ANIMAL WELFARE INSTITUTE

More Humane Farmed Animal Depopulation Methods: Information and Sources

METHOD[1]	MECHANISM OF KILLING	SOURCE	PRODUCT DESCRIPTION	OPERATIONAL CONSTRAINTS	REFERENCES
Anoxia-based Methods					
Nitrogen gas delivered via high-expansion (>300:1) foam	Provided expansion ratio and bubble size are appropriate for the species, foam is a vehicle for delivering N2 gas and displacing oxygen. Death occurs by anoxia without airway occlusion or drowning.	*Agricultural Emergency Services* Newark, Delaware Dan Hougentogler dan@agemergency.com agemergency.com/	Foam delivery system for use in whole barns or in dump trailers. Simple design and operation requiring minimal maintenance. For pigs and floor-reared poultry.	Research on-going re: use in chickens in battery cages and multi-tiered aviaries and in other species.	Multiple species:[1, 2] Poultry:[3–13] Pigs:[14–20] See also Nitrogen Gassing Trailer References below
		Livetec Systems Leighton Buzzard, United Kingdom info@livetecsystems.co.uk livetecsystems.co.uk/resource_hub/nitrogen-foam-delivery-system-nfds-product-guide/	Foam delivery system which can be used in whole barn, corral, or other holding pen. For pigs and floor-reared poultry.	Research on-going re: use in battery cages and multi-tiered aviaries. Pigs: potential for increased risk of tracheal occlusion at temperature <15˚F (-9.4˚C).	
		HEFT International Uddevalla, Sweden Sebastian Strand sebastian.strand@heftinternational.com heftinternational.com/c3/	Foam delivery system utilizing sealed containers, which may speed loss of consciousness. Foam functions as non-irritating disinfectant. For pigs and poultry.	Animals must be placed in containers; large-scale c3 system includes 20 ft x 8 ft container. Careful animal handling required.	
Nitrogen (N_2) Gassing	Rapid exposure to >97% nitrogen gas; death occurs by anoxia.	*Prairie Agricultural Machinery Institute* Humboldt, Saskatchewan, Canada pami@pami.ca 1-800-567-7264	Fully-automated trailer includes nitrogen generator, so external nitrogen source unnecessary. Prototype made for piglets but can be custom built to accommodate various sizes/species of animals.	Operation may be problematic at temperatures <14˚F (-10˚C). 200 to 700 pigs per hour depending on animal size.	Multiple species:[21, 22] Pigs:[19, 23–26] Poultry:[4, 27–29]
		Oxair Bellevue, Western Australia Matthew van den Bos mattbpe.4@bigpond.com +61 (0) 414 537 352 oxair.com.au/humane-poultry-euthanasia-systems/	Anoxiatec system uses N_2 produced from a membrane separation system to maintain N_2 concentrations >98% in a tunnel through which birds are conveyed. Modules of different capacities can be custom-built, and can be made portable.	Careful animal handling required. Further validation required, however, developer describes loss of consciousness within 30 seconds and death within 3 minutes. Air is heated during N_2 generation but has not been tested in extreme cold.	[4, 27–29, 22]
Low Atmospheric Pressure Systems	Gradual decompression to produce oxygen level to <5%; death occurs by anoxia.	*TechnoCatch, LLC* Kosciusko, MS Randolph Cheek hrcheek@technocatch.com technocatch.com/laps 662-289-1117	Trailers with mounted generator, vacuum pump, hydraulic power pack, and compressed air tanks. Chamber types and size are specific to operational needs. For birds only.	Correct rates of decompression must be used. Careful bird handling required.	[3, 30–36]

Containerized Gassing Unit	Units can be used with up to 100% nitrogen or with 80% argon/20% carbon dioxide mixture; death occurs by anoxia.	*Livetec Systems* Leighton Buzzard, United Kingdom info@livetecsystems.co.uk livetecsystems.co.uk/our-solutions/on-farm-products/containerised-gassing-units/	Birds in transport modules or crates are placed in the unit's chamber, which is then filled with compressed gas. Manual, automated, and bespoke options available.	3 sizes of containers available, with max throughput up to 10,000 kg per hour. Careful bird handling required.	4, 27–29, 37
Electrocution-based Methods					
Electrocution Trailer	1-step head-to-heart electrocution (pigs).	*University of Nebraska–Lincoln* Lincoln, Nebraska Ruth Woiwode, PhD ruth.woiwode@unl.edu 402-472-3247 970-690-9337	V-belt restrainer mounted onto 30-ft flatbed gooseneck trailer onto which electric components and drive units are mounted.	Only suitable for pigs weighing 125–600 lbs. Careful animal handling required.	19, 38–43
H2H Chicken Euthanizer	1-step head-to-heart electrocution (chickens).	Top Equipment Tiel, The Netherlands info@top-equipment.nl +31 6 537 760 43 top-equipment.nl/	Chicken (0.5–4 kg; 1.1–8.8 lbs.) is supported head down in a flexible cone for head-to-heart electrocution resulting in immediate loss of consciousness.	Because birds are killed individually, primary use is for smaller flocks. Careful bird handling required.	44–50
Carbon Dioxide-Based Methods[2]					
Whole House or Partial House Gassing of Poultry	Carbon dioxide (CO_2) causes hypercapnia, leading to central nervous system depression; hypoxia may also play a role.	*USDA National Veterinary Stockpile* contains 18 units *Linde* (formerly Praxair, Inc.) Danbury, CT Joe Shine 281-203-3235 203-482-0227 praxair.com/frac *Air Liquide* Canada Toni Mancini tony.mancini@airliquide.com 1-780-438-5602 airliquide.ca/ *Carbox Cryogénique* Longueuil, Québec, Canada Gaétan Bélanger 1-514-953-6901 carboxcryo.com/ *Livetec Systems* Leighton Buzzard, United Kingdom info@livetecsystems.co.uk livetecsystems.co.uk/our-solutions/on-farm-products/whole-house-gassing/	System includes distribution box, dosing manifolds, hoses, and monitoring devices to distribute carbon dioxide throughout the poultry house, raising CO_2 levels to 45% and reducing oxygen concentration.	Establishing reliable sources of liquid CO2 gas can improve accessibility of this method. Longer hold times and higher CO_2 levels required for waterfowl. "Homemade" WHG units are not recommended due to safety, efficacy, and animal welfare concerns.	3, 4, 27, 61–77

Containerized Gassing Units for Poultry with Controlled Gas Flow	Carbon dioxide (CO_2) causes hypercapnia, leading to central nervous system depression; hypoxia may also play a role.	*E-Z Systems* Palmer, PA Brett Field info@ezsystemsinc.com 1-877-559-0159 ezsystemsinc.com	Euthanex AgPro PC Modified Atmospheric Chamber Cart can be moved down the aisle of laying house. Euthanex MAK Trailer is placed outside the building. Gas flow and temperature are controlled in both systems.	Systems built to order. Careful bird handling required.	81, 28, 3, 64, 68, 69, 71–74, 80

1. The following depopulation methods may also be considered more humane if careful animal handling is implemented, but are not included here because sources are already well-known: movement to federal- or state-inspected slaughterhouses for carcass production, gunshot, captive bolt, cervical dislocation, KEDS, TEDS, and intravenous pentobarbital.

2. Containerized CO2 gassing for pigs has not been included due to concerns about animal welfare, as well as because pre-manufactured units are not commercially available. If converted dumpsters are utilized for pig depopulation, AWI recommends close adherence to engineering standards to ensure appropriate gas displacement rates, temperatures, etc. [51–60,19,61]

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