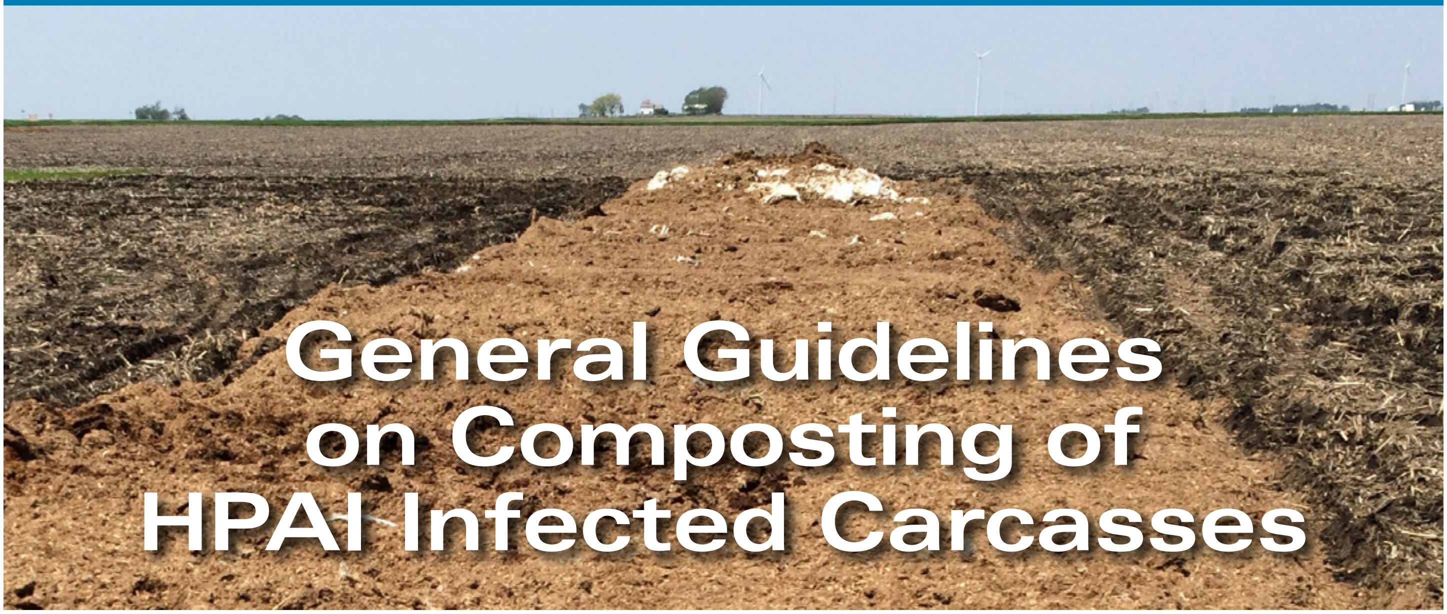

General Guidelines on Composting of HPAI Infected Carcasses

Containment of highly pathogenic avian influenza (HPAI) is a critical step which must be properly performed to ensure human and animal safety. The intent is to deactivate and eliminate the active virus thus inhibiting the probability of its further transmission. For future outbreaks of HPAI, the priority of U.S. Department of Agriculture (USDA) and Iowa Department of Agriculture and Land Stewardship (IDALS) will be to utilize on-farm mortality disposal options such as aerobic composting and/or burial. Aerobic composting, a heat producing microbial process, is a USDA-approved method which can attain and maintain temperatures needed for deactivation of the avian influenza virus in turkey and chicken carcasses.

This publication provides general guidelines for on-site aerobic composting of HPAI infected carcasses in terms of preparedness, preparation of materials for composting, potential carbon sources, amounts and volumes of carbon sources, location, equipment and building piles, monitoring and turning, finished materials, record keeping, personal protective equipment, and contact information for additional assistance.

