Part 651 – Animal Waste Management Field Handbook

Chapter 10 – Agricultural Waste Management System Component Design

IL651.1007 (f) Composting Dead Animals

Where not specifically addressed in this Illinois Supplement, facilities for composting dead animals shall be sized using the NRCS References listed below, and shall meet or exceed the provisions of the Illinois Dead Animal Disposal Act, Section 90.110. Composting facilities shall have a primary and secondary stage. The primary stage may be implemented using static bins or with a manufactured in-vessel composting device. The secondary stage shall be implemented using bins.

The design daily mortality rate shall be calculated using the greatest projected mortality rate of any given 90 day period during the year. If information on mortality is not available from the producer, the design mortality rate and carcass design weight values from Reference [2] should be used.

Bin System Composting

The available capacity of the primary composting bins shall be at least the volume determined by multiplying the design daily mortality rate (pounds of dead animals per day) by a volume factor. In general, the designer should use a volume factor of 20 cubic feet for larger animals, such as swine and cattle. This will yield enough space for 90 days of mortalities in a well-managed composting system. If a nitrogen source such as poultry litter or manure is used, the volume factor may be reduced as described in Reference [2].

Calculation of the available bin capacity should account for the angle of repose of the material in the bin. In the absence of actual data, use an angle of repose of 1:1 (45 degrees.) Note that a narrower bin width will mean less volume lost to the angle of repose.

The Illinois Dead Animal Disposal Act ("the Act") also requires the following minimum composting area:

Type of Animal Carcass	Area of Composting Required
Swine	Min. 10 ft2/1000 lbs. of carcass, with a minimum of 10 inches between the carcass and any vertical bin walls
Cattle, sheep, goats	Larger of: • 1 ft. of space provided all around the carcass, OR • 1 ft. larger than the width of the equipment used for turning the compost pile

The minimum number of primary and secondary bins required for a bin-only system is:

- Primary Bins = (No. of bins for 90 days Mortality) + 1
- Secondary Bins = No. of Primary Bins
- Total Bins = Primary + Secondary
- Minimum System Design = 4 Bins total

Additional bins may also be provided for storage of carbon source materials.

Composting Sequence

1. The primary bin will be filled and allowed to compost for 90 days after the last carcass is placed, or until the temperature in the area of the last carcass placed falls below 130°F after a period of temperatures in the range of 135°-160°F. If the temperature does not reach at least 135°F after 7 days of composting, the pile should be turned and more water or carbon source should be added to achieve a moisture content that will allow the composting process to proceed.
2. The material finished with primary composting is moved to a secondary bin. More carbon source is added as necessary to maintain desired moisture content.
3. The material will be allowed to reheat through a second composting cycle in the secondary bin for 90 days. More carbon source and/or water shall be added as necessary to maintain desired moisture content over the secondary composting period.

Filling the Primary Stage Bins

A minimum layer of carbon source should be placed on the floor of the bin prior to loading the first carcasses and on the sides and on top of the carcasses. This thickness shall also be maintained on the sides and top during the composting process. The minimum thickness of the carbon source is as follows:

Type of Animal Carcass	**Required Minimum Thickness of Carbon Source**
Swine	10 inches
Cattle, sheep, goats	12 inches

Any cattle, sheep, or goat carcass weighing over 300 lbs. is required by the Act to be processed prior to covering with the carbon source by opening the abdominal cavity and incising the large limb muscles, or other methods to increase the contact of carbon source with the carcass, hasten composting, and reduce distension of the carcass. Carcasses of those animals dying of suspect neurological causes shall not be composted.

The time to completely fill a primary bin will depend on the bin size and amount of mortalities being produced. In addition, the scheduling of bin use and degree of inactivity in a bin will depend on the number of days' worth of mortality volume that each bin will hold. A bin that holds a larger number of days' worth of mortalities results in more inactivity. To maximize bin scheduling efficiency, select an effective bin volume that can evenly multiply to 90 days (such as 30 or 45 days' worth of mortality volume). Figures 1 and 2 show examples of the composting sequence of two different primary bin sizes. In Figure 1, the primary bin volume holds 30 days of mortalities, while in Figure 2 the primary bin volume is 70 days of mortalities.

