UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

COMPOSTING FACILITY

(Ea.)

Code 317

DEFINITION

A facility for the biological stabilization of waste organic material.

PURPOSE

To treat waste organic material biologically by producing a humus-like material that can be recycled as a soil amendment and fertilizer substitute or otherwise utilized in compliance with all laws, rules, and regulations.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where: (1) waste organic material is generated by agricultural production or processing; (2) composting is needed to manage the waste organic material properly; (3) an overall waste management system has been planned that accounts for the end use of the composted material.

Waste organic material for composting may include livestock and poultry manure, dead animal carcasses, and food processing wastes where food is processed as part of normal farming operation. Municipal sludge, solid waste, and other non-farm type wastes are not included in this standard.

CRITERIA

General Criteria Applicable to all Purposes

Soils. Locate composting facilities on soils having slow to moderate permeability to minimize seepage of dissolved substances into the soil profile and movement toward groundwater. Evaluate site-paving needs in terms of effects of equipment operation on trafficability, soil compaction, and potential for contamination from compost and petrol products.

Runoff. Divert surface runoff from outside drainage areas around the compost facility. Collect runoff from the compost facility and utilize or dispose of it properly. Evaluate the effects of changed infiltration conditions on groundwater recharge, and evaluate changes in volumes and rates of runoff caused by the location of the operation. Properly manage movement of organic material, soluble substances, and substances attached to solids carried by runoff.

Carbon-Nitrogen Ratio. Calculate the amounts of the various ingredients to establish the desired carbon-nitrogen ratio (C:N) of the mix to be composted. The C:N should be between 25:1 and 40:1. Use the higher range of C:N for organic materials that decompose at a high rate (or are highly unstable) with associated high odor production.

Where more than two ingredients are to be blended, the two main ingredients are to be used in the analysis for the desired C:N and mixed accordingly. Adding up to 50 percent by weight of other ingredients to improve workability and air movement is permissible as long as the C:N of the added ingredient does not exceed the target C:N of the compost.

Odor. Select carbonaceous material that, when blended with the nitrogenous material, will result in the desired pH. The blended material should have a pH at or slightly below neutral for best odor control. Where odors do not present a problem, pH of 8 to 9 is acceptable, but strong ammonia and amine related odors will be present for up to the first 2 weeks.

Locate composting operations where movement of any odors toward neighbors will be minimized. Buffer areas, vegetative screens, and natural landscape features can help minimize the effects of odors.

Facility Configuration. Where dead poultry and other small farm animals are composted, establish the size of the composter units on the basis of locally determined animal loss rates. 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

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(usually poultry manure), carbon source material (straw is common), and dead animal carcasses are placed. A secondary composting unit is often necessary to complete the composting process.

All structures will be placed on a minimum 4 in. thick concrete pad.

Moisture. The moisture content of the blended material at start-up of the composting process should be approximately 60 percent (wet weight basis) and maintained between 40 and 60 percent during the composting process. The composting process may become inhibited when moisture falls below approximately 40 percent. Water used for moisture control must be free of deleterious substances.

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. 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.

Composting Period. The time needed for completion of the process varies with the material and must continue until the material reaches a stability level at which it can be safely stored without creating undesirable odors and poor handling features. Acceptable stability occurs when microbial activity diminishes to a low level. Stability can be obtained in about 21-28 days but can require up to 60 days or more to produce the desired quality. Visual inspection and temperature measurements will provide needed evaluation of compost status. If raw parts remain after a composting cycle, the material should be turned and allowed to undergo another composting cycle.

Storage. Provide properly designed storage facilities sized for the appropriate storage period. Protect composted material from the weather by roofs or other suitable covers. Structures must meet the requirements of NRCS Conservation Practice Standard, Waste Storage Facility, Code 313.

Federal, State, and Local Laws

Individuals designing composters will strictly adhere to Alabama laws and to rules and regulations established by the state veterinarian's office, state and local health departments, and the Alabama Department of Environmental Management (ADEM). Prior approval from the state veterinarian's office must be obtained before using compost off the farm of origin. Compost from single-stage composters and mini-composters may be spread only on the farm or origin. The producer will be responsible for securing the necessary permits to install the composter and for properly managing the unit on a daily basis.

Additional Criteria for Poultry

For meat-producing poultry (broilers, Cornish hens, etc.) the volume required for each stage of multiple stage composting units is:

No. birds x (% loss/No. days) x final wgt x 2.5* = Vol (cf)

*Note: For single-stage composters and mini-composters use a factor of 3.75.

