National Animal Health Emergency Management System Guidelines

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Operational Guidelines:

Disposal

The National Animal Health Emergency Management System Guidelines provide an operational framework for use in dealing with an animal health emergency in the United States.

The guidelines are produced by
Veterinary Services
Animal and Plant Health Inspection Service
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These guidelines are under ongoing review. Please send questions or comments to:

Emergency Management
Veterinary Services
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
4700 River Road, Unit 41
Riverdale, Maryland 20737-1231
Telephone: (301) 734-8073 or (800) 940-6524
Fax: (301) 734-7817
E-mail: NAHEMS.Guidelines.Comments@aphis.usda.gov

Preface

"Disposal," a component of APHIS' National Animal Health Emergency Management System (NAHEMS) Guidelines series, is designed for use by official response personnel in the event of a major animal health emergency such as the incursion of a foreign animal disease or a natural disaster in the United States.

The NAHEMS guidelines provide information that may be integrated into the preparedness plans of other Federal agencies, State and local agencies, Tribes, and additional groups involved in animal health emergency management activities. The guidelines are being reviewed and updated on an ongoing basis and comments and suggestions are welcome.

The general principles provided in the guidelines are intended to serve as a basis for making sound decisions. However, deviations from the guidelines may be permissible, if necessary, to address a given situation effectively. In addition, information provided in various sections may need to be combined to meet the requirements of a particular situation.

Acknowledgments

"Disposal" reflects the efforts of a number of individuals, including an APHIS Veterinary Services (VS) Writing Group, additional APHIS staff members, and a wide range of reviewers. The reviewers include Federal and State Veterinarians, members of APHIS' animal health emergency response teams, officials of other Federal agencies, representatives of industry, and additional experts. The contributions of each individual are appreciated.

Also acknowledged with appreciation are the efforts of USDA staff and external reviewers involved with the development of the VS animal health publications ("red books") and similar documents that have served as information sources for the NAHEMS guidelines.

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Introduction

Effective disposal of animal carcasses and materials is a key component of a successful response to an animal health incident. The overall goal of disposal operations is to eliminate in a timely, safe, biosecure, aesthetically acceptable, and environmentally responsible manner, all animal carcasses that result from an animal health incident. If a disease agent is involved, disposal of materials potentially contaminated with that agent must be accomplished as well, if those materials cannot be cleaned and disinfected.

In discussing disposal activities during animal health emergencies, "Disposal" focuses on evaluation of disposal sites, selection of optimal disposal procedures, and disposal of miscellaneous materials.

Disposal Sites

The selection of optimal disposal sites in an animal health incident involves a variety of factors and concerns. This section summarizes some primary considerations in site selection, including on-site disposal and additional disposal strategies such as off-site disposal and temporary storage.

On-Site Disposal

In most situations, the most expeditious method of disposal on a premises where animals are dying or being depopulated is that of burial at a single on-premises site. Compared to other disposal methods, burial is simpler, more expeditious and economical, and, depending on the seasonal high water table level and soil conditions, less likely to cause adverse environmental effects. On-site burial also minimizes biosecurity concerns involved in moving contaminated carcasses, animal products, and other materials off an affected premises. Considerations in planning for on-site disposal include:

- Public health or environmental protection laws, including fire codes and other regulations. Local authorities must be consulted as to the need for permits as well as for general advice and recommendations.

- Availability of alternative disposal sites (e.g., nearby commercial landfills).

- The suitability of potential sites for burial or incineration near the site where the animals are euthanatized.

- The number and species of carcasses and the amount and type of other material in need of disposal.

- Any potential hazard the material may pose to humans or livestock.

- The amount and size of rocks and the type of soil in the potential disposal site.

- Roads or open areas that can provide large trucks and other vehicles with access to the disposal site.

- The seasonal high water table at the proposed site. Local authorities must be consulted about the minimum permissible distance between the seasonal high water table and the bottom of the burial pit.

- The distance between the proposed site and water reservoirs and wells. Local authorities must be consulted about the minimum permissible distance between the wells and water reservoirs and the bottom of the burial pit.

- Proximity to high-density housing or other public areas (particularly if incineration is to be used).

- The location of underground and overhead utility structures (e.g., septic tanks and equipment for water, gas, electricity, telephone, and sewage).

- Climatic and weather factors (e.g., the direction of the prevailing winds) and seasonal conditions (e.g., wet or frozen ground).

- The intended use of the site after disposal activities are completed.

- Availability of the necessary equipment for the type of disposal method to be used.

- Availability of the necessary supplies for the type of disposal method to be used (e.g., fuel for incineration or citric acid for the treatment of milk and dairy wastewater prior to disposal).

In general, a single centrally located disposal site on a premises is preferable to multiple sites for reasons of disease containment (e.g., to minimize the chances of multiple-site and/or groundwater contamination and potential disease spread by feral animals). An additional consideration is the time and effort required to secure required permissions and approvals for multiple sites.

***Safety Concerns*—**Consultation with local, county, State, and Federal environmental officials will be necessary to obtain specific information on a number of the above factors. It also is important to consult with environmental authorities to minimize any negative environmental effects associated with the disposal of contaminated material.

***Use of a Common Disposal Site*—**A single on- or off-site disposal location generally is preferable to multiple on- or off-site disposal locations. Material from more than one affected premises may be disposed of at a common site if necessary or convenient.

Additional Disposal Strategies

Additional disposal strategies, including off-site disposal and temporary storage, may be necessary under certain circumstances. In some cases, for example, a strategy of off-site disposal may be necessitated by climate (e.g., accessibility concerns), high animal population densities, or the presence of wild animals (e.g., coyotes or feral pigs) that can spread disease. In other cases, carcasses or materials may need to be stored temporarily until conditions are more amenable to disposal activities (e.g., until the threat of a disease agent is reduced or until premises are more accessible).

Off-Site Disposal—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. 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.

Transporting Infected Material—When transporting contaminated material from affected premises to off-site locations, special procedures must be followed to prevent the spread of disease agents. Such procedures include the following:

- Prior to loading, carcasses must be sprayed thoroughly with a disinfectant appropriate for the pathogen of concern.

- Infected material should be transported in a large-capacity vehicle (e.g., truck or dumpster) that is leakproof or that has been made leakproof by caulking the spaces around the tailgate and any other points of access via the side walls.

- The truck box or dumpster must be lined with a tough (3 mil or more) disposable polyethylene plastic sheet and sealed at the top. The plastic sheet must be large enough to cover the carcasses and to be secured to the sides and ends of the box or dumpster. A layer of absorbent material **(**e.g., wood shavings or sawdust**)** should be placed on top of the plastic liner to prevent punctures.

- The bottom of the container must have a layer of wood shavings, sawdust, hay, or straw that is at least 1 ft (~30 cm) thick to absorb fluids.

- The handling of carcasses should be kept to a minimum.

- Carcasses must be loaded into the truck box or dumpster carefully to avoid tearing the plastic lining.

- In loading the vehicle, ample space must be left for the expansion of carcasses. At least 2 ft (~61 cm) of space—depending on the air temperature and the distance to be traveled—should be left between the carcasses and the top, sides, and ends of the truck box or dumpster. *To minimize leakage, carcasses should not be opened before loading.*

- After the carcasses are loaded, they must be sprayed with an appropriate disinfectant.

- After the carcasses have been sprayed with disinfectant, they should be covered with the plastic sheet, which should be attached to the sides and end of the truck box or dumpster in such a manner as to prevent leakage (double-sided tape may be used).

- The top of the plastic sheet must be sprayed with a disinfectant.

- After the top of the plastic sheet has been sprayed with disinfectant, a heavy tarp must be put over the entire container and secured.

- While the carcasses are being transported, speeds must be kept to a minimum to decrease the risk of spread of the disease agent en route to the disposal site.

- The vehicle operator must observe biosecurity measures upon entering and leaving the premises. Upon leaving the premises, the vehicle must be cleaned and disinfected.

- After the carcasses are unloaded, all vehicles must be cleaned and disinfected before they leave the disposal site.

- Vehicles used for transporting carcasses from an affected premises to an off-site disposal location should not be moved to an unaffected premises during the course of the outbreak.

The transport vehicle(s) must be accompanied by one or more designated Government representatives for biosecurity reasons. Depending on State law, special escort vehicles also may be required. The designated Government representative(s) should bring an appropriate disinfectant and liquid-absorbing material in addition to other tools or equipment needed to clean up any spills occurring on the way to the destination.

As mentioned, all vehicles must be cleaned and disinfected before they leave the affected premises and again after the material has been unloaded at the disposal site. Before a visit to a premises that is not known to be affected, and thus scheduled for euthanasia and/or disposal, cleaning and disinfection (C&D) procedures must be followed for all

personnel, vehicles, and equipment. (See the NAHEMS "Biosecurity" and "Cleaning and Disinfection" guidelines.)

Temporary Storage—Prompt carcass disposal after euthanasia may be impossible for a variety of reasons, especially in a major outbreak involving a large number of animals. In such situations, carcasses and other items 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, fomites (inanimate objects or materials on which disease-producing agents may be conveyed), and other disease vectors such as insects and vermin.

