United States Department of Agriculture

FY2016 HPAI Response

Using Heat Treatment for Virus Elimination

February 19, 2016

BACKGROUND

Traditionally, cleaning with subsequent application of wet disinfectant has been used to eliminate highly pathogenic avian influenza (HPAI) virus on Infected Premises. However, dry cleaning and heating of houses (also called heat treatment) is now an accepted method of disinfection/virus elimination where feasible. Heat treatment is not a "new" approach, but it has re-emerged as a tested, cost-effective option.[1]

Any disinfectant method(s) selected should consider the characteristics of the premises/houses and other factors which may impact the effectiveness of the virus elimination activities. Heat treatment may not be appropriate in all situations. The cleaning and disinfection options selected and implemented *must* be included as part of the approved cleaning and disinfection plan and approved by State Animal Health Officials and APHIS.

DRY CLEANING

Before the virus elimination/disinfection step, an Infected Premises must undergo dry cleaning. Dry cleaning must be conducted prior to heat treatment or other disinfection options. For more information, see *Cleaning and Disinfection Basics*.

By definition, dry cleaning involves the removal of any gross contamination and organic material (e.g., soil, manure, bedding, feed, eggs, feathers) from all production areas and equipment. Shovels, manure forks, brooms, and brushes should be used to sweep, scrape, and remove organic material and debris from surfaces.

While the removal of all organic material is ideal, this may not be a realistic objective for every Infected Premises. The following steps provide general guidance for dry cleaning; if there are any questions regarding dry cleaning of premises, please contact Incident Command for further guidance.

1. Minimize remaining organic material; in most cases the original surface should be visible on floors, walls, and fans (e.g., wood or metal)
2. No more than 0.25 inches of organic material should be present on any given surface that will come into contact with poultry when restocking occurs.
3. No more than 0.25 to 0.5 inches of organic material should be present on any surface that is *not* accessible to restocked poultry.
4. Priority is to ensure all wet organic material is dry or removed. This is likely to be the most recent deposits to the site and thus, the most likely to have infectious material.
5. Ensure all remaining organic material dries; i.e., if weather has made material damp or wet, allow to dry naturally or remove. Drying is an effective way to destroy/eliminate the virus.
6. The primary disposal method for poultry litter on the floor or ground is composting, with landfill, burial, or other options.
7. For situations with stored manure or manure pits, State and APHIS officials will make a disposal determination with the Incident Management Team.

[1] Heat treatment was presented as an option for inactivating AI viruses in 1986; Halvorson, David A. "Avian Influenza-A Minnesota Cooperative Control Program." *Proceedings of the Second International Symposium on Avian Influenza, Georgia Center for Continuing Education, University of Georgia, Athens, Georgia. Sept 3–5, 1986.* Symposium on Avian Influenza, US Animal Health Association.

Once dry cleaning is complete and the facility has been inspected and approved, as needed, disinfection can be performed by heat treatment of the barns/houses. This procedure involves whole house heating, carefully balancing time, temperature, and environmental factors that may impact virus elimination.

HEAT TREATMENT

Heating barns/houses that have been dry cleaned is often the most efficient way to disinfect poultry houses and destroy/eliminate HPAI virus. Current policy guidance (provided in *Cleaning and Disinfection Basics*) states that barns/houses must be heated to between 100°F and 120°F for a total of 7 days; with at least 3 *consecutive* days (of the 7 days) of heating continuously to within this temperature range. USDA APHIS does not suggest that all methods of disinfection are equivalent in terms of destroying or eliminating living organisms; however, the scientific evidence at this time demonstrates that heat treatment is effective at eliminating HPAI virus. To-date, application of heat treatment following this guidance has successfully eliminated HPAI virus. If new scientific information becomes available, this guidance may be adapted. Temperatures should generally not exceed 120°F to avoid damage to fixtures and structures.

