



NAHEMS GUIDELINES: DISPOSAL

FAD PReP

Foreign Animal Disease
Preparedness & Response Plan

NAHEMS

National Animal Health
Emergency Management System



United States Department of Agriculture • Animal and Plant Health Inspection Service • Veterinary Services

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The Foreign Animal Disease Preparedness and Response Plan (FAD PReP)/National Animal Health Emergency Management System (NAHEMS) Guidelines provide a framework for use in dealing with an animal health emergency in the United States.

This FAD PReP/NAHEMS Guidelines was produced by the Center for Food Security and Public Health, Iowa State University of Science and Technology, College of Veterinary Medicine, in collaboration with the U.S. Department of Agriculture Animal and Plant Health Inspection Service through a cooperative agreement.

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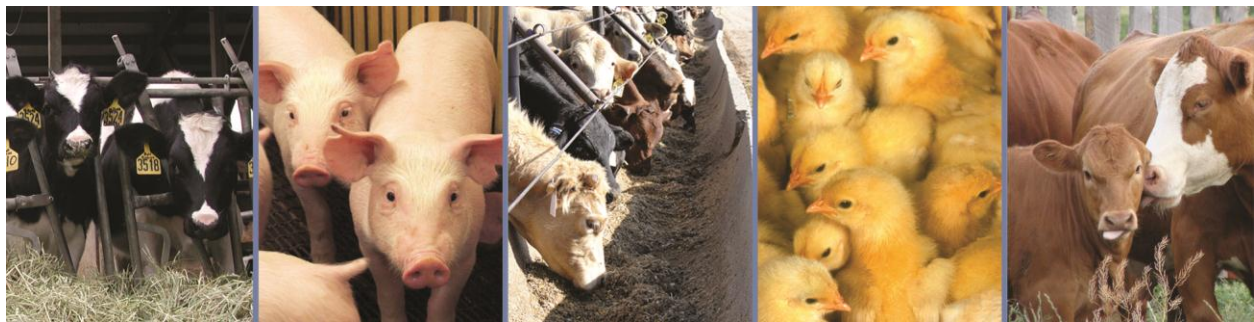
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THE IMPERATIVE FOR FOREIGN ANIMAL DISEASE PREPAREDNESS AND RESPONSE

Why Foreign Animal Diseases Matter

Preparing for and responding to foreign animal diseases (FADs), like highly pathogenic avian influenza (HPAI) and foot-and-mouth disease (FMD), are critical measures to safeguard our nation's animal health, public health, and food supply.

There are significant potential consequences of an FAD outbreak in the United States. In addition to the economic impact, the social and psychological impact on both producers and consumers could be severe. The FMD outbreak in the United Kingdom had an estimated impact of between \$12–18 billion. Studies have estimated a likely national welfare loss between \$2.3–69 billion¹ for an FMD outbreak in California, depending on delay in diagnosing the disease.²



Challenges of Responding to an FAD Event

An FAD outbreak will be challenging for all stakeholders. For example, there will be disruptions to interstate commerce and international trade. Response activities are complex, and significant planning and preparation must be conducted before an outbreak. Outbreaks can become large and widespread. Large, geographically dispersed and diverse teams will need to be assembled rapidly and must react quickly. The response effort must have the capability to be rapidly scaled up, involving many times more resources, personnel, and countermeasures. As such, responding to an FAD—large or small—may be a very complex and difficult effort.

Lessons Learned from Past FAD Outbreaks

Past outbreaks both in the United States and in other countries offer important lessons that can be applied to preparedness and response efforts. To achieve successful outcomes in future FAD response, it is vital to identify, understand, and apply these lessons learned:

- Provide a unified State-Federal-Tribal-industry planning process that respects local knowledge.
- Ensure the unified command sets clearly defined and obtainable goals.
- Have a unified command that acts with speed and certainty to achieve united goals.
- Employ science-based and risk-management approaches that protect public health and animal health, stabilize animal agriculture, the food supply, and the economy.
- Ensure guidelines, strategies, and procedures are communicated and understood by responders and stakeholders.

¹ Carpenter TE, O'Brien JM, Hagerman AD, & McCarl BA. 2011. "Epidemic and economic impacts of delayed detection of foot-and-mouth disease: a case study of a simulated outbreak in California." *J Vet Diagn Invest.* 23:26-33.

² Estimates based on models may vary: Ekboir (1999) estimated a loss of between \$8.5 and \$13.5 billion for an FMD outbreak in California. Ekboir JM. 1999. "Potential Impact of Foot-and-Mouth Disease in California: the Role and Contribution of Animal Health Surveillance and Monitoring Services." *Agricultural Issues Center.* University of California, Davis.

- Acknowledge that high expectations for timely and successful outcomes require the:
 - Rapid scale-up of resources and trained personnel for veterinary activities and countermeasures, and
 - Capability to quickly address competing interests before or during an outbreak.
- Rapid detection and FAD tracing is essential for the efficient and timely control of FAD outbreaks.

FAD PReP Mission and Goals

The significant threat and potential consequences of FADs, and the challenges of and lessons learned of effective and rapid FAD response have led to the development of the Foreign Animal Disease Preparedness and Response Plan, also known as “FAD PReP.” The mission of FAD PReP is to raise awareness, expectations, and develop capabilities surrounding FAD preparedness and response. The goal of FAD PReP is to integrate, synchronize, and de-conflict preparedness and response capabilities as much as possible before an outbreak, by providing goals, guidelines, strategies, and procedures that are clear, comprehensive, easily readable, easily updated, and that comply with the National Incident Management System.

In the event of an FAD outbreak, the three key response goals are to: (1) *detect, control, and contain the FAD in animals as quickly as possible*; (2) *eradicate the FAD using strategies that seek to stabilize animal agriculture, the food supply, the economy, and protect public health*; and (3) *provide science- and risk-based approaches and systems to facilitate continuity of business for non-infected animals and non-contaminated animal products*. Achieving these three goals will allow individual livestock facilities, States, Tribes, regions, and industries to resume normal production as quickly as possible. They will also allow the United States to regain FAD-free status without the response effort causing more disruption and damage than the disease outbreak itself.

FAD PReP Documents and Materials

FAD PReP is not just one, standalone FAD plan. Instead, it is a comprehensive US preparedness and response strategy for FAD threats. This strategy is provided and explained in a series of different types of integrated documents, as illustrated and described below.

FAD PReP Suite of Documents and Materials



Note: APHIS = Animal and Plant Health Inspection Service, NAHEMS = National Animal Health Emergency Management System, SOP = standard operating procedures.

- Strategic Plans—Concept of Operations
 - *APHIS Foreign Animal Disease Framework: Roles and Coordination*: This document provides an overall concept of operations for FAD preparedness and response for APHIS, explaining the framework of existing approaches, systems, and relationships.
 - *APHIS Foreign Animal Disease Framework: Response Strategies and Activities*: This document provides significant detail on response strategies and activities that will be conducted in an FAD outbreak.
 - *National Center for Animal Health Emergency Management (NCAHEM) Stakeholder Coordination and Collaboration Resource Guide*: This guide describes key stakeholders with whom NCAHEM collaborates.
 - *NCAHEM Incident Coordination Group Plan*: This document explains how APHIS headquarters will organize in the event of an animal health emergency.
- NAHEMS Guidelines
 - These documents describe many of the critical preparedness and response activities, and can be considered as a competent veterinary authority for responders, planners, and policy-makers.
- Industry Manuals
 - These manuals describe the complexity of industry to emergency planners and responders and provide industry a window into emergency response.
- Disease Response Plans
 - Response plans are intended to provide disease-specific information about response strategies. These documents offer guidance to all stakeholders on capabilities and critical activities that would be required to respond to an FAD outbreak.
- Critical Activity Standard Operating Procedures (SOPs)
 - For planners and responders, these SOPs provide details for conducting 23 critical activities such as disposal, depopulation, cleaning and disinfection, and biosecurity that are essential to effective preparedness and response to an FAD outbreak. These SOPs provide operational details that are not discussed in depth in strategy documents or disease-specific response plans.
- Continuity of Business (commodity specific plans developed by public-private-academic partnerships)
 - *Secure Egg Supply (SES) Plan*: The SES Plan uses proactive risk assessments, surveillance, biosecurity, and other requirements to facilitate the market continuity and movement of eggs and egg products during an HPAI outbreak.
 - *Secure Milk Supply (SMS) Plan*: Currently under development, the SMS Plan will help facilitate market continuity for milk and milk products during an FMD outbreak. This Plan also will employ proactive risk assessments.
 - *Secure Pork Supply (SPS) Plan*: Currently under development, the SPS Plan will help facilitate market continuity for pork and pork products during an FMD, classical swine fever, swine vesicular disease, or African swine fever outbreak.
 - *Secure Turkey Supply (STS) Plan*: Currently under development, the STS Plan will help facilitate market continuity for the turkey sector during an HPAI outbreak.
- Outbreak Response Tools
 - Case definitions, appraisal and compensation guidelines and formulas, and specific surveillance guidance are examples of important outbreak response tools.
- State/Tribal Planning
 - State and Tribal planning is essential for an effective FAD response. These plans are tailored to the particular requirements and environments of the State or Tribal area, taking into account animal populations, industry, and population needs.

- Industry, Academic, and Extension Planning
 - Industry, academia, and extension stakeholder planning is critical and essential: emergency management is not just a Federal or State activity.
- APHIS Emergency Management
 - APHIS directives and Veterinary Services Memorandums provide critical emergency management policy. APHIS Emergency Management documents provide guidance on topics ranging from emergency mobilization, to the steps in investigating a potential FAD, to protecting personnel from HPAI.

These documents are available on the FAD PReP collaboration website: <https://fadprep.lmi.org>. For those with access to the APHIS intranet, they are available on the internal APHIS FAD PReP website: <http://inside.aphis.usda.gov/vs/em/fadprep.shtml>.

PREFACE

The Foreign Animal Disease Preparedness and Response Plan (FAD PReP)/National Animal Health Emergency Response System (NAHEMS) Guidelines provide the foundation for a coordinated national, regional, state and local response in an emergency. As such, they are meant to complement non-federal preparedness activities. These guidelines may be integrated into the preparedness plans of other federal agencies, state and local agencies, tribal nations, and additional groups involved in animal health emergency management activities.

The Disposal Guidelines are a component of APHIS' FAD PReP/NAHEMS Guideline Series, and are designed for use by APHIS Veterinary Services (VS), and other official response personnel in the event of an animal health emergency, such as the natural occurrence or intentional introduction of a highly contagious foreign animal disease in the United States.

The Disposal Guidelines provide guidance for USDA employees, including National Animal Health Emergency Response Corps (NAHERC) members, on disposal principles for animal health emergency deployments. This Guideline provides information for Disposal Group Supervisors and other personnel associated with disposal activities involving animal carcasses and related materials. The general principles discussed in this document are intended to serve as a basis for making sound decisions regarding disposal. As always, it is important to evaluate each situation and adjust procedures to the risks present in the situation.

The FAD PReP/NAHEMS Guidelines are designed for use as a preparedness resource rather than as a comprehensive response document. For more detailed response information, consult the FAD PReP Standard Operating Procedures (SOP): 14. Disposal and plans developed specifically for the incident. Additional disposal resources are included in the references at the end of this document.

APHIS DOCUMENTS

This “FAD PReP/NAHEMS Guidelines: Disposal” has corresponding disease-specific FAD PReP Standard Operating Procedures (SOP): 14. Disposal.

Several key APHIS documents complement this “FAD PReP/NAHEMS Guidelines: Disposal” and provide further details when necessary. This document references the following APHIS documents:

- FAD PReP/NAHEMS Guidelines:
 - Health and Safety (2011)
 - Biosecurity (2011)
 - Mass Depopulation and Euthanasia (2011)
 - Cleaning and Disinfection (2011)
 - Personal Protective Equipment (2011)

- FAD PReP Standard Operating Procedures (SOP):
 - 8. Health and Safety/PPE
 - 9. Biosecurity
 - 13. Mass Depopulation and Euthanasia
 - 15. Cleaning and Disinfection

- Safety and Health Manual

Many of these documents are available on the FAD PReP collaboration website at: <https://fadprep.lmi.org>
Username and password can be requested.

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Guidelines: Disposal

1. INTRODUCTION

Preparing for and responding to foreign animal diseases (FADs), such as highly pathogenic avian influenza (HPAI) and foot-and-mouth disease (FMD), are critical measures to safeguard our nation's animal health, public health, and food supply. Effective disposal of animal carcasses and associated materials is a critical component of a successful response during an animal health emergency, such as a major disease outbreak or a foreign animal disease (FAD). During an FAD outbreak, disposal measures are implemented to prevent the introduction of or mitigate the spread of the pathogen through the elimination of infected, or potentially infected, animal carcasses and associated materials. Disposal also serves to remove potentially contaminated feed or food products from the animal feed and human food supply, protect the nation's agricultural and national economy, and also - if the disease is zoonotic, safeguard public health. In the event of an FAD outbreak, waste material such as animal carcasses will be produced if mass euthanasia and depopulation are chosen to mitigate disease. It is also likely that some animals would perish due to infection with the FAD and these would also require proper disposal. In addition to animal carcasses, related waste materials such as milk, feed materials or wool and hair will also need to be securely disposed of. This *FAD PReP/NAHEMS Guidelines: Disposal* provides guidance on choosing and using optimal disposal methods for a range of situations.

The overall goal of disposal operations during an animal health incident is to eliminate all animal carcasses and related material in a timely, safe, biosecure, aesthetically acceptable, and environmentally responsible manner.

Disposal has the following preparedness goals:

- Establish disposal protocols or procedures before an outbreak, for consistency and safeguarding, and to meet regulatory requirements.
- Identify suitable locations where disposal activities may be conducted.
- Identify suitable disposal personnel, supplies, materials, and equipment prior to the incident or FAD outbreak.
- Prevent the further spread of the disease agent, with little or no effect on the environment, considering community preferences, and conserving meat or animal protein if logistically supportable from a biosecurity viewpoint.

Disposal has the following response goal:

- Properly dispose of contaminated and potentially contaminated materials, including animal carcasses, as quickly as possible while maximizing pathogen containment, environmental sustainability, stakeholder acceptance, and cost effectiveness.

In discussing disposal activities during animal health emergencies, this Guidelines document focuses on evaluation of disposal options, selection of optimal disposal procedures, and disposal of associated miscellaneous materials. Additionally, this document focuses on essential areas such as the responsibilities of disposal personnel, disposal considerations, and disposal methods.

Qualified personnel must be proficient and knowledgeable in all aspects of potential disposal options. Decision makers must be comfortable choosing the quickest, safest, and most environmentally responsible disposal methods practicable given the circumstances. It is crucial that appropriate disposal decisions are made by these qualified personnel and that potential negative environmental and biosecurity risks associated with various disposal options are accounted for in the decision making and subsequent planning. Failure to properly account for important factors related to a disposal option can result in devastating environmental and biosecurity consequences. This document is designed for use not only during emergency situations but also in animal health emergency preparedness and response training programs. A brief overview of key elements of such programs is provided below.

In a large-scale FAD outbreak, an integrated response may include disposal, depopulation, vaccination, and decontamination and should be considered together. Cooperation and effective communication are essential in development and implementation of a cohesive response to an animal health event.

In addition to this Guideline, an associated document titled *FAD PReP Standard Operating Procedures: Disposal* has been prepared. The Standard Operating Procedures, or SOP, is written to accompany the Guidelines and provide critical tactical and operational information related to what is described in the Guidelines. This SOP provides specific direction for conducting disposal activities so that a consistent conformance to recommendations and expectations can be facilitated. It is expected that personnel participating in disposal-related activities in the context of an animal health emergency will have read and understood all sections in the SOP document that apply to them.

1.1 Emergency Response Training and Exercise

Well before an animal health emergency strikes, disposal personnel should use these Guidelines in emergency response exercises designed to help them expand their knowledge of animal health emergency management. Such sessions will help personnel test detailed response plans that have been developed for response to realistic emergency scenarios.



