NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

COMPOSTING FACILITY

(No.)

CODE 317

DEFINITION

A facility to process raw manure or other raw organic by-products into biologically stable organic material.

PURPOSE

To reduce the pollution potential of organic agricultural wastes to surface and ground water.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Organic waste material is generated by agricultural production or processing.
- A composting facility is planned and operated as a component of a planned agricultural waste management system;
- A composting facility can be constructed, operated and maintained without polluting air and/or water resources;
- There is a need to improve air quality by reducing the emissions of odorous gases.

CRITERIA

General Criteria Applicable to All Purposes

Design guidance that may be used in the design of compost facilities can be found in the Agricultural Waste Management Field Handbook, NRCS.

Laws and Regulations. The installation and operation of the composting facility shall comply with all federal, state and local laws, rules and regulations.

Safety. Safety and personal protection features and practices shall be incorporated into the facility and its operation as appropriate to minimize the occurrence of equipment hazards and biological agents during the composting process.

Facility Siting. The bottom elevation of the composting facility shall be above the seasonal high water table and on soils with a moderate or low permeability that does not allow materials to contaminate the ground water, and meets all applicable regulations, or the facility shall be installed on concrete slabs or other appropriate liners.

Ideally, compost facilities should be located outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from a minimum 25-year flood event.

Locate compost facilities so prevailing winds and landscape elements such as building arrangement, landforms and vegetation minimize odors and protect the visual resource.

Compost facilities shall not be located within 300 feet of water wells or within 10 feet of property lines or buildings. The distance from a well shall be measured from the well's centerline to the outside perimeter of the compost facility.

Direct surface runoff away from the compost facility. Direct contaminated runoff from compost facilities to an appropriate storage or treatment facility for further management.

Compost Mix. Develop a compost mix that encourages aerobic microbial decomposition and avoids nuisance odors.

Carbon-Nitrogen Ratio. The initial compost mix shall result in a carbon to nitrogen (C:N) ratio between 25:1 and 40:1. Compost with a

greater carbon to nitrogen ratio can be used if nitrogen immobilization is not a concern.

Carbon Source. A dependable source of carbonaceous material with a high C:N ratio shall be stored and available to mix with nitrogen rich waste materials. Wood chips, sawdust, peanut hulls, rice hulls, bark, peat moss, and well-bedded horse manure are good sources of carbon. Two materials may have the same carbon to nitrogen ration (C:N) but may vary significantly in "readily available" carbon. Rice hulls are an excellent source of readily available carbon while most straw sources are not. Chopped wheat straw is minimally acceptable while most straw hay and prairie hay does not give satisfactory results.

Bulking Materials. Add bulking materials to the mix as necessary to enhance aeration.

The bulking material may be the carbonaceous material used in the mix or a non-biodegradable material that is salvaged at the end of the compost period. If a non-biodegradable material is used, provision shall be made for its salvage.

Moisture Level. Large amounts of water evaporate during the composting process because operating temperatures drive off water. It is important to provide the recommended initial moisture content to promote efficient composting and a desired end moisture content. The moisture content of the blended material at start-up of the composting process should be approximately 60 percent (wet weight basis). Provision may be made for maintaining adequate moisture in the compost mix throughout the compost period within the range of 40 to 65 percent (wet basis). The composting process may become inhibited when moisture falls below approximately 40 percent. Water used for moisture control must be free of deleterious substances.

Proper moisture content is critical in a carcass composting process and varies greatly with carcass specie and size. Water is also a by-product of aerobic decomposition of animal and poultry carcasses. A minor amount of initial moisture is important in initiating the composting process. However, the number 1 source of failure in aerobic carcass composting is too much moisture either from excess application by the operator or failure to exclude outside rainfall. Learning to control moisture is a trial and error process for each size and specie of carcass. For poultry, a good rule of thumb for moisture is to spray the carcasses with a light mist roughly equivalent to autumn morning dew. Further addition of water is almost never needed in poultry composting. The composting of large swine carcasses requires a larger quantity of water to initiate the process. This is due in part because it takes a longer period of time before the swine carcass releases by-product water. Initial moisture application for swine varies from 0.25 to 0.65 pounds of water per pound of carcass depending on carcass size. A 350-pound sow requiring approximately 0.5 pounds of water per pound of carcass would require an initial addition of 175 pounds or 21 gallons of water.

