

# **Ammonia Emission From Dairy and Swine Operations**

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# Overview

- **NAEMS history and background information.**
- **The setup, monitoring, and some insights for the Indiana dairy and swine sites.**
- **Ammonia emission rates.**
- **Reporting requirements for large AFOs, and numbers of animal to exceed reportable threshold.**

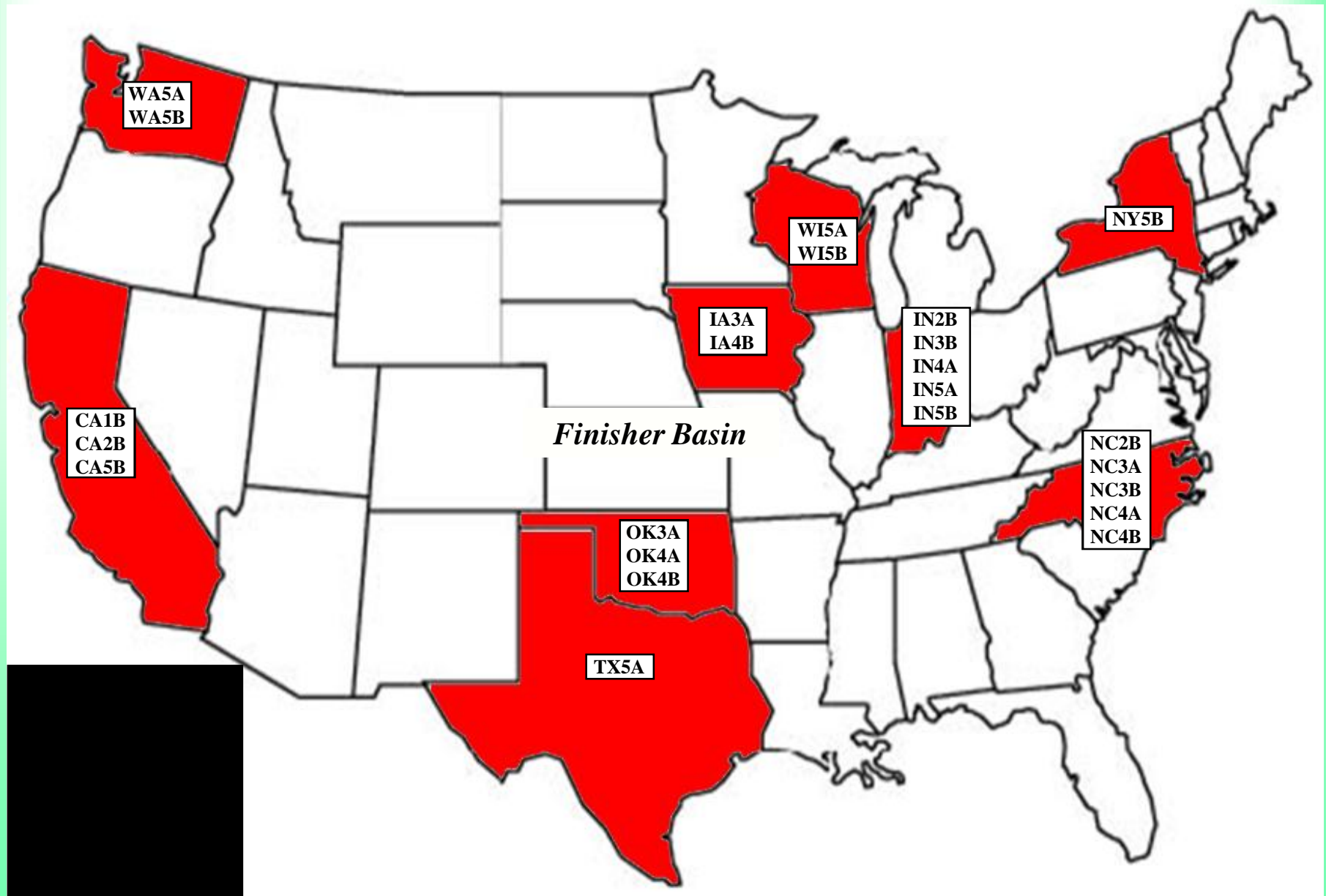
# NAEMS History and Objectives

- **Established in 2006 by a voluntary Air Compliance Agreement between the EPA and the pork, dairy, egg and broiler industries.**
- **Determine if AFOs were likely to have compliance issues regarding the Clean Air Act and/or the CERCLA.**
- **Emissions of ammonia, hydrogen sulfide, carbon dioxide, VOCs, and particulate matter.**
- **Objectives are to compile a database for estimation of emission rates, and promote a national consensus for emissions-estimation methods/procedures from livestock operations.**

# NAEMS Participants

- Funding are provided by the National Pork Board, National Chicken Council, National Milk Producers Federation, and American Egg Board, via a not-for-profit organization, the Agricultural Air Research Council.
- Study is overseen by the EPA Office of Air Quality Planning and Standards (OAQPS) and led by Purdue Air Quality Lab and Applied Meteorology Lab.
- Other universities involved: Cornell University, Iowa SU, NCSU, Texas A&M, UC- Davis, Minnesota, and Washington SU.