Single-staged composters and mini-composters may be used only for flocks of up to 45,000 roasters, 60,000 broilers or 120,000 Cornish hens without approval of the SCE. Single-stage composters and mini-composters will not be used for any birds of 5 lbs. or more.

Table 1 provides suggested values to use for various types of birds and provides the design factors used to determine first stage volume of multiple stage composting units. The design factor is multiplied by the number of birds initially placed on farm to find first stage volume. Anticipated mortality is included in this factor.

The total volume is divided by the volume of an individual composting bin to determine the number of bins required.

No. of bins = (Total 1st stage vol.) / (vol. of single bin)

Bins for multiple stage composting are typically 5 ft. high, 5 ft. deep, and 10 ft. across the front. However, widths may be adjusted to accommodate the equipment on hand. The volume required in Stage No. 2 will be equal to the first stage, as minimum. In north Alabama, the second stage should have at least twice the first stage volume to provide winter storage.

Table 1. Poultry Data and Multiple Stage Composter Design Factors

(a) Poultry Type	(b) Loss Rate (%)	(c) Flock Life (wks)	(d) Cycles Per Yr.	(e) Avg. Mkt. Wgt. (lbs)	(f) Multiple Stage Composter Design Factor* (cu ft/bird)
Broiler	4.5-5.5	6-7	5.5-6	4.2	0.0125
Roaster					
Females	3	6	4	4.0	0.0071
Males	8	10	4	7.5	0.0214
Laying Hens	14	60-65	0.9	4.5	0.0035
Breeding					
Hens	10-12	60-65	0.9	7-8	0.0048
Males	20-25	40-45	1.1	10-12	0.0238
Turkey					
Female	5-6	13-14	3	14	0.0196
Turkey Lg. Tom	9	16-16.5	3	24	0.0468
Feather Prod.	12	18-18.5	2.5	28-32	0.0741

*[(b) as decimal / (c) (days)] x (e) x 2.5 = (f)
Volume of 1st Stage = (f) x No. of animals

Table 2. Number of First Stage Composter Bins Required for Broilers Using 5 ft. x 5 ft. x 10 ft. bins.

No. of Broilers	Lbs. dead/day On day 42* --------lbs--------	Volume in 1st Stage** ------cf------	No. of bins in 1st Stage***
20,000	100	250	1
40,000	200	500	2
60,000	300	750	3
80,000	400	1,000	4
100,000	500	1,250	5
120,000	600	1,500	6
140,000	700	1,750	7
160,000	800	2,000	8
180,000	900	2,250	9
200,000	1,000	2,500	10

*Assumes mature weight of 4.2 lbs; flock loss of 5%.
**(Total weight loss near maturity) x (2.5 cf/lb dead wgt) = cu. ft. of storage required.
***Bin dimensions: 5 ft. x 5 ft. 10 ft. or 250 cf.

Mini-composters are to be 4 ft. x 4 ft. x 4 ft. Each bin of the mini-composter shall be built with 1/2 in. space between each horizontal board. Commercially supplied single-stage units may be up to 5 ft. in one horizontal dimension.

AL-ENG-25F provides details on the methodology used in sizing facilities and may be used for other types of poultry. Table 2 provides a quick summary of the number of bins required in the first stage of a multi-stage broiler composting unit using 5 ft. x 5 ft. x 10 ft. bins.

Additional Criteria for Swine

General. Composting of swine is still on a trial basis and the loading rates and time per composting cycle are not yet well defined. The following design parameters are suggested as the minimum requirements with carefully managed bins. To allow for catastrophic mortality or less than optimum management, additional space should be allowed. All composting operations should be prepared to dispose of catastrophic mortality according to NRCS Guide Sheet No. AL 317B, Emergency Disposal of Dead Animals.

1) One cubic foot of primary composter should accommodate about 5 to 8 lbs. of swine carcass at any given time. Nursery pigs and small feeder pigs can be loaded into a bin at 7 to 8 lbs. per cubic foot. Heavy feeders and sows should be loaded into primary bins at about 5 lbs. per cubic foot.

2) The secondary bin size should not be less than the primary volume, and should be twice the primary volume for winter storage in north Alabama.

3) Properly managed primary bins loaded with small pigs and lightweight feeder carcasses can be turned into the secondary bin in 60 days or less after the last carcass is placed in the bin. Allowing 90 days per cycle for filling and composting, each bin can be filled 4 times per year with the lighter carcasses.

4) Heavy feeders and sows may have to stay more than 60 days in the primary bin. Allowing 120 days per cycle for filling and composting, each bin can be filled no more than 3 times per year.

5) Trial recommendation - Provide 1 cubic foot of primary composter bin space per 30 lbs. of annual mortality for pigs up to about 100 lbs. - stacked 5 feet deep. This equals 1 square foot of primary bin floor space per 150 lbs. of annual mortality.