A good carcass compost should heat up to the 140^{o}F range within a few days. Failure of the compost material to heat properly normally results from two causes. First the nitrogen source is inadequate (example wet or leached litter). A pound of commercial fertilizer spread over a carcass layer will usually solve this problem. Secondly, the compost fails when too much water has been added and the compost pile becomes anaerobic. An anaerobic compost bin is characterized by temperatures less that 120^{o}F, offensive odors, and a black oozing compound flowing from the bottom of the compost bin.

In high precipitation climatic regions, care shall be taken to prevent excess moisture from accumulating in the compost. Facility covers may be required to provide for a suitable product.

Temperature of Compost Mix. Manage the compost to attain and then maintain the internal temperature for the duration required to meet management goals.

Temperatures should be maintained between 130^{o}F and 170^{o}F early in the compost process. When the management goal is to reduce pathogens, the compost shall attain a temperature greater than 130^{o}F for at least 5 days as an average throughout the compost mass.

This temperature and time criterion may be achieved during either primary or secondary composting stages or as the cumulative time of greater than 130^{o}F in both stages.

If temperature falls significantly during the composting period and odors develop, or if material does not reach operating temperature, investigate piles for moisture content, porosity, nitrogen content of litter, and thoroughness of mixing. A dry cover layer of 4" to 6" is needed to provide insulation to maintain adequate temperature within the compost pile.

Turning/Aeration. Heat generated by the process causes piles to dehydrate. As the process proceeds, material consolidates, and the volume of voids through which air flows decreases. Materials selected for the composting mix should provide for adequate air movement throughout the composting process. The frequency of turning/aeration shall be appropriate for the composting method used, and to attain the desired amount of moisture removal and temperature control while maintaining aerobic degradation.

Nutrients. Keep compost well aerated to minimize nitrogen loss by denitrification. Keep pH at neutral or slightly lower to avoid nitrogen loss by ammonification. High amounts of available carbon will aid nitrogen immobilization. A low C:N ratio will cause a loss of nitrogen. Phosphorus losses will be minimized when the composting process is managed according to the requirements of this standard.

Testing Needs. Test compost material for carbon, nitrogen, moisture, and pH if compost fails to reach desired temperature or if odor problems develop. The finished compost material should be periodically tested for constituents that could cause plant phytotoxicity as the result of application to crops. Composted materials that are prepared for the retail marker will require testing for labeling purposes.

Facility Type. Selection of the composting facility/method shall be based on the availability of raw material, the desired quality of final compost, equipment, labor, time and land available.

Manure and dead animal carcasses are the most common materials composted in agricultural operations. Composting methods and equipment are usually geared toward one or the other. All types of manure can be composted while dead animal carcass composting is usually limited to poultry or swine and cattle nursery stock due to animal carcass size practical constraints.

Methods of composting covered in this standard are:

1. Windrows
2. Static Pile
3. In-Vessel
4. Compost Bin

Manure is typically composted using windrows, static pile, and in-vessel methods. Dead animal carcasses are typically composted using in-vessel and compost bin methods.

Facility structural elements such as permanent bins, concrete slabs and roofs shall meet the requirements of the Oklahoma NRCS Waste Storage Facility (313) standard.

Facility Size. Size the compost facility to accommodate the amount of raw material planned for active composting plus space required for curing.

Dimensions selected for elements of the compost facility shall accommodate equipment used for loading, unloading, and aeration.

Manure composting facilities must be sized according to the amount of manure produced, the amount of carbon source needed to achieve the required C:N ratio, and the estimated number of days required to achieve the desired degree of composting.

Sizing of facilities for composting dead animals shall be based on normal mortality loss records for the operation. If this data is not available, locally established mortality rates for the type of operation shall be used.