Preparedness

Containment of avian influenza virus and its deactivation requires a rapid response once it is detected and confirmed at a turkey or chicken farm following depopulation of the birds involved. To be prepared, facility operators must take into consideration materials, space, labor, equipment, and supplies needed to place the birds into compost piles once the depopulation is complete. All depopulated carcasses, litter, egg shells, feed, bedding, paper, and other biodegradable materials in the building and on the premises should be composted. Composting of these materials will require additional carbon materials which should be pre-planned for access and availability. The preferred choice is to construct compost piles within the building space; however, outdoor construction on a well-drained site may be needed when building conditions do not allow for indoor construction. Pay loaders or skid loaders, which can easily maneuver in the building space, should be planned for use in the operation by skilled operators. Unskilled operation of such equipment can result in damage to facilities in addition to improper pile construction. Scoops, rakes, dump trucks to move materials, and flat-bed trailers to import baled carbon sources such as corn stover, should also be planned for use in this composting process. Pile monitoring will require temperature probes which have stems that are at least four feet long. Moving and spreading composted materials to the field will require dump trucks, loaders, and spreaders which need to be planned for as well. Regularly employed labor can be trained, based on skills, to perform several of the composting tasks. Plans should be reviewed with compost experts who are familiar with USDA, IDALS, and Iowa Department of Natural Resources (DNR) requirements for composting of HPAI infected carcasses. Contact information for ISU Extension and Outreach agricultural engineers who can provide guidance can be found at the end of this document.

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Preparation of materials for composting

Using a pay loader or skid loader, all depopulated carcasses should be moved toward either side of the building, clearing an aisle in the middle for equipment movement. All on-site materials, including litter, broken eggs, contaminated feed, bedding, paper, and other biodegradable materials should be distributed equally among the carcasses as they are being moved. Additional carbon sources, as needed, should be distributed equally during the carcass moving-compost pile forming process. These carbon sources should be materials such as corn stover, wood chips, fermented or partially composted materials, or other carbon sources which are sturdy enough to hold the structure of the pile and will not collapse in a couple of weeks after composting begins. Using the proper materials will allow for appropriate aeration of the windrow core (Figure 1) once the materials are placed into composting. Fine carbon sources such as sawdust, seed shells and nut hulls, fine wood shavings, etc., can be added to compensate for the amount of carbon needed to balance the materials for appropriate composting. All on-site contaminated and the additional carbon materials should be mixed with the depopulated carcasses as uniformly as possible as the carcasses are being moved to clear space for compost piles. This will help to equally distribute the materials and eliminate the need for formal mixing, which should not be performed to avoid any further aerial transmission of the virus. To keep the virus contained within the carcasses, caution should be used to not drive over dead birds. In cases where the carcasses are immediately placed into composting, no additional water for balancing the moisture may be needed. Once the space has been cleared for constructing composting piles, a 10 to 24 inch deep base of sturdy carbon material which acts as a plenum for air movement should first be formed. After the plenum has been constructed, the combined materials should then be placed on top of the plenum in layers, if possible, with 4 to 6 inches of carbon material in between each layer. When the combined materials have been placed on the plenum, an 8 to 24 inch layer of carbon material should be added as a cover to complete the pile/windrow construction.

Carbon sources

One of the easily usable, carbon sources available in Iowa is corn stover. In addition to corn stover, mulch, tree bark, shredded wood without nails, straw, and wood shavings can also be used based on availability. For the best results, carbon materials should be between 0.5 to 2 inches, with the majority of particle size being between 1 to 2 inches. Material larger than 2 inches should be avoided because the compost mixture would become too porous and be unable to maintain the desired temperature. Fine carbon sources, such as seed shells, nut hauls, sawdust, and fine ground wood shavings (Figure 1) are not suitable for building the plenum or the cover, although they can be used as a part of the compost mixture to make up for any deficiency in the amount of carbon needed. Caution should be used to make sure appropriately sized carbon material is used to ensure air movement in the mixture