One option for temporary storage involves piling carcasses in a closed building. Another option involves piling the carcasses outdoors, spraying them thoroughly with an appropriate disinfectant for the pathogen, and covering them securely with a tarpaulin. A third approach is to use earth-moving equipment to arrange the carcasses in one or more piles and then to cover them with at least 3 ft (~1 m) of soil. Control measures for insects and other fomites and vectors also should be considered.

A security guard on duty might well prevent unwanted dissemination of carcasses and parts. Methods should be put in place to discourage scavengers from entering the site.

Disposal Procedures

Although the optimal disposal method for a given incident will vary according to individual circumstances, if a disease agent is involved it is important to focus on timeliness and biosecurity. In order to minimize opportunities for the dispersal of pathogens, animal carcasses should be disposed of within 24 hours of euthanasia. Prompt disposal also is important from an aesthetic, environmental, and a public perception perspective.

The disposal of a large number of animals will occur under the jurisdiction of local, State, and Federal environmental laws and regulations. Some States have developed hierarchies as to which method is preferred for carcass disposal. Local, State, and Federal environmental officials must be consulted prior to making a decision as to which disposal method(s) will be used.

Common methods used to dispose of carcasses and materials include burial, incineration, (including pathology incineration), air-curtain incineration, landfilling, rendering, composting, and alkaline hydrolysis. Burial at a single on-premises site is the desired method of disposal and should be used whenever practical. *Carcasses and materials known to be contaminated with the BSE agent or another transmissible spongiform encephalopathy (TSE) agent, should be disposed of according to protocols specific for those agents.*

Burial

The digging of the burial pit should begin as soon as possible after confirmation of a disease diagnosis. The advice of a soil scientist as to site feasibility should be sought early in the planning stage.

Selection of a burial site involves many considerations, including:

- The need to obtain permits and clearances from the appropriate authorities to proceed with the burial.
- The accessibility of pit-digging and carcass/material delivery equipment to the site.
- The amount of surface area needed. Sufficient surface area should be allowed for the burial site and for surrounding work areas.
- The distance from the proposed site to spaces used by humans (e.g., houses, roads, or other areas of public view).
- Prevailing winds (important in odor control and management).
- Avoidance of site disturbance and/or erosion. The use of flood plains or land that slopes at an angle greater than 5 percent should be avoided.
- Space requirements for the temporary storage of backlog accumulations of carcasses awaiting disposal.
- Soil conditions, including the need for stable soils capable of withstanding the weight of equipment used to construct and fill pits.
- Avoidance of rocky areas. Digging in rocky areas may require special equipment and is likely to increase digging time and labor costs.
- Avoidance of underground and overhead utilities.
- The use of fences to protect the site from animals and unauthorized individuals, both while the pit is being prepared and filled and after it is closed. If possible, fences should be maintained for at least one year after carcass disposal.
- Environmental factors such as the location of the site in relation to pit drainage and to waterways, reservoirs, wells, and water-table levels. Diversion banks and/or ditches should be built as needed to prevent surface water runoff from entering the pit. Similar diversion banks and/or ditches should be constructed to prevent liquid from leaving the burial site.

A holding pen for confining animals prior to euthanasia should be available near the burial site. In some instances, farmyards and existing holding pens may be adapted for this purpose. In other cases, new pens may need to be constructed.

In certain disease situations, lime (calcium oxide or calcium hydroxide) is beneficial to the rapid decomposition of carcasses and the rapid destruction of organisms. The rapid decomposition of a carcass is an extra safeguard to inhibit the surfacing of viral or bacterial laden carcass remnants carried by burrowing animals or scavengers.

Burial Equipment—An excavator is typically used to dig and/or fill burial pits. This large, backhoe-type machine, mounted on tracks, sometimes is referred to as a track hoe. Among the machine's advantages is its ability to (a) construct a long, deep, straight-sided pit efficiently; (b) store topsoil separately from subsoil; (c) fill a pit with carcasses or other materials and close it without disturbing the carcasses or other material in the pit; and (d) cause comparatively little site disturbance.

Loaders, bulldozers, road graders, and backhoes (for small jobs) also may be used. With the exception of the backhoe, however, these pieces of equipment tend to be less efficient and to involve continual movement over the site while the pit is being dug, causing relatively greater damage to the site.

Because excavators and backhoes remain essentially in a fixed position while digging, they move the soil faster and with less damage to the site surrounding the pit. Most excavators have an attachable hammer for use with rock.

Burial Pit Dimensions—The dimensions of the burial pit will depend on site characteristics (e.g., soil conditions and available area), the equipment and method of excavation to be used, and the size and amount of carcasses and other material slated for disposal. The pit should have vertical sides and should be as deep as is feasible considering the nature of the soil, the water-table level, and the capabilities of the equipment.

Although the pit should be as wide as possible, it is important that it not be so wide as to limit the evenness of carcass distribution in the pit. If a bulldozer is used, for example, the pit's width should be no greater than the width of one blade—approximately 10 ft (~3 m). Otherwise, the equipment operator may find it difficult to push carcasses into the pit from one side and to fill the pit evenly.

The length of the pit will depend on the size and amount of the carcasses and other material slated for disposal. It is important to avoid situations in which the carcasses must be moved after they are placed in the pit.

Depending on soil conditions and water-table level, burial pits that are 7 ft (~2.1 m) wide and 9 ft (~2.7 m) deep are usually acceptable. If equipment and soil conditions permit, it may be desirable to dig deeper (12-20 ft or ~4-6 m) and wider burial pits. Each bovine carcass requires about 3 ft (~1 m) of trench length. Local authorities must be consulted

about the minimum permissible distance between the seasonal high water table and the bottom of the burial pit. After the burial pit is filled, it should be covered with 6 ft (~2 m) of soil, including 3 ft (~1 m) of soil mounded over the burial site starting at ground level.

Fourteen sq ft (~1.3 m^2) of surface area should be allowed for an adult bovine carcass. Five adult hogs or sheep are considered equivalent to one bovine carcass. For every additional 3 feet (~1 m) in depth, the number of animals per 14 sq ft (~1.3 m^2) of floor space can be doubled. In planning for the burial of poultry, about 1 sq ft should be allowed per bird. Allow 1 cu ft (~0.03 cu m) per 45 lb (20 kg) of poultry. Contaminated products or other contaminated items may be placed in the trench with the carcasses.

After the burial pit is filled, it should be covered with 6 ft (~2 m) of fine, dry soil to hold carcasses down and absorb fats, gases, and decomposition products. (Wet, loose soil tends to allow leakage, thereby enabling carcasses to rise more easily.) Care should be taken to ensure that the land's contour and vegetation are restored as closely as possible to their original characteristics.

The Global Positioning System (GPS) coordinates of each burial site should be recorded and entered into the Emergency Management Response System (EMRS). (See sample EMRS forms in Appendix I.)

Other Considerations—Additional considerations in the use of burial as a disposal method include gas production and site management.

Gas Production—The production of gas from decomposition within unopened carcasses may result in carcass expansion within the burial pit and cracking and heaving of the surface of the pit after it is closed. Depending on the volume of biomass, the pit may bubble and leak fluids, and carcasses may even emerge from the surface of the pit.

A track hoe or other equipment can be used to crush the carcasses in such a manner that opening of individual carcasses will be unnecessary. If this is infeasible, however, large animal carcasses (e.g., cattle, horses, hogs, sheep, and goats) should be opened to permit the escape of gas. This can be accomplished by opening the thorax and abdomen of the carcasses of all species, and the rumen of ruminants and the cecum of horses. **Note:** I*n cases of certain zoonotic diseases, special precautions must be taken during such procedures to protect personnel from contact with the disease agent.* The opening of carcasses should be done at ground level, near the side of the burial pit. **Note:** *Workers should stay out of the burial pit at all times because of the potential instability of the walls as well as the difficulty of being seen by heavy equipment operators.*

Site Management—The burial site must be inspected regularly after closure to detect seepage or other problems and any appropriate action must be taken (e.g., the building of diversion banks or ditches). The overall objective is to allow the site to return as much as possible to its original contour and condition.

The soil covering the site will probably need to be replenished periodically during the first year as the carcasses decompose and the soil settles into a depression. Depressions should be avoided because they can collect surface water that may increase percolation through the burial site and into groundwater.

Before permitting the restocking of the premises, the burial site should be re-inspected to detect any possible biological or physical risk to people or animals. Additional inspections should occur as necessary for several months following pit closure. Because the burial site is a contaminated area, a security fence that excludes people and animals should be maintained for a year.

Incineration

Incineration should be used only when burial is infeasible because burning tends to be difficult and expensive in terms of labor and materials. However, the choice of disposal method may depend on local and/or State regulations. Environmental protection considerations, or conditions such as a high water table or rocky soil, may favor use of incineration over burial.

A holding pen for confining animals prior to euthanasia should be available near the burn site. In some instances, farmyards and existing holding pens may be adapted for this purpose. In other cases, new pens may need to be constructed.

