Dairy Ammonia Loss Estimation Worksheet

Karl Czymmek and Curt Gooch, Cornell University
Adapted from: Rick Koelsch and Rick Stowell
University of Nebraska – Lincoln

(KEEP THIS WORKSHEET FOR YOUR RECORDS!)

Caution: This worksheet provides an approximation of ammonia emission based upon currently available information. There is likely to be significant variations with region of the country, climate, and management of the production or storage system. These values are also likely to change with additional research on ammonia emissions.

Purpose: This worksheet was developed to assist Large Dairy CAFO farms in performing a ***good faith estimate*** of the minimum and maximum ammonia emissions from their farmstead (barns and adjacent manure storage(s)). The worksheet is designed such that the outcomes can be used directly in filling out the EPCRA Continuous Release Report Forms.

Directions: Complete page 1 of this worksheet for each class of animals (see Table 3, pg. 2) present on each farm site. [See: PRO-DAIRY's: *How to Submit an EPRCA Continuous Release Report for Large CAFO Farms*, dated February 18, 2009 for information on the definition of a farm with respect to air emissions reporting.] Transfer Step 4 results from each page 1 completed for this farm site to a single page 3 of this worksheet for final calculations.

Farm Name: _____ **Date completed**:_____

Dairy Animal Class (See Table 3)	Facility Capacity for Animals in Class

Step 1. Select Low & High % ammonia loss factors for animal class, predominant housing and storage (Use Tables 1 and 2, pg. 2):

1.a. Animal housing: Table 1, % Loss A value: _____% 1.b. Animal housing: Table 1, % Loss B value: _____%

1.c. Manure Storage: Table 2, % Loss A value: _____% 1.d. Manure Storage: Table 2, % Loss B value: _____%

Step 2. Estimate Low & High % ammonia loss from the animal housing and storage system.

Governing Equation: Ammonia Loss (%) = Housing % Loss + [(100 – Housing % Loss) X Storage % Loss / 100]

2.a. Low Ammonia Loss (%) = _____ + [(100 – _____) X _____ / 100]
(from 1.a. above) (from 1.a. above) (from 1.c. above)

2.a. Low Ammonia Loss (%) = _____ %

2.b. High Ammonia Loss (%) = _____ + [(100 – _____) X _____ / 100]
(from 1.b. above) (from 1.b. above) (from 1.d. above)

2.b. High Ammonia Loss (%) = _____ %

Step 3. Determine unit daily ammonia loss per animal (lbs./animal-day). Using the answer in 2.a. above for low ammonia loss find the animal class in Table 3 in the left column, and the corresponding ammonia loss (%) column (across the top) that best matches the estimated ammonia loss from Step 2. Find where this row and this column (appropriate ammonia loss) intersect and record this value in 3.a. below. Repeat for 3.b. using answer from 2.b. above.

3.a. Low Unit ammonia loss = _____ lbs. / animal-day

3.b. High Unit ammonia loss = _____ lbs. / animal-day

Step 4. Estimate daily total low and high ammonia loss (lbs. /day) for Animal Class.

Governing Equation: Daily Animal Class ammonia loss = Maximum No. in Animal Class X Unit ammonia loss (Step 3)

4.a. Daily animal class low ammonia loss =_____ animals X _____lbs / animal-day
(from 3.a. above)

Daily animal class low ammonia loss = _____ lbs. ammonia per day

4.b. Daily animal class high ammonia loss =_____ animals X _____lbs / animal-day
(from 3.b. above)

Daily animal class high ammonia loss = _____ lbs. ammonia per day

Table 1. Typical ammonia loss factors from dairy housing facilities expressed as a percentage of excreted manure nitrogen.

Housing Description	%Loss A	%Loss B	Housing Description	%Loss A	%Loss B
Open dirt lots (cool, humid region)	15	30	Roofed facility (slatted floor with short-term storage below)	10	20
Open dirt lots (hot, arid region)	30	45	Roofed facility (slatted floor with long-term storage below)	30	40
Roofed facility (flushed or scraped) daily scrape and haul	5	15	Roofed facility (bedded pack)	20	40

Table 2. Typical ammonia losses factors from manure storage as a percentage of nitrogen entering storage.

