

# Ammonia and Particulate Matter Emissions from a Tom Turkey Barn in Iowa

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### Summary and Implications

Air emissions ( $\text{NH}_3$ ,  $\text{PM}_{10}$ , and  $\text{PM}_{2.5}$ ) from a tom turkey grow-out barn (60 x 335 ft) in Iowa have been continually quantified for one year, involving 3 grow-out flocks of toms grown from 35 to 140 days of age. Daily emission rate (ER) varied from 0.04 to 6.4 g/bird-d for  $\text{NH}_3$ , from 0.04 to 1.6 g/bird-d for  $\text{PM}_{10}$ , and from 0.002 to 0.137 g/bird-d for  $\text{PM}_{2.5}$ . Cumulative emissions for flock 1, 2, and 3, expressed as grams per bird marketed, were, respectively, 215, 143, and 126 for  $\text{NH}_3$ ; 64, 22, and 33 for  $\text{PM}_{10}$ ; and 5.4, 2.2, and 4.7 for  $\text{PM}_{2.5}$ . The annual mean cumulative emissions (including downtime emissions) were 157 g  $\text{NH}_3$ , 37 g  $\text{PM}_{10}$ , and 3.9 g  $\text{PM}_{2.5}$  per bird marketed.

### Introduction

Turkey production facilities generate and emit gases and particulates. In 2005 an Air Compliance Agreement (ACA) was reached between EPA and certain sectors of the U.S. livestock and poultry industries, namely, broiler, laying hen, swine, and dairy industries. The ACA studies will yield more baseline data on air emissions from U.S. animal feeding operations. However, turkey industry is not a part of the ACA and there had been no study that extensively quantifies gaseous and particulate matter (PM) emissions from U.S. turkey production facilities.

This paper presents research findings from one-year continuous measurement of  $\text{NH}_3$  and PM emissions from a tom turkey barn in Iowa.

### Materials and Methods

A commercial turkey grow-out barn in central Iowa was continuously monitored for  $\text{NH}_3$ ,  $\text{PM}_{10}$ , and  $\text{PM}_{2.5}$  emissions over one-year period (May 2007 – May 2008). The turkey barn was east-west oriented and had a total dimension of 60 x 800 ft. A section (335 ft) of the entire barn was retrofitted to mechanical ventilation (MV) by adding tunnel fans to the east end, whereas the rest of the barn (475 ft) remained naturally ventilated (NV) most of the time. Use of constant MV allowed for accurate measurement of barn ventilation rate which is one of the two key elements for determination of air emissions. At the same time, the environment of the NV section was continuously monitored to ensure similarity of MV and NV environments; otherwise, adjustments would be made to the MV section to follow the NV environment.

The MV barn had five 24-in diameter sidewall fans spaced at 60 ft apart, one 48-in and six 52-in diameter tunnel fans. At five weeks of age, the Hybrid tom turkeys were moved from brooder barn to the grow-out barn where they were raised till market age of 20 weeks at a stocking density of 4  $\text{ft}^2$ /bird. Standard commercial diets were fed *ad lib* to the birds during the study. Prior to onset of the monitoring, the barn was cleaned, disinfected and bedded with rye hulls. Between flocks caked litter was removed and fresh rye hull added. A state-of-the-art mobile air emissions monitoring unit (MAEMU) was used for the continuous measurement.

### Results and Discussion

Data on  $\text{NH}_3$  and PM emissions and related production parameters from three flocks for the period of May 2, 2007 to May 1, 2008 were collected and analyzed.

During the grow-out period, daily  $\text{NH}_3$  ER varied from 0.3 to 55.6 lb/d-house. The peak  $\text{NH}_3$  ERs were 55.6, 45.2, 36.6 lb/d-house for flock 1, 2, and 3, respectively. The average  $\text{NH}_3$  ERs over the grow-out period for the three flocks were  $16.5 \pm 13$  lb/d-house ( $1.9 \pm 1.5$  g/d-bird),  $17.6 \pm 10.1$  lb/d-house ( $1.3 \pm 0.77$  g/d-bird), and  $13.4 \pm 8.2$  lb/d-house ( $1.1 \pm 0.67$  g/d-bird) for flocks 1, 2, and 3, respectively (Table 1). The flock cumulative  $\text{NH}_3$  emissions (i.e., g/bird marketed) were 215, 143, and 126 for flocks 1, 2, and 3, respectively, which led to an annual mean of 157 g per bird marketed.