Burning a small number of carcasses may be feasible on the infected premises if fuel is easily obtainable. Permits and clearance to proceed must be obtained to avoid violating environmental laws. Available incineration methods include open burning, use of stationary incinerators (which may be available through municipalities), and use of air curtain incinerators.

Open Burning—The aim of open burning is to accomplish carcass disposal through efficient combustion—with maximum fire temperatures and minimum burning time. As detailed below, carcasses should be placed on top of sufficient combustible material, and fuel and carcasses should be arranged to allow sufficient amounts of air to enter the burn pile (pyre) from underneath the combustible material.

Selection of a Burn Site—The burn site should be selected with care. It should be located on a flat area, away from public view but readily accessible to heavy vehicles.

Selection of a site for burning requires consideration of many factors, including the following:

- Accessibility. The site should be readily accessible to heavy vehicles hauling materials and other equipment used to build the fire bed and maintain the fire.

- Aesthetics. The prevailing wind direction should be considered to prevent unnecessary quantities of smoke and objectionable odors from blowing toward farm buildings or across public roads.

- Environmental considerations. Local firefighting officials should be consulted for general advice (e.g., on planning a firebreak around the burn pile; information on procedures for obtaining burning permits, if required; and verification of the availability of firefighting equipment if needed). Local and State environmental authorities also should be consulted about air pollution regulations.

- Efficient burning. The fire will burn better if the fire bed is constructed at a right angle to the prevailing wind.

- Protection of adjacent structures. The fire should be kept well away from houses and other buildings or combustible materials (e.g., hay, straw, feed stacks). It also should be kept away from roads and utilities (e.g., overhead electric and telephone cables and underground pipes and gas mains).

Fuel—It is important to obtain sufficient quantities of suitable incendiary materials for use as fuel. Significant quantities may be needed in order to accomplish complete incineration.

Sufficient fuel should be assembled at the site, ready for use, before the burning begins. The types of fuel used should be evaluated in terms of their impact on the environment when burned. For example, some forms of pressure-treated wood must not be used because they may emit toxic environmental contaminants during incineration.

Construction of the Fire Bed—After selecting a site, the first step in constructing a fire bed is to stake out the area of the fire bed, allowing 3 ft (~1 m) of length for each adult bovine carcass. Then three rows of straw or hay bales should be laid lengthwise along the line of the fire bed. (See Figure 1, page 11.)

Allowing 3 ft (~1 m) per adult bovine carcass, the team should then lay the rows approximately 1 ft (~30 cm) apart with 1 ft between each bale in a row, pushing loose straw into the space between the bales. The large timbers should be placed lengthwise on top of each row of straw and the remaining large- and medium-sized timbers distributed across the fire bed with 6-12 in (~15-30 cm) of space between the timbers. Next, small kindling wood should be placed on the fire bed, with loose straw spread over it. Coal should be spread evenly over the wood—at the rate of 500 lb per yard (~227 kg per ~1 m)—to make a level bed. A front-end loader is useful for spreading the coal.

The carcasses should then be placed on the fire bed, positioned on their backs with their feet in the air alternately, head to tail. This can best be done with mechanical lifting equipment (front-end loaders, draglines, or trenchers) and chains. Loose straw should be placed over the carcasses and stuffed into all the spaces between carcasses.

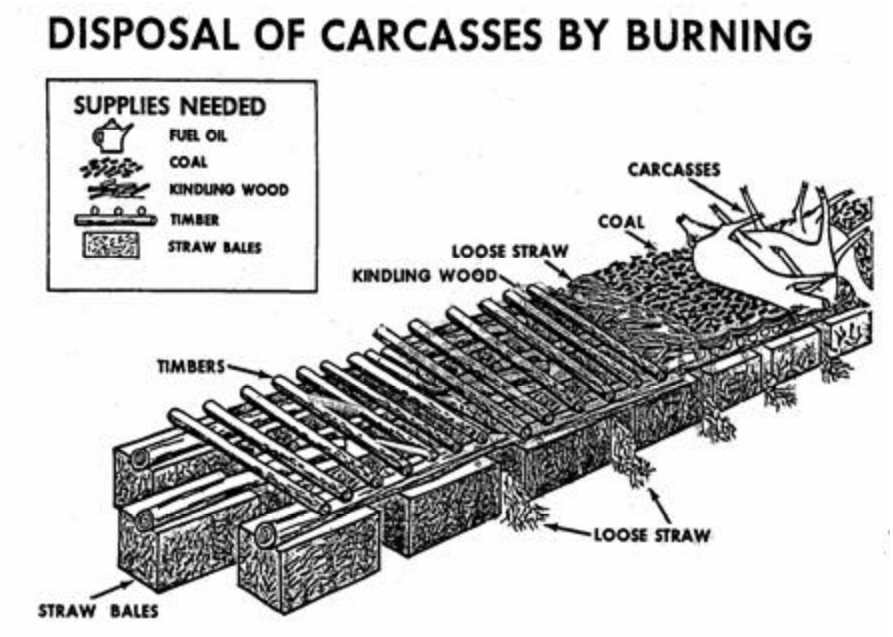

Figure 1. Construction of a fire bed for burning carcasses.

When the carcasses have been arranged on the fire bed, a liquid fuel should be poured or sprayed over the fire bed using buckets or sprinkling cans. *(**Caution**: Do not use gasoline!)* If a pump is available, the fuel can be sprayed over the pile. Rags or other material soaked in kerosene or liquid fuel can be placed about every 30 ft (~10 m) and used as points of ignition.

After making sure that all other humans, equipment, and supplies are located well away from the burn pile, the fire can be started using a torch that will burn for several minutes. It will be necessary to tend the fire, stirring it occasionally and promptly replacing carcass pieces that drop off the pile (a front-end loader can be used for this purpose).

If weather conditions are favorable, the bulk of the carcasses should burn within 48 hours. When all the carcasses have been burned completely and the fire has died, the ashes should be buried and the area cleaned up and restored as closely as possible to its original condition.

***Fuel Requirements*—**The type and amount of fuel used for incineration will be influenced by local fuel availability and conditions. For effective burning, solid fuel should be as dry as possible.

Recommended incineration materials include straw or hay, untreated heavy timber, kindling wood, coal, and liquid fuel. The amounts of each material needed for the firebed are as follows:

- Straw or hay. Allow three bales per bovine carcass. Contaminated straw or hay can be used. Additional quantities can be purchased from the owner or from local suppliers.

- Untreated heavy timbers. Allow three pieces—approximately 8 ft (~2.5 m) long by 1 ft sq (~0.3 m sq) in cross section—per bovine carcass. Wood railroad ties or bridge timbers are ideal material. If smaller materials such as fence posts or cordwood are used, a proportionately greater number of pieces will be needed.

- Kindling wood. Allow 50 lb (~23 kg) per bovine carcass. This material may be obtained from sources such as wrecking companies, farm woodpiles, or sawmill slab piles.

- Coal. Coal used as fuel should be of good quality and in large lumps, preferably 6-8 in (~15-20 cm) in diameter. Coal in small pieces should be avoided. Proportionately less coal will be required for young stock. Carcasses of goats, sheep, or swine incinerated with bovine carcasses may be placed on top of the bovine carcasses and burned without additional fuel at the rate of two animal carcasses for each bovine carcass. For larger quantities of carcasses or if goats, sheep or swine are burned alone, 100 lb (~45 kg) of coal should be allowed per animal.

- Liquid fuel. Waste oil, furnace oil, or diesel fuel should be obtained in sufficient quantity to soak the materials on the fire bed thoroughly before the fire is lighted. A minimum of 1 gal (~4 L) of liquid fuel per bovine carcass is required. A reserve supply of fuel oil should be held for use in case of burning difficulties. ***Caution****: Do not use gasoline as reserve fuel!*

Estimating Resource Needs—Careful estimation of resource needs is essential to a smoothly run incineration operation. All necessary resources, including equipment for handling carcasses, should be assembled before incineration begins.

To estimate fuel needs for the fire bed accurately, the length of the fire bed that will be needed must be estimated. To gauge the length of fire bed, the team may find it helpful to convert the number of carcasses in need of disposal into bovine-equivalent carcasses.

Estimating Bovine-Equivalent Carcasses—The first steps in estimating the number of bovine-equivalent carcasses for disposal are to (a) list the number and species of carcasses to be incinerated, and (b) convert these figures into a number representing bovine-equivalent carcasses (see Table 1, page 13).

Table 1. Estimating Bovine-Equivalent Carcasses

Animal	*Bovine Equivalent Carcasses*
1 adult cow or bull	1 bovine-equivalent carcass
5 adult swine	1 bovine-equivalent carcass
5 adult sheep	1 bovine-equivalent carcass

Estimating the Length of the Fire Bed—The next step is to calculate the length of the fire bed to be built. One yard (~1 m) of fire bed length should be allowed per bovine-equivalent carcass. Reminder: Two swine or two sheep can be layered on top of each bovine carcass.

Estimating Fire Bed Material—The amount of fire bed material needed per bovine-equivalent carcass then should be estimated (see Table 2).

