I. INTRODUCTION

This document has three major purposes:

1. To assist NRCS field office personnel when explaining various components of poultry waste management systems to prospective clients.

2. To provide all necessary forms and documentation related to poultry waste management in one, easy-to-access, three-ring binder, and, thereby, to facilitate development of poultry waste management plans.

3. To assist field office personnel who have appropriate engineering approval authority to develop designs for structural components of poultry waste management systems.

If is expected that field office personnel will use this Handbook when discussing various waste management options with poultry producers who are seeking assistance installing litter dry stacks and composter facilities. Drawings of various types of structures are presented to provide the producer with a visual presentation of the alternatives.

Appropriate blank forms are provided as well as completed forms and examples to assist field office personnel in planning a poultry waste management system. The blank forms can be reproduced as needed.

Design decision trees have been developed to provide a quick method of sizing structural members of dry stacks and composters without using the rigorous engineering calculations based on wind loads, height of structure, width of trusses, and post spacing. Four tree charts are provided based on wind loads. Two are for north Alabama and two for south Alabama (see geographic demarcation lines noted on these forms.)

A construction checklist and construction specifications are included. Field office personnel who work regularly with poultry producers should familiarize themselves with these documents since they are essential in understanding proper construction of litter storage facilities and composters. These documents should be discussed with producer and contractor prior to installation.

Field office personnel should also familiarize themselves with the guide sheets provided. Each guide sheet should be discussed with the producer and be included in the waste management plan.

II. FORMS INDEX

AL-ENG-25A - **CANCELLED.** See General Manual (AL409-20) Exhibit AL4 180 GM, Suppl AL3-January 2003.

AL-ENG-25E - Worksheet to Determine Land Area Requirements for Poultry Waste and Litter Storage Requirements. (April 2008)

AL-ENG-25F - Worksheet to Determine Size of Dead Bird Composter/Incinerator. (April 2008)

AL-ENG-25G - Poultry Manure Dry Stack Structure Design Worksheet (Three Open Sides). (April 2008)

AL-ENG-25H - Poultry Manure Dry Stack Structure Design Worksheet (Three Walls). (April 2008)

AL-ENG-25I - **CANCELLED.** Worksheet to Determine Volume of Litter Fed to Cattle.

AL-ENG-25J - Composter Loading Data. (July 2001)

AL-ENG-25K - Construction Checklist for Litter Storage/Composter Building. (March 2008)

AL-ENG-25L - Design Dimension Worksheet. (March 2008)

III. DESIGN CHARTS

IV. LITTER STORAGE STRUCTURE DESIGN

Procedure

1. Determine type of structure needed. (i.e., dry stack, composter, or combination structure)

2. Determine storage volume required. (Form AL-ENG-25E)

3. Determine size of structure. (Forms AL-ENG-25F, AL-ENG-25G, and AL-ENG-25H)

4. Review the available drawings and select the structure which is appropriate and meets the operator's needs.

5. Select exact dimensions, size members from design charts, and record. (Form AL-ENG-25L)

6. Complete drawings and add details. As a minimum include the following:

    a. Cross section of dry stack and/or composter.

    b. Plan view of dry stack and/or composter.

    c. Truss connection details.

    d. Truss cross bracing detail.

    e. Knee brace detail.

    f. Girder brace detail, if used.

    g. Post embedment detail.

    h. Composter bin detail, if used.

    i. Block wall or wood wall detail, if used.

    j. Purlin detail.

7. Provide Construction Checklist for use at a preconstruction conference and for final certification of construction. (Form AL-ENG-25K)

<u>Example Design</u>

1. Farmer Ibe John Brown of DeKalb County, Alabama has a poultry and cattle operation. He maintains an average of 200 stocker cattle that he grazes on good fescue and Bermuda pasture with about 198 spreadable acres. He produces an average of 5.5 flocks of broilers each year at 90,000 birds per flock. He is growing a 4.4 lb. bird with an average mortality of 5%. Mr. Brown cleans the houses to the ground once each year, and removes the "cake" between each batch. The cake is spread when removed, weather permitting, except in the winter when it must be stored. He wants to construct a drystack with three walls for litter storage and an attached composter structure to compost his dead birds. Mr. Brown applies litter to his pastures in split applications, so he needs storage for the litter used for the second yearly fertilizer application. He will also need storage for the litter used to operate the composter and for the cake removed during winter months.