# NAEMS Barn Sites

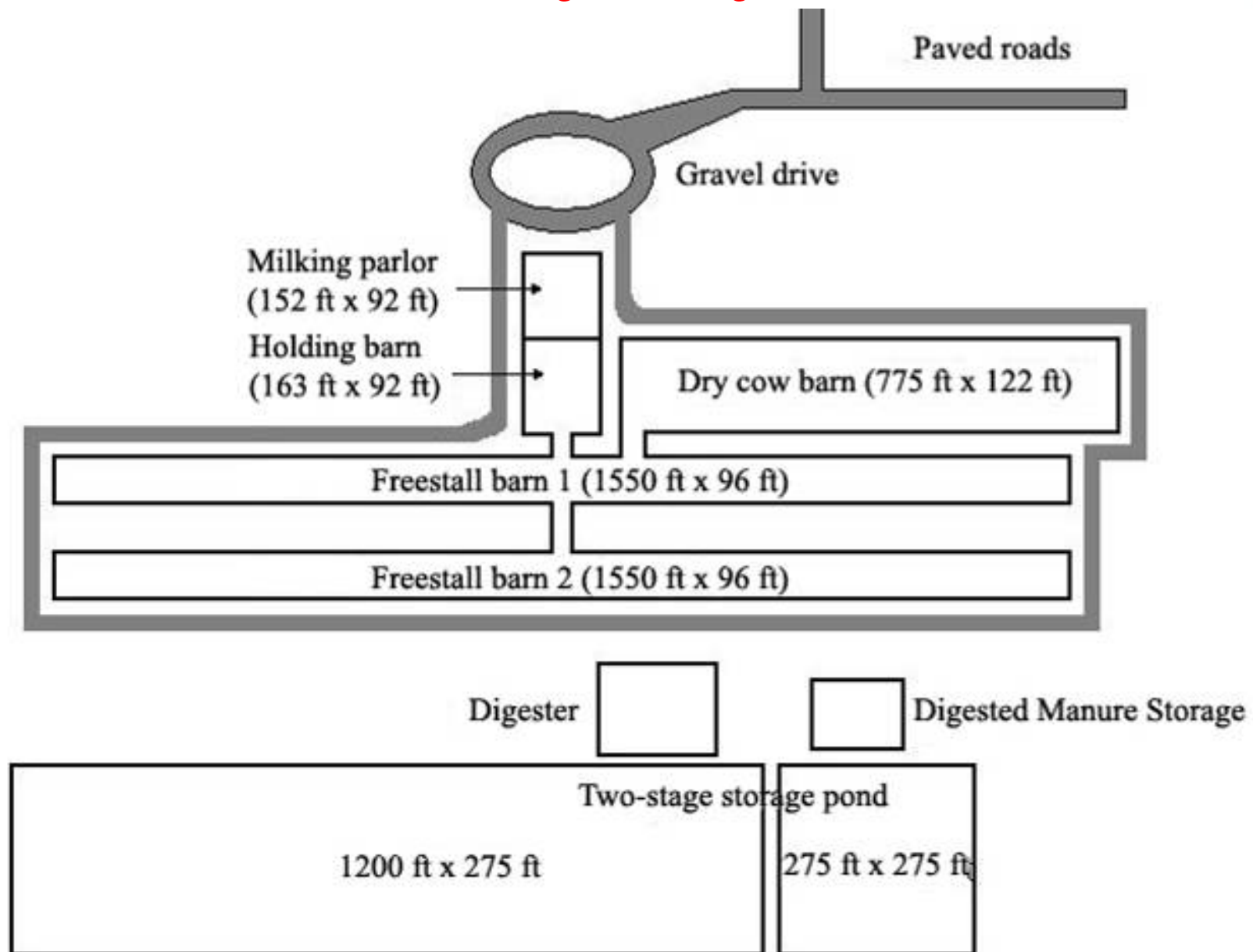


Source: Dr. Albert Heber, Purdue University

# Indiana Dairy Site

- **Freestall barns - tunnel-ventilated**
- **472 m (1550 ft) long x 29 m (96 ft) wide**
- **Each freestall barn houses 1,600 cows**
- **Avg. weight 635 kg (1400 lbs)**
- **Cows milked in mechanically ventilated milking center**
- **Feed: 50% forage (1/2 corn and 1/2 hay) and 50% grains (corn, soybeans, cottonseed, etc).  
Delivered by feed wagon**

