Information on Cleaning and Disinfection

Overview

Cleaning and disinfection can involve the use of physical (e.g., heat) or chemical (e.g., disinfectant) processes. These processes vary in their level of destruction of infectious agents. Influenza virus is sensitive to a wide range of disinfectants and can also be inactivated by heating and drying. Organic material must be removed before chemical disinfection can be effective and the disinfectant must completely penetrate any porous material present or it will not reach the pathogens that may be present. A number of chemical disinfectants have been approved for use against avian influenza. Only EPA-registered or approved products should be used. EPA disinfectant products registered and labeled with a claim to inactivate **avian influenza A** viruses on hard, non-porous surfaces can be found at https://www.epa.gov/pesticide-registration/list-m-registered-antimicrobial-products-label-claims-avian-bird-flu.

Disinfectants can be used or applied in a variety of ways (e.g., spraying, foaming, misting, wiping, submersion). The preparation and application of disinfectant solutions must be in accordance with product label directions. Disinfectants should be used only as directed; appropriate controls, such as personal protective equipment, should be in place to minimize human exposure. Generally it is best to have clean surfaces dry before disinfectant application. The label also specifies the sites (e.g., poultry houses and farms) for application of the product. Fumigation may be used in some situations for items that cannot get wet (e.g., electronics).

Contact time is essential! Microorganisms are inactivated or killed by disinfection products gradually, not instantaneously. Allowing adequate contact time increases the efficacy of any disinfectant. Contact times may vary depending on the product or method used and the ambient temperature and should be specified on the label of the product selected. Areas being disinfected should remain wet with the disinfectant during the necessary contact time. Reapplication of the disinfectant solution may be necessary to achieve the indicated contact time found on the product label. Some disinfectants may evaporate quickly (e.g., alcohols), while others may have residual activity (e.g., phenols).

Factors Affecting Cleaning and Disinfection Efficacy

Debris and organic material (e.g., soil, bedding, litter, feed, manure) can also inactivate many disinfectants (especially chlorine and iodine containing compounds). Cleaning and disinfection procedures should be carried out in a systematic manner to ensure effective reduction, removal, inactivation and destruction of the virus. Removal of all organic material prior to application of a disinfectant is essential. In some cases of lightly soiled equipment, dry cleaning with compressed air or blowers may be preferable. Some disinfectants may have some efficacy or residual activity in the presence of small amounts of organic material (e.g., phenols) and should be considered in circumstances where complete removal of organic debris is difficult but the phenols still must penetrate any organic material present. However, application of these products to a heavy organic load (e.g., non-cleaned surfaces) will not likely be effective.

Additional factors affecting cleaning and disinfection efficacy should be considered:

- **Surface type:** Porous, uneven, cracked, or pitted surfaces, especially wooden surfaces and earthen floors, are difficult to disinfect. Some chemical disinfectants may also be incompatible with or corrosive to certain materials or surface types (e.g., metal, rubber, plastic). Due to the construction and presence of uneven surfaces on equipment, equipment cleaning and disinfection

procedures can be difficult. Heat may be a more effective method for inactivating the virus on these surfaces.

- **pH:** The activity of some disinfectants is also affected by pH because it changes the degree of ionization of a chemical disinfectant, thereby impacting efficacy. For example, the efficacy of phenols, acids, and hypochlorites are decreased as pH increases; in contrast, quaternary ammonium compounds have greatest efficacy as pH increases.
- **Water quality:** The water quality used when diluting and applying detergents and disinfectants is important. Water hardness can inactivate or reduce the effectiveness of certain disinfectants (e.g., quaternary ammonium compounds). Be sure to consider any standing water or other water sources (e.g., rainfall) present that may immediately dilute the disinfectant during application
- **Temperature:** Some disinfectants are less effective or ineffective at low temperatures (e.g., cold weather conditions). Additionally, disinfectant solutions may freeze outdoors under low temperature conditions. When possible, buildings and equipment should be heated to approximately 68^{o}F (20^{o}C) when applying disinfectants. Elevated temperatures can aid in microorganism destruction; however, higher temperatures can also accelerate decomposition or evaporation of a disinfectant, thereby reducing the necessary contact time and efficacy. Excessive heat may also damage items being disinfected.
- **Weather:** Inclement weather conditions (e.g., cold, rain, wind) may also make these procedures difficult.