Table 2. Fire Bed Material Required per Bovine-Equivalent Carcass

Material	*Quantity per Bovine-Equivalent Carcass*
Straw	3 bales
Untreated heavy timbers (8 ft x 1 sq ft)	3 timbers
Kindling wood	50 lbs
Coal	500 lbs
Fuel oil	1 gal

Resource Estimation Example—An example of resource estimation is seen in a situation requiring disposal of 500 cattle, 1,000 swine, and 700 sheep. Using Table 1, the number of bovine-equivalent carcasses is calculated as follows:

500 cattle	= 500 bovine-equivalent carcasses
1,000 swine	= 200 bovine-equivalent carcasses
700 sheep	= 140 bovine-equivalent carcasses
Total	= 840 bovine-equivalent carcasses

Because two swine (or two sheep) carcasses may be put on top of each bovine carcass without requiring additional space or fuel, the 840 bovine-equivalent carcasses can be reduced by 200 bovine-equivalent carcasses to arrive at a total of 640 bovine-equivalent carcasses. Thus, the fire bed will need to be 640 yd (~585 m) long. This total length can be divided into two or three separate fire bed lines.

Finally, the amount of fire-bed material needed for 640 bovine-equivalent carcasses is calculated as follows:

- Straw @ 3 bales per bovine-equivalent carcass x 640 = 1,920 bales
- Heavy timber @ 3 timbers per bovine-equivalent carcass (increase if small timbers are used) x 640 = 1,920 timbers
- Kindling wood @ 50 lb (22.7 kg) per bovine-equivalent carcass x 640 = 16 tons
- Coal @ 500 lb (227 kg) per bovine-equivalent carcass x 640 = 160 tons
- Liquid fuel @1 gal (3.78 L) per bovine-equivalent carcass x 640 = 640 gal

***Pathology Incineration*—**Incineration in a pathology incinerator can be highly efficient, resulting in safe, complete disposal. However, this equipment tends to be available only in human and veterinary hospitals, laboratories, and medical schools. The establishment and operating costs of the incinerators and their lack of portability mean that they are unlikely to be readily available. Also, they usually are suited only to the disposal of small amounts of material.

***Air Curtain Incineration*—**In air curtain incineration, material is incinerated in a burn pit or refractory box, aided by fan-forced air. Experience has shown this technology to be successful in disposing of animal carcasses. A large quantity of dry fuel, however, is required to initiate the burning and any overloading of the incinerator with too many carcasses will slow burning and result in uncontrolled smoke. Air curtain incineration should be the method of choice when burning small numbers of carcasses because there is less concern about air pollution, the incinerator can be quickly relocated where needed, the danger of uncontrollable burning is considerably less than with other more common open incineration/burning procedures, and because of the comparative fuel efficiency and higher burn temperatures than pyres.

Air curtain incineration equipment consists of a large-capacity fan, air ducts, a manifold, and, in some cases, a steel refractory box. The manifold directs a curtain of air over the burning pit or refractory box. This air curtain, which acts as a "lid" for the incinerator, is deflected off the far wall of the burning pit into the fire, providing excess oxygen that increases the fire temperature and results in more complete combustion.

Among the advantages of air curtain incineration are its comparative fuel efficiency and its minimal environmental effects. Although extra fuel is needed to start the fire, once combustion has begun the need for fuel can be reduced substantially, depending on the condition of the carcasses and the species being incinerated. Experience has shown that under optimal conditions, as many as 4,000 pounds (~1,814 kg) of animal carcasses can be burned in a 35 ft (~11 m) pit in an hour with minimal adverse effects on air quality.

Air curtain incinerators are suitable for continuous operation and can be transported between disposal sites. A power source that is appropriate for the type of incineration unit to be used must be available.

Use of an air curtain incinerator in conjunction with an excavated burn pit rather than a refractory box usually is preferable because the burn pit makes ash disposal a one-step process. In addition, the burn pit may accommodate a greater number of carcasses. The construction of the burn pit can be similar to that of a burial pit, with the length of the pit determined by the length of the incinerator's air manifold. Incineration trench/pits locations should not be selected in high water table areas or where sandy soil conditions exist. The maintenance of good vertical trench/pit walls and the minimum entry of underground water into the burn area provides for higher incineration temperatures. The size and shape of the incineration trench/pit has been found to be critical for emission control, especially during fire start up and the addition of fuel and animal carcasses to the burn area. Prevailing wind direction should be carefully calculated in order to prevent unnecessary emissions and ensure the safety of equipment and operators. Optimal trench/pit dimensions provided by the manufacturer of the air curtain incinerator should be strictly followed.

An air curtain unit with a refractory box, however, may be required in cases in which construction of a burn pit is impossible because of soil conditions or a high water table. The unit should be located in an area that is easily accessible by carcass delivery and loading equipment.

Air curtain incinerators are specialized products and are not readily available in all locations. Information on the commercial availability of the incinerators may be obtained from VS Emergency Management staff.

Composting

The composting of diseased animal carcasses on an affected premises is a suitable alternative method of disposal if an appropriate site and the proper supplies (e.g., wood chips, sawdust and biosolids) are available. Although the composting process appears to be simple, it is an exceedingly complex process that requires good management to be successful. Most pathogens are rapidly deactivated by temperatures reached early in the composting process. While the primary objective of composting diseased animal carcasses is deactivation of disease organisms, another advantage of composting is the minimal effect on the environment and produces a useful end product.

In emergency disposal, a composting operation for large numbers of livestock carcasses should be as "low-tech" as possible, a technique sometimes called passive composting. The purpose of the operation is the safe disposal of the carcasses, not the production of compost. Compost piles (windrows) should be designed to provide proper porosity and moderately excess carbon over a long period of time with absolute minimum maintenance. The use of wood chips, sawdust, and biosolids can provide the conditions needed. The compost pile will not be uniform and as a result there will be areas within the carcass which will undergo putrefaction, however, the by-products of this decay will be composted when they come in contact with the excess carbon available in other parts of the compost pile.

***Pathogen control*—**Since foot-and-mouth disease (FMD) virus is the most contagious animal disease agent known, it will be used as the example in these comments on pathogen control. A site used for composting animal carcasses from an FMD outbreak must be considered to be uniformly contaminated, from the time of arrival of the first carcass until laboratory testing and sentinel animals have confirmed that there is no virus.

Fortunately, a number of natural processes tend to reduce the pathogen load. The muscle mass of the carcass will undergo rigor mortis with the resultant lactic acidosis effectively destroying at least that portion of the foot-and-mouth disease virus. A good deal of care should be exercised in handling animal carcasses to ensure that there is minimal fluid leakage since the fluids will be heavily virus laden. The heating effect of thermophilic organisms within the compost pile will provide significant reduction in pathogen load. Finally, the passage of time during which the viral particles are being exposed to the detrimental effects of heat/cold, wet/dry, and the ultraviolet content of sunlight will decrease the viral load at the site.

Laboratory testing can be used to help document the fact that the composting process has worked properly and produced a safe product. Any decision to use the compost commercially must take public concerns and perceptions into account. In the case of FMD virus specifically, the composting site should be kept isolated from susceptible animals until such time that laboratory testing is unable to recover virus and/or sentinel animals have confirmed that finding.

***Planning for Composting*—**The services of a consultant experienced in large scale composting of animal carcasses should be contracted if this method of disposal is chosen. The consultant should have a background and credentials which clearly demonstrate the ability to successfully blend the theory, practice, and art of composting.

The planning process for composting should also include local and State regulatory agencies. It must be noted that the composting of large animal carcasses is NOT approved in many States. It is also true that under emergency circumstances exceptions can and will be made if suitable plans and controls are in place. Close coordination with regulatory personnel is needed. Depending on local conditions, composting may be the best option available. Composting is gradually being accepted as the most environmentally sound method of disposal for animal carcasses. When available, local or State regulations will provide good guidance in regard to set-back distances to property lines and to water features (e.g., well, pond, drainage, and water table). In consideration of public opinion and to avoid litigation, all required set-backs should be increased liberally when selecting a site for emergency disposal of animal carcasses by composting. Ideally, the composting site should be more than a mile from the nearest dwelling or place of business.

***The Composting Process*—**During the process of composting, microorganisms break down organic material to stable humus. Nitrogen, carbon, oxygen, and water must be available in the proper ratio for the composting process to be effective. Heat is produced by the microorganisms during the composting process. Mesophilic organisms, i.e., (those

which prefer temperatures of 59°F to 109°F (15°C to 43°C) will initially cause the compost pile to heat up allowing thermophilic organisms to become predominate and increase temperatures further. Thermophilic organisms prefer temperatures from 77°F to 185°F (25°C to 85°C). The temperatures reached by thermophilic organisms are the most desirable because they ensure the destruction of pathogens, weed seeds, and fly eggs. For pathogen destruction, a guideline is often quoted that a compost pile should reach a temperature of 130°F (54°C) or higher for a period of at least 3 days.

Nitrogen—The animal carcasses are the source of the nitrogen for the composting process. The carbon (C) to nitrogen (N) ratio (C/N) of animal carcasses ranges between 3 and 5.