# Facility Layout



# Freestall Dairy Barns



# IN Dairy Site





**Freestall  
Barn**

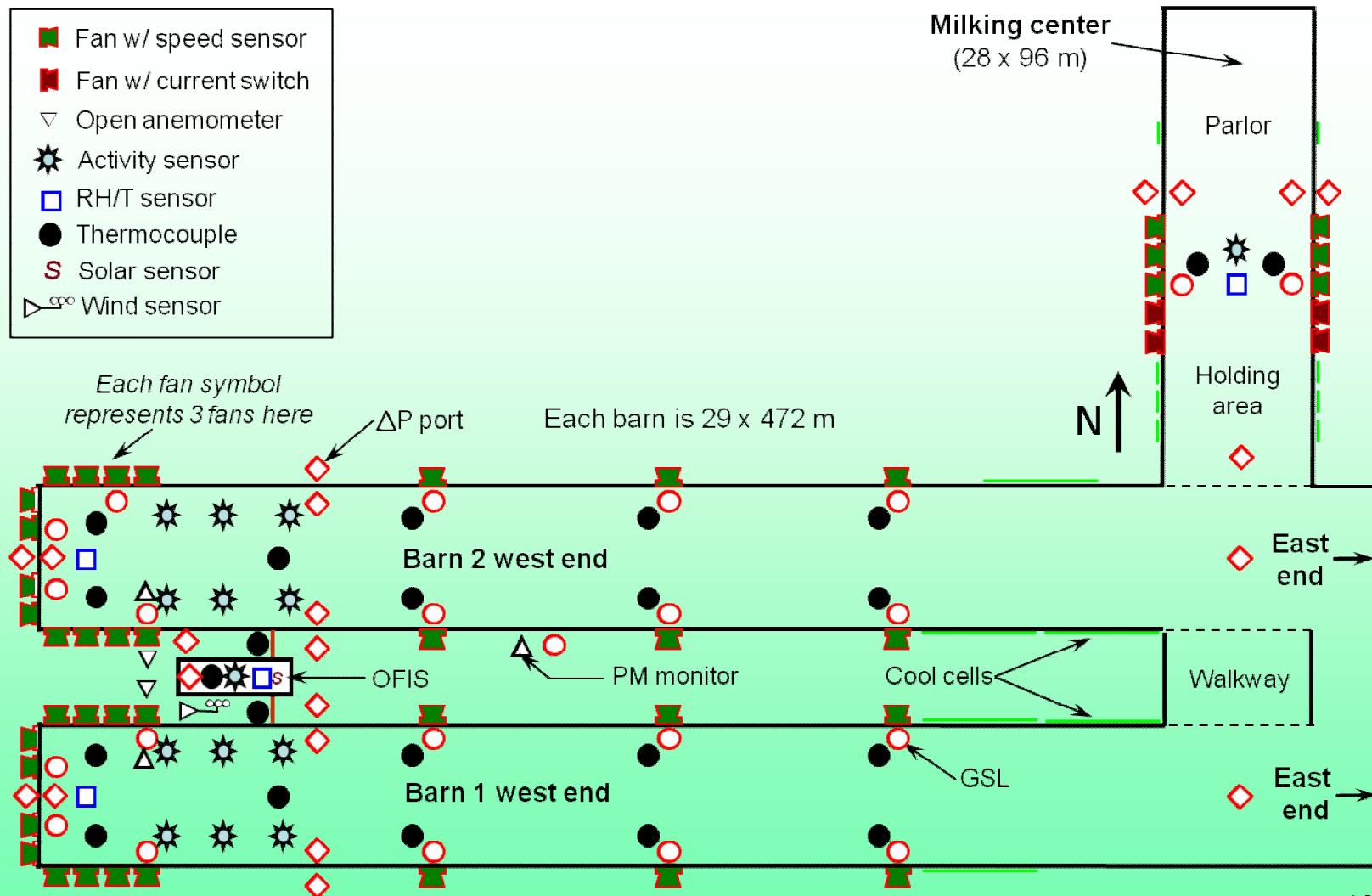
**Side  
Aisle**



# Milking Parlor



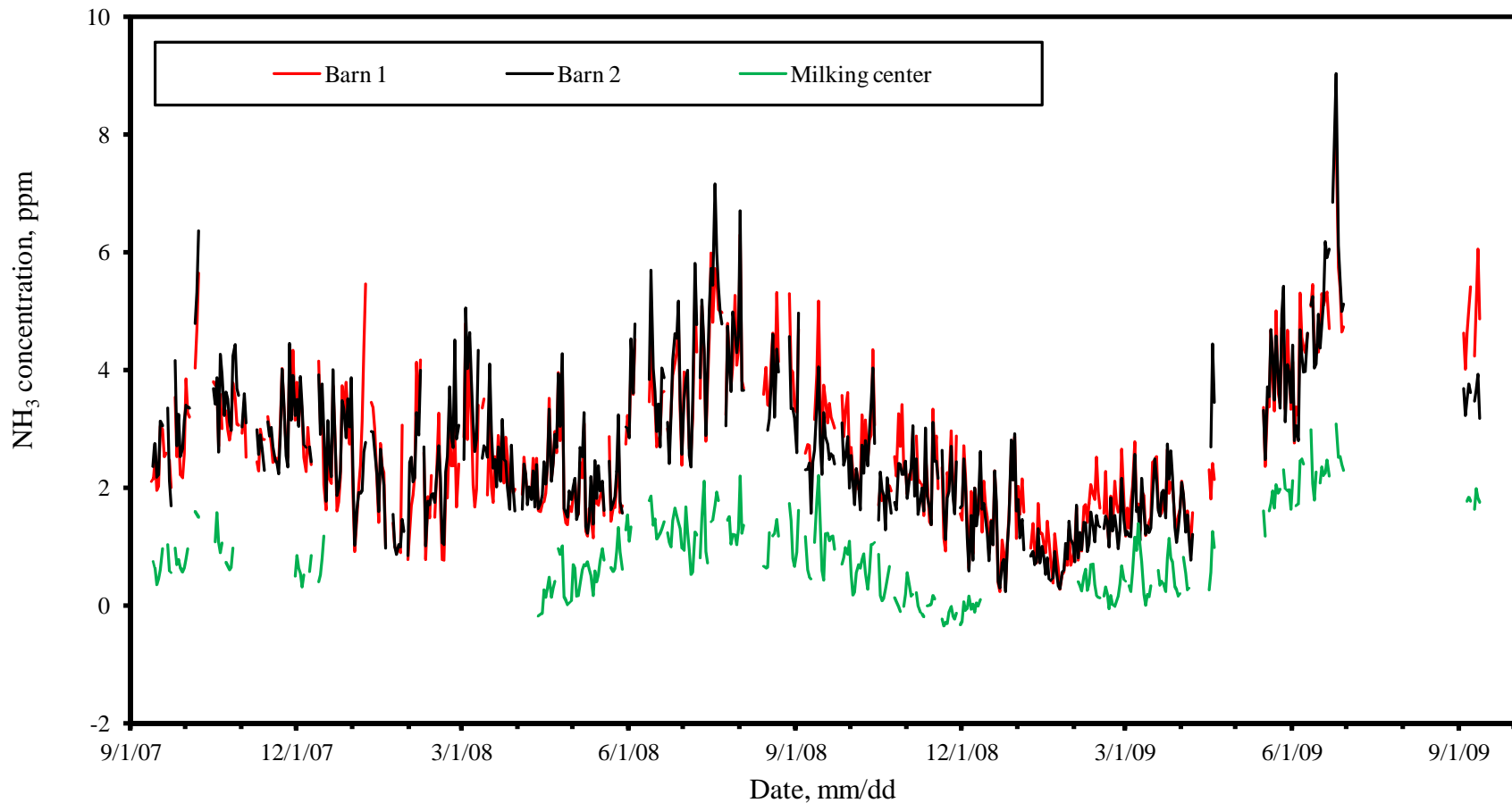
# Monitoring Plan



# Gas Measurements

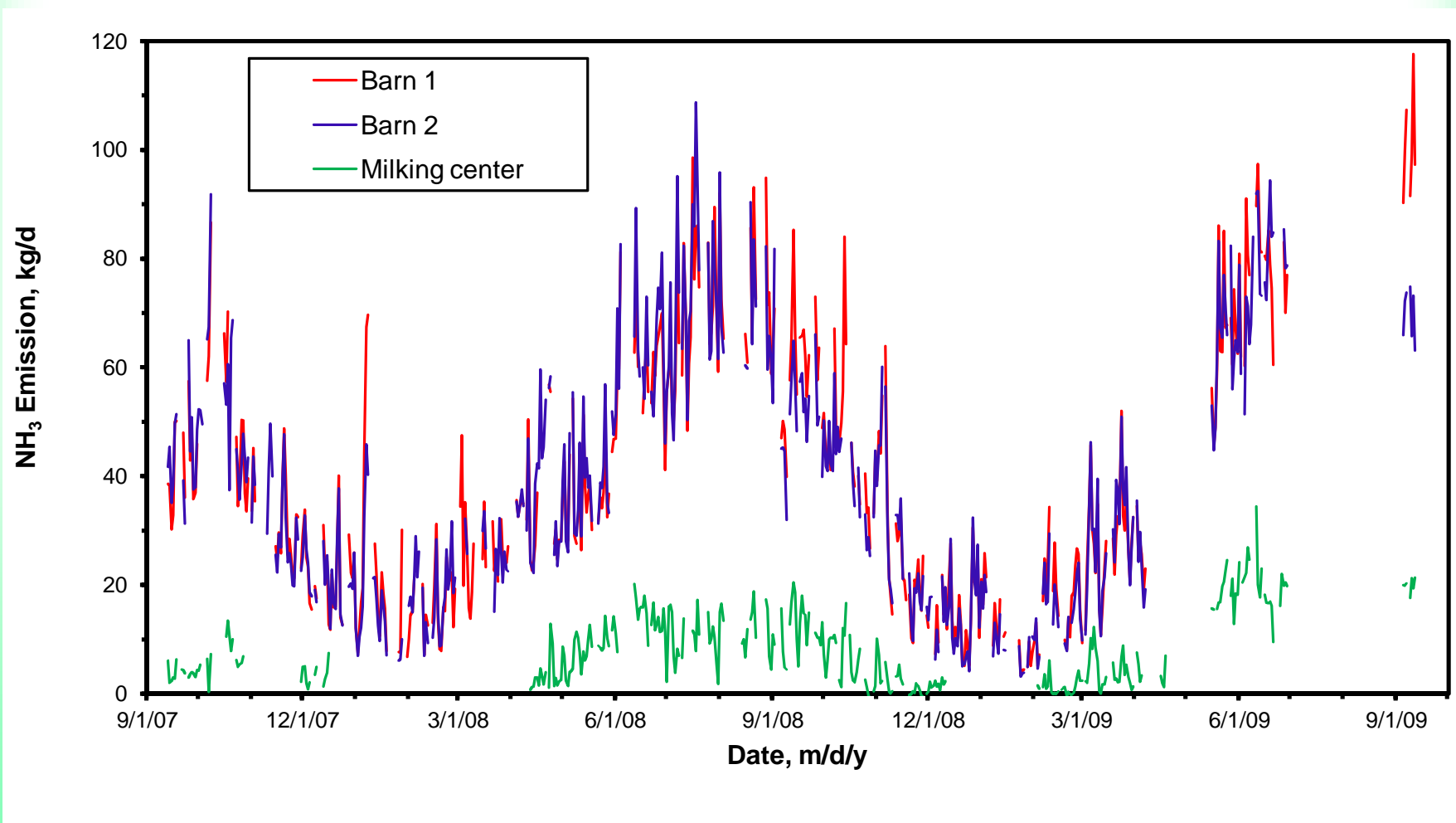
- One set of analyzers sequenced through all the Gas Sampling Locations (GSL).
- Gas analyzers: photoacoustic IR CO<sub>2</sub> analyzer, fluorescence-based H<sub>2</sub>S analyzer, chemiluminescence NH<sub>3</sub> monitor.
- Photoacoustic IR multi-gas monitor for CH<sub>4</sub>, with ethanol, methanol, acetic acid, and total VOC filters.
- Each GSL was sampled individually with one tube.

# Daily Ammonia Concentrations



The ADM ( $\pm$ SD) concentration was  $2.7 \pm 1.2$ ,  $2.7 \pm 1.3$  and  $0.1 \pm 0.3$  ppm for B1, B2 and MC, respectively.