Basic C&D Protocol

The basic C&D protocol, regardless of item involved, is as follows:

1. **Dry clean:** Remove any gross contamination and organic material.

2. **Wash and rinse:** Wash item with a detergent solution to further remove organic debris. Inspect for cleanliness and repeat wash procedure if not clean.

3. **Dry:** When possible complete drying of the items should occur before disinfectant application

4. **Disinfection application:** Apply an EPA-registered disinfectant. Follow the manufacturer directions for concentration and contact time of disinfectants. Ensure all areas are covered thoroughly with the solution and remain “wet” with the solution for the necessary contact time. Apply disinfectant a second time if necessary.

5. **Rinse and dry:** Rinse equipment thoroughly with clean, warm water. Thorough rinsing can be very important as some disinfectant solutions may cause damage to surfaces (e.g., deterioration of rubber or corrosion of metal parts), if not completely rinsed away. Allow items(s) to air-dry.

For all of the procedures above, ensure that run-off water is captured or denatured to prevent virus or chemical contamination of the environment.

Fresh solutions should be prepared prior to use; some disinfectant solutions may only be active for the same day of preparation. Failure to make fresh solutions may result in using a product that has reduced efficacy. Testing the disinfectant to determine if chemical degradation of the active ingredients has occurred and that diluted solutions contain the necessary amount of active ingredient may be helpful. Maintain an operating log, noting the temperature of wash and rinse waters, and detergent and sanitizer concentrations.

Consideration of Surfaces Being Disinfected

Metal surfaces (e.g., stainless steel, aluminum) are generally easier to disinfect than other materials, especially when the surfaces are smooth. However, some chemical disinfectants are incompatible or corrosive with metal surfaces (see table below). Flame guns or other thermal methods may be useful alternatives for some metal surfaces.

Chemical Disinfectant	Effect on metal surfaces
Sodium hydroxide	Corrosive to aluminum and derived alloys, and galvanized metal
Sodium carbonate	Corrosive to aluminum and derived alloys
Acids	Highly corrosive to metals
Glutaraldehyde, Virkon® S	Mildly corrosive to metals
Iodophors, hypochlorites, formaldehyde	Corrosive to some metals
Phenolics	Relatively non-corrosive

Rubber and plastics should be treated as hard, nonporous surfaces, however they may have interactions with some chemical disinfectant products (e.g., phenols, sodium hydroxide). Iodophors may cause staining of these materials and can be corrosive to some plastics or rubber. Alcohols can swell or harden rubber or certain plastic tubing after prolonged and repeated use. Excessive heating can melt most plastics.

Wood is extremely porous and therefore difficult to disinfect. Any decaying wood surface that cannot be disinfected should be removed, and disposed of appropriately (e.g., burn or burial). Wood surfaces should not be rinsed, soaked, or sprayed with plain water prior to washing or disinfectant application as this can cause unintended dilution; dry cleaning with appropriate downtime may be adequate and preferable. A disinfectant solution of a product registered for wood surfaces should be applied once gross organic debris has been removed.

Footwear disinfection procedures should follow basic C&D protocol when entering and exiting facilities. Remove organic matter (scrub brush); wash and rinse, or use dry disinfectants such as heat. Contact time with disinfectant solution is essential. Footwear disinfection stations should be set up at entry sites. Everyone is required to clean and disinfect their footwear or wear site-provided footwear or new footwear covers prior to entering production facilities, or processing areas. Wet footbaths must be changed at least daily or more often if the footbath collects dirt or manure and protected from the elements, freezing and dilution.

Minimizing Human Exposure

Most disinfectants can cause irritation to eyes, skin, and/or the respiratory tract; some may cause burns or other injury. The safety of all personnel must be paramount when handling, mixing, and applying chemical disinfectants. Appropriate PPE (e.g., gloves, goggles, masks) should be worn. It is essential that C&D personnel are trained on the proper mixing and application procedures as well as the hazards of the products they will be using. Always read the label for any safety concerns to people, animals, or the environment.