Carbon—High carbon content materials such as coarse sawdust (C/N=400), chopped wheat straw (C/N=125) or corn stover (C/N=70) can be used as a carbon source. If it is available, hardwood sawdust is preferred because the carbon is more available since it decomposes more rapidly. It is possible to use other high carbon materials such as ground cardboard or ground newsprint. Again, however, the services of a competent technical expert to assist in formulating the recipe for the compost cannot be overemphasized. Three different sources on composting animal carcasses provided three different estimates of the amount of carbon content material needed, ranging from 2.5 yd^3 (1.9 m^3) up to 6.7 yd^3 (5.1 m^3). The reason for the differences is that C/N contents mentioned at the beginning of this paragraph are average values for the type of material mentioned. Laboratory analysis and suitable calculations are the only way to accurately predict the quantities needed. In the absence of a consultant, plan on at least 6 yd^3 (4.6 m^3) of a sawdust/compost mix as detailed below under "Building a compost pile."

Carbon/Nitrogen ratio—The C/N ratio is the ratio of the weight of organic carbon to the total nitrogen in an organic material. A C/N ratio of 30 will provide the most ideal conditions for rapid composting and heating within the compost pile. As the C/N ratio increases, the temperature peak will be depressed and the composting time will increase—which is not desirable for pathogen kill. While composting will take place over a wide range of C/N ratios, below C/N=20 the carbon will become the limiting component and some excess nitrogen will be lost to the atmosphere with resultant odor. Ammonia (NH_3) emission is evidence of too little carbon in the compost mix. Ammonia production is unavoidable in the carcasses as they undergo putrefaction so the maintenance of the cover material as a biofilter is of utmost importance.

Bulking agent—The bulking agent serves a number of functions in the compost pile. It is the base which holds the carcass and carbon source up off the ground so air can circulate and provide oxygen. It serves as a "sponge" so that any excess liquids are absorbed and retained within the compost pile providing the necessary moisture content for composting to take place. And finally, it serves as a cover to partially retain any odors and to prevent birds, rodents, and other scavengers from having access to the carcasses. The most readily available bulking agent is 1-2 in (2.5-5 cm) wood chips. The bulking agent is vitally important because after a compost pile or windrow is formed, porosity and aeration become the critical factors for preventing excessive odor formation.

The bulking agent is not composted to any great extent but rather serves to give the compost pile the necessary porosity to ensure the availability of oxygen for aerobic decomposition. During the first period of composting, the bulking agent serves the functions listed above, but when the pile is turned and mixed, it provides for more uniform porosity. In a commercial composting operation, the bulking agent would be screened out of the compost and reused. One can expect to use about 6 yd^3 (4.6 m^3) of bulking agent per 1000 lb (454 kg) of carcass.

***Biosolids*—**Biosolids are solid organic matter recovered from a sewage treatment process and mixed with a carbon source to compost for further use, especially as fertilizer. It can be used to "jump start" the composting process. Biosolids that are in the process of active composting and which have completed the first heating cycle are the most desirable for animal carcass composting. At least 1 yd^3 (0.76 m^3) of biosolids should be evenly distributed around each thousand pounds of carcass. Double or triple this inoculum if more biosolids are readily available. If biosolids are not available, other things that can be used as a starter include any active compost (such as chicken litter) and even rich loamy earth which will contain the organisms needed for composting. Prior to use in forming the compost pile, the biosolids or composting litter must have reached a temperature of 120°F (49°C) to ensure adequate bacterial activation. The most active material will normally be found in composting piles that have been in place for 3-6 weeks, however one should rely on the guidance of the personnel in charge of composting the material.

***Moisture*—**Water is absolutely necessary to the composting process. When formed, a compost pile for large animal carcasses should have moisture content between 40 and 50 percent. As a practical example, a damp sponge that has been squeezed out so that no more moisture will run out of it has moisture content in this range. Err on the dry side when forming the compost pile because moisture can be added very easily if that becomes necessary, but removing moisture is almost impossible. The carcasses of large animals have much higher moisture content and that moisture is going to become available to the composting process as the carcass decomposes. A water truck equipped with a pump and a fog nozzle should be available to add moisture to the compost pile as it is being formed. Do not add so much liquid that the compost piles being formed are damper that the sponge mentioned above. Under no circumstances should moisture begin to pool under the pile and run out on to the ground.

***Laboratory Testing*—**Until the recipes for the compost piles have been established and reduced to volumetric values (yd^3 or m^3) for daily use, it is vital that a competent laboratory be used to determine the moisture content, carbon content, nitrogen content and pH of the compost materials. Additional analysis of materials should be done if there is any change in the raw materials being used. In the case of a bulk material such as sawdust where the moisture content can vary widely, each shipment should be tested and the recipe adjusted accordingly.

***Site considerations*—**Locate the composting site so that it is isolated and, if possible, has a minimum of 1-mile (1.6 km) buffer from populated areas. First consideration should be

given to using land which is already owned by the Federal or State government. While an improved work surface is not necessary, an old military base, especially one which has concrete pads, roadways, parking lots, or runways which can serve as a work surface would be ideal. If Federal or State land is not available, the land should be leased for at least two years with an option to extend the lease. If bare earth is to be used, the slope of the land should be at least 1 percent but no greater than 4 percent. Grade the site to provide runoff diversion and allow the collection of any leachate in lagoons. State environmental personnel can provide valuable insight regarding soil types and suitability for use. The site must be fenced to preclude entrance of larger scavengers.

Layout of the site—Lay out the site to provide for trapezoidal windrows that are 12 ft (3.7 m) across the base and 5-6 ft (1.5-1.8 m) high. There should be a minimum of 10 ft (3 m) between adjacent windrows to allow easy access for trucks and front-end loaders. The site should have two entrances and separate roadways which can be designated as "clean" for supplies or bulk materials and "dirty" for trucks carrying carcasses.

Maintenance of compost piles—The top and sides of the windrow will tend to cave in or sink over the areas where the carcasses are located. This subsidence in the windrow can be accounted for by moisture loss and the fact that compost does not have as much bulk as the raw components. Pockets must not be allowed to form in the sides and top of the windrow because they will trap excess moisture and potentially allow scavenger access to partially decomposed carcasses. The trapezoidal shape of the windrows should be maintained by adding wood chips to the top and sides as necessary. If there are no odor or moisture problems requiring immediate intervention, the first turning of the compost would occur after nine months to one year. If absolutely necessary, turning of the compost would be done to restructure the windrow at an earlier time. Commercial windrow turners, which are more efficient than front-end loaders, are available for turning compost.

Under normal circumstances, a lag time ranging from 2 days to 1 week will be observed before there is significant heating within a windrow. An individual should be made available to the hired consultant or the site director for the purpose of keeping temperature records which help to define the progress of the composting taking place within the windrows.

Cold weather—Cold temperatures will cause extended lag times before heating begins unless special effort is made to encourage the compost process. Composting carcasses as soon after death as possible, the addition of actively composting (warm) biosolids and immediate cover with wood chips, will assist in decreasing the lag time. In cold weather, the delivery of actively composting biosolids needs to be coordinated closely with the use of them in the windrow. The biosolids should be kept in compact piles if they cannot be immediately used since they will provide some of the heat that is necessary to initiate the composting reaction in the carcass/sawdust mix within the windrow. Every effort should be made to conserve the heat in the biosolids by unloading without delay, incorporating them into the compost pile and covering the carcass/sawdust/biosolids mix immediately with wood chips. The biosolids obtained should have undergone their first compost heat

cycle and be ready for turning in preparation for the second heat cycle. Conserve heat in every way possible in the winter. Cover the windrow with extra wood chips to increase protection from the cold and drying effects of the wind.

Biosecurity—The biosecurity of the site must be maintained through the use of "clean-dirty" protocols. Trucks delivering "clean" materials such as sawdust, wood chips, and biosolids should be restricted from the compost pile area to minimize the need to clean and disinfect these trucks each time a load is delivered. Delivery to working supply piles should be through a separate clean entrance and on separate clean roads from those used by trucks delivering carcasses. Trucks delivering carcasses may enter the compost pile area since they must already be cleaned and disinfected before leaving the site.

Odor control—The control of excess distressing odor has to be one of the driving considerations in setting up and managing a composting facility. In order to minimize the excess production of odor, always have excess carbon in the mix with the understanding that this must be balanced with the need to remain close to a C/N = 30 to maximize the desired heating of the compost pile. Aerobic conditions must be maintained in the pile since anaerobic decomposition produces far more distressing odor than aerobic decomposition. When carcasses are delivered to the site, they should be immediately incorporated into the windrow. There should be at least 2 ft (0.61 m) of cover material on the sides and top of the active composting area. In the interest of community relations, it is clearly better to have too much cover material rather than too little. Regular, light fogging of the exterior surface of the windrow will increase the effectiveness of the wood chip biofilter. DO NOT add so much excess liquid that it shows up as leachate.

Vector control—Covering the compost piles or windrows with a minimum of 2 ft (0.61 m) of wood chips will help exclude potential vector species. Request APHIS Wildlife Services to survey the site regularly and ensure that no scavenger species are present. In the case of insect pests, contact the local extension agent for consultation.