1.1.1 Development of Incident Specific Disposal Plans

A useful assignment challenges participants to use the Guidelines to create a detailed plan for the first 24 hours of an animal health emergency. Participants can use information in the Guidelines to answer questions such as:

- What actions will need to be taken immediately? If these actions are not taken, what consequences are likely?
- What relationships with other key personnel, including individuals in the emergency management community, should be in place prior to the emergency?
- To what degree will disposal of animal carcasses and associated materials disrupt the agricultural community? How can the effects of such disruptions be minimized?
- To what degree will disposal of animal carcasses and associated materials disrupt the community at large? How can the effects of such disruptions be minimized?
- What key information and resources (e.g., equipment and supplies) need to be readily available, and where and how will they be obtained, stored, and accessed?
- What obstacles may appear, and how will they be overcome?
- What conflicting pressures are likely, and how will they be balanced?

- If an initial plan fails, what are the elements of an effective alternative plan?
- How will psychological stressors associated with disposal activities be mitigated?

1.1.2 Evaluation

The evaluation phase of test exercises will provide participants with the opportunity to use these guidelines to (a) evaluate the strengths and weaknesses of their responses in the simulation exercises and (b) focus on ways to further enhance their strengths and improve their response capabilities in the event of an actual animal health emergency. The exercises also will underscore the need for participants to develop and maintain strong collaborative relationships with their counterparts in the emergency management.

1.2 Interagency Outreach

If the presence of an FAD or any other type of animal health emergency is detected in the United States, the appropriate local, State, Tribal, and Federal agencies and their partners in the private sector (e.g., industry and academia) must respond in a coordinated, mutually supportive manner to (a) determine the nature of the outbreak, (b) initiate an appropriate response, (c) eliminate or control the disease, and (d) facilitate recovery efforts (such as resumption of trade) while balancing environmental concerns surrounding various disposal options. When an outbreak involves an FAD, the State and the United States Department of Agriculture (USDA) are involved at the onset.

The FAD PReP/NAHEMS Guidelines are designed for use at any of three levels of response commensurate with the severity of the outbreak. In general, response levels include:

- *A local/limited response.* This level of response is managed locally, with response coordination provided primarily at the local levels and with State, regional, and/or Federal consultation and consequence management (e.g., trade issues).
- *A State/regional response.* A State/regional response is managed by the State/region, and industry officials—in some cases, with the involvement of the appropriate State emergency management agency as specified in State animal health emergency response plans. National-level crisis management, response coordination, consultation, and consequence management are required and will be provided by the Federal government.
- *A national response.* Although Federal agencies act as the lead, this level of response requires the combined efforts of local, State, industry, and Federal agricultural officials as well as nonagricultural personnel from Government (e.g., the Federal Emergency Management Agency (FEMA)) and the private sector in national-level crisis management, response coordination, consultation, and consequence management.

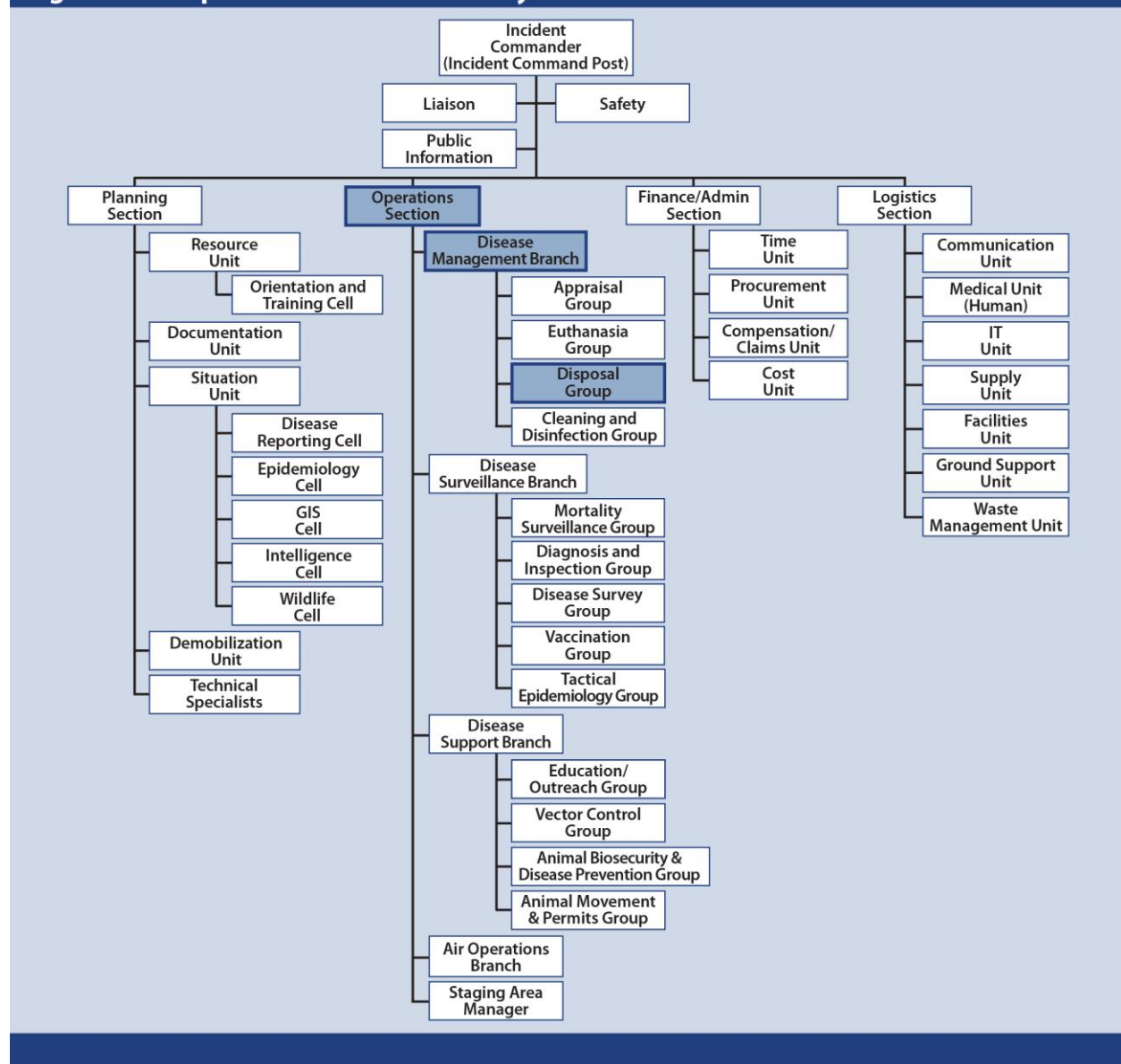
1.3 Consideration of Other Disposal Plans Already Developed

Response and recovery efforts are encouraged at the local level. In some cases, disposal plans may have been developed at a local, State, or regional level. In addition, some segments of the livestock industry have developed comprehensive disposal plans for a particular species or production type. It is also possible that memorandums of understanding (MOU) may already exist between potential disposal sites (such as fixed-facility incinerators or landfills) and industry (such as a cattle feedlot). Experts and planning officials in the community where disposal activities are planned should be consulted and, if a disposal plan exists, the plan should be thoroughly and thoughtfully considered. Every effort should be made to respectfully evaluate existing disposal plans in areas scheduled for disposal activities. If, due to costs, safety, environmental concerns, or other important considerations, the existing disposal plan is not feasible, then an alternative should be developed.

1.4 Incident Command System

Regardless of the size and scope of the incident, the agricultural community must be prepared to work closely with the emergency management community to deal with an animal health emergency. The Incident Command System (ICS) is used to efficiently manage people and resources during an incident such as an animal health emergency. The use of ICS as an emergency response approach has been adopted widely within the emergency management community. This publication refers to the titles of officials and groups in terms of the ICS model. The use of ICS terminology will promote the broadest possible application and implementation of this Guideline's content among the agricultural and emergency management communities. It is hoped that this approach will help the reader understand the essential aspects of animal emergency response activities within the context of this model. In the following example of an Incident Command System organizational structure the Disposal Group is a part of the Operations Section under the Disease Management Branch (Figure 1).

Figure 1. Sample Incident Command System



1.5 Examining State Regulations Regarding Disposal

Regulations often vary by State and region and significant regulatory differences may exist between locales. It is imperative that proper permitting and approval is obtained before disposal efforts commence. Communication and coordination with appropriate State and other officials occurs so that disposal activities are in compliance with applicable regulations. Planning and communication regarding appropriate permitting and approvals should begin prior to the detection of an outbreak. Contractors who participate in disposal activities are required to maintain compliance with all applicable permitting and approval processes *before* initiating disposal activities.

Permits for disposal related activities may be issued through various agencies for a multitude of purposes. Typically, permit requiring activities related to disposal include:

- Storage and transport of infectious material
- Operating a disposal facility
- Discharge permits required for releasing disinfectant solution and emitting air pollutants to the environment
- Approval to exercise the chosen disposal method such as mass-mortality burial
- Land use permits for burial
- Digging in an area where utilities may be present

1.6 Partnerships with Industry Stakeholders for Disposal Activities

Expertise in disposal may also be available within particular industries. For example, large poultry operations may have personnel trained in depopulation as well as disposal and may also possess associated specialized equipment. In some situations, industry stakeholders may be included in species-specific planning and assist in associated disposal activities. It is critical that participating personnel be trained in ICS to be successfully integrated into a response. In addition, involved industry stakeholders must embrace the importance of cooperation with other groups and units within and outside the ICS.

1.7 Collaboration with Federal Authorities

In addition to USDA, other Federal authorities may also provide input and expertise during an FAD response including:

- Department of Homeland Security (DHS)
- Department of Health and Human Services (HHS)
- Environmental Protection Agency (EPA)

Depending on the size and complexity of animal health incident, any or all of these agencies may collaborate and contribute to response efforts. Further information regarding specific responsibilities of agencies during a response is detailed in the *FAD PReP SOP: Disposal*.

1.8 Use of National Veterinary Stockpile Services

The National Veterinary Stockpile (NVS) program within the USDA APHIS VS National Center for Animal Health Emergency Management provides the veterinary countermeasures, such as animal vaccines, antivirals, or therapeutic products, supplies, equipment, and response support services that States, Tribes, and Territories need to respond to damaging animal disease outbreaks. The two goals of the program are to (1) deploy within 24 hours of approval countermeasures against the most damaging animal diseases, including highly pathogenic avian influenza, foot-and-mouth disease, exotic Newcastle

disease, and classical swine fever, and to (2) assist States, Tribes, and Territories plan, train, and exercise for the rapid request, receipt, processing, and distribution of NVS countermeasures during an event.

Countermeasures deployed by the NVS program include personal protective equipment, decontamination supplies, vaccines and vaccination ancillary equipment, animal handling and depopulation equipment. In addition to physical countermeasures, the NVS maintains contracts to support 3D response support services. 3D is the acronym for “depopulation, disposal, and decontamination” and represents activities commonly demanding rapid deployment of large numbers of response personnel and equipment. The 3D contractors are highly trained in emergency response, and are self-sufficient with their own equipment and supplies. Contractors can deploy within 24 hours and supply 500-600 people within 3 days and 1,000 people within a week. The NVS program serves as the single point of contact for 3D response support services. NVS staff will select the best qualified contractor(s) to support the depopulation, disposal, decontamination efforts of incident command.

Time is of the essence when responding to a damaging animal disease outbreak, and States, Tribes, and Territories need a plan to receive NVS countermeasures within 24 hours of APHIS’ approval to deploy. When developing a plan or evaluating a response strategy, NVS planners can access guidance on the process to request NVS countermeasures, including 3D response support services, from the NVS website: <http://nvs.aphis.usda.gov>. Both the *NVS Countermeasures Request Form* and instructions on how to complete the statement of work for 3D contractors are included.

2. DISPOSAL GROUP PREPARATION, RESPONSIBILITIES, AND ACTIVITIES

Response preparedness for an animal health incident is essential to effectively manage an emergency. Disposal personnel, especially those who will make management decisions, must possess extensive disposal subject matter expertise and thoroughly understand their roles and responsibilities within the context of the Incident Command System (ICS). Cooperation and communication among and within various groups involved in responding to an animal health incident is critical to a successful response. Input from qualified experts regarding disposal activities should be factored into response efforts and decision making by command staff. In addition, appropriate biosecurity measures must be implemented and personnel safety and hazard communication must remain at the forefront of group preparation. All Disposal personnel should learn as much as possible about the procedures discussed in these Guidelines and in other information sources such as those mentioned in Section 7 (References) and Section 8 (For More Information) and Disposal personnel also should participate in educational sessions and emergency response exercises designed to expand their knowledge and expertise in the area of animal health emergency management.

2.1 Disposal Group Preparation for Response to an Animal Health Incident

Cooperation and communication are critical in successfully responding to an animal health incident. As part of preparing to plan, implement, and coordinate disposal activities, the Disposal Group should work closely with associated personnel including the:

- State Veterinarian
- State Agency for Environmental Protection
- Appraisal Group and Compensation Unit
- Euthanasia Group
- Biosecurity Group
- Cleaning and Disinfection Group

In addition, cooperation and communication with Federal inspectors and regulators as well as environmental personnel that are involved in disposal response efforts should occur. State personnel such as the State Veterinarian and the State Agency for Environmental Protection should be consulted regarding State and local regulations and procedures for carcass disposal to ensure that proposed plans do not conflict with existing rules. In addition, the Appraisal Group should have completed their on-site activities prior to initiation of depopulation and disposal activities.

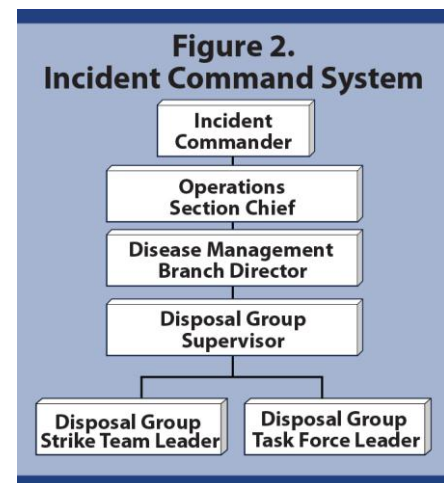
The Disposal Group must work closely with the Euthanasia Group to coordinate activities so that the rate of euthanasia activities does not greatly exceed that of the Disposal Group. Preparation should include a comparison of the estimated depopulation rate compared to the disposal rate so that advance planning and arrangements for temporary storage can occur. Depopulation should be paced so that subsequent disposal activities are not overwhelmed. When an extended delay between animal mortality and subsequent disposal of carcasses and related materials is unavoidable, then coordination between the two Groups should occur in order to ensure only a minimum time between confirmation of death and subsequent disposal occurs and to establish an approved temporary refrigeration or storage location for carcasses and materials.

The Biosecurity Group will provide guidance to the Disposal Group in ensuring that activities are conducted in a manner that maximizes biosecurity. In particular, transport of any potentially infectious material must be performed in accordance with all applicable laws, regulations, and guidance. The Cleaning and Disinfection Group should also be consulted as disposal plans are developed so C&D can be scheduled accordingly. The Incident Commander must approve the Disposal plan before implementation based on recommendations from environmental agencies and other stakeholders. For more information concerning other associated activities see *FAD PreP/NAHEMS Guidelines: Mass Depopulation and Euthanasia (2011)* and *Cleaning and Disinfection (2011)* as well as each related SOP.

2.2 Roles and Responsibilities of Disposal Group Personnel

Within the Incident Command System (ICS), the Disposal Group structure is diagrammed in Figure 2.

The total number of personnel for the Disposal Group will vary depending on the size and scope of the incident. Three ICS levels are described for the Disposal Group and include the Disposal Group Supervisor, Disposal Group Team Leaders, and Team Members. This is consistent with the principles of Chain of Command (orderly line of authority), and Unity of Command (accountability). Briefly, the Incident Commander is charged with overseeing all activities related to the event, including Logistics, Planning, Operations, and Finance/Administration. The Disposal Group Supervisor is in charge of all Disposal personnel and directly supervises Disposal Team Leaders. The Disposal Team Leaders supervise the members of the Disposal Teams.