# Daily Ammonia Emissions



The ADM ( $\pm$ SD)  $\text{NH}_3$  emission rates from B1, B2 and MC were  $39.1 \pm 23.9$ ,  $38.6 \pm 22.8$  and  $8.2 \pm 6.7$  kg d<sup>-1</sup>, respectively.

# **Reporting Requirements from Farm Animal Waste**

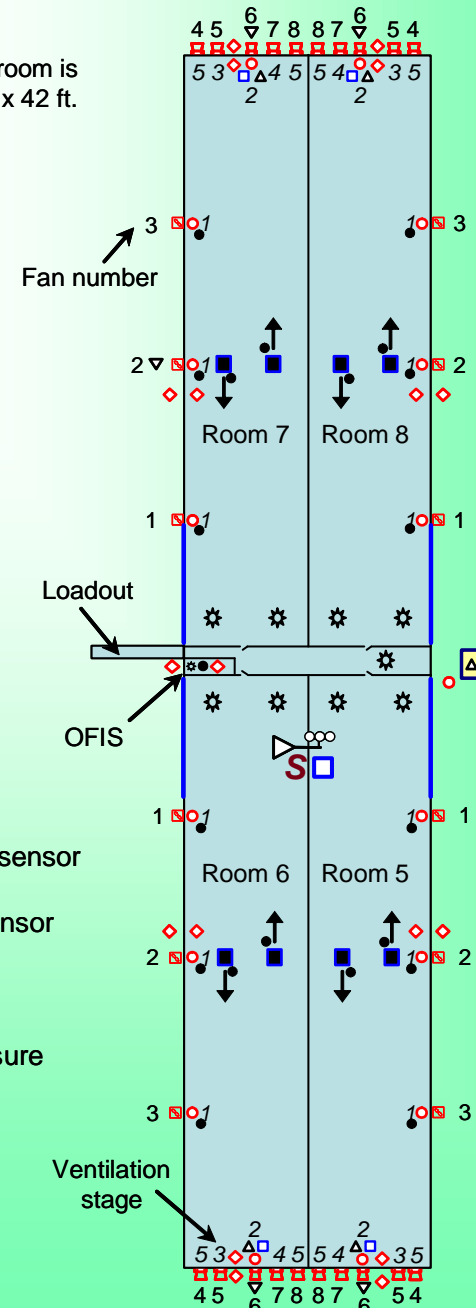
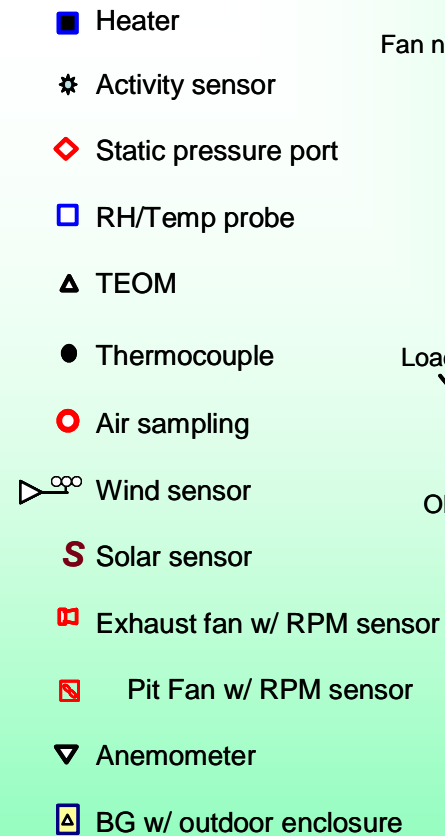
- **EPA requires only large animal feeding operations to report certain types of emissions, as directed by the Emergency Planning and Community Right-to-Know Act (EPCRA).**
- **Fact sheet also provided some websites/tools to estimate the emissions.**
- **Factors are based on literature review, which is inconsistent in ways of measuring and geographical locations.**
- **Releases of ammonia greater than 100 pounds in a 24-hour period.**