2. <u>Determine storage volume required</u>

   a. Compute total litter produced annually using AL-ENG-25E. For this example it is determined that 520 tons of waste are produced annually.

   b. Compute litter to be removed when caking. This will occur between each batch before a complete cleanout, so there will be 5 cakings annually. Estimate 3% of the total annual production for the amount of cake removed at each caking:
   0.03 x 520 tons/year x 5 cakings = 80 tons of cake/year. Normally this material will be spread directly from the houses during the growing season and stored in an empty portion of the dry stack during winter months, so no design storage volume is needed in the dry stack for this cake volume.

   c. Compute litter required to compost dead birds using Form AL-ENG-25E. For this example, it was determined that 68 tons of litter are required each year to compost dead birds. This litter will be supplied from the yearly cleanout, so storage is needed for the entire 68 tons.

   d. After completing the Nutrient Budgets and Nutrient Application Summary Worksheet (not included) and accounting for the spreading of the cake and compost, there are 141 spreadable acres of pasture available. Mr. Brown will spread 180 tons of fresh litter at cleanout, leaving 192 tons to store for a second application of stored litter (520 total tons – 80 tons of cake – 68 tons for compost – 180 tons for first application = 192 tons to store).

   e. For Mr. Brown's operation it was decided that he needed to be able to store a volume of litter equal to the combined volume from c, & d above (68 + 192 = 260 tons). For this example, allow storage of 260 tons or 17,420 cubic feet from AL-ENG-25E, line N.

3. <u>Determine size of structure.</u>

   a. Determine size of composter using AL-ENG-25F. For this example, it was determined that the daily loss of birds at maturity is 450 lbs. per day. Allowing 2.5 cu. ft. of composter volume per pound of daily weight loss, about 1,125 cubic feet is required in Stage 1 and approximately twice this volume for Stage 2. Assuming truss support posts will be spaced at 10 foot intervals, select approximate size of composter bins. Four bins 5 ft. x 6 ft. x 10 ft. provide 1,200 cubic feet of storage. Two secondary bins, size 10 ft. x 20 ft. each, will provide approximately twice the primary capacity after shrinkage.

b. Compute floor area required for litter storage using AL-ENG-25H. For this example, it was determined that a floor area of 2,880 sq ft (40 ft x 72 ft) is needed to provide litter storage. Clear space at the open end of the structure can be provided by the working area in front of the composter bins. It was decided to use a combination structure 40 ft. wide and 90 ft. long. Forty-foot trusses are readily available. Standard sizes of readily available materials should be used whenever possible.

4. After reviewing available drawings, it was decided that drawing DS/C3 meets the needs of Mr. Brown's operation. Mr. Brown also elected to add side sheds along the sides of the dry stack portion of the structure at his expense. Other arrangements would work also and the operator should be consulted before making the final decision.

5. Select exact dimensions. Determine the appropriate design chart based on location and roof slope. Use <u>Design Dimension</u> work sheet (Form AL-ENG-25L) to record selected sizes.

   a. <u>Truss Design</u> - The exact distances between posts should be set to correspond to the dimension of the trusses. This is probably more critical with metal trusses than with wood trusses since metal trusses are attached to the inside face of the post. Assume 40 ft. as the nominal truss span for this design. Mr. Brown knows of a metal truss manufacturer in the adjoining county and has decided to use metal trusses for this structure. Since metal trusses normally are fastened to the inside of the posts, the post spacing should be the same as the truss width, and the clear span between posts will be 39 feet. Request that Mr. Brown have the supplier furnish a truss design certified by a registered engineer for documentation.

   b. <u>Post Design</u> - Mr. Brown has decided a 12 ft. wall height will be adequate to provide the needed clearance for his equipment. A post spacing of 10 ft. is selected. This will also be the truss spacing. Posts to which are attached the composter bins and the sidewalls between the truss support posts in the dry stack may possibly be smaller than those posts supporting trusses in the dry stack. Size posts for both cases. The litter storage area has been sized assuming a wall is present and litter can be stacked 4 ft. high at the wall. Siding is needed above the wooden wall to protect the litter from blowing rain. Therefore size all posts for the "with siding" condition. The trusses will have a 5:12 pitch, so from the <u>Post Size</u> section of <u>Table 1a</u> using a truss span of 40 ft. or less, 12 ft. post height, 10 ft. post spacing with rigid wall support, with siding, <u>read 4 x 6 post size</u>. Use 4 x 6 posts at the composter. For the condition of without rigid wall support and with siding <u>read 6 x 6 post size</u>. Use 6 x 6 posts as truss support posts where composter walls are not attached.

   c. <u>Post Embedment Depth</u> - The soil at the site is Hartsells. This is a sandy clay soil, drained, generally suited to building sites. The soil should be described sufficiently to document its suitability for a building site. Hand auger borings should be made if it is suspected that rock or other conditions may exist which would affect the design.

