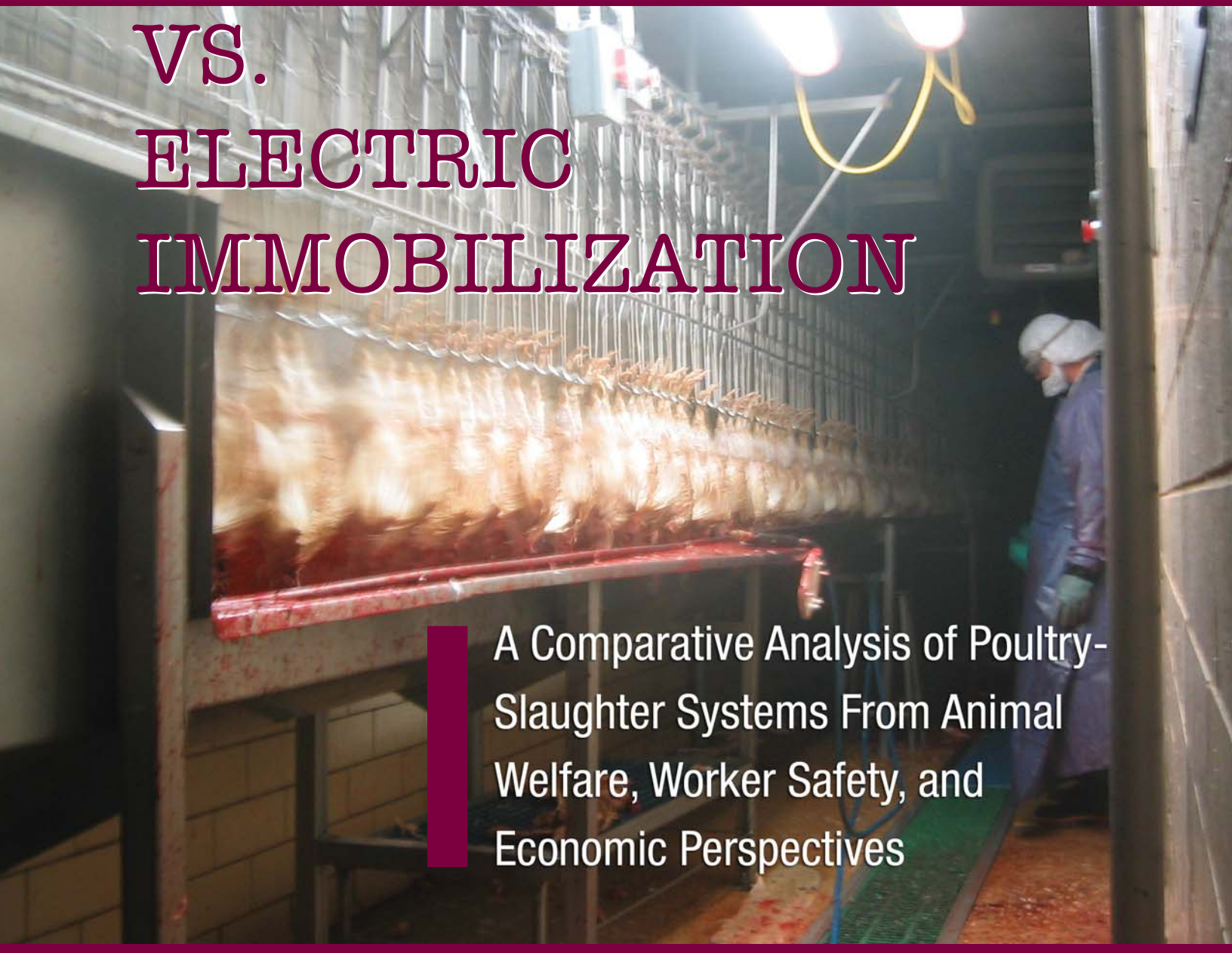
PETA

CONTROLLED-ATMOSPHERE KILLING VS. ELECTRIC IMMOBILIZATION



A Comparative Analysis of Poultry-Slaughter Systems From Animal Welfare, Worker Safety, and Economic Perspectives

"[CAK has] the double advantage of offering the industry an opportunity to boost welfare standards and cut costs at the same time."

—Elliot Morley, animal welfare minister for the United Kingdom

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EXECUTIVE SUMMARY

"Soon, clearly—for a variety of ergonomic, humane, carcass-quality, and other practical reasons—live-shackling and electro-stunning of broilers and turkeys will be things of the past. A variety of systems have been proved to be effective and profitable in [controlled-atmosphere stunning] of poultry, and many broiler and turkey plants in other places already are reaping these benefits."
—Dr. Stanley E. Curtis, Department of Animal Sciences, University of Illinois

Electric immobilization, the conventional method of slaughter in North American poultry slaughterhouses, causes an array of animal welfare, economic, and worker safety problems. The process involves dumping and shackling live birds, running them through an electrically charged bath of water to immobilize them, slitting their throats with a killing machine, and then defeathering them in tanks of scalding-hot water.

ANIMAL WELFARE

Electric immobilization systems require birds to be handled and processed while they are alive and conscious, causing them great suffering:

- Birds endure bruised and broken wings and legs and can suffocate during dumping and shackling.
- Frustrated workers often commit gratuitous acts of abuse, including documented cases of tearing live birds apart, spitting tobacco into their eyes, stomping on them, punching them, and even sexually assaulting them.
- Electric current levels are too low to render birds insensible to pain, and all birds are conscious as their throats are slit.
- Birds who miss the blades—as millions do each year—are drowned in tanks of scalding-hot water.

Such abuse is permitted because the only federal law designed to protect animals from abuse at slaughter—the Humane Methods of Slaughter Act—doesn't cover chickens or turkeys at all.

ECONOMICS

"Gas stunning of poultry in their transport containers will eliminate the need for live bird handling at the processing plant and all the problems associated with the electrical stunning."
—European Food Safety Authority

Electric immobilization has serious negative implications with regard to carcass quality, yield, and contamination:

- Dumping and shackling cause broken bones, bruising, and hemorrhaging, all of which lower carcass quality and yield.
- Birds scratch and peck at—and vomit and defecate on—each other during dumping and shackling, causing carcass contamination.
- Birds' stress prior to slaughter increases the acidity of their flesh, reduces tenderness, and increases drip loss.
- Birds often inhale pathogens in the electric water bath, causing carcass contamination.
- When they are scalded to death, birds defecate in the defeathering tanks, contaminating all the birds submerged afterward.
- Birds who are scalded to death are condemned and cannot be sold, further lowering yield.

WORKER SAFETY

Poultry slaughterhouses are dimly lit, stressful, disease-ridden places that have poor working conditions:

- Low lighting levels in the dumping/shackling area—maintained to reduce birds' struggling—create a poor working environment.
- The birds flap violently during handling, kick up dust and debris, injure workers, and defecate and vomit on them. This increases illness and injury rates, lowering worker welfare and increasing costs for employers.
- The overall poor conditions result in an extraordinarily high turnover rate among slaughterhouse workers, averaging between 75 and 100 percent annually.

Controlled-atmosphere killing (CAK) is a U.S. Department of Agriculture (USDA)-approved slaughter method that is currently used to kill 75 percent of turkeys and 25 percent of chickens in the United Kingdom (Raj 2006) and 10 percent of birds in the European Union (Lozza 2005). CAK uses gas to kill birds while they are still in their transport crates, eliminating many of the welfare, carcass quality and yield, and worker safety issues associated with electric immobilization:

- With CAK, birds are dead before they are removed from their crates, shackled, bled, and defeathered in scalding tanks. These stages do not hurt the birds, damage their carcasses, or pose a risk to workers.
- With CAK, workers never handle live birds, so there is no chance for abuse. Furthermore, worker ergonomics and safety are vastly improved. Lights can be kept bright, the air can be kept clean, and workers no longer need to struggle with live, flapping, defecating, vomiting birds.

Considering the dramatic improvements in animal welfare offered by CAK, it is no surprise that every published report on controlled-atmosphere systems to date—including a 2005 study by McDonald's—concludes that it is the least cruel form of poultry slaughter available, conclusions affirmed by top meat-industry and USDA advisors, such as Drs. Temple Grandin, Ian Duncan, and Mohan Raj.

Considering the improvements in carcass quality, product yield, and labor costs, it is no surprise that a return on investment (ROI) can be reached in less than two years.

Because of its clear benefits over electric immobilization for animal welfare, economics, and worker safety, many major purchasers of poultry products have been urging their suppliers to investigate and adopt CAK. For example, Burger King issued a "purchasing preference" for chickens killed by CAK, and Starbucks, ConAgra Foods, Denny's, CKE Restaurants, and many other companies have written to their poultry suppliers about the issue.

In North America, the poultry industry has been slow to adopt CAK, despite its many benefits, the urging of poultry purchasers, and the minimal ROI time following the adoption of CAK. There is no reason to further delay implementation of CAK in North American slaughterhouses.

"The current dumping-shackling-electrical stunning process is a dinosaur. It's inevitably rough …."
—Dr. Bruce Webster, poultry welfare scientist at the University of Georgia

CLARIFICATION OF TERMINOLOGY

At the outset, it is important to clarify the relationship between controlled-atmosphere killing (CAK) and controlled-atmosphere stunning (CAS).

- **CAS:** Animals are *rendered unconscious* but may not be dead before shackling and, therefore, risk *regaining consciousness* prior to or during throat-slitting and defeathering.
- **CAK:** Animals are completely brain-dead before being shackled or handled by workers, so there is no danger of regaining consciousness prior to throat-slitting or defeathering.

Although CAK is a form of CAS (as the animals are stunned and then killed), most CAS systems are not CAK. When reviewing industry reports and articles about controlled-atmosphere systems, it is important to understand this distinction, especially because some reports may refer to a CAK system as a CAS system. If the birds are dead and not just unconscious before they are shackled, bled, and defeathered, the system is CAK.