References:

- USDA APHIS. Foreign Animal Disease Preparedness and Response Plan Guidelines: Cleaning and Disinfection. 2014 Jul. Available at:

https://www.aphis.usda.gov/animal_health/emergency_management/downloads/nahems_guidelines/cleaning_disfection.pdf

- Secure Egg Supply (SES) Plan. Supplement 2: Cleaning and Disinfection Guidelines. 2013 Aug. Available at: http://secureeggsupply.com/wp-content/uploads/SES_Plan_Suppl2_CD_Guidelines2.pdf
- Maillard JY. Factors affecting the activities of microbicides. In: Fraise AP, Maillard JY, Sattar SA, eds. Russell, Hugo & Ayliffe's Principles and Pratice of Disinfection, Preservation and Sterlization, 5th edition. West Sussex, Wiley-Blackwell. p. 71–86.
- Amass SF, Ragland D, Spicer P. Evaluation of the efficacy of a peroxygen compound, Virkon® S, as a boot bath disinfectant. J Swine Health Prod. 2001;9(3):121–123.
- Amass SF, Vyerberg BD, Ragland D, et al. Evaluating the efficacy of boot baths in biosecurity protocols. J Swine Health Prod. 2000;8(4):169–173.

Setting up and Operating a Cleaning and Disinfection (C&D) Station

Effective disinfection of equipment and vehicles requires thorough cleaning, application of an effective disinfectant, maintaining appropriate temperature (consider ambient temperature), and time for the disinfectant to work (consult disinfectant labels to determine the contact time necessary for virus elimination/inactivation).

Establish the C&D Station

Cleaning and disinfection procedures for vehicles entering the PBA should mitigate the potential risk of bringing a virus onto the farm, and may be similar to the following:

- **Soak** the most visibly contaminated areas to aid in washing removing organic materials on tires, wheel wells, undercarriage, mud flaps, splash guards, and steps.
- **Wash**, wipe, spray or scrub the areas with excess organic matter starting with the dirtiest and working towards the cleaner areas.
    - Pressure washers can enhance organic matter removal.
    - Ensure that the spray and wash water run-off from the vehicle does not reach poultry holding/housing areas as AI virus in organic matter could result in animal exposure.
- **Rinse** and remove all detergent/soap residues by applying a low pressure water rinse on all surfaces, starting with the top of the vehicle and working down.
- **Read** the product label on the disinfectant and handle the solution correctly to ensure safety of the handler and effectiveness of the disinfectant. Personal protective equipment may be needed to mix up and apply solutions.
    - Note the recommended dilutions, water temperature, environmental temperature, and the need for ventilation when using the product.
- **Disinfect** by applying the product to the cleaned areas of the vehicle, starting with the tires to maximize contact time before moving.
    - The vehicle can be slowly rolled forward to allow the disinfectant to contact all parts of the tires.
    - Ensure that the product has adequate wet contact time (per label directions) with all surfaces to inactivate the virus. Solution must remain ‘wet’ to actively work; reapplication may be necessary.

An example SOP is below for wearing protective gear, inspecting, cleaning and disinfecting vehicles. Modify to meet your specific site needs.

Setting up the C&D Station (2+ personnel required)

1. Set up C&D station outside or adjacent to PBA. Maintain C&D station free of dirt, manure and other contaminants. Ensure the C&D station is not adjacent to poultry housing.
2. Provide and properly maintain vegetative filter area around C&D station for wash water runoff. Manage runoff so that is does not enter animal housing, drive paths, flowing streams, ditches or other avenues that leave the site. Follow state or local regulations regarding management of effluent.
3. Make sure the following supplies are available and can last four days minimum, stored out of the elements, and refilled when low
    a. Rubber gloves (2 pair for each person, each washing)