# **Freestall Dairy Ammonia Emissions**

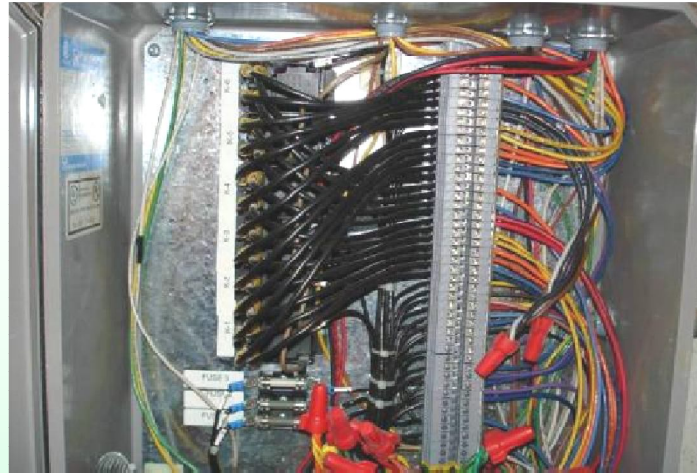
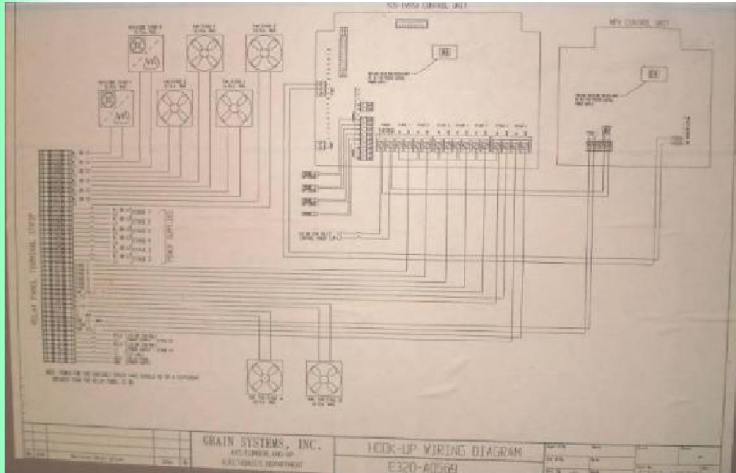
- The cow-specific  $\text{NH}_3$  emission rates from B1 and B2 were  $46.9 \pm 28.4$  and  $44.7 \pm 26.4$  g d<sup>-1</sup> cow<sup>-1</sup>, respectively.
- The number of dairy cows to release an average of 100 lb of ammonia per day would be 991, 1235 and 1263, based on data from the freestall barns in Indiana, New York and Wisconsin, respectively.
- The average number to exceed the emission threshold was 1,163 cows.
- The ammonia emission from dairy lagoons is not included in these numbers.

# IN Swine Site

- Monitor 4, 1000-head deep pit finishing rooms
- Add on project of biofilter effectiveness study

