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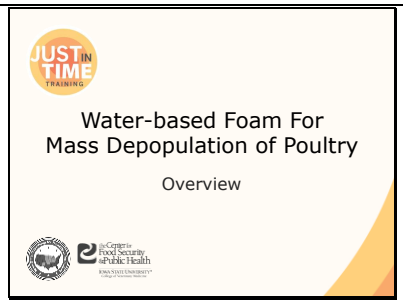
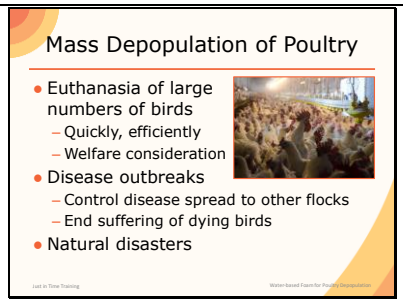


June 2016

During an animal health emergency, the mass depopulation of poultry may be a necessary response task. Various methods for poultry depopulation under emergency situations have been approved. One such method for use for floor-reared poultry is the use of water-based foam. This Just-In-Time training presentation will overview the use of water-based foam for poultry depopulation, discuss considerations when this method is used as well as safety issues.

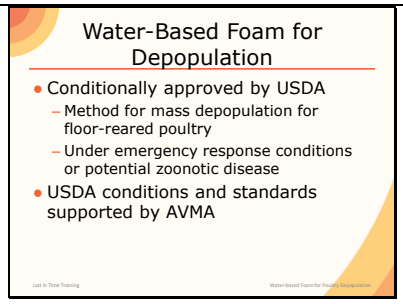
Slide 2



Mass depopulation involves the humane euthanasia of large numbers of animal quickly and efficiently, while taking animal welfare into consideration. Mass depopulation may be necessary to control pathogen spread during a disease outbreak, or to end the suffering of dying birds during a disease outbreak or following a natural disaster situation.

[Photo: A large flock of floor-reared chickens. Source: U.S. Department of Agriculture/Lance Cheung]

Slide 3



The use of water-based foam is a relatively new method of large scale depopulation for floor-reared poultry (i.e., broilers, turkeys). This method of depopulation has been conditionally approved by the US Department of Agriculture (USDA) for use with floor-reared poultry under emergency response or potential zoonotic disease situations. It is also supported by the American Veterinary Medical Association (AVMA) when used according to the USDA conditions and standards. The use of water-based foam may also by used in situations considered hazardous for human entry, such as structurally unsound buildings following natural disaster situations. While various types of foam are available and used for other situations (e.g., fire fighting), USDA-APHIS has only approved water-based foam for poultry depopulation situations. This method has been used in the United States and other countries during avian influenza outbreaks.

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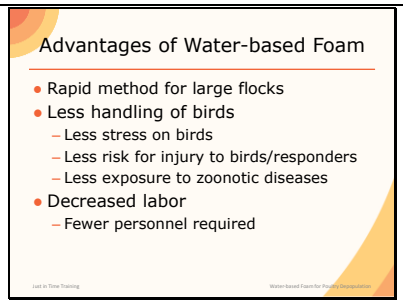

One of the advantages of using water-based foam for poultry depopulation includes the increased speed of depopulation compared to other euthanasia methods. Water-based foam works just as quickly as carbon dioxide gas alone (another method used for poultry depopulation). In most situations, especially for large flocks, water-based foam may be quicker. The use of water-based foam requires little to no bird handling, minimizing stress on the birds, and reducing the risk of injury to the birds as well as responders handling the birds. Additionally, in situations where the disease may cause illness in humans (a zoonotic disease situation), less bird handling minimizes the risk for disease transfer to responders. The water-based foam method requires fewer personnel for the preparation and implementation of the process. This can be a great advantage in situations where personnel may be limited, such as large scale, multiple site outbreaks.