      Mr. Brown wants to use a concrete slab for the entire floor area. In this case the minimum post embedment is 3 feet. If rock is closer than 3 feet to the ground surface, consult the resource engineer.

   d. <u>Rafter Design</u> - For this case with a 15.5 foot clear span under the composter roof, 2 x 10 rafters on 5-foot spacing should be used, as provided by the resource engineer.

   e. <u>Girder Design</u> - For the litter storage area, the girder under the edge of the trusses may be omitted since metal trusses will be used.

Over the composter area, the girder will support the rafters for the composter roof. From the Girder Size section of Table 1a select one 2 x 10 since no girder braces are to be used. In this case, the girder braces would be in the way of equipment loading and unloading the composter. A 2 x 12 girder is used at the drystack wall to aid in making the connection with the 2 x 10 composter rafter.

f. Purlin Design - The distance between trusses is 10 feet which is the distance the purlins must span. From the Maximum Unsupported Spans for Purlins section of Table 1a, select 2 x 4's on edge at a spacing of 24 inches. An alternate purlin design would be 2 x 6's on edge at a 48-inch spacing. This is probably an excessive spacing to adequately support metal roofing. Use the 2 x 4's at 24 inches. This spacing must be provided to the truss manufacturer so purlin brackets can be welded to the trusses at the appropriate spacing.

6. Now that the major components of the building have been sized, complete the drawings and include all appropriate details. The standard drawings may be modified as needed to tailor the drawings to the specific job as long as the assumptions from Tables 1 and 2 are not violated. Components for which no specific detail is provided should be built following good construction practices normally used for farm structures of this type. When in doubt, call the resource engineer for assistance.

WORKSHEET TO DETERMINE LITTER PRODUCTION AND STORAGE REQUIREMENTS FOR POULTRY OPERATIONS

Name of grower: Ibe John Brown County: DeKalb

A. Number of birds: 90,000 **B**. No. of Flocks per year: 5.5

C. Lbs. litter produced/yr [a/] = (**A** x **B** x Litter Production [b/] = 90,000 x 5.5 x 2.1 = 1,039,500 lbs/yr
(Ex.: 2.1 lbs/bird/flock for a 4.2 lb. broiler.)

D. Tons waste/yr = **C**/2000 = 1,039,500 /2000 = 520 tons/yr

E. **D**ensity **F**actor = **DF** = 2000/Density [b/] = 2000/ 30 = 67 cf/ton

F. Vol. of waste produced/yr [a/] = **D x DF** = 520 x 67 = 38,840 cf/yr

G. Tons for composting dead chickens:

G1. Chickens: **A** x **B** x Mortality Rate (as a decimal) [b/] x Avg Wgt [b/] / 2000 =

90,000 x 5.5 x 0.05 x 2.2 /2000 = 27 tons/yr

G2. Litter: **G1** x 2.5 = 27 x 2.5 = 68 tons/yr

H. Tons of litter to utilize = **D** - **G2** = 520 - 68 = 452 tons/yr

I. Compost = (**G1** + **G2**) x (shrinkage) = (27 + 68) x 0.8 = 76 tons/yr

LITTER STORAGE REQUIREMENTS

J. **S**tored **L**itter for fertilizer = **SL** [c/] x **DF** = 192 x 67 = 12,864 cf

K. Litter for other uses = Tons [d/] x **DF** = ______ x ______ = 0 cf

L. Litter for composting = **G2** x **DF** x (1/CO [e/]) = 68 x 67 x (1/ 1) = 4,556 cf

M. Annual Storage Requirements = **J** + **K** + **L** = 12,864 + 0 + 4,556 = 17,420 cf

N. Store **F** or **M** as appropriate = 17,420 cf
(Use appropriate engineering worksheets to size dry stack/temporary storage.)

a/ Based on one complete cleanout per year. Other cleanout schedules will require individual records to establish trends.
b/ Refer to Table 3 in Section III. of Workbook or producer records.
c/ From Nutrient Application Summary Worksheet.
d/ Amount in tons as determined by producer for purposes other than fertilizing or composting.
e/ CO = Number of cleanouts per year. If cake is used for composting, count each time cake is removed.

EXAMPLE

WORKSHEET TO DETERMINE SIZE OF DEAD BIRD COMPOSTER/INCINERATOR

B = Number of birds per confinement cycle. (No.)