Daily  $\text{PM}_{10}$  ER varied from 0.4 to 13.7 lb/d-house. Average daily  $\text{PM}_{10}$  ERs for the three flocks were  $5.1 \pm 2.9$  lb/d-house ( $0.57 \pm 0.34$  g/d-bird),  $2.6 \pm 1.0$  lb/d-house ( $0.2 \pm 0.07$  g/d-bird), and  $3.5 \pm 2.1$  lb/d-house ( $0.30 \pm 0.17$  g/d-bird) for flocks 1, 2, and 3, respectively. The cumulative  $\text{PM}_{10}$  emissions (g/marketed bird) were 64, 22, and 33 for flock 1, 2, and 3, respectively, which led to an annual mean of 37 g/bird-marketed.

Daily  $\text{PM}_{2.5}$  ER varied from 0.02 to 1.34 lb/d-house. Average daily  $\text{PM}_{2.5}$  ERs for three flocks were  $0.42 \pm 0.24$  lb/d-house ( $0.048 \pm 0.029$  g/d-bird),  $0.26 \pm 0.18$  lb/d-house ( $0.021 \pm 0.013$  g/d-bird), and  $0.51 \pm 0.35$  lb/d-house ( $0.042 \pm 0.028$  g/d-bird) for flock 1, 2, and 3, respectively. The cumulative  $\text{PM}_{2.5}$  emissions (g/marketed bird) were 5.4, 2.2, and 4.7 for flock 1, 2, and 3, respectively, leading to an annual mean  $\text{PM}_{2.5}$  emission of 3.9 g/bird-marketed.

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**Table 1. Ventilation rate (VR), concentrations and emission rates (ER) of NH<sub>3</sub>, PM<sub>10</sub> and PM<sub>2.5</sub> of an Iowa tom turkey barn during 3 flocks of production over one-year period**

	V.R., cfm/bird	Concentration			ER, lb/d-house			ER, g/d-bird			
		NH <sub>3</sub> , ppm	PM <sub>10</sub> , μg/m <sup>3</sup>	PM <sub>2.5</sub> , μg/m <sup>3</sup>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	
Flock 1	Mean	28.0	3.1	767	67	16.5	5.1	0.42	1.9	0.57	0.05
	S.D.	12.5	1.6	416	26	13.0	2.9	0.24	1.5	0.34	0.03
	Max	44.1	8.4	2558	176	55.6	13.7	0.95	6.4	1.6	0.11
	Min	1.7	0.59	174	25	0.3	0.4	0.02	0.04	0.04	0.00
Flock 2	Mean	5.7	11.7	1355	175	17.6	2.6	0.26	1.3	0.20	0.02
	S.D.	4.3	5.9	661	130	10.1	1.0	0.18	0.77	0.07	0.01
	Max	23.1	28.7	3207	500	45.2	5.3	0.66	3.4	0.39	0.05
	Min	1.1	1.81	173	18	2.6	0.6	0.02	0.20	0.04	0.00
Flock 3	Mean	5.7	12.8	1722	245	13.4	3.5	0.51	1.1	0.30	0.04
	S.D.	5.4	11.5	591	130	8.2	2.1	0.35	0.67	0.17	0.03
	Max	31.6	44.7	3384	637	36.6	7.9	1.34	3.0	0.65	0.11
	Min	0.9	1.34	200	50	1.5	0.4	0.02	0.13	0.03	0.00
Overall	Mean	13.3	9.2	1273	162	15.9	3.7	0.40	1.4	0.36	0.04
	S.D.	13.4	8.7	687	129	10.8	2.4	0.29	1.1	0.27	0.03
	Max	44.1	44.7	3384	637	55.6	13.7	1.34	6.4	1.6	0.11
	Min	0.9	0.59	173	18	0.3	0.4	0.02	0.04	0.03	0.00