It is also important to distinguish between electric stunning and electric immobilization.

- **Electric Stunning:** An inaccurate term typically used to refer to the conventional method of poultry slaughter used in North America, which uses electric currents too low to stun birds, leaving them paralyzed but still conscious and sensible to pain
- **Electric Immobilization:** An accurate term to describe the conventional method of poultry slaughter in North America, which immobilizes but does not stun birds

As this report will detail, typical electrified water-bath stunning systems used in the United States do not render birds unconscious, so the term “electric stunning” is a misnomer.

THE ELECTRIC IMMOBILIZATION SYSTEM

"[I]nadequate electrical stunning, i.e., application of a current that is not adequate to induce generalised epilepsy, would induce electro-immobilisation and cause pain and suffering. … [T]he existing U.S. electrical stunning parameters do not meet the scientific criteria used to determine the immediate induction of unconsciousness."
—Drs. Mohan Raj and Ian Duncan, "Future of Gas Stunning"

DUMPING

In order to facilitate electric immobilization, birds are dumped from transport vehicles onto a conveyor, causing broken bones, bruising, and hemorrhaging. Suffocation and injuries inflicted from extreme crowding and rough handling during unloading and dumping kill many birds (Shane 2005; Arthur 2003). These are all economic losses for the processing plant.

SHACKLING

During shackling, birds are hung upside-down by their legs on a line of shackles that pinch and compress their sensitive periostea, causing stress and suffering (Kannan and others 1997; Parker and others 1997). An inherent contradiction in electric immobilization systems is the fact that even though tight-fitting shackles improve current flow through the birds, they also cause the animals great pain as well as carcass damage, which results from prolonged and violent wing-flapping (Gregory and others 1989). Leg deformities, leg diseases, and other injuries typical of large broilers exacerbate the pain (Danbury and others 2000; Gentle and Tilson 2000). Furthermore, shackle lines move so fast—at speeds of more than 180 birds per minute at some plants—that it is impossible to handle the birds humanely. Gregory and Wilkins (1989) found that after shackling, 3 percent of broilers had broken bones and 4.5 percent had dislocations. Another study by the same authors (1990), which looked at hens before and immediately after shackling, found a 44 percent increase in newly broken bones following shackling. Others conclude that shackling is, indeed, both a physiologically and psychologically painful experience (Sparrey and Kettlewell 1994; Gentle and Tilson 2000).

In addition to the suffering that birds endure as a result of the physical act of being shackled by their fragile legs, they often suffer sadistic abuse at the hands of frustrated workers during this stage:

- At a slaughterhouse owned by Pilgrim's Pride, the largest broiler producer in the United States, workers were documented tearing the heads off live birds, spray-painting their faces, spitting tobacco into their eyes, spiking them like footballs, and slamming them into walls.
- At a slaughterhouse owned by Tyson Foods, the second-largest broiler producer in the United States, workers were documented ripping the heads off live birds.
- At a slaughterhouse owned by Butterball, the world's largest turkey producer, workers were documented stomping on live birds, slamming them against metal trailers and handrails, using them as punching bags, and sexually assaulting them.

PRE-IMMOBILIZATION SHOCKS

"The complexity of multiple bird water bath stunning systems makes welfare management extremely difficult, if not impossible, and therefore could be deemed unfit for the purpose."
—Dr. Mohan Raj, leading poultry-slaughter expert

After enduring the stress and injuries associated with being dumped and shackled, the birds proceed to the immobilization area, where they pass through an electrically charged water bath. Pre-immobilization shocks are both painful and common, occurring, for example, when a bird's wing comes into contact with the electric bath before the bird's head does. Dr. Neville Gregory observed that 13.5 percent of broilers at one slaughterhouse received "painful and alarming" shocks before fully entering the electric bath (Bell 1997).

TEMPORARY IMMOBILIZATION AND THROAT-SLITTING

"All [the stunner] does is paralyze the [chickens'] muscles. It doesn't render them unconscious or make them insensible to pain. . . . [E]very chicken is bled out while still sentient. They hang there and look at you while they are bleeding. You can definitely tell that they know what is going on. Sometimes if they are not completely immobilized by the stunner (which happens frequently), they will try to hide their head from you by sticking it under the wing of the chicken next to them. They will also flop around and peck at your hands as you are cutting their throats. One last futile act of self-defense, I guess."
—Virgil Butler, eight-year veteran of poultry slaughterhouses

In the United States, the electric water bath is intended to ensure that birds are hanging uniformly when they hit the throat-slitting blade; it is not designed to cause unconsciousness. Voltage levels are not sufficient to render birds insensible to pain, and the birds are merely immobilized. Studies suggest that birds do experience pain after electric immobilization but are not able to display a pain reflex because of temporary paralysis. This means that virtually all birds slaughtered in the United States have their throats slit while they are still conscious and able to feel pain. A study by four British poultry-slaughter supervisors (Richards and others 1967, cited in Heath and others 1981) acknowledged that

This chicken on the slaughter line at a Tyson Foods slaughterhouse has suffered a painful broken bone.

"electrical paralysis may occur under certain conditions in man and other animals, during which pain can be perceived but reaction to it is impossible."

Most producers insist on keeping settings that are too low—significantly lower than the 120mA used at most facilities in the United Kingdom—to achieve anything more than temporary paralysis. A metastudy of electric immobilization methods (Boyd 1994) verifies that in North America, "the development and application of [electrical] poultry stunning had more to do with facilitating processing than with humane slaughter." In fact, one United States manufacturer of electric immobilization equipment wrote that "[t]he typical amperage used in stunning by our pulsating direct current pre-stunner is approximately 12 to 15 mA" (Austin 1994, cited in Davis 1996). The Scientific Panel for Animal Health and Welfare of the European Food Safety Authority (EFSA 2004) reviewed the scientific literature and concluded, "In the absence of convincing neurophysiological evidence, it will be unwise to argue that poultry can be stunned with low currents (e.g., 10 mA) …." Such low electrical settings, which paralyze but do not stun, have dangerous consequences for birds.

Humane Farming Association investigator Gail Eisnitz explains: "Since it's easier to bleed a bird that isn't flapping and struggling, most live birds have their heads dragged through an electrically charged water bath to paralyze—not stun—them. Other industrialized nations require that chickens be rendered unconscious or killed prior to bleeding and scalding, so they won't have to go through those processes conscious. Here in the United States, however, poultry plants—exempt from the Humane Slaughter Act and still clinging to the industry myth that a dead animal won't bleed properly—keep the stunning current down to about one-tenth that needed to render a chicken unconscious."

Although it has been argued that voltage settings delivering current in excess of 120mA may induce unconsciousness in chickens if they are applied properly, it is almost impossible to ensure that every animal is rendered unconscious because differences in the birds' body compositions hinder the effectiveness of the electrical settings. In other words, because each bird has a different weight, fat content, age, number of feathers, level of cleanliness, brain resistance, and leg size (which determines shackle-to-leg contact)—all of which influence the stunning effectiveness of an electrical shock—it is nearly impossible to ensure proper stunning unless the settings are changed to accommodate each individual bird. Only around 10 percent of the electric current goes through the brain of each bird (Wooley and others, 1986a, 1986b); with as many as 20 birds in the water bath at any one time—each with a different impedance (Sparrey and others, 1992, 1993)—some birds inevitably will get too much current, causing bone breaks and muscle hemorrhaging, while others will get too little and suffer during bleeding. Boyd (1994) concludes that "[t]he high occurrence of improper stuns is testimony to the difficulty of controlling all these variables," and as a

result, "under many commercial conditions in poultry slaughterhouses, we have little reason to believe that proper electrical stunning is achievable consistently." This was confirmed by a Farm Animal Welfare Council report (Heath 1984) to the British minister of agriculture, which surveyed facilities in the United Kingdom and found that one-third of chickens were improperly stunned and, therefore, not rendered insensible to pain during electrical stunning.

Furthermore, studies of brain patterns show that even with high levels of current, birds appear conscious. The most accurate indication of insensibility to pain is an isoelectric (flat) EEG pattern, and electrical immobilization does not immediately produce such a pattern, even at high voltage. It has been hypothesized that the epileptiform brain activity that electrical immobilization does induce in some animals is akin to a human *grand mal* epileptic seizure during which the subject is unconscious. Although this argument may be appropriate for sheep and pigs—who display the high-frequency polyspike activity found in *grand mal* seizures after being electrically shocked—chickens present a markedly different reaction. In fact, in 90 percent of chickens, electrical immobilization produces low-frequency polyspike activity that is "associated with petit mal epilepsy in humans and is not necessarily associated with unconsciousness" (Boyd 1994); this was also suggested by Gregory and Wotton (1987). Higher voltage settings do not necessarily remedy the problem by causing higher frequency polyspike activity, which implies that regardless of the electrical settings, chickens appear not to be rendered unconscious as a result of electric shock unless they are killed (Gregory 1986; Gregory and Wotton 1987).

FAILED IMMOBILIZATION AND THROAT-SLITTING

"[E]lectrical stunning is one of the most complex operations in the processing chain given the number of variables that interact during stunning. These include bird size, flock uniformity, dry or wet birds, and skull-bone thickness. These factors combined make it almost impossible to fully neutralize the potential problems associated with electrical stunning."
—*Meatingplace* (meat-industry publication), May 2007

Other birds are able to avoid the electric bath by lifting their heads or flapping their wings, and these birds are still conscious and not paralyzed when they are moved to the next area. During the McLibel lawsuit in the U.K., by the McDonald's Corporation against two activists, Dr. Gomez Gonzales, a meat-management technician for the McDonald's Corporation, testified that between 1 and 2 percent of chickens miss the electric bath entirely in the company's U.S. slaughterhouses (Bell 1997). This has serious welfare consequences for those birds.