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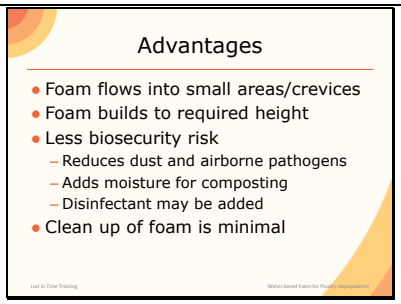
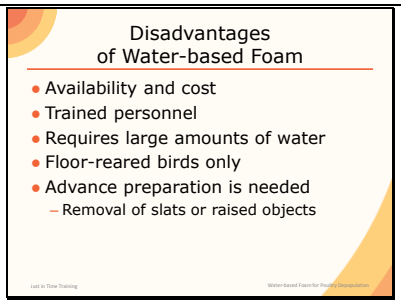


Additional advantages for the use of water-based foam include:

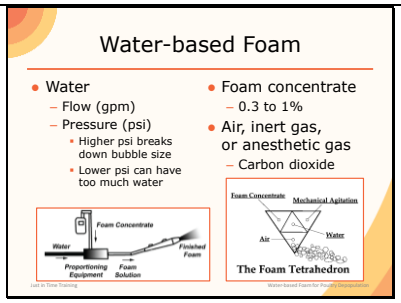
- The ability of foam to easily flow into small areas and fill crevices for complete coverage. This provides greater flexibility for use in various style production facilities. Poultry housing situations vary widely and can have large surface areas and multistory housing designs.
- Foam of the appropriate formulation and body can easily build up to the depths required (above the height of the birds).
- Foam can also reduce biosecurity risks by dampening down dust and airborne pathogens. The additional moisture can also aid situations where composting is planned as the carcass disposal method. The addition of chemical disinfectants to the foam solution can help to decontaminate the immediate environment.
- Clean up is minimal with water-based foam, as the foam will dissipates over a few hours.

Slide 6



There are disadvantages to the use of water-based foam for poultry depopulation. The cost and availability of the specialized equipment needed, may limit its use. Additionally personnel trained on the preparation and delivery of the foam will be required. Large quantities of water will be needed for foam generation. This can be a limiting factor in the use of this method. Depending on the location and water sources available, water may need to be trucked to the site. As previously mentioned, the use of water-based foam has only been conditionally approved for use for floor-reared birds during emergency situations. Therefore, its use may require some advanced preparation, such as removing slats or other items that may allow the birds to get off the floor and away from the foam. Other depopulation methods must be used for caged birds.

Slide 7



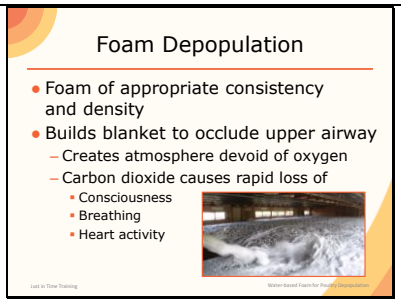
Water-based foam primarily consists of a solution of water, foam concentrate and air, inert gas or an anesthetizing agent, such as carbon dioxide. The mixture is generated and mixed by special equipment. The proportion of each determines the foam bubble size, consistency and in the situation of depopulation, killing efficacy.

- Water is supplied by a pump. The flow (gallons per minute [gpm]) and the pressure (psi) at the nozzle tip help determine the consistency of the finished foam. An ideal psi is around 20-25. A higher psi can break down the foam bubble size while a lower psi will incorporate too much water.
- Foam concentrate is added to the water. This can be done as simply as batch mixing in a tank, or through the use of a more complex pump proportioning system. The goal is to mix the foam concentrate into the water in a controlled accurate manner. This finished foam solution is used to make a final foam blanket. Differences exist between foam manufacturers and formulations (e.g. surfactants, solutions, stabilizers) as well as the biodegradability and residues of the product.

- Air, inert gas or anesthetic gas is added to provide mechanical agitation to create the foam. For poultry depopulation, carbon dioxide is the most common gas used. It is readily available and has been used extensively in the past for mass euthanasia during disease eradication. Carbon monoxide, nitrogen and argon gas have also be used to euthanize poultry but are much more difficult to use.