2.2.1 Disposal Group Supervisor

The Disposal Group Supervisor should be identified well before an animal health emergency occurs. This individual is assigned to the Incident Command Post (ICP) and reports to the Disease Management Branch Director. This individual is in charge of all Disposal Teams and has the primary responsibility for ensuring that disposal measures are implemented effectively during an animal disease emergency, and that all disposal personnel are familiar with the proper disposal techniques for the specific incident being

managed. The Disposal Group Supervisor has extensive training and/or experience in disposal methods, is able to make informed recommendations for optimal disposal options, and possesses the management skills needed to organize and direct all disposal activities for the incident.

Additional duties of the Disposal Group Supervisor include:

- Appoints Team Leaders
- Consults with Team Leaders
- Serves as an expert resource for disposal issues and maintains a working knowledge of State and Federal regulations pertaining to disposal of carcasses and related materials
- Prepares a site-specific plan to determine the number and types of personnel, vehicles, and other resources and equipment needed to conduct disposal operations. This includes defining needs and requirements for contracts to be issued and communicating with the Operations Section Chief to ensure that the required resources are available.
- Identifies personnel training requirements and orienting new personnel to the specifics of their duties within the Disposal Group.
- Assigns Disposal personnel as necessary to achieve the goals outlined by the Incident Commander.
- Coordinates Disposal Group activities with other response Groups.
- Prepares regular briefings and reports for the Operations Section Chief and notifies him or her immediately of any problems.
- Maintains working relationships with appropriate animal health emergency groups, environmental regulatory agencies, and other industry stakeholders.
- Ensures that disposal is implemented in compliance with relevant policies and in accordance with the approved plans and environmental regulations.

2.2.2 Disposal Team Leader

The Disposal Team Leader focuses primarily on ensuring that safe, effective, and environmentally sensitive disposal procedures are carried out in an animal health emergency. Each Team Leader should be identified well before a disease outbreak or other animal health emergency occurs. Typically, the Disposal Team Leader is given responsibility for the implementation of disposal activities in a clearly delineated area or on a specific number of premises.

A Disposal Team Leader supervises a single Disposal Team and reports to the Disposal Group Supervisor. Multiple teams of responders, each under the direction of a Team Leader, may be assembled depending on the scope of the incident. In addition, the Team Leaders assist the Disposal Group Supervisor with duties including:

- Determining the number and types of resources needed to conduct disposal operations.
- Instructing and training Disposal Team Members in disposal protocols, policies and procedures, and general safety precautions and biosafety.
- Assigning tasks to Disposal Team Members and ensuring accomplishment of mission objectives.
- Ensuring compliance of Disposal Team Members with relevant policies, plans and environmental regulations.
- Establishing communication and coordination with other units and groups involved in response.
- Serving as a technical resource for information on current disposal methods and procedures.
- Preparing briefings and reports for the Disposal Group Supervisor.
- Notifying Disposal Group Supervisor of relevant issues or problems.

2.2.3 Disposal Team Members

In the event of an animal disease emergency, the work of the Disposal Group on infected or exposed premises is essential to the containment and control of a disease outbreak. The Disposal Group is composed of credentialed Team Members who are experienced or trained in Disposal SOP and can carry out disposal activities under supervision. The Disposal Group Supervisor will assign Disposal Team Members to premises or specific mission assignments as soon as possible after an Infected or Contact Premises is declared and disposal activities are imminent. Team Members may be assigned to a Task Force or a Strike Team.

A Task Force is composed of a collection of mixed resources managed under one Leader. It is a versatile combination of resources which allows efficient management of several elements. An example of a Disposal Task Force might include one with mixed personnel (veterinarians, police officers, technicians), and mixed equipment (excavation/earth moving equipment for disposal). A Task Force is used when the mission focus is varied and a variety of activities must take place to accomplish the mission's objective.

In contrast, a Strike Team is a collection of similar resources managed under one Leader. All Members in a Strike Team have similar capacity and knowledge. For example, a Disposal Strike Team may be composed of heavy equipment operators who must excavate land to prepare for burial of materials. The planning, ordering, utilization, and management of Strike Teams are more streamlined when compared to Task Forces. Thus, a Strike Team is utilized when the mission focus requires similar resources.

2.3 Assessing Needs

Needs for qualified credentialed disposal personnel, vehicles, equipment, and supplies will be determined at the time of the animal health emergency by the Disposal Group Supervisor in consultation with Disposal Team Leaders. An assessment of needs will also be based on information obtained from other groups that have visited the premises such as personnel from the Disease Surveillance Branch and Disease Management Branch as well as the Appraisal and Euthanasia Groups. At a minimum, collected information should include: global positioning system coordinates (GPS) for premises and any on-site disposal areas, owners name and address (include mailing if different than physical), and available on-site supplies associated with disposal.

The Disposal Group Supervisor, in consultation with Team Leaders will determine needed material, supplies, and equipment including vehicles. Logistics is tasked with securing required supplies including coordination of delivery location, date, and time. The Disposal Group Supervisor will work with State emergency management agencies to identify disposal personnel with the required expertise from multiple governmental and private sources including industry stakeholders who may possess specialized equipment and/or training. The Disposal Group Supervisor should advise the Operations Section Chief of any personnel requirements that cannot be satisfied locally so that arrangements for additional personnel can be made.

Depending on the level of the response, the Disposal Group Supervisor will work with the appropriate local, State, and Federal emergency management and response agencies to meet the needs identified. In addition, the Disposal Group Supervisor will work with those in the Finance/Administration Section to issue contracts and leases regarding personnel or equipment for the disposal operation. Emergency response exercises held prior to an animal health emergency will provide disposal personnel with the opportunity to become familiar with standard contracts and leases and to consider the feasibility of putting contracts and other arrangements in place prior to an animal health emergency.

2.4 Recordkeeping and Reporting

The Disposal Team Leader should obtain basic information about each premises visited by the Disposal Team and should provide this information to the Disposal Group Supervisor. Essential information includes the owner's name, the mailing address of the premises, the GPS coordinates for the premises and any disposal sites it may contain (if available), and the number, species, and type of the animals disposed of on the visit. Reports should be submitted promptly to the Emergency Management Response System (EMRS) or a similar acceptable reporting system.

The APHIS EMRS is used by VS personnel and other animal health emergency response officials to manage and investigate animal health emergencies in the United States. Information about EMRS is available at http://www.aphis.usda.gov/animal_health/emrs/.

2.5 Hazard Communication

Before any disposal activities are initiated, Disposal Team Members should be briefed fully by the Orientation and Training Cell as to the nature of the disease with which they are dealing and any associated hazards. Specific safety precautions and/or hygiene requirements should be explained before the team enters the premises. This is particularly important if a zoonotic disease is involved. In addition, the team should be supplied with appropriate personal protective equipment (PPE) and other necessary safety equipment. Respiratory protection, gloves, and eye protection, for example, must be supplied if the personnel are at risk from a disease organism or chemical hazard, if significant amounts of dust are generated, or upon individual request. For further information, see the *FAD PReP/NAHEMS Guidelines: Health and Safety (2011)* and the *FAD PReP/NAHEMS Guidelines: Personal Protective Equipment (2011)*. Other applicable information can be located in the APHIS Health and Safety Plan (HASP) at: http://www.aphis.usda.gov/emergency_response/hasp/health_safety_procedures.shtml. Disposal Team Members should wear appropriate PPE to ensure personal safety and compliance with Occupational Safety and Health Administration (OSHA) standards. All PPE must be used according to an established biosecurity protocol and guidelines established by the Safety Officer. Appropriate public health agencies and medical assistance teams should work with responders to monitor them for signs of disease and to develop protocols for self-assessment.

Additional biosecurity and cleaning and disinfection procedures may be required to address the risks posed by serious zoonotic diseases. Cleaning and disinfection procedures are outlined in *FAD PReP/NAHEMS Guidelines: Cleaning and Disinfection (2011)*. Biosecurity measures are also described in the *FAD PReP/NAHEMS Guidelines: Biosecurity (2011)*. The associated SOP documents also provide important information.

2.6 Media and Public Relations Considerations

A major disease outbreak and response in this country can be expected to attract considerable media attention and interest, especially in the early stages of the incident. It is important that animal emergency response personnel make an effort to gain the support of the public. The media may be helpful in raising public awareness of the necessity of the disposal activities associated with depopulation or euthanasia activities in response to an animal health emergency. Appropriately crafted media messages will help the public to understand the need for the depopulation and disposal of some number of animals and associated materials as well as why this is being done to protect the food supply and public health.

The Public Information Officer(s) in the Joint Information Center will be primarily responsible for coordinating communications with stakeholders. The Public Information Officer will regularly update representatives of the media, including updates on euthanasia and disposal activities included in approved

press releases. If possible, information will be provided to the general public on a proactive basis to educate them on the issues pertaining to disease eradication—including disposal issues—and to assure them of the appropriateness of disposal procedures and activities. The Joint Information Center is also tasked with monitoring and responding to the press, public, industry, and affected parties for specific concerns and problems during an FAD.

Disposal sites should be protected from media personnel and the public as much as possible. Care should be taken during disposal activities to prevent or lessen the likelihood of inappropriate aerial photography and videos. There will be no other personnel permitted on-site other than official or credentialed personnel as visitors' safety cannot be guaranteed and may interrupt the efficiency of activities as well as the safety of credentialed personnel.

2.7 Biosecurity/Containment Measures

Observance of strict biosecurity and cleaning and disinfection measures by Disposal Team Members is essential to prevent the possible spread of disease between premises. Personal biosecurity measures as well as vehicular and equipment biosecurity is critical to help contain disease and prevent further spread. For a more in-depth discussion of these topics, it is strongly recommended that readers access <https://fadprep.lmi.org>. For more information regarding specific procedures for biosecurity, and for cleaning and disinfection, refer to:

- *FAD PReP/NAHEMS Guidelines: Biosecurity (2011) and SOP*
- *FAD PReP/NAHEMS Guidelines: Cleaning and Disinfection (2011) and SOP*
- *FAD PReP/NAHEMS Guidelines: Health and Safety (2011) and SOP*
- *FAD PReP/NAHEMS Guidelines: Personal Protective Equipment (2011)*

A comprehensive understanding of the type and strain of pathogen associated with the decision to depopulate and dispose of animals is essential to prevent further spread of infection and to safeguard human, animal, and environmental safety and security. In addition, it also weighs heavily in transportation planning as well as human safety—both during disposal activities and following them. Biosecurity and cleaning and disinfection protocols will be largely based on the type and strain of pathogen, and its possible modes of transmission.

In the event of a highly contagious FAD, a Control Area will be established around premises identified as Infected Premises or Contact Premises. Effective biosecurity and surveillance play key roles in the detection and prevention of further disease spread. Biosecurity measures and movement restrictions for personnel, animals, and resources will vary between zones. A brief description of zones and areas is shown in Table 1.

Table 1: Definition of Zones and Areas

Zone	Definition
Infected Zone (IZ)	Zone that immediately surrounds an Infected Premises
Buffer Zone (BZ)	Zone that immediately surrounds an Infected Zone or a Contact Premises
Control Area (CA)	Consists of an Infected Zone and a Buffer Zone
Surveillance Zone (SZ)	Zone outside and along the border of a Control Area
Free Area (FA)	Area not included in any Control Area
Vaccination Zone (VZ)	Emergency Vaccination Zone classified as either a Containment Vaccination Zone (typically inside a Control Area) or a Protection Vaccination Zone (typically outside a Control Area). This may be a secondary zone designation.

Personnel must be aware of what zone they are in and what protocols and restrictions are in place. For example, upon arrival at the entrance to a premises, Disposal Team Members may need to change to protective clothing (e.g., coveralls, rubber boots, and hat) and follow other procedures. Upon departure from the premises, strict adherence to biosecurity protocols should be maintained. Disposal Team Members will likely need to clean and disinfect their clothing, including boots and hats according to an established protocol. Procedures should be in place for the removal and disposal of protective clothing.

3. DISPOSAL METHODS

3.1 Overview

During a large scale animal health emergency, it is likely that more than one disposal method will be utilized and competent professionals registered in the affected State(s) should be included among decision makers. The leadership should be skilled and experienced in integrating several disposal technologies into an overall disposal strategy. In addition to the likelihood of utilizing multiple disposal methods, the strategy should remain flexible so that necessary improvements and changes can be implemented as seamlessly as possible. Professionals likely to have such expertise include licensed professional environmental, civil, or agricultural engineers and scientists with demonstrated experience in waste disposal/remediation. To work effectively with waste management specialists, it is useful for ICS team members to understand carcass disposal options and the various advantages, disadvantages, and limitations as described in this section of the Guidelines.



During an animal disease outbreak, there is a very high likelihood of generating massive amounts of contaminated biomass which can have a severe impact on public health. During the 2001 FMD outbreak, the United Kingdom (UK) found unlined burial to have unacceptable public health risks. Therefore, due to potential negative risks to public health associated with improper burial, it is imperative that carcass

disposal decisions be made by qualified waste disposal experts who are familiar with livestock industry concerns as well as State/local environmental concerns. State-level environmental and animal health agencies will need to be consulted and must approve large-scale animal disposal plans.

This Guidelines document will discuss major disposal methods most likely to be considered during an animal health emergency. They include:

- Composting
- Rendering
- Permitted Landfill/Burial
- Fixed-Facility Incineration
- Air-Curtain Incineration
- Open-air/Uncontrolled Burning

In addition to these disposal methods, several emerging technologies will also be discussed. This section will also discuss environmental and biosecurity considerations for disposal options and transportation of waste material.

3.2 Composting

3.2.1 Overview of Composting Disposal Method

Composting is a carcass disposal method that promotes decomposition through placement of carcasses between layers (approximately two feet thick) of carbon rich organic materials. During the composting process decomposition requires nitrogen, carbon, oxygen, and moisture for optimal tissue breakdown. Although technically an aerobic process, a totally aerobic composting process is typically only reached under intensively managed (i.e. industrial) conditions that are unlikely to occur in emergency composting. In carcass composting, carcasses serve as the source of nitrogen and the addition of high carbon plant material (variously referred to as co-compost or cover material) serves to meet the carbon requirement, absorb excess moisture, and retain heat/sustain high internal temperatures necessary for rapid decomposition and pathogen suppression. Composting may take place indoors or outside. The decomposition process and underlying scientific principles are similar for indoor and outdoor composting.

3.2.2 Composting Process

The use of composting as a disposal method can provide a nutrient rich product that can be applied to land to increase productivity if materials such as solid semi-dry manure are used. If nutrient poor co-compost materials (cornstalks, straw, sawdust, wood shavings) are used, then the final nutrient content will be lower. However, it is unlikely that mortality compost would be used as a soil amendment if compost is derived from infected animals. Carcasses can be composted whole or, to speed the process, can be ground and mixed with co-compost (sawdust, wood chips, ground cornstalks, and ground straw) prior to pile formation to improve microbial activity and speed of soft-tissue decomposition. Care must be taken to prevent dispersion of pathogen-laden aerosols during grinding and mixing if the carcasses are infected. To increase decomposition speed, carcasses that are composted in their entirety may need to be mechanically turned at least three times during composting to promote aeration and further decomposition. Infected carcasses should be turned only minimally, if at all, to avoid dispersing pathogens. While turning



can speed decomposition if done correctly, pile turning is not necessary and is not recommended for infected carcasses.

A thick envelope of co-compost over the carcasses retains heat, absorbs odorous decomposition gases, and provides a favorable environment for microbes which degrade decomposition gases into less odorous compounds. The addition of sufficient plant material also reduces the likelihood of pathogen release due to wind, insect activity, or scavenging animals. An adequate source of carbon (plant material) must be available to maintain the compost pile. A carbon to nitrogen ratio ranging from 25:1 to 40:1 is optimal to provide energy for decomposition and to minimize the production of odors during the initial phase.

In the first phase of carcass composting, the desired core temperature of the composting pile is between 135-140 degrees F within 15 days of compost initiation. Many compost piles do reach these temperatures quickly, particularly during warm weather. However, if composting is initiated during cold seasons, optimal temperatures may not be reached until much later than 15 days post compost initiation. Depending upon the size of the carcass biomass, this temperature should optimally be maintained for a length of time—between 3 and 12 weeks. Heat is a significant driver in pathogen destruction but other factors such as microbial competition, drying, and toxic decomposition gases will often aid in reduction of pathogen populations. During emergency composting, optimal temperatures may be difficult or impossible to reach. This is due to large carcass and pile size and high organic loading (causing oxygen depletion) in the core of the compost pile. Subsequently, the interior zones of mortality composting piles are likely to be anaerobic or have very low oxygen levels, while zones closer to the surface are aerobic.