    b. Waterproof outerwear covering street clothing, skin, head, neck (2 sets in sizes …)
    c. Safety glasses or goggles (2 pairs)
    d. Protective footwear (in sizes: _____) that remain at the C&D station
    e. Plastic garbage bags for disposal of gloves
    f. NAME OF DISINFECTANT: _____
    g. Water (60 gallons per vehicle)
    h. Pressure washer
    i. Fuel or power source for pressure washer
    j. Long handle brush (2)
    k. Timer for disinfectant contact times
    l. Vehicle log sheet with pens
4. Maintain a supply inventory log and written plan for restocking supplies, including names, addresses and other contact information for suppliers and the means by which supplies are delivered to the company or transporter/driver in a timely manner
5. Mix the (NAME OF DISINFECTANT: _____) solution fresh daily. (Example: Citric acid disinfectant 3% solution is 13 pounds of 99% food grade anhydrous powder to 50 gallons of water). Mix thoroughly.
    a. Wear protective gear when mixing up solution. Read label to see if there are other personal protections you need to take with this disinfectant.
    b. Do NOT mix or use any other disinfectant with bleach or chlorinated products
6. Maintain a Vehicle C&D log. It is recommended that the log is available for review by Responsible Regulatory Officials if requested.

Putting on (Donning) Protective Gear at C&D Station

1. Select the appropriate personal protective equipment (PPE) for the given disinfectant (consult the label for more information).
2. Inspect all protective gear for damage or contamination; do not use unless intact and clean.
3. Consider safety and efficacy of disinfectant during inclement weather
    a. Protect susceptible disinfectants from sunny or hot conditions
    b. Shield personnel from blowing disinfectant during windy weather.

Inspecting and Cleaning Vehicles

1. Wash down the wash pad surface to remove mud/manure before vehicle enters
    a. Monitor wash effluent to ensure it enters a vegetative area or other contained location and does not cross the pavement
    b. If crosses, build a berm to hold it within the wash area
2. Guide vehicle to concrete wash pad
3. Driver remains in vehicle
4. Record vehicle entry details on log sheet
    a. Origin of vehicle, driver name, contact number, vehicle identification, previous and next stop (name and location)
5. Walk around and visually inspect the exterior of vehicle for contamination, focusing on the tires, wheel wells, undercarriage, mud flaps, splash guards and steps
6. If exterior is visibly contaminated, soak the dirty areas with water and soap
    a. Have driver move vehicle forward slightly to ensure tire contact surface is cleaned
    b. Scrub heavily soiled areas
7. Pressure wash off the soap and visible contamination
8. Rinse with low pressure water working from the top of the contaminated area down

Disinfecting Vehicles

1. Apply the (NAME OF NONCORROSIVE DISINFECTANT: _____) to the cleaned areas of the vehicle, starting with the tires to maximize contact time before moving
    a. Have driver move vehicle forward slightly to ensure disinfectant contact with the entire tire surface
2. Allow the (NAME OF NONCORROSIVE DISINFECTANT: _____) to contact the surfaces for _____ minutes (start time upon first application) to inactivate the virus
    a. Solution must remain 'wet' to actively work; reapplication may be necessary
3. Wash down drive path area where wash water/run off traveled
4. Apply (NAME OF NONCORROSIVE DISINFECTANT: _____) solution to drive path where wash water/run off traveled and allow _____ minutes of wet contact time
5. Allow vehicle to enter site; ensuring gate is closed after vehicle has entered.

Removing (Doffing) Protective Gear at C&D Station

1. Water rinse off protective gear from top to bottom to remove any potential contamination from outerwear, gloves, and footwear
2. Remove personal protective equipment (PPE); PPE should be removed in the following order (if present): face shield, gloves, protective outerwear, and protective footwear. Store reusable items in a protected location near the C&D station to be worn upon next vehicle C&D, or dispose of items in a garbage bag.
3. Put on clean protective site-dedicated footwear before leaving C&D station, at the Biosecure Entry Procedure
4. Remove all disposable PPE and dispose of properly

Vehicles Exiting Site

1. Proceed to exit, wait for individuals working on the site to open gate, and leave site
2. Individuals working on the site will close gate upon vehicle exit and record departure information on Vehicle, Equipment Entry Log

Example* C&D Station Supply Inventory Log

Minimum 4 day supply, maintain in good condition, inventory every 6 months

Farm Name: _____ Farm PremID (PIN): _____
Address: _____ Contact Name: _____ Phone: _____

Supplies	**Inventory Date**	**Current Amount/ Sizes**	**Supply Order Invoice #**	**Purchased From**	**Additional Info (make, model#)**	**Initials**
Rubber Gloves						
Waterproof outerwear						
Safety glasses/ goggles/ face shields						
Protective footwear						
Water storage						
Pressure washer & fuel/propane						
Timer						
Waste Receptacle						
Long handle brush						
Disinfectant						
Light source with power cord						
Signage						
Barrier Gate(s)						

*Note that this form is just an example and may not necessarily meet the requirements of the Responsible Regulatory Official or the needs of the producer.