6) Trial recommendation - Provide 1 cubic foot of primary composter bin space per 20 lbs. of annual mortality for pigs heavier than 100 lbs. - stacked 5 feet deep. This equals 1 square foot of primary bin floor space per 100 lbs. of annual mortality.

7) Average bin size = 10 ft. x 6 ft. x 5 ft. deep = 60 square feet or 300 cubic feet. Properly managed, this should handle about 2,250 lbs. of lightweight carcasses per compost cycle or 9,000 lbs. per year (4 cycles). For heavier feeders, sows, boars, or gilts, it may handle only 1,500 lbs. per cycle or 4,500 lbs. per year (3 cycles).

Growing-Finishing Unit. Assumptions:

Mortality Averages 3%
Growout from 40 lb. to 240 lb. hogs
2.75 batches per year (17 weeks in, 2 weeks out)

Average death loss per batch:
2,625 lbs. of carcass per 625 animals finished
4,200 lbs. of carcass per 1000 animals finished

Average death loss per year:
7,220 lbs. of carcass per 625 head capacity
11,550 lbs. of carcass per 1000 head capacity

Number of standard size primary bins:
2 bins minimum, regardless of facility size
1.6 bins per 625 head capacity
2.6 bins per 1000 head capacity

Middle or P2 Unit. Assumptions:
Mortality averages 3%
Growout from 10 lb. to 60 lb. hogs
7 batches per year (6 weeks in, 2 weeks out)

Average death loss per batch:
1680 lbs. of carcass per 1600 animals finished

Average death loss per year:
11,760 lbs. of carcass per 1600 head capacity

Number of standard size primary bins:
2 bins minimum, regardless of facility size
1.3 bins per 1600 head capacity

Farrowing Unit. Assumptions:
Sow and boar mortality averages 3%
Average weight all sows, boars, and gilts = 375 lbs.
19 live pigs born per sow/gilt per year
2 dead pigs born per sow/gilt per year
Pig mortality averages 3%
Pig weight = 3 to 40 lbs.

Average death loss per year per 100 sows:
1200 lbs. sows, boars, gilts
600 lbs. fetus
1200 lbs. pigs

Number of standard size primary bins:
2 bins minimum, regardless of facility size
1 bin per 150 sow capacity

Additional Criteria for Other Animals and Food Processing Wastes

Other animals and food processing wastes from agricultural operations can successfully be composted. Guidance from the state environmental engineer on design criteria shall be used in the design.

CONSIDERATIONS

Types

Three types of composting operations are covered in this standard; aerated windrows, static piles, and in-vessel. Aerated 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, promoting the composting process.

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.

In-vessel composting in a totally enclosed structure is performed on a blended organic material under conditions where temperature and air flow are strictly controlled. In-vessel composting also includes naturally aerated processes where organic materials are layered in the vessel in a specified sequence. Layered, in-vessel materials are usually turned once to facilitate the process. Vessel dimensions must be consistent with equipment to be used for management of compost.

Process

Composting is accomplished by mixing an energy source (carbonaceous material) with a nutrient source (nitrogenous material) in a prescribed manner to meet aerobic microbial metabolic requirements. The process is performed under specific moisture and temperature conditions for a specified period of time. Correct proportions of the various compost ingredients are essential to minimize odors and to avoid attracting flies, rodents, and other small animals.

Carbon Source

A dependable source of carbonaceous material must be available. The material should have a high carbon content and high carbon to nitrogen ratio (C:N). Wood chips, sawdust, peanut hulls, straw, corn cobs, bark, peat moss, and well bedded horse manure are good sources of carbon.

Moisture Control

Large amounts of water are needed during the composting process because operating temperatures evaporate water. A source of water should be available for compost pile moisture control from start-up through completion. Proper moisture facilitates the composting process and helps control odors. A mixture that is too wet will become anaerobic, creating potentially offensive conditions.

Equipment Needs

Appropriate equipment should be available for initial mixing, turning, and hauling composted material and carbonaceous material. Appropriate long stem thermometers should be available for monitoring temperatures during the composting process.

Bulking Materials

Bulking materials may be added to enhance air flow within the composting material. Piles that are too compact will inhibit the composting process. The carbonaceous material can be considered as a bulking agent. Where it is desirable to salvage carbonaceous material, provisions for removing the material, such as screening, should be made.

Management

Composting operations require close management. Management capabilities of the operator and availability of labor should be assessed as part of the planning and implementing process.