Building a compost pile—There are subtle differences in the forming of a compost pile for small animals (poultry, piglets) and large animals (>100 lb or ~45 kg). The main difference is allowing for the water content of the large animal carcass and for the mass of nitrogen containing material which is going to undergo anaerobic decomposition before entering the composting reactions.

Small animal carcasses—Spread wood chips on the ground 12-15 in (~30-38 cm) deep by 12 ft (3.7 m) wide and as long as necessary for the number of animals to be composted. On top of the wood chips, place a layer of sawdust 12-15 in (~30-38 cm) deep by 8 ft (2.4 m) wide. The sawdust should be mixed with an equal quantity of actively composting litter or actively composting biosolids. The moisture content of this layer should be 40 percent. Note that there will be a 2 in (5 cm) border of wood chips on both edges where more wood chips will be piled for the sides of the compost windrow. On top of the sawdust/compost layer place a single layer of animal carcasses. Fog the animal carcasses lightly to wet the skin, feathers, or hair. DO NOT add excess moisture.

The carcasses may be in contact with each other and can be piled up to 10 in (25.4 cm) thick. Keep the carcasses at least 6 in (15 cm) from the edge of the sawdust/compost layer. Place a 6-8 in (15- 20 cm) layer of sawdust/compost on top of the animal carcasses and place another layer of animal carcasses. Repeat the process until the windrow is 5-6 ft (1.5-1.8 m) high.

Make each layer narrower to produce a trapezoid shape which will shed water. Cover the entire composting mass with a 2 ft (0.61 m) layer of wood chips. The pile should not be compacted during any of the steps of this process.

Large animal carcasses—Spread wood chips on the ground 2 ft deep by 16 ft (0.61 m by 4.9 m) wide and as long as necessary for the number of animals to be composted. On top of the wood chips, place a layer of sawdust 18-24 in (45.7-61 cm) deep by 12 ft (3.65 m) wide. The sawdust should be mixed with an equal quantity of actively composting litter or actively composting biosolids. The moisture content of this layer should be 40 percent. Note that there will be a 2 ft (0.61 m) border of wood chips on both edges where more wood chips will be piled for the sides of the compost windrow. Wet the skin and hair of the animal carcasses. On top of the sawdust/compost layer place the animal carcasses, back down. Disarticulate the limbs and place them alongside the carcass. Open the carcass, making a minimum of four cuts into the thorax and open the abdomen and make cuts into rumen, stomach, large intestine and small intestine. The animal carcasses should be separated by 8-12 in (~20-30 cm). Keep the carcasses at least 1 ft (~30 cm) from the edge of the sawdust/compost layer. Place a 10-12 in (~25-30 cm) layer of sawdust/compost on top of the animal carcasses and place another layer of animal carcasses. Repeat the process until the windrow is 5-6 ft (1.5-1.8 m) high. Make each layer narrower to produce a trapezoid shape which will shed water. Cover the entire composting mass with a 2 ft (0.61 m) layer of wood chips. The pile should not be unnecessarily compacted during any of the steps of this process although some compacting will take place because of the need to walk on the pile while dissecting the carcasses.

Other materials—Add other materials requiring disposal to the compost windrows. Silage, feed, straw, hay, manure, and bedding can all be composted. The C/N ratios as well as moisture and particle size must be carefully considered if substituting any of these materials for the primary carbon source, but the addition of small amounts (1/2 yd^3 [382 L]) with each 1000 lb (454 kg) of carcass will have little affect, adverse or otherwise.

Composting Schools—A number of the major universities have training programs which specifically address the practical aspects of animal carcass composting. The schools are usually designed around the specific regulations of the State where they are given and are intended for the disposal of normal daily mortality. However, the principles are the same and it is only a matter of scale between composting daily mortality and composting catastrophic animal mortalities.

Records—In the event composting is to be used, it is important to maintain records of compost temperatures, times recorded, and dates and locations compost piles were started.

Commercial Landfills

Perhaps the most significant advantage to landfills for carcass and material disposal is the fact that the infrastructure already exists and the capacity (depending on the landfill) can be relatively large. Landfill sites, particularly Subtitle D landfills, will have been evaluated for suitability and the necessary environmental precautions designed and implemented. Landfills therefore pose little risk to the environment. In the event of an emergency or catastrophic event, time is a very important factor and landfills offer pre-existing sites for disposal of carcasses/materials with the necessary equipment, personnel, procedures, and containment systems. It is important to note that some landfills might have a limited capacity because of the particular containment system used, especially small arid landfills that rely on natural processes to manage waste byproducts.

The other advantage to landfills is the wide geographical dispersion. A majority of locations do have a landfill site in relatively close proximity. There can be situations, however, where large volumes cannot be disposed in the closest landfill. The cost of landfilling carcasses can be equivalent or favorable to alternative methods of carcass disposal.

Even though disposal by landfill is an allowed option, a suitable landfill or one that can handle the necessary capacity might not be located in the proximity of the incident. For a variety of reasons, some landfill operators may not be willing to accept animal carcasses. Often there is public opposition to landfilling large volumes of animal carcasses. The public information component needs to be addressed early and often when landfills are used for mass carcass disposal especially when an infectious disease is involved. Development of a landfill can be and often is a lengthy, difficult, and expensive proposition, so landfill operators and planning authorities are sometimes not willing to use domestic waste space for large volumes of animal carcasses. Often landfill sites are not accessible when needed or when convenient. Special arrangements can be made, but may increase disposal costs.

When landfills are to be used for carcass disposal, there must be coordinated efforts with the landfill management. A time schedule for delivery of carcass/material for landfilling needs to be coordinated, so that prior to delivery, the landfill operators can excavate the trenches that will be used to bury the carcasses or other materials. It is also necessary to have personnel available at the time of delivery to immediately cover the carcasses (preferably with dirt), however solid municipal waste is also acceptable. The same standards for burial in the ground should be followed for burial in landfills. A C&D station must be set up near the landfill exit so that all trucks or any other delivery vehicles can be thoroughly cleaned and disinfected as they leave the landfill site.

In some cases it may be possible to use commercial landfills to dispose of large numbers of carcasses. However, several criteria need to be met before commercial landfills can be used, including meeting local/State environmental requirements (e.g., water table levels, leachate management, and gas treatment regimes) and obtaining the necessary permits. Obstacles to using commercial landfills may include opposition by local authorities, by people living near the landfills, and by livestock owners near the sites who may consider that there would be too great a biosecurity risk. The movement of carcasses to a landfill poses some additional risk of spreading a disease agent.

Some states have an agreement in principle with a commercial landfill to take carcasses in emergencies. Other States would be well advised to explore similar agreements so that the landfill option would be available in an emergency situation.

Rendering

Rendering is the most economical method of disposing of carcasses, though satisfactory rendering plants are not always available. The movement of carcasses to the rendering plant poses some additional risk of spreading a disease agent. For information on minimizing this risk, see the subsection on "Transporting Infected Material."

It is preferable to contract for continuous rendering rather than batch rendering because each time a batch rendering vessel is opened or discharged, fine vapor and materials (primarily fat particles) become airborne and may be deposited on nearby surfaces and equipment. These fat particles complicate the necessary cleaning and disinfection of trucks traveling off the premises as well as the final C&D of the rendering facility. The managers of rendering facilities under consideration for a contract must be willing to stop all other operations in order to render only the materials presented or authorized.

Only rendering facilities that have minimum standards for elimination of the disease agent should be approved for use. These standards include the following:

- The particle size of the material to be rendered can be no greater than 1 in (~2.5 cm). (If the anvil gap is greater than 1-1/2 in (~3.8 cm), repairs should be made.)

- The temperature of the material must be monitored continuously in the rendering vessel at the prescribed 260 °F (127 °C). An adequate alarm system must be in place to notify personnel if the operating temperature falls below the set point. Should the temperature of the material fall below this point, the material must be reprocessed.

- The material must remain at 260 °F (127 °C) for at least 15 minutes. The input rate relative to the size of the rendering vessel must be monitored to ensure that the material is not processed too quickly, and this monitoring information should be recorded for documentation purposes.

- The facility must have adequate security to exclude animals and unauthorized individuals.

- The receiving side of the facility must be separated completely from the finished (rendered) product area, with (a) no personnel movement from the receiving area to the finished-product area without prior personal C&D measures being taken, (b) no equipment movement that might permit the carrying of contaminated material from the receiving area to the finished-product area, and (c) no drainage from the receiving area that might contaminate the finished product or trucks used to haul the finished product.

- The air flow within the plant must be directed from the finished-product area to the receiving area.

Any decision to use the rendered material commercially must take public concerns, perceptions, and possible disease transmission (e.g., from BSE) into account. Material known to be contaminated with the BSE agent or other TSE agents should not be rendered.

Alkaline Hydrolysis

Alkaline hydrolysis tissue digesters originally were developed to dispose of radioactive animal carcasses generated from biomedical and pharmaceutical research and development. Recent advances in technology and equipment development have made this method of carcass disposal an option in situations in which more common disposal methods are infeasible (see "BSE Considerations" below).