Birds also suffer when they are conveyed toward the automated spinning blade, commonly referred to as the "killing machine," which is designed to cut their necks. Many birds are able to avoid this blade by lifting their heads or flapping their wings. Research (Boyd 1994)

examining the electric immobilization of poultry verifies that "birds dodge the knives, some completely, some partially, because they are not fully stunned." Gregory (1991) wrote that "problems associated with inefficient neck cutting [are] only too common in poultry processing plants." The McLibel lawsuit highlighted the high number of occasions during which broilers were not paralyzed during neck-cutting. For example, Chief Justice Bell estimated that based on the evidence presented during the trial, more than two birds per minute in the U.K.—and more in the U.S.—were not stunned when their throats were cut (McSpotlight 1997). When Dr. Gonzales' estimate that between 1 and 2 percent of chickens miss the electric bath in McDonald's U.S. slaughterhouses is applied to USDA statistics (USDA 2006) for a typical year (e.g., more than 9 billion chickens were slaughtered in the U.S. in 2005), it can be concluded that every year, up to 180 million chickens completely miss the electric bath and have their throats cut while they are conscious and unparalyzed.

SCALDING

After going through the "killing machine," birds usually pass by a worker, commonly referred to as the "backup killer," who manually cuts the throats of any birds who are still alive with a knife, but with such fast-moving lines, it is impossible to ensure that every bird is dead—let alone unconscious—before proceeding to the next step: the scalding tank.

Birds are dipped into the scalding tank—which contains scalding-hot water—to facilitate feather removal. On its Food Safety and Inspection Service (FSIS) Web site and in instructional materials used to train inspectors (FSIS 2001), the USDA states, "Poultry that die from causes other than slaughter are condemned under the cadaver category. These birds are not dead when they enter the scald vat. When submerged in the hot water, they drown …." Furthermore, under a U.S. federal regulation (9 CFR, Ch III, Part 381, §381.90) titled "Cadavers," "Carcasses of poultry showing evidence of having died from causes other than slaughter [i.e., in the scald tank] shall be condemned." According to USDA poultry-slaughter statistics, more than 3 million chickens per year are classified as "cadavers" and were either scalded to death or drowned in the scalding tanks (USDA 2002, 2003, 2004, 2005, 2006). A number of studies confirm that sentient birds enter the scalding tanks, including Heath and others (1981) and Griffiths and Purcell (1984), who examined several Australian chicken processing plants and concluded that some birds are "not killed before they reach the scald tank." At least two studies have concluded that "red-skin" chicken carcasses—commonly found in electric immobilization systems—are caused by a physiological response to heat when live birds enter a scalding tank (Heath and others 1983; Griffiths and Purcell 1984). According to a recent issue of *Watt Poultry USA* (Shane 2005), birds scalded to death can represent as much as 3 percent of throughput in plants that lack adequate supervision.

Clearly, drowning or scalding millions of birds to death in scalding-hot water is unacceptable—yet it is unavoidable with the electric immobilization system.

ADVANTAGES OF CONTROLLED-ATMOSPHERE KILLING FOR ANIMAL WELFARE

"[T]he hanging process causes fear and struggle and creates risk of injury. The experience of hanging by the legs in a metal shackle is undoubtedly uncomfortable. All of the CAS methods eliminate handling of conscious birds by humans at the shackling station. CAS methods which stun birds in transport cages also eliminate the disturbance, struggle, and risk of injury associated with the removal of the birds from the cages. The ability of CAS to mitigate handling-related stress and injury at unloading and hanging is already recognized as a major welfare, and thus ethical, advantage for CAS systems."
—Dr. Bruce Webster, poultry welfare scientist at the University of Georgia

IMPROVED WELFARE

CAK addresses all the major welfare problems inherent in the electric immobilization slaughter system and suffered by billions of birds each year in the United States. A proper CAK system kills birds—while they are still in their transport containers—using a mixture of inert gases (i.e., nitrogen and argon) and/or carbon dioxide. In most CAK systems, birds are taken directly from the transport vehicles in their crates or modules, which are inserted into a chamber where CAK takes place. In an alternate system in use in at least one American plant, gas is delivered directly into partitioned sections of the transport trucks. In both types of CAK systems, the animals are shackled, cut, bled, and scalded only after death, thereby eliminating the abuse inflicted in the electric immobilization system.

The switch from electric immobilization to CAK would result in such vast welfare improvements that—according to Dr. Mohan Raj, one of the world's foremost experts on the subject—doing so would eliminate the "stress and trauma associated with removing conscious birds from their transport containers, in particular, under the bird handling systems which require tipping or dumping of live poultry on conveyors; the inevitable stress, pain, and trauma associated with shackling the conscious birds, i.e., compression of birds' hock bones by metal shackles; the stress and pain associated with conveying conscious birds hanging upside-down on a shackle line which is a physiologically abnormal posture for birds; the pain experienced by some conscious birds that receive an electric shock before being stunned (pre-stun shocks); … the pain and distress experienced by some conscious birds which miss being stunned adequately (due to wing flapping at the entrance to the

water bath stunners) and then pass through the neck cutting procedure; [and] the pain and distress associated with the recovery of consciousness during bleeding due to inadequate stunning and/or inappropriate neck cutting procedure" (Raj 1998b). The Canadian Food Inspection Agency (1999a) also issued a news release stating that an "advantage of using [controlled-atmosphere killing] for poultry is that it eliminates uncrating and shackling of conscious birds and thus contributes to reduce stress to the birds. The procedure is fast, painless, [and] efficient, and there is no risk of recovery from unconsciousness."

Indeed, by eliminating the live dumping and shackling of birds, the prestun shocks they often face, the conscious throat-slitting and scalding, and the handling of live birds by slaughterhouse workers, animal welfare is improved dramatically.

Top industry and government animal welfare advisors—including Drs. Temple Grandin, Ian Duncan, and Mohan Raj—agree that CAK is far superior to electric immobilization with regard to animal welfare. Every published review of the science to date—including one done by McDonald's Corporation in 2005—has drawn the same conclusion.

"Controlled-atmosphere [killing] of chickens has important welfare advantages [over electric immobilization]. The main advantage is that live chickens no longer have to be hung on shackles."
—Dr. Temple Grandin, world-renowned animal welfare scientist and USDA advisor

CONTROLLED-ATMOSPHERE KILLING

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ELECTRIC IMMOBILIZATION AND POTENTIAL ANIMAL WELFARE CONSEQUENCES

Transport
Extreme crowding in transport crates

↓

Dumping
Extreme crowding; suffocation; worker abuse

↓

Shackling
Broken bones; injuries; worker abuse

↓

Electric Water Bath
Prestun shocks; paralysis; improper stunning

↓

Killing Machine (Throat-Slitter)
Live throat-slitting; many birds avoid the machine

↓

Back-Up Killer
Live throat-slitting; many birds are missed

↓

Scalding Tank
Conscious birds scalded to death or drowned

↓

Evisceration and Further Processing

CONTROLLED-ATMOSPHERE KILLING AND POTENTIAL ANIMAL WELFARE CONSEQUENCES

Transport
Extreme crowding in transport crates

↓

CAK Chamber
Potentially aversive environment, depending on gas mixtures and concentrations

↓

Shackling

↓

Electric Water Bath

↓

Killing Machine (Throat-Slitter)

↓

Back-Up Killer

↓

Scalding Tank

↓

Evisceration and Further Processing

This chart represents the potential animal welfare consequences of electric immobilization and controlled-atmosphere killing. Note that the shaded areas represent stages during which the birds are dead; they thus present no animal welfare consequences.

MAXIMIZING ANIMAL WELFARE WITH A CAK SYSTEM

Inert gases, like nitrogen and argon, are completely undetectable to birds and painlessly render them unconscious and then dead. All chickens voluntarily enter a chamber filled with argon (Raj 1996), and they approach the chamber just as they would enter one filled with air (Webster and Fletcher 2004). When exposed to inert gases, chickens do not withdraw (McKeegan and others 2006) and show no behavioral signs of distress (Wooley and Gentle 1988). Concerning CAK with inert gases, Dr. Ian Duncan (1997) said, "In my opinion, this is the most stress-free, humane method of killing poultry ever developed. The birds are quiet throughout the operation. They remain in the transport crate until dead and the killing procedure itself is fast, painless, and efficient. There is no risk of recovery from unconsciousness."

By contrast, carbon dioxide (CO_2) is aversive and, at high concentrations, very painful in humans and birds (Gregory and others 1990; Anton and others 1992). Raj (1998a) states that "[c]arbon dioxide is an acidic gas and is pungent to inhale at high concentrations. It is also a potent respiratory stimulant that can cause breathlessness before the loss of consciousness. The welfare implication of this is that birds could experience unpleasant sensations either during initial inhalation of carbon dioxide or during the induction phase." The European Commission's Scientific Committee on Animal Health and Animal Welfare (1998) explains that "while CO_2 is able to stun or kill, it is also [an] irritant, for example, to mucous membranes of the nose and mouth due to the formation of carbonic acid." Researchers have found that CO_2 causes birds' trigeminal nerve fibers to fire, indicating aversiveness, and that high concentrations activate pain receptors in their nose and mouth (McKeegan and others 2003, 2004). A number of studies have observed that although 100 percent of tested hens voluntarily entered a feeding chamber filled with 90 percent argon, most refuse even to set foot in a chamber containing CO_2 (Raj 1994, 1996; Webster and Fletcher 2004). Many studies have also reported that unlike inert gases, CO_2 exposure causes head-shaking and gasping (Raj 1996; Lambooij and others 1999; Coenen and others 2000; Webster and Fletcher 2004). The United Kingdom's Department for Environment, Food & Rural Affairs (2001) confirms these findings by reporting that "[o]bservational studies have shown nitrogen and other inert gases to be less aversive to birds than carbon dioxide."