[Diagram: Foam components. Source: Source: Class A Foam: Awareness and Operations Level Workbook and Glossary. http://www.tft.com/literature/library/files/LTT-300.pdf]

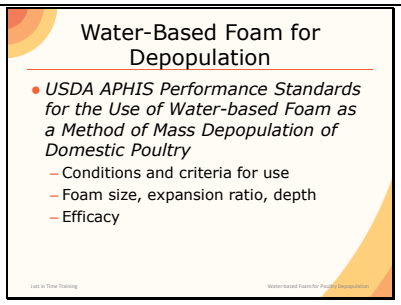
Slide 8



The use of water-based foam for the depopulation of poultry results in rapid euthanasia of the birds. As the foam surrounds and covers the birds, the foam obstructs the airway of the birds, creating an atmosphere devoid of oxygen. The carbon dioxide gas causes a rapid loss of consciousness, breathing and heart activity.
The foam must be of appropriate consistency and density to ensure the process is rapid to prevent the birds from experiencing unnecessary stress during euthanasia. Carbon dioxide gas is heavier than air and will sink to the bottom of the room making it convenient to use for floor-reared situations.

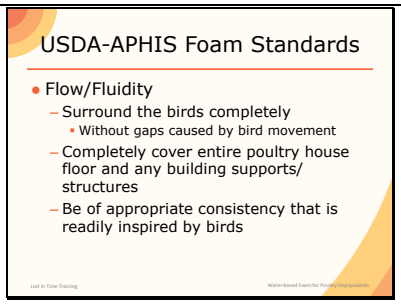
[Photo: Water-based foam being spread into a poultry house with adequate flow and depth. *Source: Dan Wilson, North Carolina Department of Agriculture*]

Slide 9



The *USDA APHIS Performance Standards for the Use of Water-based Foam as a Method of Mass Depopulation of Domestic Poultry* outlines guidance, criteria and conditions for use, including foam parameters (e.g., foam size, expansion ratio, depth, efficacy). The following slides discuss these performance standards provided by USDA-APHIS for the use of water based foam for the depopulation of floor-reared poultry.

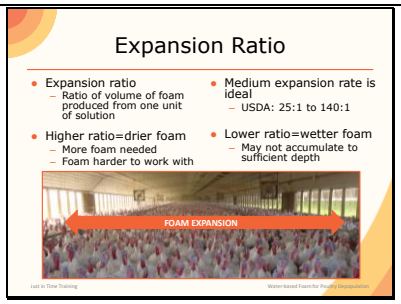
Slide 10



Flow of the foam is important to consider since it regulates how far the foam can spread of expand within the poultry house as well as within the trachea of the bird to cause euthanasia. The foam should be able to expand to cover the birds as well as reach all areas of the poultry house that birds could be hiding in. Foam that is not able to flow to all corners of the poultry house may not be able to euthanize all the birds. The water-based foam must be fluid enough to meet the following conditions:

- Surround the birds completely without gaps in the foam (e.g., caused by bird movement)
- Completely cover the entire poultry house floor and any building supports or structures
- Be of appropriate consistency that is readily inspired by birds.

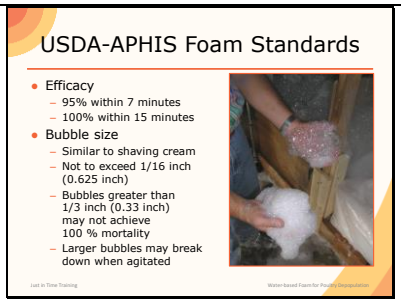
Slide 11



Fluidity of the foam includes the expansion ratio and the moisture contents. The expansion ratio is the volume of foam produced from one unit of water/foam solution. A medium expansion rate is ideal. USDA guidance recommends an expansion ratio of 25:1 to 140:1. As the expansion ratio increases, the foam becomes more dry – ultimately requiring more foam to be made. Below 35:1 may not be able to accumulate to sufficient depth to cover birds.