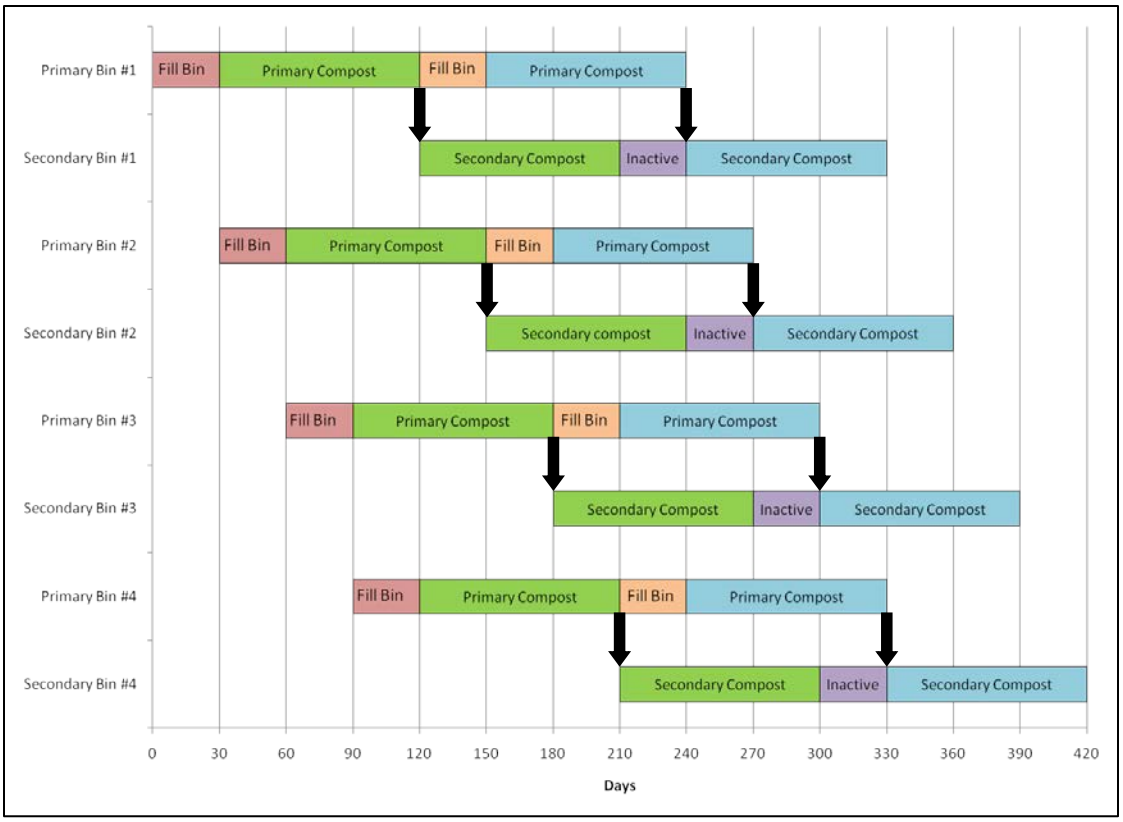

Figure 1. Example composting sequence for 30-day capacity bins

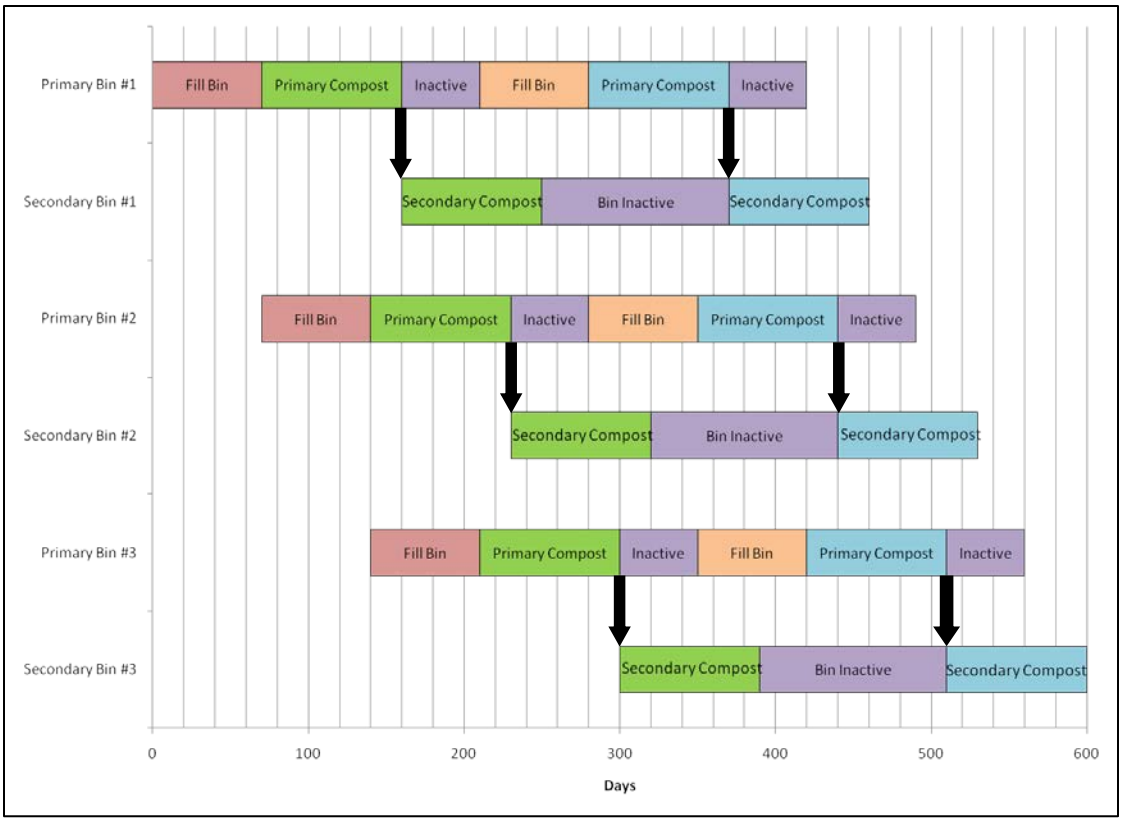

Figure 2. Example composting sequence for 70-day capacity bins

(210-VI-AWMFH, Notice IL21, March 2013)

Operation and Maintenance of a Bin Composter

The operation and maintenance instructions are very important for composting systems. The instructions should include both the primary and secondary bins. Some general considerations include:

1. Typically, coarse sawmill sawdust, shredded cornstalks, coarse-ground corn cobs, and other materials possessing like properties and having similar particle size are recommended for the carbon source due to their high bulk, ease of handling, absorbency and high carbon content. Straw and very fine sawdust are recommended with reservation because the fine texture of these materials restricts proper air movement, and straw will flatten out.
2. Do not use oak, cedar, or redwood material because of their tannin content. Do not use treated wood material because the treatment will kill the aerobic bacteria that are needed to accomplish the composting.
3. Provide a recommendation for a startup recipe and operation. Determining the best recipe for the operation will require some initial experimentation. The initial compost mix shall result in a carbon to nitrogen ratio between 25:1 and 40:1. A suggested startup mix for composting of swine mortalities is 3.7 cubic yards of carbon source for each 1000 lb of carcass.
4. Provide a recommendation for monitoring of moisture in the bins. To meet NRCS Conservation Practice Standard 317 – Composting Facility, the moisture content of the compost mix must be maintained at 40-65% by weight (wet basis), to enable the aerobic bacteria to work effectively. Too much moisture in the mix prevents adequate oxygen content and inhibits the composting activity. Add bulking material to create a more porous mix whenever moisture content begins to approach the upper limit, and monitor more frequently until moisture content is successfully brought back down to the desired range.