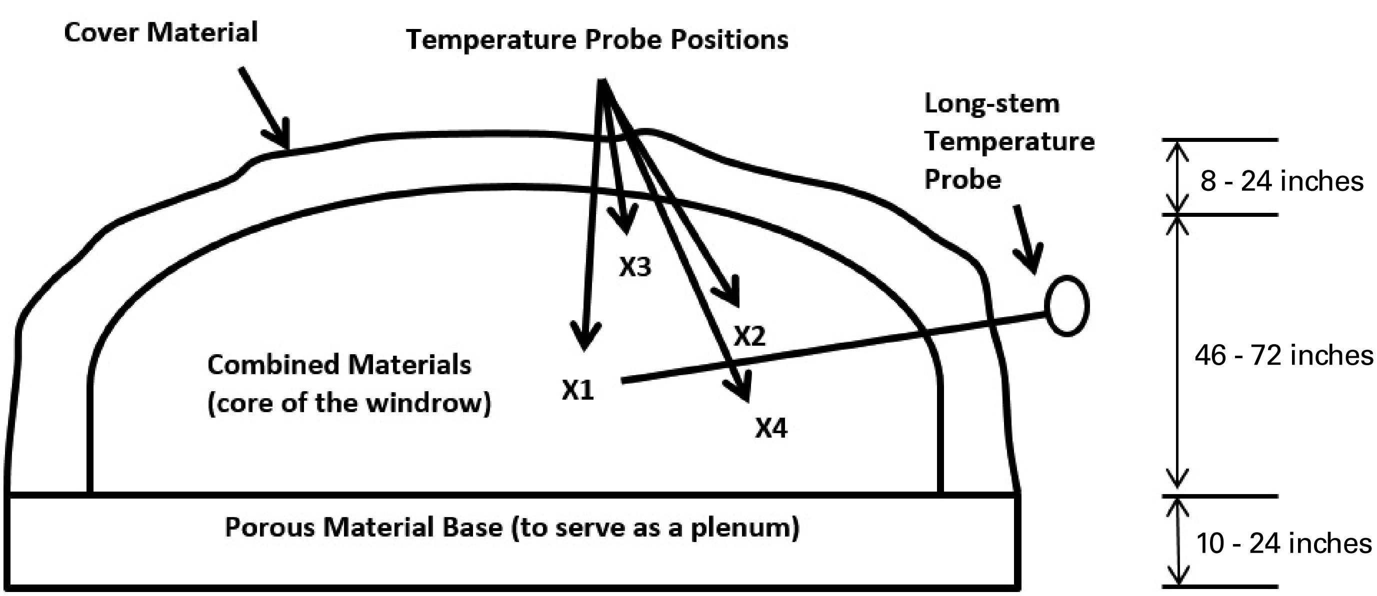

Figure 1. A typical cross-sectional schematic of a constructed windrow (not to scale). Combined materials (core of the windrow), if possible, can be formed by alternate layers of carcasses and carbon materials (4-6 inches of carbon materials per layer of poultry carcasses).

Table 1. Requirement of carbon material volume for the base and the cover for three different base widths.		
Base width, ft.	Base volume per 10 ft. length, cubic yards	Cover volume per 10 ft. length, cubic yards
10	5.6	5.4
12	6.7	5.9
15	8.3	6.7

and that the pile maintains it structural integrity. Carbon sources to be used for construction of the plenum and the cover should not be stored on-site to avoid any potential contamination at onset of any outbreak.

Amount and volume of carbon sources

The porous base on which the combined materials are to be placed for composting should be approximately 12 to 15 feet wide. Narrower bases can also be constructed when dealing with lesser total amount of combined materials. Table 1 shows the volume of an 18-inch deep base with 10, 12, and 15 feet widths. Calculations shown are for every 10-foot length for the respective width of the base, along with the respective cover volume for the configuration shown in Figure 1. Cover, typically 12 inches deep, should be placed on the top the windrow, such that the resulting total windrow height does not exceed 8 feet. Cover material can be the same material as used in the base or different material depending upon availability. Volume of litter added to the core material should be subtracted from the total volume of carbon material needed for adding to the combination of materials. Total volume of carbon material, with an estimated bulk density of 30 pounds per cubic foot, can be calculated based on the USDA recommendations which state that 2 cubic feet is needed for every 40 pounds of bird weight or 1 cubic foot is needed for every 20 pounds of bird weight (USDA, 2015). After an estimation of the additional volume of carbon material needed has been made, the bulk densities listed in Table 2 can be used to estimate the tons of material needed to be transported to the site.