Aeration is optimal during the first phase. It is during the first phase that some pathogenic bacteria such as *Salmonella* spp. and *Shigella* spp. may be destroyed; particularly if core temperature can meet or exceed 149 °F for 1 to 2 days. To speed the composting process, the compost pile can be passively aerated by constructing a porous compost pile that allows air to enter the pile naturally via diffusion or aided by wind. Although grinding carcasses and turning the piles may be useful for non-infected mortality composting, it is not recommended during an animal disease outbreak emergency response due to biosecurity concerns.



During the second phase, aeration is not as critical. The time to complete phase 2 is also dependent upon the carcass size and can vary from an estimated 10 days (chickens and other poultry) to approximately 240 days (heavier carcasses such as mature cows and horses).

When selecting composting as a disposal method, an important consideration is the availability of large quantities of carbon sources—both as a cover material and as a thick base layer. For example, emergency bovine composting may require 10-12 cubic yards of cover material (ground cornstalks, ground straw, or corn silage) per 1,000 lb. of carcass. If very large numbers of carcasses must be disposed, locating, transporting, and grinding sufficient quantities of cover material will be a significant task.

3.2.3 Indoor Composting

The poultry industry has widely implemented indoor composting for bird mortalities. Indoor composting processes are less affected than outdoor composting by weather events, ambient temperatures, and seasonality. This option may work well in poultry houses without significant indoor constraints such as

support poles. When compared to outdoor composting, indoor composting is more protected from the wind, has less risk from scavengers, and from drying conditions. Indoor composting often presents some challenges for space limitations and restricted space for the use of heavy equipment to turn piles. Copious amounts of water are used for foam depopulation of poultry and, although some water can expedite composting, excessive water volume can prolong decomposition times in the composting process. When choosing indoor composting as a disposal method following foam depopulation, the Virginia Cooperative Extension Service reports it is important to use a neutral pH water source that is “soft” or minimally hard and has low sediment concentrations. There are also some differences in environmental and biosecurity impacts between indoor and outdoor composting and these are addressed in Section 3.7.2.



3.2.4 Outdoor Composting

When composting is the selected disposal method for large animal species such as beef and dairy cattle, it typically occurs outdoors. Site selection for outdoor composting is critical and experts should be consulted to identify and secure an optimal composting site. In general, potential sites must be located at least 300 feet away from bodies of water and should be well drained and downwind of public areas or communities. Site accessibility should not be hindered by typical seasonal weather changes and a reasonable plan to control runoff must be in place. Since composting is very sensitive to environmental moisture levels, it is recommended that outdoor compost piles be covered with a tarp or roof in more humid climates so that excessive pile wetness does not prolong composting times. However, this would not likely be possible during an animal health emergency. Piles would likely be formed into long, narrow windrows. Since emergency outdoor windrow composting is typically unsheltered, adverse weather events such as high wind weather advisories and extreme precipitation can affect compost pile quality. To help offset any added moisture, base and cover layers of the compost pile may be made more absorbent by constructing them with additional thickness. Engineers and personnel experienced with composting should be consulted to determine the recommended thickness for a given situation.

3.3 Rendering

3.3.1 Overview of Rendering Disposal Method

Rendering is an off-site process that uses heat to convert carcasses into protein-based solids (meat and bone meal), water, and melted fat/tallow. Rendering plants may be integrated with existing packing or poultry processing plants or may operate independently and obtain animal carcasses from farms, ranches, or other entities. Integrated rendering plants associated with a packing plant or poultry processing facility may produce edible fats and proteins that might be used in the manufacture of gelatins or cosmetics if they conform to Food and Drug Administration (FDA) processing standards. Since independent rendering plants often obtain input materials from a variety of sources, the resulting rendering products are deemed inedible for humans but may be used in some livestock feeds, soap, and other production processes. Only inedible rendering will be discussed in this document.



Independent full-service rendering companies are capable of efficiently transporting and processing one million or more pounds per day of raw animal by-products and mortalities. Only rendering facilities that comply with applicable regulations should be considered for performing the rendering process. If rendering is being considered during an animal health emergency, then care must be taken to coordinate activities with the rendering plants so that their facilities are not overwhelmed. Rendering plants typically have service contracts with other entities that must be fulfilled and, if operating contractually at full capacity, may be unable to accept emergency carcasses and associated waste material. Plans for temporary storage should be considered because decomposed carcasses cannot be rendered. As part of planning, efforts should be made during disease-free periods to negotiate Indefinite Delivery/Indefinite Quantity (ID/IQ) contracts with rendering facilities that can enable an effective and efficient response. Additionally, adequate biosecure transport must be arranged to deliver waste material from depopulation site to rendering plant.

If rendering is chosen as a disposal method during an animal health emergency, careful consideration and planning are critical in developing a workable plan. The number of rendering plants is reportedly much lower than it was 30 years ago. Many rendering plants may be operating at or near capacity as part of normal business operations and the surge capacity may be limited. Some areas no longer have local rendering plants, necessitating long distance transport in specially designed trucks. Prior to rendering any material from an animal health emergency, all parties need to be aware of the fact that some rendered product may not be marketable. A plan for the final disposal of that product must be developed. Landfilling or burial may be options. Rendering facilities sometimes have established biosecurity procedures in place to minimize risk of pathogen transmission. In some cases, biosecurity protocols may be modified if necessary to address specific diseases. Rendering facilities also have procedures in place for dealing with waste water and other byproducts associated with the rendering process. This Guidelines' associated SOP provides direction in general planning and coordination when choosing rendering as a disposal option. The National Renderers Association maintains a list of members, including rendering plants. The association may be accessed at <http://www.renderers.org>.

3.3.2 Overview of Dry Rendering Process

There are two types of inedible rendering: dry rendering and wet rendering. Dry rendering is the only type of rendering process currently utilized in the U.S. rendering industry, and materials are processed using either batch or continuous rendering. Carcass materials subjected to continuous rendering use a single cooker to complete the heating and cooking process. In contrast, batch rendering involves transfer of the heated product to another cooking cylinder before completion of the cooking process.

In general, the dry rendering process occurs off-farm, necessitating transport that poses some risk of pathogen spread. These risks can be mitigated through careful route selection, and use of leak-proof rendering transport trucks or emergency installation of plastic liners to make non-leak-proof trucks tight.

Modern rendering facilities are constructed to separate raw material handling from the processing and storage areas. The process is performed and monitored through computer technology to achieve time and temperature recordings for appropriate thermal kill values for specific microorganisms.

Dry rendering cooks ground carcasses in their own fat while contained in a horizontal, steam-jacketed cylindrical vessel equipped with an agitator. The final temperature of the cooker (250-275°F) destroys harmful pathogens and produces usable end products such as meat, feather, bone, and blood meal that can be used in animal feeds.

Heat generated by steam condensation is applied to the jacket and agitator blades to ensure uniform heat distribution and shorten the time necessary for cooking the carcass materials. Indirect heat of the dry

system converts the moisture in the carcasses to steam; the resulting steam pressure inside the vessel, combined with continuous agitation, breaks down fat cells and disintegrates the material. The cooker is brought to the required steam pressure at which it is maintained for a specified period of cooking time. Cooked material is monitored periodically to determine when the cooking process is complete. The slight grittiness and fibrous nature of the cracklings (a solidified protein material product resulting from the rendering process) provides indications of the progress of the cooking process. After cooking, steam generated inside the cooker is removed through a steam release valve adjusted at specific pressure.

3.3.3 Dry Rendering Using Batch Configuration

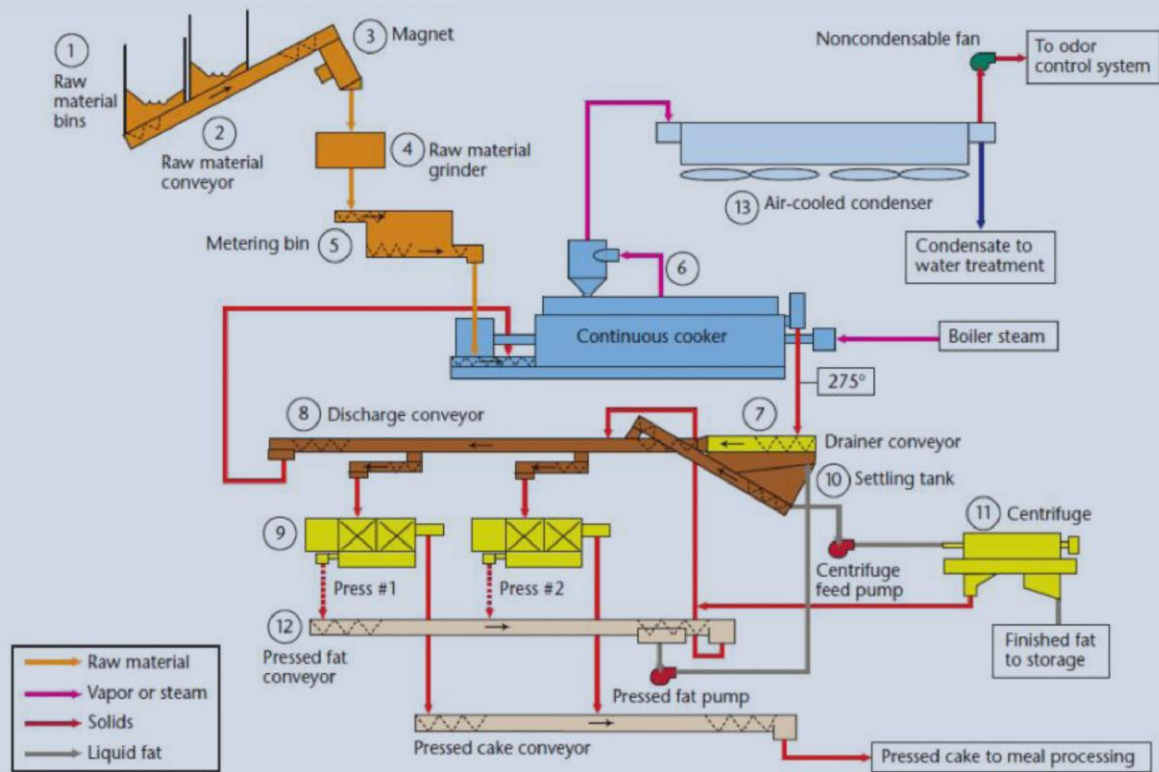
Dry rendering systems may be used in a batch configuration. In the first stage, the raw material from a receiving bin is conveyed to a crusher or similar device to reduce its size to pieces of 1-2 inches for efficient cooking. Cookers are heated at normal atmospheric pressure to around 212°F until the moisture is driven off through vents in the form of steam and the temperature rises to 250-275°F depending on the type of raw materials. This high temperature breaks the cell structure of the residue and releases the fat as tallow. The cooked material is discharged into a separate container, which allows the free-run fat to drain away from the protein solids known as tankage or cracklings.

The heating process during batch rendering normally takes 2-3 hours. In terms of loading, some plants discharge raw materials to the batch cooker when the batch maximum temperature is reached; others utilize a holding time of up to 30 minutes. After the heating process, which normally takes up 2-3 hours, the tallow is decanted off and the solids are emptied from the cooker.

3.3.4 Dry Rendering Using Continuous Rendering Configuration

In continuous rendering all the rendering processes are done simultaneously and consecutively. Most continuous rendering systems require little to no manual operation and finished products will be generated at a constant rate if there is a constant supply of carcasses. Continuous rendering systems are generally equipped with automatic controls for both time and temperature. More automated control is exercised over the crushing of big particles, uniform mixing of raw material, and the maintenance of required time and temperatures of the cooking processes. Compared to batch rendering configuration, continuous systems also generally offer greater flexibility, allowing a wider range of time and temperature combinations for cooking raw materials. Figure 3 shows the dry rendering process using the continuous system.

Figure 3. Dry Rendering - Continuous System



Adapted from a diagram courtesy of Dr. David Meeker of National Renderers Association, Alexandria, VA

3.4 Permitted Landfill/Burial

3.4.1 Overview of Permitted Landfill Methods

Some types of commercial or industrial permitted landfills may provide a reasonable option for carcass disposal in some cases. Modern landfills are required to meet design and operating standards outlined in Subtitle D of the Resource Conservation and Recovery Act (RCRA). These RCRA regulations are contained in Title 40 Code of Federal Regulations (CFR) Parts 239-299. Key features of the permitted landfill design include liners, leachate containment systems, and gas collection systems.

Three types of permitted landfills exist in the United States: construction and demolition, hazardous waste, and municipal solid waste. Municipal solid waste landfills are often the most appropriate for catastrophic carcass disposal, as the carcasses can be layered between compacted soil and solid waste materials. These landfills are generally clay and/or synthetically lined and have leachate collection and gas recovery. They include municipal solid waste landfills (MSWLFs) and industrial solid waste landfills that are in compliance with Federal criteria. Landfills meeting the criteria to be included in Subtitle D are an optimal type of landfill for catastrophic animal carcass disposal. Landfill sites may be privately owned or may be operated by municipalities. Approximately 1,600 solid waste landfills currently operate in the U.S. See EPA's I-WASTE Tool for a listing of landfills (<http://www2.ergweb.com/bdrtool/login.asp>).

It is important for emergency planners to understand that many smaller or older landfills are unlikely to have extensive environmental protection features. Large landfills, or those specifically planned to handle toxic materials are more likely to meet criteria for Subtitle D regulations but are also less common and may be more difficult to access. Small local landfills (the type most likely to be found in rural regions where livestock are raised) may not include leachate collection/treatment, gas collection, or synthetic membrane liners. However, landfills are usually located at sites specifically selected to minimize potential risks to groundwater, surface water, and other environmentally sensitive areas. Many smaller or medium sized landfills may decline carcasses and will not participate in emergency disposal operations because of lack of personnel, equipment, and stockpiled soil to rapidly cover a sudden influx of carcasses.

For landfills to be considered a viable disposal option, officials should obtain a pre-catastrophe agreement with the landfill management/ownership for use of a landfill if necessary during an animal health emergency. Use of this method requires careful planning because of the limited capacity of most landfills as well as high regulatory requirements. See the associated SOP for additional information regarding planning and operation procedures for this disposal method.

In some instances, acceptance of carcasses may be restricted or prohibited from some solid waste landfills. In other instances, the site operator will be required to obtain additional regulatory approvals before accepting the materials. Operational issues at a landfill—opening of a new disposal cell, recent odor complaints, pending permit approvals, or lack of available capacity (such as at smaller landfills)—may limit carcass disposal or make it unacceptable to the landfill operator. Public perception may also present issues for obtaining approval for disposal at publically owned landfills. This is of particular concern when the disease has zoonotic potential. The generator of the waste, likely the State or Federal government who has or will pay indemnity for the animals, remains liable for environmental contamination caused by a landfill even if the government agency wasn't responsible for the actual release. Therefore, only well-run landfill operations with few violations should be used to avoid future clean-up liability.



Landfill sites are typically staffed and operated on an as-needed basis and include regular hours of operation. In the event that a landfill is used to dispose of significant volumes of carcass material during an FAD outbreak, it is likely that additional staff will be required as a result of extended hours of operation, additional security or traffic control, or additional biosecurity measures such as cleaning and disinfecting of transport vehicles. Additional training for landfill employees on the biosecurity measures necessary to prevent the spread of an FAD may be needed.

Most states have regulations that define allowable carcass disposal options. In many states disposal in landfills is permitted, although different options may be allowed under different circumstances. The fact that landfilling may be allowed does not necessarily mean it will be an available option; it is generally at the landfill operator's discretion as to whether or not carcass material will be accepted.