5. Measurement of moisture content may be done by visual observation if the producer has experience with silage production. Proper silage moisture content is approximately 65%, so the operator would need to make sure that the mix does not get quite that wet. Another method is to take some compost material in your hand and squeeze it. Compost at proper moisture content should stick together in a ball. If it falls apart, it is too dry; if it expands or moisture squeezes out, it is too wet.
6. Provide a recommendation for monitoring of temperature. Illinois NRCS Conservation Practice Standard 317 refers to the Illinois Dead Animal Disposal Act for temperatures, which specifies that the compost temperature must reach 135° to 160°F during the composting cycle, and be recorded daily.
7. For the secondary stage bins, compost temperature should again reach at least 135°F and then cool to a temperature lower than 100°F.

In-vessel Composting

The in-vessel composter may be selected from the list of approved products in Exhibit A. The selected product shall have a capacity adequate to handle the design daily mortality rate determined above, using manufacturer's recommendations.

Sizing the Secondary Bins

For the selected in-vessel composter product, design the capacity of the secondary bins to handle the output of the in-vessel composter when running at full capacity (which may be higher than the design daily mortality rate), to account for instances when higher than average mortality is experienced.

Use the manufacturer's predicted rate for output volume of primary stage compost per day. This will be less than the theoretical output of the device if calculated based strictly on available volume and cycle time, because during proper operation, there will be significant air space in the vessel to allow for proper moisture control and aerobic bacteria composting activity. Also, a volumetric reduction takes place during the primary composting phase in the vessel.

Plan for a percentage of the primary stage compost to be recycled back into the in-vessel composter along with any bones that have not been fully processed, to be used as part of the carbon source for new mortalities. Use manufacturer's recommendation for this percentage.

