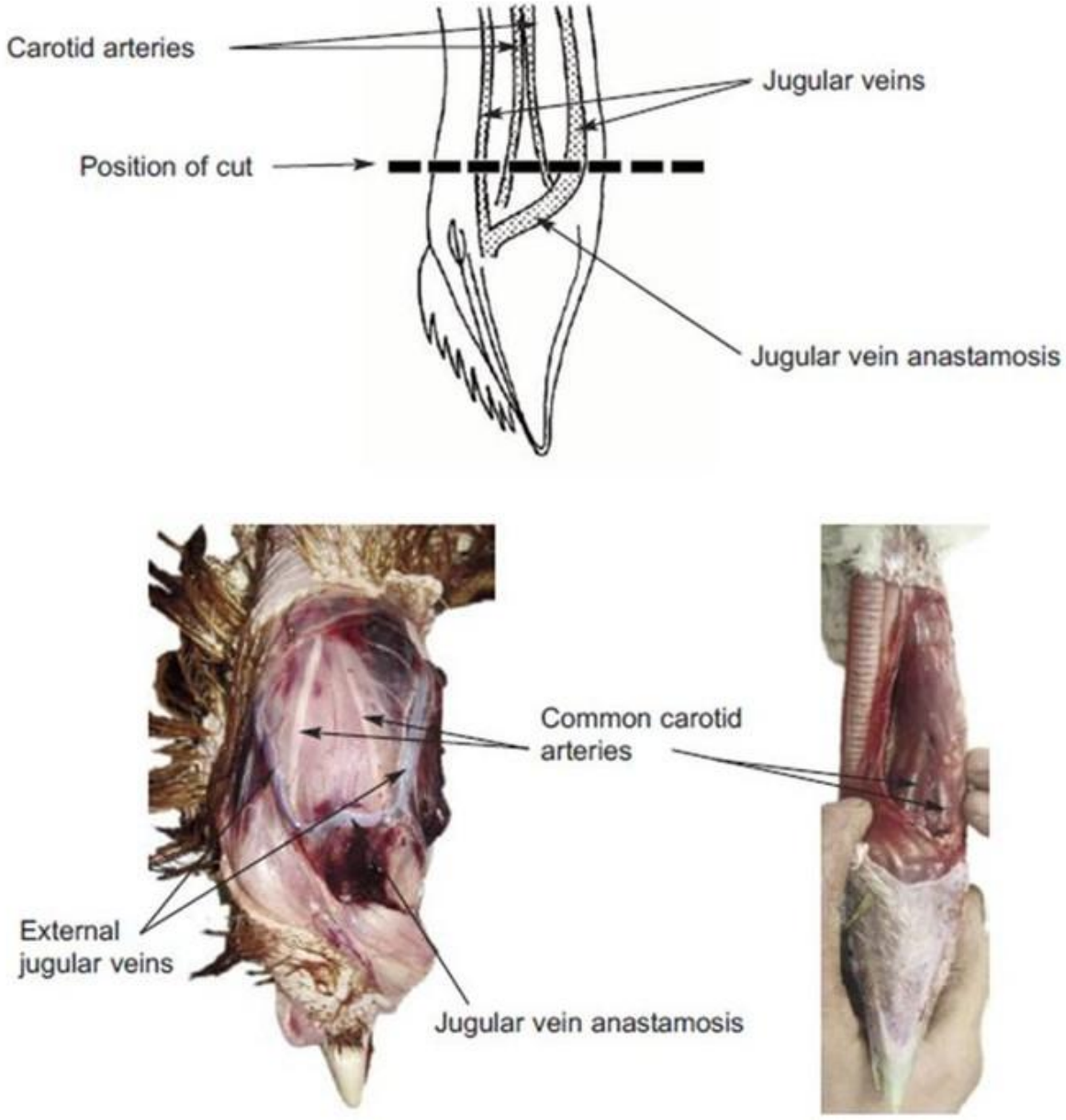

Figure 1: Diagram of ventral neck cut across carotid arteries and jugular veins

Advantages of CAS killing
The use of CAS systems for poultry killing has several welfare and commercial advantages in comparison to electrical waterbath stunning. These include:

- birds are not inverted and shackled whilst conscious or alive, thus reducing handling stresses and the risk of injury to both the bird and the shackler hanging-on
- birds are killed within their transport modules/crates, so do not experience handling and unloading stress
- in the UK birds are killed in the systems so the risk of recovering consciousness before bleeding is eliminated
- the possibility of pre-stun shocks is eliminated
- the possibility of birds receiving inadequate current levels within a multi-bird waterbath and therefore being ineffectively stunned is eliminated
- the possibility of birds missing the electric waterbath due to size differences or water depth are eliminated
- it is easier to determine whether birds have been effectively stunned/killed

Disadvantages of CAS killing
Some disadvantages of CAS killing also need to be considered. These include:

- birds do not lose consciousness immediately, so there is a potential for suffering during the induction of unconsciousness, the extent of which depends on the CAS method used. Systems that avoid any exposure to elevated carbon dioxide likely have the best welfare potential, but systems involving carbon dioxide have commercial advantages as post-stun convulsions are supressed, and birds lose consciousness and die more quickly
- there are more moving parts in the system compared to electrical waterbath stunners, therefore there may be an increased chance of a system breakdown
- the initial cost of fitting the equipment is high
- argon is more expensive than other gases available

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DISCLAIMER OF LIABILITY
In no circumstances can the HSA accept liability for the way in which the equipment in this leaflet is used: or for any loss, damage, death or injury caused thereby, since this depends on circumstance wholly outside the HSA's control

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Further Reading

HSA Online Guides: www.hsa.org.uk/publications/online-guides

- Electrical Waterbath Stunning of Poultry
- On-Farm Killing of Livestock for Disease Control Purposes
- Practical Slaughter of Poultry
- TN11: On-farm Killing of Large Poultry Flocks

Defra Guidance:

- White meat slaughterhouses: unloading, handling, holding, restraining, stunning and killing
https://www.gov.uk/guidance/white-meat-slaughterhouses-unloading-handling-and-holding-restraining-stunning-killing#gas-stunning

Relevant Legislation:

- Regulation (EC) 1099/2009 on the protection of animals at the time of killing
www.legislation.gov.uk/eur/2009/1099

- The Welfare of Animals at the Time of Killing (England) Regulations 2015*
www.legislation.gov.uk/uksi/2015/1782

* Northern Ireland, Scotland and Wales have their own variations of this regulation