Location

It is preferred that the composting of depopulated birds take place inside the building where they were being raised. In cases where the building structure has limited space for windrow formation and equipment maneuvering, construction of the windrows should occur outside, which is generally the case with layer houses. In these cases, the windrows should be constructed on-site of the production facilities. The outdoor sites should be well drained and able to handle equipment traffic. The site should also be evaluated for suitability to ensure that any free liquid does not pose a threat to groundwater, odors do not create site issues, and flies and other vectors do not create nuisance issues. Special precautions should be taken to adequately cover the windrows so that scavengers cannot drag carcasses out of the windrows. In cases where scavengers are prevalent, it may be necessary to double the thickness of the windrow cover to a minimum of 24 inches. Separation distances, according to Iowa DNR requirements, to water sources, wells, wetlands, property lines, and residences should also be maintained. Windrows should not be constructed in grassed waterways, flood plains, or in locations where water presence is imminent.

Equipment and building piles

Operators should not drive over the base material once it is laid down. To avoid compaction, the combination of

Table 2. Estimated characteristics of selected materials available in Iowa needed for calculating required volumes of different materials.					
Materials	Type of value	% N (dry weight)	C:N ratio (weight to weight)	% Moisture content (wet weight)	Bulk density (lbs per cubic yard)
Corn cobs	Average	0.6	98	15	557
Corn stover	Average	0.6	80	20	120
Turkey litter	Average	2.6	16	26	783
Broiler litter	Average	2.7	14	37	864
Laying Hen Manure	Average	8.0	6	69	1,479
Corn silage	Typical	1.2-1.4	38-43	65-6	-
Straw-general	Agerage	0.7	80	12	227
Sawdust	Average	0.24	442	39	410
Wood chips	Average	0.24	442	42	676
Source: NRAES 54 – On-farm Composting Handbook and ISU Extension and Outreach, and Anderson et al. (2016)					

materials consisting of the carcasses should be placed on the base from either side. All eggs should be broken and added to the combination of materials for microbial access, whereas the carcasses should not be driven upon causing further damage. Precautions should be taken not to overfill the loader bucket to avoid carcasses rolling off and requiring additional handling.

When placing the combined materials on the base, attempts should be made to distribute the materials over the base in a single layer approximately 12 to 15 inches thick (Figure 2). Any exposed carcasses should then be covered with 4 to 6 inches of carbon material, if possible, before starting the next layer as previously indicated. This process increases the total carbon material needed on-site for pile construction. Worksheet 1 shows example calculations for the total amount of bulking material needed for composting a 10,000-head turkey barn, a 30,000-head broiler building, and a 100,000 laying hen facility. The same calculations can be repeated for any specific type of animal using information provided in Table 1 and Table 2. It is recommended that the same dedicated equipment be used until all windrows have been constructed. When complete, the equipment can then be sanitized according to protocols for other on-farm use.

Figure 2. Combined materials being placed with a front-end loader and a telehandler from either side of the base without driving over it.

Monitoring and turning

Constructed windrows should be divided into five sections when the windrows are shorter than 200 feet. If the windrow is longer than 200 feet, it should be divided into 50 foot sections. Temperature measurements should be taken at a minimum of one location per section. Flags should be placed at each measurement location for easier identification. At each flagged location, the temperature reading should be taken at four positions (X1, X2, X3, and X4) as shown in Figure 1. These four positions should be one-fourth of the depth into the pile near the bottom, mid and top of the pile height, and one-half of the depth into the pile at the middle height. Stainless steel temperature probes with a 4 foot or longer stem should be purchased and used to reach into the core of the windrow to obtain accurate readings. Multiple probes should be purchased and one probe should be stored at each premise.

To capture a reading, the temperature probe should be inserted into the windrow without climbing on the side to avoid carcass exposure. For best results, the temperature probe should be left in position for a minimum of 60 seconds to allow the temperature reading to stabilize. Measurements exceeding the minimum temperature requirements can be recorded without waiting for the temperature reading to fully stabilize to minimize the time spent inside the building. After each use, the temperature probes should be disinfected and safely stored on the premise.

