

Center for Agricultural Air Quality Engineering and Science

Texas A&M University

College Station, Texas

Analysis of Sampling Protocols for the EPA Animal Feeding Operations Consent Agreement

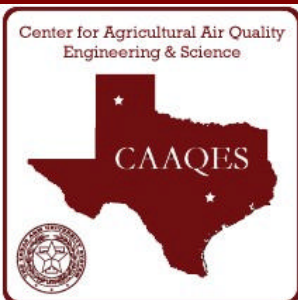
William B. Faulkner

Bryan W. Shaw

Ronald E. Lacey

**Center for Agricultural Air Quality
Engineering and Science**

**Biological and Agricultural Engineering Department
Texas A&M University
College Station, Texas**



Consent Agreement

- Two-year, nationwide air emission monitoring study
- Determine compliance of AFOs with the CAA, CERCLA, and EPCRA
- Determine emission rates of specified air pollutants from AFOs



Consent Agreement

Animal	Facility	Pollutants to be Monitored
Swine	Mechanically Ventilated Barns	NH ₃ , H ₂ S, CO ₂ , TSP, PM _{2.5} , PM ₁₀ , VOC
	Lagoons	NH ₃ , H ₂ S, VOC
Laying Hens	Mechanically Ventilated Barns	NH ₃ , H ₂ S, CO ₂ , TSP, PM _{2.5} , PM ₁₀ , VOC
Meat Birds	Mechanically Ventilated Barns	NH ₃ , H ₂ S, CO ₂ , TSP, PM _{2.5} , PM ₁₀ , VOC
	Open Manure Piles	NH ₃ , H ₂ S
Dairy	Naturally Ventilated Buildings	NH ₃ , H ₂ S, CO ₂ , TSP, PM _{2.5} , PM ₁₀ , VOC
	Manure Storage Systems	NH ₃ , H ₂ S, VOC
	Mechanically Ventilated Buildings	NH ₃ , H ₂ S, CO ₂ , TSP, PM _{2.5} , PM ₁₀ , VOC



Ammonia Emissions

Mechanically Ventilated Swine, Poultry, and Dairy Barns

- Chemiluminescence
- Photoacoustic Infrared
- Airflow

Manure Storage and Naturally Ventilated Dairy Barns

- FTIR
- UV-DOAS
- Gaussian Modeling
- BLS modeling



Chemiluminescence

Method:

- Oxidizes ammonia to form excited NO_2
- Measures radiation emitted during reduction

Pros:

- Sensitivity range from 1 ppb to 500 ppm
- Precision of ± 3 ppb

Cons:

- Requires frequent and careful calibration
- Does not usually achieve 100% conversion
- Other chemicals are also converted to NO_2
- Cannot measure adsorbed ammonia



Photoacoustic Infrared

Method:

- Measures absorption of infrared radiation

Pros:

- Selectivity and sensitivity can be enhanced
- Detection range down to 20 ppb
- Effects of temperature and pressure are known

Cons:

- Require frequent and careful calibration
- Sensitivity is not isolated to ammonia
- Cannot measure adsorbed ammonia



Airflow

Method:

- Fan Assessment Numeration System (FANS)
- Continuously measure static pressure and fan operational status

Pros:

- Yields in situ airflow measurements
- Accounts for changes in performance with static pressure and use

Cons:

- Static pressure can vary across a building
- Cannot perform FANS test in an occupied building
- Time consuming



FTIR

Method:

- Measures absorption peaks of infrared light
- Interprets peaks using Fourier Transformations

Pros:

- Isolates species of interest
- Detection limit of 1.5 ppb

Cons:

- Requires frequent and careful re-calibration
- Requires costly standard gas mixtures
- Requires an experienced operator to yield good results



UV-DOAS

Method:

- Measures absorption peaks of UV light
- Compares sampled spectra with a calibrated database of calibrated absorption spectra

Pros:

- Corrections for interfering gases are available

Cons:

- Limited effective measurement distance
- Mixed review of data quality



Modeling

Gaussian Modeling

- Used by the USEPA for regulatory purposes
- Assumes normal distribution of pollutants
- Accuracy has long been debated

Lagrangian Stochastic Modeling

- Attempts to determine particle trajectories
- Requires fewer sampled data points

“Cross-model” Issue

When emission factors from WindTrax (bLS model) are used in ISCST3 (a Gaussian model), the modeled concentrations are approximately 10 times the measured concentrations (Price et al, 2004)



PM Emissions

Mechanically Ventilated Swine and Poultry Facilities

- TSP – Isokinetic Multipoint Gravimetric Samplers
- PM₁₀ – TEOMs with PM₁₀ pre-collectors
- PM_{2.5} – FRM PM_{2.5} Sampler (for at least one month)

Dairy Facilities

- Little specific protocol
- “particle samplers located with a sampling height of 5m”



TSP Emissions

Sampling

- Isokinetic multipoint gravimetric samplers
- No detail is given on the filter media to be used

Analysis

- No detail is given



PM₁₀ Emissions

Method:

- TEOMs with PM₁₀ pre-collectors

Pros:

- USEPA equivalent method
- Continuous monitoring

Cons:

- Uncertainties with airflow measurements
- Significant differences between TEOM and gravimetric sampling concentration data
- Over sampling bias of PM₁₀ pre-collectors in agricultural environments



PM_{2.5} Emissions

Method:

- Gravimetric FRM sampler
- Monitored for at least one month per site

Pros:

- Insufficient details are available

Cons:

- Over sampling bias of PM_{2.5} pre-collectors in agricultural environments
- Limited sampling times will not allow for measurement of temporal variations



Conclusions

- Amendments should be made to the Consent Agreement's sampling protocol to address deficiencies in the current plan and quantify uncertainties associated with measured and calculated values.
- Data and emission factors derived from sampling under the Consent Agreement should be used cautiously and applied only with an understanding of the limitations of the sampling protocol.