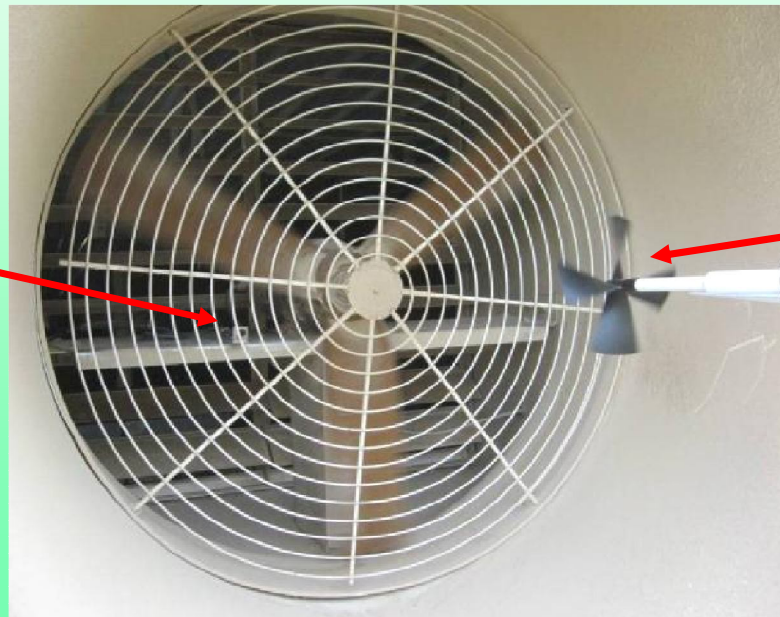


# Monitoring of Fan Operation



Monitor fan stage  
using dry relay  
contact or current  
switch

RPM sensor



Impeller  
anemometer

# Field Measurement of Airflow



**FANS: Portable fan airflow rate measurement unit**

# Barn Static Pressure Monitoring



Bank of static  
pressure sensor



Static pressure  
tubing, and  
snubber to prevent  
water/ice clogging