Composter sizing shall be based on requirements found in the Agricultural Waste Management Field Handbook, Chapter 10.

Pile Configuration. Compost piles for windrowed and static piles should be triangular to parabolic in cross-sectional form with a base width to height ratio of about 2 to 1.

The windrow method involves the arrangement of compost mix in long, narrow piles or windrows. Windrows are more suited to large volumes of organic material that are managed by power equipment used to turn the

composting material periodically. Periodic turning re-aerates the windrows.

The static pile method consists of mixing the compost material and then stacking the mix on perforated plastic pipe or tubing through which air is drawn or forced. Organic material in static piles is initially mixed to a homogeneous condition and not turned again throughout the composting process. Static pile material must have the proper moisture content and bulk density to facilitate air movement throughout the pile. Forced air might be necessary to facilitate the composting process.

Increased surface area favorably affects evaporation and natural aeration and increases the area exposed to infiltration from precipitation in uncovered stacks. Aligning piles north to south and maintaining moderate side slopes maximizes solar warming. Windrows should be aligned to avoid accumulation of precipitation.

In-vessel composting in a totally enclosed structure is carried out on a blended organic material under conditions where temperature and air flow is strictly controlled. Vessels usually have an agitating device to ensure proper mixing. Vessel dimensions must be consistent with equipment to be used for management of compost.

Dead Animal Carcass Composting Bins. Composting facilities for the purpose of processing animal carcasses are to include a primary composting unit into which alternate layers of low moisture content manure (usually poultry manure), carbon source material (straw, rice hulls), and dead animal carcasses are placed. A secondary composting unit is also required to complete the composting process. This secondary unit may consist of either additional bins or a larger storage area.

The size of the composter units shall be based on the operations animal mortality rates.

Dead animal carcass composting bins shall be designed to facilitate transfer of compost material from the primary stage to the secondary stage. The primary stage will require multiple bins to properly load, monitor, and turn the compost.

All bins and areas for storing composting materials shall be covered by a roofed structure to keep out precipitation.

Compost Period. Continue the composting process long enough for the compost mix to reach the stability level where it can be safely stored without undesirable odors. It shall also possess the desired characteristics for its use, such as lack of noxious odor, desired moisture content, level of decomposition of original components and texture. The compost period shall involve primary and secondary composting as required to achieve these characteristics.

Test the finished compost as appropriate to assure that the required stabilization has been reached.

Use of Finished Compost. Land application of finished compost shall be in accordance with the Oklahoma NRCS Nutrient Management (590) and Waste Utilization (633) standards.

CONSIDERATIONS

Develop an initial compost mix with a carbon to nitrogen ratio of at least 30:1 to reduce most offensive odors.

Minimize odors and nitrogen loss by selecting carbonaceous material that, when blended with the nitrogenous material provides a balance of nutrients and porous texture for aeration.

A chemical neutralizing agent should be used if structural components do not provide adequate odor reduction.

In humid areas, do not locate piles (windrows) across the slope to prevent ponding and sogginess.

Protect compost facilities from the wind in cold climates. Wind protection may help prevent excess drying of the compost in dry climates.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use.

OPERATION AND MAINTENANCE

Develop an operation and maintenance plan that is consistent with the purposes of this practice, and the life of the composting facility.

Recipe ingredients and sequence that they are layered and mixed shall be given in the plan.

Safety requirements for operation of the composting facility shall be provided.

Manage the compost piles for temperature, odors, moisture, and oxygen, as appropriate. Make adjustments throughout the composting period to insure proper composting processes.

Closely monitor temperatures above 165^{o}F. Take action immediately to cool piles that have reached temperatures above 185^{o}F.

The operation and maintenance plan shall state that composting is a biological process. It requires a combination of art, science, and flexibility for success. Hence, the operation may need to undergo some trial and error in the start-up of a new composting facility.

REFERENCES

Northeast Regional Agricultural Engineering Service, Cooperative Extension "On-Farm Composting Handbook", NRAES-54.