During the 2001 outbreak of FMD, the UK identified minimum criteria for determining the suitability of a landfill for disposal of infected animal carcasses. The criteria were based on the assumptions that infectivity of material deposited in the landfill would be low and short-lived, and that the carcass material could generate leachate for up to 20 years after disposal. The criteria include the following:

- **Location.** Prohibited use of some sites based on proximity to various protected zones, aquifers, water tables, floodplains, etc.

- **Liner.** Required that the base and sides be comprised of at least 1 meter of well-engineered clay.
- **Leachate management.** Required an effective and robust leachate management system to ensure efficient collection of leachate for the next 20 years. Required contingency planning for treatment and disposal of leachate of very high organic loading for a period of at least 20 years.
- **Gas management.** Required adequate gas management infrastructures to collect gas from the whole of the site.
- **Monitoring.** Required a monitoring plan for groundwater, surface water, and leachate as well as an associated contingency plan in the event of an identified problem.
- **Odor & vermin control.** Required effective odor and vermin control plans.
- **Documentation.** Required documentation of the location, number, and extent of animal carcasses deposited within the site for future reference.

The resources and infrastructure necessary to dispose of animal carcasses at a landfill site are much the same as those required to operate the landfill on a daily basis. However in cases such as animal disease outbreaks, the disposal of large volumes of carcass material may require unique resources. When it is necessary to dispose of large numbers of carcasses using a commercial landfill, it is especially important to consider transportation in the planning because obtaining a sufficient number of large trucks suitable for transporting carcasses is often a limiting factor. Large quantities of cleaning and disinfecting supplies and additional personal protective equipment will be needed for the biosecure movement of trucks and personnel. For more information, see the *FAD PRoP/NAHEMS Guidelines: Cleaning and Disinfection (2011)* and *Personal Protective Equipment (2011)* as well as the associated SOP.

3.4.2 Overview of Unlined Burial Techniques

Burial techniques discussed in this section are differentiated from the previously discussed landfill disposal options because they are designed and engineered solely for the disposal of carcasses and associated materials while landfills are/were utilized for other uses prior to becoming considered as a disposal option in the event of an animal health emergency. Unlined burial techniques may be utilized during an animal health emergency. The use of unlined burial as a disposal option has been utilized in several recent animal health emergency events, including FMD in the UK and South Korea. In general, unlined burial of carcasses and related materials such as ash from other disposal procedures involves placing them in a trench or large, earthen hole or pit. Eventually, buried materials are degraded and broken down into minerals and organic material. Carcass degradation will generate significant quantities of leachate and groundwater contamination may result. The property owner is typically liable for all environmental remediation costs associated with the disposal method. As with all on-site burial options, the costs of installing and maintaining groundwater monitoring wells; collecting water samples, lab analysis of samples, environmental remediation (particularly groundwater remediation), etc. should be taken into account. Land taken out of production for disposal also brings costs.

An extensive inventory of heavy equipment will likely be necessary to facilitate burial when used as a disposal method. Machinery and equipment will be needed for digging burial pits, burying carcasses and associated material, as well as cleaning and disinfection activities. Equipment such as backhoes, bulldozers, dump trucks, scrapers, and trench diggers will be necessary. Exact equipment requirements will vary between sites and scenarios.

3.4.2.1 Unlined Trench Burial

Unlined trench burial typically takes place on or adjacent to premises where euthanasia occurs. Trenches involve the excavation and creation of trapezoidal or vertical trench for placement of carcasses in the trench. Care must be taken to maintain trench wall integrity when utilizing heavy machinery to excavate near the edges of the trench. Waste materials are then covered with the excavated material (backfill trenches may vary from an estimated 4 feet to 8 feet in depth and are typically about six feet wide so that two large animal carcasses may be placed side by side within the trench. Trench burial is a disposal method that typically takes place on-farm. A schematic example of trench burial is provided in Figure 4.

Figure 4. Trench Burial



USDA, Natural Resources Conservation Service, Texas, 2002

Soil type is critical in the decision to utilize trench burial. Important characteristics in determining the suitability of a site for burial include:

- Soil properties (texture, permeability, surface fragments, depth to water table, depth to bedrock)
- Slope or topography
- Hydrologic properties
- Proximity to water bodies, wells, public areas, roadways, dwellings, residences, municipalities, or property lines
- Accessibility
- Subsequent intended use of site

A less permeable soil type such as loam soil is appropriate for burial. Highly permeable soils should not be present in areas where burial is being considered. Resources such as the National Resource Conservation Service (NRCS) and appropriate State and university sources should be part of the sampling and geotechnical assessment. In addition, the strategic use of the NRCS Geographic Information Systems (GIS) tool to evaluate environmental suitability may provide valuable guidance in decision making for site selection. In states where carcass disposal is regulated, trench burial is frequently one of the options allowed. However, State regulations vary considerably in terms of specific criteria required for a suitable burial site. In addition, the appropriate Services must be obtained to insure no underground lines or similar hazards are present where digging is proposed. If predators are a problem, special care must be taken to prevent them from accessing carcasses. If trench burial is being considered, the premises must be assessed to determine if it is large enough for on-site burial of the carcasses. See the *FAD PReP SOP: Disposal* for specific details in construction of a trench burial site.



The length of time required to dispose of carcasses via trench burial will depend on:

- The time required to identify an appropriate site.
- The time required to gain approval of the site by regulatory bodies such as environmental regulatory agencies.
- The species and total number of carcasses to be buried.
- The total excavation area and volume required.
- The type, quantity, and availability of excavation equipment, as this determines the time required to excavate the necessary area. An estimate of the typical capacity of excavator-type equipment (i.e., a backhoe) can be roughly equated to the bucket size.

Response time can likely be minimized if as many of these issues as possible are addressed prior to the time of need.

The principal by-products resulting from burial of carcasses are those that result from the decay process, namely leachate and gases such as methane, carbon dioxide, hydrogen sulfide, and others. The quantity of these by-products produced will relate to the volume of carcass material buried. Generally these by-products are of no commercial value. The property owner is typically liable for all environmental remediation costs associated with the unlined trench burial. As the carcass mass decomposes over time, settlement of the site will occur. Additional backfill may be required to prevent pooling of water at the site and to help restore the natural land surface. Depending on the volume of carcass material buried, some additional repair steps to contain gas or leachate may be needed.

3.5 Thermal Disposal Methods

3.5.1 Overview of Thermal Methods

Thermal methods use high-temperature combustion to destroy animal carcasses and associated animal materials. Incineration is a method that has been used historically as a disposal option and continues to be utilized in some circumstances. It was used extensively during the 1967 and 2001 FMD outbreaks in the UK. Various fuel sources are used to start and accelerate combustion and include diesel fuel, propane, and furnace or waste oils. Gasoline or other highly explosive accelerants should not be used. To effectively render Transmissible Spongiform Encephalopathy (TSE) agents noninfectious, materials must be subjected to very high temperatures - at least 1,560° Fahrenheit (850° Celsius) for at least 15 minutes. If possible, a higher temperature of 1,830° F (1000° C) should be reached to optimize the likelihood that TSE agents are rendered noninfectious, although viral agents are inactivated at lower temperatures. This section will discuss fixed-facility incineration, open air/uncontrolled burning, and air-curtain incineration.

3.5.2 Fixed-Facility Incineration

Fixed-facility incineration takes place in a completely contained environment and is usually highly controlled. Fixed-facility incinerators are typically fueled by diesel, natural gas, or propane and have emission control devices installed as part of an environmental protection plan. Disposal using fixed-facility incinerators may also use enormous amounts of fuels such as diesel or propane. This incineration method has been successfully used in the UK to dispose of Bovine Spongiform Encephalopathy (BSE) infected cattle. Fixed-facility incineration can be highly efficient disposal method which produces little residue as carcasses and associated materials are reduced to inert ash.



Some larger animal production facilities have on-site incinerators, and veterinary schools and diagnostic laboratories may also use incineration to dispose of animal carcasses. Although private facility incinerators may play a part in disposal during an FAD response, it is unlikely that they would have sufficient continuous capacity to handle large emergency losses. Small, fixed-facility incinerators may be operated on some farms. However, these are sized for routine production losses and would be too small for catastrophic whole-herd disposal.

The concept of incinerating carcasses in large hazardous waste, municipal solid waste, and power plants has also been suggested as a potential disposal method. However, large-scale whole-carcass disposal would be problematic given the batch-feed requirements at most biological waste incineration plants. Hazardous waste incinerators typically require waste to have a heating value of at least 5000 BTU/lb. If waste material has a heating value of less than 5000 BTU/lb., then additional fuel must be added to maintain correct temperatures. Pathological waste such as animal waste usually has a heating value of approximately 1000 BTU/lb. and requires substantial addition of fuel to maintain an appropriate temperature. In addition, carcasses are approximately 70 percent water as opposed to preferred waste which is typically around 25 percent water. Thus, many waste incineration facilities simply refuse to accept dead animals because of the low heating value and high water content. Additional issues in accepting pathological waste include lack of capacity to dispose of the additional waste and problems with acceptability of processing pathological wastes.

The type of species has a large influence on the speed at which carcasses are incinerated; the greater the percentage of animal fat, the more efficient the carcass will burn. Swine have a comparatively high fat content and burn hotter and more quickly than other species. Because of the higher fat content often present in swine, personnel should avoid placing too much high fat material in the unit at one time because the liquid fat can accumulate and overflow the incinerator to surrounding areas. The throughput of fixed-facility incinerators depends on the chamber's size. Large carcasses may need to be macerated prior to incineration to efficiently and properly combust the remains. For small animal carcass incinerators, which can be used on farms for fallen stock, the throughput may reach only 110 lbs. per hour. Larger facilities dedicated to the incineration of animal remains may be able to accommodate larger volumes.

Most large incinerators are fitted with afterburners that further reduce emissions by burning the smoke exiting the primary incineration chamber. The State agency responsible for environmental compliance will likely require carcass incinerators to meet State air quality (opacity) (and other) requirements. Incinerator ash is typically considered acceptable for landfill disposal.

3.5.3 Open-air/Uncontrolled Burning

Historically, open-air or uncontrolled burning has been used to thermally destroy animal carcasses and associated materials during animal health crises. Open-air burning may be termed uncontrolled burning because it has the least opportunity for inputs to be monitored. Neither the fuel nor air inputs can be controlled, the result of open-air burning is often an incomplete (very smoky) and relatively low-temperature combustion. Many states allow for incineration of carcasses on-farm but specifically prohibit burning them in the open. Open-air burning should be conducted as far away as possible from the public. Only properly trained and credentialed personnel should conduct open-air burning and local fire authorities should be included in decision making. Public perception of open-air burning is overwhelmingly negative and, if



selected as a disposal method, this aversion must be addressed during planning. Open pyre burning during the FMD outbreak in the UK brought such negative press and public concern that the British government stopped this practice in the early months of the outbreak.

Using this method, carcasses can be burned in open fields, on combustible heaps called pyres, or with other burning techniques that are unassisted by incineration equipment. To enable and promote thermal production, materials such as hay, straw, dry timbers, or other kindling is added to the carcasses. In addition, diesel or other fuels are typically used in open-air burning. State regulations should always be checked before a decision is made to use open-air burning as a disposal method. In addition, the potential for aerosol pathogen transmission from open air burning must be addressed when considering this disposal method.

Open-air burning is the most lengthy of all incineration processes. The type of species burned influences the length of time; the greater the percentage of animal fat, the more efficient a carcass will burn. For example, swine typically have a higher fat content than cattle or horses and will burn more quickly.

3.5.4 Air-Curtain Incineration

Air-curtain incineration is a thermal method that uses a combination of forced air and fuel (such as diesel or wood) to burn carcasses and/or associated materials. This method, which may be either a mobile technology or fixed technology, still burns carcasses or other materials outside but, in contrast to open-air burning, a manifold is used to greatly increase the air flow. Introduction of this high volume air greatly increases the temperature and accelerates carcass combustion process when compared to open-air burning. This can occur up to six times faster than open-air burning. Large-capacity fans driven by diesel engines deliver the high-velocity air down into either a metal refractory box or burn pit (trench). This process is extremely fuel-intensive.

Air-curtain systems vary in size according to the carcass mass to be incinerated. Air-curtain incineration can be used on the farm and, technically, is an open-air thermal disposal method since it does occur in the outside environment. The incinerator can produce significant noise and should be located away from residential centers and the general public to avoid producing a noise nuisance. The use of refractory boxes is particularly useful when soil type makes trench digging difficult or when higher water tables are an issue. Resources associated with using air-curtain incineration are generally portable. Transportation and placement would be limited by terrain or other environmentally limiting factors.

Dry wood or coal for fuel is essential for air-curtain incineration and plays a critical role in ensuring a proper air/fuel mixture. Diesel may also be used to fuel the fire as well as the air-curtain fan. Speed of throughput depends on the manufacturer, design, and management of the air-curtain system. The type of species also influences the throughput; the greater the percentage of animal fat, the hotter and more efficient a carcass will burn.

Air-curtain incineration, like other combustion processes, yields ash. Air-curtain incineration may be advantageous for disposal if it occurs in pits where the ash can be buried. However, in sensitive groundwater areas ash will most likely be disposed of in permitted landfills.

3.6 Other Disposal Procedures

Disposal experts continue to develop and refine effective disposal methods that may be used safely and with minimal negative environmental effects. Novel methods that will be briefly discussed in this Guideline include lactic acid fermentation, gasification, in situ plasma vitrification, and alkaline hydrolysis. Currently, these disposal options are expensive and are typically used only by highly

specialized operations such as veterinary schools or large research facilities. They are typically sized for routine operations rather than emergencies.

3.6.1 Alkaline Hydrolysis

Alkaline hydrolysis uses high temperature (such as steam heat), pressure and pH (usually strong base like potassium hydroxide or sodium hydroxide) to process carcasses and associated materials. Using this mobile technology, solid by-products and a sterile aqueous solution are the products of the conversion of lipids, proteins, and nucleic acids. This technology can take place on-site or at a fixed-facility. Alkaline hydrolysis is limited by low carcass material capacity, and is also time consuming, requiring at least 3 hours to kill microbial pathogens and 6-8 hours to deactivate transmissible spongiform encephalopathy (TSE) prions. Because it is one of only a few technologies that can destroy BSE, it remains a viable disposal method. However, the use of alkaline hydrolysis for disposal in a large-scale animal health crisis is significantly limited by its low capacity. In addition, alkaline hydrolysis results in significant quantities of potentially hazardous liquid waste. This hazardous waste, termed effluent, has an extremely high pH and must be discharged in an environmentally safe manner.

3.6.2 Anaerobic Digestion

Anaerobic digestion is a disposal method that has historically been used successfully for a variety of livestock species. Using this technology, carcasses may first be ground, then placed in a digester and decomposed by anaerobic bacteria. Gas, mostly methane, is released as a result of the digestion process. This technology may be appropriate to consider for all livestock and poultry species, and it results in a product that may be used as fertilizer. However, this would be unlikely if carcasses were infected with a contagious disease prior to undergoing anaerobic digestion. Temperatures may vary considerably during the anaerobic digestion process and may not consistently reach high enough temperatures to deactivate pathogens of concern such as those causing anthrax or clostridial diseases.

Lactic acid fermentation is a type of anaerobic carcass digestion that reduces carcasses to water, methane, and carbon dioxide. This process does not inactivate normal proteins and therefore should not be used in cases of confirmed or suspected TSE. It can, however, be used for carcasses infected with other virus and bacterial diseases. Before being subjected to fermentation using lactic acid, carcasses must first be pre-processed by grinding. Ground carcasses and associated materials are then mixed in fermenting tanks with lactic acid bacteria and fermentable carbohydrates such as whey, corn, or sucrose. This induces a process that results in the production of lactic acid as well as odors from ammonia, carbon dioxide and other organic smells. To reduce odors, digested carcass material should be stored in sealed and controlled-vented containers. Although regulatory restrictions are usually low, the speed is not great and the process may take 7-10 days to complete. Once the carcass material has undergone sufficient fermentation, the material may be stored in vented vats and transported to a rendering facility. With the exception of TSE's, disposal using lactic acid fermentation results in a lower risk of transmitting infection when transporting carcasses off-site.