To meet the requirements, the windrow should reach a temperature of over 100°F (38°C) within 72 hours of construction. After the first 72 hours, the windrow should maintain a temperature of over 131°F (55°C) for three consecutive days, and should maintain a temperature of over 100°F for 14 consecutive days. To ensure consistency in reporting, temperatures should be taken daily at the same four locations by the same individual during the first 14 days of composting.

After the windrows have maintained temperatures of over 131°F for three consecutive days to ensure virus kill, the temperature measurement positions can be reduced to two positions (X1 and X2) to save time. If any of these conditions are not met, a compost expert should be consulted immediately.

To be safe, building fans should be turned on or the doors and curtains opened to allow for adequate air exchange. A minimum ventilation rate of 5 to 10 air changes per hour, as done when raising the birds during cold weather, should be considered for ventilation. This is to ensure that the gaseous levels for carbon dioxide (CO_2) and ammonia (NH_3), below the permissible exposure limits for human health, are achieved. It is advisable for the operator to wear a protective mask with ammonia-filtration cartridges during the first few days of composting when inside the building taking temperature measurements. A second person should keep watch, staying outside the building, to ensure safety of the person performing the work inside.

Windrow turning should take place only after the temperature profiles previously indicated have been met. Once constructed, the windrows should not be turned in the first 14-day time period. After 14 days, turn the windrows to fluff up any slumped material, break up any stagnant air pockets, remove preferential air flow paths, and aerate the material by using loaders, turners, and/or a combination of similar equipment. Turning will cause the cover material to mix with the rest of the compost materials. If the soft tissue is exposed after turning, an additional 6 or more inches of cover material should be applied on top of the turned windrow.

After the turning has been completed, the windrows should be monitored for temperatures for a second 14-day time period. During this second time period, the windrows should maintain an internal temperature of over 100°F. If, during the initial or the second, 14-day time period, the temperatures fall below 100°F and/or if the windrows get excessively hot with temperatures over 160°F (71°C) for three consecutive days, a compost expert should be consulted. After the temperature requirements have been met for the initial 14-day and the second 14-day time period, consult the authorized representative for release of the windrow(s) in terms of monitoring requirements, moving materials off-site, and other cleanup operations. If all soft tissue, feathers, and majority of bones have not fully composted, additional composting may be needed. This process may take one to two additional months to complete depending upon weather conditions.

Finished materials

A publication by North Carolina State University (NCSU) on mortality composting provides an average analysis for the turkey carcass compost. This average is most likely to be achieved if excessive carbon materials are not used in windrow building. For example, Iowa State staff took samples of the finished materials and analyzed for nutrients. Percent differences between the average sample results and values from the NCSU publication are provided in Table 3. The nutrient contents of the Iowa State samples are lower due to the excessive use of wood chips as a carbon source. Given how the nutrient content in the actual composted material can vastly differ from the published values, it is necessary for producers to test their finished compost. Finished materials should be land applied based on the calculated application rates of a nutrient and/or manure management plan. If any stockpiling of finished materials occurs during land application, it should be done in accordance with Iowa DNR and IDALS requirements.

Record keeping

Record keeping is required for all premises that have tested positive for HPAI. Records include dates activities took place, volumes by each material, estimated sizes of windrows, carbon sources and amounts used, daily temperature logs, turning records, stockpiling, and final spreading of the finished materials.

Personal protective equipment (PPE)

Ventilation should be minimized once the building is confirmed positive for avian influenza and mass depopulation has been achieved to reduce the risk of disease transmission. Further work in the building to transfer all potentially infected materials, moving birds out of cages, housing equipment, loose cords, cables, taking temperatures, and related tasks requires personnel to wear personal protective equipment. Operators and workers at the livestock operation should work with their family physician, local hospital, or medical clinics that offer OSHA fit testing to ensure they meet the health requirements to wear the appropriate masks needed during the cleanup work.

Table 3. Average sampled and book values of nutrient content of the finished materials.