100-120°F for a Total of 7 days

- At least 3 consecutive days of drying and heating must be at this specified temperature (maintaining a temperature within this range).

Examples of Heat Treatment

In the first example, the premises is able to keep the barn at the specified temperature (between 100°F and 120°F) for seven straight days. This fulfills the requirement for a total of 7 days at temperature as well as 3 consecutive days at temperature:

Example 1. Successful Heat Treatment

Heat Treatment Begins
- Day 1 – 100°F
- Day 2 – 100°F
- Day 3 – 110°F
- Day 4 – 105°F
- Day 5 – 110°F
- Day 6 – 115°F
- Day 7 – 115°F

Heat Treatment Ends

In the second example, the premises experiences a severe cold wave at the same time as a heater breakdown. This premises is able to repair the heater quickly, but the barn temperature slips below 100°F for 2 days. In this case, the premises must heat the barn for a longer period to fulfill the requirement of 7 total days at temperature and 3 consecutive days at temperature.

However, the premises can count that first day at temperature towards the 7 total day requirement.

Example 2. Successful Heat Treatment

Heat Treatment Begins
- Day 1 – 100°F
- Day 2 – 95°F
- Day 3 – 95°F
- Day 4 – 100°F
- Day 5 – 110°F
- Day 6 – 115°F
- Day 7 – 110°F
- Day 8 – 105°F
- Day 9 – 100°F

Heat Treatment Ends

If a premises cannot meet the 7 day total requirement (between 100 and 120°F) in addition to the 3 consecutive day requirement at temperature for an extended period of time (greater than 2 weeks or as recommended by Incident Command), the premises may need to consider an alternative means of disinfection, in discussion with State and APHIS officials.

Use & Positioning of Sensors/Thermometers

When heat treatment is used for virus elimination, temperature monitoring is required. At a minimum, there should be three thermometers placed in each barn (at each end and in the center). Additional sensors, particularly in larger facilities, are recommended. Preferably, sensors should transmit the temperature remotely and continuously to ease the burden of monitoring. In all cases, sensors/thermometers should be checked and in good working order prior to use. In turkey houses, sensors should be placed between 4 and 6 feet high. In layer houses, sensors should be placed at the cage level. To avoid an artificially high temperature reading, do not place sensors near or directly on an individual heat source.

Documentation

If heat treatment is used for virus elimination, it is critical to document the barns/houses reaching and maintaining appropriate temperatures. Incident Command can provide logs for documentation; records should indicate the temperature of the house at least two to four times per day for the seven day period. These logs should be uploaded in the Emergency Management Response System (EMRS).

Environmental Sampling

In addition to cleaning and disinfection steps, including heat treatment, environmental sampling is conducted at the completion of virus elimination activities. Taking environmental samples and testing them for HPAI provides additional confidence that virus elimination activities have been successful. Please see *Post C&D Sampling Guide* for more information.

EVIDENCE SUPPORTING THE USE OF HEAT TREATMENT

It is well established that HPAI viruses can survive in cool and moist conditions, particularly when organic material is present.[2] The World Organization for Animal Health (OIE)[3] along with other research[4] has demonstrated that avian influenza (AI) viruses can live for extended periods in water, liquid feces, and in soil at ambient temperatures (see Table 1). In particular, evidence suggests that both dry and wet feces can harbor the virus for extended periods of time. One study of H5N1 suggested that virus can remain infectious in both wet and dry feces for 18 hours, even when the temperature is raised to 107.6°F.[5]

Conversely, in the absence of moisture and at high temperatures, AI viruses can be quickly inactivated. At 107.6°F, the virus was inactivated in both wet and dry feces after 24 hours; at 98.6°F, virus was no longer infectious after 30 hours. HPAI virus also does not survive extended periods of time on surfaces that are not contaminated with organic matter.