3.6.3 Gasification

Gasification is an emerging thermal technology that converts carcasses into gasses—mainly carbon dioxide, carbon monoxide, methane and hydrogen. Some ash is also produced and can be managed using methods outlined for incineration. The conversion, which takes up to 12 hours, requires the use of slow heating (1,100-1,900 ° F) in containers that contain primary (gasification) and secondary (combustion) chambers. Some of the produced gas may be used for heat energy to further the gasification process. There are two types of gasification systems: batch and continuous. Continuous gasifiers, still under development, are advantageous because they are more efficient when compared to batch systems.

3.6.4 Plasma Vitrification

In situ plasma vitrification, or simply vitrification, is an emerging technology that is still being studied. This process uses electrically generated heat to ionize compressed air. All gaseous emissions resulting from the procedure are captured and treated. This process results in temperatures in excess of 7000°C in the torch and, when carcasses are subjected to the high temperatures in the vicinity of the torch, water is completely vaporized. Still in an experimental phase, this method may produce sufficient heat to inactivate BSE prions and mobile configurations are possible. It has been shown to destroy all known contaminants (chemical agents, viruses, bacteria, fungal and prion pathogens). It also pyrolyzes organic materials, vitrifies inorganic materials. One advantage of this method is that it reduces the biomass of the original substance by about 97%. It also produces a rock-like solid residue that is highly resistant to leaching with no requirement for hazardous waste disposal. Air emissions from plasma vitrification are not well-characterized.

A disadvantage is that transportation of carcass material is required if a mobile configuration is not utilized, thus increasing the risk of spreading infection. Also, carcasses larger than 100 pounds should be shredded before entering the plasma reactor. However, worker exposure to pathogens is minimized for smaller carcasses. It is somewhat limited by processing speed, currently at about 6-8 tons/day per module.

3.7 Environmental and Biosecurity Considerations of Disposal Options

3.7.1 Overview of Environmental and Biosecurity Considerations

This section will discuss environmental and biosecurity considerations associated with major disposal options outlined in sections 3.2-3.5. Consideration of potential negative environmental impacts and biosecurity factors must figure into effective disposal planning and response. All disposal options present some potentially negative environmental effects and must be accounted for in planning. Biosecurity risks are also present to varying degrees in each of the presented disposal methods.

Appropriate environmental regulatory agencies and stake holders should be included in planning for disposal site selection. Potential negative environmental effects of the selected disposal method on air quality, water quality, soil integrity, and other environmental factors should be considered. For example, when considering disposal methods, particularly unlined burial, the distance between the proposed disposal site and water reservoirs and wells should be determined so that appropriate environmental measures can be implemented to avoid contamination. It is critical that disposal planning include steps to prevent or mitigate negative environmental effects that may also ultimately impact human or animal health.

Potential human and vehicular traffic must also be considered and steps should be taken to maintain biosecurity in the surrounding areas. In planning for disposal, the initial stages will require access to roads and open areas that can provide a way for large trucks and other vehicles to access the disposal site. Careful planning and implementation of a biosecurity plan to prevent spread of infection from trucks and other equipment involved in transportation is critical to limiting disease.

Of particular concern is planning for disposal when the animal health event involves a TSE, diseases caused by prions. Bovine Spongiform Encephalopathy (BSE) is a type of TSE disease that poses an especially difficult challenge because the causal prions are extremely temperature resistant. Other diseases in this category include scrapie and chronic wasting disease. Very high temperatures (at least 1,830 °F or 1,000 °C) must be reached for a *minimum* of 15 minutes to destroy prions. Currently, only alkaline hydrolysis and fixed-facility burning can successfully destroy BSE prions in animal carcasses.

Efforts should also be directed at protecting wildlife and domestic scavengers from consuming or being exposed to carcasses and any associated infectious materials or pathogens. Exposure to or consumption of infectious materials by scavengers may increase the risk of mechanical transfer of the pathogen by wildlife or scavengers following contact with contaminated material. Scavenging may also result in the unintended movement of infected tissue or of accidental infection of susceptible wildlife that could then expose other susceptible animals.

3.7.2 Composting

Indoor and outdoor composting has similar environmental and biosecurity considerations and will be discussed together in this section. The initial composting phase may contribute to significant odors if site selection and technical procedures are not completed correctly. Care should be taken to select an appropriate site (downwind and adequate distance) to minimize the likelihood of causing a public odor nuisance. When using either indoor or outdoor composting, environmental and biosecurity risks will be decreased by utilizing well drained locations that are located outside floodplains and away from ground and surface water sources. Both indoor and outdoor composting requires prolonged management, maintenance, and monitoring. Care must be taken to identify a site that will have all-season access by personnel. Poor compost pile quality can result in various negative environmental effects and biosecurity concerns.



When outdoor composting is conducted at a proper site on well-compacted soil with appropriate cover, the risk of environmental contamination is low. One of the more likely forms of contamination is nitrogen in the form of ammonia or nitrate which is produced by decaying carcasses and could be released in the groundwater and surrounding soil. Ammonia concentrations beneath compost windrows have been shown to increase 40-160 times. These increases were limited to the top 15 cm of soil, however, and no statistically significant increases in ammonia were found below 90 cm. Further this is mitigated by using a 2-foot base of carbon source, which is the current standard practice. Total nitrogen added to the soil by composting has been estimated to be 25% or less of the amount of nitrogen added to the soil if carcasses were buried instead of composted. Environment plays a role in the amount of nitrogen released outside the compost pile. Regions where precipitation is higher will have an increased risk of nitrogen distribution from composting compared to more arid regions.

On-site composting reduces the biosecurity risks associated with transporting waste material off-site. However, if off-site carbon sources must be obtained, then biosecurity plans must be in place for incoming transportation vehicles to be decontaminated prior to leaving the site.

Covering the carcasses with sufficient material prevents the attraction of flies and scavengers (of particular concern in outdoor composting). If composting is performed properly, the temperatures achieved will inactivate most pathogens. One study demonstrated that 89% of compost piles using corn silage as the outer envelope (first few inches of compost pile) material of the compost pile met EPA Class A standards for biosolids (55° C or 131° F for at least 3 consecutive days) and 100% met Class B standards for biosolids (40° C or 104° F for at least 5 consecutive days). Other types of envelope material had lower success rates, so the choice of envelope material can be important in quickly achieving pathogen-killing temperatures, particularly during cold seasons.

Care must also be taken to ensure that core zones of the compost pile reach appropriate temperatures. It is unrealistic to expect all zones of an unturned or infrequently turned compost pile to reach pathogen killing temperatures. A practical approach is to place pathogen contaminated tissues in the core of the pile where temperatures are naturally highest and to use a sufficient thickness of envelope material around the core to insulate the core. This helps to retain heat and sustain higher temperatures where the contaminated material is located. Temperatures in the outer zones (top and sides of the pile) are less important since this material is not pathogen contaminated. Even if lethal temperatures are reached, some bacterial pathogens have been known to regrow when temperatures decline again. The regrowth populations, however, rarely equal peak populations found in untreated material because other factors in addition to temperature inhibit growth (e.g., organic acids, ammonia, and competitive microorganisms). Inhibition of bacteria can decline during long-term storage (i.e., two years), however, allowing pathogens to regrow.

As stated earlier, indoor composting may be chosen to dispose of poultry carcasses that have been depopulated using foam. Compared to outdoor composting, indoor composting may present less risk for spreading of infectious material outside the composting area due to uncontrolled weather or environmental effects. Regardless of composting method, composted materials should be tested prior to transportation to assure disease causing pathogens are not present.

3.7.3 Rendering

The rendering process is closely regulated to keep it environmentally safe, but biosecurity during handling and transportation can be problematic. If rendering is chosen as a carcass disposal option, selection of a facility with optimal biosecurity protocols is critical. Continuous rendering is often preferable when compared to batch rendering because of the decreased risk of spreading infectious disease. During batch rendering, each time a vessel is opened (for discharge of rendered contents or for re-filling), airborne particles are released and biosecurity is threatened. The airborne particles may compromise biosecurity when they are released and land on surfaces.

Rendering plant personnel should be familiar with the Code of Practice approved by the North American Rendering Industry. Though these practices were likely developed more for preventing pathogens from entering pet food supplies, they are relevant to processing waste materials during an animal health emergency. Rendering personnel should be trained in the site-specific biosecurity plan. Additional information can be found at <http://www.animalprotein.org>.

Handling and transportation of carcasses and other waste material increase the risk of spreading disease. This risk may be exacerbated if the number of carcasses exceeds facility capacity and some of the carcasses must be stored. Once the carcasses have been rendered, however, the end product is generally considered biosecure. The temperatures typically produced during rendering can kill many pathogens such as *Salmonella* spp. *Escherichia coli*, as well as other pathogens that may cause diseases such as botulism, tuberculosis, Plague, and tetanus. Carcasses that are contaminated with endotoxins, chemical residues, or are infected with pathogens that are not killed by rendering cannot be rendered into feed ingredients but are sometimes safe for landfills.

3.7.4 Permitted Landfill/Burial

3.7.4.1 Permitted Landfill

The construction of new trenches into the solid waste sections of an existing landfill may release odors and blowing trash. However, soil is an excellent odor absorbent and good landfill practices include prompt covering of odorous materials. Only fenced landfills should be utilized for disposal so that the impact of any blowing trash is minimized. Additional cover soil and/or improved gas collection may be

necessary to control the odor. Leachate recirculation may be required as a precautionary treatment, and some agencies require air and leachate sampling. Large numbers of carcasses can generate high amounts of leachate and methane that exceed landfill capacity. Any leaks or seepage should be repaired immediately. If the landfill is properly permitted and operated, these issues should be non-existent or minimal.

The output material resulting from the disposal of animal carcasses in landfills would be generally similar to that resulting from typical operations: leachate and landfill gas. Because these are normal byproducts of the landfill municipal site waste, systems are already in place to collect and treat these outputs. Depending on the type of pathogen, no additional systems will be necessary. However, because the composition of animal carcasses differs from that of typical municipal site waste, the disposal of significant quantities of carcass material in a landfill could affect the quantity and composition of leachate and landfill gas generated, and may warrant adjustments to the collection and/or treatment systems.

Like all off-site disposal methods, transportation of carcasses to landfills presents additional biosecurity challenges and plans must be in place to prevent spread through lapses during transportation. Workers who handle infectious carcasses need to take proper precautions and should be equipped with appropriate PPE in accordance with site-specific plans. In cooperation with appropriate public health agencies and medical assistance teams, personnel should be monitored afterward for signs of illness if pathogen of interest is zoonotic. Proper storage for carcasses awaiting disposal should prevent scavenging by wildlife. Carcasses that have been infected with persistent or potentially persistent pathogens should not be placed in landfills without prior regulatory approval.

3.7.4.2 Unlined Trench Burial

Unlined burial is often considered a disposal method that can be rapidly implemented. However, using burial as a disposal method during an animal health emergency also has significant environmental challenges. Contamination from leachate, runoff and ash burial can result in negative impacts to both private and public water supplies. The selection of a burial site is critically important and care must be taken to ensure that water sources are protected as well as private property and residences and public spaces such as roads, public lands, community parks, etc.

In addition to protecting water sources, goals for burial should include odor mitigation and prevention of negative environmental impacts on soil and air quality. Decomposition of carcasses and related materials is lengthy and residues may persist in the soils for years. Burial of significant numbers of carcasses in mass burial sites will create tremendous volumes of leachate requiring further management and disposal. Additionally, gaseous products may require extra management if produced in significant quantities.

Certain geological conditions, such as sandy soil and a high seasonal water table, can increase the risk of contaminants reaching the groundwater. For this reason, states that allow the burial of livestock usually have regulations that dictate how close a burial pit can be located to water sources.

Although nitrogen is ubiquitous in the environment, mass burial practices can exceed the normal load. One thousand pounds of carcasses contains about 20 pounds of nitrogen, so high density mass burial (30 lbs. /ft²) over a large area can add the equivalent of over 20,000 pounds of nitrogen per acre to soil beneath the carcasses. Bacteria (and sometimes fungi) convert this nitrogen to ammonium, which is highly toxic to fish if it reaches the water supply. Ammonium is then converted to nitrate, which is a concern for drinking water because it can cause human health problems. Nitrates also contribute to the deposition of excessive nutrients in surface water (termed eutrophication), a process that leads to algal blooms, reduced water quality, fish kills, and decreased biodiversity. Though not as prevalent as nitrogen, phosphorus is another by-product of decomposition that can cause eutrophication.

If on-site burial is chosen, then biosecurity considerations associated with transportation of potentially infected material is not required. On-site burial limits the movement of carcasses—thus preventing the geographic spread of infection—but the burial process does not inactivate pathogens. This poses biosecurity risks that must be accounted for if burial is chosen as a disposal method. Some pathogens can be very persistent. Cattle carcasses that have been experimentally infected with *Salmonella typhimurium*, *Salmonella enteritidis*, *Bacillus cereus*, and *Clostridium perfringens* have been shown to cause extensive contamination in the soil and in a nearby drainage ditch within one week of burial. In addition, the EPA has reported that avian influenza virus has the potential to survive in groundwater for more than thirty days. These pathogens continued to be isolated for another 15 weeks. Anthrax spores, from the bacterium *Bacillus anthracis*, can be especially problematic because they can survive for long periods in the soil and can resurface even without mechanical disturbances such as plowing. Thus, carcasses infected with spore forming bacteria may not be candidates for burial and incineration should be strongly considered as an option. Pathogens, like chemicals, can also reach the water supply, but the risk seems to be related to similar geological factors. Burial is also not a suitable disposal option to consider for animals infected with or exposed to a TSE.

Regardless of the cause of an animal health emergency, if burial is used as an option, then plans must include long term monitoring, management and environmental testing of burial sites. Plans should also include steps for environmental remediation in the likely event that monitoring reveals elevated levels of contaminants.

3.7.5 Thermal Methods

Thermal methods have important environmental and biosecurity considerations. In terms of monetary costs, air-curtain and fixed-facility incineration are considered relatively economical disposal methods. During an animal health emergency involving a TSE the use of fixed-facility incineration is very biosecure and advantageous because this method is capable of inactivating prions.

Open burning may negatively affect groundwater and other public and private water sources supplies but air-curtain and fixed-facility incineration do not typically result in environmental water issues. Negative air quality effects are of particular concern when utilizing open-air burning. Thus, proper planning and effective communication with all applicable agencies and stakeholders is critical when considering this method.



If fixed-facility incineration is chosen as a disposal method, biosecure transport to the facility and plans for temporary carcass storage should be included in overall planning. This planning will be critical because fixed-facility incineration will likely be limited in its capacity to keep up with the depopulation rate.

3.7.5.1 Fixed-Facility Incineration

Although fixed-facility incineration can only dispose of limited amounts of waste material, this method has less negative environmental impact when compared to air-curtain or open-air burning. However, regulations are managed at the State level and may vary from state to state. It may be costly for a fixed-facility incinerator to comply with environmental regulations. Similar to what was described with open-air burning; some air pollution is associated with this method. However, this problem can be mitigated with emission control devices and reduced when afterburners are installed on the incinerators to process

the smoke. In addition, the ash generated using this method is often less problematic to manage compared to open-air burning because it is in a discrete closed container rather than distributed over open land. Cleaning and disinfection of a fixed incineration facility after it has processed infectious material presents a considerable challenge and it is essential for operators to be trained in biosecurity procedures.

Fixed-facility incineration may take place on-farm in some cases when the incinerator has already been installed on the premises. This may result in decreasing associated transportation costs as well as reducing likelihood of disease transfer associated with transportation of waste material. However, in an animal disease emergency, these smaller on-farm incinerators would likely be overwhelmed.

Operation of the fixed-facility incinerator by knowledgeable and trained personnel is critical to reduce negative environmental impacts because overloading of the incinerator can contribute to odor problems. In addition to odor issues, overloading of carcasses into the incineration unit can contribute to increased smoke.

Similar to open-air burning, the temperatures reached during incineration will inactivate many pathogens. In addition, the high temperature reached in a fixed-facility incinerator is capable of destroying prions. The incineration unit must not be overloaded with carcasses and related waste material because that can cause temperatures to drop below optimal levels. Since this disposal method would likely require transportation of carcasses, one biosecurity risk that must be planned for is the increased risk of disease transmission during movement of carcasses from premises to the fixed-facility.