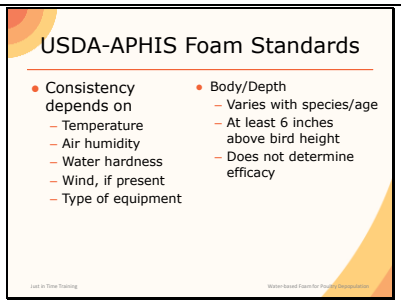
[Photo: Floor-reared turkeys. Source: Iowa State University]

Slide 12



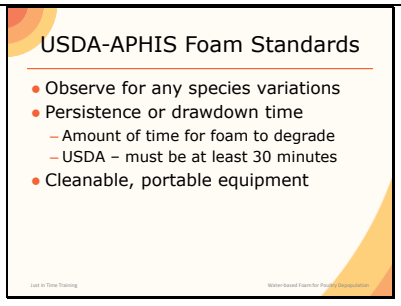
The overall characteristics used for foam application must have an efficacy of 75% mortality after 7 minutes or less, and 100% mortality within 15 minutes of dispersal. Bubble size should not exceed 1/16 inch (0.625 inch). Bubble sizes greater than 0.33 inches may not achieve 100% mortality of some types of poultry. Large bubbles can break down when agitated by bird movement (e.g., flapping wings). Smaller bubbles euthanize birds faster with less break down. The desired bubble size should resemble that of shaving cream. This photo shows examples of different foam consistencies. The top shows a higher expansion, dry foam. The bottom a lower expansion, wet foam. Photo source: Eric Benson, University of Delaware. Basics of Foam at http://udel.edu/~ebenson/PDF/Depopulation/Depopulation_Part_III.pdf.

Slide 13



- The consistency of the foam depends on a variety of factors, including temperature, air humidity, water hardness and wind (if present). Additionally, the type of equipment (e.g., proportioner, nucleation screen) will affect the foam consistency.
- The depth of the foam required will vary depending on the species and age of birds being depopulated. Older turkeys will need more foam than young broiler chicks. The body or consistency of the foam should be adequate to cover all birds by at least 6 inches over the height of the birds. In the case of full grown turkeys, this may require depths of at least 54 inches. However, depth of the foam does not solely determine the efficacy, the density and flow of the foam should also be considered.

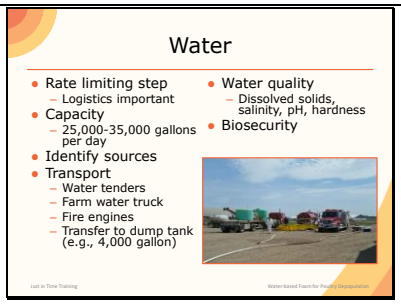
Slide 14



Additional criteria for the foam used include the following criteria:

- The use of foam for the depopulation of species for which no data is available, should involve close observation in case inappropriate reactions occur, additionally termination times may vary compared to chickens or turkeys.
- The foam persistence or drawdown time – the amount of time for foam to degrade – must be at least 30 minutes.
- All equipment used for the foaming procedure must be cleaned and disinfected after use as well as portable to take to multiple buildings for depopulation if necessary.

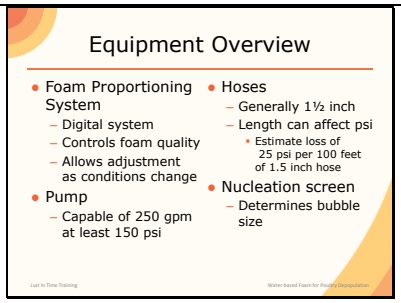
Slide 15



Water is an essential and the rate limiting step. Depending on type and number of birds and the size of the facility, as much as 25,000 to 35,000 gallons per day may be required. Sources of water should be identified prior to the depopulation process, and in some cases water may need to be hauled to the site; this should be determined prior to initiating the depopulation process. Water logistics can be a determining factor in constant foam production. Additionally, water should be transported close to foam generation site – this may involve the need and use of water transport vehicles. Water quality is equally important and can affect the characteristics of the foam generated. Parameters such as dissolved solids, salinity, pH, or water hardness may require larger amounts of foam concentrate to obtain the needed foam quality. Throughout the entire depopulation, including water transport, close attention must be paid to biosecurity measures to avoid further spread of the disease between locations or sites on a premises.