Carbon dioxide is aversive to birds at any concentration, and inert gases are clearly superior from an animal welfare perspective. However, most chickens and turkeys can tolerate CO_2 levels of up to 30 percent without experiencing great pain (Gregory and others 1990; Raj 1998a; McKeegan and others 2006). This concentration is sufficient to cause unconsciousness in birds but not to kill them. Therefore, if producers use CO_2, they should use a gas mixture combining inert gases with no more than 30 percent CO_2 and ensure that the birds are killed and not merely stunned by the time they exit the chamber. Alternatively, many producers now use a multistage process in which birds are rendered unconscious with

30 percent CO_2 in air and then killed with a higher concentration only after unconsciousness has been achieved. Such systems must leave the birds in 30 percent CO_2 for at least a full minute in order to ensure that all birds are unconscious before proceeding to the next stage (Raj 2007).

In addition to using proper gas mixtures, in order to ensure the highest level of animal welfare, neither live dumping nor live shackling should occur. Killing birds while they are still in their transport crates eliminates live dumping. Ensuring that the gas kills—rather than merely stuns—the birds before shackling eliminates live shackling. Studies examining the stunning of chickens using various gas concentrations found that many birds rapidly regained consciousness, making stunning without killing unsuitable on welfare grounds. Raj and Gregory (1990) have recommended that "birds should be killed rather than stunned by the stunning gases" and that this "will not only obviate the recovery of consciousness, but subsequent operations such as uncrating and shackling of the birds and neck cutting would be performed more easily on the dead and hence relaxed carcasses."

"[CAK] of poultry in transport containers as they arrive at the processing plant would eliminate all the welfare concerns associated with the existing live bird handling, stunning, and slaughter systems."

—Dr. Mohan Raj, leading poultry-slaughter expert

ADVANTAGES OF CONTROLLED-ATMOSPHERE KILLING FOR SLAUGHTERHOUSE WORKERS

"Before [we switched to CAK], every week there was a new person. Now, [hanging is] one of the nicer jobs in the plant."
—Don Weber, director of operations for MBA Poultry's Tecumseh, Nebraska, plant, whose turnover rate dropped by 75 percent after switching to CAK

In addition to causing immense suffering for birds, the electric immobilization process results in extremely poor working conditions. As University of Georgia poultry welfare scientist Dr. Bruce Webster (2007) explains, "With current electrical stunning systems … the shackling station is loud with the distress calls of birds, the work is difficult with the continuous need to control struggling birds (for large turkeys, the work can be punishing), the air is filled with dust and bird dander kept aloft by the wing flapping of struggling birds, and the lighting is kept very dim to minimize bird reactivity as much as possible. Bird handlers must cover their arms and hands to protect themselves from claw scratches and must wear breathing protection against the dust in the air. The disagreeable nature of the work environment leads to poor worker morale and high worker turnover. By contrast, hanging of birds stunned/killed by CAS can be done in bright, relatively quiet circumstances with clean air and no struggle. Poultry companies which have adopted CAS systems have noted serendipitous benefits related to the management of the work force assigned to bird handling at the plant."

Conditions for workers in plants that use electric immobilization pose risks of physical injury, disease, and respiratory problems from live birds who struggle violently, vomit and defecate, and foul the air with dust. In some facilities, lighting is so low that workers must handle birds under ultraviolet black light. They also risk injury from their own knives when attempting to kill animals who survive the "killing" machine. The resulting extremely high turnover rates average between 75 and 100 percent each year (PBS).

In CAK systems, workers do not handle live, flapping birds. Lights can be kept bright, and the air is not dusty with fecal matter and debris. Overall working conditions are improved, fewer injuries are sustained by workers, and birds do not vomit or defecate on workers. Hanging areas remain calm, clean, and brightly lit—turning hanging into a desirable job.

One CAK plant in Michigan reports an annual turnover rate of only 20 percent (O'Keefe 2006b); the industry average is 375-500 percent as high as that plant's rate (PBS).

A Le Clezio plant in France switched to CAK after its live hangers went on strike over working conditions and were backed by the rest of the plant's union employees. The plant now touts improved ergonomics (O'Keefe 2006a).

The owner of an Emsland plant in Germany said that CAK has improved hangers' quality of life, noting, "After all, the birds are unconscious when they are hung on the shackles. There's better working conditions for the team" (Dunn 2006).

The Canadian Food Inspection Agency (1999b) looked into CAK and concluded, "The environment for the personnel working in the poultry stunning area is also very much improved …. Dust is reduced since unconscious birds are placed on the evisceration line."

Workers must often manually pull live birds from crates to shackle them, as demonstrated in this Butterball slaughterhouse. The process is arduous and creates extremely poor working conditions as well as enormous animal welfare problems.

ECONOMIC ADVANTAGES OF CONTROLLED-ATMOSPHERE KILLING FOR PRODUCERS

"[E]lectrical stunning … can cause bruises, broken bones, and blood spots on breast meat and tenders. These defects … are of significant economical importance."
—*Meatingplace* (meat-industry publication), May 2007

FEWER BROKEN BONES, LESS HEMORRHAGING, AND REDUCED BRUISING

Researchers at the University of Bristol (Raj and others 1997) compared the carcasses of gas-stunned broilers with those of electrically immobilized broilers and concluded that the incidence of broken bones and breast muscle hemorrhaging would be "substantially reduced by gas killing of broilers." Raj and Gregory (1991) also found this to be the case and concluded that "the advantages of gaseous stunning include improved meat quality, fewer broken bones, and less muscle hemorrhaging." Another study at the University of Bristol (Raj and others 1990) found that "gaseous stunning of broilers produced relatively better quality carcasses and meat than electrical stunning and therefore may have commercial advantages." Specifically, gassed broilers had a lower incidence of broken bones and breast- and leg-muscle bruising. The authors suggested that the increased incidence of leg-muscle bruising during electric immobilization was a direct result of shackling live birds. Even industry journals recognize this problem; *Poultry* (McGuire 2003) reports that "[d]uring processing, shackles can be too tight and the hanging of the bird too rough, which causes more severe bruising in the thigh areas." And the Canadian Food Inspection Agency (1999a) found that "the use of controlled atmosphere stunning in poultry reduces the incidence of broken bones, bruises, and haemorrhages in muscle, all of which are commonly associated with electrical stunning."

Farsaie and others (1983) report that bruising may be found on up to 25 percent of broilers processed in the U.S. According to the USDA (2002, 2003, 2004, 2005, 2006), each year approximately 400,000 to 1 million carcasses are condemned for bruises. CAK would significantly reduce this problem, and the resulting reduction in bruising would have important implications for the producer because it would "improve the yield and the value of products" and almost completely eliminate blood stains (EIPPCB 2003; Raj 2003).

REDUCED INTERNAL AND EXTERNAL CONTAMINATION

"[P]oultry products are more likely to be adulterated if … they are produced from birds that have not been treated humanely …."
—USDA Food Safety and Inspection Service
(70 Fed. Reg. 56624)

"Studies show that current inhumane poultry slaughter methods can lead to increased fecal contamination of the carcass. By handling meat that is the product of an inhumanely slaughtered bird, consumers may well be at an increased risk for contracting a potentially life-threatening food-borne illness."
—Michael Greger, M.D.

During electric immobilization, chickens tend to defecate and inhale water when they spasm after being electrically shocked. Gregory and Whittington (1992) examined this tendency by including a radioisotope in the electric bath and then looking at carcasses to determine whether internal radioactivity was detected. The results clearly showed that "chickens can and do inhale water during electrical [immobilization] in a waterbath and that no remedy is available at the moment." The authors suggest that the respiratory tract could, thus, be contaminated with bacteria from the stun bath, which could leak onto the edible portions of the carcass during evisceration.

When using electric immobilization, chickens commonly enter the scalding tank while they are still alive (see "Scalding" section above). When this happens, external contamination is a concern because of live birds' tendency to defecate in the scalding tank. Subsequent birds are then dipped into the contaminated water, spreading pathogens and necessitating excessive rinsing with water later down the line.

Furthermore, the dumping of live birds onto the conveyor under the electric immobilization model leads to scratches and wounds because the birds land on each other or otherwise struggle or panic as they try to regain their bearings. Raj (1998b) suggests that these skin wounds not only reduce the value of the carcass but also "can become a potential site for microbial attachment."

Furthermore, bruises sustained during dumping and shackling can further increase contamination. According to the World Bank Group International Finance Corporation's Good Practice Note (IFC 2006), "Bruised chicken meat is more prone to microbial contamination." One study reports that—in less hygienic conditions like those typical in plants using electric immobilization systems—"with bruises produced 5 [minutes] before death, bacterial numbers were 10 times higher in the bruised tissue …" (Gill and Penney 1979).

The CAK model almost completely eliminates all these forms of potential contamination by killing birds in their transport containers rather than dumping and shackling them alive, so they do not inhale in the stun bath or defecate in the scalding tank and are not prone to bruising during shackling. This has significant implications for producers since, according to the USDA (2002, 2003, 2004, 2005, 2006, 2007), about 4 million chickens are condemned each year for being contaminated.

IMPROVED SHELF LIFE AND QUALITY

"You don't get the blown vessels in the wing joints. We are starting to quantify the improvements in yield and labor, but visually we already see the benefits in wings, wing meat, and breast meat."
—Dale Hart, general manager of Cooper Farms processing plant in Ohio, on the immediate benefits of switching to a CAK system

"[B]lood spots on the fillets and tenders have disappeared, and that of course is a quality issue for us."
—Mark Haskins, founder, president, and CEO of MBA Poultry

In addition to animal welfare benefits, CAK provides producers with improved quality when compared to electric immobilization methods. Comparisons with electrical systems found that "killing broilers with [CAK] eliminated or substantially reduced the prevalence of carcas and meat quality defects" (Raj and others 1997). The European Commission's Scientific Committee on Animal Health and Animal Welfare (1998) agrees, writing that "[a]nother advantage of … gas killing methods, in comparison with electrical stunning, is that they may improve carcass and meat quality." These improvements include fewer broken bones, less hemorrhaging, reduced bruising, reduced internal and external contamination, improved shelf life and quality, and unimpeded bleedout.