In alkaline hydrolysis, sodium hydroxide or potassium hydroxide is used as the agent that—under heat and pressure—digests carcass tissue, leaving only liquid effluent and the mineral portion of bone and teeth. The effluent has a pH level ranging from 11.4 to 11.7 and therefore, in most cases, can be discharged into municipal sewage systems. If potassium hydroxide is used, the effluent can be dehydrated and used as fertilizer. The bone and teeth easily can be crushed into a fine powder and sent to a landfill.

Although alkaline hydrolysis involves a low operational cost per pound of tissue disposed, the equipment is expensive to purchase. Therefore, this method of carcass disposal would have limited application in a disease outbreak.

The commercially available equipment for alkaline hydrolysis is designed for permanent installation in a building with a temperature-controlled environment. Portable units, currently under development, are expanding the options for use of this disposal method. Information on the availability of alkaline hydrolysis equipment may be obtained from APHIS-VS Emergency Management staff.

BSE Considerations—The use of alkaline hydrolysis tissue digesters currently is the preferred method for disposal of BSE-contaminated carcasses. Research has demonstrated that alkaline hydrolysis is effective in significantly reducing the infectivity of the prion causing BSE as well as in destroying the infectivity of bacteria and viruses.

Disposal of Miscellaneous Material

Most contaminated or potentially contaminated carcasses and animal products, materials, and wastes will be disposed of by one of the methods previously outlined. Special disposal considerations are required for the materials listed below.

Milk

The disposal of milk presents particular difficulties because large volumes often are involved. It is essential that milk be treated to inactivate any disease agents before disposal measures are implemented. This can be accomplished by reducing the pH of the milk to less than 3 or increasing it to more than 11, and holding the milk at this level for an hour.

Normally, milk held on a premises for disposal is in small quantities and can be disposed of—after disease agent deactivation—in a burial pit along with carcasses if necessary. On premises where other disposal methods (e.g., incineration) are used, milk can undergo agent deactivation and subsequently be disposed of in a shallow burial pit, through the sewage system, or in a sewage lagoon.

In cases involving large volumes of contaminated milk, (e.g., at dairy plants or transfer facilities) the milk should undergo disease agent inactivation (by heating or adjustment of pH) and then should be pumped into a shallow, fenced-off pit. After the milk has evaporated or seeped into the surrounding soil, the pit can be covered.

Dairy Wastewater

Wastewater from dairy plants contaminated with infected milk must be treated to inactivate disease agents in such a way as to render the wastewater acceptable for disposal in a sewage system. This can be accomplished by adding sufficient citric acid to the wastewater to reduce its pH level to less than 3. Risk from the wastewater can be further reduced by diluting it and/or by using larger than normal quantities of water in plant operations.

If necessary, acidified wastewater can be neutralized (to a pH of ~7) through the addition of sodium hydroxide or sodium bicarbonate. The wastewater may then be discharged into the sewer system.

Lagoons

Manure and wastewater from concentrated animal production operations are often contained in lagoons before being disposed of in accordance with the waste management plan for the farm. When a lagoon becomes contaminated with a disease pathogen, it will be necessary to quarantine the lagoon to prevent the spread of the pathogen to other animals. Adequate fencing is necessary as a part of this quarantine. Samples from the lagoon should be tested and found free of the disease agent before the material is handled.

When adequate space exists in the lagoon to contain the wastewater resulting from C&D, the C&D should be completed before sampling the lagoon since the wastewater from C&D will contain appreciable amounts of detergent and disinfectant. Any routine operations of stirring or bubblers in the lagoon should continue during the C&D operations.

Small amounts of material can be removed to provide space when the lagoon is at maximum capacity and wastewater from C&D would exceed the maximum allowable level. The material removed can be handled in a variety of ways. The pH can be adjusted to < 3 or > 11 by the addition of organic acid or alkaline reagents. If this method of handling is chosen, ensure that the material is mixed very thoroughly before taking the sample to test for pH. It is unlikely that a suitable site, free of susceptible livestock or wild species, could be found to spread untreated material from a lagoon. When composting is being used to dispose of animal carcasses, small quantities of lagoon contents can be added to the compost windrows under the guidance of an expert consultant. The lagoon contents to be added to a compost windrow should be agitated thoroughly to add as much oxygen as possible to the material. Any lagoon contents added to compost should not be contaminated with wastewater from C&D.

Eggs and Hatchery Waste

Contaminated hatching eggs and hatchery waste should be buried after verifying that the eggs are no longer viable. Landfilling may also be an acceptable option for disposal if transporting the material leads to an unacceptable biosecurity risk.

Feed, Grain, Hay, and Straw

Feed, grain, hay, and straw that may have been contaminated should be burned or buried. This includes the parts of the stocks or bins over which the owner has been walking while removing hay or grain and the parts with which animals may have had direct contact. At least 3 ft (~1 m) of loose material, two layers of bales, or one layer of sacks should be removed from such contact areas and burned, buried, or landfilled. If composting is being used as a disposal method for animal carcasses, include any of these materials in the compost windrows (see the section on composting for further discussion).

Should it be necessary to salvage feed, grain, hay, or straw on premises where large quantities are stored, the possibility and extent of contamination should be determined

through careful study. Contaminated material should be burned, buried, composted, or landfilled. The surfaces of remaining stacks of grain, hay, straw, or sacked feed should be fumigated or sprayed thoroughly with an appropriate disinfectant.

Silage

Contaminated silage and contaminated portions of silage pits must be removed and destroyed. Depending on the nature of the disease agent, the remaining silage may need to be sealed off for a period of time before being used as animal feed. In some cases, it may be necessary to plow under field crops that may be contaminated.

Manure

Contaminated manure may be burned, buried, composted, or landfilled. Manure that cannot be burned or buried should be fenced off. Depending on the nature of the disease agent and on environmental conditions, manure must remain composted for a period of time in order to inactivate the disease agent.

Wool and Mohair

Wool and mohair are difficult to incinerate. Burial is the preferred method of disposal for these substances, however they can also be landfilled.

Germplasm

If germplasm (e.g., semen or ova) is determined to pose a risk of agent spread, it should be disposed of safely. Pathology incineration or burial are probably the best options. Any germplasm that is not disposed of can be moved only under USDA permit.

References

General

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U.K. Ministry of Agriculture, Fisheries and Food (now U.K. Department for Environment, Food, and Rural Affairs). *State Veterinary Service Field Service Manual*.

Additional general information may be obtained from sources such as:

- Cooperative Extension programs (see the home page of USDA's Cooperative State Research, Education, and Extension Service at http://www.csrees.usda.gov).
- The National Biosecurity Resource Center for Animal Health Emergencies at http://www.biosecuritycenter.org/carcass.htm.

Composting

Brodie, H.L. and Carr, L.E. "Composting Animal Mortalities on the Farm." University of Maryland Cooperative Extension Service, Fact Sheet 717.

Fulhage, C. and Ellis, C. "Composting Dead Swine." Available from Extension Publications, University of Missouri-Columbia, 2800 Maguire Blvd., Columbia, MO 65211; phone 800-292-0969.

Haug, R.T. *The Practical Handbook of Compost Engineering.* Lewis Publishers, 1993.

Merka, B., Lacy, M., Savage, S., Vest, L., and Hammond, C. "Composting Poultry Mortalities." The University of Georgia College of Agricultural & Environmental Sciences (http://pubs.caes.uga.edu/caespubs/pubcd/c819-15w.html).

Natural Resource, Agricultural, and Engineering Services. "On-Farm Composting Handbook," NRAES-54., Available from Natural Resource, Agriculture, and Engineering Service (NRAES), Cooperative Extension, PO Box 4557, Ithaca, New York 14852-4557; phone 607-255-7654

Natural Resource, Agricultural, and Engineering Services. "Field Guide to On-Farm Composting," NRAES-114., Available from Natural Resource, Agriculture, and

Engineering Service (NRAES), Cooperative Extension, PO Box 4557, Ithaca, New York 14852-4557; phone 607-255-7654

Ohio Environmental Protection Agency. "Dead Animal Composting and the Management of Such Practices in Ohio." Fact Sheet, September 1996.

"Compost Materials," 1996, EBAE172-93, North Carolina Cooperative Extension Service, Raleigh, North Carolina.

Rodale, J.I. *The Complete Book of Composting. Rodale Press,* 1950.

Further information can be obtained on the Internet (do a search for "animal mortality composting").

- "Composting Animal Mortalities," University of Minnesota at http://www.mda.state.mn.us/composting/compostguide.pdf. Information is also available for ordering "Resource Notebook on Animal Composting" which is 250 pages and includes step-by-step instructions.
- "Cornell Composting," Cornell Waste Management Institute at http://cwmi.css.cornell.edu/Composting.html.
- Alabama Cooperative Extension Service at http://www.aces.edu (use "composting" as a search word on this site).

Incineration

Ford, W.B. "Air Curtain Incinerator™ System Test for Disposal of Large Animal Carcasses." *Foreign Animal Disease Report, 22-2,* USDA, 1994.