# Weather Station Installation

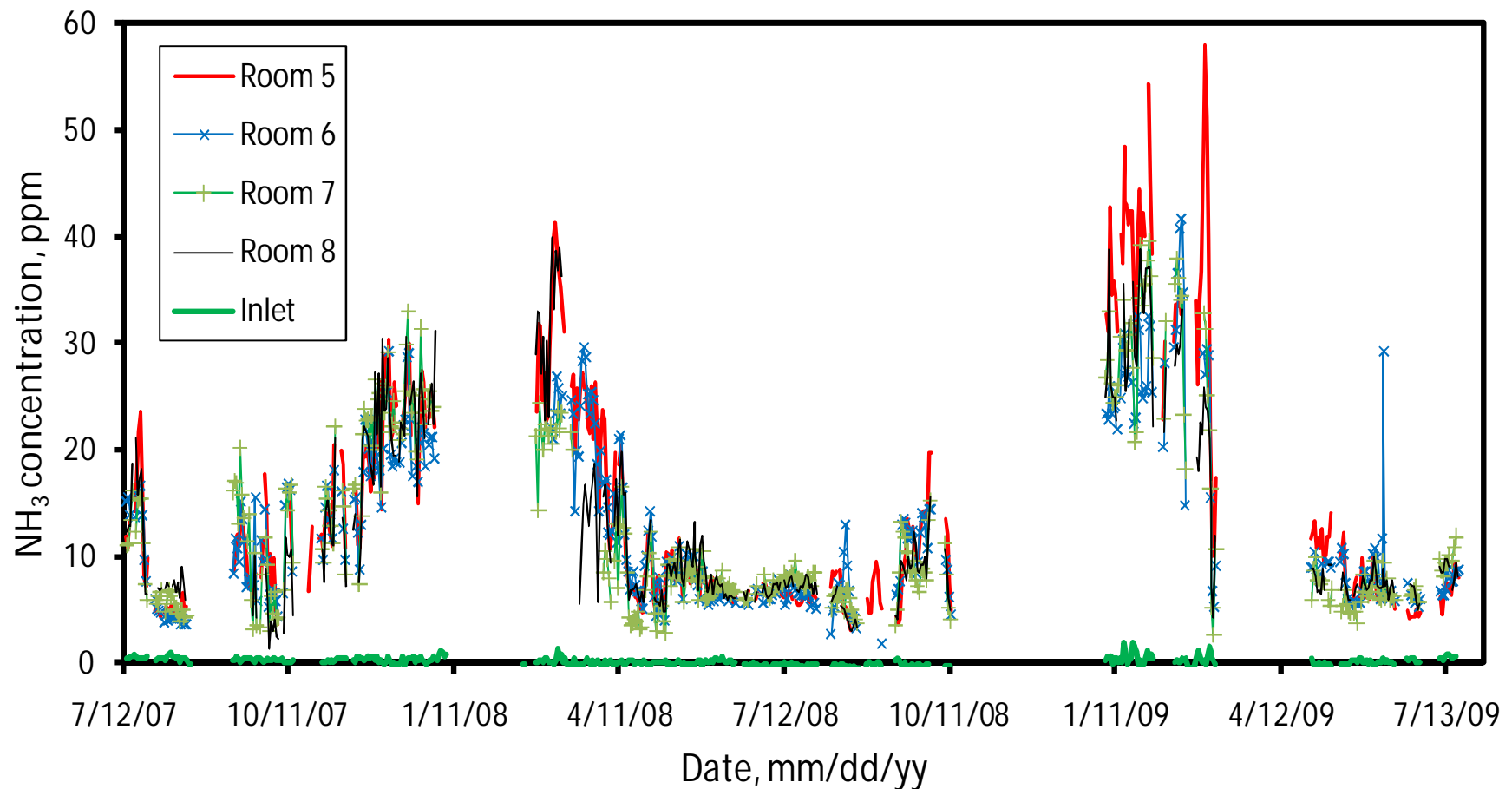


Rooftop weather  
station

Crank-up weather  
tower

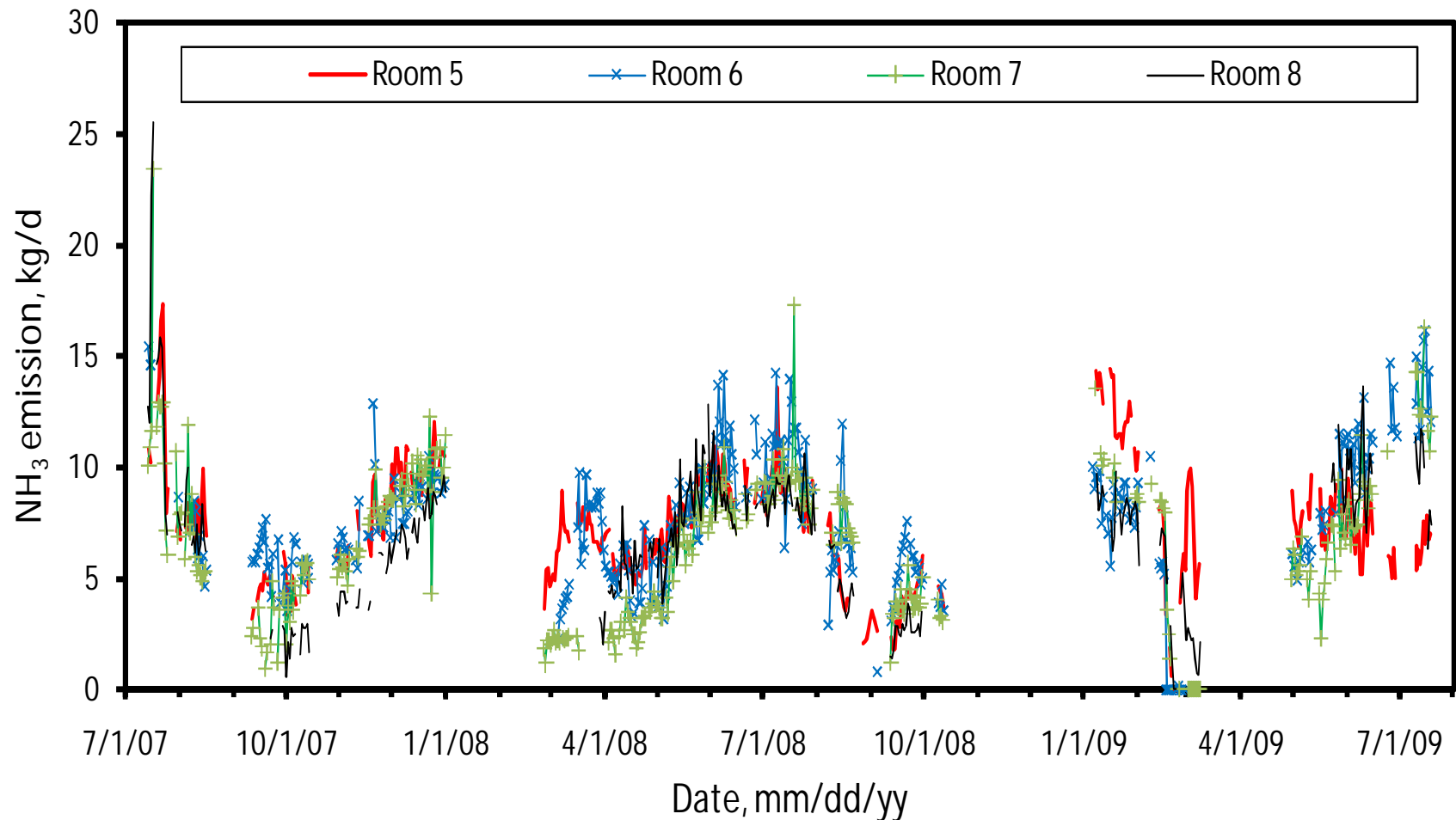


# Daily Ammonia Concentrations



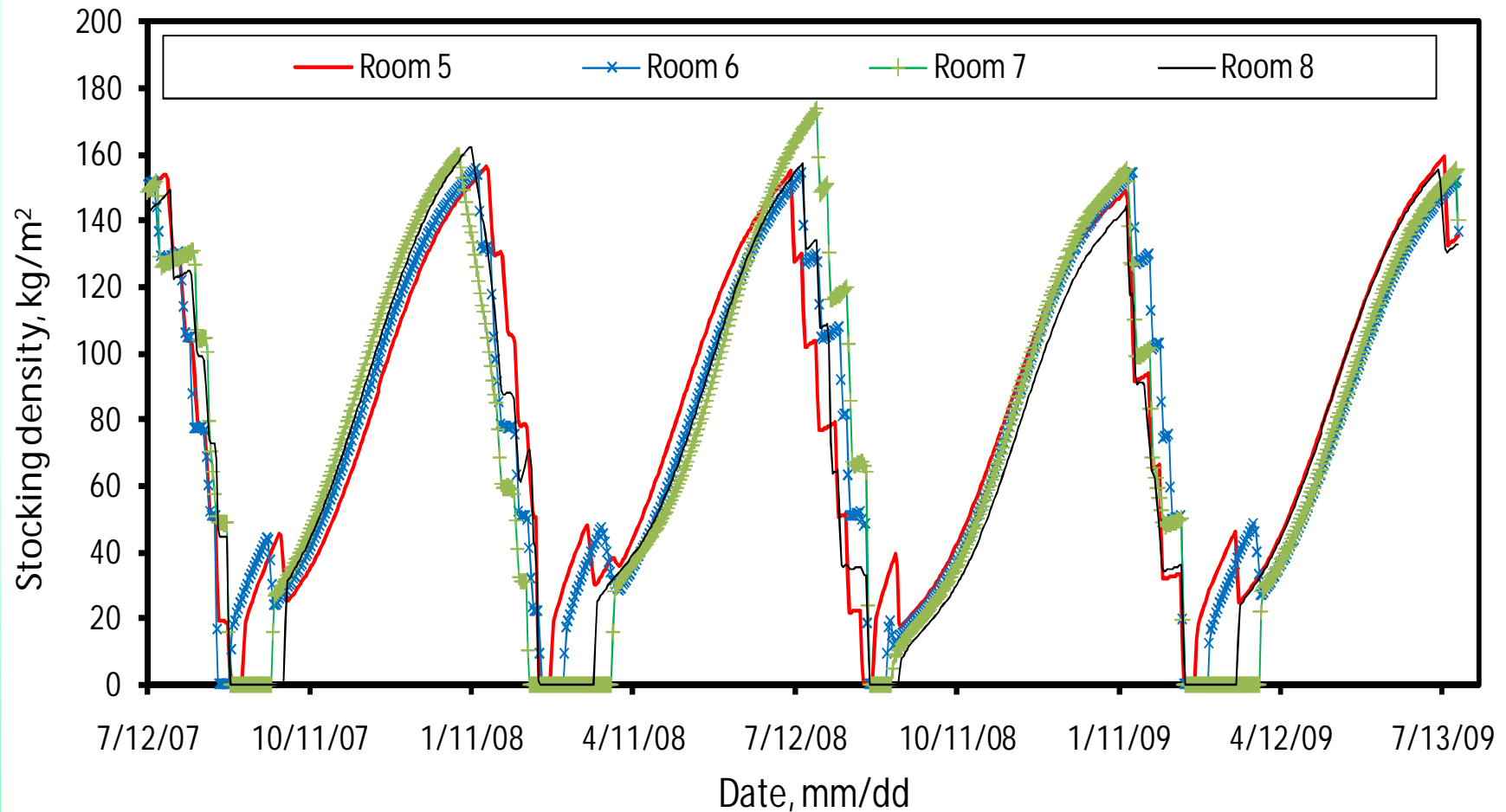
The ADM ( $\pm$ SD) concentration was  $14.6 \pm 11.0$ ,  $12.7 \pm 7.9$ ,  $12.8 \pm 8.8$  and  $13.2 \pm 9.1$  ppm for rooms 5 to 8, respectively.