M = Anticipated mortality per confinement cycle. (Decimal)
(NOTE: Mortality may range from 2% to 25%. Use actual data or refer to Table 3 in Section III of the Waste Utilization and Facility Design Workbook.)

$\mathbf{W_B}$ = Weight of birds at maturity. (lbs.) (Ex.: 4.2 lbs. for broilers)

T = Typical length of confinement cycle. (Days) (Ex.: 42 days for broilers)

$\mathbf{W_T}$ = Weight of daily loss for design. (lbs./day)

B	x	M	x	W_B	/	T	=	W_T	
90,000	x	0.05	x	4.4	/	44	=	450	lbs/day

For an *<u>incinerator</u>, the capacity should be the minimum size which will meet* W_T.
For *<u>Stage 1</u> of a 2-stage composter, allow 2.5 cf composter volume per lb. of weight loss per day.*
For *<u>Single-stage composter</u>, allow 3.75 cf of composter volume per lb. weight loss per day.*
For *<u>flock life over 75 days</u>, disregard formula, design bin size and number to provide primary storage volume for 30 days of mortality.*

<u>STAGE 1</u>:

V_1 = Volume of stage one bins: **2.5 (or 3.75)** x W_T = V_1

2.5 x 450 = 1,125 cf

Dimensions of Composter Bins:
(Single-stage composting bins shall have dimensions of 4' x 4' x 4'. Bins must have 0.5 to 1.0 inch spaces between each horizontal board.)

h = height of bin (4 to 5 ft.) = 5 ft.

$\mathbf{y_1}$ = depth of bin (varies) = 6 ft.

$\mathbf{y_2}$ = width (front) of bin (8 to 10 ft.) = 10 ft.

V_B = Individual bin volume: **h** x y_1 x y_2 = V_B

5 x 6 x 10 = 300 cf

No. of bins: V_1 / V_B

1,125 / 300 = 3.75 bins

Round to nearest whole number: use 4 bins in Stage 1.

<u>STAGE 2</u>:

Volume shall equal or exceed $\mathbf{V_1}$. (Volume should be **2 x** $\mathbf{V_1}$ in north Alabama for winter storage.)
In sizing width of bin(s), consider width of front-end loader.

Number and size of Stage 2 bins: 2 - 5' x 10' x 20'

POULTRY MANURE DRY STACK STRUCTURE

DESIGN WORKSHEET
(THREE WALLS)

Vol = Volume of litter stored (Form AL-ENG-25E, Item "O."): **17,420** cf

W_b = Width of building: **39** ft. (Use actual inside working dimension; i.e., 39 ft.)

H_m = Max height of pile in middle (Max. 7 ft.): **7** ft.

H_s = Height of pile at side walls (Max for wooden wall = 4 ft.): **4** ft.

H_w = Height of wall (H_s + Freeboard): **5** ft. (Maximum 5 ft.)

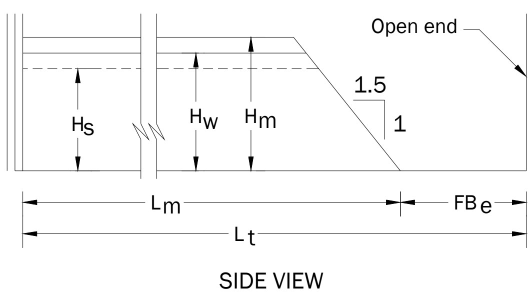
A_x = Cross sectional area of pile (calculate below).

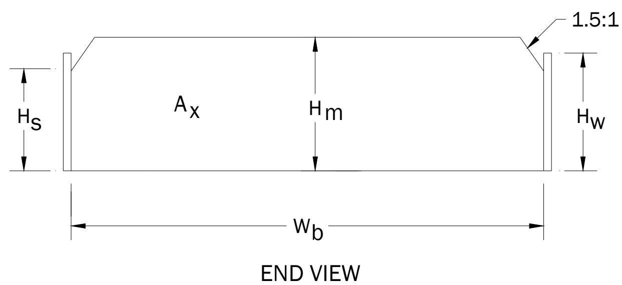
L_m = Length on manure pile (calculate below).

L_i = Length of building (initial calculation) including FB_e.

L_t = Total length; L_i adjusted to account for spacing between side posts.

FB_e = Horizontal freeboard from toe of pile to open end of building. If composter occupies this space, let FB_e = length of composter = **20**; otherwise FB_e = 12.





$A_x = H_m W_b - 1.5 (H_m - H_s)^2$ = (**7** x **39**) - 1.5 (**7** - **4**)^2 = **260** sq. ft.