3.7.5.2 Air-Curtain Incineration

Incineration processes such as air-curtain incineration can emit hydrocarbons, heavy metals and metal salts, fuel specific chemicals, nitrous particles, sulfur dioxide, nitrogen dioxide, dioxins and other pollutants into the air. Air-curtain incineration is the most rapid of the thermal disposal methods and can be considered for large-scale events. Air-curtain incineration is one of the most practical and environmentally acceptable emergency incineration options. It is relatively clean-burning if operated correctly (not loaded too fast with carcasses), with a relatively high capacity that can be set up quickly on the disaster site. It can be a “fixed” or on-site technology as well as a mobile disposal technology. Because of its speed and capacity, it produces lower amounts of air-emissions compared to open-air burning. Air-curtain incineration traps unburned particles present in smoke under a curtain of air so they can be burned down to an almost gaseous state. Water misters may also be used to potentially further reduce emissions. Pollutants can be potentially further reduced with the use of a refractory box instead of trenches. Improper loading can produce smoke and odor, though, so air-curtain incinerators still require monitoring to ensure the safety of local residents. Even if emissions do not reach hazardous levels, the smoke and odor can generate nuisance complaints. Air-curtain incineration may also have indirect environmental impacts because carcasses typically have high water content (estimated 70%) and require large amounts of fuel to burn. In some cases, wood or coal may need to be transported long distances for use in incinerators. Residues produced by air-curtain incineration may contain nutrients that can cause algal blooms if local water sources become contaminated. This method requires less liquid fuel than open-air burning but locating large amounts of wood fuel for this disposal option can be difficult in some regions.

Air-curtain incinerators are mobile, reducing the biosecurity risks associated with carcass transport. Incineration also destroys many viruses, so the ash may be disposed of either on-site or off-site. Although temperatures are typically higher than those reached in open-air burning, they cannot be adequately monitored or regulated to ensure that TSE infected material would be rendered non-infectious. Thus, this method is not recommended for disposal of carcasses with a suspected or confirmed infection with a TSE agent.

3.7.5.3 Open-air Burning

Uncontrolled open-air burning has the potential to generate excess pollutants in the form of smoke and odor, the possibility of creating a public nuisance, the risk of causing unintended fires, and the violation of regulatory restrictions. Uncontrolled open-air burning is distinguished from air-curtain incineration, which is also done in the open; because air-curtain incineration combustion is comparatively clean due to control of the air/fuel mixture during combustion. Uncontrolled open-air burning may also have indirect environmental impacts because carcasses have high water content and require large amounts of fuel to burn. The water content also makes open burning a slow process.

Incineration processes such as open-air burning can emit hydrocarbons, heavy metals and metal salts, fuel specific chemicals, nitrous particles, sulfur dioxide, nitrogen dioxide, dioxins and other pollutants into the air. Ground water and soil contamination may also result from pollution by hydrocarbons. Open-air burning of carcasses yields relatively benign waste such as ash which does not attract pests. However, the volume of ash generated by open-air burning can be significant. Each ton of carcasses yields 0.3 tons of ash which presents another material that must be disposed of, particularly when many tons of carcasses are incinerated. Depending on groundwater considerations ash-disposal options range from burying it on-site to disposing of it at landfills. Additional clean-up challenges surround groundwater and soil contamination caused by hydrocarbons used as fuel.

Biosecurity risks must also be considered for open-air burning. Temperatures reached during open burning vary more than other incineration methods, so pathogens may not be inactivated and could be dispersed in smoke particles. As with all disposal options, any backlog of carcasses could pose an additional biosecurity threat and storage methods must be considered.

3.8 Transportation of Waste Materials

Although not always possible, on-site disposal is preferred from a biosecurity perspective so that biosecurity issues associated with transportation of carcasses are avoided. However, onsite disposal options have serious limitations such as environmental harm with unlined burial; lack of carbon sources and inadequate space for composting; and limited throughput for transportable options, making transport likely. Transportation of carcasses requires thoughtful and extensive planning to ensure good biosecurity and to prevent further spread of disease. Biohazardous waste must be transported in closed, leak-proof dumpsters or trucks and the exterior of the loaded vehicle must be disinfected prior to transport. Additional or secondary containment may be necessary.

In cases where conventional on-site disposal methods (e.g., burial or incineration) are deemed infeasible, plans should be made for the safe, efficient transfer of carcasses and material to another site for disposal. There are also additional costs involved in transporting as well as considerable time and investment in biosecurity and cleaning and disinfection of all transportation vehicles. Some pre-processing of carcasses may also be necessary before transportation to the main facility or disposal area. Careful planning is also necessary as animals, if not preprocessed, must be transported in a timely manner so that excessive decay has not set in.

Examples of situations in which off-site disposal may be considered include the following:

- Infectious material from laboratories in need of disposal and on-site disposal facilities are limited or unavailable.
- On-site constraints such as insufficient space, unsuitable soil, a high water table, or seasonal conditions make on-site disposal infeasible.

- All on-site locations are too close to areas of human habitation.
- Carcasses can be landfilled or rendered off-site more efficiently than they can be disposed of on the premises.

Transportation of contaminated waste materials from affected premises to off-site locations requires that special procedures be followed to prevent the spread of disease agents. In addition to EPA regulations, the U.S. Department of Transportation also requires materials to be classified prior to transport on public roads. According to the Department of Transportation Hazardous Materials Program Definitions And General Procedures at 49 CFR 105.5(b), “Hazardous material means a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and has designated as hazardous under section 5103 of Federal hazardous materials transportation law (49 U.S.C. 5103).”



Vehicles must be cleaned and disinfected before they leave the affected premises and again after the material has been unloaded at the disposal site. Depending on State law, special escort vehicles also may be required. Before a visit to a premises that is known to be infected or potentially exposed, and thus scheduled for euthanasia and/or disposal, cleaning and disinfection procedures must be followed. The *FAD PReP/NAHEMS Guidelines: Cleaning and Disinfection (2011)* and *Biosecurity (2011)*, as well as the associated SOP, should be consulted for further information.

4. SITE-SPECIFIC DISPOSAL METHOD SELECTION CRITERIA

4.1 Overview

The selection of optimal disposal sites in an animal health incident involves a variety of factors and concerns. Disposal plans must be site-specific and account for many variables including pathogen and species type, environment, and public health perception. USDA APHIS Veterinary Services NACHEM has developed a series of questions to aid in determining the most appropriate site-specific method of disposal. The questions have been ordered to minimize waste of material and transport, and maximize generation of beneficial products. This decision tree can be reviewed in the *FAD PReP SOP: Disposal*. This section summarizes some primary considerations in site selection, including decision making, on-site disposal, and additional disposal strategies such as off-site disposal and temporary storage.

4.2 Regional Limitations

Consultation with local, county, State, and Federal environmental officials will be necessary to obtain specific information for the region or community in order to minimize any negative environmental effects associated with the disposal of contaminated material. To gain information regarding geophysical considerations regarding soil type/condition and water table level, consult the USDA Natural Resources Conservation Service. All applicable public health or environmental protection laws, including fire codes and other regulations should be determined and followed. Regional climatic trends should also be considered (for example,



the general direction of prevailing winds) and seasonal considerations (precipitation, thermal factors) when considering various on-site methods of disposal. When burial will be used as a method of disposal, local authorities must be consulted about the minimum permissible distance between wells and water reservoirs at the bottom of the burial pit. In addition, local authorities should be consulted to determine what permits need to be obtained as well as for general advice and recommendations.

4.3 Safety Considerations

The assigned Safety Officer should be consulted to provide guidance in disposal site selection. Proper site selection protocols must be followed to avoid injury. On-site burial decisions must be made by communicating and cooperating with appropriate technical and decision making groups within the incident command structure. Proximity to high-density housing or other public areas should be avoided, particularly if incineration or open-air burning is to be used. All personnel should be properly trained and knowledgeable of the planned strategies. A Safety Officer should be available at all times for further guidance and direction. The U.S. Occupational Safety and Health Administration (OSHA) has outlined requirements and recommendations for those working in hazardous waste operations involving pathogens (CFR, Part 21, Chapter 1910, <http://www.osha.gov/SLTC/hazardouswaste/index.html>).

4.4 Number, Species, Types of Animals to be Disposed

The overall biomass of the animal carcasses to be disposed of must figure heavily into disposal method considerations. Obviously, the disposal of 1,000,000 chickens (each weighing perhaps 3.5 pounds) presents a different scenario than disposing of 1,000,000 head of cattle (each weighing an estimated 1,000 pounds). Necessary equipment to handle carcasses will also vary by animal type and species as well as number. Personnel required to carry out disposal activities will also vary based on number, species, and types of animals to be disposed of. In addition, potential animal by-products should also be considered when planning. For example, disposal activities related to dairy cattle will also need to include plans for disposal of milk.

4.5 Considerations for Temporary Disposal Storage

Prompt carcass disposal following depopulation activities may be impossible due to factors such as exceeding the capacity of the selected disposal method and equipment breakdown. During an animal health emergency that involves depopulation, members of the Disposal Group strive to properly dispose of contaminated or potentially contaminated animal carcasses and related materials within 24 hours of depopulation. However, in a major animal health emergency, carcasses will likely exceed the capacity of available disposal methods and temporary storage may be necessary. As part of selecting a disposal option and planning disposal activities, preparations must occur to account for where and how carcasses and related materials will be stored before undergoing the selected disposal procedure. In such situations, carcasses and associated materials awaiting disposal should be secured to prevent unauthorized access and potential disease spread to susceptible species. Disease transmission can occur via humans, domestic pets, wild animals, birds and fomites.

The EPA has published regulations regarding storage and collection of solid waste, which can be applied to animal mortalities, which are essentially food waste. According to 40CFR243.200-1(a):

“All solid wastes ... shall be stored in such a manner that they do not constitute a fire, health, or safety hazard or provide food or harborage for vectors, and shall be contained or bundled so as not to result in spillage. All solid waste containing food wastes shall be securely stored in covered or closed containers which are nonabsorbent, leak-proof, durable, easily cleanable (if reusable),

and designed for safe handling. Containers shall be of an adequate size and in sufficient numbers to contain all food wastes, rubbish, and ashes that a residence or other establishment generates in the period of time between collections. Containers shall be maintained in a clean condition so that they do not constitute a nuisance, and to retard the harborage, feeding, and breeding of vectors. When serviced, storage containers should be emptied completely of all solid waste.”

One option for temporary storage involves refrigeration in a closed building. Another involves grinding and preserving carcasses. Guidance should be sought from State and local regulatory agencies regarding any required minimum setback distances. Care must be taken to plan for temporary storage in areas that are not near public areas or roads. In some cases, carcasses may be stored on trucks to await transportation for disposal. Trench silos or pits may also be used to temporarily store carcasses but care must be taken to prevent environmental contamination. Proper planning and implementation of a biosecurity plan to prevent the further spread of disease will be critical when planning for temporary disposal storage.

5. CLASSIFICATION OF WASTE MATERIALS

During an animal disease emergency involving large numbers of animal mortalities, carcass disposal will be a priority. However, in addition to animal carcasses, significant amounts of associated materials will require disposal. Other common waste material types likely to be encountered during a response include:

- Animal by-products—milk, wool, etc.
- Bedding of all types, manure, hatchery waste
- Feeds-hay, grains, silage
- Equipment, supplies, and materials (e.g., personal protective equipment, trash, and sharps such as vaccination or diagnostic syringes and needles)
- Debris, including buildings and structures

All waste materials slated for disposal and/or transport during an FAD response must be correctly classified prior to disposal to assure that appropriate disposal and transportation methods are selected. Most animal related waste generated during a response to an animal health incident will be classified as solid waste, but not classified as hazardous waste for disposal purposes. However, for transport purposes, infectious waste (including carcasses, bedding, etc.) which can cause disease or death in animals or humans is classified as hazardous material.

According to the EPA website (<http://www.epa.gov/osw/hazard/wastetypes/wasteid/index.htm>):

The hazardous waste identification (HWID) process is the crucial first step in the hazardous waste management system. Correctly determining whether a waste meets the Resource Conservation and Recovery Act (RCRA) definition of hazardous waste is essential to determining how the waste must be managed. The waste generator has responsibility for determining if a waste is a RCRA hazardous waste. (See: 40 CFR [Code of Federal Regulations] 262.11)

Waste classification can be complex and it may have far ranging implications of handling, transportation and disposal. Classification, transportation, and subsequent disposal of waste materials should comply with all applicable laws. Strict consideration needs to be given to federal laws, as well as the laws of the state where the waste is generated and where the waste is disposed of. In some instances, local jurisdictions will also have relevant and applicable regulations to consider. Classification is a determining factor in considering whether a proposed facility is permitted to accept the waste. Because regulations may vary between states, do not assume all states' waste classification regulations are similar when planning and responding. This is particularly relevant if waste generated during a response could be transported across state lines for further processing.

The relationship between state and federal government authority for waste classification and disposal may vary between responses and even between states for the same response. Personnel involved in decision making should identify and consult all relevant requirements for guidance on waste classification.

Unless designated as nuclear waste, all wastes are termed “solid.” Following designation as solid waste, further classifications may occur. Solid waste materials related to disposal are likely to be further classified into the following categories:

- Hazardous (solid) waste
- Medical and infectious (solid) waste

Waste classifications may vary widely in regards to diseased animal disposal as well as disposal of associated waste materials. Professionals familiar with all regulations in the affected states should be included in planning and response related to waste classification and disposal methods. Once classified, the EPA’s I-WASTE Tool (<http://www2.ergweb.com/bdrtool/home.asp>) may provide guidance to those making disposal decisions. Further discussion of the tool as well as a disposal options matrix is found in the *FAD PReP SOP: Disposal*.

5.1 Solid Waste

Subtitle D landfills can be used to dispose of solid waste that is not classified as hazardous as well as some medical waste. Most Subtitle D landfills are privately owned and operated; however, some municipalities still operate landfills. The local or state permit or license under which each landfill operates will dictate the range, quantity and types of materials they can accept; however, privately held landfills are generally under no obligation to accept wastes and they could restrict the disposal of response related materials. The development of pre-event agreements regarding the acceptance of appropriate response-related solid waste could facilitate and expedite disposal.

5.2 Hazardous (Solid) Waste

Classification of waste is affected by 40 CFR 262.11(<http://www.gpo.gov/fdsys/pkg/CFR-2011-title40-vol26/xml/CFR-2011-title40-vol26-sec262-11.xml>) which requires that any person generating a waste must determine if that waste is hazardous waste, following strict protocols.

The EPA (<http://www.epa.gov/osw/hazard/index.htm>) defines a hazardous waste as: “waste that is dangerous or potentially harmful to our health or the environment.” Hazardous wastes can be liquids, solids, gases, or sludges. They can be discarded commercial products, like cleaning fluids or pesticides, or the by-products of manufacturing processes.” As an example, many of the chemicals used to disinfect premises following disposal procedures may be considered hazardous waste. Any response related waste that is classified as hazardous waste will require special shipping and manifesting to a permitted treatment-storage-disposal facility approved to accept the materials being disposed of. The generator of the waste will need to obtain a generator number from the appropriate authority (state or federal) and the waste will need to be shipped by a permitted transporter.

5.3 Medical and Infectious (Solid) Waste

A portion of the waste material associated with a response to an animal health emergency may be classified as medical and/or infectious waste. The Medical Waste tracking Act of 1988 (<http://www.epa.gov/osw/nonhaz/industrial/medical/index.htm>) defines medical waste as "any solid waste that is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals." This definition includes “all

waste materials generated at health care facilities, such as hospitals, clinics, physician's offices, dental practices, blood banks, and veterinary hospitals/clinics, as well as medical research facilities and laboratories.” There are exemptions from some waste being designated as medical waste but the determination must be performed using expert opinion.

Several federal agencies regulate different aspects of medical waste management that could impact disposal:

- The Department of Transportation regulates medical waste transportation
- The Occupational Safety & Health Administration regulates medical waste in the workplace
- The Food and Drug Administration regulates medical devices such as sharps containers which safely contain needles used during an animal health emergency

The EPA does not have any specific or unique regulations on disposal of medical wastes at landfills. Although it may not be directly applicable to a livestock disease response, EPA does have regulations governing emissions from Hospital/Medical/Infectious Waste Incinerators as well as requirements under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) for medical waste treatment technologies which use chemicals for treating the waste. These regulations may affect disposal technologies such as fixed-facility incineration as well as alkaline hydrolysis.