The improved meat quality extends down to the cellular level. Iwamoto (2002) found that CAK results in better muscle fiber structure, concluding that "[CAK] was a better method for … meat quality than electrical stunning." Raj (1998b) explains that using inert gases induces anoxia on the cellular level in carcass muscles, which can "change the oxidation/reduction (radox) potentials" and, thus, lead to "increased shelf-life of meat due to a slow rate of development of off-odours … and discoloration …." Tests on CAK-slaughtered chickens determined that "meat tenderness and drip losses will improve. The blood spots, especially those on the thighs and breasts caused by stunning and hanging, disappear altogether" (Hoen and Lankhaar 1999). The Canadian Food Inspection Agency (1999a) states that CAK "is also reported to produce more tender breast meat than when electrical stunning is used." Taken together, these statements mean that CAK produces better-quality meat that lasts longer—in terms of smell and color—than the meat of electrically immobilized birds.

The use of gas rather than electricity not only improves meat quality, it also reduces the harmful effects on meat quality of preslaughter stress levels caused by violent treatment during dumping and shackling. The birds' physical suffering causes internal biological changes, including the breaking down of muscle glycogen, resulting in low-pH (acidic) meat known as "pale soft exudative" with poor flavor and color (FAO 2001). Researchers have investigated the effects of suffering during shackling on chicken meat quality and shown that the resulting meat is high in acid and pale in color, with increased drip loss and a lower curing-cooking yield (Berri and others 2005; Debut and others 2003). Since CAK involves shackling only dead birds, it completely avoids this source of meat degradation.

UNIMPEDED BLEEDOUT

"We have seen less visually recognizable blood in breast meat [since switching to CAK] …."
—Dale Hart, Cooper Farms

"Our white meat looks better, our dark meat looks better, our birds are bleeding out better—we actually gained benefits we weren't even expecting."
—Don Weber, director of operations for MBA Poultry

Raj and others (1997) compared the bleed-out rate of controlled-atmosphere-killed birds and electrically immobilized birds and found that after one minute, the differences were "not sufficient to impede the bleeding efficiency of broilers." Other studies give similar results (Hoen and Lankhaar 1999; Raj and Gregory 1991). A European Commission reference document (EIPPCB 2005) also reports that gas killing "does not impede blood loss, therefore, residual blood in the carcase meat is low."

INCREASED MEAT YIELD

"Stress immediately prior to death has a negative impact on pH and thus water holding capacity. … To maximize yield during further processing, the birds should be handled in a minimum stress environment prior to death."
—*Poultry* (meat-industry publication), October/November 2006

"Some of the results that we have gotten I did not assume we would get when we decided to go forward. Our bleed-out is better; the birds don't do damage to themselves when they are here any longer. It is just a better system for us."
—Mark Haskins, founder, president, and CEO of MBA Poultry

The CAK model results in increased meat yield by reducing the number of broken bones, hemorrhaging, and bruising and by reducing drip losses caused by preslaughter stress. CAK further increases yield by eliminating the possibility that live birds will enter the scalding tank and be condemned. Even a small increase in meat yield per bird can lead to a significant

increase in revenue. For example, with as little as a 1 percent increase in yield, a plant processing 1.3 million birds per week—based on an average ready-to-cook weight of 4 pounds per bird (USDA 2007) and an average ready-to-cook composite wholesale price of $0.7412 per pound—would earn an additional $2 million a year (3 cents per bird).

Reducing the number of birds who are dead on arrival—which can be achieved by eliminating dumping and other areas of rough handling that are inherent in the electric immobilization process—will provide yet another source of increased revenue. It is also important to note that the significant rearing costs associated with each bird (e.g., feeding, housing, lighting, transport) are completely lost when a carcass is condemned or discarded. By increasing meat yield, producers who use CAK would be able to recoup these otherwise wasted costs, providing yet another financial advantage.

REDUCED REFRIGERATION AND ENERGY COSTS

Raj and others (1997) found that CAK causes a more rapid pH fall in the carcasses than electric immobilization, resulting in faster carcass-maturation times and enabling early filleting. This has important financial benefits, as refrigeration can be significantly reduced, thus saving on storage, energy, and refrigeration equipment and maintenance costs. The EIPPCB (2003) also reports that CAK results in "[r]educed energy consumption due to reduced refrigeration time and space requirements because it is no longer necessary to mature the carcasses."

REDUCED LABOR COSTS

"The introduction of CAS has helped our ability to control staff welfare, and makes working overtime and weekends far more acceptable to them. On the meat side, bruising and bone damage arising from hanging on are now a thing of the past. And the difference in the quality of the breast meat really has to be seen to be believed. We can now de-bone hens on line, maturing in just two hours rather than the 24 hours that we used to."
—Terry Fowler, plant manager of Dean Foods

As detailed in the above section ("Advantages of CAK for Slaughterhouse Workers"), labor costs are drastically reduced with CAK in lower payouts for worker injury and illness and in lower employee turnover rates.

Furthermore, a reduction in bruising and broken bones lowers labor costs by reducing the need for carcass and fillet examination. This is significant, considering that Raj (1998b) estimates that a typical U.S. slaughterhouse that processes 1.3 million broilers per week incurs more than $277,000 per year in labor costs "associated with carcass handling" (figure adjusted for inflation from 1995 to 2007).

ENVIRONMENTAL BENEFITS

Improved quality and yield from CAK leads to a "reduced by-product destined for disposal as waste," and "the increase in yield, in turn, leads to a tendency to store more of the slaughterhouse output in conditions which won't cause spillage or odour problems" (EIPPCB 2003). Also, reduced contamination means that less water is needed to rinse off carcasses—the electric immobilization model typically uses about 15 liters of water per bird (Raj 2003)—therefore, there is less runoff, and water-treatment needs are reduced.

EXCERPTS FROM 'ADVANCES IN CAS TECHNOLOGY' (*WATT POULTRY USA*, FEBRUARY 2006)

"Lorenzo Battistini, director [of the] technical department, said that Amadori was interested in CAS because the company wanted to improve ergonomics for the live hangers, animal welfare, labor efficiency, and meat quality. He said that the CAS has given them improvements in each of these areas and that the meat quality improvement manifests itself in fewer blood spots and less hemorrhaging in the breast meat and thigh meat. … The CAS systems have been in use at [Amadori's] Cesena [plant] for three years, and Amadori installed another CAS system at the company's Tereamo broiler plant this summer."

"[La Clezio plant manager Jean Marc Venault] said that … DOAs have dropped by 50 percent [since switching to CAS and] … there are better ergonomics for the live hangers at the plant now because the birds are stunned when hung and not picked up to have their legs put in the shackles. Venault said that meat quality has improved with use of the CAS, and there is less blood in the breast and thigh meat. He said that carcass bleed-out has not been affected by the switching from electrical stunning to CAS."

"We are also very impressed with the improved staff working conditions and the dramatic change in meat quality. We aimed for a certain level, but the actual results have far exceeded our expectations."

—Mark Gaskin, divisional director of Deans Foods

COSTS OF IMPLEMENTING A CONTROLLED-ATMOSPHERE KILLING SYSTEM

There are two main types of CAK systems: the conventional systems that are generally used in Europe and the U.S.—which move birds into the CAK chamber while they are still in their transport containers—and a new system designed by Praxair, which delivers gas to birds while they are still on transport trucks. With either system, the initial cost of switching from electric immobilization to CAK can be offset and quickly surpassed by gains achieved from improving carcass quality and meat yield and from lowering costs by reducing the need for refrigeration, storage, labor, and environmental cleanup.

START-UP COSTS

CAK systems have a number of manufacturers and formats, and equipment costs vary. Praxair's unconventional system, which delivers gas to birds while they are still on transport trucks, is the least expensive. Converting a large plant has been estimated to cost about $100,000 and can be done in just two weekends (Grandin 2006).

Among conventional CAK systems, American Autoflow states that the "average price for an in-plant Easyload system fitted with gas stunning; washer; automatic drawer loading and unloading is approximately 1.5 million USD" (Burgos 2003). Ian Taylor, sales director of American Autoflow (Taylor 2003), also explains that if the source of the live birds is close to the slaughterhouse—as is often the case—or if the producers already have a "drawer system" in place, as is reportedly the case with some major U.S.-based companies such as Perdue Farms, then loading modules can be double-shifted at no additional cost, allowing the system to process approximately 128,000 birds per day (two eight-hour shifts running at 8,000 birds per hour). However, if additional modules are required to double-shift the line, Taylor estimates that the added cost would be only about $350,000 more. Thus, according to this estimate, between $1.5 million and $1.85 million would be required to install a CAK line capable of processing more than 46.7 million birds per year (with two shifts running daily).

The European Commission gives a similar estimate in its *Reference Document on Best Available Techniques in the Slaughterhouses and Animal By-Products Industries* (EIPPCB 2005), calculating the total cost for the complete installation of one CAK processing line using inert gases and a line speed of 7,000 birds per hour at around $1.4 million.* This

*All monetary figures in this paragraph have been converted to U.S. dollars using the exchange rates as of January 1, 1995, and have been adjusted for inflation from 1995 to 2007 using the U.S. Bureau of Labor Statistics' Inflation Calculator.

includes about $400,000 for the CAK equipment itself, about $400,000 for the loading machinery, and $600,000 for 240 modules, each holding 288 birds at $2,500 per module. It is important to note, however, that these figures are from 1995 (adjusted for inflation) and that with the rapid improvements in equipment technology within this sector, it is expected that these costs would be even lower today (Raj 1998).

OPERATING COSTS

According to the EIPPCB (2005), the estimated operating costs of using approximately 17 liters of gas mixture per bird—with an 80 percent nitrogen and 20 percent argon mixture—are between 0.52 and 0.87 cents per bird. And in a *Watt Poultry USA* article (O'Keefe 2003), Ian Taylor from American Autoflow estimates the gas cost of killing to be between 0.5 and 0.75 cents per bird. For a line that processes 128,000 birds per day, these figures translate to between $640 and $1,114 per day.