Economics

Benefits associated with the ultimate use of the composted material should be compared to the capitol expenditure and operating costs of the composting operations. In addition to cost return, benefits can include environmental protection, improved handling, disposal of dead poultry and other farm animal carcass, odor control, and reduced need for storage volume.

Effects of Composting on Water Quality

Composting should improve water quality by eliminating alternative methods of disposal which could pollute surface and ground water. Also, since poultry compost is higher in organic nitrogen than broiler litter, the potential for leaching and loss in surface runoff will be reduced. The bacteria and viruses associated with the carcasses and the manure are essentially destroyed, making compost a safer fertilizer than plain broiler litter. Caution must still be taken to prevent spreading near surface waters because the high level of organic matter, if allowed to enter water, could cause oxygen depletion problems.

PLANS AND SPECIFICATIONS

Plans and specifications for an organic composting facility shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. Plans and specifications include construction plans, drawings, job sheets, construction specifications, narrative statements in conservation plans, or other similar documents. For single-stage and mini-composters, the conservation plan will include a statement indicating that the owner/operator has been advised of possible problems with this type of system, including fly and odor problems, consolidation and difficulty of removal of the material, high manual labor requirements, and rain entering the system. A written operation and maintenance plan shall be developed with full knowledge and input of the owner-operator and included with the documents provided to the owner-operator. The Construction Specification for NRCS Conservation Practice Standard, Waste Storage Facility, Code 313, will be utilized for the construction of a compost facility.

OPERATION AND MAINTENANCE

General

Temperature. For best results, operating temperature of the composting material should be 130°F to 170°F once the process has begun. It should reach operating temperature within about 7 days and remain elevated for up to 14 days to facilitate efficient composting. The material should remain at or above 110°F for the remainder of the designated composting period.

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, and thoroughness of mixing. Compost managed at the required temperatures will favor destruction of any pathogens and weed seeds.

Excessive temperature in the composted material of 190°F or more can indicate the potential for a fire to develop. To prevent fires in litter or compost piles, follow the recommendations in NRCS Guide Sheet No. AL 313, Preventing Fires in Litter Storage Structures.

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. Periodically turning the piles and maintaining proper moisture levels for windrows and static piles will normally provide adequate aeration.

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. Phosphorus losses will be minimized when the composting process is managed according to the requirements of this standard. Include compost nutrients in nutrient management plans and determine the effects of use and management of nutrients on the quality of surface water and groundwater as related to human and livestock consumption.

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 market will require testing for labeling purposes.

Maintaining the Structures. The compost structure should be inspected at least twice each year when the facility is empty. Replace any damaged wooden parts or hardware. Roof structures should be examined for structural integrity. Walls of composters that are constructed with lumber treated to a 0.25 pcf retention level may need replacing during the life of the structure.

Land Applying the Compost. Compost should be analyzed for nutrient content and land applied in accordance with NRCS Conservation Practice Standard, Nutrient Management, Code 590 or Waste Utilization, Code 633.

Poultry

The composting process uses a simple mixture of dry poultry manure, poultry carcasses, wheat straw, and water. (Other carbon sources such as peanut hulls, cotton seed hulls, etc., may be used in place of straw. Poultry manure cake has also been found to be an acceptable material in lieu of dry poultry manure and wheat straw.) The components of the mixture must be added according to guidelines to ensure proper growth of the bacteria and fungi needed for decomposition. Litter used for composting should be managed to ensure that adequate bacterial counts and temperature are present. Guidance for operation and maintenance of poultry compost facilities can be found in NRCS Guide Sheet No. AL 317, Composting Poultry Mortality.

Swine

Swine composting continues to be a developing technology. Guidance for operation and maintenance for a swine compost facility can be found in NRCS Guide Sheet No. AL 317A, Composting Swine Mortality. The suggested recipes in the Guide should be carefully followed until it is determined that the process is working well. Ingredients may be substituted on a trial basis once it has been determined that the process is working well.

Other Animal and Food Processing Wastes

The operation and maintenance of composting facilities for other dead animals and for food processing wastes from agricultural operations can be similar to those for poultry and swine. Engineers should receive guidance from the state environmental engineer for specific operation and maintenance requirements.

REFERENCES

-Alabama NRCS Guide Sheet Nos.
AL 317, AL 317A, and AL 317B
-Alabama NRCS Engineering Forms
AL-ENG-25E and AL-ENG-25F
-Alabama Poultry Waste Management - Waste Utilization and Facilities Design Workbook.
-Arkansas Swine Composting Guidelines.
-AWMFH, Chapter 7, NEH Part 651.
-NRCS Conservation Practice Standards:
Nutrient Management, Code 590
Waste Storage Facility, Code 313
Waste Utilization, Code 633.