L_m = Vol / A_x + ($0.75H_m$) = (**17,420** / **260**) + (0.75 x **7**) = **72** ft.

$L_i = L_m + FB_e$ = **92** ft. Post spacing: **10** ft. c-c

L_t = **90** ft. (NOTE: Round L_i up or down to accommodate post spacing.)

Floor area = W_b x L_t (For W_b use nominal width; i.e., 40 ft.) + Composter Area (See Drawings)

40 x **90** + **2 x 16' x 20'** = **4,240** sq.ft.

Floor area x cost/sq. ft. = Estimated total cost of structure

4,240 x $ **7.50** = $ **31,800**

U.S. Department of Agriculture
Soil Conservation Service

EXAMPLE

AL-ENG-25L
Feb. 1993

DESIGN DIMENSION WORKSHEET
FOR
DRY MANURE AND DEAD BIRD COMPOSTING BARN

NAME Ibe John Brown COUNTY DeKalb STATE AL

DATE 7/01

PURPOSE Drystack/Composter

LOCATION: North Alabama x (Use Table 1 or 1a)
South Alabama ___ (Use Table 2 or 2a)

TRUSS DESIGN Minimum design load = 20 psf live load
Plus dead load of roof

Roof Slope: 4:12 ________ 5:12 x

Truss span between supports 39 (Ft.)

Supplier designed Yes x No ___. If Yes attach copy of design computations certified by a registered engineer. If No state designer and approving engineer.

Designed by ________________ Approved by ________________

POST DESIGN

Design chart used: Table 1a

Post height 12 (Ft.) Post spacing (C-C) 10 (Ft.)

Does building have composter or reinforced block walls providing rigid support to posts @ about 5 ft. above floor? Yes x No ___ (At Composter Only)

If Yes, go to "with rigid support".

With rigid support: Will wall above composter have
siding: Yes x No ___
Post size from Table 1 or 2 4 x 6 (at composter)
nominal x full size ___

Without rigid support: Will wall have siding?
Yes x No ___
Post size from Table 1 or 2 6 x 6 (at dry stack)
nominal x full size ___

POST EMBEDMENT DEPTH

Foundation description: Soil Name ____**Hartsells**________________
Unified classification symbol _______**SC**____________ General Description (Excavated, compacted fill, depth to seasonal water table, etc.)
Soil is firm sandy clay. Site almost level with 1 ft. of cut at back left corner and 1 in. of fill at right front corner. Site is well-drained, water table > 3 ft. below surface, Rock 4 ft. below slab grade.

NOTE: Designs for structures on weak, soft, wet or highly plastic soils must be checked by an Engineer.

Are posts encased in a floor slab? Yes _**x**___ No ____

If Yes, embedment = 3 ft. min. below top of slab.

If No embedment = ______ ft. min. from Table 1 or 2

GIRDER DESIGN

Are trusses or side shed rafters supported by girders?
Yes _**x**__ (Composter Side Sheds) No _**x**__ (Trusses)

If No: Use minimum size from Table 1 or 2, 1 - 2 x _----_. (Not needed)

If Yes: Supports trusses only, from Table 1 or 2
_____ - 2 x _____ with/without girder braces.

Supports side shed rafters only, from Table 1 or 2
1 - 2 X ___10____ with/without girder braces.

Supports side shed rafters and trusses, from Table 1 or 2
2 - 2 X ___________ with girder braces.

PURLIN DESIGN

Distance between trusses, ___10______ ft. = Purlin Span

Purlin size, from Table 1 or 2, ___2 in._____ X ___4 in._____

Laid flat _______ on edge ___**x**_____

V. DRAWINGS

Non-NRCS interested parties in Alabama should contact the local Alabama NRCS field office for copies of typical drawings of drystack and composter barns.

All other interested parties should contact Jeff Dowdy, Civil Engineering Technician, NRCS State Office, Auburn, Alabama.

VI. APPROVED TRUSSES

Non-NRCS interested parties in Alabama should contact the local Alabama NRCS field office for copies of typical drawings of drystack and composter barns.

All other interested parties should contact Jeff Dowdy, Civil Engineering Technician, NRCS State Office, Auburn, Alabama.

VII. SPECIFICATION

Waste Storage Facility with Construction Specification - Code 313

VIII. GUIDE SHEETS INDEX

IX. STANDARD DRAWINGS AND PACKAGES

Non-NRCS interested parties in Alabama should contact the local Alabama NRCS field office for copies of typical drawings of drystack and composter barns.

All other interested parties should contact Jeff Dowdy, Civil Engineering Technician, NRCS State Office, Auburn, Alabama.