Using Heat Treatment to Disinfect Poultry Houses

Heat treatment for disinfection of poultry houses is an effective method for elimination of pathogens, including high pathogenicity avian influenza virus. Any method selected should consider specific characteristics of the premises/houses and other factors which may impact the effectiveness of disinfection; heat treatment may not be appropriate in all situations. Some factors to consider include weather, temperature, relative humidity, UV light, remaining organic material, pathogen strain, and type of surface material (wood, concrete, etc.). For more information considering surfaces being disinfected, see Appendix J. Equipment damage or degradation (e.g., lubricants, hydraulic fluids, oil) can occur. Extremely hot and cold temperatures can also crack or damage electronic components.

Dry cleaning must be completed prior to disinfection (whether heat treatment or chemical). This includes removal of gross contamination and organic material. Heat can be applied under moist (e.g., steam) or dry (e.g., baking) conditions. When heat treatment is used for disinfection, temperature monitoring is required. Thermometers should be placed in each barn or house; at least one at each end and one in the center; more are recommended for larger facilities. Thermometers should be checked for accuracy before being placed in poultry houses during heat treatment. Placement of thermometers should be at 4-6 feet high for turkeys and at cage level for layers. Do not place sensors near or on an individual heat source. In addition, temperature logs should be maintained indicating the temperature of the house at regular intervals (recommend 2-4 times daily). Documentation should indicate that the barns/houses are reaching and maintaining appropriate temperatures.

Most vegetative bacteria are inactivated at moist-heat temperatures of 131-149°F (55-65°C). Many viruses are labile at temperatures close to 158°F (70°C). Several research studies have evaluated the effect of heat on the avian influenza virus. AI viruses can be harbored in both wet and dry feces for extended periods of time. Virus elimination of HPAI in poultry houses may be achieved by heating the house to 110-120°F for 7 days, with at least 3 consecutive days continuously maintaining a temperature within this range. The following table is adapted from the USDA document, “Using Heat Treatment for Virus Elimination”, available at: https://www.aphis.usda.gov/animal_health/emergency_management/downloads/hpai/heattreatment.pdf; this document includes additional materials and persistence at lower temperatures.

Material	Temperature (°F)	Duration
Liquid feces[a]	68	7 days
	77-89.6	4 days
Dry feces[a]	N/A	14 days
Wet and dry feces[b]	107.6	18 hours
Dried egg white[c]	152.6	20 hours
	129.9	21.4 days
Feathers[d]	68	15 days
Soil[e]	41	365 days
	71.6	49 days
Surfaces (e.g., steel, tiles, tire, plastic, etc.) [e]	N/A	3 days

References:

[a] World Organization for Animal Health (OIE), 2009, OIE Technical Disease Card.

[b] Baleshwari Kurmi et al., 2013. "Survivability of High pathogenicity Avian Influenza H5N1 Virus in Poultry Faeces at Different Temperatures." Indian J. Virol. 24(2):272-277. DOI 10.1007/s13337-013-0135-2.

[c] OIE, 2014, Terrestrial Animal Health Code. Chapter 10.4: Infection with Avian Influenza Viruses.e USDA, 2015. "Reduction of Infectious HPAI in Animal Agricultural Settings."

[d] USDA, 2015. "Reduction of Infectious HPAI in Animal Agricultural Settings." https://www.aphis.usda.gov/animal_health/downloads/animal_diseases/ai/hpai-reduction-of-infectious.pdf.

[e] M. Ellin Doyle et al., 2007. "Destruction of H5N1 Avian Influenza Virus in Meat and Poultry Products." UW-FRI Briefings. https://fri.wisc.edu/files/Briefs_File/FRI_Brief_H5N1_Avian_Influenza_8_07.pdf.

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