USDA, APHIS. "Swine Carcass Disposal Evaluation using Air Curtain Incinerator System, Model T-359." 1994. Reprinted 1996, 1998, 1999, 2001, 2002 by Air Burners, LLC (http://www.airburners.com).

Acronyms

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

AUSVETPLAN—The Australian Veterinary Plan

BSE—Bovine spongiform encephalopathy ("mad cow" disease)

EMRS—Emergency Management Response System

FMD—Foot-and-mouth disease

NAHEMS—National Animal Health Emergency Management System

NVSL—National Veterinary Services Laboratories

TDD—Telecommunications device for the deaf

TSE—Transmissible spongiform encephalopathy

USDA—United States Department of Agriculture (http://www.usda.gov)

VS—Veterinary Services (http://www.aphis.usda.gov/vs/); a program in the Animal and Plant Health Inspection Service

Glossary

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

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

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

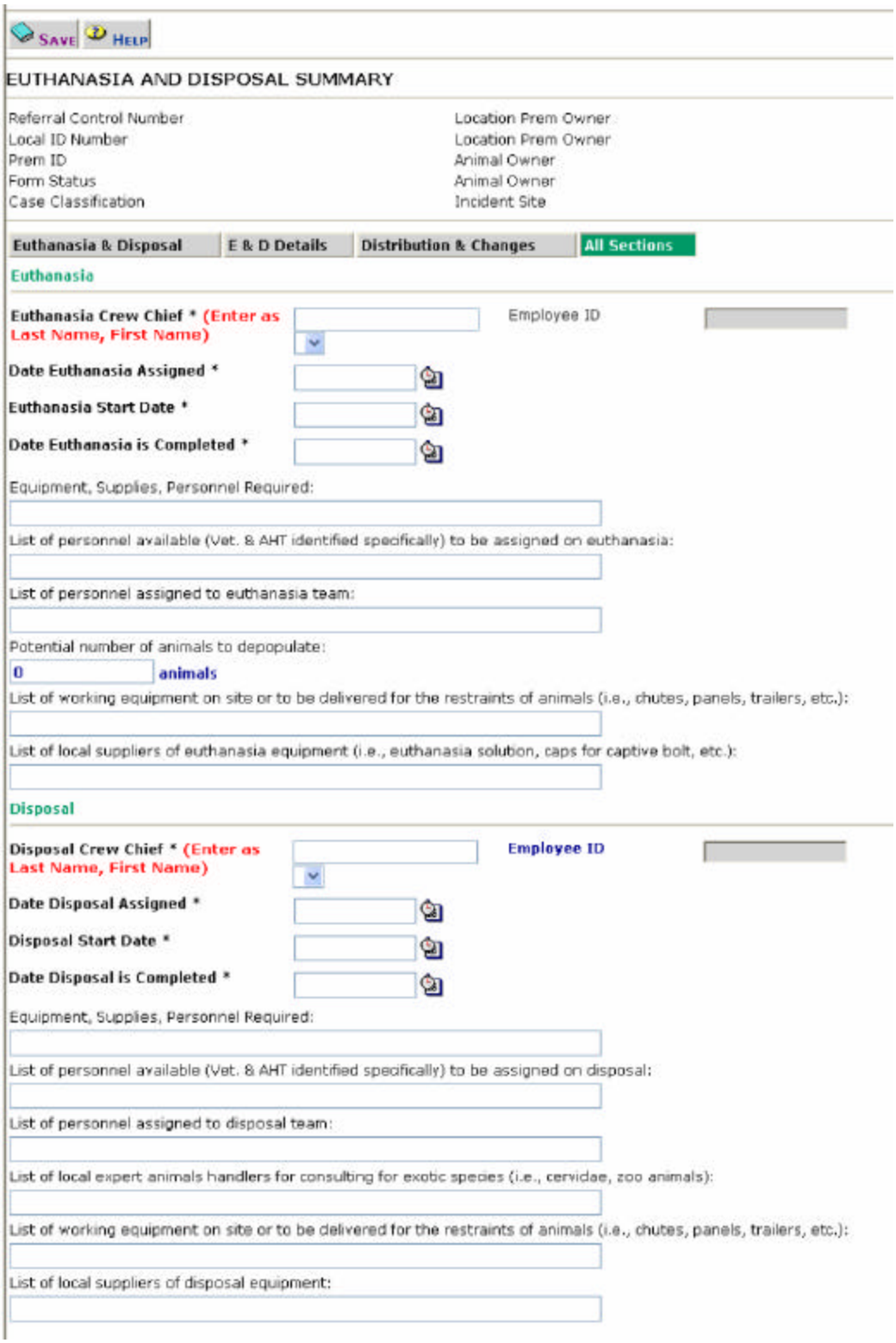
Premises—A tract of land, including its buildings, or a separate farm or facility that is maintained by a single set of services and personnel.

Rendering—The processing of animal carcasses or meat wastes into usable products. The wastes are subjected to heat, resulting in the inactivation of most infective agents. (Rendering does not inactivate the agents that cause transmissible spongiform encephalopathies such as BSE.)

State—Any of the States, the District of Columbia, the Commonwealth of Puerto Rico, Guam, the Commonwealth of the Northern Mariana Islands, the Virgin Islands of the United States, or any territory or possession of the United States (Animal Health Protection Act, 2002).

Zoonotic disease—An infectious disease that is transmissible from vertebrate animals to humans.

Appendix I
EMRS Forms



SAVE HELP

EUTHANASIA AND DISPOSAL SUMMARY

Referral Control Number
Local ID Number
Prem ID
Form Status
Case Classification

Location Prem Owner
Location Prem Owner
Animal Owner
Animal Owner
Incident Site

Euthanasia & Disposal | E & D Details | Distribution & Changes | All Sections

Euthanasia

Euthanasia Crew Chief * (Enter as Last Name, First Name)
Employee ID
Date Euthanasia Assigned *
Euthanasia Start Date *
Date Euthanasia is Completed *

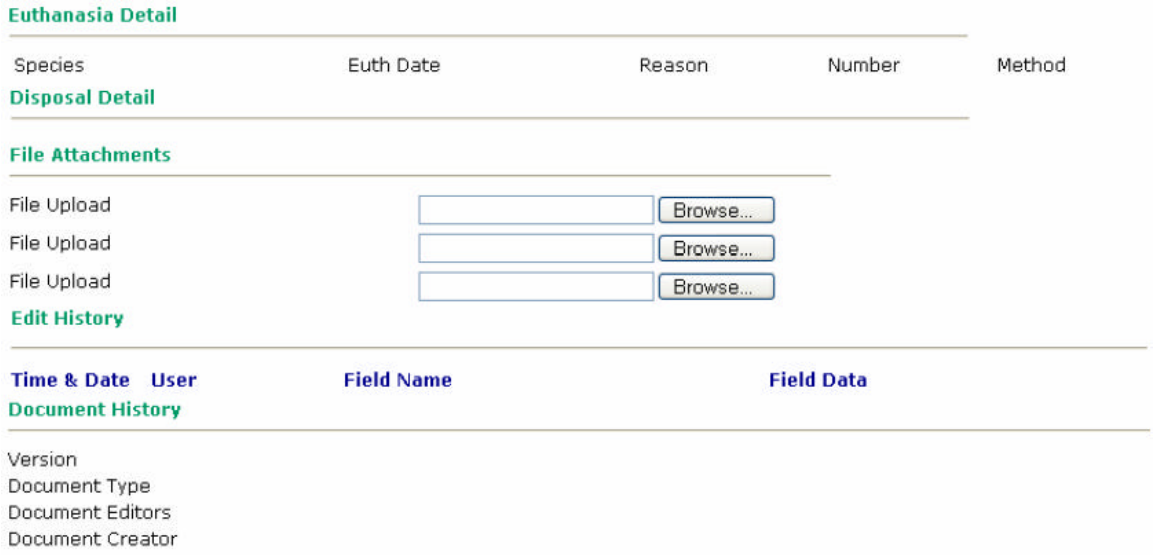
Equipment, Supplies, Personnel Required:
List of personnel available (Vet. & AHT identified specifically) to be assigned on euthanasia:
List of personnel assigned to euthanasia team:
Potential number of animals to depopulate:
0 animals
List of working equipment on site or to be delivered for the restraints of animals (i.e., chutes, panels, trailers, etc.):
List of local suppliers of euthanasia equipment (i.e., euthanasia solution, caps for captive bolt, etc.):

Disposal

Disposal Crew Chief * (Enter as Last Name, First Name)
Employee ID
Date Disposal Assigned *
Disposal Start Date *
Date Disposal is Completed *

Equipment, Supplies, Personnel Required:
List of personnel available (Vet. & AHT identified specifically) to be assigned on disposal:
List of personnel assigned to disposal team:
List of local expert animals handlers for consulting for exotic species (i.e., cervidae, zoo animals):
List of working equipment on site or to be delivered for the restraints of animals (i.e., chutes, panels, trailers, etc.):
List of local suppliers of disposal equipment:

Appendix I
EMRS Forms (cont.)



Appendix I
EMRS Forms (cont.)