For heat treatment to be an effective virus elimination step, it remains critical to ensure 1) organic material is removed as prescribed above and 2) barns are heated to the recommended time and temperature, with adequate monitoring and documentation. Heat treatment is a valuable and cost effective option to eliminate virus from Infected Premises. [6]

Where Heat Treatment is Not Effective

As also seen in Table 1, heat treatment is not effective at deactivating HPAI virus in dried egg white, even at extremely high temperatures.[7] Evidence from the 2014–2015 HPAI outbreak confirms that HPAI viruses can live for extended periods in the presence of dried egg white/albumen, including on egg belts or elsewhere that this material may be found (e.g., on the floor underneath an egg belt).

For egg belts, two options are available: (1) the egg belt can be removed, disinfected with an approved disinfectant, dried, and that belt may be replaced or (2) the egg belt can be disposed of, through approved mechanisms, and replaced with a new egg belt. The most cost effective option should be implemented.

It is critical that where dried egg white (egg albumen) is present, these areas are disinfected with an approved disinfectant (if heat treatment is applied to the rest of the premises). In some cases, it may be necessary to consider other methods of disinfection for the entire barn/house.

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[2] David E. Swayne, 2008. "Epidemiology of Avian Influenza in Agricultural and Other Man-Made Systems," in David E Swayne, ed., Avian Influenza. Ames, IA: Blackwell Publishing.

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

[4] 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.

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

[6] Heat treatment has been used effectively to eliminate other diseases, such as infectious laryngotracheitis in broiler houses, demonstrating some industry knowledge and familiarity with this approach: see Giambrone, J.J. et al., 2008. "Management Practices to Reduce Infectious Laryngotracheitis Virus in Poultry Littler." J. Appl. Poult. Res. 17:64–68.

[7] For more information, also see Swayne, D.E. & Beck, J.R. 2004. "Heat inactivation of avian influenza and Newcastle disease viruses in egg products." *Avian Pathology.* 33(5):512-518. DOI 10.1080/03079450400003692.

Table 1. Avian Influenza Viral Persistence

Material/Substance	Temperature (°F)	Duration (Days unless otherwise noted)
Water[a]	82.4	26-30
	62.6	94-158
Liquid Feces[a]	39.2	30-35
	68.0	7
	77.0-89.6[b]	4
Dry Feces[a]	N/A	14
Wet & Dry Feces[d]	107.6	18 hours
Dried Egg White[f]	152.6	20 hours
	129.9	513 hours (21.4 days)
Feathers[e]	68.0	15
Culture Media[c]	Room Temp.	15
	Refrigeration Temp.	243
Soil[c]	41.0	365
	71.6	49
Surfaces (e.g., steel, tiles, tire, plastic, etc.)[c]	N/A	3

[a] World Organization for Animal Health (OIE), 2009, OIE Technical Disease Card.
[b] These temperatures were taken in the shade.
[c] 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.
[d] Baleshwari Kurmi et al., 2013. "Survivability of Highly Pathogenic Avian Influenza H5N1 Virus in Poultry Faeces at Different Temperatures." Indian J. Virol. 24(2):272-277. DOI 10.1007/s13337-013-0135-2.
[e] 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.
[f] OIE, 2014, Terrestrial Animal Health Code. Chapter 10.4: Infection with Avian Influenza Viruses.

Other Factors Affecting Virus Elimination

Many factors impact the survivability of HPAI viruses. Changing any one factor may influence the virus's ability to survive in the environment. These factors include:

- Relative Humidity
- Weather
- Type of Surface Material (e.g. wood, concrete, etc.)
- pH
- Salinity
- Time
- Temperature
- Light (UV)
- Virus Strain
- Matrix (the makeup of any remaining organic material).

The current policy guidance for heat treatment (between 100°F and 120°F for 7 days; with at least 3 consecutive days continuously maintaining a temperature in this range) takes into account that many of these factors are difficult or impossible to control. In the future, there may be additional recommendations reflecting the role that these factors can play in the effectiveness of virus elimination activities.