Regulated medical waste (RMW), also known as ‘biohazardous’ waste or ‘infectious medical’ waste, is the portion of the waste stream that may be contaminated by blood, body fluids or other potentially infectious materials, thus posing a significant risk of transmitting infection. There are several key categories of waste that are typically classified as ‘regulated.’ Each category typically has special handling requirements that may be state-specific. Most state laws require RMW to be rendered non-infectious before it can be disposed of as solid waste. RMW is unique to the healthcare sector and presents a number of compliance challenges, however, contaminated animal carcasses, body parts and bedding from animals intentionally exposed to pathogens in research, biologicals production, or in vivo pharmaceuticals testing may be RMW. Unlike many regulations that apply to healthcare, most regulations governing medical waste are defined at a state, rather than a federal level. Adding yet a further level of complexity, authority for medical waste rules often comes from multiple agencies at the state level.

EPA also provides guidance on medical-infectious waste. According to the EPA website (<http://www.epa.gov/wastes/nonhaz/industrial/medical/disposal.htm>), medical waste includes all waste materials generated at health care facilities, such as hospitals, clinics, physician’s offices, dental practices, blood banks, and veterinary hospitals/clinics, as well as medical research facilities and laboratories. Typically, State Departments of Health issue the regulations that determine which wastes are considered ‘regulated’ or require special handling. Use the RMW State Locator (<http://www.hercenter.org/rmw/rmwlocator.cfm>) to find the definitions that apply in your state. The RMW State Locator provides contact information for individuals in state agencies who may help resolve questions of interpretation. Most waste generated during a response to an animal health crisis will be classified as solid waste. Some waste may be classified as medical waste and little, if any waste, is likely to be classified as hazardous waste.

It is imperative that waste materials related to disposal during an animal health crisis are correctly classified. Because state rules and regulations vary for disposal of diseased animals and associated waste materials, all applicable or relevant and appropriate requirements must be consulted. Planning and response efforts for waste classification should include consultation with experienced personnel familiar with all disposal regulations in the affected areas.

6. CONSIDERATIONS FOR SELECTION OF POTENTIAL DISPOSAL METHODS FOR SELECTED WASTE MATERIALS

6.1 Overview of Considerations

Expertise in disinfection should be sought prior processing liquid wastes such as milk, dairy wastewater, or fluids from lagoons. It is important to plan appropriately for biosecure disposal of manure, litter, and slurry infected or exposed to the bacterial or viral pathogen of concern. Depending on the pathogen, contaminated materials may be burned, buried, composted, or landfilled. Manure or litter that cannot be burned or buried should be fenced off. Once treated and rendered non-infectious, the waste can be applied to the land. Hatching eggs should be macerated to ensure death before disposing by burial or other means.

Livestock feeds such as dry grains, hay, and straw all act as potent fomites and can harbor the infectious agent. If not properly handled and treated, they can facilitate the spread of infection. If on-site methods such as burying or incineration are used to manage carcasses, these materials may be processed in a similar manner. In some cases, off-site management, such as transport to a landfill, could be an option. If this is chosen, biosecurity measures must be utilized to prevent further transmission of disease through transport of this material.

Silage and wet or modified distiller grains may be composted on-site in some cases. It is possible to combine these with other feeds, straw, hay, manure, and bedding. The carbon nitrogen ratio as well as moisture and particle size must be carefully considered if substituting any of these materials for the primary carbon source. However, the addition of small amounts ($1/2 \text{ yd}^3$ or 382 L) with each 1000 lb. (454 kg) of carcass will have little effect. If germplasm such as semen or ova is determined to pose a risk of agent spread, it must be disposed of safely. Pathology incineration or burial represent viable options. Any germplasm that is not disposed of can be moved only under USDA permit.

In order to ensure compliance with all environmental regulations, waste materials from a response should be sorted by class and material type. The plan should include consideration of the types of waste expected and the corresponding classifications. Once the various waste streams are identified, quantities of each waste type can be estimated to facilitate efficient transport and to identify appropriate disposal options.

6.2 Type and Strain of Pathogen

A comprehensive understanding of the type and strain of pathogen associated with the decision to depopulate and dispose of animals is essential to prevent further spread of infection and to safeguard human, animal, and environmental safety and security. In addition, it also weighs heavily in transportation planning as well as human safety—both during disposal activities and following them. Biosecurity and cleaning and disinfection protocols will be largely based on the type and strain of pathogen. The *FAD PreP SOP: Disposal* provides further details regarding potential health risks, disposal methods and potential pathways of pathogen transfer to humans.



6.3 APHIS Emergency Management Tools Decision Tree and Checklist

USDA APHIS has developed emergency management tools to be utilized during an animal health emergency. Disposal decision trees are an aid to determining the most appropriate disposal option. This useful tool provides a simple and straightforward method to determine optimal types of disposal for a specific site. The tools can be accessed at:

http://www.aphis.usda.gov/emergency_response/tools/aphis_disposal_tree.shtml.

In addition to the decision tree, a checklist has been developed by the USDA and provides further guidance to the Disposal Group Supervisor and other key decision makers in the creation of a realistic and effective site-specific disposal plan. The checklist has been included in the *FAD PReP Standard Operating Procedures: Disposal* and is based on the disposal goals defined in the Introduction of this Guidelines document.

- Efficient outbreak containment
- Environmental sustainability including minimizing waste
- Stakeholder acceptance
- Cost effectiveness

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8. FOR MORE INFORMATION

- Riverside County California Waste Management Department has a video on animal carcass burial in landfills. Go to <http://www.rivcowm.org/>
- The Ohio State University offers a livestock producers' program on mortality composting certification offered through their Agriculture and Natural Resources Office: http://oardc.osu.edu/ocamm/t01_pageview/Home.htm
- The Ohio State University also offers a compost course titled, "Science, Art of Large-Scale composting". See http://oardc.osu.edu/ocamm/t01_pageview/Home.htm.
- Online Carcass Disposal Training Modules through APHIS are available at: http://www.aphis.usda.gov/emergency_response/tools/aphis_role_emergency_tools.shtml
- University of Nebraska at Lincoln Extension: http://www.extension.org/pages/28022/livestockand-poultry-mortality-composting#Routine_.26_Emergency_Carcass_Composting
- Cornell University Waste Management Institute - <http://cwmi.css.cornell.edu/mortality.htm>
- Washington State University Agricultural Extension - <http://extension.wsu.edu/agriculture/animals/Pages/default.aspx>
- Kansas State University, Purdue University, and Texas A&M University <http://fss.k-state.edu/FeaturedContent/CarcassDisposal/CarcassDisposal.htm>
- The Solid Waste Association offers certification programs and educational programs on various solid waste topics: landfilling, composting, and the collection and transfer of solid waste. See <http://swana.org/Education/Educate/tabid/53/Default.aspx> for a list of programs.
- There is an annual symposium on the Management of Animal Carcasses, Tissue and Related Byproducts. See <http://extension.umaine.edu/ByproductsSymposium09/proceedings/InternationalSymposiumProceedings.pdf> for a sample of the 2009 proceedings.
- Purdue University's National Biosecurity Resources Center for Animal Health Emergencies offers a Graduate Certificate Program in Veterinary Homeland Security in a class titled, "Euthanasia and Carcass Disposal" is offered as part of the certificate program. The course discusses different disposal methods such as rendering, burial, incineration, and composting. See <http://www.biosecuritycenter.org/article/vetHomelandProgram> for more information on the certificate program and course offerings.
- USDA APHIS, Carcass Disposal Training Tool: On-site Burial and Treatment Course, http://www.aphis.usda.gov/emergency_response/tools/on-site/htdocs/index.html
- USDA APHIS Online Carcass Disposal Options training module at http://www.aphis.usda.gov/emergency_response/tools/aphis_role_emergency_tools_disposal_training.shtml

- USDA APHIS, Carcass Disposal Training Tool: In-House Composting Training Module, http://www.aphis.usda.gov/animal_health/emergency_management/in-house_composting/
- Rendering information- Essential Rendering” a comprehensive scientific reference developed by the NRA. The link to Essential Rendering is: nationalrenderers.org/publications/essential-rendering
- For a list of renderers see <http://assets.nationalrenderers.org/NRA2010directory.pdf>
- For more information on ICS concepts, see FEMA training at <http://training.fema.gov/EMIWeb/IS/ICSResource/index.htm>
- A list of state environmental agencies is maintained by the United States Environmental Protection Agency at: <http://www.epa.gov/epahome/state.htm>
- A list of State Public Health Veterinarians is maintained by the AVMA at: <https://www.avma.org/KB/Resources/Reference/disaster/Pages/Disaster-Preparedness-State-public-health-veterinarians-of-the-United-States.aspx>
- The U.S. Occupational Safety and Health Administration (OSHA) have outlined requirements and recommendations for those involved in hazardous waste operations involving pathogens. (Code of Federal Regulations, Part 21, Chapter 1910, <http://www.osha.gov/SLTC/hazardouswaste/index.html>)
- To locate a list of local landfills and other disposal sites for off-site disposal, go to the EPA’s I-WASTE tool at: <http://www2.ergweb.com/bdrtool/login.asp>.
- To locate applicable information on health and safety, consult the APHIS Health and Safety Plan (HASP) - http://www.aphis.usda.gov/emergency_response/hasp/health_safety_procedures.shtml

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10. PHOTO AND ILLUSTRATION CREDITS

- Page 2** This photo depicts participants in an emergency response training exercise. Photo source: Randy Schawang, David City, Nebraska
- Page 4** Figure 1. This figure demonstrates a sample Incident Command System. Graphic illustration by: Andrew Kingsbury, Iowa State University
- Page 7** Figure 2. This illustration shows the position of a Disposal group within the ICS Structure. Graphic illustration by: Andrew Kingsbury, Iowa State University
- Page 12** **(Top)** Table 1. This table defines Zones and Areas established around some premises in the event of a highly contagious FAD. Graphic illustration by: Dani Ausen, Iowa State University
(Bottom) This photo shows the disposal of personal protective equipment that may be used during a FAD response. Photo source: Iowa Department of Agriculture and Land Stewardship
- Page 13** This image depicts a composting pile at an outdoor composting facility. Photo source: Ken Hammond, USDA Agricultural Research Service
- Page 14** This photo depicts heavy equipment and personnel involved in the turning of compost. Photo source: USDA Agricultural Research Service
- Page 15** **(Top)** This is an image of an indoor composting facility. Photo source: Danelle Bickett-Weddle, Iowa State University
(Bottom) This is an image of a rendering plant. Photo source: David Meeker, National Renderers Association
- Page 18** Figure 3. This schematic diagram illustrates the machinery, equipment, and material flow in a continuous dry rendering process. Content provided by: David Meeker, National Renderers Association
- Page 19** This photo shows the disposal of waste material at a landfill. Photo source: David Meeker, National Renderers Association
- Page 21** **(Top)** Figure 4. This is a schematic diagram of trench burial. Graphic illustration by: Andrew Kingsbury, Iowa State University
(Bottom) This is an image of trench burial. Photo source: Jeff G. Taber, County of Kings Department of Public Health, Hanford, California
- Page 22** This photo is of a disposal using a fixed-facility incinerator. Photo source: Iowa State University Veterinary Diagnostics and Production Animal Medicine
- Page 23** This is an image of burning waste material. Photo source: Norman Fuhrmann, Air Burners, LLC
- Page 27** This image illustrates a compost pile with a thick cover. Photo source: Iowa State University Veterinary Diagnostics and Production Animal Medicine
- Page 30** This is an image of open-air burning. Photo source: Norman Fuhrmann, Air Burners, LLC
- Page 33** **(Top)** This is an image depicting cleaning and disinfection of a vehicle involved in a FAD response. Photo source: Danelle Bickett-Weddle, Iowa State University
(Bottom) This image illustrates the importance of consultation with local, county, State, and Federal environmental officials to select an optimal disposal method during an FAD. Photo source: Alex Ramirez, Iowa State University
- Page 38** This image depicts a responder in PPE and demonstrates the importance of considering safety when choosing a disposal method. Photo source: Andrew Kingsbury, Iowa State University

Glossary

Animal

Any member of the animal kingdom, except a human (Animal Health Protection Act, 2002).

Animal and Plant Health Inspection Service

Agency within USDA responsible for protecting livestock and plant health.

Biosecurity

A series of management practices designed to prevent the introduction of disease agents onto or prevent the spread from an animal production facility.

Biosecurity Plan

A plan or protocol that reflects biosecurity principles and procedures concerning the movement of personnel, vehicles, and equipment; examination of animals (alive or at necropsy); mass depopulation; and the disposal of animal carcasses, animal products, feed, water, straw, hay, and other materials potentially carrying a disease agent.

Bovine

Common domestic cattle and other members of the Family Bovidae.

Cleaning and Disinfection (C&D)

Practices involving a combination of physical and chemical processes that kill or remove pathogenic microorganisms—a combination that is vital for the eradication of disease.

Compost

Compost is the semi-stable humus resulting from the biologic degradation of organic matter under aerobic conditions.

Euthanasia

Deliberate ending of an animal's life in a manner that causes minimal pain and distress.

Feedlot

An area of land where cattle are fattened for harvest. Cattle are kept in groups/pens and fed custom diets that are designed to increase their rate of gain.

Fomite

An inanimate object or material on which disease-producing agents may be conveyed (e.g., feces, bedding, harness, etc.).

Foreign Animal Disease

A terrestrial animal disease or pest, or an aquatic animal disease or pest, not known to exist in the United States or its territories.

Hay

A high fiber crop (grass or legumes) that is mowed, allowed to dry in the field and made into bales (square or round) and moved to the dairy to be fed to cows as roughage.

Incident Command System

A standardized, on-scene, all-hazards incident management approach that allows for the integration of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure; enables a coordinated response among various jurisdictions and functional agencies, both public and private; and establishes common processes for planning and managing resources.

Leachate

The liquid or fluid released from the decaying carcasses.

National Veterinary Stockpile (NVS)

Established by Homeland Security Presidential Directive 9 and operational in 2006. Able to deploy large quantities of veterinary resources anywhere in the continental U.S. within 24 hours.

Personal Protective Equipment (PPE)

Equipment used as a barrier between an individual and a hazard that could result in an injury or occupational illness.

Premises

A tract of land, including its buildings, or a separate farm or facility that is maintained by a single set of services and personnel.

Ruminant

Animals (cattle, sheep, goats, deer and camels) with a four-compartment stomach (rumen, reticulum, omasum, abomasum) that digests forages and grains and turns it into energy. Ruminants chew their cud (regurgitate forages from the rumen) to aid in digestion.

Zoonotic Disease/Zoonoses

Diseases that are transmissible from animals to humans under natural conditions.

Acronyms

APHIS

Animal and Plant Health Inspection Service (<http://www.aphis.usda.gov>); an agency of the U.S. Department of Agriculture

APPI

Animal Protein Producers Industry

ARARS

Applicable or relevant and appropriate requirements

AVMA

American Veterinary Medical Association

BSE

Bovine Spongiform Encephalopathy

CFR

Code of Federal Regulations

C&D

Cleaning and Disinfection

EMRS

Emergency Management Response System

EPA

Environmental Protection Agency

FAD

Foreign Animal Disease

FMD

Foot-and-Mouth Disease

GIS

Geographic Information Systems

GPS

Global Positioning System

ICS

Incident Command System

I-WASTE

Incident Waste Assessment & Tonnage Estimator

MSWLF

Municipal Solid Waste Landfills

NAHEMS

National Animal Health Emergency Management System

OSHA

Occupational Safety and Health Administration

NRCS

Natural Resources and Conservation Service

NVS

National Veterinary Stockpile

PPE

Personal Protective Equipment

SOP

Standard Operating Procedures

TSE

Transmissible Spongiform Encephalopathy

USDA

United States Department of Agriculture

VS

Veterinary Services; a division of APHIS