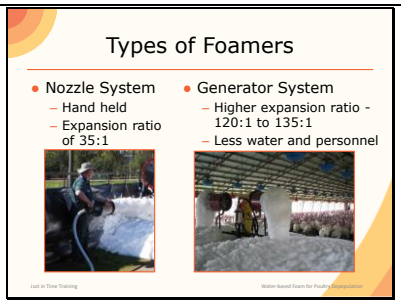
[Photo: Various water hauling vehicles. Photo source: Dustin Oedekoven, South Dakota Animal Industry Board]

Slide 16



As previously mentioned, foam is generated by specially designed equipment that mixes the components in a controlled and accurate manner. In some cases a foam proportioning system may be used. This is a digital system to control foam quality and allow for setting adjustment as conditions change. Generally a pump capable of 250 gpm at least 150 psi will be needed to propel the solution. The foam solution is transferred via hoses - generally a 1.5 inch in size. Be aware the length of the hose can affect the psi; estimate approximately 25 psi will be lost per 100 feet of 1.5 inch hose. A nucleation screen is used at the end of the hose to generate the desired bubble size. The hole size and configuration of the nucleation screen influences the bubble size. The smaller the screen, the smaller the bubbles. Resources for equipment may include the existing fire service in the area, or industry owned response teams.

Slide 17



Foam delivery is generally by one of two methods: a hand held nozzle system or a generator system on a cart.
The nozzle system generally has a lower expansion ratio, but is good for small or odd shaped facilities. The generator system has a higher expansion ratio and requires less water and personnel.

[Photo (left) Hand held nozzle system. Source: Lyndon Badco, Washington State Department of Agriuclture]
[Photo (right) Generator type foamer. Source: U.S. Department of Agriculture]

Slide 18

FOAM DEPOPULATION PROCESS

Let's look at the basic process for depopulation using water-based foam. Specific requirements will be determined by the equipment used, type of facility, and other factors previously discussed.

Slide 19

Before Beginning

- Trained personnel to properly run equipment
- Water supply/sources
- Condense large areas
  - Construct walls to help obtain/maintain height
    - Plywood and 2x6s
    - Seal seams with duct tape
  - Do not overcrowd

Before beginning the procedure, personnel trained to properly run the foam equipment should be identified, as should sources of water. For large facilities, the construction of plywood panels may be useful to condense the area the birds occupy; thereby reducing the amount of foam needed; it can also help to obtain and maintain the necessary foam height needed. If these are used, ensure seams are sealed to avoid foam loss between the cracks. Additionally, avoid overcrowding the birds into too small of a space.

[Photo: Example of plywood wall setup. Photo source: Dustin Oedekoven, South Dakota Animal Industry Board]

Slide 20

Foam Generator Placement

- Place generator at one end of facility
- Connect to hose/pulley at other end

Once setup is complete, the foam generator should be placed at the back end of the facility. It is connected by a hose at the front end of the facility, that is attached to an pulley system to retract and pulls the foam generator from one end of the facility to the other. In the case of a nozzle system, a trained operator would hold the nozzle, but proceed in a similar manner (back to front). Regardless of which foam generator is used, trained personnel should implement the procedure or be on site to advise. Inadequately trained personnel operating the foam generator may use the equipment improperly and may cause undue stress on the birds.

[Photo: A foam generator. Source: U.S. Department of Agriculture]

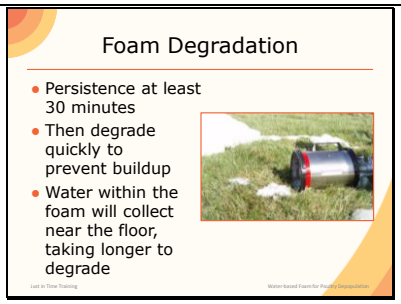
Slide 21

Foam Generator Operation

- Generator pumps foam and retracts hose as it travels across the house
- Experienced personnel
  - Equipment operator: Outside
  - Pump operator: Inside
- Maintain constant foam production

Once the foam generator is properly hooked up, begin to pump the foam mixture and retract the hose as it travels across the poultry house. There should be at least two experienced people operating the foam generator; one to run the equipment outside of the poultry house and one to run the pump generator inside the poultry house. During the process, it is essential to maintain constant foam production to ensure complete coverage. Avoid stopping to refill water tanks.