Sizing of the secondary bins may be done as follows:

1. Determine the daily production volume (cubic feet per day) of primary stage compost to be moved into secondary processing, by applying the manufacturer's recommended percentages and rates as described above.
2. Select a bin size that will work for the producer, taking into account available equipment and management style.
3. For the selected bin size, calculate the available volume of each bin. In the absence of actual data, use an angle of repose of 1:1 (45 degrees.) Note that a narrower bin width will mean less volume lost to the angle of repose.
4. Determine the number of days' worth of storage each bin represents, by dividing the available bin volume by the daily production volume.
5. Determine process and storage time. Plan for the secondary treatment to take 90 days. This is conservative. If appropriate for the planned management of the system, add up to 60 days' worth of storage capacity for each batch of compost, to accommodate scheduling of land application, for a total of up to 150 days that a batch of compost will occupy the secondary bin after the bin is completely filled.
6. Calculate total cycle time by summing the number of days to fill the bin with the process and storage time determined above. This cycle time represents the amount of time until each bin can be emptied and used again.
7. Calculate minimum number of secondary bins needed, by dividing the total cycle time by the number of days to fill the bin. Add an extra bin if desired, for storage of carbon source.
8. The minimum number of secondary bins required is two.

Operation and Maintenance of an In-vessel Composter

The operation and maintenance instructions are very important for the in-vessel composting system, and should rely heavily on the manufacturer's recommendations. The instructions should include both the primary device and the secondary bins. Some general considerations include:

1. Typically, wood chips or shavings are ideal carbon sources due to their high bulk, ease of handling, absorbency and high carbon content. Straw or sawdust are not recommended because these materials are too fine and do not allow proper air movement, and straw will flatten out. However, use the manufacturer's recommendations for carbon source.
2. Do not use oak, cedar, or redwood material because of their tannin content. Do not use treated wood material because the treatment will kill the aerobic bacteria that are needed to accomplish the composting.
3. Provide a recommendation for a startup recipe and operation. The initial compost mix shall result in a carbon to nitrogen ratio between 25:1 and 40:1. Use manufacturer's instructions. Determining the best recipe for the operation will require some initial experimentation.
4. Provide a recommendation for monitoring of moisture in the in-vessel unit. To meet NRCS Conservation Practice Standard 317 – Composting Facility, the moisture content of the compost mix must be maintained at 40-65% by weight (wet basis), to enable the aerobic bacteria to work effectively. Manufacturer's recommendations may vary; the resulting instructions should meet both NRCS standard and manufacturer's recommendations. Too much moisture in the mix prevents adequate oxygen content and inhibits the composting activity. Add bulking material to create a more porous mix whenever moisture content begins to approach the upper limit, and monitor more frequently until moisture content is successfully brought back down to the desired range.
5. Measurement of moisture content may be done by visual observation if the producer has experience with silage production. Proper silage moisture content is approximately 65%, so the operator would need to make sure that the mix does not get quite that wet.
6. Provide a recommendation for monitoring of temperature. Some in-vessel composters contain built in thermometers for this purpose. Illinois NRCS Conservation Practice Standard 317 refers to the Illinois Dead Animal Disposal Act for temperatures, which specifies that the compost temperature must reach 135° to 160°F during the composting cycle, and be recorded daily.
7. For the secondary stage bins, compost temperature should again reach at least 135°F and then cool to a temperature lower than 100°F.
8. Adjustment of the basic recipe is done by observation of the color of the completed primary stage compost, as instructed by the manufacturer. In general:
   Chocolate color is desirable
   Tan color means add more recycle materials
   Coffee color means add more fresh carbon source

References

1. NRCS National Engineering Handbook Part 637, Environmental Engineering, Chapter 2 - Composting
2. NRCS National Engineering Handbook Part 651.1007, Agricultural Waste Management Field Handbook

EXHIBIT A. Approved Product List – In-vessel Composters

This product list represents information provided to Illinois NRCS by vendors of in-vessel composter products and is not all inclusive.

Product	**Manufacturer and Contact**	**Size Range** *(smallest to largest)*	**Capacity** *(lbs/day carcass)*
Biovator	Nioex Systems USA, Inc http://nioex.com/biovator John Walser 507-381-1556	BIO316: 16’ long x 3’ dia. … BIO442: 42’ long x 4’ dia.	120 500
Ecodrum	Tri-Form Poly, Inc http://www.ecodrumcomposter.com/ MidWest Livestock Systems 800-742-5748	Model 260: 22’ long x 5’ dia. … Model 660: 66’ long x 5’ dia.	379 1110
Dutch Composter	Dutch Industries, Ltd http://www.dutchcomposter.com Jeff Lorenz Bellar Construction Management Inc. 866-752-8748	Dutch Composter	50 – 700
Smidley	Marting Mfg. of Iowa, Inc. http://www.marting.com/ Michael Handrich Great Lakes Territory Representative 800-392-5632	SM412: 12’ long x 4’ dia … SM648: 48’ long x 6’ dia *custom sizes available	150 1200