# Daily Ammonia Emissions



The ADM  $\text{NH}_3$  emission rates from rooms 5-8 were  $7.4 \pm 2.7$ ,  $7.7 \pm 3.0$ ,  $6.6 \pm 3.3$ , and  $6.2 \pm 3.6$  kg d<sup>-1</sup>, respectively.

# Stocking Density vs. Emissions

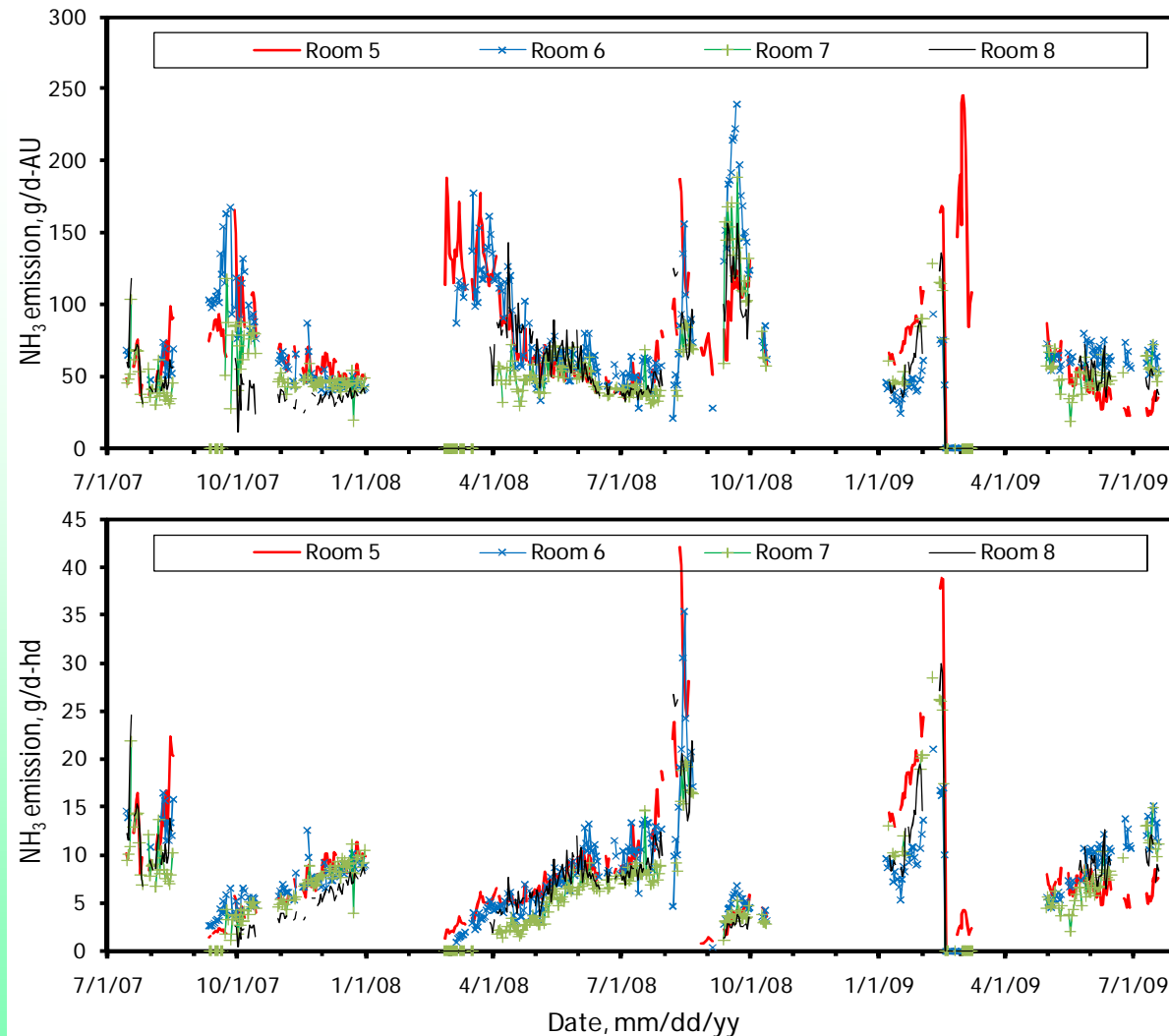


The monitoring spanned five growth cycles, occupancies averaged 1066, 1039, 825, and 804 hogs in rooms 5 to 8, respectively.

# Swine Finisher Ammonia Emissions

- The pig-specific  $\text{NH}_3$  emission rates from rooms 5-8 were  $8.4 \pm 6.5$ ,  $8.2 \pm 4.4$ ,  $7.4 \pm 4.4$ , and  $8.4 \pm 5.2$  g d<sup>-1</sup> pig<sup>-1</sup>, respectively.
- These values are only 42% to 47% of the 6.4 kg  $\text{NH}_3$  hd<sup>-1</sup> yr<sup>-1</sup> for finishing pigs based on reviews of five European, one North Carolina reports, and one waste design handbook recommended by Battye et al. (2003).
- However, the IN finisher emission rates were within 30% of the U.S. EPA (2005) emission factor of 3.4 kg  $\text{NH}_3$  hd<sup>-1</sup> yr<sup>-1</sup> for swine housed in facilities with deep pits.

# Swine Finisher Ammonia Emissions



The average results for AU-specific NH<sub>3</sub> emissions were 75.2, 73.1, 51.3, and 50.7 g AU<sup>-1</sup> d<sup>-1</sup>, for rooms 5-8, respectively.

# Numbers of Animals Exceeding Reportable Quantities

## NC Swine Finisher

	Barn 1	Barn 2	Barn 3	
Emission, g d <sup>-1</sup> hd <sup>-1</sup>	8.1±5.3	8.0±3.8	8.4±3.8	
N to exceed limit, hd	5606	5679	5414	

## IN Swine Finisher

	Room 5	Room 6	Room 7	Room 8
Emission, g d <sup>-1</sup> hd <sup>-1</sup>	8.3±6.5	8.0±4.5	6.7±4.7	7.2±5.6
N to exceed limit, hd	5460	5678	6817	6289

The average animal numbers exceeding 100 lbs ammonia per day were 5814 head based on these numbers.