Systems that use carbon dioxide have even lower operating costs. Anglia Autoflow (2007) calculates the gas cost at about 0.1 cents per chicken, which translates to just $128 per day for a plant processing 128,000 birds per day. These costs are not only relatively insignificant, they are more than made up for in savings and increased revenue.

REACHING A RETURN ON INVESTMENT

Considering the increased revenue created by improving meat quality and lowering operating costs, the initial costs of switching to a CAK system can be recouped quickly. Costs will be offset in an even shorter time period for plants that are using electric immobilization equipment that must be replaced anyway. Based on the estimates above, a plant that installs a CAK line at a cost of either $1.5 million (without extra modules) or $1.85 million (with extra modules)—with a capacity to slaughter 128,000 birds per day (47 million annually)—would have yearly operating costs of as little as $47,000 for carbon dioxide and $230,000 to $410,000 for inert gas. Even based on the extremely conservative assumption of a mere 1 percent increase in meat yield—an average 3 cents in added revenue per bird—and neglecting all other revenue enhancements, such a plant would see a yearly increase in revenue of $1.4 million (47 million x 3 cents). The added revenue from increased meat yield alone could pay for the CAK line in about 13 months if extra modules were not needed and in about 16 months if extra modules were required. When other economic benefits are factored in, producers using CAK systems will begin to realize significant economic savings over electric immobilization in shorter time frames. Furthermore, the Praxair system's low initial investment of about $100,000 may be recouped even faster.

Once payback has been achieved, a 1 percent increase in meat yield alone would increase revenue at a rate of $29,000 per million birds for carbon dioxide systems—or between

$21,300 and $25,000 per million birds for inert gas systems, depending on the gas that is used ($30,000 in increased meat yield revenue minus $1,000 to $8,700 for the cost of gas). For a line capable of processing 128,000 birds per day—and most major producers process far higher numbers—once the initial costs of the CAK system are recovered, this translates to an additional $1 million to $1.3 million in profit annually from improvements in meat yield alone when compared to an electric immobilization system; these gains would continue throughout the equipment's lifetime. It is also important to note that when elements of the equipment have to be replaced, the subsequent costs will be significantly less than the initial purchase since certain components (e.g., modules) can have greater longevity than others.

COST-BENEFIT ANALYSIS FOR ADOPTING CAK

The Costs

Installation Cost	$1.5 million to $1.85 million (or $100,000 for the Praxair system)
Gas Cost per Bird	0.1¢ for CO_2 0.5¢ to 0.87¢ for inert gas

The Return

Increased Revenue

- Increased Meat Yield
- Increased Line Speed
- Improved Meat Quality
- Extended Shelf Life
- Decreased Contamination

Decreased Costs

- Less Worker Turnover
- Less Labor Needed
- Fewer Worker's Compensation Claims
- Lower Energy and Water Costs

Example: Tyson Foods

- Tyson has 40 processing plants that slaughter an average of 150,000 chickens per day.
- These figures assume just a 1 percent increase in meat yield and neglect all other economic benefits (estimated at 3¢ per bird wholesale based on recent USDA market data for ready-to-cook chicken).

Start-Up Costs	$60 million to $74 million
Revenue Increase	$66 million per year
Operating Costs	$2.2 million per year (for CO_2) or $11 million to $19 million per year (for inert gas)
Increased Profit*	**$47 million to $64 million per year (depending on choice of gas)**
Time Until ROI	**1 year to 1.6 years (depending on choice of gas)**

*Increased revenue from meat yield minus the cost of gas

SELECT POULTRY-INDUSTRY ENDORSEMENTS OF CONTROLLED-ATMOSPHERE KILLING

- "Brandons haven't just benefited from better meat quality and welfare improvements. The advantages have been seen right across the plant. … [There has been] a 50% reduction in hang-on-line employee costs. Line speed has increased [by 20%]. … [Y]ield has gone up by up to 1.5% …."
  —Case study of Brandons plc by Anglia Autoflow

- "On the turkey line … each hanger places around 7.66 birds per minute in the shackles … compared to around 5.125 birds per minute in a U.S. plant. This gives a pounds-per-man-hour improvement of almost 50%, because the hangers do not have to remove the birds from the cages by hand, like they do in a traditional U.S. … live-hanging operation."
  —*Watt Poultry USA* on Amadori, February 2006

- "Around 140,000 broilers per day are processed at the Flixton plant …. A company official said that the CAS was installed to improve bird welfare [and] worker ergonomics. As a side benefit, the plant now runs the line faster than before. Flixton processed only 110,000 birds per day prior to installing the CAS."
  —*Watt Poultry USA*, February 2006

- "'There's less cutting and trimming on the line because there are many fewer … spots and other damage that can come from electrical stunning,' says Henry Kuypers, production manager for the Pingo Poultry plant …. Gas stunning has allowed [the company] to produce a tender product [in] just three hours … [as opposed to] as long as 12 or even 24 hours. 'This variable maturation period also affected product uniformity,' Kuypers explains."
  —*Poultry* , October 2006

- "We are starting to quantify the improvements in yield and labor, but visually we already see the benefits in wings, wing meat, and breast meat."
  —Dale Hart, general manager of Cooper Farms

- "[T]he CAS system improves the environment for the workers in the live receiving area, improves the ergonomics of hanging live turkeys, and reduces carcass damage."
  —*Watt Poultry USA* on Cooper Farms, November 2006

- "Amadori was interested in CAS because the company wanted to improve ergonomics for the live hangers, animal welfare, labor efficiency, and meat quality. [T]he CAS has given them improvements in each of these areas …."
  —*Watt Poultry USA*, February 2006

- "The installation of gas stunning markedly reduced downgrades due to hemorrhages and bone fractures and improved fillet color and texture compared to previous stunning with an AC water-bath unit. As in EU plants, MBA Poultry can justify gas stunning based on the contribution from incremental revenue, which more than offsets the additional capital and operating costs incurred."
  —*Watt Poultry USA*, April 2005

- "[M]eat quality has improved with use of the CAS, and there is less blood in the breast and thigh meat. ... [C]arcass bleed-out has not been affected by the switch from electrical stunning to CAS."
  —*Watt Poultry USA* on Le Clezio, February 2006

- "[W]hile trying to maximize yield while processing 11,000 birds per hour, we also have to take a lot of care to ensure that the meat is unmarked. CAS has resulted in very high standards in this aspect. . . . There's [also] better working conditions for the team."
  —Richard Wenneker, Emsland Frischgefluegel

- "Meat quality has dramatically improved with no blood spots, and as a result, no trimming is required. This has seen notable benefits in an increase in yield. The cut-up operation now employs less people as a direct result of the benefits of … CAS."
  —Case study of Prior Norge by Anglia Autoflow

- "The introduction of CAS has helped our ability to control staff welfare, and makes working overtime and weekends far more acceptable to them. On the meat side, bruising and bone damage arising from hanging on are now a thing of the past. And the difference in the quality of the breast meat really has to be seen to be believed. We can now de-bone hens on line, maturing in just two hours rather than the 24 hours that we used to."
  —Terry Fowler, plant manager of Dean Foods

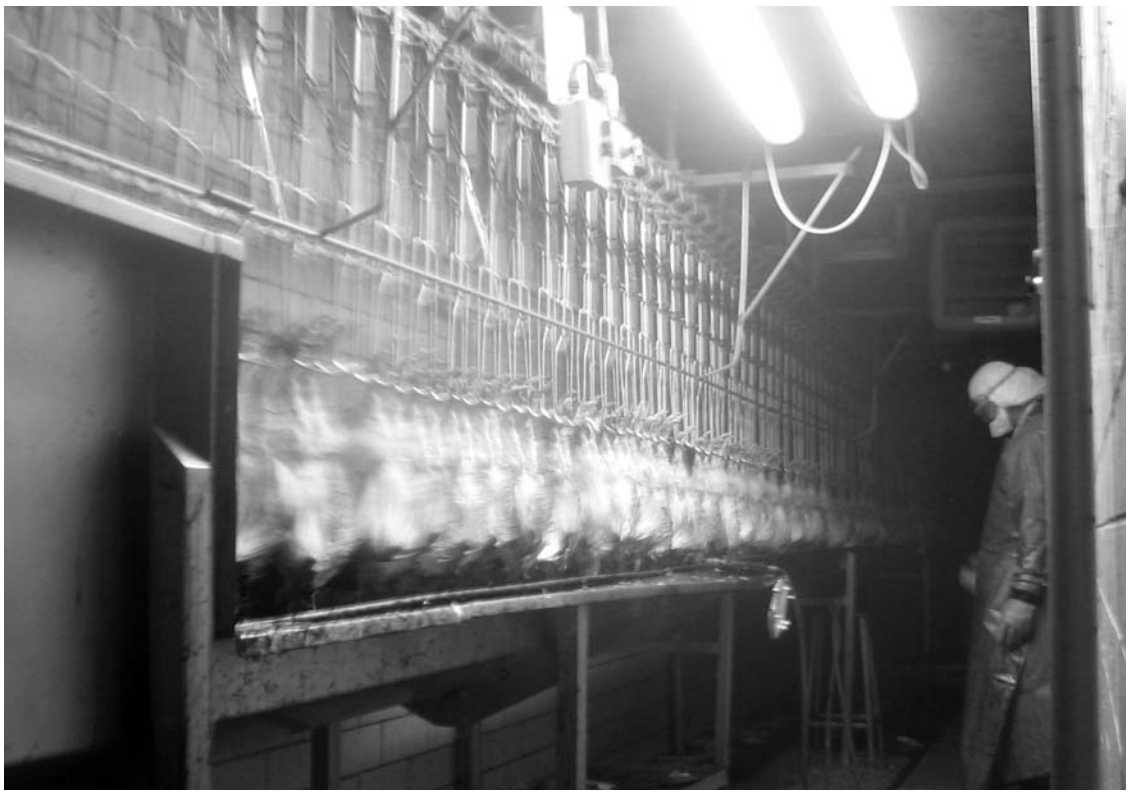
- "We are also very impressed with the improved staff working conditions and the dramatic change in meat quality. We aimed for a certain level, but the actual results have far exceeded our expectations."
  —Mark Gaskin, divisional director of Dean Foods

- "[B]lood spots on the fillets and tenders have disappeared …."
  —Mark Haskins, founder, president, and CEO of MBA Poultry

- "Some of the results that we have gotten I did not assume we would get when we decided to go forward. Our bleed-out is better; the birds don't do damage to themselves when they are here any longer. It is just a better system for us."
  —Mark Haskins, founder, president, and CEO of MBA Poultry

- "Our white meat looks better, our dark meat looks better, our birds are bleeding out better—we actually gained benefits we weren't even expecting."
  —Don Weber, director of operations for MBA Poultry

- "Before [we switched to CAK], every week there was a new person. Now, [hanging is] one of the nicer jobs in the plant."
  —Don Weber, director of operations for MBA Poultry



Shackled birds pass by the "back-up killer" in a Tyson Foods slaughterhouse where management told a PETA investigator that it was acceptable for live birds to be scalded to death.