Manure Storage Description	A % Loss	B % Loss	Manure Storage Description	A % Loss	B % Loss
Temporary stacked manure (no turning)	10	20	Pit below slatted floor (included in Table 1 values)	0	0
Composted manure (no carbon amendment)	30	40	Earthen storage pit (minimal treatment)	20	35
Composted manure (significant carbon amendment)	5	10	Formed manure storage (bottom loaded)	10	10
Bedded Pack Manure (included in Table 1 values)	0	0	Formed manure storage (top loaded)	30	30
Runoff holding pond (precipitation runoff only)	2	3	Anaerobic Lagoon (significant treatment)[1]	65	75

[1]This is for long-term storages specifically designed to biologically treat dairy manure and wastewater and are common only in hot climate such as in California, Arizona, Florida, etc. Much of the lagoon loss can be due to denitrification (N_2 and N_2O), so the ammonia loss may only be half of what is shown.

Table 3. Estimates of ammonia nitrogen losses (lbs./animal-day). Excretion estimates based upon 2005 ASAE Standard (proposal) for typical animals.

Dairy Animal Class	Typical Nitrogen Excretion (lbs per animal per day)	Ammonia Loss (% of excreted nitrogen) 10%	20%	30%	40%	50%	60%	70%	80%	90%
		Estimated Ammonia Loss (lbs per animal per day)…converts N to NH_3 by multiplying by 1.21								
Lactating cow - 100 lbs milk/day	1.04	0.13	0.25	0.38	0.51	0.63	0.76	0.88	1.0	1.1
Lactating cow - 88 lbs milk/day	0.99	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.1
Lactating cow - 70 lbs milk/day	0.83	0.10	0.20	0.30	0.40	0.50	0.60	0.71	0.81	0.91
Lactating cow - 50 lbs milk/day	0.66	0.080	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72
Dry cow	0.5	0.061	0.12	0.18	0.24	0.30	0.36	0.43	0.49	0.55
Milk fed calves	0.017	0.0021	0.0041	0.0062	0.0083	0.010	0.012	0.014	0.017	0.019
Weaned calves (up to 400 lbs)	0.14	0.017	0.034	0.051	0.068	0.085	0.10	0.12	0.14	0.15
Heifers (400 to 1,200 lbs)	0.26	0.032	0.063	0.095	0.13	0.16	0.19	0.22	0.25	0.28

Step 5. Determine total daily ammonia loss (lbs./day) from farmstead facility.

Transfer the animal class daily low (from Step 4.a., page 1) and the animal class daily high (from Step 4.b., page 1) estimated emissions for each class of animals analyzed to the spaces provided below. Sum each column to determine the estimated low and high daily ammonia emissions for the farmstead facility.

Class of Animal	**Estimated Low Daily Ammonia Emission (lbs./day), from 4.a.**	**Estimated High Daily Ammonia Emission (lbs./day), from 4.b.**
Lactating cows		
Dry cows		
Milk fed calves		
Weaned calves (up to 400 lbs.)		
Heifers (400 to 1,250 lbs.)		
Sum Total Estimated Emission (lbs./day):	5.a. Low:	5.b. High:

Use the answers in 5.a. and 5.b. in the Upper and Lower bound sections of "page 4 of 5" in the EPA form.
Also use the answer in 5.b for the Upper bound for ammonia on "page 5 of 5" in the EPA form.

Step 6. Determine estimated total quantity (lbs.) of ammonia released in the previous year for the facility. This will be based on the average of the high and low estimated daily ammonia emissions from the facility as calculated in Step 5 above. The final estimate (6.a.) is required by the EPA Continuous Release Reporting form, "page 4 of 5".

6a. Calculate the total average potential ammonia emissions (lbs.) for the year:

6.a. _____(Low) + _____ (High) / 2 x 365 = _____ lbs. of ammonia annually
(from 5.a. above) (from 5.b. above)

-----END of WORKSHEET-----