Analytic	KK1	KK2	KK3	KK4	KK5	KK6	Average	NCSU Value	Percent difference
Moisture %	39.10	36.68	34.88	46.34	26.15	22.92	34.35	40	14
Nitrogen %	1.57	1.03	2.44	2.04	2.02	1.85	1.83	3.6	49
Phosphorus (P_2O_5), %	1.26	0.36	1.71	1.68	1.38	1.61	1.33	1.4	5
Potash (K_2O), %	1.29	0.95	1.57	1.56	1.18	1.5	1.34	1.7	21

Source Andersen et al. (2016)

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Information contained in this document is subject to change as situations develop and additional experience is gained in HPAI-infected carcasses aerobic composting.

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Photo Credit

Iowa Turkey Federation.

Worksheet 1

Procedure for estimation of the amount of bulking agent needed to be obtained and brought to the site for composting HPAI Infected Birds. Caution should be used when using this worksheet due to changes in moisture content and bulk densities of materials listed in Table 2.

Step #	Description				
1	Animal type of the species housed	Toms	Broilers	Laying Hens	Any Barn
2	Number of birds in the barn	10,000	30,000	100,000	
3	Estimated average body weight per bird at depopulation, pounds	30	6	3.3	
4	Estimated total body weight depopulated, pounds (multiply Step 2 by number of birds in the barn)	300,000	180,000	330,000	
5	Volume of bulking material needed, cubic yards (divide Step 4 by 20 and then divide by 27)	556	334	612	
6	Volume of litter in the building needing to be incorporated assuming manure storage is one-third full or about 10 tons per 1,000 toms or 3.33 tons per 1,000 broilers or 3.33 tons per 1,000 laying hens (Use bulk density from Table 2) (litter weight times litter bulk density times number of birds/1000), cubic yards	255	231	451	
7	Volume of bulking material needed corrected for litter, cubic yards (subtract Step 6 from Step 5)	301	103	161	
8	Assuming corn stover is used as bulking agent, tons needed (Step 7 times bulk density from Table 2 divide by 2000)	19	7	10	
9	Volume of the mixed core, cubic yards (divide the added weights in pounds of Step 7, Step 6, and Step 4 by estimated mixed bulk density of 800 pounds per cubic yard)	673	493	1,217	
10	Volume of the mixed core, cubic feet (multiply Step 9 by 27)	18,171	13,311	34,317	
11	Length of the mixed core placed in 10 feet wide by 5.5 feet high (Divide Step 10 by 3 and then by the windrow width and then by windrow corrected height and multiply by 2) **NOTE:** An 8 foot high windrow with 18-inch base and 12-inch cover will only have 5.5 feet height of the mixed material without any additional bulking material added in-between layers)	496	364	936	
12	Amount of base material needed for 18-inch thick base, cubic yards (Divide Step 11 by 10 and multiply by the corresponding number from Table 1)	278	204	524	
13	Amount of cover material needed for 12-inch thick cover, cubic yards (Divide Step 11 by 10 and multiply by the corresponding number from Table 1)	268	197	505	
14	Amount of cover material needed for a second 6-inch layer on top of first layer of core material, cubic yards (Divide Step 12 by 3 for toms as there will only be one layer of cover needed; divide Step 12 by 3 and then multiply by 2 for broilers and laying hens as there will be two layers of cover needed by reaching the 5.5 height)	89	136	349	
15	Amount of cover material needed for a second 6-inch cover after turning at the end of 28-days, cubic yards (Only if needed, divide Step 13 by 2)	134	98	253	
16	Total bulking material needed, cubic yards (Add Steps 7, 12, 13, 14, and 15)	1,069	737	1,793	

Worksheet 2

Temperature log for different windrows for four temperature logging positions of X1, X2, X3, and X4 as shown in Figure 1. Note that the temperatures measurement positions can be reduced to two positions (X1 and X2) to save time after the windrows have maintained temperatures of over 131°F for three consecutive days to ensure virus kill.

	Windrow #______ Positions				Windrow #______Positions				Windrow #______Positions			
Day	**X1**	**X2**	**X3**	**X4**	**X1**	**X2**	**X3**	**X4**	**X1**	**X2**	**X3**	**X4**
1												
2												
3												
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