SELECT EXPERT ENDORSEMENTS OF CONTROLLED-ATMOSPHERE KILLING

DR. TEMPLE GRANDIN

"Controlled-atmosphere stunning of chickens has important welfare advantages. . . . The U.S. poultry industry should move toward controlled-atmosphere stunning."

Dr. Temple Grandin is perhaps the world's foremost expert on the handling and slaughtering of animals. She is an associate professor of animal science at Colorado State University and the founder of Grandin Livestock Handling Systems. She designed the animal-handling systems currently used in nearly half of the cattle slaughterhouses in the United States. Dr. Grandin has authored more than 300 publications, and she has served as an animal welfare consultant for companies including McDonald's, Burger King, and Wendy's.

DR. MOHAN RAJ

"[CAK] of poultry in transport containers as they arrive at the processing plant would eliminate all the welfare concerns associated with the existing live bird handling, stunning, and slaughter systems."

Dr. Mohan Raj is a world-renowned expert on chicken and turkey stunning and slaughter. He is a veterinary scientist and senior research fellow at the School of Clinical Veterinary Science at the University of Bristol. He has published more than 50 peer-reviewed papers in international scientific journals. He is a member of the European Food Safety Authority's Panel on Animal Health and Welfare. He has also served as an expert advisor on the European Union Scientific Veterinary Committee Working Group on the stunning and killing of animals, as a member of the European Food Safety Authority's working group on the stunning and killing of animals, and as a member of the World Organization for Animal Health's ad hoc group on the welfare of animals during stunning and slaughter for human consumption.

DR. IAN DUNCAN

"In my opinion, [CAK] is the most stress-free, humane method of killing poultry ever developed. The birds are quiet throughout the operation. They remain in the transport crate until dead and the killing procedure itself is fast, painless, and efficient. There is no risk of recovery from unconsciousness."

Dr. Ian Duncan is North America's leading expert on chicken and turkey welfare. He is a professor of poultry ethology and the chair of animal welfare in the Department of Animal and Poultry Science at the University of Guelph. He has published more than 150 scientific papers, most of which focus on chicken and turkey welfare. His awards include the Award for Innovative Developments in Animal Welfare, The Humane Society of the United States' inaugural award for the best course in North America dealing with animals and society, and the Robert Fraser Gordon medal for outstanding services to poultry science. He has served as an advisor to the Commission of the European Communities on matters related to animal welfare. He is the only scientist who has given keynote addresses at meetings of both the Poultry Science Association and the American Society of Animal Science.

CONCLUSION

It is clear that animals suffer in electric immobilization systems in the United States, from unloading to defeathering. Chickens and turkeys endure the stress and pain of being dumped onto a crowded conveyor, where they sometimes suffocate; being roughly hung upside-down by their legs in shackles; experiencing painful prestun shocks from the electric bath; having their throats slit while they are still conscious; and being scalded to death.

Every published report on the science of CAK concludes that it significantly alleviates these welfare problems. At the same time, CAK improves carcass quality and revenue for producers. The initial costs for a complete CAK line can be recovered quickly—within a year to a year and a half based on improvements in meat yield alone and even faster as other benefits are realized. Thereafter, these savings will continue to provide producers with increased profits as a result of the switch.

Several systems that use controlled atmospheres to kill birds in transport containers prior to shackling are currently available for commercial use and are USDA-approved. A number of large-scale systems have already been implemented in Europe and North America with great success. The United Kingdom's animal welfare minister, Elliot Morley, put it best when he explained that adopting a CAK model for poultry has "the double advantage of offering the industry an opportunity to boost welfare standards and cut costs at the same time" (DEFRA 2001).

Considering the enormous animal welfare and economic advantages of CAK over electric immobilization, producers should make rapid implementation of CAK a priority.

APPENDIX A: MANUFACTURERS OF CONTROLLED-ATMOSPHERE KILLING EQUIPMENT

The following producers can provide additional information concerning the adoption of controlled-atmosphere systems:

Anglia Autoflow
Wortham Ling
Diss
Norfolk IP22 1SR
England
011-44-1379-651031
011-44-1379-652832 (fax)
sales@aaflow.com
www.aaflow.com

REFERENCES

Anglia Autoflow. 2007 Apr. Leaflet. Universal gas stunning system.

Anton F, Euchner I, Handwerker HO. 1992. Psychophysical examination of pain induced by defined CO_2 pulses applied to the nasal mucosa. Pain 49:53-60.

Arthur K. 2003 Mar 2. Testimony. Located at: People for the Ethical Treatment of Animals, Norfolk, Va.

Austin W. 1994 Feb 1. Letter to Clare Druce. In: Davis K. 1996. Prisoned chickens, poisoned eggs: An inside look at the modern poultry industry. Summertown: Book Publishing Company. p 175.

Bell R. 1997 Jun 19. McLibel Verdict. Available at: http://www.mcspotlight.org/case/trial/verdict/verdict_jud2c.html.

Berri C and others. 2005 Oct. Variations in chicken breast meat quality: Implications of struggle and muscle glycogen content at death. Br Poultry Sci 46(5):572-9.

Boyd F. 1994. Humane slaughter of poultry: The case against the use of electrical stunning devices. J Agric Environ Ethics 7:221-36.

Burgos D. 2003. Letter. Located at: People for the Ethical Treatment of Animals, Norfolk, Va.

Canadian Food Inspection Agency [CFIA]. 1999a. Canadian Food Inspection Agency liaison, preparedness and policy coordination: Regulatory impact analysis statement. Available at: www.inspection.gc.ca/english/reg/appro/1999/97014riae.shtml.

Canadian Food Inspection Agency [CFIA]. 1999b. Canadian Food Inspection Agency liaison, preparedness and policy coordination: Regulations amending the meat inspection regulations. Available at: canadagazette.gc.ca/partII/1999/19991013/html/sor369-e.html.

Coenen A, Smit A, Zhonghua L, van Luijtelaar G. 2000. Gas mixtures for anaesthesia and euthanasia in broiler chickens. World's Poultry Sci J 56:225-34.

Danbury TC, Weeks CA, Chambers JP, Waterman-Pearson AE, Kestin SC. 2000. Self-selection of the analgesic drug carprofen by lame broiler chickens. Vet Rec 146:307-11.

Debut M and others. 2003 Dec. Variation of chicken technological meat quality in relation to genotype and preslaughter stress conditions. Poultry Sci 82(12):1829-38.

Department for Environment, Food & Rural Affairs (UK) [DEFRA]. 2001 Dec 6. DEFRA action on inert gases boosts

Linco Food Systems, Inc.
6245 Shiloh Rd., Ste. A
Alpharetta, GA 30005
770-844-8000 or 1-800-TO-LINCO
770-844-7900 (fax)
linco@lincofood.us
www.lincofood.us

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716-879-2040 (fax)
1-800-772-9985 (fax)
info@praxair.com
www.praxair.com

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Gainesville, GA 30503
770-532-7041
770-532-5706 (fax)
usa.foodsystems@stork.com
www.storkgamco.com

poultry welfare. News release. Available at: defraweb/news/2001/011206a.htm.

Duncan IJH. 1997. Killing methods for poultry: A report on the use of gas in the UK to render birds unconscious prior to slaughter. Campbell Centre for the Study of Animal Welfare.

Dunn N. 2006 Oct-Nov. CAS-ting call. Poultry 18-20.

European Food Safety Authority [EFSA]. 2004 Jun 15. Welfare aspects of animal stunning and killing methods: Scientific report of the scientific panel for animal health and welfare on a request from the commission related to welfare aspects of animal stunning and killing methods. Question nr EFSA-Q-2003-093.

European Integrated Pollution Prevention and Control Bureau (EC) [EIPPCB]. 2005 May. Reference document on best available techniques in the slaughterhouses and animal by-products industries.

Farsaie A, Carr LE, Wabeck CJ. 1983. Mechanical harvest of broilers. Trans ASAE 26:1650-3.

Food and Agriculture Organization of the United Nations [FAO]. 2001. Guidelines for humane handling, transport, and slaughter of livestock. RAP Publication 2001/4.

Food Safety and Inspection Service (US) [FSIS]. 2001 Jun. Poultry postmortem inspection.

Gentle MJ, Tilson VL. 2001 Aug. Nociceptors in the legs of poultry: Implications for potential pain in preslaughter shackling. Animal Welfare 9:227-36.

Gerlis LM. 1986. An up-to-date assessment of the Jewish method of slaughter. In: UFAW. Proceedings of the Humane Slaughter of Animals for Food Symposium; Potters Bar, Hertfordshire, England.