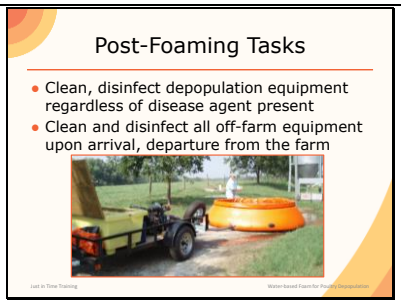
Slide 22



Once the foam has covered all of the birds, USDA does require the foam to persist at least 30 minutes to ensure euthanasia has been successful. After this time, the foam will need to degrade on its own within the poultry house. Water within the foam will follow gravity and be closer to the floor of the house, so the wettest foam will collect on the floor and take a longer time to degrade.

[Photo: Water-based foam degrading in a grassy area as part of a field demonstration of foam depopulation in poultry housing. *Source: Dan Wilson, North Carolina Department of Agriculture*]

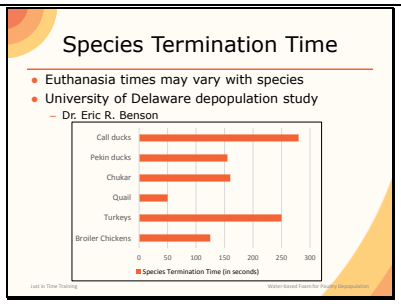
Slide 23



Once the depopulation process has been completed, the equipment should be cleaned and disinfected after use and prior to moving to a new location to prevent the spread of any disease organisms to other farms.

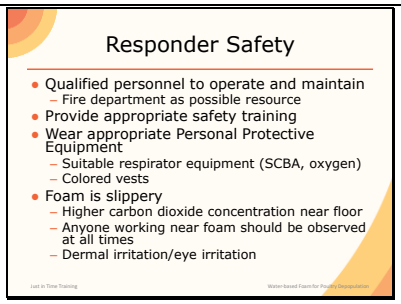
[Photo: All equipment and vehicles used for foam depopulation must be cleaned and disinfected upon arrival and departure from the facility. *Source: Dan Wilson, North Carolina Department of Agriculture*]

Slide 24



Euthanasia times may vary depending on the bird species. Current data on the use of water-based foam for waterfowl or other bird species (e.g., quail) is limited. Additionally there may be variations within a particular species (e.g., chickens, turkeys). This table shows the termination times (in seconds) for various avian species that were euthanized using carbon dioxide foam in a study by Dr. Eric Benson from the University of Delaware http://udel.edu/~ebenson/PDF/Depopulation/Depopulation_Part_V.pdf

Slide 25



As with any response task, responder safety is a key concern. Only qualified personnel should operate foam depopulation equipment; the local fire department may be a possible resource for foam expertise. Personnel must be provided with appropriate safety training and wear appropriate PPE, including respirators. This may include having a self-contained breathing apparatus and oxygen equipment available on site. Carbon dioxide gas can affect humans as well as birds. As previously mentioned, carbon dioxide is heavier than air and will accumulate in higher concentrations near the floor. Should personnel slip under the foam, they will be susceptible to the gas as well if proper respiratory protection is not worn. Foam can be slippery, therefore, any personnel inside the facility should be observed at all times in the case of slipping under the foam or succumbing to the carbon dioxide gas. Given that the foam and TyVek suits are both white in color, it may also be helpful to have personnel inside the facility some sort of colored personal protective equipment (e.g., vest) for better visualization. As with all chemicals, precautions should be taken to avoid splashes to the eyes and skin. Have eyewash equipment available onsite. If skin contact occurs, flush the area with clean water immediately.

Slide 26		In this presentation, we briefly overviewed the use of water-based foam for large scale depopulation of floor-reared poultry in emergency situations. For additional information on this topic, consult these additional resources.
Slide 27		Information provided in this presentation was developed by the Center for Food Security and Public Health at Iowa State University College of Veterinary Medicine, through funding from the Multi-State Partnership for Security in Agriculture.