Gill CO, Penney N. 1979 Dec. Microbiology of bruised tissue. Applied Environ Microbiol 38(6):1184-5.

Grandin T. 2006 Dec 19. Summary of telephone conversation. Located at: People for the Ethical Treatment of Animals, Norfolk, Va.

Gregory NG. 1986. The physiology of electrical stunning and slaughter. In: UFAW. Proceedings of the Humane Slaughter of Animals for Food Symposium; Potters Bar, Hertfordshire, England.

Gregory NG. 1991. Humane slaughter. Outlook Agri 20:95-101.

Gregory NG, Austin SD, Wilkins LJ. 1989. Relationship between wing flapping at shackling and red wingtips in chicken carcasses. Vet Rec 124:62.

Gregory NG, Raj ABM, Audsley ARS, Daly CC. 1990. Effects of carbon dioxide on man. Fleischwirtschaft 70:1173-4.

Gregory NG, Whittington PE. 1992. Inhalation of water during electrical stunning in chickens. Res Vet Sci 53:362.

Gregory NG, Wilkins LJ. 1989. Duration of wing flapping in chickens shackled before slaughter. Vet Rec 121:567-9.

Gregory NG, Wilkins LJ. 1990. Broken bones in chickens: Effects of stunning and processing in broilers. Brit Poultry Sci 31:53-8.

Gregory NG, Wotton SB. 1987a. Effect of electrical stunning on the electroencephalogram in chickens. Brit Vet J 143:175-83.

Gregory NG, Wotton SB. 1987b. Poultry stunning and slaughter. In: European Conference Group on the Protection of Animals. Pre-slaughter Stunning of Food Animals; Horsham, Sussex, England.

Griffiths GL, Purcell DA. 1984. A survey of slaughter procedures used in chicken processing plants. Aust Vet J 61:399-401.

Heath GBS. 1984. The slaughter of broiler chickens. World's Poultry Sci J 40:151-9.

Heath GBS, Watt DJ, Waite PR, Meakins PA. 1983. Brit Vet J 139:285.

Heath GBS, Watt DJ, Waite PR, Ormond JM. 1981. Observations on poultry slaughter. Vet Rec 108:98.

Hoen T, Lankhaar J. 1999 Feb. Controlled atmosphere stunning of poultry. Poultry Sci 78(2):287-9.

International Finance Corporation [IFC]. 2006 Oct. Creating business opportunity through improved animal welfare. Good Practice Note 6.

Iwamoto H, Ooga T, Moriya T, Miyachi H, Matsuzaki M, Nishimura S, Tabata S. 2002 Aug 1. Comparison of the histological and histochemical properties of skeletal muscles between carbon dioxide and electrically stunned chickens. Brit Poultry Sci 43(4):551-9.

Kannan G, Heath JL, Wabeck CJ, Mench JA. 1997. Shackling of broilers: Effects on stress responses and breast meat quality. Brit Poultry Sci 76:523-9.

Katme AM. 1986. An up-to-date assessment of the Moslem method of slaughter. In: UFAW. Proceedings of the Humane Slaughter of Animals for Food Symposium; Potters Bar, Hertfordshire, England.

Lambooij E, Gerritzen MA, Engel B, Hillebrand SJW, Lankhaar J, Pieterse C. 1999. Behavioral responses during exposure of broiler chickens to different gas mixtures. Applied Animal Beh Sci 62:255-65.

Lozza L. 2005 Jun 18. CAS systems in Europe: Process, control and implementation. PowerPoint presentation. 7th European Symposium WPSA on Poultry Welfare: 5.

McGuire, AR. 2003 Feb-Mar. Improving carcass quality. Poultry 10(1):25-6.

McKeegan DEF. 2004. Mechano-chemical nociceptors in the avian trigeminal mucosa. Brain Res Rev 46:146-54.

McKeegan DEF, Demmers TGM, Wathers CM, Jones RB. 2003. Chemosensitivity responses to gaseous pollutants and carbon dioxide: Implications for poultry welfare. Poultry Sci 82(1 Suppl):16.

McKeegan DEF, McIntyre J, Demmers TGM, Wathes CM, Jones RB. 2006. Behavioural responses of broiler chickens during acute exposure to gaseous stimulation. Applied Animal Behav Sci 99:271-86.

McSpotlight. 1997. Transcript of trial verdict on CD-ROM.

O'Keefe T. 2003 Jun. Stunning developments. Watt Poultry USA 42-55.

O'Keefe T. 2006a Feb. Advances in CAS technology. Watt Poultry USA 7(2):29-33.

O'Keefe T. 2006b Sep. MTP cooks its way to value. Watt Poultry USA 7(9):16-22.

Parker LJ, Bajoie KC, Catille S, Cadd GG, Satterlee DG, Jones RB. 1997. Sex and shank diameter affect struggling behaviour of shackled broilers. Poultry Sci 76(1 Suppl):88.

Public Broadcasting Service [PBS]. Modern meat: Interview with Eric Schlosser. PBS Frontline. Available at: www.pbs.org/wgbh/pages/frontline/shows/meat/interviews/schlosser.html.

Raj ABM. 1994. An investigation into the batch killing of turkeys in their transport containers using gases. Res Vet Sci 1994;56:325-31.

Raj ABM. 1996. Aversive reactions of turkeys to argon, carbon dioxide and a mixture of carbon dioxide and argon. Vet Rec 138:592-3.

Raj ABM. 1998a. Welfare during stunning and slaughter of poultry. Poultry Sci 77:1815-9.

Raj ABM. 1998b Mar 30. Untitled. Proceedings from inert gas: A workshop to discuss the advantages of using inert gas for stunning and killing of poultry. University of Guelph, Guelph, Canada.

Raj ABM. 2003 May 13. Summary of telephone conversation. Located at: People for the Ethical Treatment of Animals, Norfolk, Va.

Raj ABM. 2006 Sep. Recent developments in stunning and slaughter of poultry. World's Poultry Sci J 62(3):467-84.

Raj ABM. 2007 Apr 25. E-mail to PETA. Located at: People for the Ethical Treatment of Animals, Norfolk, Va.

Raj ABM, Gregory NG. 1990. Investigations into the batch stunning/killing of chickens using carbon dioxide or argon-induced hypoxia. Res Vet Sci 49:366.

Raj ABM, Gregory NG. 1991. Efficiency of bleeding of broilers after gaseous or electrical stunning. Vet Rec 128:127.

Raj ABM, Grey TC, Gregory NG. 1990. Effect of electrical and gaseous stunning on the carcass and meat quality of broilers. Brit Poultry Sci 31:725.

Raj ABM, Wilkins LJ, Richardson RI, Johnson SP, Wotton SB. 1997. Carcass and meat quality in broilers either killed with a gas mixture or stunned with an electric current under commercial processing conditions. Brit Poultry Sci 38:169-74.

Richards S, Sykes AH. 1967. Res Vet Sci 8:361.

Scientific Committee on Animal Health and Animal Welfare (EC). 1998 Jun 23. The use of mixtures of the gases CO_2, O_2, and N_2 for stunning or killing poultry. Available at: europa.eu.int/comm./food/fs/sc/scah/out08_en.html.

Shane S. 2005 Apr. The future of gas stunning. Watt Poultry USA 20.

Sparrey JM, Kettlewell PJ. 1994. Shackling of poultry: Is it a welfare problem? World's Poultry Sci J 50:167-76.

Sparrey JM, Kettlewell PJ, Paice MER. 1992. A model of current pathways in electrical waterbath stunners used for poultry. Brit Poultry Sci 33:907-16.

Sparrey JM, Kettlewell PJ, Paice MER, Whetlor WC. 1993. Development of a constant current water bath stunner for poultry processing. J Agric Engineering Res 56:267-74.

Taylor I. 2003. Summary of telephone conversation. Located at: People for the Ethical Treatment of Animals, Norfolk, Va.

U.S. Department of Agriculture [USDA]. 2002 Apr. Poultry Slaughter 2001 Annual Summary. Available from: NASS;Pou 2-1(02).

U.S. Department of Agriculture [USDA]. 2003 Mar. Poultry Slaughter 2002 Annual Summary. Available from: NASS;Pou 2-1(03).

U.S. Department of Agriculture [USDA]. 2004 Mar. Poultry Slaughter 2003 Annual Summary. Available from: NASS;Pou 2-1(04).

U.S. Department of Agriculture [USDA]. 2005 Feb. Poultry Slaughter 2004 Annual Summary. Available from: NASS;Pou 2-1(05).

U.S. Department of Agriculture [USDA]. 2006 Feb. Poultry Slaughter 2005 Annual Summary. Available from: NASS;Pou 2-1(06).

U.S. Department of Agriculture [USDA]. 2007 Feb. Poultry Slaughter 2006 Annual Summary. Available from: NASS;Pou 2-1(07).

Webster AB. 2007 Jan 23. "Is gas stunning/killing ethical?" bioethics symposium: Proactive approaches to controversial welfare and ethical concerns in poultry science (Revised). p 16-21.

Webster AB, Fletcher D. 2004. Assessment of the aversion of hens to different gas atmospheres using an approach-avoidance test. Applied Animal Behav Sci 88:275-87.

Wooley SA, Brothwick FJW, Gentle MJ. 1986a. Flow routes of electric currents in domestic hens during pre-slaughter stunning. Brit Poultry Sci 27:403-8.

Wooley SA, Brothwick FJW, Gentle MJ. 1986b. Tissue resistivities and current pathways and their importance in pre-slaughter stunning of chickens. Brit Poultry Sci 27:301-6.

Wooley SA, Gentle M. 1988. Physiological and behavioural responses of the domestic hen to hypoxia. Res Vet Sci 45:377-82.

501 Front St.
Norfolk, VA 23510
757-622-PETA
757-622-0457 (fax)
PETA.org

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